UNIVERSITY OF KWAZULU-NATAL ™

INYUVESI YAKWAZULU-NATALI

The association of organizational contextual factors and HIV-Tuberculosis service integration following exposure to quality improvement interventions in primary healthcare clinics in rural KwaZulu-Natal

by

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STUDENT NUMBER: 204507742

24 August 2021

Submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy (Public Health) by publication in the
School of Nursing and Public Health

Declaration by Supervisor and Co-supervisor

Declaration by supervisor

As the candidate's supervisor I, Dr. Marian Loveday, agreed to the submission of this thesis.

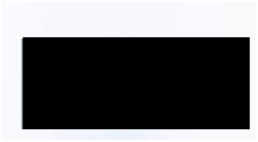
Date: 24 August 2021

Signed: 

Declaration by co-supervisor

As the candidate's co-supervisor I, Prof Myra Taylor, agreed to the submission of this thesis.

Date: 24 August 2021

Signed: 

Declaration by PhD Candidate

I, **Santhanalakshmi Gengiah,** declare that:

(i) The research reported in this dissertation, except where otherwise indicated, is my original work.

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Dedication

To my mother Sally Gengiah, father Narayansamy Gengiah and my sister Tanuja Gengiah, for their steadfast support, encouragement, and belief in me. Without them, nothing would be possible…

Acknowledgements

My PhD journey was a long and winding path to the finish. I would not have accomplished this work without the support and guidance of a 'village' of people. My sincerest gratitude to the following people, institutions and funders who contributed to and supported this work.

Colleagues, collaborators, and friends

My supervisors, Dr Marian Loveday and Prof. Myra Taylor, for their expert supervision, encouragement, and patience.

Prof. Kogieleum Naidoo, who generously provided the resources and support needed for the PhD project and for trusting me with this very important study.

Prof. Nesri Padayatchi, Dr Nonhlanhla Yende-Zuma, Prof. Andrew Nunn, and Prof. Pierre Barker for their scientific input, advice, and motivation.

Mrs Catherine Connolly and Mr Mesuli Mhlongo for their support and advice on the statistical analysis.

Mr Nhlaka Memela, Mr Jay Ramota and Mrs Regina Mlobeli for their tireless effort and dedication in the field and contributing to data collection, coordinating clinic visits and ensuring the timely submission of data for the study.

Mr Mduduzi Mbatha (TB Manager, King Cetshwayo District) and Mr Shane Naidoo (TB Manager, Ugu District) who supported and championed this study in the study districts.

Institutions

I acknowledge the following institutions for their support and contribution to the study:

- Mrs Maureen Tshabalala and Prof. Pierre Barker from the Institute for Healthcare Improvement who guided the study team in QI implementation.

- The District Management Team in the Ugu and King Cetshwayo Districts who facilitated access to clinics, participated in the study and tirelessly strive to improve healthcare services in the districts.

- The healthcare workers at the study clinics for welcoming the study team and sharing their ideas and best practices with us and each other.

- Dr Pria Subrayen, Mrs Lynn Footit, Mrs Dhirisha Naidoo, and Mrs Mabuyi Mnguni, from BroadReach Group for facilitating access to study clinics.

Funders

- The research reported in this thesis was supported by the South African Medical Research Council with funds received from the South African National Department of Health, and the United Kingdom (UK) Medical Research Council, with funds received from the UK government's Newton Fund. This UK funded award is part of the EDCTP2 programme supported by the European Union.

- The PhD candidate is a University of KwaZulu-Natal (UKZN) Developing Research Innovation, Localisation and Leadership in South Africa (DRILL) fellow. DRILL is a NIH D43 grant (D43TW010131) awarded to UKZN in 2015 to support a research training and induction programme for early career academics. The content is solely the responsibility of the author and does not necessarily represent the official views of DRILL and the National Institutes of Health.

- The UKZN College of Health Sciences PhD scholarship for funding research expenses that arose during the PhD project.

Family and friends

Dr Navisha Dookie, Mrs Taruna Chetty and Mrs Cheryl Pillay for their encouragement, motivation, and friendship as I undertook this journey.

Finally, my mother Sally Gengiah and my sister Tanuja Gengiah, for their advice, patience, understanding and giving me the space and time that I needed for the PhD work.

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Acronyms and abbreviations

3HP	A weekly dose of Rifapentine and Isoniazid for three months to prevent TB infection
AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral Treatment
BMC	BioMed Central
BMGF	Bill and Melinda Gates Foundation
BREC	Biomedical Research Ethics Committee
BTSC	Breakthrough Series Collaborative Approach
CAPRISA	Centre for the AIDS Programme of Research in South Africa
CFIR	Consolidated Framework for Implementation Research
CI	Confidence Interval
COACH	Context Assessment for Community Health
CPT	Clinic Profile Tool
DMT	District Management Teams
DoH	Department of Health
EBP	Evidence-based Practice
FGD	Focus Group Discussions
HAST	HIV/AIDS/STI/TB
HCW	Healthcare workers
HIV	Human Immunodeficiency Virus
HIV-TB	Refers to both HIV and TB diseases
HR	Hazard Ratio
HTS	HIV Testing Services
ICF	Intensified Case Finding
IHI	Institute for Healthcare Improvement
IPT	Isoniazid Preventive Therapy
IQR	Interquartile range
IS	Implementation Science
KCD	King Cetshwayo District
KZN	KwaZulu-Natal
LMICs	Low- and middle-income countries
MDI	Monitoring Data for Improvement
NGO	Non-Governmental Organizations

NHLS	National Health Laboratory Services
OCF	Organizational Contextual Factor
OM	Operations Manager
OR	Odds Ratio
PARIHS	Promoting Action in Research Implementation in Health Services
PDSA	Plan-Do-Study-Act
PHC	Primary Healthcare
PhD	Doctor of Philosophy
PLWH	People Living with HIV
PRISM	Practical, Robust Implementation and Sustainability Model
QA	Quality Assurance
QI	Quality Improvement
RE-AIM	Reach, Effectiveness, Adoption, Implementation and Maintenance
RR	Relative Risk
SA	South Africa
SA DOH	South African Department of Health
SAPiT	Starting Antiretroviral Therapy at Three Points in Tuberculosis
SD	Standard Deviation
SMART	Specific Measurable Achievable Relevant Timebound
SOC	Standard of Care
SUTHI	Scaling up TB HIV integration
TB	Tuberculosis
TIER	Three Integrated Electronic Register
TPT	TB Preventive Therapy
TST	Tuberculin Skin Test
USA	United States of America
UKZN	University of KwaZulu-Natal
UNAIDS	Joint United Nations Programme on HIV/AIDS
VL	Viral Load
vs	versus
WHO	World Health Organization
Xpert MTB/RIF	A rapid, molecular, cartridge-based test used for tuberculosis diagnostics that provides an immediate Rifampicin resistance result

List of PhD-related manuscripts

This thesis is based on three first-authored publications and one co-authored publication listed below. At the time of submitting the thesis, the PhD candidate had two first-authored manuscripts accepted and in press, and one first authored manuscript was under review with the journal. The manuscripts and publications are referred to in the thesis by their roman numeral.

FIRST-AUTHORED PHD-RELATED MANUSCRIPTS

Paper I: Gengiah S, Naidoo K, Mlobeli R, Tshabalala MF, Nunn AJ, Padayatchi N, et al. A Quality Improvement Intervention to Inform Scale-Up of Integrated HIV-TB Services: Lessons Learned From KwaZulu-Natal, South Africa. Glob Health Sci Pract. 2021;9(3):444-58.

Paper II: Gengiah S, Barker PM, Yende-Zuma N, Mbatha M, Naidoo S, Taylor M, et al. A cluster-randomized controlled trial to improve the quality of integrated HIV-tuberculosis services in primary health care clinics in South Africa. Journal of the International AIDS Society. 2021;24(9):e25803.

Paper III: Gengiah S, Connolly C, Yende-Zuma N, Barker PM, Nunn AJ, Padayatchi N, et al. Organizational contextual factors that predict success of a quality improvement collaborative approach to enhance integrated HIV-tuberculosis services: a sub-study of the Scaling up TB/HIV Integration trial. Implement Sci. 2021;16(1):88.

CO-AUTHORED PUBLICATIONS RELEVANT TO THE PHD PROJECT

Paper IV: Naidoo K, Gengiah S, Yende-Zuma N, Padayatchi N, Barker P, Nunn A, Subrayen, P, Abdool Karim, S. S. Addressing challenges in scaling up TB and HIV treatment integration in rural primary healthcare clinics in South Africa (SUTHI): a cluster randomized controlled trial protocol. Implement Sci. 2017;12(1):129.

Summary

A key strategy to reduce Tuberculosis (TB)-related mortality among people living with HIV is integrating HIV and TB diagnostic and treatment services. In South Africa, integrated HIV-TB service provision is standard of care, however, there is evidence that patients accessing primary healthcare clinics (PHC) are missed for HIV and TB testing and screening, diagnosis, linkage to treatment, and preventive services. Gaps in the HIV-TB care cascade are indicative of weaknesses in healthcare systems at the frontline. Quality Improvement (QI) collaboratives are a widely adopted approach to facilitating improvement among multiple clinics and scaling up best practices to improve on a given health topic. Little is known of the effectiveness of QI collaboratives and less is known of the role of organizational contextual factors (OCFs) in influencing the success of QI collaboratives to improve integrated HIV-TB services.

Scaling up TB/HIV Integration (SUTHI) was a cluster-randomised trial designed to test the effectiveness of a QI intervention to enhance integrated HIV-TB services on mortality in HIV, TB, and HIV-TB patients. The study was from 01 December 2016-31 December 2018. Sixteen nurse supervisors (clusters) overseeing 40 PHC clinics were randomized (1:1) to receive either a structured QI intervention (QI group), which comprised, clinical training, three QI workshops timed at 6-month intervals, and in-person mentorship visits; or standard of care (SOC group) supervision and support for HIV-TB service delivery. This PhD project was a nested sub-study embedded in the SUTHI trial which aimed to describe and assess the influence of OCFs on the QI intervention to improve process indicators of HIV-TB services.

A description of the QI intervention, including change ideas generated and lessons learned from practical application of the intervention in 20 QI clinics are presented in Paper I. Baseline performance of indicators was highlighted as important in influencing the size of improvements. OCFs that undermined the QI process were poor data quality, data capturing backlogs, lack of data analytic skills among clinic staff, poor transfer of training knowledge to peers, low clinic staff motivation to consistently track performance and limited involvement of the clinic management team in QI activities due to heavy workloads.

A comparison between the QI and SOC group clinics showed that the QI intervention was only effective in improving two of five HIV-TB indicators, HIV testing services (HTS) and

Isoniazid Preventive Therapy (IPT) initiation rates in new antiretroviral therapy patients. HTS was 19% higher (94.5% versus (vs) 79.6%; Relative Risk (RR)=1.19; 95% CI:1.02% - 1.38%; p=0.029) and IPT initiation was 66% higher (61.2% vs 36.8%; RR=1.66; 95% CI:1.02% -2.72%; p=0.044), in the QI group compared to the SOC group. Small clusters showed larger improvements in IPT initiation rates compared to big clusters, likely due to better coordination of efforts (Paper II). Several OCFs were quantitatively assessed and inserted into a linear mixed model to determine which factors likely influenced the improvement observed in the IPT initiation rates (Paper III). The practice of monitoring data for improvement was significantly associated with higher IPT initiation rates (Beta coefficient (β)=0.004; p=0.004). The main recommendations made from the PhD project are to encourage the practice of monitoring data for improvement among clinic teams; provision of widespread QI training for all levels of staff, different staff categories and leadership; to ensure good quality of routine data, and provision of regular performance feedback from upper management to the clinics.

Structure of the PhD Thesis

The PhD thesis was structured in accordance with the guidance provided by the College of Health Sciences, University of KwaZulu-Natal for the thesis by manuscript format. The PhD thesis comprises five chapters and appendices containing supporting documents. The chapters are divided as follows:

Chapter 1: Introduction
This chapter provides an overview of the spread and burden of the TB, HIV and HIV-TB epidemics globally and in South Africa. A review of evidence-based practices that have been shown to reduce HIV-TB mortality is presented followed by evidence of gaps in HIV-TB service delivery. Evidence for the effectiveness of quality improvement (QI) in improving HIV and TB services is presented. The chapter ends with a rationale for the PhD project and the primary aim and specific objectives of the project are given.

Chapter 2: Theoretical frameworks
This chapter presents the theoretical framework used to identify key organizational contextual factors that may influence QI implementation. The QI collaborative approach and frameworks that guided the QI implementation are described.

Chapter 3: Methods
This chapter explains the study design of the PhD project and the Scaling up TB/HIV integration (SUTHI) trial (parent study) within which the PhD project was embedded. The study setting, description of the QI intervention, QI and data collection tools, and schedule of study events are explained.

Chapter 4: First-authored PhD manuscripts
This chapter contains three manuscripts arising from the findings of the PhD work. The PhD candidate is the first author for each manuscript. The PhD candidate's contribution to each manuscript is summarized and a brief discussion of the manuscript is provided. Each manuscript is a stand-alone document, complete with its own methodology, statistical considerations, and references. Supplementary materials referenced in the manuscript can be found at the end of the manuscript itself. There is some unavoidable duplication of information between the manuscripts, and Chapters 2 and 3.

Chapter 5: Synthesis

This chapter provides an overarching discussion of the major findings of the PhD project. Organizational contextual factors that emerged in all three manuscripts and their roles in influencing improvement in HIV-TB processes are discussed. A set of recommendations to strengthen future QI interventions to improve HIV-TB services are provided.

References

A single reference list in the Vancouver format for references cited in chapters 1, 2, 3 and 5 is available. Reference lists for each PhD-related manuscript are available after the manuscript itself.

Appendices

The appendices section contains the one co-authored publication that adds more information about the parent study. Ethical approvals, the informed consent form, data collection tools and templates relevant to the PhD project can be found in this section.

CHAPTER 1: INTRODUCTION

1.1 Background and Literature Review

1.1.1 The burden of Tuberculosis and Human Immunodeficiency Virus globally and in South Africa

Globally, Tuberculosis (TB) has been the leading cause of death from an infectious disease since 2007.[1] In 2019, there were an estimated 10 million people who were infected with TB and of these 1.4 million have died.[2] People of all age groups and both sexes are affected by TB.[1] Figure 1, shows the countries that recorded at least 100 000 incident TB cases in 2019.[2] Most incident TB cases are found in South-East Asia (44%), followed by the African continent, which contributed to 25% of global TB infections (Figure 1).[2]

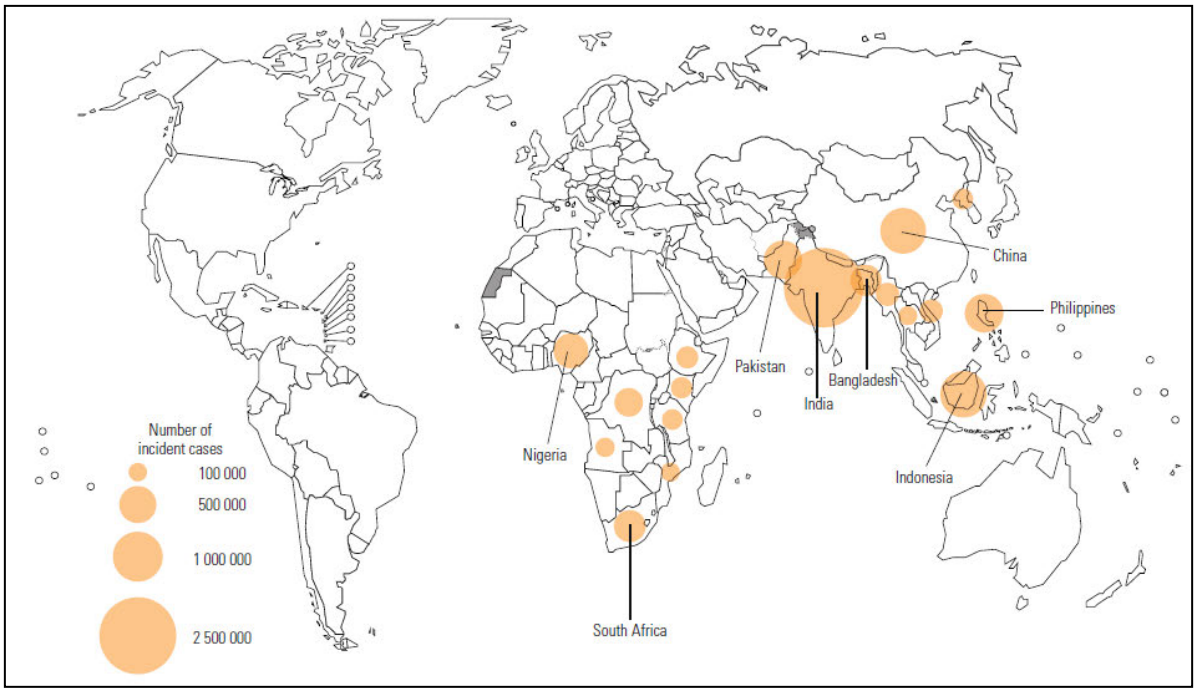

Figure 1: Countries with at least 100 000 incident TB cases in 2019[2]

Of the global TB cases, an estimated 8.6% were co-infected with Human Immunodeficiency Virus (HIV).[1] Africa has the largest population of people living with HIV (PLWH), estimated at 25.8 million (68%) out of a global total of 38 million.[3] The high HIV prevalence in Africa is largely responsible for driving the TB epidemic and created one of the largest populations of HIV-TB co-infected patients, estimated at 24%.[4]

There is an established epidemiological link between TB and HIV.[5] The risk of developing active TB disease after infection is higher among PLWH and other immunocompromised individuals.[6-8] PLWH are 26 times more likely to develop TB disease than HIV negative

people.[9] Figure 2 illustrates the HIV prevalence rates in new and relapse TB cases around the world and sub-Saharan Africa is worst affected by the HIV-TB co-epidemic. Deaths in HIV-TB co-infected patients are usually due to complications from TB disease or to impaired immunity from advancing Acquired Immune Deficiency Syndrome (AIDS).[10, 11] In 2019, there were 208 000 deaths recorded among HIV-TB co-infected patients worldwide and 169 000 (81.3%) were from Africa.[2]

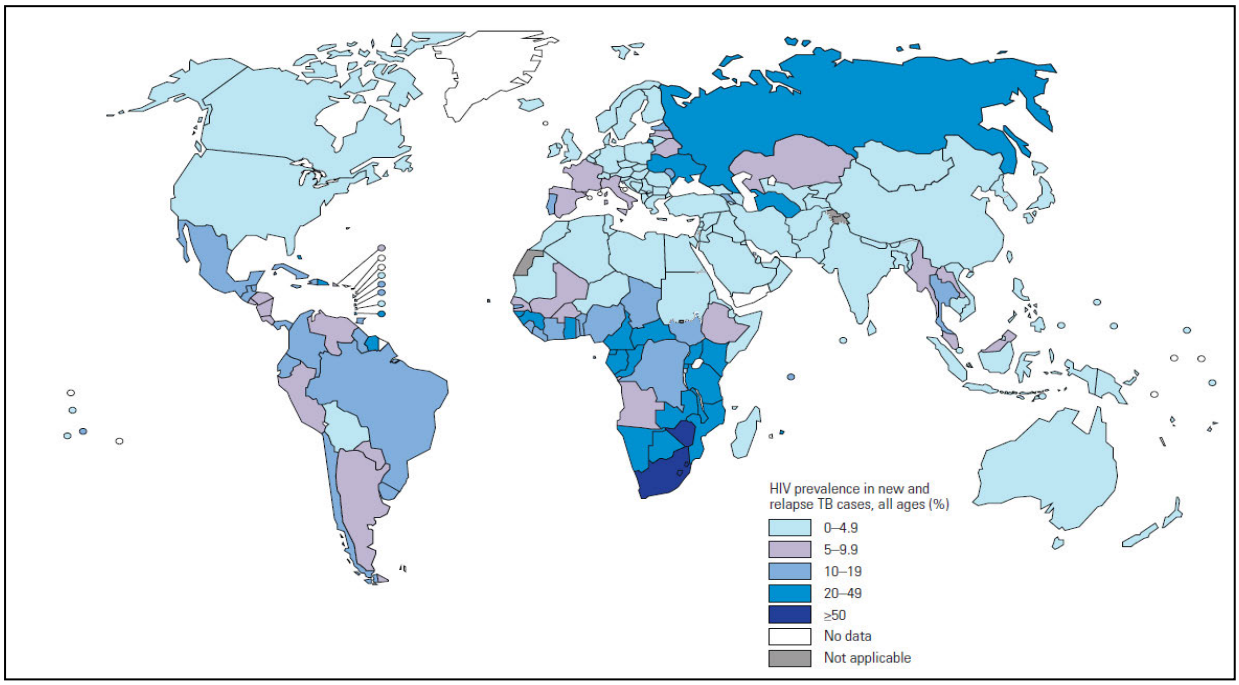

Figure 2:Estimated HIV prevalence in new and relapse TB cases in 2019 [2]

South Africa (SA) is among four sub-Saharan countries with a greater than 50% HIV prevalence rate in newly diagnosed TB patients (Figure 2).[2] High TB incidence rates have been a public health challenge in SA even before the emergence of the HIV epidemic.[12] Between 2012-2018, a decline in TB incidence rates was observed (Figure 3).[1, 2, 8, 9, 13-16] In 2019, SA recorded TB incidence rates of 615 per 100 000 people, an 18% increase from 2018.[2] Possible reasons for this increase may include: the use of updated TB incident estimates from the first ever National TB Prevalence Survey which were used to derive the TB incidence rates; intensified efforts to improve TB case finding using better tools; ongoing community transmission of TB due to failure to trace TB contacts; poor linkage to TB treatment; and the lack of unique patient identifiers in SA may have led to duplications in patient databases which inflated the TB numbers.[2, 17]

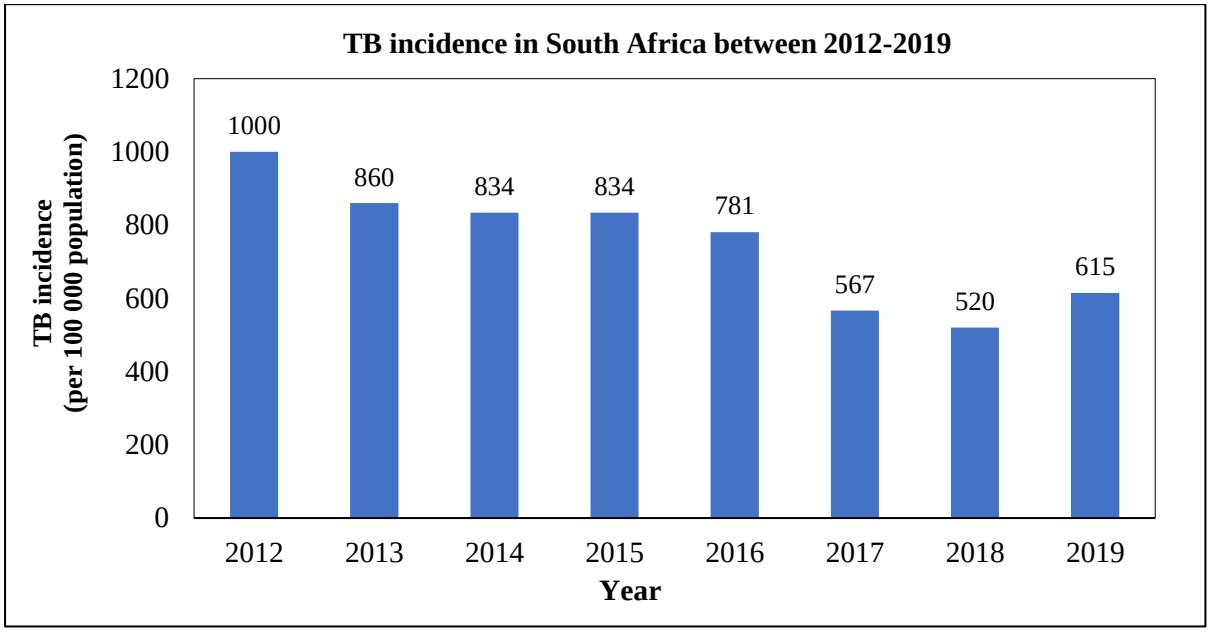

Figure 3: TB incidence in South Africa 2012 -2019 [1, 2, 8, 9, 13-16]

The high TB incidence rate, coupled with an estimated 7.5 million PLWH (12% HIV prevalence) in SA, have created one of the largest populations of HIV-TB co-infected patients in the world.[2, 18] Between 2012-2019, more than half of new TB cases were co-infected with HIV (Figure 4).

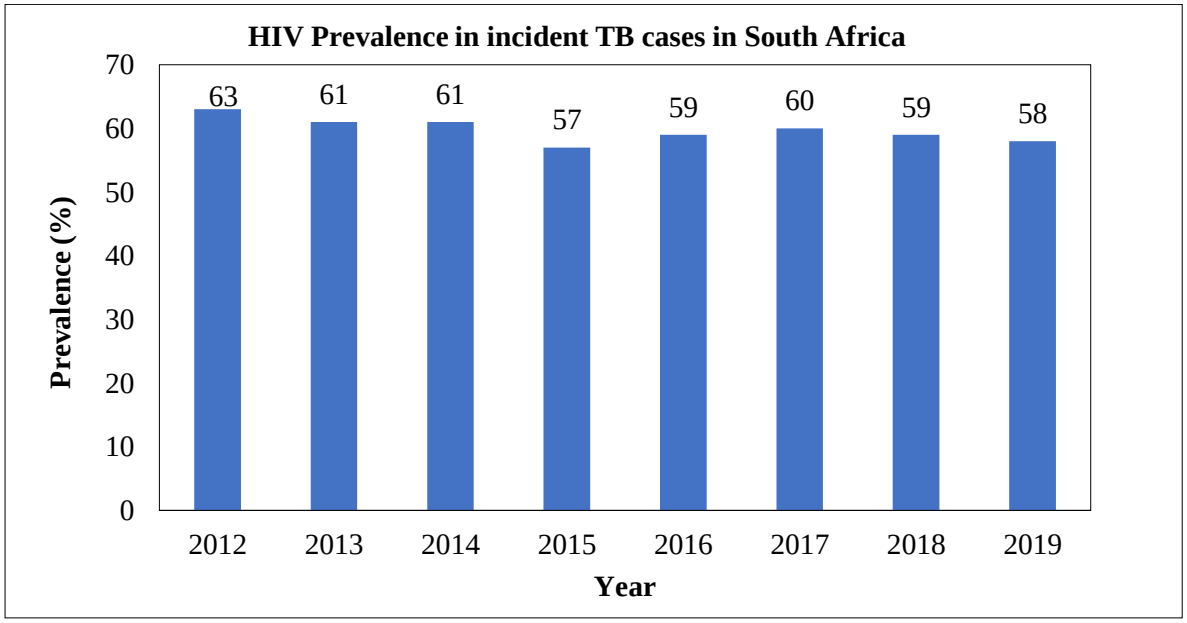

Figure 4: HIV positive prevalence in incident TB cases in South Africa [1, 2, 8, 9, 13-16]

In South Africa, between 2012-2019, mortality rates among HIV-TB co-infected patients were considerably and consistently higher than HIV negative TB patients (Figure 5). In 2016, the HIV-TB co-infected mortality rate was 4-fold higher than in HIV negative TB patients (Figure

5).[15] The gap in mortality rates began to close in 2017 and by 2019, HIV-TB mortality rates were 2-fold higher than in HIV negative TB patients , 62 (95% CI: 25-115) per 100 000 versus 38 (95% CI: 36-40) per 100 000.[2]

Further efforts are required to decrease HIV-TB mortality rates and to sustain this decrease, especially given that TB is a preventable and curable disease and major improvements in antiretroviral therapy (ART) for HIV makes it a manageable chronic disease.

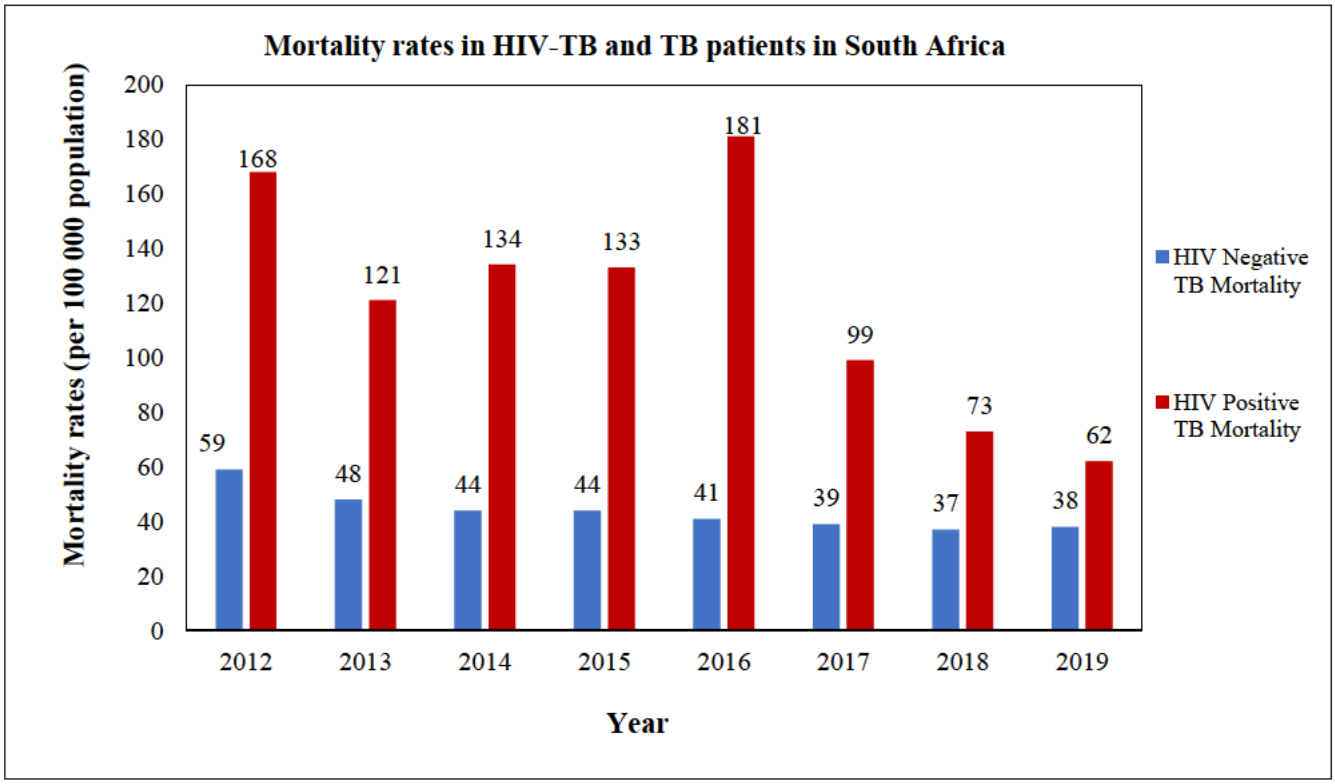

Figure 5: Mortality rates in HIV-TB and TB patients 2012 – 2019 in SA [1, 2, 8, 9, 13-16]

1.1.2 Global strategies to reduce the burden of HIV and TB

A worldwide coordinated plan to end TB and reduce TB-related mortality is proposed in the World Health Organization (WHO) End TB strategy document which was adopted in 2014.[19] The End TB strategy proposes an ambitious goal to reduce world-wide TB deaths by 95% and TB incidence by 90% (as compared to 2015) by the year 2035.[19] To accomplish this goal, the End TB Strategy rests on three pillars: (Pillar I) adopting a patient-centred and integrated approach to identifying, treating, and preventing TB; (Pillar II) adopting policies and supportive systems that ensure adequate resources, community support and political commitment to reducing the burden of TB; (Pillar III) promoting research and innovation in TB diagnostics, treatment and vaccine research and development.[19]

To address the HIV epidemic, the Joint United Nations Programme on HIV/AIDS (UNAIDS) developed a strategy document that proposes challenging targets for key HIV care and treatment services. [20] The UNAIDS 90-90-90 strategy challenged HIV programmes to achieve the following by 2020: [20]

- 90% of all people living with HIV must know their HIV status
- 90% of all people with diagnosed HIV infection must receive sustained antiretroviral therapy
- 90% of all people receiving antiretroviral therapy to have achieved viral suppression

In the June 2015, UNAIDS released 'FAST-TRACK' a strategy document that built on the 90-90-90 strategy and proposes a target increase to 95-95-95 (for the above mentioned services) to be achieved by the year 2030.[21]

Both the End TB strategy and UNAIDS targets serve to invigorate the global response to the HIV and TB epidemics. As a country with one of the highest HIV-TB rates in the world, SA's efforts to reducing TB-related morbidity and mortality in PLWH is an important contribution to achieving global targets. Given the problem of HIV-TB co-infection in SA, it is not possible to address one epidemic without considering the other. The End TB strategy document encourages integration between HIV and TB programmes but little is said of how to achieve this integration.[19]

The next section is a review of research that has been conducted to identify the best strategies for jointly addressing the HIV and TB co-epidemic and clinical interventions that have been shown to reduce mortality in HIV-TB coinfected patients, prevent TB in PLWH, and improve clinical outcomes of HIV-TB patients.

1.1.3 Definition and benefits of integrating HIV-TB services

In this section, the concept of 'integrated HIV-TB services' is explored followed by a review of evidence-based practices (EBPs) that together offer a potentially effective package of services to address both HIV and TB diseases. Gaps in the delivery of these EBPs are highlighted and the potential role of Quality Improvement (QI) methods to improve HIV-TB service integration is introduced. Lastly, the effectiveness of QI in improving HIV and TB services is described and the importance of focusing on organizational context to improve the success of QI interventions is explored.

1.1.3.1 Definition of integrated HIV-TB services

A systematic review of 133 TB and HIV studies from low- and middle-income countries (LMICs) synthesized knowledge on the most effective ways of offering integrated HIV and TB services in public health facilities.[22] The authors identified five distinct TB and HIV service delivery models, each with varying degrees of integration (Figure 6).[22] The models ranged from providing referrals between TB and HIV services (which is the least integrated model) to providing TB and HIV services at the same facility by the same healthcare worker (the most integrated model).[22] The advantage of separately located TB and HIV services that refer to each other is the reduced chances of HIV patients acquiring nosocomial transmission of TB and there is minimal effort and time required of healthcare workers (HCWs).[22] On the other hand this model is criticised for its loss to follow up rates between programmes, reliance on patients to seek continued care, and long diagnostic and treatment delays that increase the risk of poor health outcomes. [23]

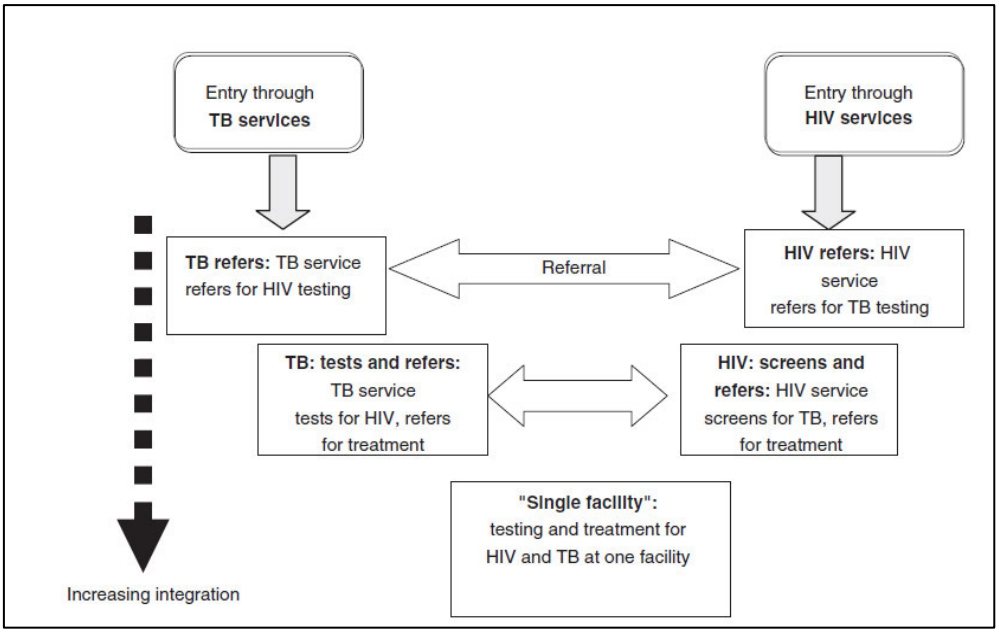

Figure 6: Models of HIV-TB integration [from Legido-Quigley et al. (2013), page 202] [22]

The 'single facility' model refers to all HIV and TB testing and treatment taking place in one facility.[22] A Zambian quasi-experimental pre-and post-intervention study, assessed the effects of offering HIV and TB services at the same facility on TB treatment outcomes and time to ART initiation. [23] The study compared 248 HIV-TB patients before the introduction of HIV-TB integrated services (pre-intervention) to 225 HIV-TB patients after the integration of HIV-TB services (post intervention).[23] Patients in the post intervention period were two-times more likely to have a successful TB treatment outcome [Odds Ratio (OR)=2.02 times (95%

Confidence Interval (CI): 1.11–3.67)] and 1.3 times [Hazard Ratio (HR) = 1.33, 95% CI: 1.00–1.77] more likely to start ART within 8 weeks of starting TB treatment compared to pre-intervention patients. [23]

The WHO's policy on collaborative TB/HIV activities, recommends the "single facility" model and the SA Department of Health (DOH) has adopted this recommendation.[24] This model is preferred for its cost-saving benefits to patients (reduces travel costs) and avoiding the need to refer patients to other facilities, thus reducing patient losses to care. [25] Importantly, a single facility model increases the risk of nosocomial spread of TB, however, the WHO recommends simple low-costs solutions to reduce the spread of infection including: identifying high risk areas where overcrowding is possible, early identification and treatment of TB, ensuring clinics are well ventilated, reducing patient waiting times, and surgical masks for all patients and healthcare workers. [26] For this PhD project, the term integrated HIV-TB services (also written as HIV-TB services) is defined as "A coordinated set of clinical activities to diagnose, treat, prevent and provide continuous care for both TB and HIV diseases at the same facility, by the same clinic team on the same visit day."

1.1.3.2 Survival benefit of integrated HIV-TB services

Two studies conducted in LMICs that evaluated survival and treatment outcomes, before and after the introduction of integrated HIV-TB services, showed that there is a survival benefit associated with single facility integrated HIV-TB services. [27, 28] A Guatemalan study conducted in one regional hospital compared outcomes of 99 patients prior to HIV-TB service integration to 155 patients enrolled after the introduction of HIV-TB service integration. HIV-TB co-infected patients treated after the introduction of integrated services had 78% lower risk of mortality than those in the pre-integration period, HR=0.22 (95% CI:0.14 – 0.33).[28]

Using a similar study design, a Ugandan study evaluated 14 rural health facilities. [27] In the period after the introduction of integrated HIV-TB services, the risk of mortality was 62% lower in HIV-TB coinfected patients compared to patients in the pre-integration period. [27] Both studies concluded that the early ART initiation and presence of both HIV and TB healthcare practitioners in the same clinic, contributed to the lower mortality rates.

1.1.4 Evidence-based practices to reduce mortality in HIV-TB co-infected patients

One of the elements in the definition of integrated HIV-TB services (section 1.3.1), is that a 'coordinated set of clinical activities' is at the core of HIV-TB services. This section describes the set of key clinical activities that are considered essential to integrated HIV-TB services.

The findings that early co-treatment of HIV and TB dramatically reduces mortality, elevated the importance of rapid and early identification of HIV and TB infection which is crucial for entry into the care continuum and subsequent linkage to treatment. [29, 30] Consequently, mass TB screening identified PLWH with no signs and symptoms of TB, presenting the opportunity to prevent TB and interrupt transmission. Isoniazid Preventive Therapy (IPT) became an important strategy in reducing TB-related mortality among PLWH.[4] In 2012, the WHO released the "Policy on Collaborative TB/HIV Activities", that outlined guidance for addressing the dual burden of HIV and TB and emphasized the three "I's" as key to reducing TB mortality in PLWH. These are: Intensified case finding (ICF) for TB, IPT, and infection control practices for TB.[25] This policy has been adopted and integrated into SA DoH HIV and TB treatment guidelines.[31]

In the Scaling up TB HIV Integration (SUTHI) trial, researchers conducted an extensive review of published literature and identified seven clinical HIV-TB services that could be integrated.[32] These seven HIV-TB services coupled with integrating HIV and TB electronic databases and patient files, formed a package of HIV-TB services in the SUTHI trial. The PhD project is nested in the SUTHI trial, and the package of HIV-TB services listed in Figure 7 are key to the PhD project. Each of the seven clinical HIV-TB integration services are described below.

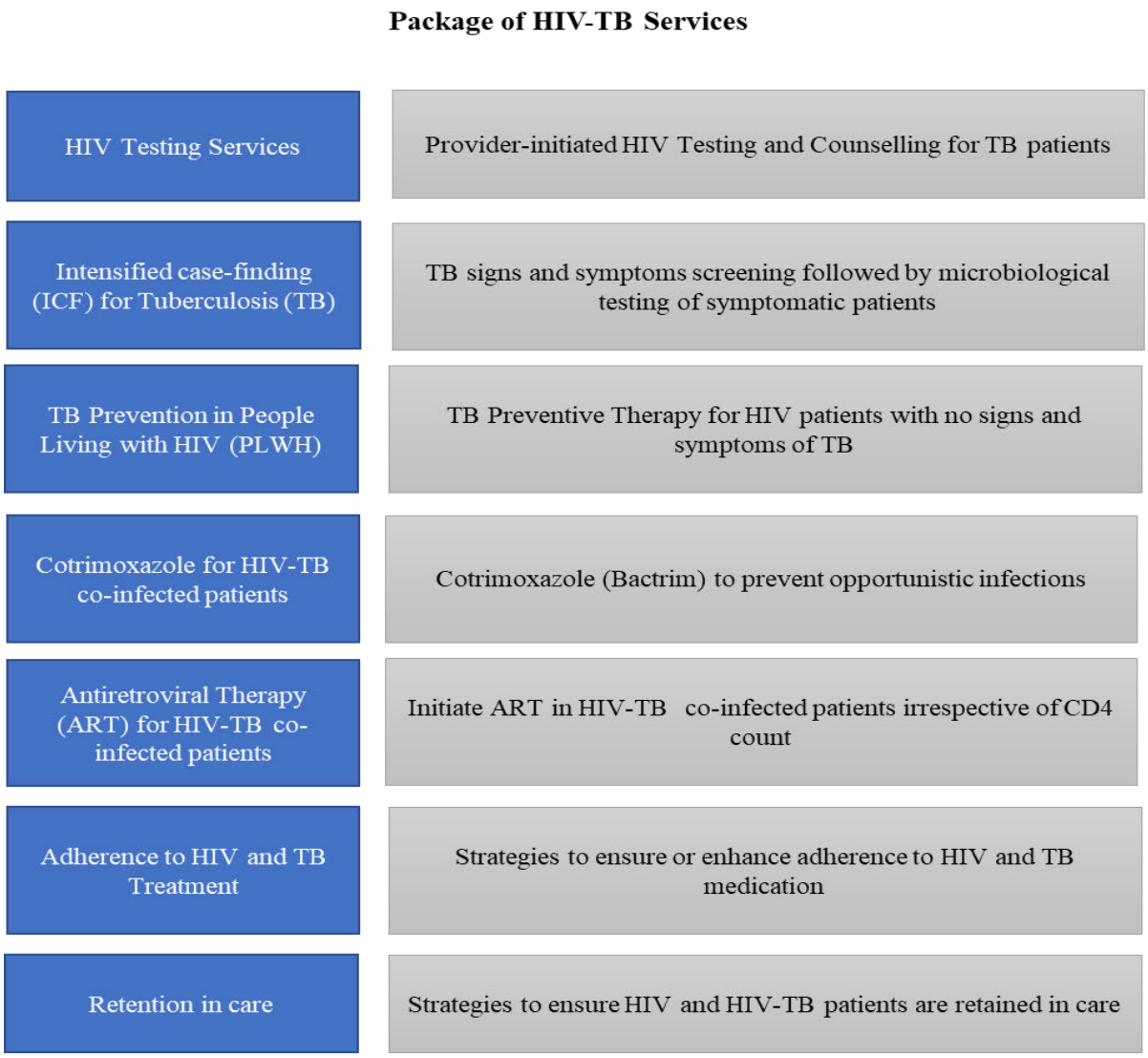

Figure 7: Package of integrated HIV-TB services

HIV Testing Services (HTS)

HIV Testing Services (HTS) is a widely recognised key entry point into the continuum of care, access to treatment and prevention services. [25, 33] It is important that TB patients and patients with presumptive TB are aware of their HIV status.[33] Dual infection with TB and HIV warrants early initiation of TB treatment and ART initiation within 2 weeks of starting TB treatment.[34] Evidence suggests that implementation of routine provider-initiated HIV testing and counselling at the primary health care clinics results in higher testing uptake compared to referral of patients with TB to freestanding voluntary counselling clinics and is feasible and acceptable to TB patients and TB suspects.[35] Several studies advocate for provider-initiated counselling and testing for HIV in patients with presumptive TB as this method has been highly successful in uncovering the highest number of HIV-infected patients in this most "at risk" group.[36-40] A systematic review of 44 studies which aimed to assess the operational issues

associated with provider-initiated counselling and testing in sub-Saharan Africa found that this strategy more than quadrupled the number of HIV cases uncovered in one South African study.[40] Fifty percent (50%) of patients in an Ethiopian study included in the review did not believe they were at risk for HIV, emphasizing the need for provider-initiated counselling and testing.[40]

Intensified case finding (ICF) for Tuberculosis

ICF for TB involves actively searching for signs and symptoms of TB by asking patients if they had the presence of common signs and symptoms of TB.[25] This is opposed to passive case finding which is reliant on patients self-reporting their symptoms.[41] According to the WHO guidelines, ICF is a continuous activity conducted at the time of initial presentation for HIV care and at every subsequent visit to a health facility.[25] The TB screening algorithm begins with a four-item signs and symptoms checklist consisting of: presence of cough, fever greater than two weeks duration, loss of weight greater than 1.5kg in a month and drenching night sweats.[25, 34] Patients presenting with any one of these signs and symptoms are investigated further for TB by taking a sputum sample for Xpert MTB/RIF which is a test for rapid diagnosis of TB.[25, 34]

Tuberculosis Preventive Therapy

TB is preventable and in HIV-infected patients, TB preventive therapy (TPT) decreases the chances of TB-infection by 30%.[42] In South Africa, a daily dose of Isoniazid for 6-9 months was the standard of care prior to March 2020.[43] New evidence of a shorter and equally effective TPT regimen, consisting of a weekly dose of Rifapentine and Isoniazid for three months (3HP) is currently being rolled out in South Africa which started on 24 March 2020.[43] During the PhD project, the only TPT available was IPT, therefore, going forward only IPT is discussed.

There are several clinical trials that have demonstrated the efficacy of IPT in preventing TB.[42, 44-48] A systematic review of 41 published IPT effectiveness studies, conducted in resource limited settings, demonstrated that IPT is effective in reducing TB morbidity in PLWH provided that the Tuberculin Skin Test (TST) was positive.[46] A meta-analysis of 10 IPT clinical trials from high burdened countries, synthesising existing evidence of the protective effects of IPT, concluded that there is an overall 35% TB risk reduction in PLWH however, a larger benefit of IPT was observed in patients with a positive TST, with a TB risk

reduction of 52%.[45] After reviewing three systematic reviews, a common finding emerging among studies was that IPT appears to have no significant impact on mortality reduction. [42, 45, 46] This finding contradicts the main outcome of the TEMPRANO trial. The TEMPRANO trial was an open-label randomized controlled trial of 2056 HIV-infected patients with a CD4 count less than < 800. [49] The study was in Ivory Coast and aimed to assess the efficacy of early antiretroviral therapy (ART) and the combined benefit of early ART with IPT.[49] Patients randomized to receive early ART and six months of IPT had a 44% lower risk of severe HIV-related illness and 35% lower risk of death than those patients who were randomized to deferred ART (ART was initiated only when patients met the WHO criteria) and no IPT.[49] The authors concluded that these results were driven largely by the early initiation of ART (CD4 <500) combined with concomitant IPT and that both interventions prevented TB and invasive bacterial diseases.[49]

Cotrimoxazole Preventive Therapy

Cotrimoxazole taken daily reduces the risk of serious opportunistic infections and death in HIV-infected persons [50-53]. The low cost and straightforward regimen of Cotrimoxazole coupled with its safety, efficacy, and tolerability provides strong motivation for implementation of this intervention to scale in PLWH [54-56].

ART for HIV-TB co-infected patients

Three prominent clinical trials shaped the treatment landscape by demonstrating empirical evidence that initiating HIV and TB treatment together was safe and reduced mortality in co-infected patients.[29, 30, 57] In 2010, the Starting ART at Three Points in TB treatment (SAPiT) trial showed a 44% reduction in mortality among co-infected patients randomized to integrated HIV and TB treatment.[29] The Adult Clinical Trials Group A5221 study, demonstrated reduced rates of new AIDS-defining illnesses and deaths in TB patients with CD4 less than 50 when ART was initiated early.[30] Data from the International Network for Strategic Initiatives in Global HIV Trials network study on Strategic Timing of Antiretroviral Therapy provided evidence of a 53% reduction in pulmonary TB or death, in asymptomatic HIV-infected patients who initiated ART with a CD4 count greater than 500 cells/mm^3, highlighting the benefit of early ART for PLWH.[58]

Adherence to Tuberculosis and HIV medication

Retention and adherence are often discussed together, and the two indicators are closely intertwined. Poor adherence to ART and/or TB treatment can lead to poor treatment outcomes and could potentially lead to drug resistance.[20] An observational cohort study in Kenya, to identify which programme components promote adherence, observed 301 patients in an ART programme and collected treatment outcome data.[59] Time to treatment failure was significantly longer in patients who had pill counts, participated in support groups and were exposed to home-based visits by clinic staff. [59] While these interventions enhanced adherence and prolonged viral suppression, the authors were cautious to suggest scaling up this intensive adherence programme due to the high demand on staff, resources and unknown costs of implementation. [59]

Retention in care

According to the target set by the UNAIDS 90-90-90 strategy, HIV programmes must strive to ensure that 90% of all people with diagnosed HIV infection will receive *sustained* antiretroviral therapy.[20] In developed countries such as the United States of America (USA), only 50% of patients are retained in long term care and of these only 60% achieved virologic suppression.[60] In LMICs with even fewer resources, retention rates vary between 2%-59%.[61] In South Africa a cohort analysis of over 6000 patients who initiated ART between 2004 – 2007, found that after 12 months 79% of the cohort remained in care and this dropped to 35% at 10 years post ART initiation.[62] Seven studies were reviewed to determine the challenges and facilitators of good patient retention.[59-61, 63-66] In four of the seven studies, the researchers conducted chart reviews to retrospectively identify the reasons for losses to follow up in HIV programmes. [61, 63, 65, 66] The most common documented reasons for patients being lost to HIV care programmes was death followed by relocation and transfers to other clinics. [61, 64, 65] Unknown reasons for losses to follow up occurred in 20%-25% of patients and this can be attributed to inefficient tracking systems for patients and incorrect patient contact details being recorded.[61, 65]

In two prospective cohort studies and one qualitative study, HIV programmes in resource limited settings were assessed for determinants of retention in care and it was demonstrated that retention is influenced by both patient-level and health systems factors. [61, 64, 65] Patient level factors include: fear of stigma, substance abuse and treatment literacy. [64, 65] Health systems factors that adversely impacted retention, included: unprofessional staff, limited

clinic hours, disorganized clinic processes and long waiting times at the clinic.[60] Health systems factors that positively impact on patients returning to clinics included: caring and supportive staff who demonstrate genuine interest in patients, staff who assisted in developing individualised treatment plans for patients, provided pillboxes, sent reminders and co-location of other health services at the same site.[60] While there is clear evidence that retention in care is an important factor that HIV programmes must manage, there is little guidance on how facilities should support retention in care.

1.1.5 The HIV and TB programme in South Africa (2016- 2018)

The SA DoH has adopted several strategies to reduce TB in PLWH and increase accessibility of treatment. Even with an estimated 4.5 million on treatment, SA requires a further 3 million new ART initiations to reach the target of 95% of PLWH on ART by 2030. [20] In September 2016, the SA DoH adopted the Universal Test and Treat strategy which effectively removed CD4 count as an eligibility criterion for ART initiation and encouraged same-day initiation of ART for people testing positive for HIV.[67] The goal of this strategy was to increase accessibility of ART, however, no additional human resources were provided to support the large influx of patients entering the ART programme. [68] Instead, strategies to manage the large number of ART patients were introduced such as Adherence Clubs, multi-month dispensing of ART (2-3 months), fast-tracking stable patients during clinic visits, and expanding ART pick up points (external to the clinic) for stable patients. [67]

To reduce TB-mortality among PLWH, the SA treatment guidelines recommend integration of HIV and TB services. [34] This entails: HIV testing for TB patients, TB screening for HIV patients, universal TB screening (signs and symptoms checklist) for PLWH, Xpert MTB/RIF rapid testing for PLWH that have TB signs and symptoms, cotrimoxazole preventive therapy for HIV-TB patients with no CD4 count requirement, and IPT for PLWH. [34] The 2015 treatment guidelines recommended all PLWH should be considered for IPT. [69] In addition, the duration of IPT was dependent on tuberculin skin test availability and ART status. Briefly, in the absence of a tuberculin skin test result and not on ART, then IPT could be initiated for a 6-month duration or for 12 months if the tuberculin skin test was negative. In 2018, the SA DoH changed IPT guidelines removing the tuberculin skin test as a requirement for 12-month duration of IPT. In addition, targeted TB screening of household contacts of TB patients was expanded and linkage of children less than 5 years old in the household to IPT was given priority.[34]

1.1.6 Gaps in the HIV-TB care cascade

An evaluation of South Africa's progress in meeting the UNAIDS 90-90-90 target was conducted using data from a large-scale, national survey.[70] An estimated 36 784 people participated in the survey, of which, 61% agreed to complete a questionnaire and provided blood samples for HIV testing, ART use and VL testing.[70] The survey found that among people 15 years and older, 84.8% knew their HIV positive status, of these 70.7% were currently on ART, and of these 87.4% had a suppressed viral load at the time of the survey.[70] This survey highlighted that HIV testing appears to be well on track to meeting the 90% target, but ART coverage requires major improvement. Although, VL suppression is close to reaching the 90% target, we must interpret this in the context of the 70.7 % people on ART. Aside from this national surveillance study, several other studies have aimed to identify causes of or contributing factors to ongoing HIV and TB mortality.[71-73]

Extensive evaluations of HIV-TB services in LMICs show that efficient integration of services is impeded at the patient, healthcare worker and health systems levels.[22, 74-76] Stigma and discrimination associated with TB and HIV was the foremost patient-level barrier to integrated services.[72, 73, 77] Fear of discrimination by their communities deters patients from accepting the HIV test, however, a South African study which interviewed HCWs, found that if given enough motivation and encouragement by HCWs, the majority of patients accepted the HIV test.[77] Long waiting times at the clinic and limited clinic operating times were factors that discouraged patients from attending the clinic.[72, 78] However, one South African study investigated the factors that affect health care utilization among TB patients found that patients prefer integrated HIV-TB clinics as this minimizes travel costs and time.[79]

A very important study that attempted to quantify losses along the TB care cascade, found that patient losses occurred all along the care cascade.[80] Some of these losses may be attributed to the patient factors above, but several studies have demonstrated that patients already accessing care at facilities were not tested for TB.[81-84]

It is concerning that early in the TB care cascade many patients are missed for TB screening and diagnosis, as these are the key points of entry into the TB care continuum.[85] In South Africa, two studies evaluated compliance to TB screening guidelines in PHC clinics and quantified the number of patients missed by healthcare workers for TB screening and TB

diagnostic testing. Chiota et al. (2015) found that even with the roll-out of Xpert MTB/RIF rapid testing, the likelihood of patients being tested for TB did not improve.[81] Of a sample of 3604 consecutive adults with at least one TB sign or symptom that exited a PHC clinic, 60% reported their TB symptoms and only 22.7% were offered a microbiologic test.[81] Kweza et al. (2018), found that of patients seeking care for TB-related symptoms, 79% were screened and of those seeking care for other reasons only 21% were screened.[83] Both studies concurred that patients are more likely to be screened for TB when they came seeking care for a TB-related sign or symptom which suggests that TB screening is not routinely offered to all patients accessing the clinic. Studies that implemented the standardised patient method, which entails deploying a 'trained patient' to assess the quality of health services, have found gaps in TB services in SA where 84% had a sputum collected for laboratory testing and 47% were offered an HIV test.[86]

A large-scale chart review conducted in KwaZulu-Natal (KZN) between 2016 and 2018, aimed to assess the HIV-TB care cascade among patients accessing care in 17 public health settings (10 PHCs and 7 district hospitals).[87] The chart review was conducted by the Centre for the AIDS Programme of Research in South Africa (CAPRISA) and the results were presented by the PhD candidate at the 5th TB Conference in Durban, South Africa. Of the 3027 ART patient files reviewed, 24% (735/3027) were not screened for TB at the ART initiation visit.[87] Of the 76% (2292/3027) that were screened for TB, 18% (404/2292) were offered an Xpert MTB/RIF test. Of these, 10% (42/404) were diagnosed and started on TB treatment.[87] No TB outcomes were available, and documentation of TB management was very poor in ART files.[87] Overall, 38.3% of patients were screened for TB at all clinic visits after ART initiation, 14.3% were screened for TB for greater than 50% of visits and 11.9% were screened for less than 50% of clinic visits.[87] In the same chart review, of the 1888 ART patients eligible for IPT, only 46.5% were prescribed IPT and of these 582 (66.3%) completed IPT treatment and 33% had an unknown IPT completion status.[87]

1.1.7 Health systems' weaknesses in HIV-TB service delivery

All the above studies, that evaluated some or all aspects of the HIV-TB care cascade have highlighted health systems' weaknesses that contribute to poor quality of care for patients already accessing facilities.

Table 1 below provides a summary of health systems' weaknesses extracted from other studies. Uncovering gaps, bottlenecks and weaknesses in the HIV and HIV-TB care cascade

are important because while many patient-related factors, such as stigma and discrimination, are difficult to address, health systems weaknesses may be easier to influence and rectify.

Table 1: Health systems' weaknesses affecting HIV and HIV-TB services

Poor infrastructure
• Lack of space to triage and separate TB and non-TB patients [88, 89] • Crowded waiting areas and poor ventilation which increased risk of nosocomial transmission [89] • No safe or private spaces for sputum induction[78] • No privacy for counselling of patients [37] • Stockouts of drug supply [90]
Lack of skilled healthcare workers
• No confidence in ruling out TB as a prerequisite for IPT or in managing IPT side-effects [90-92] • Co-management of complex TB and HIV patients (e.g., immune reconstitution inflammatory syndrome) [75] • Lack of skills to manage patient psychosocial aspects of HIV and TB [37] • Failure to implement guidelines correctly [73]
Inefficient coordination and planning for integrated services
• Currently no ideal model for implementing integrated HIV and TB services [22] • Separate nurses to treat HIV and TB [22] • No integration of patient TB and HIV records or TB and HIV electronic systems [22] • Poor coordination between clinic departments (TB nurse and ART nurse) [75] • Lack of systems for tracking patients [93]

ART, Antiretroviral Therapy; IPT, Isoniazid Preventive Therapy; TB, Tuberculosis

There is an increasing demand for better quality patient HIV and TB care with very ambitious targets to be met. With little or no additional human and financial resources to meet demands, HIV and TB programmes are required to adopt more effective and efficient use of current resources. Quality Improvement (QI) may offer methods, tools, and direction in addressing health systems weaknesses and ensuring quality care to patients.

1.2 Quality Improvement

The Quality Improvement (QI) approach to improving healthcare services is preferred and widely adopted in LMICs, largely because of its underlying assumption that healthcare can be improved with no or little need for additional resources.[94] QI is distinctly different from Quality Assurance (QA). QA focuses on identifying and addressing the errors of individuals after the fact, whereas the defining principle of QI is the focus on improving underlying systems and processes used in an organization. [95]

The USA's Health and Human Services guidance document defines QI as:

> *"systematic and continuous actions that lead to measurable improvement in health care services and the health status of targeted patient groups"* Page 1 [96]

Several researchers concur with this definition. [97-101] A few researchers add that while QI is a focus on improvement of systems, a key characteristic is its simple, low-cost strategy approach to addressing performance in health care services.[102] Building on the definition of QI offered by the USA's Health and Human Services, some authors stress the use of local data to monitor the performance, identify gaps in performance and feedback on practices.[102]

Total Quality Management and QI are terms often used interchangeably. [103, 104] While QI is a focus on systems and processes that can be undertaken at any level of an organization, Total Quality Management is a more comprehensive, management-led initiative that uses QI to make improvements with a focus on the entire organization and its goal is to instil a culture of QI within the organization.[105] There are 8 key principles TQM, including: (i) Top management-initiated and led QI initiative; (ii) Patient orientated; (iii) Seeks to prevent systems failures before they occur; (iv) Measurement of quality of services; (v) Continuous Quality Improvement to improve systems and processes; (vi) Mutually beneficial supplier relationship (i.e. only seeks the highest quality supplies, equipment and service providers); (vii) Benchmarking (adopts industry best practices), and (viii) Company-wide initiative involving all employees at all levels. [103] For the purposes of the PhD project, 'QI' is used throughout the thesis and the definition adopted by the PhD project is explained below.

In this PhD project the definition of QI from the USA's Health and Human Services department will be adapted. The adapted definition of QI is as follows:

> *QI is an organization-wide process of: (i) using local data (i.e., clinic data) and feedback processes to identify and address gaps and weaknesses in service delivery and (ii) developing and implementing continuous and systematic actions to ensure measurable improvement in health care services and patient outcomes.*

1.2.1 Effectiveness of Quality Improvement to improve healthcare services

QI has been extensively and successfully implemented to reduce transmission of HIV from mother to child and, maternal and infant mortality in LMICs.[97, 99, 101, 106-109] A 3-year South

African-based QI project to improve infant and maternal outcomes decreased HIV positivity among infants from 7.6% to 5%.[101] A Ghanaian QI project involving 27 healthcare facilities, successfully reduced neonatal mortality from 2.5 deaths per 1000 live births to 0.9 deaths per 1000 live births and infant mortality decreased from 3.5 deaths per 1000 to 2.3 deaths per 1000 live births.[110] Similarly, a QI project in Malawi demonstrated a 22% lower neonatal mortality rate and 16% lower perinatal mortality.[111]

QI has been implemented to improve various HIV and TB treatment and care services. Table 3 below lists nine published studies which implemented QI methods to improve process indicators of HIV or TB service delivery. The majority of HIV and TB indicators improved at the end of the evaluation period compared to the baseline (pre-QI period). Of the nine studies reviewed, an average of two indicators were the focus for the improvement efforts. Enhancing TB screening was the focus of five studies, improving ART coverage was the focus in three studies, IPT initiation improvement was addressed in two studies and cotrimoxazole initiation in one study. None of the QI studies attempted to improve integration of HIV and TB services.

While it is very encouraging to note there was improvement in most indicators, it is noteworthy that six of the nine studies (67%) adopted a pre- and post-intervention study design. This is a common study design used to evaluate effectiveness of QI, however, without the presence of a comparison group (control group) it is difficult to conclude with certainty that these improvements can be attributed to the QI intervention alone and not to other programmes or initiatives, including policy changes.

Table 2: Published studies of effectiveness of QI to enhance HIV and TB service delivery

Reference	Study Design	Country	Quality Improvement Intervention	TB or HIV indicator	Size of improvement		
					Pre-QI	Post QI	Difference[†]
Davis et al. (2011) [112]	Pre- and post-test	Uganda	To improve TB identification and linkage to treatment using real-time monitoring and evaluation	Patient rreferrals for sputum microscopy	21%	53%	32
Webster et al. (2011)[100]	Prospective cross-sectional study	South Africa	To improve ART initiation uptake	ART initiations	179 per month	511 per month	332
Thanprasertuk et al. (2012) [113]	QI programme evaluation	Thailand	To improve HIV services using performance measurement and QI.	CD4 testing rates	24%	99%	75
				ART initiation	100%	90%	-10
				TB Screening	24%	99%	75
Afanvi et al. (2015)[114]	Pre- and post-test	Togo	To decrease TB mortality by improving TB treatment success rates among pulmonary TB patients	TB treatment success outcomes	80%	95%	15
				TB mortality	13%	3%	-10
				Failure to follow up rate	3%	2%	1
Bardfield et al. (2015)[115]	Pre- and post-test	Namibia	Capacitate senior department of health officials with QI skills to improve HIV public healthcare service delivery	ART coverage	83%	94%	11
				CD4 count monitoring	74%	70%	-4
				ART adherence	90%	97%	7
				TB Clinical screening	81%	87%	6
				IPT initiation	16%	28%	12
				Cotrimoxazole Preventive Therapy	86%	93%	7
				Sputum positive patients referred for TB treatment	71%	84%	13
Karamagi et al. (2017)[116]	Pre- and post-test	Uganda	To improve utilization of GeneXpert testing	Sputum samples sent for Xpert MTB/Rif[‡]	91	448	357
				Identification of TB positive patients	19	76	57
Karamagi et al. (2018) [117]	Pre- and post-test	Uganda	To improve identification of TB in patients	TB case identification rates (per 100 000)	171	223	52
Golden, et al. (2018)[118]				HIV re-testing rates	36%	100%	64

	Case control study	South Africa	To increase HIV re-testing rates among pregnant women		Retesting rates were 20% higher in intervention clinics		
Ogunsola et al. (2019) [119]	Pre- and post-test	Nigeria	To improve uptake of IPT initiation and IPT completion	IPT initiation	11%	50%	39
				IPT completion	53%	95.4%	42.4

† This is the absolute difference between the post-QI and pre-QI period

‡ Xpert MTB/Rif is a rapid, molecular, cartridge-based test used for tuberculosis diagnostics that provides an immediate Rifampicin resistance result

ART, Antiretroviral Therapy; IPT, Isoniazid Preventive Therapy; QI, Quality Improvement; TB, Tuberculosis

Importantly, the size of the improvement achieved was different for every study. For example, one study achieved 12% improvement in IPT initiation and another achieved 39% improvement, yet both had similar baseline performance.[115, 119] Variability in the results was shown in several systematic reviews of QI interventions.[120-123] A systematic review of QI interventions that aimed to improve ART outcomes uncovered large variations in improvement for ART uptake [median increase of 14%; (interquartile range (IQR): -9 – 29.3)], adherence [median increase of 22%; (IQR: -7 – 25)] and viral load (VL) suppression [median increase of 26% (IQR: -8 – 26)] [121]

The QI methodology has been implemented in low and middle-income countries to improve service delivery in healthcare and treatment outcomes with varying success. [99, 102, 111, 124] Variability in the outcomes of QI interventions poses a major challenge to implementers. It is an indication that QI interventions may not have the same effect (e.g., size of improvement) in all settings. This affects the transferability and scalability of QI interventions. As a result of the observed variability in QI outcomes, the field of Implementation Science (IS) research has witnessed rapid increase in research to explain why this variability exists. The resounding answer has been that the uniqueness of the context in all settings influences the success or failure of QI initiatives. [125, 126] Organizational context has been of particular interest to IS researchers, as this encompasses the teams, resources, infrastructure, and environment in which care is provided.

The next section explores organizational context and what is known of its influence on the success of QI interventions.

1.2.2 Definition of organizational context

Organizational context is a broad term and defined in multiple ways. In relation to QI, Kaplan et al. (2010) defined context as "everything not directly part of the technical QI process." [126] The Promoting Action Research Implementation in Health Services (PARIHS) framework defines context as "the environment or setting in which people receive healthcare services, or the environment or setting in which the proposed change is to be implemented." [127, 128] A review of definitions of 'context' concluded that while definitions are varied, broad or narrow, it is agreed that organizational context is dynamic, multi-layered, and complex. [129] In definitions of organizational context, a wide range of factors are often just listed as a

means of depicting what constitutes organizational context.[129] Most commonly listed factors are organizational culture, climate, resources, teamwork, and leadership. [129]

To further understand and 'organize" the definition of organizational context, some researchers depict organizational context on three levels: the macro-, meso- and micro-levels. [130] The macro-level is the broadest level and recognizes the influence of politics, policy, economics, and regulations. The meso-level refers more to organizational characteristics of culture and climate. The micro-level refers to the level at which care is delivered – the front line of healthcare. [130]

Damschroder et al. (2009), offer a definition of context, specifically for implementation research, which states:

> *"For implementation research, 'context' is the set of circumstances or unique factors that surround a particular implementation effort"* (Page 3)[131]

The work of Damschroder et al. (2009), in developing the Consolidated Framework for Implementation Research (CFIR), identified the "inner setting" and "outer setting" as critical elements that drive implementation of an intervention.[131] The outer setting includes the economic, political, and social context that an organization inhabits. The inner setting includes both tangible and intangible features including structural characteristics (staffing, physical infrastructure, resources), networks and communications (quality of communication and relationships between people), culture (shared norms and values about how things should be done), implementation climate (capacity and capability to make changes). [131]

This PhD project is situated at the inner setting or micro-level. Going forward most articles reviewed are those where the QI project focused on the inner setting or at a facility (clinic) level. In terms of a definition for organizational context at the inner setting, this will be understood as all factors, both tangible and intangible, that influence the implementation of interventions or evidence-based practices (EBPs). Kaplan et al (2010), in a systematic review, identified close to 66 organizational contextual factors that could possibly influence the success of a QI intervention.[126] It is not possible to measure all organizational contextual factors in the inner setting, however, there are factors that repeatedly emerge as important in predicting success of QI interventions.

The next section explores research studies that identified organizational contextual factors which appear to influence QI intervention success.

1.2.3 Influence of organizational context on Quality Improvement interventions

QI and organizational context are closely intertwined because the nature of improvement requires organizational change. [126] There is a substantial amount of research dedicated to understanding which organizational contextual factors (OCFs) influence QI interventions and why.[125] Most of the studies found on this topic are systematic reviews of QI interventions. [125, 126, 132] Table 3 lists the OCFs that have emerged from systematic reviews which aimed to extract or understand the role of organizational context in influencing QI interventions. The most common factors found were leadership, organizational culture, and data infrastructure.

Table 3: List of organizational contextual factors extracted from systematic reviews

Author and Year	**Type of review**	**Type of country**	**Organizational Contextual Factors identified**
Kaplan et al. (2010) [126]	Systematic Review	High income	• Leadership from top management • Organizational culture • Data infrastructure and information Systems • Years involved in quality improvement
Kringos et al. (2015) [133]	Systematic Review	Primarily high income	• Leadership from upper management • Organizational culture • Accessible and functional data systems • Organizational culture of improvement • Team member diversity
Li et al. (2018) [130]	Systematic Review	High income	• Leadership • Organizational culture • Networks and communication • Resources • Evaluation, monitoring and feedback • Championship
Coles et al. (2020) [125]	Synthesis of data	High income	• Leadership • Organizational culture • Individual skills and capabilities • Organizational capacity and capabilities • Data and technical infrastructure • Readiness for change • Championship • Relationships

Identification of OCFs is important as well as understanding how they influence the outcomes of QI. A Norwegian study interviewed 20 clinicians to understand how contextual factors affected a QI intervention to reduce surgery cancellations.[134] The QI intervention was successfully implemented in that surgery cancellations were reduced from 8.5% to 4.9% and sustained for 26 months after the QI intervention.[135] The clinicians interviewed attributed the success of the intervention to a positive organizational culture, describing it as one which recognised a problem with a system when it arose and was willing to implement changes to address the issue.[134] In this QI intervention, leadership involvement and support for the QI initiative from upper levels of management was a major facilitator influencing improvement in QI interventions.[134] In addition, leadership which was permissive of change and allowed a 'bottom-up approach' with frontline staff developing solutions and affecting changes was a facilitator influencing QI improvement. Additional facilitators included: i) that the QI intervention was interdisciplinary, in that it involved all staff in meetings and shared data and progress with team members who were not necessarily part of the QI team or involved in the project; and ii) easy and quick access to data for tracking progress The authors acknowledge that due to the qualitative nature of the this study, it was not possible to confirm associations between the organizational contextual factors identified and the QI outcomes. [134]

Sommerbakk et al. (2016), carried out a similar study in Norway, and interviewed 20 healthcare workers from five healthcare facilities where QI was implemented, to improve palliative care for patients with cancer and dementia. [136] OCFs which facilitated implementation were similar to those identified in the previous study and included: organizational culture amenable to change, leadership support, collaborative meetings and working with a diverse team. New facilitative OCFs were face-to-face contact and meetings with other staff aiming to improve services; previous experience with QI; subject matter expertise in palliative care boosted confidence; and ease of the implementation strategy where a simple strategy that was not too onerous made organizational change easier. [136]

QI in healthcare is relatively new and much of the development of QI to improve healthcare services was driven by the Institute for Healthcare Improvement (IHI), based in the USA and other high-income countries.[125] This is evident in Table 3 above and signals a major knowledge gap for the field of organizational contextual influences in LMICs. More LMICs are adopting the QI approach and given the lack of resources, human and financial

constraints, it is possible that organizational contextual factors that affect QI success in LMICs may be different to those in high-income countries. In addition, to my knowledge, there were no studies that explored the relationship between organizational contextual factors and their influence on QI to improve HIV-TB integration. Improvement in HIV-TB integration is among the highest priorities in LMICs with high burdens of TB and HIV. Understanding how and why QI worked or did not work to improve HIV-TB integration is critical to LMICs replicating the successes of QI interventions from one setting to another.

1.3 Rationale

Integrating HIV and TB services is challenging in LMICs because of the high level of coordination and joint planning that is required to coordinate both services, while providing high quality care. On 5 May 2017, the South African Minister of Health, launched ”Quality Improvement for TB” in 9 selected sub-districts in South Africa in collaboration with IHI and the Bill and Melinda Gates Foundation (BMGF).[137] The intention of the SA DOH is to roll-out the QI initiative to improve TB outcomes in other areas of SA. Addressing TB outcomes is not possible without addressing HIV as well. To increase the success of the roll-out of QI, research is needed to determine if QI will be effective in enhancing HIV-TB services and which organizational contextual factors are facilitators or barriers to implementing QI.

Previous studies that have explored organizational context influence on QI outcomes have employed cross sectional surveys or qualitative interviews. To the best of my knowledge there are no randomized controlled trials that have compared change over time of organizational culture, climate, and readiness to change of clinic teams that are participating in QI interventions. The introduction of control clinics receiving standard support for integration of TB/HIV services, provides an opportunity to determine if clinics not receiving QI perform any worse or better given the organizational context.

This study has the potential to give recommendations to the SA DOH on the OCFs that need to be fostered or considered to produce the best results when implementing QI to integrate HIV-TB services.

1.4 Primary Aim

To determine the influence of organizational contextual factors on a Quality Improvement intervention to enhance integrated HIV-TB service delivery in rural primary healthcare clinics in KwaZulu-Natal.

1.4.1 Specific Objectives

Specific objective 1: To determine if the QI intervention improved integrated HIV-TB services, which include HTS; TB screening; TPT; Cotrimoxazole Preventive Therapy; ART for HIV-TB co-infected patients; viral load coverage; and retention in care, in intervention clinics compared to control clinics.

Specific objective 2: To identify the organizational contextual factors, such as, physical infrastructure; leadership support; monitoring data for improvement; key staffing, supportive contexts for change; and the Degree of integrated TB and HIV services offered, that facilitate QI to enhance HIV-TB services

Specific objective 3: To determine which organizational contextual factors influence success of QI interventions to improve integrated HIV-TB services.

CHAPTER 2: THEORETICAL FRAMEWORKS

Theoretical frameworks played a major role in the PhD project. The PARIHS framework guided the study in identifying which OCFs likely influence QI success and needed to be assessed. The entire QI approach was embedded in the Breakthrough Series Collaborative (BTSC) which is a framework suitable for multiple organizations (or clinics) working toward a common goal and the QI implementation at the clinic level was informed and guided by the Model for Improvement which included the Plan-Do-Study-Act (PDSA) framework for rapid development and testing of change ideas. This section explains describes the frameworks that were selected.

2.1 Frameworks for understanding the role of organizational contextual factors

The are many frameworks that attempt to explain the complexity of how contextual factors influence the adoption of changes or new evidence in a settings.[138] The diffusion of innovations model explains the how and why an innovation or change spreads through a system and at what rate.[139] The model proposes that innovations are likely to be adopted if: (i) it is more advantageous to what was done before; (ii) it lends itself to being tested before full implementation; (iii) it is compatible with the current values held by a team; (iv) it is not too complex to implement; and (v) the results can be observed by others or measured.[139] The RE-AIM framework which stands for (Reach, Effectiveness, Adoption, Implementation and Maintenance) is an evaluation framework for interventions which assesses implementation of these concepts primarily through quantifying the concepts mentioned. [140] The Practical, Robust Implementation and Sustainability Model (PRISM) framework offers a very comprehensive and robust framework, borrowing concepts and ideas from several other frameworks, including Diffusion of Innovation and RE-AIM.[138] The model considers the dynamic interplay between the intervention, external environment, infrastructure, and the recipients of the intervention and how they influence adoption, implementation, and maintenance.[138] PRISM identifies leadership, organizational culture, readiness to change and infrastructure as key among a host of organizational contextual factors that influence implementation on a new intervention or change.

The PARIHS framework is one of the most cited implementation frameworks in the Implementation Science field.[128, 141] PARIHS has been used to inform other frameworks, such as PRISM.[138] It was selected for this PhD project because it offered definitions for

complex terms such as context and refers specifically to implementation of new interventions and embedding change at the clinic level.[128] In addition, the framework highlights key elements of context that are considered critical to successfully embedding new evidence or change. [128]

2.2 The Promoting Action in Research Implementation in Health Services Framework

The PARIHS framework operates on the principle that implementation of evidence-based practices or change in a particular setting occurs as a function of the interplay between three elements: evidence, context, and facilitation (Figure 8).[128]

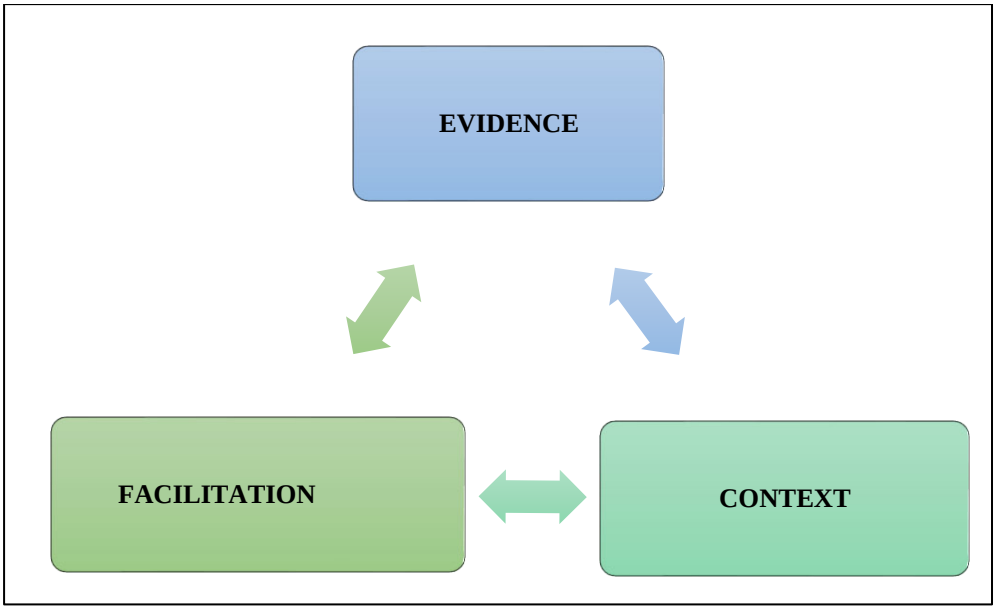

Figure 8: Elements of the PARIHS Framework

Evidence

The element of evidence refers to the knowledge or intervention to be implemented. The PARIHS framework states that evidence is more likely to be implemented by clinic teams if it is deemed reliable and relevant. [128] The evidence should be derived with scientific rigour but must also have the support of clinical experts, be supported by patients and in their best interests. Local data must be used to show the effectiveness of the evidence. [128]

Context

The PARIHS framework defines context as the setting or environment in which care is given or in which change is to take place.[128] The framework places an emphasis on three characteristics of context that play a role in the implementation of evidence: organizational

culture, leadership, and monitoring and evaluation. [128] The PARIHS framework defines organizational culture as a set of norms and values held by a team which shapes behaviour. A prevailing organizational culture of learning, facilitates change because this type of culture is one that considers work processes, allows for group decision-making, and emphasizes collaboration between manager and employee as opposed to an autocratic management style. The PARIHS framework and a host of other literature have identified good leadership as an indispensable characteristic within a context.[125, 126, 128, 130] Leadership is a complex characteristic because there are different levels of leadership in a particular setting (upper management, middle management, clinic level). The six most common styles of leadership, include: transformational, transactional, autocratic, laissez-faire, task-oriented, and relationship-oriented leadership.[142]

The PARIHS framework places an emphasis on transformational leadership style as the most conducive to facilitating change. [128] Transformational leadership is characterised by inspiring change through being supportive and motivational to employees. Transformational leaders strengthen staff morale, ensure that there is a shared vision among clinic teams, are interested in employee job satisfaction and challenge and question how things are done while still being encouraging and supportive. [128]

Other leadership styles also have good attributes and may be useful in certain circumstances. Transactional leadership is characterised by managing change and using reward and punishment to achieve change. [143] Autocratic or hierarchical leadership is suited for settings where adherence to protocol is essential for improvement (surgical wards) or in emergency situations. [142, 144] This style is one where the leadership makes all decisions and does not invite opinions from others. [142, 144] Laissez-faire leadership style involves a leader who makes very few decisions and allows employees to have decision making power and autonomy. [144] Task-oriented leadership style involves high-levels of planning, assigning roles within a team or a group of people, setting objectives and monitoring of processes. Lastly, relationship-oriented leadership style incorporates support, development, and recognition. [142]

Evaluation and monitoring of performance is key to a context that is conducive to change. Feedback on individual and team performance using local data promotes change. The

framework does not explicitly say who needs to perform the feedback and evaluation or if teams should themselves conduct feedback and evaluation.

Facilitation

Lastly, the method or technique of facilitating change and the facilitator is key to implementing changes. The PARIHS framework emphasizes that facilitation can be from an external source and that the facilitator should be skilled with expertise to guide a team to making changes. The purpose and role of the facilitator must be clearly defined.

2.3 The PARIHS framework utilization in the PhD Project

Elements that comprise the PARIHS framework guided the PhD project. Integration of HIV-TB services was already incorporated into guidelines and policies; hence, we did not have the challenge of having to convince clinic teams of the importance of integrating HIV-TB services however, clinical training to refresh HCWs knowledge and ad hoc guideline training was allowed in the study. Concepts and characteristics of context mentioned in the PARIHS framework, and which were included in the PhD project included leadership, organizational culture, and monitoring performance for improvement. [128]

To facilitate the delivery of the intervention, experts in the field of HIV-TB integration and QI formed the core study team. The SUTHI trial facilitated improvement primarily through QI skills building and mentorship. While the PARIHS framework highlighted important elements and concepts of context to be measured and evaluated, the most effective model for facilitating the QI intervention needed to be selected.

2.4 Organizational Readiness for Change Theory

Several theories exist on what drives organizations, individuals, and teams to implement changes and adopt new ideas. [145] The Organizational Readiness for Change Theory proposes a definition of organizational readiness for change and the factors that potentially drive change behaviour. [146] This theory defines organizational readiness as the extent to which organizational team members are psychologically and behaviourally prepared to implement an organizational change. [146] The theory proposed that organizational readiness is driven primarily by two factors: an organization's willingness to change and an organization's capability to implement change. [146] A high willingness to change depends on team members shared belief that change is warranted and beneficial. Implementation capability depends on knowing what course of action is necessary, availability of resources, and understanding the

sequence of change activities. [146] The theory suggests that when organizational teams have common understanding of resource availability and task demands, then their collective sense of confidence in executing change is high. [146] In this study, we aimed to boost organizational readiness to change by strengthening the clinic team's capabilities to effect changes. Building skills and capacity in QI methods was an ideal strategy to strengthening organizational capabilities.

2.5 Selecting a Quality Improvement model and approach

A QI model was selected as the intervention for a number of reasons: (i) QI offered a solution to improving HIV-TB integration at PHC clinics without forming a dependence on study staff; (ii) capacitating HCWs with QI skills would be beneficial to the SA DOH; (iii) HCWs would drive the improvement, making the intervention potentially sustainable beyond the study period; (iv) the project period and funding was limited to only 36 months and the first 12 months was spent in project planning, hiring staff, training staff on QI methods and acquiring DOH support for the study.

There were four QI models that were considered at the start of the study: The Care Model, Six Sigma, Lean, and the Model for Improvement. Each model seeks to improve systems; however, each works only in particular situations. Table 4 lists the attributes of the QI models considered.

1 **Table 4: Types of Quality Improvement models: Benefits and challenges**

QI Model	Description	Mechanism for Improvement	Benefits	Challenges	Industry
The Chronic Care Model [147]	A patient-centered approach that promotes interaction between patients and healthcare providers to improve health systems	Identified and aims to improve 6 components of care: -Health systems -Clinical patient information systems -Decision support for HCWs with latest evidence - Delivery system that is patient-centered -Self-management support -Community mobilization to suit patient needs.	Found to promote patient compliance. Enhances patient knowledge and health awareness	Requires motivated patients Time consuming to focus on all 6 components	Patient Home Care and Ambulatory Patients
The Lean Model [148]	An approach that seeks to define what a customer (patient) values in a system and then maps and works to perfect that system by making it time efficient and cost effective	Continually improves a process by removing non-value-added steps, or continuously identifying wastefulness	Saves patients time and money. Shortens processes, removes duplication	Requires a culture change Long and arduous process	Business sector. Works well in healthcare settings if time and resources are allocated.
Six Sigma Model [149]	Aims to remove the defects and variations of a manufacturing/business process that has multiple steps	Generates large amounts of data on a process and aims to remove defects until the product is perfect	Lowers or cuts out wasteful processes and expenditure	Requires large amounts of data and is costly in the long term	Industry and Manufacturing
Model for Improvement [150]	Aims to improve performance gaps in healthcare	Focused of three questions: What are we trying to improve? What change will result in improvement? How will we know that improvement occurred ?	Rapid, easily scalable Easy to use	Additional work for HCWs to track performance Requires motivated clinic teams	Healthcare

2

2.6 The Model for Improvement

A common framework adopted by most QI initiatives in healthcare is the Model for Improvement.[151] We adopted the Model for Improvement because it is relatively easy to implement, and it does not require large amounts of data on an entire system. The Model for Improvement provides a systematic approach for clinic teams to address performance gaps (Figure 9).[150] The approach to QI as directed by the Model for Improvement begins with clinics assembling a QI team. The QI team spearheads the collection of clinic data and interrogates clinic performance for a selected clinical service.[150] Through a process of brainstorming and using techniques for root cause analysis (e.g., process mapping), QI teams identify the underlying cause of poor performance. A practical, innovative, and low-cost idea of how to address the underlying problem is identified and agreed upon by the QI team. This idea is often referred to as the 'change idea'.[151] The change idea is tested over a short period of time and the ongoing collection of clinic data is key to determining if the change idea is leading to an improvement in clinic services.

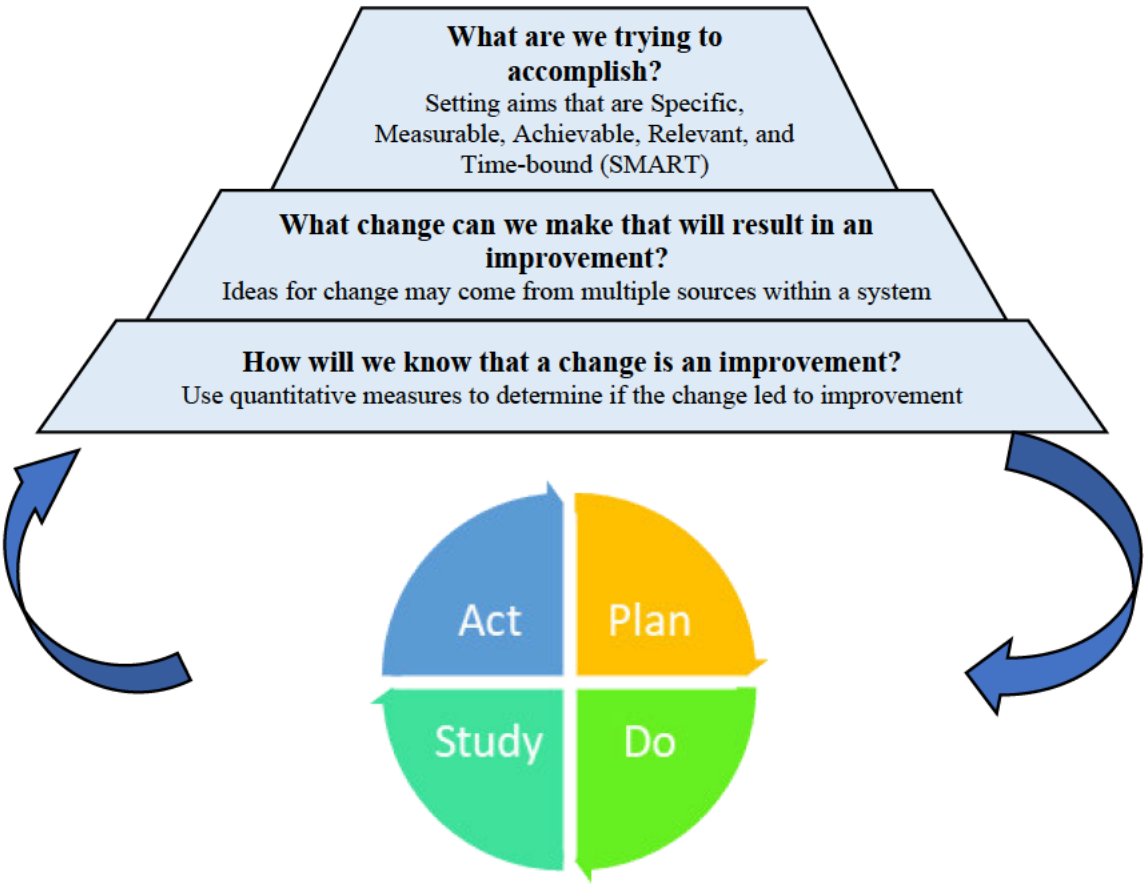

Figure 9: The Model for Improvement

2.6.1 Plan-Do-Study-Act (PDSA)

At the core of the Model for Improvement is the Plan-Do-Study-Act (PDSA) cycle. [150] The PDSA cycle outlines the cyclical stages of improvement that the QI teams undergo to systematically evaluate and address performance gaps. The PDSA cycle (Figure 9) contains 4 stages or phases:

- The Plan phase is a planning period for the selection of QI team members. This is followed by collection and analysis of clinic data. An analysis of this data is undertaken to determine if clinics are meeting set targets or performing well in coverage of services. Once a gap or weakness is identified, clinic QI teams develop a 'change idea'. The change idea can be an innovative idea (change in clinic flow processes or development of a new tool/checklist etc.) that the clinic will test to determine if any improvement is seen. A very clear aim statement is defined which states the clinic process that requires improvement (e.g. TB screening, Viral load coverage), a measurable goal expressed numerically (e.g. to improve from 50% TB screening to 90% TB screening) and a time frame for achieving the goal. [150]

- The 'Do' phase is the actual implementation of the change idea and includes monitoring the activity to be improved (e.g., measuring TB screening), continued collection of data pertaining to the clinical activity selected for improvement and documenting negative or unintended consequences of the change idea (e.g., lengthy patient waiting times).

- The 'Study' phase is a meeting of the QI team to interrogate the data collected and determine if the change idea is leading to improvement. At this phase the clinic QI team weighs the cost of the change idea in terms of staff time and efficiency versus the improvement noticed.

- The Act phase is the point where clinic teams decide if the change idea is working and should be adopted, or requires slight adjustment (adaption), or should be abandoned completely and begin the cycle anew with a different change idea. [150]

2.7 The Breakthrough Series Collaborative Framework

The BTSC framework was first drafted in 1995 and subsequently improved and implemented by IHI and is currently widely acclaimed as a successful framework for the spread of change ideas, group learning and support for facilities undertaking QI initiatives. [100, 111, 151, 152]

An illustration of the BTSC framework is available below in Figure 10, taken from IHI white paper on the BTSC.[153] The BTSC framework operates on the principle that when multiple organizations (clinics) are faced with a common problem, organizations will learn more and improve faster if they combine their efforts and share their experiences. [153, 154]

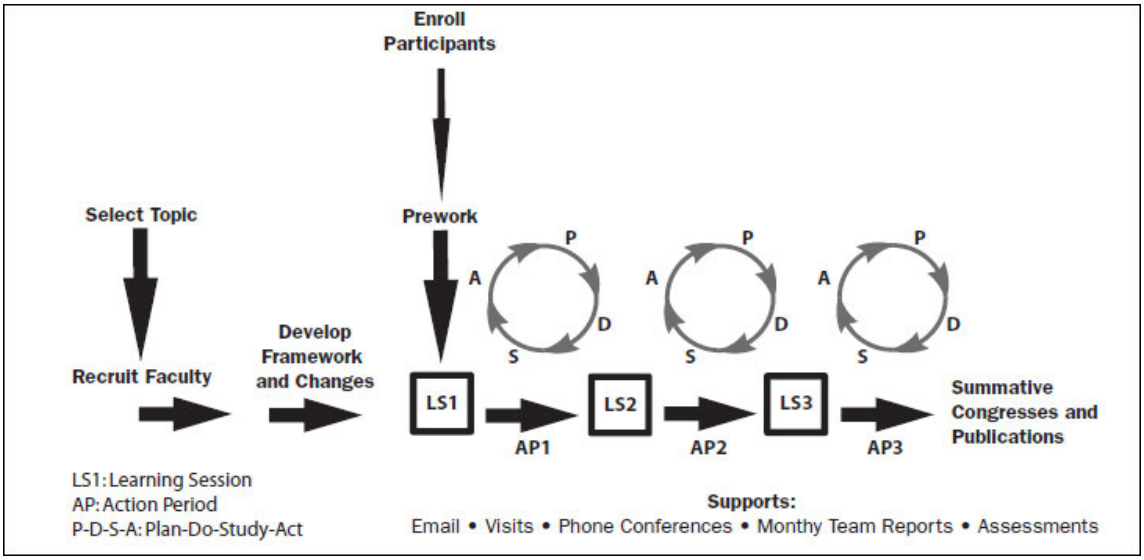

Figure 10: The Breakthrough Series Collaborative Framework [153]

Figure 10 illustrates the essential steps that are involved to operationalize the framework. An essential first step is selecting an improvement topic or defining an area of concern in healthcare that is appropriate and a shared problem among different clinics. Second, a core team needs to be assembled to drive the initiative and ensure that the process proceeds from one stage to the next. The core team should comprise clinical and QI subject matter experts, and implementers with previous experience. Third, clinics are selected to be a part of the collaborative, mainly through an application process. Fourth, the QI teams from each participating facility meet for 3-4 face-to-face meetings called Learning Sessions (also referred to as QI workshops) during the life span of the collaborative to learn QI skills and exchange experiences and best practices. Fifth, during action periods the PDSA cycle is implemented at clinics. These action periods occur between Learning Sessions where clinic QI teams are supported by a QI mentor as they try out new change ideas.

The QI collaborative approach has been widely adopted in high income countries and spread to LMICs. [123, 152, 155] The approach is favoured for its optimal use of experts and ability to accelerate learning and sharing of experiences and best practices between multiple clinics. However, in recent years the collaborative approach has come under some criticism because it is a resource-intensive activity, in terms of human and financial resources.[156]

CHAPTER 3: METHODS

This PhD project was embedded in the SUTHI trial conducted by CAPRISA. In this chapter, the PhD candidate briefly explains the design and aim of the SUTHI trial and positions the PhD project within the SUTHI trial. The study setting, tools and techniques, data collection, and theoretical frameworks used in the PhD project are explained in this chapter.

3.1 The Scaling Up TB HIV Integration trial design

The SUTHI trial was a cluster-randomized controlled trial, and its full title was *"*Addressing challenges in scaling up TB and HIV integration in rural public healthcare settings in KwaZulu-Natal, South Africa." The primary aim of the SUTHI trial was to test the effectiveness of a QI model of integrating HIV and TB services on mortality in HIV, TB and HIV-TB co-infected patients treated in rural primary health care clinics in KZN, South Africa.

The study design and methods were published in BioMed Central (BMC) Implementation Science in 2017 and the publication is available in Appendix I.[32] The PhD candidates' role in this publication is described in Appendix Ia. Lists of PHC nurse supervisors who worked in the study districts were provided by the Ugu and King Cetshwayo District (KCD) Health offices in KZN. In total the lists showed 16 PHC nurse supervisors who oversaw 79 PHC clinics. PHC nurse supervisors typically oversee between 3-5 PHC clinics, hence, to reduce contamination between study groups the PHC nurse supervisors were selected as the unit of randomization. Prior to randomization each PHC nurse supervisor and their respective clinics were carefully screened for study eligibility. The only inclusion criteria for nurse supervisors was verbal agreement to participate in the study. All nurse supervisors agreed to participate, and none withdrew during the study. Among the PHC clinics, 39 did not meet inclusion criteria which included designation as a municipal clinic, mobile clinics or clinics that had only one nurse. The SUTHI trial statistician used computerised-generated randomization to allocate PHC nurse supervisors and their respective clinics to study groups. The SUTHI trial randomized 16 PHC nurse supervisors and the 40 clinics under their supervision, using a 1:1 allocation ratio, to either the QI intervention group or to standard of care (SOC) supervision and support for improving integrated HIV-TB services.[32]

Concealment of study group allocation was not possible in this study. Instead, efforts to reduce contamination were carried out during the study, which included 'by invitation only' QI training workshops and randomization of PHC nurse supervisors.

The primary outcome of the SUTHI trial was mortality and focused largely on the impact of QI on patient clinical outcomes.[32] Eight PHC supervisors and their respective 20 clinics were randomized to the QI group and eight PHC supervisors and their respective 20 clinics were assigned to the SOC group. The SUTHI trial was implemented from 01 December 2016-31 December 2018. All clinics were followed up for an 18-month period.

3.2 The PhD project design

This PhD project was a nested sub-study embedded in the SUTHI trial. The PhD project and SUTHI trial are closely integrated with the main difference between the two is that the focus of the PhD project was on the effectiveness of QI on HIV-TB process indicators and the influence of OCFs on QI implementation to improve integrated HIV-TB services. The primary outcome of interest in the SUTHI trial was mortality. [32] The PhD project adopted a mixed-methods approach to describing and understanding the influences of organizational contextual factors in the study. Surveys, Focus Group Discussions (FGDs) with healthcare workers, research team observations and study field notes were the methods of data collection. HIV-TB process indicators were collected from clinic registers, electronic databases, and patients' files. The PhD project collected data for an 18-month period from all study clinics. The information contained in this chapter refers primarily to the PhD project. The SUTHI trial is referred to only when necessary.

3.3 Study Setting

The study was conducted in the Ugu District and KCD in KwaZulu-Natal (KZN) Province in South Africa.

3.3.1 KwaZulu-Natal Province

Figure 11 shows a map of KZN which comprises 11 districts and is home to an estimated 11.1 million people. [157] The Ugu District is in the south and KCD in the north of KZN (Figure 11). In 2015, KZN recorded 66 512 TB cases followed by Eastern Cape with 59 205, Gauteng with 4 822 TB cases, and Western Cape with 37 967 TB cases. [158] These four provinces contributed to 74% of absolute TB cases in SA.[158] In TB high-burden provinces,

the majority of TB cases are located in metropolitan areas and in KZN, eThekwini and Umgungundlovu contributed 40.9% and 9% of TB cases respectively. [158] The largely rural, Ugu and KCD Districts, contributed 7.9% and 8.5% of TB cases, respectively. [158]

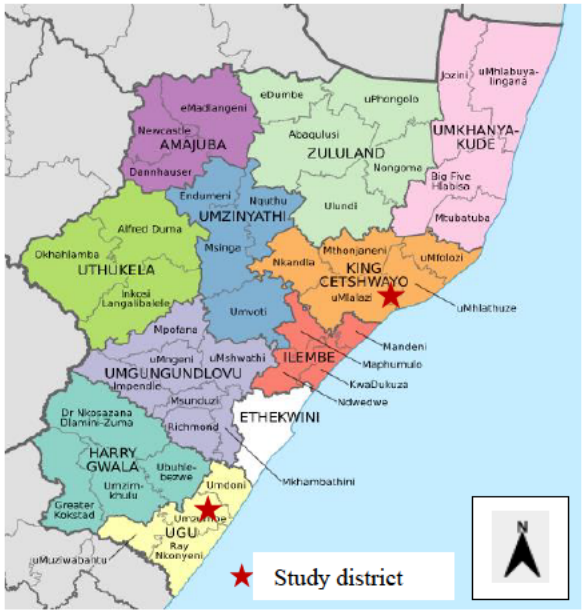

Figure 11: Map of KwaZulu-Natal in South Africa

Map Source: https://bit.ly/3rrGqk3 [159]

In addition to the burden of TB, KZN has the highest HIV prevalence of all the provinces, 27% (95% CI: 23.9% - 30.4%).[160] The presence of both HIV and TB in the province, made KZN an ideal location to test a QI intervention to integrate HIV and TB services.

3.3.2 The Ugu District

In 2016 , the Ugu District had a population of 759 134 people and occupied an area of 4791 km^2.[33] TB incidence rates were 699 (95% CI: 681-719) per 100 000 in 2015.[158] HIV prevalence among antenatal patients was 45.9% (CI 95%: 39.9% - 52.1%) in 2015 which decreased to 43.4% (95% CI: 40.2%-46.7%) in 2017. [161] The HIV-TB co-infection rate was 60.5% and HIV and TB accounted for 35% of all-natural deaths.[33] Figure 12 shows the location of the SUTHI trial clinics which were well distributed throughout the district.

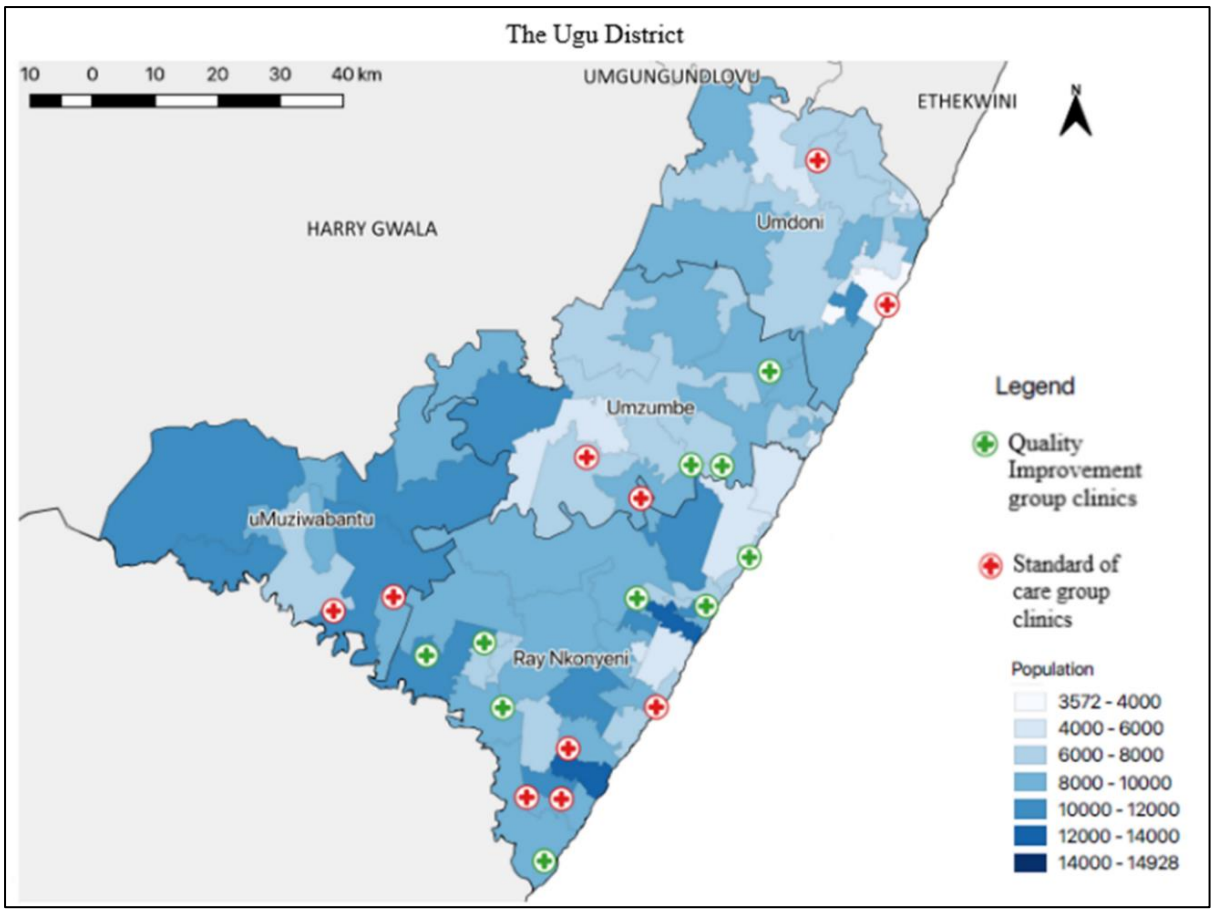

Figure 12: The Ugu District in KwaZulu-Natal Province*
* Map created using QGIS Geographic Information System, courtesy of Ms Sandrini Moodley (Geospatial Analyst)

3.3.3 King Cetshwayo District

In 2016, KCD had a population of 968 621 people and occupies an area of 8213 km^2. [33] In 2015, the TB incidence was 599 (95% CI:584-615) per 100000. [158] The antenatal HIV prevalence in 2015 was 45.9% (95% CI:37.0-% - 55.1%) and decreased to 39.1% (95% CI: 34.0 – 44.5%) in 2017. [161] The HIV-TB co-infection rates were 59.9% and deaths by HIV and TB accounted for 36% of all-natural deaths in 2016. [33] Figure 13 shows the distribution of SUTHI clinics in KCD and it is notable that most SOC clinics are in the least populated areas.

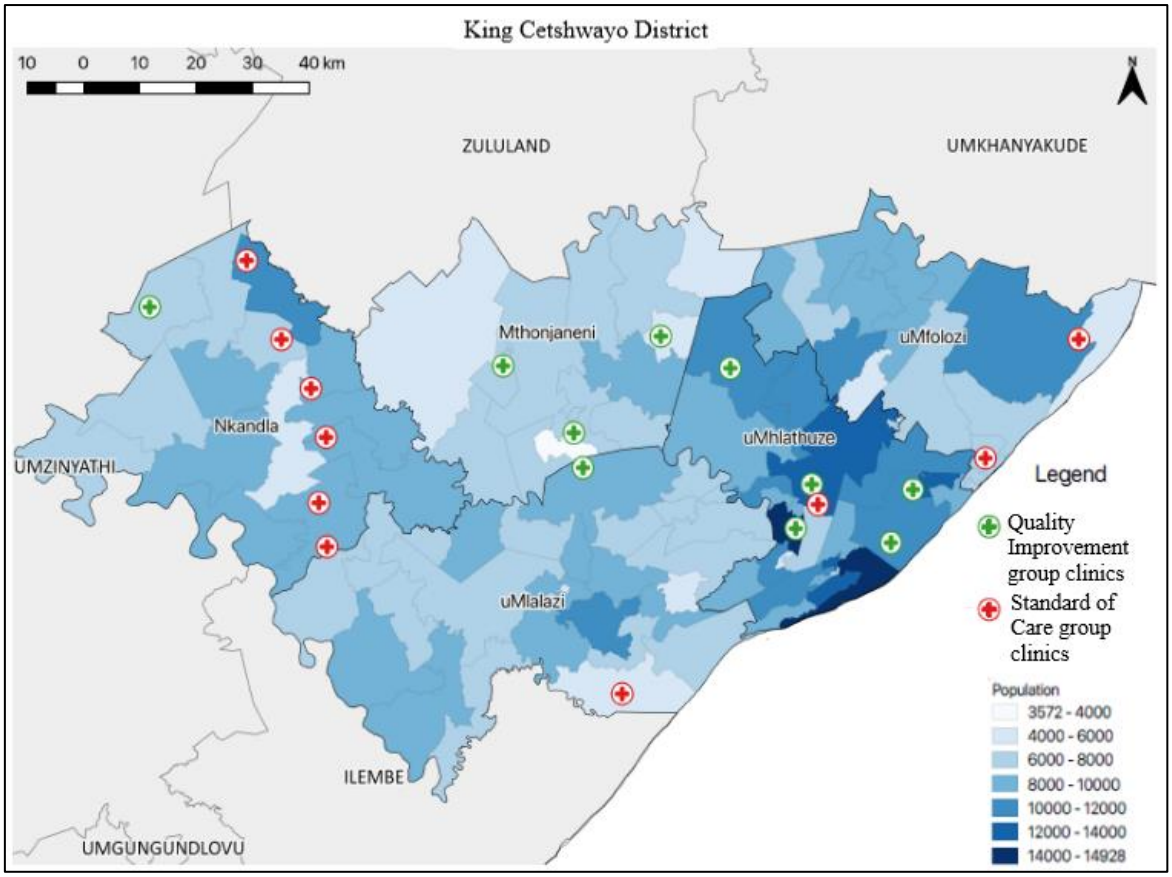

Figure 13: The King Cetshwayo District in KwaZulu-Natal Province*

* Map created using QGIS Geographic Information System, courtesy of Ms Sandrini Moodley (Geospatial Analyst)

Given the high TB incidence and HIV prevalence rates, both the Ugu District and KCD were ideal locations for the SUTHI trial.[32] In both districts, primary health care is free and PHC clinics are the first and main points of entry into the healthcare system for most of the population. [162] PHC care is nurse-driven with only part-time support from a medical doctor. [32]

3.4 The Quality Improvement (QI) intervention

The SUTHI trial structured the QI intervention using the Breakthrough Series Collaborative (BTSC) approach. The eight PHC supervisors and their 20 clinics formed a learning collaborative. The learning collaborative met three times during the 18-month study period for learning sessions (QI workshops). Between learning sessions, two study appointed QI nurse mentors made in-person, face-to-face visits to QI clinics to meet with the clinic teams.

The core QI team was an IHI advisor who served as the subject matter expert in QI, the lead clinician on the SUTHI trial served as the advisor on HIV-TB integration, a data manager with several years of experience in working with SA DOH electronic and database systems

provided expertise on navigating and collecting data from the different SA DoH databases. SA DOH TB and HIV/AIDS, STI and TB (HAST) managers were a part of the core team and gave their input on the possible systems weaknesses and indicators that required intervention.

3.4.1 Learning Sessions

Learning sessions were held over 2 days and facilitated by the study team and an IHI QI Advisor. Clinics assigned to the QI intervention arm were invited to learning sessions, however, to avoid adversely affecting clinic operations, we recommended that only one clinic team member from each major staff category should attend the learning sessions. Major staff categories include nurses, Lay Counsellors and Data capturers. All nurse supervisors assigned to the QI group were invited. Mostly, who could attend the learning sessions was at the discretion of the Nurse supervisors and Operations Manager (OM). The learning sessions were interactive and included: (i) presentations on the epidemiological burden of HIV and TB globally, in South Africa and the study districts; (ii) the principles and theory for the Model for Improvement. (iii) interactive teaching was conducted via group work assignments and time allocated for clinic teams to develop clinic flow charts and use root cause analysis tools. HCWs would showcase ('sell') their change ideas in 'marketplace' sessions. This is where representatives from a clinic were allocated 5 minutes to explain their clinics problem and the change ideas that were developed and tested. Routine clinic data was used to illustrate performance. Critical and constructive feedback was encouraged from all attendees to improve upon change ideas and suggest alternatives or give advice from their own experiences.

3.4.2 Quality Improvement Visits

During clinic visits QI nurse mentors re-enforced knowledge from the learning sessions. At the clinic level, the Model for Improvement framework was adopted where clinic teams identified a specific problem, developed change ideas that addressed the problem and used measurable outcome indicators to monitor that improvement indeed occurred. To drive improvement at the clinic, the PDSA cycle was used to rapidly test and monitor change ideas. QI mentors facilitated clinic-level QI meetings and provided advice, supervision, and mentorship to continue the QI momentum achieved at the learning sessions.

3.4.3 Role of study collaborators

The South African Department of Health

At each learning session, a senior DoH representative from the District Health Office, presented the overall performance of the study district in achieving the UNAIDS 90-90-90 targets for HIV, and highlighted gaps in HIV-TB service delivery. While the presentations were important in emphasizing targets and highlighting gaps, the presence of senior management gave legitimacy and importance to the QI intervention.

The Institute for Healthcare Improvement

The QI advisor from IHI provided the QI training materials and tools and facilitated the learning sessions. Between learning sessions, the QI advisor provided virtual support to study QI nurse mentors via fortnightly teleconferences and reviewed clinic data to track improvement in HIV-TB indicators.

Role of CAPRISA facilitators

All the CAPRISA facilitators and QI mentors attended a 'Train the Trainer' QI course hosted by IHI which facilitated topics such as how to set aim statements, how to conduct root cause analysis, basic data analysis, and data interpretation. Thereafter, CAPRISA facilitators played a major role in training on QI methods under the close supervision of the QI Advisor from IHI. At learning sessions, the PhD candidate provided the overall vision of the QI project and the HIV-TB burden that the QI intervention would attempt to address. The QI mentors' roles also extended beyond the learning session in the form of bi-weekly on-site mentorship visits.

3.5 The standard of care supervision and support

In the study setting, SOC supervision and support comprised monthly visits from the PHC nurse supervisor and quarterly visits by the TB manager and HAST managers from the District Health Offices. In-person visits lasted one to two hours and consisted of a random review of patient chart notes and registers followed by a feedback session to the clinic teams as well as troubleshooting with problems that impeded operations.

The PHC nurse supervisor and the representatives from the District Health Offices adopted a performance feedback approach to improvement using routine data. It is mandatory for all SA DoH facilities to submit their clinics' monthly performance on several HIV and TB indicators, for example, number of HIV tests conducted, or number of clinic attendees screened for TB. This monthly data is used by the District Management Teams (DMT) and

PHC nurse supervisors to make decisions about the HIV and TB programmes and the clinics' performance under their management.

A DOH-initiated initiative of monthly performance monitoring meetings called 'Nerve Centre Meetings' coincided with the start of the SUTHI trial. These mandatory meetings became the key mechanism through which clinics and hospitals received feedback on performance in TB and HIV healthcare delivery and was typically attended by at least one representative from each facility. In addition, members of the DMT made quarterly in-person visits to clinics to review data, monitor service delivery and provide feedback to clinic teams.

Local non-governmental organizations (NGO) are common in the South African healthcare context. Prior to and during the study, PHC clinics in both districts received technical support from local NGOs. Technical support for HIV and TB service delivery included: direct patient care, clinical and data management training.

3.6 Schedule of events and data collection

Table 5 below shows the schedule of events in the PhD project, including timing of learning sessions, QI mentorship visits and data collection.

The Baseline phase: Months -5 to month 0 was the baseline phase (prior to study intervention). HIV-TB process indicators were retrospectively collected for this period.

The Lead-in phase: Month 1 to Month 6 was termed the lead-in phase because the QI group clinics were still becoming accustomed to the intervention,

The Intensive phase: Month 7 to month 12 was termed the intensive phase as two learning sessions were held with fortnightly QI mentor visits, clinic teams were becoming more familiar with QI and taking on more HIV-TB indicators.

The Withdrawal phase: Month 13 to month 18 was termed the withdrawal phase because QI mentors reduced their visits to once a month and no further learning sessions were held.

Table 5: PhD Project Schedule of Events

Study Activity	Baseline	Lead-in						Intensive						Withdrawal						Data Tool
	M -5 to 0	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	Data Collection Tool
ALL CLINICS (INTERVENTION AND CONTROL CLINICS)																				
Retrospective collection HIV-TB process indicators	X																			TB / HIV Integration Data Indicators
SA DOH electronic data downloads	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	Three Integrated Electronic Registers (TIER) and ETR, National Health Laboratory Services (NHLS)
TB and HIV process data collection from registers	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	TB / HIV Integration Data Indicators
Assessment of clinic infrastructure	X																			Clinic profile tool
HIV-TB service integration survey	X						X						X						X	Degrees of HIV-TB integration
Context Assessment for Community Health (COACH)	X						X						X						X	COACH
Data Quality Improvement		Fortnightly QI mentor visits						Fortnightly QI mentor visits						Monthly QI mentor visits						
INTERVENTION CLINICS ONLY																				
Learning Sessions (LS)		X LS1						X LS2					X LS3							
QI mentorship		Fortnightly QI mentor visits						Fortnightly QI mentor visits						Monthly QI mentor visits						

X = Required study activity; M=Month ; LS=Learning Session; QI= Quality Improvement; South African Department of Health; TIER=Three Integrated Electronic Registers, ETR=Electronic TB Register; NHLS=National Laboratory Services

3.6.1 Data Quality Improvement

A roving data quality improvement team, which consisted of data capturers and data managers, were responsible for ensuring the timeliness and good quality data for the study. The responsibilities of the roving data team were to ensure completeness, legibility, and accuracy of the paper-based data sources required for the study (e.g., clinic HTS register, ART register, TB register). A semi-annual patient file audit was conducted to compare accuracy of patient file data to the electronic database. At start of the SUTHI study, the SA DoH rolled out a new version of the patient electronic system which consisted of a new TB data section. This new version of the patient software was to capture TB data into the ART programme data, thereby, integrating ART and TB data into a single database. The roving data team played a role in ensuring that data captured into the electronic TB module was complete and accurate for the duration of the study. Introductory training to the TB module was undertaken by the SA DoH for Data Capturers and the study team provided ad hoc training and support. Data quality improvement activities were conducted in both QI and SOC group clinics to ensure good quality data in both study groups.

3.7 Quality Improvement strategies to identify health systems' weaknesses

A key step in improvement is identifying the problem, weakness or bottleneck in a process that is impeding efficient service delivery. Tools and techniques that were taught to HCWs in the learning sessions are explained below.

3.7.1 Root cause analyses tools

At learning sessions HCWs were introduced to three root cause analysis tools: Process charts, the '5 Whys?', and the Fishbone. The tools were paper-based and HCWs had an opportunity to practice using the tools and present their work at the learning session.

Process flow charts

Process flow charts were used to create a visual representation of patient flow through the clinic or data flow systems. HCWs were taught the correct use of flow chart symbols. [150] Appendix II shows an example of a process flow chart presented in a learning session. The purpose of the flow chart was to create a visual representation of clinic processes to: (i) understand the relationship between different processes, (ii) identify opportunities for improvement (reducing repetition, eliminating wasteful steps, identifying bottlenecks), (iii) standardizing procedures, (iv) showing a

multidisciplinary team the different roles of all individuals and appreciate their own and other team member's contributions. [150]

The 5 Whys?

The '5 Whys' is a brainstorming technique to assist teams to get to the root of a problem. It is an interrogative technique in which clinic teams identify a problem and continue to ask why that problem exists (at least 5 times) until they identify the root cause is. This technique is useful to assist teams in investigating deeper causes of a problem that are sometimes overlooked. While this is a very simple and easy to use technique, there is a concern that healthcare systems are very complex and the 5Whys method does not do justice to the complexity of problems. [163] Addressing the single problem found at the end of the interrogation is not enough to understand the depth and breadth of the problem. [163]

The Fishbone technique

The fishbone analysis is a more sophisticated technique that provides a structured way of analysing a problem. Figure 14 illustrates the fishbone template used to guide HCWs' thinking through a problem. The broad headings forced more thinking across a broader range of topics. QI mentors or clinic teams can control the topics that go in the boxes. The fishbone organises ideas/problems around themes/topics rather than suggests these up-front.

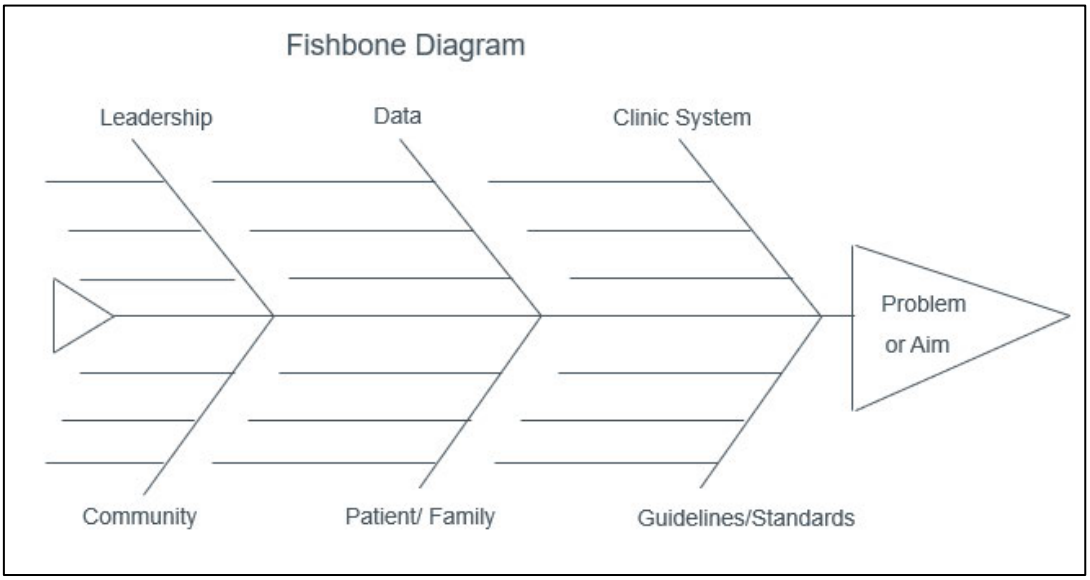

Figure 14: The fishbone diagram

While this technique generated an array of potential problems to address, QI teams may not be able to address all barriers or causes of problems. Instead, teams were encouraged to address problems which were within their control given available resources.

3.7.2 Quality Improvement Tools

The Plan-Do-Study-Act Cycle Template

A template to guide QI clinic teams and document their progress at each step of the PDSA cycle was provided by IHI and is shown in Appendix III. The tool provided a compact, one-page, overview of the specific problem and the plan for addressing the problem. The PDSA template was structured to first display an aim statement, written at the top of the page as a SMART (Specific Measurable Achievable Relevant Timebound) aim. To the extreme right of the page, the process indicators to be measured are listed and on the extreme left of the page the specific change idea to be implemented was described. In the centre of the page, a large PDSA cycle divided into four segments was available, and clinic teams recorded as much detail as possible of the plan, the execution, the progress, and decision on whether to adopt, adapt or abandon the change idea that was tested. Every PDSA cycle had one template dedicated to it and in the next cycle a new sheet was started until the change idea was adopted. These completed PDSA templates were filed at the clinic and study staff collected copies for analysis in the study.

Annotated run charts (line graphs)

Clinic QI teams assessed weekly or daily progress in improvement of an indicator by plotting data onto line graphs. QI mentors and clinic staff annotated the line graphs (using graph paper) with brief notes of any extraordinary events that explained highs and lows in data points. These line graphs were displayed in public areas in the clinic to showcase the clinic's attempts at making progress in HIV-TB service delivery.

3.8 Study population and sample

The PhD study had two study populations of interest: (i) Data was prospectively collected from clinic registers and patient medical files for those accessing HIV and TB services between 01 December 2016 - 31 December 2018 (ii) The healthcare workers providing healthcare services (including data management-related services).

3.8.1 Patients accessing HIV and TB services

Patient accessing HIV and TB services between 01 December 2016 – 31 December 2018 were included in the study. This included patients who were already initiated onto ART and TB treatment as their viral load testing rates were required for this study. The outcome of interest was HIV-TB process indicators which were represented as a proportion of patients eligible for a service who received that service.

3.8.2 Eligibility criteria for Healthcare Workers

Healthcare workers that provided services to patients and employed at the clinic were considered for participation in the surveys and FGDs. Healthcare workers were included in this study if they:

i. Were full time staff members at the clinic
ii. Served at the clinics for at least 1 year
iii. Rendered a medical service to patients or
iv. Were involved in clinic data capturing or
v. Provided administrative support
vi. Agreed to participate and signed the informed consent form

Healthcare workers were excluded if:

i. They were temporary staff or student nurses or volunteers
ii. They did not render a service to the patients (e.g., security guards, cleaners)
iii. They decline voluntary participation

3.9 Study recruitment of Health Care Workers

This study recruited volunteer clinic staff to complete the questionnaires administered by a trained fieldworker. The OM, nurses, lay counsellors and data capturers were invited to participate in the study and the same staff members were approached where possible throughout the study. Participation in the study was on a voluntary basis and staff who agreed to participate had an ethics approved consent form administered to them by a study staff member. It was anticipated that at least one representative from every department within a clinic will participate in the study. No monetary reimbursement was available for participation; however, light refreshments were provided.

Participation in the surveys and FGDs were open to all HCWs from both study groups if they had worked in the clinic for at least 1 year. Study staff attended clinic meetings to prepare the clinic staff for the administration of surveys or to plan for FGDs. Both were on a voluntary basis. Study staff

were instructed to encourage participation from each category of clinic staff. All surveys and FGDs were conducted in private spaces within the clinic. Staff could choose to withdraw from this study after signing the informed consent and continue to participate in the parent study. During the study, no healthcare workers declined participation in the study.

3.10 Quantitative measurement

3.10.1 Process indicators vs patient outcomes

In the PhD project, the main outcome of interest were HIV-TB process indicators. There is a debate regarding which is more useful to monitor, in terms of process indicators or patient outcomes.[164] The advantage of using process indicators over patient outcomes is that they are a direct measure of healthcare quality, they are sensitive to changes in healthcare quality, and easy to interpret. Patient outcomes, such as mortality, are important indicators and often more desirable because they represent the most important goal – to save lives – and mortality is a single measure encapsulating all processes in healthcare quality. [164] The disadvantage of using mortality in the PhD project was that many other factors impact patient mortality that are out of the control of the healthcare system and the QI intervention. In addition, process indicators can be measured in the short-term whereas mortality required a longer follow up time before a difference could be observed. [164]

3.10.2 Data Collection tools

Research in the field of organizational contextual has demonstrated that quantifying contextual factors is possible. [122, 165] For the PhD project this presented a more feasible option, given that 40 clinics were included in the study. Three structured surveys were used to measure aspects of organizational context: The Clinic Profile Tool (CPT), the Context Assessment in Community Health (COACH) tool and the Degrees of HIV-TB integration tool.

The Clinic Profile Tool (CPT)

An element of context that is key to implementation of new practices is access to resources, both human, and physical infrastructure. [128] The Clinic Profile Tool (CPT) was provided by IHI and adapted by the study team to measure availability and utility of five infrastructure domains. Table 5 provides a brief description of each sub-scale in the CPT. The CPT was administered at baseline only and was completed jointly by a study team member and the Operations Manager or designee. The tool is available in Appendix IV.

Table 6: Sub-scales of the Clinic Profile Tool

Sub-scales	Sub-scale description	No.# of scale items	Comment
Clinic Operating time	Operating hours and days of the clinic	4	An indication of flexibility of the clinic to accommodate patients in their community during work hours, after hours, weekends and public holidays.
Infrastructure and Environment	Assesses the presence, utility and cleanliness of clinical rooms and areas of the clinic in which patient care/consultation is carried out.	12	An assessment of physical space required to treat patients (e.g. consultation rooms, waiting areas, pharmacy) and staff areas.
Communication and basic services availability	Availability of electricity, water, telephone services, internet.	6 items	Assesses if basic services are in good supply
Staff employed at the clinic	Categories of staff including, clinical and support staff	17 items	Assesses number of staff per category
District management leadership presence	This category also assesses frequency of leadership visits from the District Management Teams	12 items	Frequency of visits was placed on a scale starting at weekly visits, bi-monthly, monthly, and quarterly
Data Collection Tools & Statistics	Assessed the availability and utility of routine data	10 – items	Use of routine data and electronic databases as well as feedback on performance to clinic teams was assessed.

Supportive context for change

Supportiveness of organizational contexts to make changes or to implement EBPs, is an emerging and widely regarded organizational contextual factor that predicts successful outcomes of improvement interventions.[130, 165] The Context Assessment for Community Health (COACH) tool was designed to measure the extent to which nurses perceived their work environment (i.e., at the clinic level) as receptive and prepared for implementing changes or EBPs.[165] The COACH Tool assesses eight dimensions of organizational context including: Resources, Community Engagement, monitoring services for action, sources of knowledge, commitment to work, work culture, leadership, informal payment. The tool was selected because of its rigorous validation in resource-constrained settings. It has a high Cronbach's Alpha score of ≥ 0.70 which is an indication that items like each other are highly correlated and this is reflective of a reliable tool. [165] The COACH tool was administered at baseline

and at months six, 12 and 18 of the study and was completed by clinic staff who volunteered and agreed to sign the informed consent. The tool is available in Appendix V.

The degree of integrated Tuberculosis and HIV services

The degree to which HIV and TB services are integrated at a clinic level is a function of joint planning and coordination of different clinic teams and systems.[166] A group of researchers developed a survey to rapidly quantify the extent to which HIV and TB services are integrated at primary healthcare clinics.[166] The survey had eight sub-scales that measured aspects of HIV-TB integration, namely, integrated TB and ART service delivery, availability of policies and protocols, integrated TB and pre-ART service delivery, same clinicians for both TB and HIV services, TB infection control, co-operation between TB and ART staff, TB screening, and clinician awareness of patient's co-infection status. The survey was validated in South Africa and has a Cronbach's Alpha of > 0.70. The Degree of integrated TB and HIV services tool was administered at baseline and months six, 12 and 18 of the study and was completed by clinic staff who volunteered and agreed to sign the informed consent. The tool is available in Appendix VI.

Further detail on the scoring of the CPT, COACH and degree of integrated TB and HIV services tool can be found in the Paper III chapter (Table 1 of Paper III) on Page 136 – 138.

HIV-TB Integration process outcomes

HIV-TB process indicators were captured on a paper-based form. The form was structured to capture 12 HIV-TB indicators : HTS coverage, HIV testing for TB patients, HIV / TB Co-infected patients, TB screening coverage (< 5 years), TB screening coverage (> 5 years), TB screening for new HIV positive patients, ART coverage for HIV / TB co-infected clients, TB treatment coverage for HIV co-infected clients, IPT coverage (newly diagnosed HIV clients), IPT coverage for new ART patients, IPT completion rates, Cotrimoxazole Preventive Therapy for HIV / TB co-infected clients. This data was collected monthly for every indicator. Each indicator comprised a numerator and denominator and trained study-appointed data capturers were required to collect this data from clinic registers and if necessary, verify data with patient files and electronic data systems. The tool can be found in Appendix VII.

3.11 HCWs experiences with QI and HIV-TB service integration

FGDs were held in the last 6 months of the study and were intended as study exit interviews. FGDs were planned for that time to allow for QI intervention clinics to be exposed to QI methods for at least 12 months. The purpose of the FGDs was to describe HCWs understanding of HIV-TB integration and their perceptions of QI in QI group and to contrast this with perceptions of the SOC group clinics. Due to budget and time constraints only one round of FGDs with a few clinics were possible.

3.11.1 Recruitment of Healthcare Workers for Focus Group Discussions

Participation in the FGDs were on a voluntary basis for all clinic staff in all study clinics and study staff were requested to recruit at least one representative from each staff category to ensure that all staff were represented in the FGDs. Clinic staff were eligible for participation if: they were either a Professional Nurse, or Enrolled Nurse, or Lay Counsellor, or Data Capturer; had served at the clinic for at least one year; and were full-time employed. Volunteers were required to sign the informed consent form. FGDs were conducted in private spaces within the clinic. In total there were 43 volunteers and 11 FGDs were conducted. Six FGDs with an average of three participants each were from the QI group and five FGDs with an average of four participants were from the SOC group. In the QI group, there were 16 female and four male participants and the mean number of years served in the clinic was 5.5 years (min-max: 1-15). In the SOC group there were 18 females and three males and the mean number of years served in the clinic was 6.8 years (min-max:1-16).

On average, four HCWs participated in FGDs in the QI group and an average of three HCWs participated in the SOC group clinics. In the QI group clinics, there were HCWs from all categories of staff, such as, nurses, lay counsellors, and data capturers. In the SOC group, mostly nurses and data capturers participated.

3.11.2 Data Collection and Analysis Procedures

A study staff member with previous experience in conducting interviews was the Interviewer who led the FGDs. The Interviewer was fluent in the two main local languages (*isiZulu* and English). FGDs were voice recorded and a research assistant made notes and recorded the demographic details of staff who participated in FGDs. FGDs were conducted during clinic lunch breaks (when most staff were available) and lasted between 45- 60 minutes. Two voice recorders were used, and the electronic recording was transferred to a study laptop which was accessed controlled. Electronic

recordings were also saved on the voice recorder and the recorder itself was stored in a locked cupboard when not in use. All FGDs were in *isiZulu.*

Two study staff members, who were not involved in the FGDs, transcribed the discussions verbatim and another staff member then translated the discussions to English for analyses. A random sample of isiZulu transcripts were checked for accuracy and completeness by a research assistant. No major discrepancies were found during the quality assurance process. Two study staff read the English transcripts separately and extracted themes, including any barriers or facilitators to implementing QI or HIV-TB service integration. Themes were compared and common themes adopted. An excel spreadsheet was used to record key sections of the discussion that both coders found to be of relevance to the study. Direct quotes that supported a theme were highlighted. An example of the excel sheet is attached as an Appendix VIII as the entire workbook was too large to append to the thesis.

Transcripts were not re-coded and FGDs were only conducted as a once-off event. Hence it was not possible to follow up on issues raised for further clarification and exhaustively search for themes. The Interviewer and coders had past experience in collecting and analysing qualitative data and had a working knowledge of QI, the SA HIV and TB landscape and challenges experienced in the HIV-TB programme. The study provided extensive training to research staff on HIV and TB guidelines and prior to conducting the interviews several team meetings detailed how the FGDs would be conducted, scripts to introduce participants to the discussion and various scenarios were discussed (e.g. how to deal with long pauses and strong personalities).

The FGD interview guide is available in Appendix IX. The FGD interview guide was developed by the PhD candidate in collaboration with the study QI nurse mentors and field coordinator. The interview guide was designed to guide the FGD, and the interviewer and it contains questions for QI group clinics and SOC group clinics along with prompts to assist the interviewer.

3.12 Collaboration with external stakeholders

At CAPRISA there was no in-house expertise on QI implementation. IHI was contracted to guide the study QI team in implementing QI and to serving as QI mentors the QI intervention group clinics. IHI trained all members of the study team, the PhD candidate, the field coordinator, the QI Nurse mentors on Quality Improvement Leadership Management. This was a 5-day workshop offered by

IHI, for leaders, managers and implementers seeking to improve healthcare services using the Model for Improvement.

The South African Department of Health was also a stakeholder and invited collaborator in the QI intervention and the study. It was anticipated that the SA DOH would play a key role in the implementation of the QI. First, the Director of TB programmes at the provincial level in KZN was a key individual to lend their support to the study and approve the use of an integrated HIV and TB electronic data system. At the study district level, the TB Managers and HIV/AIDS/STI (HAST) Managers were invited to be facilitators and active participants in the QI workshops and clinic-level meetings. At the sub-district level, it was envisioned that PHC Nurse Supervisors would lead the QI implementation at the clinic level and play a key role in championing the QI initiative, thereby creating a potentially sustainable and effective intervention after the study period as well as capacitating a very important cadre of staff – the intermediaries between clinic staff and district level staff.

SA DOH facilities in the Ugu district and KCD are supported by Non-Governmental Organizations (NGO) and for-profit organizations. Prior to the start of the SUTHI study, CAPRISA had been approached by the BroadReach Group (https://broadreachcorporation.com/) to design an intervention that would improve integrated HIV-TB services in clinics being supported by the BroadReach Group. The BroadReach Group is a for-profit organization that has supported SA DOH facilities in the Ugu and KCD district by providing human resources to assist with direct patient care and data management support, particularly with the electronic database development and upkeep. It is through the BroadReach Group that CAPRISA was introduced to PHC clinics and nurse supervisors. Their long-standing relationship and trust built allowed for a smoother entry of the CAPRISA QI mentors and data teams to become a part of the health community in these districts. The BroadReach Group played a role in negotiating access and when needed both organizations assisted with data entry in electronic systems.

3.13 The PhD candidate's role in the SUTHI trial

The PhD candidate was employed at CAPRISA from 01 May 2007 – 31 December 2019 as a Study Coordinator. The student has a Masters degree in Research Psychology, and is an experienced Study Coordinator who has managed several CAPRISA research projects for many years. Her particular interest is health systems strengthening of HIV and TB services. Between 01 May 2014 – 31 December 2019, she was the study coordinator assigned to the SUTHI trial. Her role in the study was

to manage the trial and coordinate the field team. She was responsible for acquiring all regulatory approvals and permissions for the study, training the field team on the study protocol, liaising with study collaborators, and submitting progress reports to the funder.

Assessing the role of OCFs in influencing the QI intervention was conceived by the student and the SUTHI trial Principal Investigator supported the sub-study. The PhD candidate was responsible for designing and identifying data collection tools for the sub-study, acquiring ethics approvals, and training the field staff on data collection procedures. Literature on QI in the TB Programme is scarce and the PhD candidate makes a unique contribution as this is the first study in South Africa to assess the effectiveness of QI in the TB programme while adopting a randomized controlled trial design. The contribution of the PhD candidate to each manuscript is described in Chapter 4.

3.14 Data Management

The data management system that was used for this study is the DataFax system. DataFax is CAPRISA's preferred data management system. The strength of the DataFax system was that it transformed handwritten completed surveys or questionnaires into electronic data and can be programmed to detect missing fields and erroneous data values. All data collection tools were printed at the CAPRISA Head Offices onto bar-coded forms. Data collection tools were completed, and quality checked by the field staff and the study Data Manager for completeness and eligibility. The PhD candidate conducted quality checks on a small number of completed surveys, during field visits. The study Data Manager and PhD coordinator generated data error reports from the DataFax system and set up and coordinated a system for field staff to resolve data errors.

The data collection forms did not record HCW identifiers, such as, South African identity number, DOH staff/personnel number or first and last names. Instead, the HCWs were assigned a unique identifier which they retain for the duration of their participation in the study. A linking log was used to link the unique identifier to the HCW for the purposes of repeat administration of the questionnaires at the different study time points and to resolve any data discrepancies post administration of the questionnaires. Completed data collection forms, signed informed consents, and linking logs were stored in a locked cabinet at the Ugu and KCD field offices and eventually archived by CAPRISA at the end of the study.

3.15 Ethical considerations

3.15.1 Study Permissions

The SUTH trial was submitted to the University of KwaZulu-Natal (UKZN) Biomedical Research Ethics Committee (BREC) and approval was obtained on 13 November 2014 (BREC Reference: BF 108/14) (Appendix X). In addition, the KZN Research Ethics committee approved the study on 19 November 2017 (see Appendix XI). This PhD sub-study was approved by the UKZN BREC, BE673/17 (Appendix XII). The SUTHI trial Principal Investigator granted the PhD candidate permission to embed the project in the SUTHI trial and access data (Appendix XIII)

3.15.2 Confidentiality

HCWs were anonymized on the data collection tools. A unique identifier was allocated to the HCW and a linking log that links the unique identifier to the HCWs names was kept confidentially and securely stored by study staff.

3.15.3 Informed Consent Form

All HCWs who agreed to participate in the surveys or FGDs were administered the informed consent form by a trained field worker. Informed consent forms were available in English or isiZulu depending on the preference of the HCW (Annexure XIV).

CHAPTER 4: PHD MANUSCRIPTS

4.1 PAPER I

A quality improvement intervention to inform scale-up of integrated HIV-Tuberculosis services: Lessons learned from KwaZulu-Natal, South Africa

4.1.1 PhD Candidate's contribution

Student name: Santhanalakshmi Gengiah **Student number:** 204507742

Title of the article: A quality improvement intervention to inform scale-up of integrated HIV-Tuberculosis services: Lessons learned from KwaZulu-Natal, South Africa

Authors: Santhanalakshmi Gengiah, Kogieleum Naidoo, Regina Mlobeli, Maureen F. Tshabalala, Andrew J Nunn, Nesri Padayatchi, Nonhlanhla Yende-Zuma, Myra Taylor, Pierre M. Barker, Marian Loveday

Journal: Submitted to Global Health: Science and Practice on 12 February 2021
Status: Published

Doctoral student's contribution to the journal article:

1. Formulation of the hypothesis: Not applicable

2. Study Design: I was responsible for the design of the intervention in collaboration with the QI advisor from IHI. I designed the change theory for the study and collaborated with SA DoH stakeholders to understand possible primary and secondary drivers that influence HIV-TB integration. I developed the learning session agenda and invited relevant SA DoH stakeholders to be facilitators at learning sessions. I oversaw that the QI clinic teams came prepared to share their experiences and best practices, by designing and providing them with presentation templates. I assisted in developing the study protocol and acquired relevant ethics and SA DoH gatekeeper approvals.

3. Work involved in the study: I oversaw the logistics of planning and coordinating the learning sessions and QI mentor visits to clinics. I set up a feedback system for QI mentors and study clinics to report on all change ideas, special events and occurrences, that may explain performance in HIV-TB process indicators.

4. Data Analysis: I reviewed completed PDSA templates and developed a database to record the health systems weaknesses identified by the QI clinic teams and the associated changes ideas to address weaknesses. I was able to develop a change package by extracting the most common

change ideas used. I developed the dummy tables and figures required for the paper and I worked closely with the study statistician and answered all queries to facilitate the analysis.

5. Write up: I wrote the first draft of the paper and circulated it to co-authors. All co-authors' comments and revisions were incorporated into the paper. I took responsibility for finalizing the manuscript and submitted it to the journal.

I declare this to be a true reflection of my contributions to this manuscript.

Signature:  Date: 08 August 2021

4.1.2 Paper I

GLOBAL HEALTH: SCIENCE AND PRACTICE
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ORIGINAL ARTICLE

A Quality Improvement Intervention to Inform Scale-Up of Integrated HIV-TB Services: Lessons Learned From KwaZulu-Natal, South Africa

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Key Findings

- The quality improvement (QI) intervention was able to guide clinic staff in developing simple but effective change interventions, using resources already available, to improve HIV-TB integrated service delivery.
- The QI intervention implemented dramatically improved isoniazid preventive therapy initiation rates among eligible HIV patients and resulted in moderate improvements in HIV testing and screening, TB screening, and viral load monitoring.

Key Implications

- Program managers should ensure that all categories of health care workers from all levels of the health care system are included in QI workshops or learning sessions to harness the knowledge and experiences of all role players working within the system.
- QI implementers should consider adopting a combination approach to improvement interventions, such as QI training combined with mentorship, collaborative learning, and data QI activities.
- To strengthen and ensure the success of QI interventions, senior-level program managers should consider allocating resources (human, financial, and infrastructure) dedicated to data QI for a sustainable and effective QI program.

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ABSTRACT

Introduction: In South Africa, mortality rates among HIV-TB coinfected patients are among the highest in the world. The key to reducing mortality is integrating HIV-TB services, however, a generalizable implementation method and package of tested change ideas to guide the scale-up of integrated HIV-TB services are unavailable. We describe the implementation of a quality improvement (QI) intervention, health systems' weaknesses, change ideas, and lessons learned in improving integrated HIV-TB services.
Methods: Between December 1, 2016, and December 31, 2018, 8 nurse supervisors overseeing 20 primary health care (PHC) clinics formed a learning collaborative to improve a set of HIV-TB process indicators. HIV-TB process indicators comprised: HIV testing services (HTS), TB screening among PHC clinic attendees, isoniazid preventive therapy (IPT) for eligible HIV patients, antiretroviral therapy (ART) for HIV-TB coinfected patients, and viral load (VL) testing at month 12. Routine HIV-TB process data were collected and analyzed.
Results: Key change interventions, generated by health care workers, included: patient-flow redesign, daily data quality checks; prior identification of patients eligible for IPT and VL testing. Between baseline and post-QI intervention, IPT initiation rates increased from 15.9% to 76.4% (P=.019), HTS increased from 84.8% to 94.5% (P=.110), TB screening increased from 76.2% to 85.2% (P=.040), and VL testing increased from 61.4% to 74.0% (P=.045). ART initiation decreased from 95.8% to 94.1% (P=.481).
Discussion: Although integrating HIV-TB services is standard guidance, existing process gaps to achieve integration can be closed using QI methods. QI interventions can rapidly improve the performance of processes, particularly if baseline performance is low. Improving data quality enhances the success of QI initiatives.

INTRODUCTION

In South Africa, TB remains a public health challenge largely driven by a high background prevalence of HIV, estimated at 12% in the general population.[1] In 2019, an estimated 58,000 people died from TB, of whom 36,000 (62%) were coinfected with HIV.[2] For South Africa to achieve its goal of reducing TB deaths by 95% by 2035, steps to accelerate the reduction in TB mortality are needed, specifically in HIV-TB coinfected patients.[3]

Integrating HIV and TB services (hereafter written HIV-TB services) is a key strategy in reducing TB-related deaths among people living with HIV.[4] HIV-TB services refers to screening, diagnosis, and treatment services provided for both diseases at the same clinic, by the same clinic team, on the same visit day.[5,6] We have previously published the key evidence-based, clinical HIV-TB integration activities that have been shown to reduce TB-related mortality among people with HIV, TB, and both HIV and TB.[7] Specific integration services include HIV testing services (HTS) for all TB patients, TB screening for all clinic attendees, isoniazid preventive therapy (IPT) initiation for eligible HIV patients, antiretroviral therapy (ART) and cotrimoxazole for all HIV-TB coinfected patients, and retention and treatment adherence monitoring.[7] All HIV-TB integration activities mentioned are incorporated into the South Africa National Department of Health (DOH) HIV treatment guideline document.[8] However, suboptimal implementation of HIV-TB services in public health facilities has been observed where opportunities to screen patients for TB, test for HIV, and subsequent linkage to treatment have been missed.[3,9,10] While patient-related factors such as stigma and fear of HIV testing may be contributing to gaps in the HIV-TB care cascade, there is mounting concern that weaknesses in health care systems at the frontline are not adequately addressed.[11]

Operationalizing and delivering high-quality HIV-TB services is complex and challenging in resource-constrained settings.[5,12] The need for simple, low-cost, and sustainable solutions to enhance service delivery was the impetus for introducing quality improvement (QI) methods in public health settings.[13,14] The defining principle of QI is the focus on improving underlying health systems and addressing gaps with feasible solutions.[15] In South Africa, QI was successfully implemented to reduce mortality in mothers, neonates, and infants.[16,17] However, little is known of the effectiveness of QI in reducing mortality in patients accessing public health facilities for HIV, TB, and HIV-TB services.[7]

The Centre for the AIDS Programme of Research in South Africa (CAPRISA), implemented a cluster-randomized trial, the scaling up TB and HIV treatment integration (SUTHI) trial, designed to test the effectiveness of a QI intervention in enhancing HIV-TB service integration to reduce mortality in HIV-TB patients.[7] CAPRISA, in partnership with the Institute for Healthcare Improvement (IHI), designed and implemented a QI intervention to enhance HIV-TB service delivery by identifying and addressing the health system's weaknesses at the primary health care (PHC) clinic level.[7]

In this article, we describe the QI intervention, our theory of change, report the impact of the intervention on HIV-TB services, identify changes that were associated with improved processes outcomes, and elucidate challenges associated with implementing QI to improve HIV-TB services in PHC clinics.

METHODS

The SUTHI Trial

The design and rationale for the SUTHI trial are published elsewhere.[7] Briefly, SUTHI was a cluster-randomized trial in which 16 PHC nurse supervisors (clusters) and the 40 PHC clinics under their oversight were randomly assigned to receive either a structured program of QI training and mentorship to expand the skill and capacity of health care workers in improving HIV-TB services (QI intervention group) or to the standard of care supervision and support (SOC) group as carried out by the South Africa DOH. Eight nurse supervisors and their 20 clinics were assigned to the QI intervention group and 8 nurse supervisors and their 20 clinics were assigned to the SOC group. All clinics were followed up for 18 months.

Setting

The SUTHI trial was located in the King Cetshwayo District and Ugu District in KwaZulu-Natal Province, South Africa. The King Cetshwayo District and Ugu Districts have reported incident TB rates of 859 per 100,000 and 810 per 100,000, respectively; antenatal HIV prevalence rates of 33.4% and 41.7%, respectively; and mortality rates attributable to TB and HIV of 36% and 35%, respectively.[18] Given the high rates of TB and HIV, both districts were ideal locations for the SUTHI trial. In South Africa, PHC clinics are the first point of entry into the health care system for a large majority of the population and services are free.[7] The South African DOH HIV treatment guidelines recommends provision of integrated HIV-TB health care as standard practice.[8]

A QI intervention was implemented to enhance HIV-TB service delivery by identifying and addressing the health system's weaknesses at the primary health care clinic level.

Standard Support and Supervision

The QI intervention in the SUTHI trial was implemented in parallel to other improvement activities undertaken by the district management team (DMT). Improvement initiatives undertaken by the DMTs were considered as a SOC and were

available to the QI group clinics and the SOC group clinics. Both study districts were supported by a highly motivated DMT who conducted routine, in-person, quarterly PHC clinic visits, and weekly data-driven progress update meetings with representatives from all facilities, including SUTHI study clinics. DMT involvement was maintained throughout the study period. Support from local, nongovernmental organizations (NGOs) for the improvement of the HIV and TB programs in both districts were present both before and during the study.

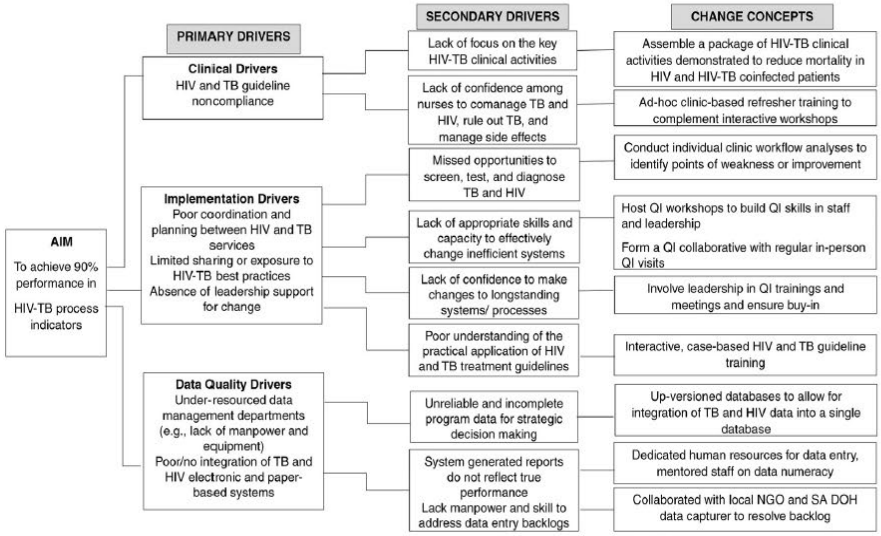
CHANGE THEORY

A change package to guide implementation of HIV-TB services was not available. Instead, we implemented an intervention that would allow change ideas to emerge from the input and experiences of the clinic staff and nurse supervisors in the QI intervention group. Our change theory was premised on a collective understanding from published articles and feedback from implementers on the primary and secondary drivers of poor performance in HIV-TB service integration (Figure 1). Primary elements of our change theory were: (1) HIV-TB clinical content comprising a package of essential evidence-based interventions supported by an implementation algorithm suitable for a clinic setting, (2) implementation content comprising health care worker training and clinical skills capacity building for improved identification and treatment of HIV-TB patients as well as training in QI methodology; and (3) data quality improvement to enhance reliability and completeness of routine HIV-TB data.

Clinical Content

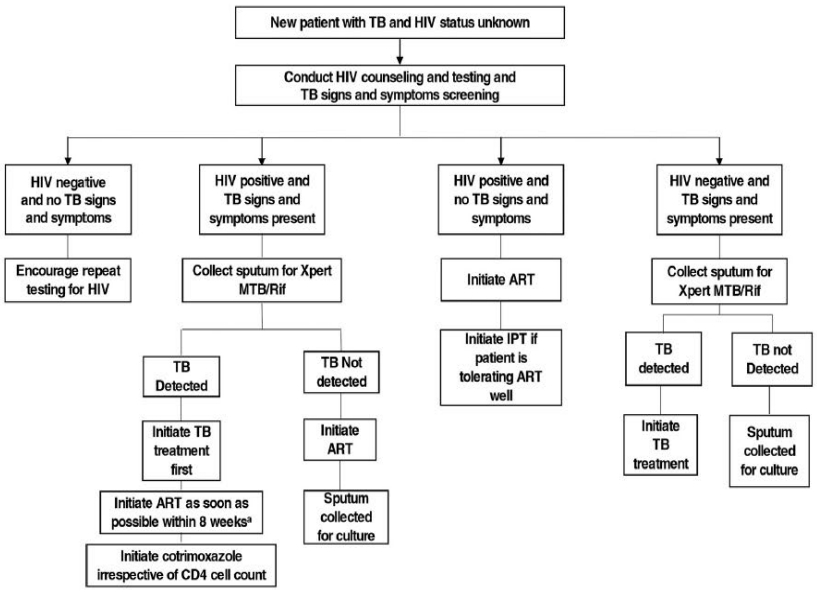
The development of the package of HIV-TB services was preceded by a review of published literature, South African HIV and TB treatment guidelines and policies, and input from experts in the field of HIV-TB co-management to identify the most effective evidence-based clinical activities associated with a reduction in mortality in HIV-TB coinfected patients. We assembled key HIV-TB clinical services into an HIV-TB care algorithm (Figure 2) that served as a training tool for QI group clinics. Health care workers in the QI collaborative were trained to appropriately identify, triage, and treat HIV-TB patients and prevent TB in HIV patients.

FIGURE 1. Change Theory Based on Primary and Secondary Drivers of Poor Performance in Integrated HIV-TB Services and Change Concepts Used in a Quality Improvement Intervention for HIV/TB Service Integration in KwaZulu-Natal, South Africa



Abbreviations: NGO, nongovernmental organization; QI, quality improvement; SA DOH, South African Department of Health.

FIGURE 2. Key HIV-TB Services Care Algorithm Training Tool Used in a Quality Improvement Intervention for HIV/TB Service Integration in KwaZulu-Natal, South Africa



Abbreviations: ART, antiretroviral therapy; IPT, isoniazid preventive therapy; Xpert/MTB/Rif, a rapid, molecular, cartridge-based test used for TB diagnostics that provides an immediate rifampicin resistance result.

[a]For HIV-TB coinfected patients: If CD4<50 cells/μl, initiate ART within 2 weeks of starting TB treatment AND if CD4>50 cells/μl, initiate ART within 2–8 weeks of starting TB treatment.

Implementation Content

Historically, HIV and TB services operated separately; however, the directives, policies, and guidelines from South Africa National DOH to co-locate and integrate both services at a single facility, without adequate implementation guidance, failed to integrate HIV-TB health care delivery.[5] Efficient integration of services requires joint planning and coordination between different departments within a clinic together with the provision of relevant training.[19] We undertook to ensure that staff had the clinical skills to find and treat HIV-TB coinfection and quality improvement skills to strengthen and optimize HIV-TB patient flow and workflow processes.

Improving Clinical Skills in Screening, Diagnosis, and Management of HIV-TB Coinfection

At the start of the study, a 1-day training workshop in each district was conducted for the QI collaborative with a study-appointed clinician trainer and members of the DMT serving as facilitators. The training session emphasized that integrated HIV-TB services meant delivering both HIV and TB care and treatment at the same facility, by the same clinic team on the same day, also known as "the single facility approach."[5] Training content included a review of the Xpert MTB/RIF algorithm for the screening and diagnosis of TB; timing and criteria for ART initiation in TB patients; HIV-TB comanagement in adults, pregnant women, and pediatrics; and utilization of data reports from routine electronic databases to track health systems performance. An interactive, case-based mode of teaching was adopted where treatment and patient scenarios resembled typical real-world situations to which the audience could relate.

Use of QI Methods to Improve Integrated HIV-TB Services

In this study, we used the Model for Improvement as the methodological framework to identify systems' weaknesses and optimize workflow to enhance the performance of HIV-TB services to

acceptable standards stipulated in the UNAIDS 90-90-90 strategy document (Supplement Figure 1).[20]

Each clinic in the QI collaborative reviewed their clinic patient flow to understand the system and identify weaknesses, bottlenecks, or potential improvements that would strengthen HIV-TB care delivery. The clinic QI team consisted of 1 representative from each staff category to ensure all perspectives were represented. Whenever possible, PHC clinic supervisors and clinic operations managers participated in biweekly QI meetings.

The plan-do-study-act (PDSA) cycle was the guiding framework used to test and accumulate knowledge on proposed change ideas. During the plan phase, appropriate clinic team members, who would test the change idea, were identified and roles and responsibilities explained. Change ideas were recorded and as a QI team member tested changes (do phase), other team members collected process data and made observations of any unintended or negative impacts on the system. During the study phase, annotated run charts were used to track the performance of HIV-TB service outcomes and reviewed every 2 weeks by QI clinic teams. In the act phase, the QI team decided on adapting, adopting, or abandoning change ideas. On average, 4 PDSA cycles per HIV-TB indicator were completed before a change idea was perfected and adopted.

Participation in a Learning Network

By partnering with IHI, the SUTHI trial gained an experienced leader in QI implementation methods.

All nurse supervisors and clinics in the QI intervention group formed a learning collaborative that was based on an approach designed by the IHI called a Breakthrough Series Collaborative.[21] The Breakthrough Series Collaborative operates on the principle that, when brought together, organizations working toward a common goal can accelerate learning by sharing knowledge, data, challenges, and experiences.[21] In this study, the learning collaborative was brought together for 3 learning sessions timed at 6-month intervals from the month of study enrollment (details of the learning session content are available in Supplement Figure 2). Key elements of the learning sessions were: (1) didactic teaching emphasizing the global and local seriousness of the HIV-TB co-epidemic and the evidence for integrating HIV-TB services, (2) an analysis of local PHC clinic data and identification of gaps in meeting HIV-TB service delivery targets, and (3) interactive group sessions among clinic teams to discuss challenges and potential solutions. Two study-appointed QI nurse mentors conducted bimonthly face-to-face visits in the first 12 months and thereafter reduced to monthly face-to-face visits in the last 6 months of the study. Face-to-face visits included meeting with the clinic QI teams, observing the clinic teams in their daily routine, and ensuring implementation of QI plans.

Improving Data Quality

A roving team of study-appointed data capturers conducted regular quality assurance checks on patient registers, chart notes, and electronic HIV and TB databases maintained at the clinic. Paper-based systems were checked for completeness, legibility, and accuracy. Every 6 months patient chart note data were compared to the electronic system data for a randomly selected sample of HIV, TB, and HIV-TB patients. Feedback on discrepancies, incorrect, or missing data was given to clinic teams. The roving team assisted with clearing major backlogs in data entry.

Key Inputs for QI Intervention Implementation

The implementation of the QI intervention required the establishment of a partnership between CAPRISA and IHI, appropriately skilled staff to drive the QI activities, and technically skilled data staff to improve data quality.

Local QI expertise, with formal QI training and practical experience, was a scarce resource at the start of the trial. By partnering with IHI, the SUTHI trial gained an experienced leader in QI implementation methods. At the design phase of the study, IHI played a key role in training study staff in QI methods using a train the trainer model. Two study-appointed professional nurses (1 per study district) trained by IHI, drove the QI process at the clinic level and were under the oversight of a QI advisor from IHI who provided mainly virtual support. Each nurse supported 10 QI clinics. Between study enrollment to month 12 made fortnightly, the nurse made in-person mentorship visits to QI clinics. These visits were reduced to monthly mentorship visits between month 13 and month 18.

A data manager based at the CAPRISA headquarters oversaw the roving data quality improvement team that consisted of 2 data coordinators (1 per district), and 6 data capturers (3 per district). The intervention was implemented in the context of a cluster-randomized trial and to ensure that we had comparable data in the QI clinics and SOC clinics, the data team conducted improvement activities in both study groups during the

study. The data team made fortnightly visits to QI improvement clinics and similarly to SOC clinics.

In addition, due to the nature of the trial design, learning sessions were held in conference venues and not on South Africa DOH premises. All costs of the venues, accommodation for trainers, and transport of health care workers were borne by the study.

Study Outcomes and Data Collection

HIV-TB process indicators were collected every month from paper-based registers (ART, TB, and HIV registers), electronic databases, and patient chart notes. These data were recorded onto paper-based data collection tools and faxed to the central office. Training registers were completed at each QI workshop, recording the number and designation of health care workers that attended. The QI nurse mentor and clinic QI team maintained detailed records on a PDSA template (provided by IHI) of the dates that QI work began per indicator and the change ideas, adaptations, and challenges encountered. The completed PDSA templates were submitted for analysis. Table 1 defines the HIV-TB process indicators that clinic teams selected for improvement and data elements used to calculate performance. For ease of reference, a shortened name (abbreviation) was assigned to each indicator in Table 1 and will hereafter be used in all subsequent sections.

Statistical Analysis

We analyzed data at the nurse supervisor level (the cluster). Monthly performance for each HIV-TB process outcome was calculated by summation of numerators of all clinics that comprised a cluster and divided by the sum of the denominators of all respective clinics in the cluster. The mean of all cluster means reflected the monthly performance, which was then plotted as *xmr*-charts (Figure 3). A run of 8 or more data points on 1 side of the center line was defined as a shift and a run of 8 or more data points in an upward or downward direction was defined as a trend.[22] Geometric means were calculated as a single estimate of baseline performance (last 6 months before study enrollment) and for the post-QI intervention phase (months 13–18) (Table 2). The absolute difference between the post-QI intervention geometric mean and the baseline geometric mean was calculated to reflect the size and direction of the improvement. Paired *t*-test was used to determine if differences between

TABLE 1. Definitions of HIV-TB Process Indicators Used in the Quality Improvement Intervention to Integrate HIV-TB Services in KwaZulu-Natal, South Africa

HIV-TB Process Indicator	Abbreviation	Definition
HTS for PHC clinic attendees	HTS	Percentage of patients that accessed HIV tests, expressed as a percentage of the clinics' HIV testing target[a] Numerator: Number of patients tested for HIV Denominator: Clinic assigned target for HTS
TB screening among PHC clinic attendees	TB screening	Percentage of clinic attendees screened for TB signs or symptoms[b] Numerator: Number of clinic attendees screened for TB signs and symptoms (adults and children) Denominator: Clinic headcount (Number of people accessing any health services at a facility during a specified period)
Initiating IPT among eligible new ART patients	IPT initiation	Percentage of new ART patients initiated onto IPT Numerator: Number of new ART patients initiated on IPT Denominator: Number of new ART patients with no signs or symptoms of TB
ART initiation among TB/HIV coinfected patients	ART initiation	Percentage of TB/HIV coinfected patients initiated on ART Numerator: Number of TB/HIV coinfected patients initiated on ART Denominator: Number of confirmed TB patients tested positive for HIV
VL testing at month 12 after ART initiation[c]	VL testing	Percentage of eligible ART patients who had a VL test at month 12 after ART initiation Numerator: Number of ART patients who received a VL test at month 12 after ART initiation Denominator: Number of ART patients eligible for a VL test at month 12 after ART initiation

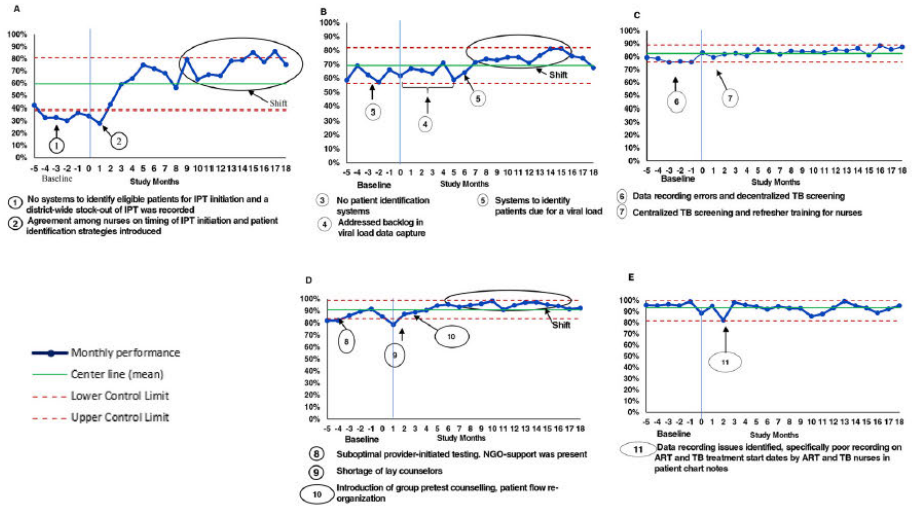
Abbreviations: ART, antiretroviral therapy; HTS, HIV testing services; IPT, isoniazid preventive therapy; PHC, primary health care; VL, viral load.
[a] All clinics receive a monthly target for HIV Testing Services from their respective District Offices.
[b] TB signs and symptom screening refers to the verbal screening checklist which documents the common signs and symptoms of TB (current cough of any duration, fever for >2 weeks, drenching night sweats, Unexplained weight loss of >1.5kg in a month).
[c] According to the South African National Department of Health National Consolidated guidelines, a viral load test is required at month 6 and month 12 after ART initiation and annually thereafter. This study focused on the month 12 viral load only.

TABLE 2. Summary of Changes in HIV-TB Process Indicators Used in the Quality Improvement Intervention to Integrate HIV-TB Services in KwaZulu-Natal, South Africa

HIV-TB Process Outcomes	Proportions (95% CI)		Absolute Difference	*P* Value	Clinics[a] (N=20)	PDSA Cycles Mean, (Range)
	Baseline	Post-QI Intervention				
HTS	84.8 (75.5,95.3)	94.5 (89.3,99.9)	9.7	.110	12	3 (1–7)
TB screening	76.2 (65.4, 88.9)	85.2 (78.7,92.2)	9.0	.040[b]	17	4 (1–9)
IPT initiation in new ART patients	15.9 (4.8,52.5)	76.4 (66.3,88.1)	60.5	.019[b]	20	4 (1–11)
ART initiation in HIV-TB patients	95.8 (93.3,98.3)	94.1 (89.7,98.6)	−1.7	.481	3	1 (1–3)
Viral load monitoring	61.4 (56.4,66.8)	74.0 (65.5,83.6)	12.6	.045[b]	20	4 (1–7)

Abbreviations: ART, antiretroviral therapy; CI, confidence interval; HTS, HIV testing services; IPT, isoniazid preventive therapy; PDSA, plan-do-study-act; QI, quality improvement.
[a] Number of clinics engaged in quality improvement.
[b] *P* value significant at <.05 using paired *t*tests.

FIGURE 3. xmr Charts of Monthly Performance in HIV-TB Process Indicators in a Quality Improvement Intervention for HIV/TB Service Integration in KwaZulu-Natal, South Africa (a) Percentage of Eligible New ART Patients Initiated on IPT; (b) Percentage of ART Patients With a Viral Load Test Conducted; (c) Percentage of PHC Clinic Attendees Screened for TB; (d) Percentage of HIV Target Achieved; (e) Percentage of HIV-TB Coinfected Patients Initiated on ART



Abbreviations: ART, antiretroviral therapy; IPT, isoniazid preventive therapy; PHC, primary health care.

baseline and post QI intervention phases were statistically significant for each indicator. Completed PDSA templates were examined by 2 study staff members and common systems weaknesses and associated change-ideas were identified and summarized.

Ethics

The SUTHI trial was approved by the Biomedical Research Ethics Committee of the University of KwaZulu-Natal (BREF Ref 108/14). Informed consent for the study was waived.

The KwaZulu-Natal Health Research and Knowledge Management committee granted permission to access PHC clinics in the study districts of KwaZulu-Natal (HRKM309/14).

RESULTS

The QI intervention was conducted from December 1, 2016, to January 1, 2019. Table 3 provides a summary of health care workers who attended the 3 learning sessions. At no learning session were all 8 PHC clinic supervisors present.

Clinic QI teams identified HIV-TB processes for improvement based on findings of patient- and work-flow analyses and suboptimal performance at baseline (Table 4). Systems weaknesses and opportunities for improvement were identified in all clinics for IPT initiation and VL testing at month 12 after ART initiation. However, HTS, TB screening, and ART initiation became the foci of QI initiatives in, 17 and 3 clinics, respectively. Clinics that did not actively engage in improving an indicator continued to monitor performance only. All clinics were included in analyses of the performance of the collaborative.

IPT initiation at baseline was 15.9% (95% confidence interval (CI)=4.8,52.5) (Table 2). The main causes of poor IPT initiation were identified as uncertainty among nurses on timing of IPT initiation in new ART patients and weak systems to identify returning ART patients who were eligible for IPT (Table 4). The improvement in IPT initiation observed after the start of the QI intervention was due to a district-level IPT stock-out in the baseline period. (Figure 3A). By study month 6, a 64.8% IPT initiation rate was achieved. In the last 6 months of the study, the QI collaborative achieved a mean of 76.4% (95% CI=66.3,88.1), a 5-fold higher mean than at the baseline phase, P=.019 (Table 2). On average clinics carried out 4 PDSA cycles to improve IPT initiation, and while major improvement was observed, the target of 90% was never attained in the study. Improvement in IPT performance is observed from month 1; however, a shift above the mean was observed from month 9 to 18 (Figure 3A).

At baseline, the mean rate of VL testing was 61.4% (95% CI=56.4,66.8), 28.6% below the 90% desired target. Major backlogs in VL data entry that generated inaccurate VL completion reports were the main cause of poor performance identified by the QI teams. In the first 6 months post-study enrollment, no QI activities were recorded in any QI clinics to improve VL, instead, efforts to reduce the data entry backlog for the last 12 months were undertaken and QI activities were started closer to study month 6 (Figure 3B). A shift above the mean was observed from month 6 to 16. During the last 6 months of the study, the

TABLE 3. District and Clinic Staff Trained in Quality Improvement Methods for a Quality Improvement Intervention for HIV/TB Service Integration in KwaZulu-Natal, South Africa

Staff Category	Pool of Health Care Workers Available N=259	Actual Number Trained in QI: Learning Session 1 N = 63 n (%)	Learning Session 2 N=61 n (%)	Learning Session 3 N = 45 n (%)
District Management Team				
TB program manager	3	2 (3)	1 (2)	2 (4)
HIV/AIDS/Sexually transmitted infection and TB manager	2	2 (3)	2 (3)	2 (4)
Training coordinator	2	2 (3)	2 (3)	0
Nurse supervisors	8	5 (8)	4 (6)	3 (7)
Subtotal	**15**			
Clinic Staff Categories				
Operations managers	19	11 (17)	9 (15)	9 (20)
Professional nurses	85	6 (10)	11(18)	8 (18)
Enrolled nurses/ enrolled nurse assistants	61	8 (11)	6 (10)	1(2)
Data capturers	36	17 (27)	18 (30)	19 (42)
Lay counselors	43	10 (16)	8 (13)	1 (2)
Subtotal	**244**			

TABLE 4. Health Systems Weaknesses Identified and Associated Change Ideas for a Quality Improvement Intervention for HIV/TB Service Integration in KwaZulu-Natal, South Africa

HIV-TB Process	Health Systems' Weaknesses Identified	Change Concepts
HTS	Relying only on patient requests or referrals for HIV testing.	**Introduced strategies to enhance provider-initiated testing:** • Offered group pretest counseling in all patients' waiting areas • Implemented a daily roster system of staff to conduct pre-test counseling • Nurse in charge or designee to check accountability log daily
	Missed opportunities to offer HTS to all patients • Acute patients were overlooked for HTS services (e.g., wound care patients)	**Redesigned clinic patient flow** • Ensure that acute patients are directed to lay counselors after vitals assessments[a] are conducted • If above not possible, then staff caring for acute patients were (i) trained in HIV testing and counseling and (ii) provided with the appropriate HTS stationery
	HTS data inaccuracies caused by: • Not completing HTS registers in real-time • Misplacing HTS registers	**Daily data quality control checks** • Daily quality control of HTS registers and frequent audits of patient files and electronic data to ensure HIV status is known for all patients
	Overdependence on lay counselors • HTS viewed as the work of lay counselors • Lack of counseling skills among nurses to relieve/stand-in for lay counselors	**Increasing the accountability and responsibility for the HTS program** • On-site HTS refresher training was held which addressed: pre- and post-test counseling messages, conducting HIV rapid tests, and data recording • Awareness of clinic target set by the district health office was disseminated
TB screening among PHC clinic attendees	Missed opportunities to offer TB screening to all clinic attendees	**Centralized TB screening** • Made TB screening mandatory at an identified strategic point visited by all patients, such as, vitals assessment[a] station • Visual prompts and reminders to conduct TB screening included large and colorful TB posters, printed and easily accessible signs, and symptoms checklists • Made TB screening mandatory for acute patients
	Inaccurate TB screening data	**Data quality control checks** • Daily data quality control checks conducted by nurse in charge or designee to check: ◦ Completeness and accuracy of daily TB screening register ◦ Number of symptomatic patients and number of sputum samples sent for Xpert/ MTB Rif[b] testing • Quality control of clinic headcount[c] data: ◦ Exclude patient representatives or family members ◦ Subtract TB confirmed patients from the clinic headcount ◦ Mass TB screening campaigns conducted in communities must be distinguishable from screening conducted in the clinic
IPT initiation among new ART patients	Ambiguity in IPT initiation guidelines • Nurses lack clarity on timing of IPT initiation • Individual nurses use own discretion to start IPT	**Clarify IPT initiation timing and arrive at mutually agreed upon timing for initiation** • Each clinic team arrived at a common time to start IPT (e.g., 7,14, or 30 days after starting ART) • Agreed upon timing was documented and standardized for entire clinic

Continued

TABLE 4 Continued

HIV-TB Process	Health Systems' Weaknesses Identified	Change Concepts
	Confusion about roles and responsibilities of clinic staff	**Enhancing accountability and responsibility for IPT program** • Roles and responsibilities were assigned to all staff categories and documented
	No system for identifying patients eligible for IPT	**Strategies to identify patients returning at the agreed upon time for IPT** • The "box system" -eligible patients' files placed in a decorated box for easy identification, OR • Tagged files of eligible patients with stickers or red ink OR • The "diary system" reminder note in clinic diary to initiate IPT at next visit and note attached to patient file
	Poor recording of IPT initiation date in clinic chart notes	**Refresher training on clinic stationery to document IPT** • Nurses directed to document start date in designated fields and data capturers shown where to find the start date
	Nurses lack confidence to rule out TB	**Host a training for nurses, lay counselors, and data capturers highlighting the importance and potential benefit of IPT for HIV-infected patients** • Link this training with the TB screening training (above) to boost confidence to rule out TB
ART initiation among HIV-TB coinfected patients	**Patient chart notes for TB and ART kept separately** • TB and ART files not integrated • No unique identifier for TB and ART file	**Combining ART and TB files** • For HIV-TB coinfected patients, ART and TB chart notes were physically combined • The district health office agreed upon a common unique identifier to be used • The TB module on the electronic ART database was activated to accommodate TB and ART data
	Poor coordination between NIMART and TB nurses regarding ART and TB treatment initiation	**Refresher training for nurses** • Clarified patient flow for ART initiation visits in TB/HIV coinfected patients • Improved chart notes for ART and TB treatment start dates
VL monitoring at month 12 after ART initiation	No system to identify patients eligible for month 12 VL tests	**Generate report from electronic system of patients due for VL** • Address the data capturing backlog of VL results and ART initiation • Draw on the assistance of local nongovernmental organizations and support partners for assistance with data capture • Generate VL reports from the data system to determine which patients have not had or are due for VL test (filter out deceased and transferred-out patients) • Tag/mark the files of patients due for VL for easy identification • Trace patients who were missed for a VL test

Abbreviations: ART, antiretroviral therapy; HTS, HIV testing services; IPT, isoniazid preventive therapy; NIMART, Nurse Initiated Management of Antiretroviral Therapy; PHC, primary health care; VL, viral load.

[a] Vitals assessments refers to general measures of well-being which typically include weight, body temperature, blood pressure measurements.

[b] Xpert/MTB RIF a rapid, molecular, cartridge-based test used for TB diagnostics that provides an immediate rifampicin resistance result.

[c] Clinic headcount refers to the total number of patients who accessed the clinic for any type of clinical service.

mean VL monitoring rate was 12.6% higher than the baseline rate (P=.045), which was less than 50% of what was needed to meet the target (Table 2).

Data inaccuracies were noted at baseline for TB screening (Figure 3C). Data quality checks and refresher training were change ideas tested for improvement (Table 4). Mean TB screening rates

improved by 9% between the baseline period and post-QI intervention (Table 2), and the 90% target was not achieved by the collaborative.

Mean ART initiation rates were greater than 90% at baseline and continued post-intervention period (Table 2). The monthly performance in ART initiation was addressed only in 3 clinics, and the decrease of 1.7% was not significantly different from baseline performance (P=.481). HTS was the only indicator that was improved and exceeded the 90% target (Figure 3D, Table 2).

DISCUSSION

This article describes the QI intervention implemented in the SUTHI cluster-randomized trial to improve HIV-TB health care performance. In South Africa, integrated HIV-TB services are mandatory, and this study shows that improvement in HIV-TB process outcomes is needed and possible. Using the Model for Improvement, we showed that IPT initiation improved substantially; whereas HIV testing, TB screening, and VL monitoring were moderately improved, and ART initiation among HIV-TB coinfected patients was an already well-performing indicator that required monitoring and only a few clinics had to strengthen coordination between the TB nurses and ART-initiating nurses. An important output of the QI intervention was a set of change ideas that are potentially transferrable to other settings and could contribute to the improvement of integrated HIV-TB services.

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The role of contextual factors in influencing improvement outcomes is emerging as an important consideration when assessing QI initiatives.

Several factors can be attributed to the success of IPT initiation rates in this study. First, clarifying nonspecific initiation guidelines improved decisiveness among nurses in the timing of IPT initiation. Second, as IPT is an indicator monitored at the district and provincial levels, clinic staff were motivated to improve IPT performance. Third, low performance at baseline (15.9%), increased the likelihood and potential for improvement. Fourth, improving IPT initiation and data completeness in patient files and on IPT dispensing and stock charts, subsequently improved the IPT supply chain. The supply of IPT depends on demand for IPT. Improved IPT dispensing data provided a better reflection of the clinics' demand for IPT, and the ordering of stock was adjusted accordingly. Interestingly, approximately 6 months of QI to improve IPT and HTS was undertaken before the shift was observed. This may indicate that clinics require approximately 6 months to completely embed new processes into the clinic.

Three systematic reviews evaluating the effectiveness of QI collaboratives concurred that the size of improvement observed is often a function of baseline performance and low-performing indicators are more likely to have larger improvement.[23,24] A QI approach to improving IPT initiation was successful in other resource-constrained settings. In a Namibian case study of QI capacity development, IPT initiation resulted in a 12% increase (from 16% to 28%) at a national level.[25] In a Nigerian case study, situated at a single state-run hospital, IPT initiation improved by 39% (11% to 50%).[26] Interestingly, the Namibian study was at a national level and the Nigerian study was conducted at 1 facility.[25,26] Similar to the SUTHI study, the Nigerian study was more active in addressing issues of organization, process, management, and systems. The authors surmise that root cause analysis and first-hand involvement of clinic staff in developing systems played a role in achieving improvement.[26]

A systematic review of strategies to improve health care performance showed that large improvements (defined as 20–30 percentage point improvement) are generally achieved in strategies that used a combination of training, collaborative learning, supervision, and improvement of infrastructure (such as data quality improvement), as was done in the SUTHI trial.[27] Yet, provider-initiated HIV testing and TB screening achieved modest improvement (defined as 5–10 percentage points). VL monitoring moderately improved from baseline (defined as between 10–20 percentage points) and ART initiation slightly decreased. These results are evidence that other factors drive the success of an improvement strategy. The role of contextual factors in influencing improvement outcomes is emerging as an important consideration when assessing QI initiatives.[28,29] Work culture, access to knowledge resources, QI leadership, supportiveness of work environments, and staff motivation and willingness to question the status quo, are but a few examples of contextual factors that may influence the success of QI initiatives.[28,30,31]

Lessons Learned

In the SUTHI trial, we identified important factors that may explain the suboptimal improvement for some indicators. The effect of baseline performance was to the advantage of IPT improvement; however, HIV testing services and ART initiation in HIV-TB coinfected patients were high at baseline, and there was little room for improvement thereafter. Future QI interventions should consider baseline performance when setting expectations for improvement, however, we do not recommend that

baseline performance be considered the sole criteria for selecting indicators for improvement. This study showed that there are indicators that are close to reaching targets but appear to be plateauing, for example, VL testing (Figure 3B) and TB screening (Figure 3C). QI improved both indicators and still has a role to play in addressing the barriers that prevent these indicators from reaching the desired target of 90%.

Capacitating clinic staff with data analytic skills is an important factor in ensuring the success of QI interventions because it improves technical skills, confidence, and self-efficacy of clinic teams.[32] In addition, monitoring improvement using routine data is fundamental to the QI intervention. Learning sessions covered the basics of how routine data can be analyzed (e.g., calculation of percentages, means, and medians), plotted onto run charts, and interpreted using run-chart rules. QI mentors reinforced this knowledge at QI mentorship visits. Poor data quality threatens clinic teams' efforts to monitor improvement and is a barrier to successful QI implementation.[33] Despite our attempts to address the completeness and accuracy of routine data, poor data quality undermined our QI intervention. For example, TB screening data were adversely impacted by inflated clinic headcount numbers (the denominator), incorrect completion of TB screening registers, and misplaced TB registers. The success of VL monitoring improvement depended on accurate and complete data entered into the patient electronic database; however, nearly 6 months of addressing data entry backlogs reduced the time available to improve the indicator coupled with challenges of tracing of patients to return to the clinic. Tracking patients is a resource-intensive effort due to poor telephonic services, lack of vehicles, and incomplete patient contact information (namely, telephone/mobile data, lack of street addresses).

A Ugandan-based QI project that aimed to improve TB case notification also relied on routine data to monitor improvement and went beyond checking clinic registers for completeness and accuracy.[34] A data tool was used to triangulate patient data from multiple sources, that is, laboratory data, patients' chart notes, and TB laboratory data.[34] Unfortunately, no data metrics were available to quantify the extent to which data was improved. A South African QI project to prevent mother-to-child transmission of HIV in labor wards used a specially designed checklist that included prompts for nurses to complete and document important tasks.[17] Following this intervention, there was a marked improvement in data quality with erroneous data, namely, percentages greater than 100% being eliminated. These studies demonstrate that innovative measures are needed to improve the quality of routine data and adding additional human resources to improve the completeness and accuracy of data may not be sufficient.

We intended for PHC clinic supervisors to lead the QI intervention, but their involvement was limited by their workloads and conflicting meetings. Clinic staff selected to attend the learning sessions did not always pass on their learnings from the workshops to their colleagues and the study-appointed nurse mentors reported resistance from non-workshop attendees to the workflow changes. A mixed-methods study identified personal- and work-environment-related factors that influence a health care worker's ability to transfer knowledge from QI trainings to peers.[35] Health care workers that are successful in transferring training knowledge have a positive attitude to implementing changes, interpersonal skills to address resistance from peers, and the ability to question the status quo.[35] A work environment in which teams are receptive to new ideas, supportive of change, and leadership support is present, facilitates the transfer of training knowledge.[35] In the SUTHI trial, selection of clinic staff to attend learning sessions was at the discretion of the PHC clinic nurse supervisor and nurse in charge of the clinic. While individuals from all clinic departments were trained, staff categories, such as data capturers and lay counselors may not have been empowered enough to transfer their new knowledge to more senior colleagues. Future QI interventions must consider screening potential QI trainees for the appropriate qualities that will allow for the transfer of QI knowledge.

Despite our attempts to address the completeness and accuracy of routine data, poor data quality undermined our QI intervention.

Future QI interventions must consider screening potential QI trainees for the appropriate qualities that will allow for the transfer of QI knowledge.

Challenges in QI Implementation

Implementation of QI at the clinic level was accompanied by several challenges. First, QI was vaguely understood in both districts and clinic teams often believed that they were implementing QI by virtue of the weekly nerve center meetings and discussing problems and challenges at staff meetings. The need for the SUTHI QI intervention was initially unclear to QI clinics. The learning sessions established the importance of using a QI approach that is guided by a framework (Model for Improvement and PDSA), uses tools (e.g., process charts), locally developed strategies (change ideas), and monitoring progress with

Consistent visits and mentorship by the QI nurse mentors were critical in demonstrating how the frameworks and tools translated to practice.

data. Importantly, the consistent visits and mentorship by the QI nurse mentors were critical in demonstrating how the frameworks and tools translated to practice.

Secondly, QI implementation adds additional work for clinic staff, in that data needed to be collected and recorded to track progress more frequently. While change ideas were implemented, it was a challenge to keep staff motivated to track their performance. For example, in HTS, group pretest counseling was a key change idea; however, the source documents developed to track the number of group pretest counseling sessions in patients' waiting areas were not completed.

Third, leadership at the clinic level was supportive of the QI intervention; however, due to many commitments in and outside of the clinic, there was little involvement of clinic leaders in the QI meetings. This delayed implementation of some change ideas, as junior-level clinic staff do not have major decision-making power to make changes, such as in clinic patient flow.

Limitations

The study had limitations. First, while the QI intervention was implemented in the context of a randomized controlled trial, we were unable to prevent exposure of QI clinics from other improvement interventions to enhance integrated HIV-TB services, particularly, improvement efforts of the DMTs and technical assistance from local NGOs. Motivated DMTs in both study districts frequently monitored the progress of HIV and TB process indicators, fed back to poorly performing clinics, and conducted quarterly in-person visits to all clinics. The true effect of the QI intervention has likely been masked by the improvement efforts of the DMTs and local NGOs. Although the study was unable to separate the effect of the DMTs' efforts and QI intervention efforts on improvements observed, the baseline period (Figure 3A–3E) offers some insight into the performance before and after the QI intervention was implemented. The QI intervention ideally complemented the performance monitoring and feedback efforts of the DMTs which were seldom able to conduct in-depth root cause analyses of systems weaknesses and develop clinic-specific interventions. Second, the study was not adequately resourced to determine if improvements in the QI clinics were sustained beyond the study period or if the QI tools, strategies, and best practices were scaled up to more clinics in other areas. Staff turnover and changes in key personnel, who were trained in QI methods, may add to the challenge of sustaining and scaling up QI activities once the study ended. Third, as per the study design, all analyses were at the cluster level and clinics within each cluster were considered as 1 unit. However, the QI intervention was at the clinic level, and different clinics within a cluster adopted different change ideas (such as the different timing of IPT initiations in Table 4), and we could not compare clinics to determine which change ideas translated to larger improvements.

CONCLUSION

This study showed that a QI approach to improving HIV-TB health care delivery is feasible and uptake of QI among clinic teams is evident across all indicators. With guidance, clinic staff can reveal weaknesses and gaps known only to the people who work within a system. Baseline performance of an indicator should be considered when setting expectations and assessing the size of improvement. Efforts to improve the quality of routine HIV and TB data need to be intensified for future QI efforts to be successful. The importance of basic clinical skills training should not be underestimated; however, innovative approaches to teaching health care workers need to be introduced for information to be retained and facilitate practical application. Lastly, QI complements the efforts of local NGOs and routine monitoring activities of the South Africa DOH.

Acknowledgments: We thank the South African Department of Health, District Management Teams of the Ugu and King Cetshwayo Districts for supporting this study; the nurse supervisors and clinic staff for sharing their best practices, supporting the study, and collaboration between clinics; the CAPRISA SUTHI Quality Improvement nurse mentors and the roving Data Management Team for their tireless efforts in the field.

Funding: SG is currently a University of KwaZulu-Natal (UKZN) Developing Research Innovation, Localisation and Leadership in South Africa (DRILL) fellow. DRILL is a NIH D43 grant (D43TW010131) awarded to UKZN in 2015 to support a research training and induction program for early-career academics. SG was supported by the European and Developing Countries Clinical Trials Partnership (EDCTP) Grant TMA2018SF-2467. The research reported in this manuscript was supported by the South African Medical Research Council, with funds received from the South African National Department of Health, and the United Kingdom (UK) Medical Research Council, with funds received from the government's Newton Fund. This UK-funded award is part of the EDCTP2 program supported by the European Union.

Disclaimer: The content is solely the responsibility of the authors and does not necessarily represent the official views of Developing Research Innovation, Localisation and Leadership and the National Institutes of Health. The funders had no role in the study design, execution of the study, analyses and interpretation of data, or the decision to submit results for publication.

Author contributions: SG was responsible for the study conduct, had oversight of the study operations, development of the first draft of the manuscript, intellectual input, analysis, and interpretation of the results. KN edited and reviewed the manuscript and had oversight of the study. RM led the field team and edited the manuscript. MFT provided guidance to the field

team on QI implementation and interpretation of results. AJN and NYZ provided input on the analysis and interpretation of results. NP provided intellectual input and contributed to the writing of the manuscript. MT edited the manuscript and provided intellectual input. PMB provided input on the study design and manuscript. ML provided input on the interpretation of the data, intellectual input, and editing of the manuscript.

Competing interests: None declared.

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Peer Reviewed

Received: February 9, 2021; **Accepted:** July 22, 2021.

Cite this article as: Gengiah S, Naidoo K, Mlobeli R, et al. A quality improvement intervention to inform scale-up of integrated HIV-TB services: lessons learned from KwaZulu-Natal, South Africa. *Glob Health Sci Pract*. 2021;9(3):444-458. https://doi.org/10.9745/GHSP-D-21-00157

4.1.3 Discussion of Paper I

Paper I is responsive to specific objective 2 of the PhD thesis. The paper was accepted on 22 July 2021 and currently is in production with Global Health: Science and Practice. This paper provides a detailed description of the change theory that guided the implementation of the QI intervention, the change ideas that emanated from clinic staff, and implementation of the intervention in the field. We document the lessons learned in implementation of the QI intervention and various organizational contextual factors are highlighted either as barriers or facilitators to the QI process.

A highlight of the paper are the health systems' weaknesses identified by clinic staff and the change ideas developed and tested to address them. The paper shows the extent to which the QI intervention was able to improve HIV-TB process indicators between the baseline and withdrawal phase. This gives the reader a opportunity to observe trends in improvement at all phases of the QI intervention. In summary, not every HIV-TB process indicator required improvement and those that did could only be improved to a certain extent. Of the 20 QI clinics only three implemented QI to improve ART initiation in HIV-TB co-infected patients. This indicator remained above 90% for the duration of the study. QI was used for HTS and TB screening in 12 and 17 QI clinics, respectively. All QI clinics worked on improving IPT and VL testing. IPT improved dramatically (increased by 60.5% from baseline to the withdrawal phase) and VL testing was moderately improved (increased by 12.6% from baseline to the withdrawal phase).

Completed Plan-Do-Study-Act templates and annotated run charts used by QI clinics were a key resource in explaining the extent to which the QI intervention was successful in some indicators. Poor baseline performance of the IPT indicator was a major factor contributed to the large improvement observed in this indicator. A major threat to the QI process is poor data quality and a lack of access to routine data. The paper ends with a list of lessons learned from the study which future researchers and implementers could use to inform future scale-up efforts including: careful selection of clinic staff to attend QI training workshops; considering baseline performance when setting expectations and targets; making data quality improvement a priority; and creating a work environment that is supportive of change.

4.2 PAPER II

A cluster-randomized controlled trial to improve the quality of integrated HIV-Tuberculosis services in primary healthcare clinics in South Africa

4.2.1 PhD Candidate's contribution to the manuscript

Student name: Santhanalakshmi Gengiah **Student number**: 204507742

Title of the article: A cluster-randomized controlled trial to improve the quality of integrated HIV-Tuberculosis services in primary healthcare clinics in South Africa

Authors: Santhanalakshmi Gengiah, Pierre M. Barker, Nonhlanhla Yende-Zuma, Mduduzi Mbatha, Shane Naidoo, Myra Taylor, Marian Loveday, Mesuli Mhlongo, Clark Jackson, Andrew J. Nunn, Nesri Padayatchi, Salim S. Abdool Karim, Kogieleum Naidoo

Journal: Submitted to the Journal of the International AIDS Society (JIAS) on 07 February 2021

Status: Published

Doctoral student's contribution to the journal article:

1. Hypothesis: I assisted the protocol team in formulating the study hypothesis and conceptualized the study objective. I was responsible for acquiring all ethics and gatekeeper approvals.

2. Study Design: I screened the PHC nurse coordinators and assessed their respective study clinics for study eligibility. I developed the study schedule of events for monthly data collection of HIV-TB process indicators and timing of the QI learning sessions and QI mentor in-person visits. I was responsible for defining the HIV-TB process indicators and the data elements (numerators and denominators) needed to calculate the HIV-TB indicators.

3. Work involved in the study: From 01 May 2014-31 December 2019, I was employed at CAPRISA as the study coordinator assigned to the SUTHI trial. My study responsibilities were extensive, and I had permission from Prof. Kogieleum Naidoo to integrate my PhD objectives into the SUTHI trial. I trained the field team on the study protocol. I designed the data collection tool for the study and identified the appropriate data sources from which to collect HIV-TB indicator data. I collaborated with the QI Advisor from the Institute for Healthcare Improvement (IHI) to develop the QI workshop agenda and oversaw the logistics of the workshop and fortnightly QI mentor visits. I facilitated sessions in the QI workshops and once every month I made random unannounced visits to the study field team and either attended QI meetings at intervention clinics or observed the field teams' activities at control clinics.

4. Data Analysis: I was involved in each step of the data analysis. I created dummy tables and figures that would be needed for the paper and liaised closely with the study statistician during the analysis. I took responsibility for reviewing the results, interpreting the findings, and answered queries from the statistician.

5. Write up: I wrote the full first draft of the manuscript and incorporated comments and feedback from the co-authors. I took responsibility for finalizing the manuscript and submission to the journal.

I declare this to be a true reflection of my contributions to this manuscript.

Signature:  Date: 08 August 2021

4.2.2 Paper II

S Gengiah et al. *Journal of the International AIDS Society* 2021, **24**:e25803
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25803/full | https://doi.org/10.1002/jia2.25803

JIAS JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

RESEARCH ARTICLE

A cluster-randomized controlled trial to improve the quality of integrated HIV-tuberculosis services in primary healthcareclinics in South Africa

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Clinical Trial Number: Clinicaltrials.gov, NCT02654613. Registered 01 June 2015.

Abstract

Introduction: : Tuberculosis (TB) remains the most common cause of death among people living with HIV. Integrating HIV and TB services reduces mortality but is sub-optimally implemented. Quality improvement (QI) methods offer a low-cost and easily implementable approach to strengthening healthcare delivery systems. This trial assessed a QI intervention on key process indicators for delivering integrated HIV-TB care in rural South African primary healthcare (PHC) clinics.

Methods: Sixteen nurse supervisors, (each with a cluster of clinics) overseeing 40 PHC clinics, were randomized 1:1 to the intervention or the standard of care (SOC) groups. The QI intervention comprised three key components: clinical and QI skills training, on-site mentorship of nurse supervisors and clinic staff, and data quality improvement activities to enhance accuracy and completeness of routine clinic data. The SOC comprised monthly supervision and data feedback meetings. From 01 December 2016 to 31 December 2018, data were collected monthly by a team of study-appointed data capturers from all study clinics. This study's outcomes were HIV testing services (HTS), TB screening, antiretroviral therapy (ART) initiation, isoniazid preventive therapy (IPT) initiation and viral load (VL) testing.

Results: The QI group (eight clusters) comprised 244 clinic staff who attended to 13,347 patients during the trial compared to the SOC group (eight clusters) with 217 clinic staff who attended to 8141 patients. QI mentors completed 85% (510/600) of expected QI mentorship visits to QI clinics. HTS was 19% higher [94.5% vs. 79.6%; relative risk (RR)=1.19; 95% CI: 1.02–1.38; p=0.029] and IPT initiation was 66% higher (61.2 vs. 36.8; RR=1.66; 95% CI: 1.02–2.72; p=0·044), in the QI group compared to SOC group. The percentage of patients screened for TB (83.4% vs. 79.3%; RR=1.05; p=0.448), initiated on ART (91.7 vs. 95.5; RR=0.96; p=0.172) and VL testing (72.2% vs. 72.8%; RR=0.99; p=0.879) was similar in both groups.

Conclusions: QI improved HIV testing and IPT initiation compared to SOC. TB screening, ART initiation and VL testing remained similar. Incorporating QI methods into routine supervision and support activities may strengthen integrated HIV-TB service delivery and increase the success of future QI scale-up activities.

Keywords: cluster-randomized; collaboratives; HIV-TB services; integration; primary healthcare clinics; quality improvement

Additional information may be found under the Supporting Information tab of this article.

Received 9 February 2021; **Accepted** 5 August 2021

1 | INTRODUCTION

In South Africa (SA), the convergence of the HIV and tuberculosis (TB) epidemics created one of the largest HIV-TB co-epidemics in the world [1]. In 2016, an estimated 59% of newly diagnosed TB patients were co-infected with HIV and the TB mortality rate in HIV-TB co-infected patients was 180 per 100,000 people, compared to 41 per 100,000 in HIV-negative TB patients people [1]. To reduce TB-related mortality in people living with HIV, the World Health Organization recommended integration of TB and HIV treatment and care services, hereafter written as HIV-TB services [2]. In practice, this translates to making both HIV and TB services available to patients at the same facility, on the same visit day, by the

Box 1: Package of integrated HIV-TB services

- Testing and counselling for HIV in all patients with TB
- Intensified case finding for TB in HIV-infected patients
- IPT for HIV-positive patients who screen TB negative
- ART initiation for all HIV-TB co-infected patients
- CPT for HIV-TB co-infected patients
- Enhanced retention in care strategies
- Enhanced ART and TB treatment adherence strategies, including, viral load testing coverage
- A fully integrated data management system — adopting the approach of one patient, one appointment, one file and one data management system

ART, antiretroviral therapy; CPT, cotrimoxazole preventive therapy; IPT, isoniazid preventive therapy; TB, tuberculosis; VL, viral load

same clinic team [2]. In resource-constrained settings, HIV-TB services optimally utilize very limited healthcare resources, are known to improve AIDS-free survival and preferred by patients as a cost- and time-saving strategy [2–4].

By 2016, HIV-TB services were routine care in SA and comprised: early antiretroviral therapy (ART) for TB patients irrespective of CD4 cell count; isoniazid preventive therapy (IPT) for eligible HIV patients; HIV testing services (HTS) for all patients, especially TB patients; TB screening and diagnostic testing [5]. Evidence has surfaced of patients accessing primary healthcare (PHC) clinics and being missed for HIV and TB services [6–9]. Integrated HIV-TB service delivery requires high-level organization and planning by clinic teams against a backdrop of large patient numbers and constrained resources [6,7,10,11]. Innovative solutions to strengthen systems for HIV-TB service delivery are needed [12].

Effective strategies to improve integrated HIV-TB service delivery are unknown [13]. Quality improvement (QI) offers a potential approach for consideration due to its focus on improving underlying systems and engaging PHC staff to identify practical, low-cost solutions to address deficiencies with available resources. [14,15] QI interventions to reduce mother-to-child HIV transmission and mortality have been successful in many African countries [16,17]. Little is known of the effectiveness of QI to impact HIV-TB services [12].

Evaluations of QI effectiveness have rarely been conducted within a randomized controlled trial. Given the considerable commitment of time, effort, financial and human resources dedicated to implementing QI, rigorous testing of the approach is warranted. The Centre for the AIDS Programme of Research in South Africa (CAPRISA) conducted the *Scaling up TB HIV integration* (SUTHI) trial, which tested the effectiveness of a QI intervention in improving HIV-TB services to reduce mortality in HIV and HIV-TB patients. This paper assesses the effectiveness of QI to improve process indicators of HIV-TB service delivery compared to standard support and supervision.

2 | METHODS

2.1 | Study design

This is a nested sub-study within the SUTHI trial. The SUTHI trial design was published elsewhere [12]. SUTHI was a cluster-randomized trial that tested the effectiveness of a QI intervention to improve HIV-TB service delivery in reducing TB-related mortality among HIV, TB and HIV-TB patients. The trial was conducted between 01 December 2016 and 31 December 2018. At the PHC level in SA, nurse supervisors typically oversee 3–5 PHC clinics. In the SUTHI trial, the 'clusters' were the nurse supervisors. PHC clinics were assigned to the same study arm as their respective nurse supervisor and followed up for 18 months. The primary outcome of the SUTHI trial was all-cause mortality among HIV, TB and HIV-TB patients. This nested sub-study evaluated a set of process indicators that typically comprise integrated HIV-TB service delivery.

2.2 | Study setting

The SUTHI trial was conducted in two predominantly rural districts, the Ugu and King Cetshwayo District (KCD), in KwaZulu-Natal (KZN) Province, SA. Figure 1 shows the study districts and summarizes the burden of HIV and TB. HIV and TB are responsible for over a third of all deaths in Ugu and KCD, 35% and 36%, respectively [18,19].

2.3 | Randomization

The KZN District Health Offices provided a list with a total of 16 nurse supervisors for the Ugu district and KCD. Study eligibility criteria of nurse supervisors and clinics have been published elsewhere [12]. The main criterion was acquiring verbal agreement of nurse supervisors and nurses-in-charge of individual clinics for study participation. The study statistician randomized supervisors in a 1:1 ratio using computer-generated randomization. Clinics classified as municipal clinics were automatically excluded as their management and resource allocation were different to those of typical PHC clinics (Figure 2). No nurse supervisors or clinics declined or withdrew their participation.

2.4 | Study intervention

The QI intervention comprised three essential components delivered as a 'package': (1) training and capacity building of healthcare workers; (2) in-person QI mentorship of clinic staff; and (3) data quality improvement (DQI) activities to enhance reliability of routine clinic data. Figure 3 provides detail on each component.

The QI intervention was structured as a Breakthrough Series Collaborative [20]. Nurse supervisors and their respective clinics formed a 'collaborative'. The collaborative met at three QI workshops, timed at 6-month intervals, for QI and clinical skills training, and shared experiences and best practices [20]. At least one member of each department within a clinic (i.e. nurses, lay counsellors and data capturers) and nurse supervisors participated in QI workshops which were interactive and promoted group work.

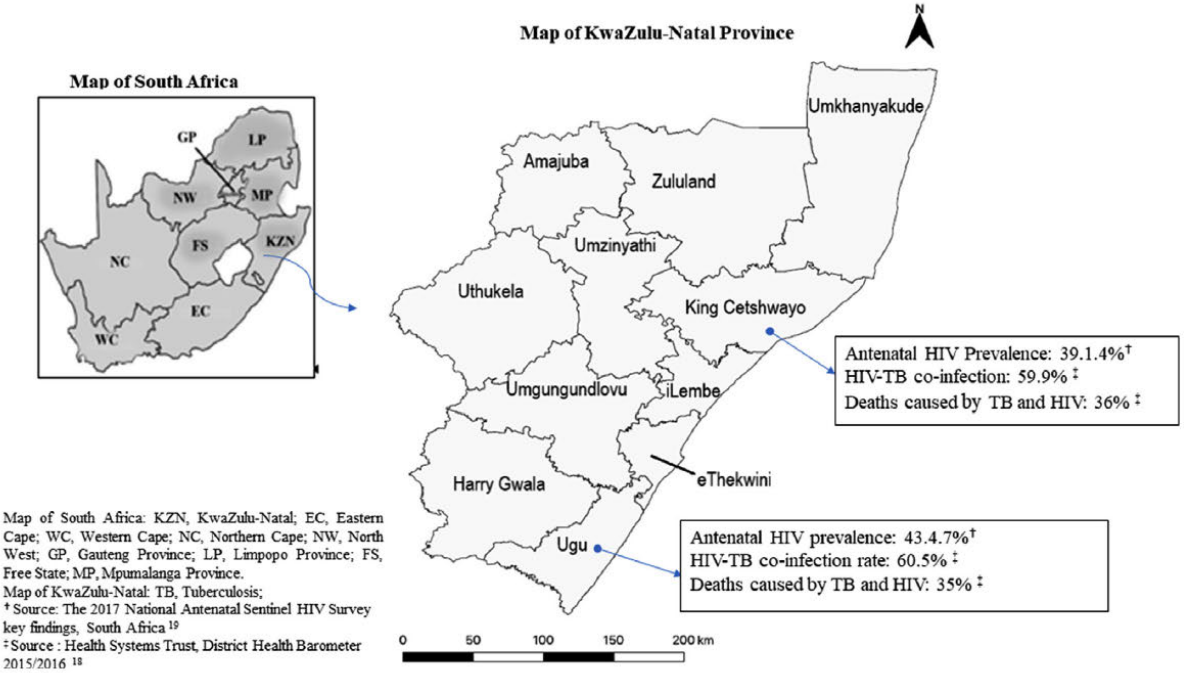


Figure 1. Map of KwaZulu-Natal Province in South Africa.

Between QI workshops, a study-appointed QI nurse mentor conducted in-person mentorship visits to clinics to reinforce workshop content, review clinic data and guide change idea development. Figure 4 illustrates the timing of workshops and mentorship visits. The Plan-Do-Study-Act cycle was the guiding framework to develop, test and improve upon change ideas for HIV-TB service delivery. Box 1 lists the set of routine HIV-TB integration services that the collaborative aimed to improve [12].

Lastly, DQI activities were conducted to ensure that the most accurate and complete data possible were available to QI clinic teams to drive the QI process and for research purposes (Figure 3).

2.5 | Standard support and supervision

All study clinics received standard support for all health services, including HIV and TB services. Standard support activities comprised: (1) monthly clinic-based visits by the nurse supervisor; (2) quarterly visits by the District Management Team (DMT), usually represented by the TB and HIV/ART/STI/TB (HAST) Managers from the district health office; and (3) monthly performance monitoring and feedback meetings hosted by the DMT to identify gaps in HIV and TB service delivery. Supervisory visits typically consisted of file and summary data reviews, with feedback to senior clinic management. In April 2016 (8 months prior to the SUTH trial), the Department of Health (DOH)-initiated monthly performance monitoring meetings called 'Nerve Centre Meetings' in both districts. These mandatory meetings were the key mechanism through which facilities received feedback on performance and were typically attended by at least one representative from each facility. Assistance to clinics by local non-governmental organizations (NGOs) is common in the South African healthcare context. Prior to and during the study, PHC clinics in both districts received technical support from local NGOs, such as direct patient care, clinical and data management training. DQI activities were conducted in standard of care (SOC) clinics to ensure comparability in data between both groups.

2.6 | Study procedures and phases

Figure 4 illustrates the timing of study activities in both study groups. Baseline was defined as the period 6 months prior to study enrolment. The 18-month follow-up period was divided into three phases of 6-months duration, and each phase contained a different level of QI support. The *lead-in phase* was the period from months 1 to 6, when the first of three QI workshops was completed, and bi-weekly QI mentor visits commenced. The *intensive phase* was the period from months 7 to 12 when the second and third QI workshops were completed, and bi-weekly QI mentor visits continued. The QI intervention was at its maximum strength in this phase. The *withdrawal phase* was the period from months 13 to 18 with minimal QI support, reduced to once-a-month visits.

Two study-appointed QI mentors were expected to each make at least 30 QI visits per clinic during the study. This comprised 24 QI visits (two visits per month) in the lead in

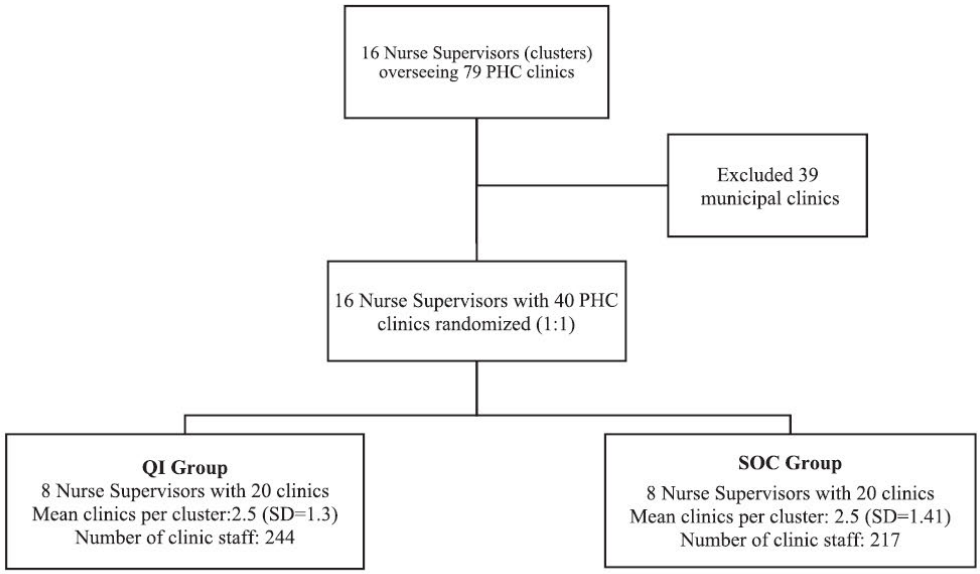


Figure 2. Randomization of nurse supervisors and respective clinics.

and intensive phases and six QI visits (one visit per month) in the withdrawal phase.

From 01 December 2016 to 31 December 2018, data were collected monthly by study-appointed data capturers. Paper-based registers, patient charts and patient electronic databases were the data sources for HIV-TB process indicators. Quarterly reports from the National Health Laboratory Service and Electronic TB Register were used to assess the number of sputum samples sent for TB diagnostic tests and confirmed TB patients. Summaries of data were recorded on a study data collection form and transmitted via fax to a central database.

2.7 | Study outcomes

For this sub-study, we assessed changes in key process indicators representative of integrated HIV-TB healthcare service delivery. Table 1 lists and defines the process indicators and the data elements (numerators and denominators) that were used to calculate proportions of patients who were eligible for and received HIV-TB services. HIV-TB process indicator performance was aggregated at the month-level. Patients who received a service (counted in the numerator) are a sub-group of the patients who were eligible for the service (counted in the denominator). Occasionally, patients received the service in the next month and were subsequently added to the previous month's data.

3 | STATISTICAL ANALYSIS

In this study, the cluster was the unit of analysis, hence, all clinics and its respective patients in a cluster we considered as one unit. Study group proportions per study phase were calculated as follows: First, the proportions per cluster were calculated by summation of numerators divided by the sum of the denominators of all respective clinics in a cluster per month. A proportion of zero was replaced with 0.00001 (or 0.001 when using percentages). If a denominator was zero (i.e. no one was eligible), then that month was ignored. Second, we calculated cluster-specific geometric means (GM) across months associated with a phase (Figure 4). Third, study group-specific GM were calculated as cluster-specific proportions per phase. An unpaired *t*-test was used to compare the study groups.

The relative risk (RR) between study groups was calculated to provide a measure of the improvement within each phase. Changes in HIV-TB process indicator performance between baseline and intensive phase are shown as the QI intervention was at its maximum strength during this phase (Figure 4). In a post-hoc analysis, HIV-TB process indicators of interest were stratified by cluster-specific patient volume to understand how results varied within clusters of different sizes. We sorted cluster-specific patient volume into three categories with the following ranges: category 1 included cluster headcounts of less than or equal to 2500 (<2500), category 2 included cluster headcounts of greater than 2500 and less than or equal to 3500 ($\geq$ 2500 $\leq$3500) and category 3 included cluster headcounts of greater than 3500 (>3500). Statistical analyses were performed using SAS (SAS Institute, Cary, NC, USA) version 9.4.

3.1 | Ethics and gatekeeper permissions

The SUTHI trial was approved by the Biomedical Research Ethics Committee of the University of KwaZulu-Natal (BF108/14). Participant informed consent was waivered for this study. The KZN Health Research and Knowledge

Table 1. Definitions of HIV-TB process indicators

HIV-TB services	HIV-TB process indicator	Data elements used to express process indicators as a proportion	Primary data sources[c]
HTS for PHC clinic attendees	Proportion of patients who accessed HIV tests, as a percentage of the clinics' HIV testing target	Numerator: Number of patients tested for HIV Denominator: Clinic assigned target for HTS[a]	HTS Register
	Proportion of new TB patients tested for HIV	Numerator: Number of new TB patients tested for HIV Denominator: Number of new TB patients	ETR
	Proportion of new TB patients tested HIV positive	Numerator: Number of TB patients tested HIV positive Denominator: Number of new TB patients tested for HIV	
TB screening among PHC clinic attendees (TB screening)	Proportion of clinic attendees screened for TB signs or symptoms	Numerator: Number of clinic attendees screened for TB signs and symptoms (adults and children) Denominator: Clinic headcount[b]	TB screening register
Confirmed new TB cases	Proportion of Xpert MTB/RIF tests with a 'TB detected' outcome	Numerator: Xpert MTB/RIF tests with a 'TB detected' outcome Denominator: Number of sputum samples collected for Xpert MTB/RIF testing for initial TB diagnosis	NHLS
TB confirmed patients initiated onto TB treatment	Proportion of patients with a TB confirmed Xpert MTB/RIF# result initiated onto TB treatment	Numerator: Number of patients initiated onto TB treatment Denominator: Number of patients with a 'TB detected' MTB/RIF result	ETR
IPT initiation among eligible new ART patients (IPT initiation)	Proportion of new ART patients initiated onto IPT	Numerator: Number of new ART patients initiated on IPT Denominator: Number of new ART patients with no signs or symptoms of TB	Patient file
ART initiation among HIV-TB co-infected patients	Proportion of HIV-TB services co-infected patients initiated on ART	Numerator: Number of HIV-TB co-infected patients initiated on ART Denominator: Number of confirmed TB patients tested positive for HIV	ART register
VL testing at month 12 after ART initiation (VL testing)	Proportion of eligible ART patients who had a VL test 12 months after initiating ART	Numerator: Number of ART patients who received a VL test at month 12 after ART initiation Denominator: Number of ART patients eligible for a VL test at month 12 after ART initiation	TIER.Net

Abbreviations: ART, antiretroviral therapy; ETR, Electronic TB Register; HTS, HIV testing services; IPT, isoniazid preventive therapy; NHLS, National Health Laboratory Services; PHC, primary healthcare; TIER, Three Integrated Electronic Registers; TB, tuberculosis; VL, viral load.
Xpert MTB/Rif, a rapid, molecular, cartridge-based test used for tuberculosis diagnostics that provides an immediate rifampicin resistance result.
[a]All primary healthcare clinics are given an HIV testing services target each year by the respective District Health office. Targets were calculated based on HIV prevalence and patient population within a clinic's catchment area.
[b]Number of people accessing any health services at a facility during a specified period.
[c]Data sources listed were considered the primary source of data but if necessary other data sources were used to verify data.

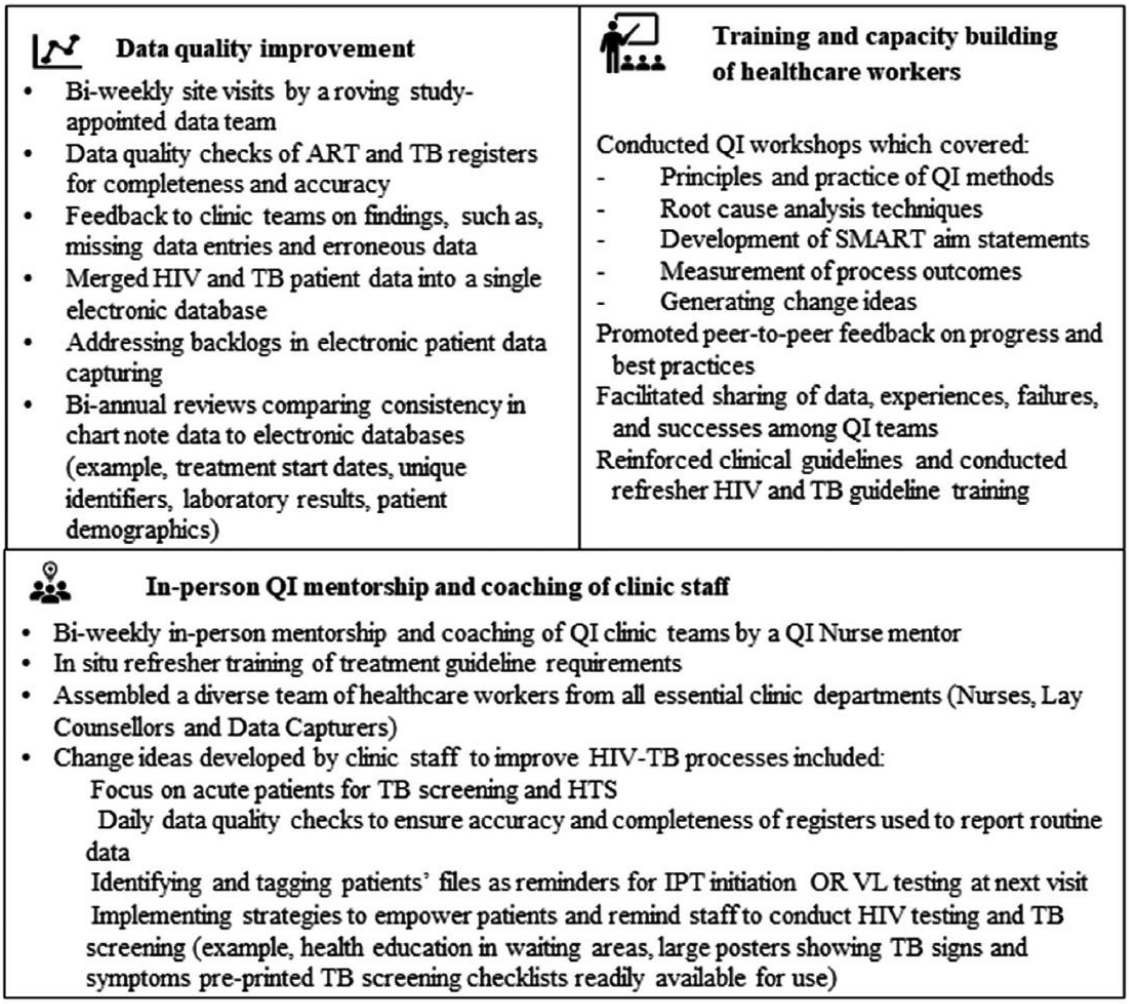


Figure 3. The three-component quality improvement intervention.

Management committee granted permission to access PHC clinics in the study districts.

4 | RESULTS

Between 01 April 2016 and 30 June 2016, 16 nurse supervisors and 79 clinics under their oversight were screened for the SUTHI trial. All nurse supervisors agreed to participate; however, 39 municipal clinics were ineligible, hence, 40 clinics were included in the randomization (Figure 2). Eight nurse supervisors overseeing 20 clinics were randomized to the QI group and 16 nurse supervisors overseeing 20 clinics were randomized to the SOC group. In the QI group, 244 clinic staff who served 13,347 HIV and HIV-TB patients were exposed to QI mentorship. In the SOC arm, 217 PHC staff, who served 8141 HIV and HIV-TB patients, received standard support and supervision. The mean headcount was 3448.8 [Standard Deviation (SD)=1833.1%] and 70% (14/20) of clinics were high-burden in the QI group compared to a mean headcount of 2836.4 (SD=993.8) and 55% (11/20) high-burden clinics in the SOC group (Table 2). Table 3 shows the proportion of completed visits per QI group cluster. QI mentors completed 85% (510/600) of expected visits. Completed visits across the eight clusters ranged from 77% to 100%.

The QI intervention addressed five of the eight HIV-TB services in Box 1, specifically: HTS, TB screening, IPT initiation, ART initiation in HIV-TB co-infected patients and viral load (VL) testing at 12 months on ART. An integrated electronic TB and HIV data systems was rolled-out at the start of the trial and implemented in all clinics. Missing data and limited study resources were barrier to addressing cotrimoxazole preventive therapy (CPT) and retention in care.

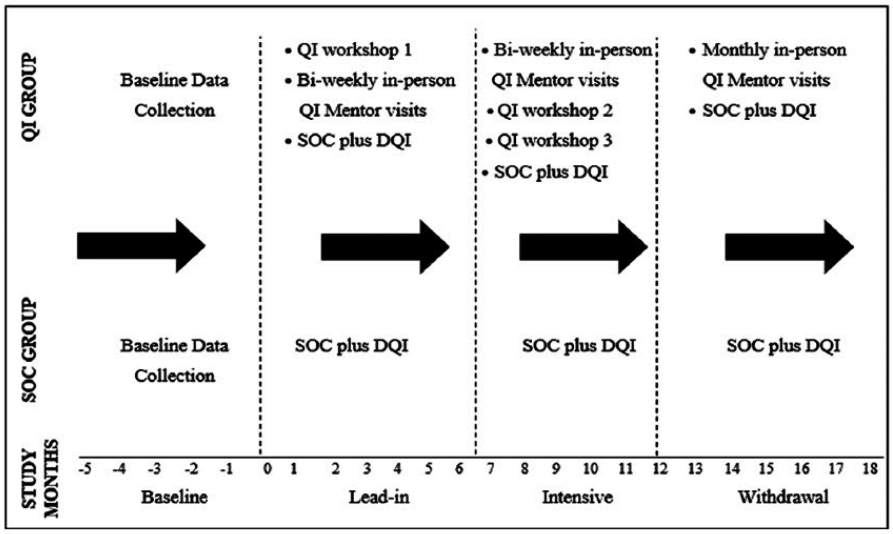


Figure 4. Study procedures and sequence of events.

Table 2. Baseline characteristics of the quality improvement (QI) group and standard of care (SOC) group clusters

	QI group	SOC group
Patients in care, mean per month (SD)		
Patient headcount[a]	3448.8 (1833.1)	2836.4 (993.8)
HIV patients in care	1047.6 (1250.45)	653·0 (443.3)
HIV-TB patients in care	133.8 (128.5)	84.7 (60.3)
Clinic categorization *n/N* (%)[b]		
High-burden clinics	14/20 (70%)	11/20 (55%)
Low-burden clinics	6/20 (30%)	9/20 (45%)
Staff complement (*n*)		
NIMART trained nurses[c]	79	79
TB trained nurses[d]	29	39
Enrolled nurses	27	17
Data capturers	30	29
Lay counsellors	43	38
Community caregivers	274	286
Nurse:patient ratio		
Monthly nurse:patient ratio	1:308	1:266

Abbreviations: NIMART, Nurse Initiated Management of Antiretroviral Therapy; QI, quality improvement; SD, Standard Deviation; SOC, standard of care; TB, tuberculosis.
[a]Refers to all patients accessing the clinic for any care service.
[b]Mean monthly patient headcount ≥2500 = High burden, < 2500 =Low burden.
[c]Refers to nurses who are initiating and managing patients on ART after undergoing the necessary training provided by an appropriate service provider. NIMART training was not provided in the study.
[d]Refers to nurses who are initiating and managing TB patients after undergoing the necessary training provided by an appropriate service provider. Training for TB treatment initiation and management of TB patients was not provided in the study.

Table 3. Expected quality improvement (QI) visits completed in the QI group clusters

QI group clusters				
Cluster	Number of clinics (*n*)	Actual visits per cluster (*n*)	Expected visits per cluster (*N*)	Percentage of expected visits completed (%)
I1	1	25	30	83
I2	1	26	30	87
I3	3	73	90	81
I6	3	84	90	93
I7	4	92	120	77
I8	1	30	30	100
I12	4	100	120	83
I14	3	80	90	89
Total	20	510	600	85

Abbreviations: I, intervention (i.e. the QI group); QI, quality improvement.

Table 4 compares the performance of the QI and SOC groups at the baseline and intensive phases.

At baseline, both groups were similar in performance for all process indicators. The QI group improved HTS by 9.7% from 84.8% (95% CI: 75.5–95.3) to 94.5% (95% CI: 91.9–97.1), compared to a decline of 5.7% from 85.3% (95% CI: 74.9–97.2) to 79.6% (95% CI: 68.7–92.3) in the SOC group. By the intensive period, HTS was 19% higher in the QI group than in the SOC group (94.5% vs. 79.6%; RR=1.19; 95% CI: 1.02–1.38; p=0.029). Figure 5a concurs with this finding and shows higher monthly HTS performance in the QI group between months 0 and 13. Thereafter, the QI group maintained its performance and the SOC group increased its performance (Figure 5a).

Table 4. Comparison of HIV-TB service delivery between quality improvement and standard of care groups

	QI group		SOC group			
	N	Percentage (95% CI)	*N*	Percentage (95% CI)	RR (95% CI)	*p*-value
HTS for PHC clinic attendees						
Baseline	40,184	84.8 (75.5–95.3)	28,666	85.3 (74.9–97.2)		
Intensive phase	35,164	94.5 (91.9–97.1)	32,839	79.6 (68.7–92.3)	1.19 (1.02–1.38)	0.029*
HTS in TB patients						
Baseline	984	88.7 (79.6–98.9)	581	85.7 (78.3–93.7)		
Intensive phase	917	92.8 (88.3–97.4)	542	91.3 (87.1–95.7)	1.02 (0.96–1.08)	0.589
TB screening for PHC clinic attendees						
Baseline	470,192	76.2 (65.4–88.9)	360,028	78.9 (68.3–91.1)		
Intensive phase	442,127	83.4 (76.5–90.9)	354,339	79.3 (70.1–89.8)	1.05 (0.92–1.21)	0.448
ART initiation among HIV-TB patients						
Baseline	657	95.8 (93.3–98.3)	380	98.9 (97.6–100.0)		
Intensive phase	547	91.7 (86.3–97.4)	333	95.5 (93.1–98.0)	0.96 (0.90–1.02)	0.172
Initiating isoniazid preventive therapy (IPT) among eligible new ART patients						
Baseline	5004	15.9 (4.8–52.5)	2739	27.7 (16.2–47.1)		
Intensive phase	3138	61.2 (50.6–74.1)	1884	36.8 (22.8–59.4)	1.66 (1.02–2.72)	0.044*
VL testing at month 12 after ART initiation						
Baseline	3082	61.4 (56.4–66.8)	2183	57.5 (45.7–72.4)		
Intensive phase	4663	72.2 (65.0–80.1)	2816	72.8 (66.4–79.8)	0.99 (0.87–1.12)	0.879
Additional outcomes						
Confirmed new TB cases, % (*n*)						
Baseline	6720	8.7 (583)	4655	7.9 (369)	0.8	†
Intensive phase	6007	9.9 (598)	4531	8.1 (365)	1.8	†
TB confirmed patients initiated onto TB treatment, % (*n*)						
Baseline	583	98.5 (574)	369	93.8 (346)	4.7	†
Intensive phase	598	87.5 (523)	365	88.5 (323)	−1.0	†

Abbreviations: ART, antiretroviral therapy; CI, confidence interval; HTS, HIV testing services; IPT, isoniazid preventive therapy; PHC, primary healthcare; QI, quality improvement; RR, relative risk; SOC, standard of care; TB, tuberculosis; VL, viral load.
*p-value significant at <0.05.
†Only quarterly summary data were available.

At baseline, IPT initiation rates in the QI and SOC groups were 15.9% (95% CI: 4.8–52.5) and 27.7% (95% CI: 16.2–47.1), respectively. By the intensive phase, IPT initiation rates were 61.2% (95% CI: 50.6–74.1) and 36.8% (95% CI: 22.8–59.4) in the QI and SOC groups, respectively, RR=1.66; 95% CI: 1.02–2.72; p=0.044 (Table 4). Table S1 shows the study groups' performance in the lead-in and withdrawal phases. In the withdrawal phase, the QI group achieved IPT initiation rates of 76.4% (95% CI: 66.3–88.1), compared to 50.8% (95% CI: 36.2–71.2) in the SOC group, RR=1.51; 95% CI: 1.06–2.14; p=0.026. Figure 5c illustrates the sustained higher improvement in the QI group during the study.

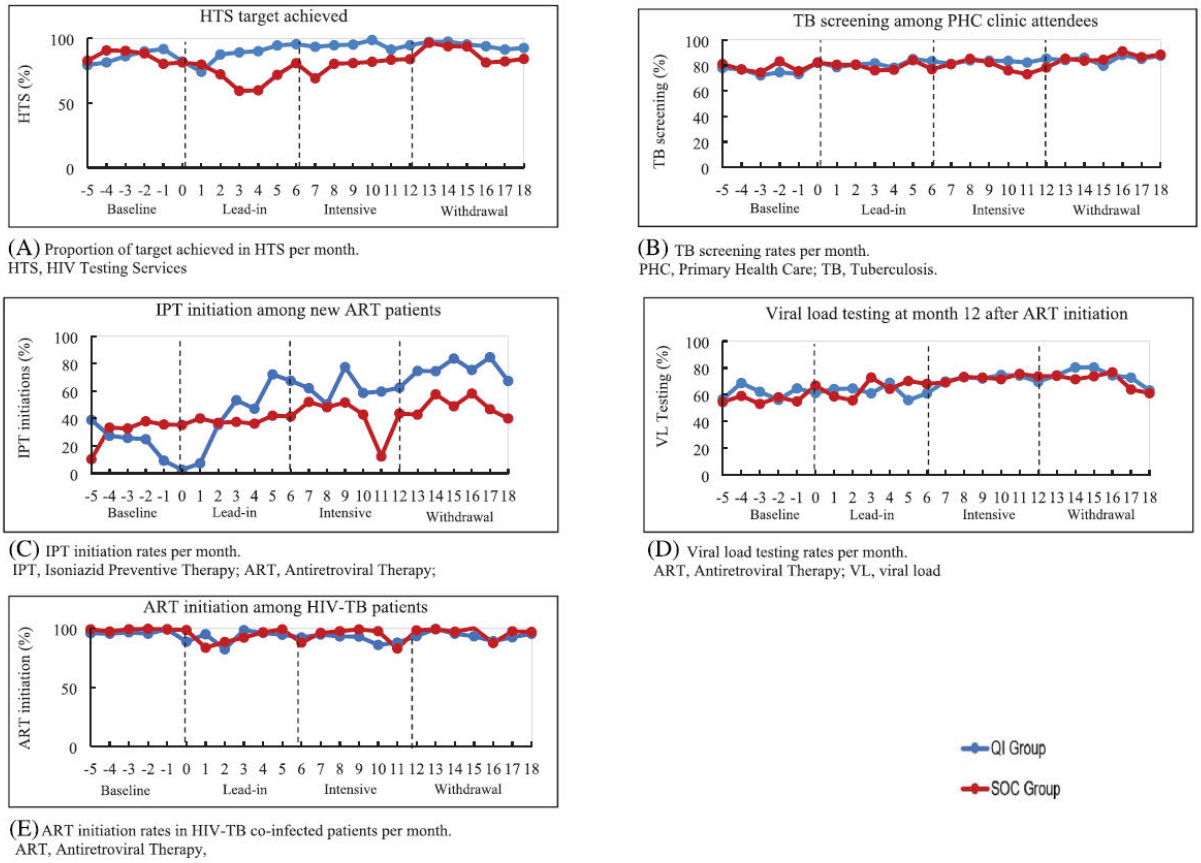
TB screening, ART initiation in HIV-TB patients and VL testing in QI compared to SOC groups were (83.4% vs. 79.3%; RR=1.05; 95% CI: 0.92–1.21; p=0.448), (91.7 vs. 95.5; RR=0.96; 95% CI: 0.90–1.02; p=0.172) and (72.2 vs. 72.8; RR=0.99; 95% CI: 0.87–1.12; p=0.879), respectively (Table 4). Figures 5b–e illustrate the similarity in monthly performance between the study groups.

4.1 | Post-hoc analysis

Figure S1 shows the IPT initiation rates for QI and SOC clusters sorted into three categories representing patient volume. Of the eight QI clusters, four were classified as category 1 and four as category 3. Of the eight clusters in the SOC group, one was classified as category 1, six as category 2 and one as category 3.

In the QI group, category 1 clusters had baseline IPT initiation rates that ranged from 0.9% to 22.7% and the size of improvement ranged from 30.4% to 68.3% (Figure S1). Category 3 clusters had baseline IPT initiation rates that ranged from 35.8% to 45.0% and size of improvements ranged from 3.4% to 54.7%. In the SOC group, the category 1 cluster had a baseline IPT initiation rate of 8.7% and improved to 10.0%. Category 2 clusters and the one category 3 cluster made improvements in IPT initiations that ranged from 10.6% to 21.7% and 29.7%, respectively.

Figure S2 shows cluster-specific HTS rates for QI and SOC clusters. In the QI group, category 1 clusters achieved



(A) Proportion of target achieved in HTS per month.
HTS, HIV Testing Services

(B) TB screening rates per month.
PHC, Primary Health Care; TB, Tuberculosis.

(C) IPT initiation rates per month.
IPT, Isoniazid Preventive Therapy; ART, Antiretroviral Therapy;

(D) Viral load testing rates per month.
ART, Antiretroviral Therapy; VL, viral load

(E) ART initiation rates in HIV-TB co-infected patients per month.
ART, Antiretroviral Therapy,

Figure 5. HIV-TB process indicator performance in quality improvement and standard of care groups.

baseline HTS rates which ranged from 85.2% to 98.6% and improvement rates that ranged from 0.8% to 29.7%; category 3 clusters achieved baseline rates of 64.7–90.7% and improvement sizes ranged from 0.8% to 29.7%. In the SOC group, categories 1, 2 and 3 were 83.6%, 63.2–100% and 79.4%, respectively, at baseline. In category 2, five clusters showed decreases in HTS rates, which ranged from 0.5% to 20.8%.

5 | DISCUSSION

This trial demonstrated the effectiveness of QI interventions in improving two key HIV-TB services, HTS and IPT initiation. The QI intervention did not significantly improve ART initiation in TB patients, TB screening and VL monitoring compared to the SOC group. CPT and retention in care for HIV-TB patients were not addressed by the intervention because resources required to locate and capture large amounts of missing data were beyond the budget and time frame of the study. Instead, the study leadership took a decision to focus on indicators for which data were adequately available and improvement activities would make a meaningful impact.

The QI group's improvement of IPT initiations can be attributed to low baseline performance that offered large room for improvement and a comprehensive set of change ideas, which included: identification of a common time to start IPT after ART initiation (either 7, 14 or 30 days); development of an early identification system for patients eligible for IPT (e.g. tagged patient files); TB screening refresher training to boost nurses' confidence to rule out TB; and clarifying staff responsibilities for IPT recording, stock control and data quality checks. In the QI group, small clusters made larger improvements in IPT initiation than large clusters, likely due to better coordination of efforts. HTS is a well-established service within the public health sector and intervention generated an appreciable increase in HTS rates in larger clusters. Change interventions, such as group pretest counselling in waiting areas and targeting acute patients, maximized the larger clinics' ability to offer HTS to large numbers of patients accessing the facility.

In SA, ART coverage among TB patients is 88%, an indication of the successful ART programme scale-up and strong national policy. The pre-existing high performance

precluded our ability to show an impact of QI for this service [21]. For TB screening, proportions were reduced due to over-inflated headcount data (the denominator) that erroneously included patients' caregivers or accompanying family members not accessing services at the clinic. Despite DQI efforts, this data inaccuracy persisted in the study.

The QI intervention created a 'demand' for VL test completion reports, which are generated from electronic patient databases, and were only as accurate as the data entered. Backlogs in data capture prevented generation of timely and trustworthy reports. We dedicated approximately 6 months to addressing VL data backlogs which limited the time available to effectively address VL testing. Tracing patients to return for VL tests was resource-intensive and required already scarce human and infrastructure resources.

Improvements in HIV-TB service delivery after QI implementation have been observed in other studies. A Thai study evaluated QI in HIV care services between 2002 and 2008, and showed 75.0% improvement in TB screening (24.0–99.0%) [22]. The size of improvement is likely due to introduction of new TB services rather than strengthening pre-existing services as per our project. A Namibian QI program had similar TB screening improvement (81.0–87.0%) to our study, but attained modest IPT initiation improvements (16–28%) [23].

We acknowledge the impact of the DMTs in SOC group improvements. A Ugandan study showed performance feedback to be an effective intervention in improving TB services, however, was unable to establish its sustainability [24]. Our study demonstrated sustained improvement in SOC group clinics. The influence of the DMTs is observed in HTS, particularly a rapid improvement in HIV testing after a notable decline between months 1 and 6 (Figure 5a); however, TB screening and VL testing remained unchanged. IPT initiations improved and were sustained in the SOC group; however, the size of improvements was lower than in the QI group. While the DMTs were effective in making improvements, QI methods intensified that improvement.

We recommend that future scale-up activities should initially target poor performing indicators to showcase the large improvements that are possible with QI and use these early successes to attract more clinics or districts to adopt QI. A systematic review of 27 QI collaboratives found that baseline performance levels in indicators $\leq$50% were 10 times more likely to reach levels of >80% [25]. Implementers of scale-up should consider directing more resources and support to large clinics, particularly if interventions required are complex. Well-established services should still be considered for improvement to encourage re-assessment of ingrained systems that could benefit from revitalization. Lastly, the affordability and sustainability of QI interventions may be enhanced if DMTs (or similar group in other settings) complemented performance feedback with the structure, strategies and tools offered by QI.

QI collaboratives, as a scale-up approach, have been widely adopted in high-income countries and have rapidly spread to low- and middle-income countries [26,27]. However, costs associated with implementing collaboratives are a potential scale-up barrier [28]. Cost considerations, specifically at the start-up phase, include face-to-face meetings, in-person mentorship visits, clinicians' time spent on clinical skills training, baseline data clean-up and analysis, coordination of QI collaborative activities, and administrative and personnel support [28,29]. Encouragingly, studies show that QI collaboratives can be cost-effective in improving implementation of clinical guidelines for acute and chronic conditions [28]. The benefit to large populations and reduced need for expensive treatment and high-care are cost savings that outweigh the costs of the QI collaborative itself [28].

In SA, a scale-up strategy for QI collaboratives to improve HIV-TB services is achievable with optimal use of resources and systems, namely the Nerve-Centre meetings. Successful scale-up requires a national leader to manage and coordinate activities. To this end, local NGOs have an important role to play. A previous partnership between the SA DOH and a network of NGOs to improve prevention of mother-to-child HIV transmission was highly successful [30]. In Table S2, we outline the scale-up activities and resource inputs needed, namely: (1) partnership between the SA DoH and NGOs, (2) development of a best-practices package; (3) skilled QI trainers to build QI capacity; and (4) mechanisms for distribution and access to QI training and tools.

This study had limitations. Larger clusters were randomized to the QI group, which may have been prevented if Nurse Supervisors were matched by patient volume. Matching was not possible as groups of clinics were assigned to Nurse Supervisors by the SA DOH, driven largely by geographic location. Further, matching of clusters would have introduced limitations in conducting analyses (loss of degrees of freedom) and in making statistical inferences. Contamination between the QI and SOC group clinics cannot be ruled out. Highly motivated DMTs frequently and consistently reviewed data with study clinics and were privy to QI trainings and materials. Both QI and SOC group staff attend DMT meetings and sharing of ideas and best practices were unavoidable and potentially reduced the true difference between the groups.

6 | CONCLUSIONS

QI interventions were effective in improving HTS and IPT initiations. Contexts where performance feedback is a routine practice likely enhance the success of QI interventions. QI methods can complement and strengthen standard supervision and support; however, poor data quality is a threat to the success of QI interventions.

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COMPETING INTERESTS

The authors declare they have no competing interests.

AUTHOR CONTRIBUTIONS

SG led the implementation of the study, data validation and cleaning, wrote the original draft and interpreted results. KN acquired funding for the study and is the grant holder, had study oversight and contributed to writing and editing the manuscript. SSAK, PMB and AJN contributed to the study design, intervention design and edited the manuscript. NYZ, MM1 and CJ conducted data analysis verification, interpretation and reviewed and edited the manuscript. MM, SN, MT, ML and NP interpreted the results and reviewed and edited the manuscript for critical intellectual content. MM1 and SG validated the data and conducted analyses. All authors have read and approved the final manuscript.

ACKNOWLEDGEMENTS

SG is a University of KwaZulu-Natal (UKZN) Developing Research Innovation, Localisation and Leadership in South Africa (DRILL) fellow. DRILL is a NIH D43 grant (D43TW010131) awarded to UKZN in 2015 to support a research training and induction programme for early career academics. The content is solely the responsibility of the authors and does not necessarily represent the official views of DRILL and the National Institutes of Health.

SG was supported by European and Developing Countries Clinical Trials Partnership (EDCTP) Grant TMA2018SF-2467.

We thank the South African Department of Health, District Management Teams of the Ugu and King Cetshwayo Districts for supporting this study; the nurse supervisors and clinic staff for sharing their best practices, supporting the study and collaboration between clinics; BroadReach for facilitating access to clinics, and all members of the SUTHI study field team.

FUNDING

The research reported in this paper was supported by the South African Medical Research Council with funds received from the South African National Department of Health, and the UK Medical Research Council, with funds received from the UK governments Newton Fund.

This UK-funded award is part of the EDCTP2 programme supported by the European Union.

DISCLAIMER

The funder of the study had no role in the study design, data collection, data analysis, data interpretation or writing of the manuscript. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

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SUPPORTING INFORMATION

Additional information may be found under the Supporting Information tab for this article:
Supporting Information

4.2.3 Discussion of Paper II

Paper II addressed specific objective 1 of the PhD thesis. This paper was accepted by the Journal of the International AIDS Society on 05 August 2021 and is currently in production. Paper I primarily described the QI theory and approach that was adopted and used only the QI group data from baseline to the withdrawal phase to demonstrate the size of improvements (if any) throughout the study for the purpose of examining trends and illustrating challenges. In Paper II, a comparison of the QI group and SOC group is undertaken between baseline and the intensive phase (when the intervention was at its maximum strength). This paper adopts a more analytical approach to whether the QI intervention was an actual success. To my knowledge there are no other studies that used a cluster-randomized trial design to assess the effectiveness of a QI intervention to improve integrated HIV-TB services. The strength of this paper is the presence of the standard of care group which represent typical SA DOH clinics to which the QI group clinics were compared to determine if improvement would have occurred anyway.

The highlight of paper II were the significantly higher rates of IPT initiation and HTS observed in the QI group compared to the SOC group. In the QI group, the IPT initiation rate was 15.9% (95% CI:4.8-52.5) at baseline which improved nearly 4-fold in the intensive phase [61.2% (95% CI: (50.6%-74.1%)]. In comparison the SOC group, which had an initial IPT initiation rate of 27.7% [95% CI: (16.2%-47.1%)] and improved to 36.8% (95% CI: 22.8%-59.4%). In the QI group HTS was 84.8% (95% CI: (75.5%-95.3%) at baseline and improved to 94.5% (95% CI: 91.9%-97·1%) in the intensive phase. In the SOC group, HTS decreased from 85.3% (95% CI: 74.9%-97.2%) at baseline to 79.6% (95% CI:68.7%-92.3%) in the intensive phase. TB screening, viral load testing and ART initiation among co-infected HIV-TB patients improved in both arms with no statistically significant difference in performance between the two arms.

An important finding of the paper is that the efforts of the District Management Team (DMT) played a role in the improvement observed in the SOC group. This study was conducted in a context where performance monitoring and feedback to clinics is a routine activity embedded in standard of care, hence, we observed the capability of the SOC group to also make improvements.

QI complements and strengthens standard supervision and if resources can be allocated for QI mentorship and training, it should be incorporated into routine support for primary healthcare clinics.

4.3 PAPER III

Organizational contextual factors that predict success of a quality improvement collaborative approach to enhance integrated HIV-Tuberculosis services: a sub-study of the Scaling up TB/HIV Integration Trial

4.3.1 PhD Candidate's contribution to the manuscript

Student name: Santhanalakshmi Gengiah

Student number: 204507742

Title of the article: Organizational contextual factors that predict success of a quality improvement collaborative approach to enhance integrated HIV-Tuberculosis services: a sub-study of the Scaling up TB/HIV Integration Trial

Authors: Santhanalakshmi Gengiah, Catherine Connolly, Nonhlanhla Yende-Zuma, Pierre M. Barker, Andrew J. Nunn, Nesri Padayatchi, Myra Taylor, Marian Loveday, Kogieleum Naidoo

Journal: Submitted to BioMed Central (BMC) Implementation Science on 09 April 2021

Status : Published

Doctoral student's contribution to the journal article:

1. Formulation of the hypothesis

I conceptualized the study objective and adjusted the main trial protocol to incorporate the objective into the study protocol. I was responsible for acquiring ethics approval and submitting protocol amendments.

2. Study Design

I set the study eligibility criteria for HCWs. I identified the validated measures to assess HCWs perceptions of workplace supportiveness and preparedness to integrate HIV-TB services. I worked closely with the study Data Manager to develop a tool to assess clinic infrastructure and resources. I developed the schedule of events regarding the timing of the administration of measures.

3. Work involved in the study

I trained the field team on the correct administration of Informed Consent Forms (ICF) and on administering the measures (surveys) to HCWs. I oversaw that the completed surveys were transmitted via fax to the CAPRISA headquarters and conducted quality control checks to ensure that all data fields are completed accurately and legibly. The focus group discussion guide was developed by me and the QI mentors on the study. I oversaw the logistics for all focus group discussions. I conducted only one focus group discussion because it could only be conducted in English.

4. Data Analysis

I created dummy tables for the paper and worked closely with the statistician in every step of the analysis. I contacted the developers of the COACH tool and Degrees of HIV/TB integration tool to request advice on scoring the measures. I reviewed every focus group discussion and extracted common themes that emerged from the discussions.

5. Write up

I wrote the completed first draft and circulated the manuscript to the co-authors. All comments, suggestions and corrections were incorporated into the manuscript. I took responsibility for the submission of the manuscript.

I declare this to be a true reflection of my contributions to this manuscript.

Signature : 

Date: 08 August 2021

4.3.2 Paper III

Gengiah *et al. Implementation Science* (2021) 16:88
https://doi.org/10.1186/s13012-021-01155-7

Implementation Science

RESEARCH Open Access

Organizational contextual factors that predict success of a quality improvement collaborative approach to enhance integrated HIV-tuberculosis services: a sub-study of the Scaling up TB/HIV Integration trial

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Abstract

Background: A quality improvement (QI) collaborative approach to enhancing integrated HIV-Tuberculosis (TB) services may be effective in scaling up and improving the quality of service delivery. Little is known of the role of organizational contextual factors (OCFs) in influencing the success of QI collaboratives. This study aims to determine which OCFs were associated with improvement in a QI collaborative intervention to enhance integrated HIV-TB services delivery.

Methods: This is a nested sub-study embedded in a cluster-randomized controlled trial. Sixteen nurse supervisors (clusters) overseeing 40 clinics were randomized (1:1) to receive QI training and mentorship, or standard of care support (SOC). In the QI arm, eight nurse supervisors and 20 clinics formed a "collaborative" which aimed to improve HIV-TB process indicators, namely HIV testing, TB screening, isoniazid preventive therapy (IPT) initiations, viral load testing, and antiretroviral therapy for TB patients. OCFs measured at baseline were physical infrastructure, key staff, flexibility of clinic hours, monitoring data for improvement (MDI), and leadership support. Surveys were administered to clinic staff at baseline and month 12 to assess perceptions of supportiveness of contexts for change, and clinic organization for delivering integrated HIV-TB services. Linear mixed modelling was used to test for associations between OCFs and HIV-TB process indicators.

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Results: A total of 209 clinic staff participated in the study; 97 (46.4%) and 112 (53.6%) from QI and SOC arms, respectively. There were no differences between the QI and SOC arms scores achieved for physical infrastructure (78.9% vs 64.7%; $p = 0.058$), key staff (95.8 vs 92; $p = 0.270$), clinic hours (66.9 vs 65.5; $p = 0.900$), MDI (63.3 vs 65; $p = 0.875$, leadership support (46.0 vs 57.4; $p = 0.265$), and perceptions of supportiveness of contexts for change (76.2 vs 79.7; $p = 0.128$ and clinic organization for delivering integrated HIV-TB services (74.1 vs 80.1; $p = 0.916$). IPT initiation was the only indicator that was significantly improved in the parent study. MDI was a significantly associated with increasing IPT initiation rates [beta coefficient (β) = 0.004; $p = 0.004$].

Discussion: MDI is a practice that should be fostered in public health facilities to increase the likelihood of success of future QI collaboratives to improve HIV-TB service delivery.

Trial registration: Clinicaltrials.gov, NCT02654613. Registered 01 June 2015.

Keywords: Quality improvement collaboratives, HIV-TB integration, Cluster-randomized trial, Organizational contextual factors, South Africa

Contributions to the literature

- QI uptake maybe enhanced in settings where monitoring data for improvement has been a routine practice.
- The effects of QI interventions are enhanced in contexts that are supportive of change and well organized for delivering integrated HIV-TB services.
- The Context Assessment for Community Health tool should be considered for rapid assessment of whether a setting is receptive and ready for change.
- Fostering a culture of using data for improvement can be facilitated by ensuring data is accurate and accessible to clinic teams.

Background

Among high burden countries for tuberculosis (TB), South Africa ranks second highest for TB incidence rates, estimated at 615 cases per 100 000 population [1]. Fifty-eight percent of new TB cases are co-infected with HIV and mortality rates among HIV-TB co-infected cases (62 per 100 000 population) are double that of TB mono-infected cases (38 per 100 000 population) [1]. The World Health Organization's End TB Strategy set ambitious targets to reduce TB incidence and mortality by 90% and 95%, respectively, by 2035 [2]. South Africa has a significant contribution to make in achieving these targets and addressing the HIV-TB burden is a key public health priority [3]. To this end, the South African National Department of Health treatment guidelines, recommend integrated HIV-TB services, care, and treatment as routine care [4]. Recent studies have highlighted gaps in integrated HIV-TB service delivery such as patients missed for screening and diagnosis of HIV and TB [5–7]; missed viral load monitoring [8]; and sub-optimal coverage of TB prevention treatment for eligible HIV patients [1].

Missed opportunities to offer HIV-TB services to patients already accessing healthcare point to health systems weaknesses at the frontline of healthcare. Quality improvement (QI) methods offer an ideal solution to improve underlying systems for HIV-TB service delivery [9]. QI collaboratives offer a potentially effective strategy to facilitate scale-up of best practices in HIV-TB service delivery [9]. While there are many adaptions of QI collaboratives, the essential components include (i) different facility teams work together to improve performance on a common health topic, led by a faculty of experts; (ii) sharing of experiences, change ideas, and best practices between clinic teams; and (iii) mentorship of clinic teams to develop and rapidly test change ideas for a given improvement aim [10]. This approach is premised on the principle that group learning accelerates the generation of change ideas and optimally utilizes experts to facilitate learning and inform best practices [10, 11].

First becoming popular in high-income countries before spreading to low- and middle-income countries, QI collaboratives are widely adopted and utilized for improvement in a multitude of health topics since their introduction over 30 years ago [10, 11]. As the strategy proliferated, concerns regarding lack of clear evidence of effectiveness, cost-effectiveness, replicability, and sustainability have been raised [10–15].

A systematic review of QI to improve antiretroviral (ART) uptake reported modest improvement with wide variations between QI collaboratives from one setting to the next; median improvement was 22% ranging from 12.8 to 29.8% [16]. Similarly, a review of 29 QI collaboratives, specifically from low- and middle-income countries, found variations in improvement; however, larger improvements were more likely when a training component was added to the QI collaborative strategy as opposed to QI collaborative alone [14]. On its own, QI collaboratives showed no to little improvement in patients' outcomes (median effect size (MES) less than 2%);

however, combined with a training component, both patients' outcomes (MES of 111.6%) and healthcare provider practice outcomes (MES from 52.4–63.4%) improved [14].

The variation between settings suggests that what works in one setting may not work in other settings [10]. Much of the explanations for the variations is attributed to "organizational context" and the inherent differences and uniqueness of organizations, individuals, and teams from one setting to another [17]. The Promoting Action on Research Implementation in Health Services (PARIHS) framework defines "context" as the environment or setting in which people receive healthcare services, or the environment in which the proposed change is to be implemented [18, 19].

The few studies that investigated contextual factors influencing the QI outcomes, attribute variations to baseline performance (low performing indicators have a larger room for improvement) [13], simplicity of interventions [20], and clinic team characteristics such as leadership, access to resources, and clinical skills [21, 22]. In recent literature, supportiveness of organizational contexts for change is emerging as a key factor for implementing new interventions or changes [23, 24]. Given the use of experts, time away from clinics to attend collaborative meetings, and in-person mentorship activities, QI collaboratives represent a substantial investment in time and resources and have been cited as costly [12]. Understanding which and how contextual factors impact QI collaboratives is important to enhance success and sustainability of this strategy [11, 17].

The Scaling up TB/HIV Integration (SUTHI) trial tested the effectiveness of a QI collaborative approach to enhancing integrated HIV-TB services [9]. This is a substudy of the SUTHI trial, to determine which organizational contextual factors influenced the QI intervention to improve HIV-TB services so that these factors can be strengthened in future scale-up efforts. A secondary objective was to determine if there were any major differences in organizational contextual factors (OCF) in the QI arm compared to the standard of care arm (comparator group) which may explain the differences in HIV-TB process outcomes observed in the two study arms.

Methods

Study design: The Scaling Up TB HIV trial

The design and rationale for the SUTHI trial are published elsewhere [9]. Briefly, SUTHI was a cluster-randomized trial to determine the effectiveness of QI methods in integrating HIV-TB services on mortality in TB, HIV, and HIV-TB patients [9]. Sixteen nurse supervisors (clusters) and the 40 primary healthcare (PHC) clinics under their oversight, were randomly assigned (1:1) to either a QI intervention (hereafter known as the QI arm) or to standard of care (SOC) support and supervision (hereafter known as the SOC arm). Eight nurse supervisors and their 20 clinics were assigned to the QI arm and eight nurse supervisors and their 20 clinics were assigned to the SOC arm. The study was implemented in the Ugu and King Cetshwayo Districts of KwaZulu-Natal, South Africa from 01 December 2016–31 December 2018. All study clinics were followed up for 18 months.

Study design: Organizational contextual factors nested sub-study

This is a nested sub-study of the SUTHI trial which was designed to collect data on OCFs that may influence improvement of integrated HIV-TB service delivery and explain why the QI intervention was successful or not. Parallel to the implementation of the parent study, OCFs were assessed at set study time points using surveys administered to consenting clinic staff, and study exit focus group discussions (FGDs) conducted with clinic staff from both study arms.

The intervention: The Breakthrough Series Collaborative

The SUTHI trial adopted a QI intervention structured as a Breakthrough Series Collaborative [25]. Nurse supervisors and clinics in the QI arm formed the QI collaborative. The collaborative met for three 2-day learning sessions timed at 6-month intervals. Learning sessions included coursework on the principles and practice of QI methods and interactive group-based work. Figure 1 illustrates the topics covered at each learning session. Six-month intervals allowed clinic teams time to develop and test changes ideas, and acquire best practices to present to each other. Between learning sessions, a QI nurse mentor, made in-person visits to clinics and provided QI mentorship, reinforced knowledge from learning sessions, and reviewed clinic data. The Model for Improvement was the methodological framework to identify, develop and test change ideas [26]. Rapid, plan-do-study-act cycles facilitated the development and testing of change ideas at the clinic level. QI mentorship visits were fortnightly for the first 12 months and reduced to once a month for the last six months of the study period.

The QI collaborative worked toward a single goal of improving integrated HIV-TB service delivery and focused on eight HIV-TB process indicators, namely: HIV Testing Services (including testing TB patients); TB screening; isoniazid preventative therapy (IPT) for eligible HIV patients; ART for all HIV-TB patients; cotrimoxazole therapy for HIV-TB co-infected patients; retention in care strategies; enhanced treatment adherence strategies including, viral load testing coverage; and

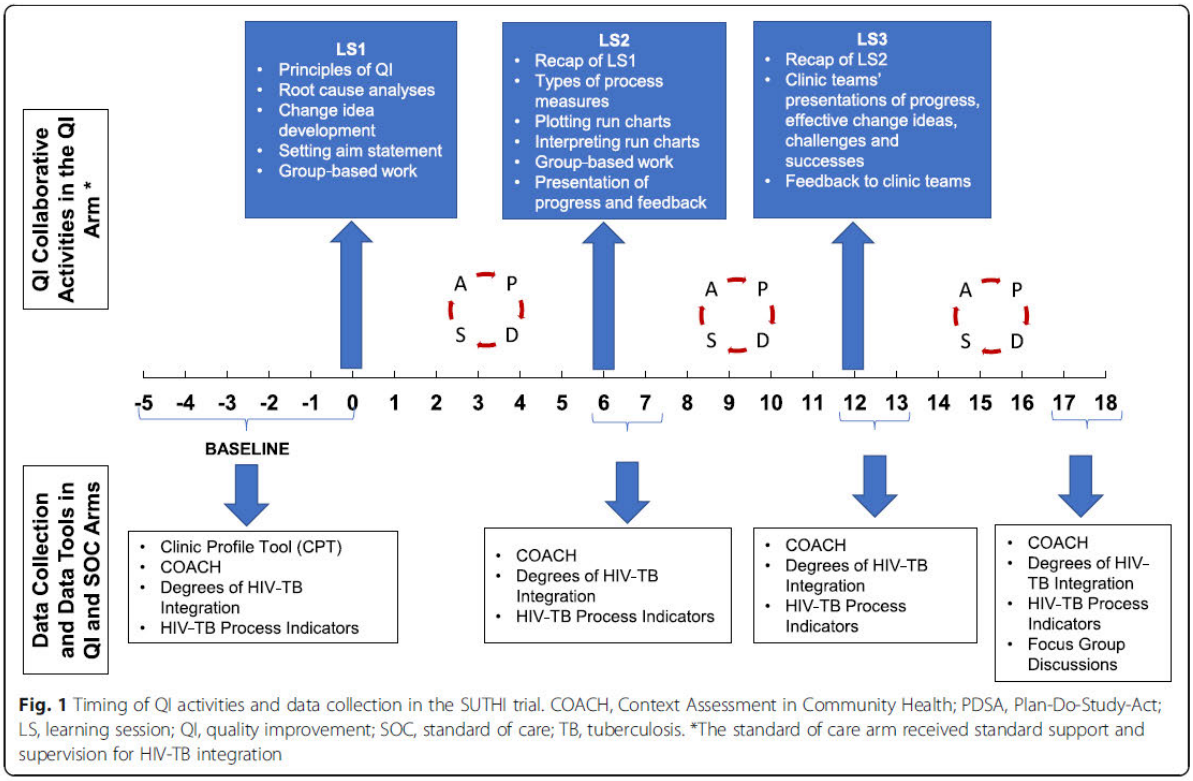

Fig. 1 Timing of QI activities and data collection in the SUTHI trial. COACH, Context Assessment in Community Health; PDSA, Plan-Do-Study-Act; LS, learning session; QI, quality improvement; SOC, standard of care; TB, tuberculosis. *The standard of care arm received standard support and supervision for HIV-TB integration

a single integrated data management system for both HIV and TB data.

Identification of organizational contextual factors

The PARIHS framework contributed to defining and identifying key OCFs measured in this sub-study [19]. The framework proposes that successful implementation of evidence is a function of three inter-related key elements: (i) the strength of the evidence being implemented, (ii) the supportiveness of the context in which implementation is occurring, and (iii) the facilitation mechanism used to introduce change [19]. In this paper, reference to 'organizational context' pertains to the clinic-level where care is provided, and OCFs are the elements of organizational context that facilitate the adoption of changes.

The PARIHS framework identified key elements of a supportive organizational context, namely: physical infrastructure, human resources, leadership support, monitoring and evaluation of performance, and receptiveness of contexts to implement changes [19]. These key elements were adopted and assessed in this sub-study. In addition, we reviewed other studies that measured clinic-level factors and identified flexibility in clinic hours, and clinic-level organization and planning for integrated HIV-TB service delivery, as elements of organizational context that were relevant to this sub-study [27, 28]. In Table 1, we define each the OCFs assessed in this study.

Data collection tools and surveys

We searched for piloted, validated, and published measures to quantitatively assess the selected OCFs. We adopted tools appropriate for low-and middle-income countries and where no tool was available or appropriate, we designed a tool in-house. In this sub-study, three surveys were used, the Clinic Profile Tool (CPT), The Context Assessment for Community Health (COACH) survey, and the Degrees of integrated Tuberculosis and HIV services survey. Figure 1 illustrates the study time points at which each survey was administered and Table 1 shows who were involved in completing the surveys.

The Clinic Profile Tool

The Institute for Healthcare Improvement (IHI) provided a survey, routinely used in past QI projects, to assess resources at facilities and we amended the survey in collaboration with an IHI QI advisor. Amendments included using words and terms that were familiar to clinic staff in our setting and we added on items pertaining to integration of HIV and TB systems. The CPT contained several sub-scales; however, we only assessed

Table 1 Definition and measurement of organizational contextual factors

Organizational contextual factors (OCFs)	Definition	Allocation of scores	Max score per clinic	Method	Completed by	Survey used
Physical Infrastructure	Refers to availability, utilization, and cleanliness of spaces, rooms, and facilities that are required for patient care, consultation rooms, waiting areas, designated cough booth, designated pharmacy, privacy for patients, vitals assessment* room, and ablution facilities.	1 point allocated to each area for each attribute of availability, utilization, and cleanliness Availability = 7 Utilization = 7 Cleanliness = 7	21	Key areas were directly observed and scored.	Jointly completed by study staff and facility manager or designee	Physical infrastructure is a sub-scale located in the CPT
Key staff	Refers to frontline healthcare workers that are considered key personnel in providing patient care and monitoring delivery of healthcare services at the clinic level. Key staff included: - Facility manager - NIMART nurse - PN trained to initiate and manage TB treatment - Lay counsellors - Data capturer - Enrolled nurses	1 point allocated if key staff post was filled at the time of completing the survey	6	Data received directly from facility manager or designee	Jointly completed by study staff and facility manager or designee	Key staff is a sub-scale located in the CPT
Flexibility of clinic hours	Refers to the operating hours of clinics as a proxy measure for the extent to which clinic services are available to the community. Normal hours were defined as Monday to Friday from 07:00 to 16:00. Flexibility is defined as normal hours plus any hours on either side of normal hours or normal hours plus weekends or public holidays	Availability of clinic services during normal working hours = 1 point; extended hours = 2 points; weekends, extended hours, and public holiday = 3 points	3	Data received directly from facility manager or designee	Jointly completed by study staff and facility manager or designee	Flexibility of clinic hours is a sub-scale located in the CPT
Leadership support *	Refers to leadership support visits from the DMT conducted within the last 6 months. Key DMT staff considered were: TB manager, HAST manager, QA manager, M&E manager. Frequency with which the facility manager** was off-site for meetings was considered and combined with the leadership visits score.	1 point allocated to each of the 4 DMT members who visited the clinic even once in the last 6 months **plus** Frequency facility manager is off-site: Weekly = 1 Bi-monthly = 2 Monthly = 3 Quarterly = 4	8	Data received directly from facility manager or designee and confirmed with the Clinic Visitor's logbook	Jointly completed by study staff and facility manager or designee	Leadership support is a sub-scale of the CPT
Monitoring data for improvement (MDI)	Refers to the extent to which clinic teams have accessed and utilized integrated HIV and TB electronic databases, met to discuss performance, and monitors HIV and TB programme outcomes.	Key systems in place for MDI allocated 1 point each and evidence of implementation allocated 1 point each: - Team information meetings—2 - -Ability to generate reports from the patient electronic database—2 - HIV-TB mortality data reviewed—2 - Single electronic system for HIV and TB—2 - Data quality assurance systems in place and implemented—2 - Clinic improvement team available and functional—2	12	Data received directly from facility manager or designee Team meetings verified by meeting minutes. Direct observation of integrated electronic and patient file system Data quality assurance plans observed on file	Jointly completed by study staff and facility manager or designee	Monitoring data for improvement is a sub-scale located in the CPT

Table 1 Definition and measurement of organizational contextual factors *(Continued)*

Organizational contextual factors (OCFs)	Definition	Allocation of scores	Max score per clinic	Method	Completed by	Survey used
Supportive contexts for change	Refers to clinic staff perceptions of the extent to which their work environment was supportive to making changes.	The COACH survey scored as per developers' guidance which was to calculate the mean of all sub-scale means	Mean of 5	Survey administered to clinic staff volunteers by a trained study staff member	Clinic staff who volunteered and agreed to sign the informed consent	COACH tool
The degree of integrated TB and HIV services	Validated survey that assessed the perceptions of healthcare workers in the extent to which staff and clinic processes were organized and coordinated toward integrated HIV-TB services	Degree of integrated TB and HIV survey as per developer's guidance which was to calculate the mean of all sub-scale means	Mean of 5	Survey administered to clinic staff volunteers by a trained study staff member	Clinic staff who volunteered and agreed to sign the informed consent	Degree of integrated TB and HIV survey

CPT Clinic Profile Tool, *DMT* District Management Team, *HAST* HIV/AIDS/STI and TB, *M&E* monitoring and evaluation, *COACH* Context Assessment for Community Health, *NIMART* Nurse-Initiated Management of Antiretroviral Therapy, *OCF* organizational contextual factors, *PN* professional nurse, *QA* quality assurance, *TB* tuberculosis

*The scoring of the Leadership sub-scale deviated from the original plan to give regular visits higher scores. We learnt that DMTs are mandated to visit clinics quarterly. Quarterly scores would have been assigned a score of 1 which would have been an inaccurate reflection of the leadership support. Instead, we rephrased the question, to capture if any leadership visits had occurred in the last 6 months from the time the questionnaire was administered

**On-site leadership support is often compromised by the demand placed on facility managers to attend meetings hence we included this item in the leadership support sub-scale

the following: physical infrastructure, key staff availability, flexibility of clinic hours, monitoring data for improvement, and leadership support from the District Health Offices. This survey was completed jointly by a trained study staff member and the clinic facility manager and in some instances direct observation by study staff were used to confirm responses. All responses were binary, that is, either a "yes" or "no" was required. Table 1 shows the scoring method used to assess each OCF. The CPT was administered at baseline only (Fig. 1). Due to limited study resources and time, the CPT was not validated. Additional file 1 contains the full CPT.

Supportiveness of contexts for change

To assess clinic staffs' perceptions of the supportiveness of contexts to implement changes, we used a validated survey, called the Context Assessment for Community Health (COACH) survey. Developed by Bergstrom et al. (2015), the COACH was designed to measure the extent to which nurses, physicians, midwives, and community health perceived their work environment as receptive and prepared for implementing changes [23]. We extended the administration of the COACH survey to non-clinically trained staff. The survey has eight sub-scales, namely: resources, community engagement, monitoring services for action, knowledge sources, commitment to work, work culture, leadership, and informal payment (Additional file 2). Sub-scale items are phrased as statements to which respondents could agree or disagree on a 5-point Likert-type scale;1 =Strongly Disagree and 5=Strongly Agree. The COACH survey had a Cronbach's Alpha score of $\geq$ 0.70, which is an indication that items similar to each other are highly correlated and this is reflective of a reliable tool [23] The COACH survey was administered at baseline and months 6, 12 and 18 of the study (Fig. 1).

Importantly, some sub-scales in the COACH survey overlap with the CPT (Leadership, Resources, and Monitoring data for improvement); however, the defining characteristic is that the COACH measures perceptions of clinic staff and the CPT was a relatively more objective measure where direct observation and verification of data were used.

Degree of integrated tuberculosis and HIV services

The degree to which HIV and TB services are integrated at a clinic level is a function of joint planning and coordination of different clinic teams and systems. Uyei et al. (2016) developed and validated the Degree of Integrated Tuberculosis and HIV Service Delivery tool (Additional file 3), which quantifies the extent to which respondents perceived their clinic processes and systems to be organized and prepared for offering integrated HIV/TB services (Cronbach's alpha of $\geq$ 0.70) [28]. The tool measured eight sub-scales, namely, integrated TB and ART service delivery, availability of policies and protocols, integrated TB and pre-ART service delivery, same clinicians for both TB and HIV services, TB infection control, co-operation between TB and ART staff, TB screening, and clinician awareness of patient's co-infection status. Sub-scale items are phrased as statements to which respondents could agree or disagree on

a 5-point Likert-type scale; 1=Strongly Disagree and 5= Strongly Agree. The tool was administered at baseline and months 6, 12, and 18.

HIV and TB process indicators

The parent study collected data on HIV-TB process indicators in both study arms from clinic registers and patient electronic database downloads. Monthly summary data on the number of patients that received a service (numerator) and number of patients who were eligible for a service (denominator) were collected and proportions calculated to monitor improvement for each HIV-TB process indicator.

Focus group discussions with clinic staff

Clinic staff from both arms were recruited to participate in a study exit interview. The exit interviews were conducted as FGDs and designed to assess understanding of integrated HIV-TB service delivery, describe experiences of the QI clinic staff in implementing QI methods and document any improvement efforts of the SOC clinics. The FGDs were an opportunity to collect any insights on OCFs that were missed by the surveys. A purposive sample of clinic staff were recruited based on category of staff, availability and years spent in the clinic (at least 1 year). FGDs were conducted, using a semi-structured interview guide that was developed in-house (Additional file 4).

FGDs were conducted primarily in isiZulu and voice recorded. All participating clinic staff provided signed consent. Voice recordings were transcribed verbatim and then translated to English for analyses. Two study staff read the transcripts separately and extracted themes, including any barriers or facilitators to implementing QI or HIV-TB service integration. Themes were compared and common themes adopted. Direct quotes that supported a theme were highlighted.

Eleven FGDs involving 43 clinic staff were conducted. Six FGDs with an average of three participants each were from the QI arm and five FGDs with an average of four participants were from the SOC arm. In the QI arm, there were 16 female and four male participants and the mean number of years served in the clinic was 5.5 years (min-max: 1–15). In the SOC arm there were 18 female and three male participants and the mean number of years served in the clinic was 6.8 years (min-max:1–16).

Recruitment of clinic staff

Participation in the surveys and FGDs were offered to professional nurses, enrolled nurses, lay counsellors, and data capturers. Written consent and at least 1 year of full-time employment were the minimum criteria. At baseline, we approached clinic staff in both the QI and SOC arms and gauged their interest for participation in the surveys once every 6 months. It was neither practical nor possible to administer the surveys to all clinic staff, hence, we recruited one team member from each staff category. During the study, we attempted to administer the survey to the same team member; however, work demands, time constraints, vacation leave, and absenteeism made this impossible. If the team member was not available, that individual was replaced with another team member from the same staff category in the same clinic. All surveys and FGDs were conducted in private spaces within the clinic.

Data collection and management

Between 01 December 2016 to 1 June 2017, clinic infrastructure data were collected from all 40 study clinics. Surveys were paper-based and devoid of any identifiers that could link responses to a clinic staff member. All completed surveys were faxed to the study offices and electronically captured.

Statistical analysis

The COACH survey and Degrees of Integrated TB and HIV services survey were used to develop a score for supportive contexts for change and the extent to which clinic teams were organized to offer integrated HIV and TB services, respectively. Both surveys were scored as follows : sub-scale means were calculated by adding up all responses and dividing by the number of items in that sub-scale. A total score was calculated by adding all sub-scale means and dividing by the number of sub-scales. A clinic's score was calculated as the mean of all clinic staff who completed the survey. A cluster mean was calculated as the mean of clinic means in that cluster and finally, the study arm mean was the mean of all cluster means. The highest possible mean for both surveys was five. Means were converted to percentages by dividing by 5 and multiplying by 100. This was done to make survey scores standardised with other scores. If a survey question was missed by the researcher, a score for that question was replaced by the mean of all other items in that sub-scale.

Responses to items in the CPT were 'Yes' or 'No' responses and coded as a one or zero, respectively. As per Table 1, mean scores for physical infrastructure, staffing availability, flexibility of clinic hours, monitoring data for improvement and leadership support, were calculated for each clinic by adding all items in the sub-scale and dividing by the number of items in that sub-scale. The mean cluster score was the mean of all clinic scores in that cluster. The study arm score was the mean of the cluster score means.

A *t*-test was used to compare scores between the QI and SOC arms. We compared baseline and month 12 scores for the COACH and Degrees of Integrated TB

and HIV services as the QI intervention was at its full strength during this period. Linear mixed modelling was conducted to determine which OCFs best predicted improvements for each HIV-TB process indicator. Each OCF were analysed separately in the model adjusted for study arm, time, and the interaction of study arm and time. The model assumed an exchangeable covariance and time was nested within the cluster for HIV-TB process indicators. The statistical software used was STATA, version 15.1.

Ethics approval

The study was approved by the University of KwaZulu-Natal Biomedical Research Ethics Committee (BF 108/14). All clinic staff who agreed to complete a survey or who participated in FGDs, signed an informed consent form in English or *isiZulu*.

Results

Across the 40 study clinics, a total of 461 clinic staff were available for this sub-study and 209 (45.3%) completed at least one survey (Fig. 2). Of the 209 clinic staff, 97 (46.4%) and 112 53.6%) were from the QI and SOC arms, respectively (Table 2). In the QI and SOC arm, 51.5% (50/97) and 54.5% (61/112) of respondents were nurses (Table 2). Most respondents (>80%) were female. The mean years of experience was 8.8 years [standard deviation (SD)=4.4] and 8.4 years (SD=5.4) in the QI and SOC arms, respectively.

A comparison between QI clinics and SOC clinics, showed similar access to basic services and staffing (Table 3). The QI arm had more high-volume clinics than the SOC group (14% versus (vs) 11 %). The mean monthly headcount in high-volume clinics were similar in both arms (Table 3).

Differences in Integrated HIV-TB service delivery performance

The parent study evaluated improvement in HIV-TB process indicators in the QI arm at baseline and post QI intervention (defined as months 13-18) [29]. Of the eight HIV-TB process indicators, we were unable to intervene

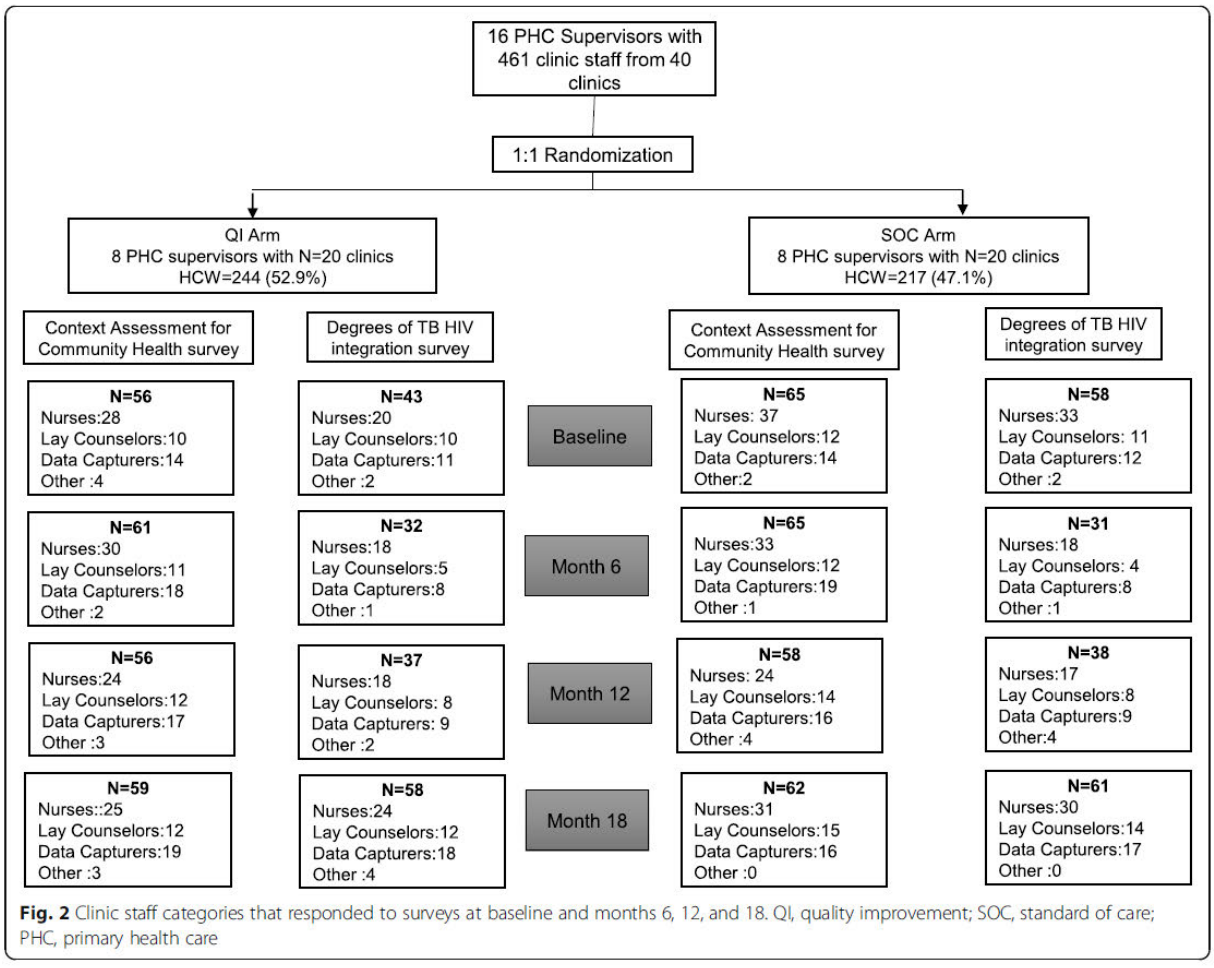

Fig. 2 Clinic staff categories that responded to surveys at baseline and months 6, 12, and 18. QI, quality improvement; SOC, standard of care; PHC, primary health care

Table 2 Characteristics of healthcare workers who participated in the study

Characteristics	QI arm	SOC arm	Total
	n = 97	*n* = 112	*N* = 209
Mean age (years), mean (SD)	39.7 (9.4)	38.7 (8.9)	39.2 (9.1)
Female *n* (%)	81 (83.5)	97 (86.6)	178 (85.2)
Category of staff—*n* (%)			
Nurse categories			
Facility managers	12 (12.4)	9 (8.0)	21 (10.0)
Professional nurses	16 (16.5)	22 (19.6)	38 (18.2)
Enrolled nurses	22 (22.7)	30 (26.8)	52 (24.9)
Data capturers	22 (22.7)	22 (19.6)	44 (21.1)
Lay counsellors	17 (17.5)	25 (22.3)	42 (20.1)
Other	8 (8.2)	4 (3.6)	12 (5.7)
Mean years of experience, mean (SD) [min-max]	8.8 (4.4) [1–22]	8.4 (5.4) [1–34]	8.6 (4.9) [1–34]

QI quality improvement, *SD* standard deviation, *SOC* standard of care

Table 3 Clinic characteristics of the quality improvement arm and standard of care arm clinics

Clinic characteristic	Description	QI clinics (*N* = 20)	SoC clinics (*N* = 20)
Clusters per district (*n*)	KCD	5	4
	Ugu	3	4
Access to basic services one month prior to study enrolment *n* (%)	Electricity	18 (90)	19 (95)
	Water	16 (80)	17 (85)
	Telephone services	19 (95)	18 (90)
	Internet	2 (10)	0 (0)
Clinic operating hours *n* (%)	Normal working hours	5 (25)	4 (20)
	Extended working hours	15 (75)	16 (80)
High and low patient volume clinics[†]	Low volume clinics *n* (%)	6 (30)	9 (45)
	Low volume clinics mean (min–max)	1770 (1262–2383)	1755 (575–2380)
	High volume clinics, *n* (%)	14 (70)	11 (55)
	High volume clinics, mean (min–max)	4708 (2521–9638)	4029 (2577–6468)
Staff complement mean (min–max)	Low volume clinics		
	NIMART trained nurses	2 (1–3)	2 (2–3)
	TB trained nurses	2 (1–3)	2 (1–3)
	Enrolled nurses	1 (1–2)	1 (1–2)
	Data Capturers	1 (1)	2 (1–2)
	Lay counsellors	1 (1–2)	2 (1–2)
	Community caregivers	12 (5–18)	10 (4–32)
	High volume clinics		
	NIMART trained nurses	5 (1–11)	5 (2–12)
	TB trained nurses	2 (1–4)	3 (1–8)
	Enrolled nurses	2 (1–3)	2 (1–3)
	Data capturers	2 (1–3)	2 (1–3)
	Lay counsellors	3 (1–7)	2 (1–4)
	Community caregivers	16 (1–34)	18 (6–41)

Clustering was not considered for Table 2

[†]High volume clinics were defined as having a mean patient volume of > 2500 and low volume was defined as a patient volume ≤ 2500 per month

on and analyze cotrimoxazole therapy and retention in care for HIV-TB patients, due to large amounts of missing data and limited study time and funds. An integrated patient electronic database was implemented in both study arms. Supplementary Figures 1 (A-F), shows the proportions achieved at baseline and post-QI intervention in the QI and SOC arms. In the QI group, IPT initiation rates improved by 60.5%, (Supplementary Figure 1D) [29]. In comparison the SOC arm improved by 23.1%. Modest improvements are noted in the QI and SOC for HIV testing services (9.7% versus 2.9%), HIV testing services in TB patients (7.6% versus 9.2%), TB screening (9.0% versus 7.7%) and viral load testing (10.8% versus 15.3%).

Comparison of organizational contextual factors in QI and SOC arms

The mean scores achieved for OCFs measured in the QI and SOC arms are compared in Table 4. There were no OCF scores that were statistically significantly different between the QI and SOC arms. The largest difference in scores was observed in Physical Infrastructure which was 78.9% and 64.7% in the QI and SOC arms respectively; $p = 0.058$. The QI arm achieved a score of 46% for Leadership support visits versus 57.4% scored in the SOC arm; $p = 0.265$. The QI and SOC groups scored similarly in monitoring data for improvement (63.3% vs 65%; $p = 0.875$); however, both groups demonstrated a very wide range in scores, with some clinics scoring 100% in both groups.

The QI and SOC arms achieved scores of 77.5% and 79.0%, respectively at baseline, on the COACH survey (Table 4). After 12 months in the study, the QI and SOC arms scored 76.2% versus 79.7%, respectively; $p = 0.128$. After scoring the Degrees of integrated HIV-TB service delivery survey, the QI and SOC arm scored 77.1% and 76.1% respectively, at baseline. After 12 months in the study, QI and SOC arm, scored 74.1% and 80.1% respectively, $p = 0.916$.

Organizational contextual factors associated with IPT initiation rates

While improvements were noted in HIV testing, TB screening and viral load monitoring, regression analyses were not possible in these indicators due to the small improvements made and the regression models did not converge. We used IPT initiation rates as the outcome variable in our regression analyses. Table 5 shows the bivariate linear mixed modelling that tested for associations between each OCF and IPT initiation rates adjusted for time, study group and the interaction between study group and time. MDI was significantly associated with increasing IPT initiation rates ($\beta = 0.04$; $p = 0.004$). All other OCFs showed no statistically significant association with IPT initiation rates. In every bi-variate linear mixed model, the interaction of study group and time was significantly associated with increasing IPT initiation rates, suggesting that exposure to QI over time is predictive of increasing IPT performance irrespective of the influence of the OCF ($\beta = 0.012$; $p = 0.004$).

Clinic staff reflections on integrated HIV-TB service delivery and improvement activities

Barriers and facilitators to integrated HIV-TB service delivery extracted from the FGDs were related to (i) Understanding of what constitutes HIV-TB services, (ii) Awareness of gaps in HIV-TB service delivery (iii) Motivation to make improvements.

Understanding of integrated HIV-TB services

Understanding of integrated HIV-TB service delivery was similar in both study arms, with one exception, the mention of IPT to prevent TB. Focus group participants in both arms emphasized testing and screening for both diseases at the same clinic visit, linkage to TB and HIV

Table 4 Comparison of organizational contextual factor (OCF) scores between QI and SOC groups

Organizational contextual factors	QI arm ($N = 8$)		SOC arm ($N = 8$)		*p*-value
	Mean (%)	Range (%)	Mean (%)	Range (%)	
Physical infrastructure	78.9	(66.7–90.5)	64.7	(42.9–80.0)	0.058
Key staff	95.8	(85.7–100)	92.0	(80.0–100)	0.270
Flexibility of clinic hours	66.9	(25–100)	65.5	(0–100)	0.900
Monitoring data for improvement (MDI)	63.3	(38.9–100)	65.0	(41.7–100)	0.875
Leadership support	46.0	(25.0–75.0)	57.4	(25.0–100)	0.265
Supportive context for change (baseline)[#]	77.5	(72.6–78.8)	79.0	(74.1–84.6)	0.248
Supportive context for change (month 12)[#]	76.2	(73.4–81.8)	79.7	(72.1–92.0)	0.128
Degree of integrated HIV-TB services (baseline)[#]	77.1	(72.8–82.9)	76.7	(66.7–82.4)	0.916
Degree of integrated HIV-TB services (month 12)[#]	74.1	(68.4–80.2)	80.1	(76.7–81.7)	0.916

QI quality improvement, *SOC* standard of care
[#]Mean scores were converted to percentages for comparability

Table 5 Linear mixed models testing associations between organizational contextual factors and isoniazid preventive therapy

Organizational contextual factors	Coefficient (β)	Standard error (SE)	95% confidence interval (CI)		*p*-value
Physical infrastructure	0.002	0.003	− 0.005	0.008	0.605
Study group	− 0.006	0.094	− 0.190	0.178	0.950
Time (months)	0.008	0.003	0.002	0.014	**0.012**
Study group*Time	0.012	0.004	0.004	0.020	**0.004**
Constant	0.335	0.222	− 0.099	0.769	0.131
Flexibility of clinic hours	0.001	0.001	− 0.001	0.004	0.277
Study group	0.016	0.080	− 0.141	0.173	0.842
Time (months)	0.008	0.003	0.002	0.014	**0.012**
Study group*Time	0.012	0.004	0.004	0.020	**0.004**
Constant	0.357	0.099	0.163	0.551	< 0.001
Monitoring data for improvement	0.004	0.002	0.001	0.008	**0.004**
Study group	0.026	0.069	− 0.110	0.161	0.712
Time (months)	0.008	0.003	0.002	0.014	**0.012**
Study group*Time	0.012	0.004	0.004	0.020	**0.004**
Constant	0.156	0.112	− 0.063	0.374	0.163
Leadership support	0.003	0.002	0.000	0.006	0.056
Study group	0.053	0.078	− 0.099	0.205	0.494
Time (months)	0.008	0.003	0.002	0.014	**0.012**
Study group*Time	0.012	0.004	0.004	0.020	**0.004**
Constant	0.267	0.107	0.057	0.477	0.013
Supportive context for change (month 12)	− 0.009	0.008	− 0.024	0.007	0.267
Study group	− 0.012	0.084	− 0.178	0.153	0.884
Time (months)	0.008	0.003	0.002	0.014	**0.012**
Study group*Time	0.012	0.004	0.004	0.020	**0.004**
Constant	1.137	0.626	− 0.089	2.364	0.069
Supportive context for change (month 12 adjusted for baseline)	− 0.014	0.008	− 0.030	0.002	0.08
Study group	0.002	0.081	− 0.158	0.161	0.98
Baseline score	0.023	0.014	− 0.005	0.050	0.11
Time	0.008	0.003	0.002	0.014	**0.012**
Study group*Time	0.012	0.004	0.004	0.020	**0.004**
Constant	− 0.198	1.022	− 2.201	1.806	0.85
Degree of integrated HIV-TB services (month 12)	0.009	0.013	− 0.016	0.034	0.49
Study group	0.016	0.082	− 0.144	0.175	0.85
Time (months)	0.008	0.003	0.002	0.014	**0.012**
Study group*Time	0.012	0.004	0.004	0.020	**0.004**
Constant	0.019	0.614	− 1.185	1.223	0.98
Degree of integrated HIV-TB services (adjusted for baseline)	0.010	0.013	− 0.015	0.036	0.43
Study group	0.083	0.109	− 0.130	0.296	0.45
Baseline score	0.018	0.019	− 0.020	0.056	0.35
Time	0.008	0.003	0.002	0.014	**0.012**
Study group*Time	0.012	0.004	0.004	0.020	**0.004**
Constant	− 0.957	1.208	− 3.324	1.411	0.43

Table 5 Linear mixed models testing associations between organizational contextual factors and isoniazid preventive therapy *(Continued)*

Organizational contextual factors	Coefficient (β)	Standard error (SE)	95% confidence interval (CI)		*p*-value
District	− 0.107	0.067	− 0.238	0.025	0.111
Study group	0.005	0.078	− 0.147	0.157	0.951
Time (months)	0.008	0.003	0.002	0.014	**0.012**
Study group*Time	0.012	0.004	0.004	0.020	**0.004**
Constant	0.499	0.065	0.372	0.625	< 0.001

Each model is adjusted for study group and time

treatment, and a single file system. Nurses in the QI clinics provided more comprehensive definitions of what it means to offer integrated HIV-TB services.

> Coinfected patients should have one file for both TB/HIV. A person infected with HIV only should be screened for TB every visit. A person infected with TB only should be screened for HIV every 3 months. A person with both TB/HIV should be initiated to cotrimoxazole. Those that do not have TB but have HIV should be on INH to be prevented from contracting TB. (QI group, nurse)

Awareness of service delivery gaps

Lack of monitoring and evaluation of the IPT programme emerged as a possible reason for the low baseline IPT initiation rates in the QI clinics. Clinic staff in the QI arm reported being unaware that IPT initiation rates were low until it was highlighted during QI activities and the data was revealed to them. When asked to comment on how QI has improved HIV-TB integration, the QI group (without being prompted about IPT initiation) expressed how the QI highlighted IPT initiation and performance.

> ...things like IPT, IPT coverage, initiating IPT within 28 days of ART and all of that, you do not realize it is a problem until you start plotting and seeing what is happening. It also has helped to see staff performance (QI group, Professional nurse)

In the SOC clinics, three nurses reported receiving regular feedback from the District Health Offices and facility managers, on service delivery gaps.

Motivation to make improvements

In the QI clinics, interviewees mentioned several facilitators to making improvements in their clinic, including, a sense of shared responsibility for improvement efforts, clarity and transparency of individual roles and responsibilities, healthy competition, and benchmarking with other clinics in the collaborative. According to two nurses the QI trainings were too few learning sessions and limited to a small number of attendees which was a barrier to improvement in some clinics. Transfer of knowledge from learning session attendees to non-attendees was described as vague and incomplete which may have led to some clinic staff feeling 'distanced' from the QI intervention.

SOC clinics reported having access to resources for improvement, such as file audit templates, and access to expertise from local non-governmental organizations for data analysis, and development of performance charts. However, a lack of formal training and in-house experience in implementing improvement were barriers mentioned.

Discussion

In the SUTHI trial, IPT initiation rates were dramatically improved in the QI arm compared to the SOC arm (Supplementary Figure 1D). After testing several OCFs for association with improvement in IPT initiation rates, we found that MDI and exposure to QI over time were the only factors significantly associated with increasing IPT initiation rates. Importantly, in this study MDI was a factor that was measured at baseline (before QI intervention implementation). In South Africa, an electronic health information system was designed for the purpose of collecting and analysing patient and process data and evaluating the HIV and TB programme for effectiveness. The practice of MDI is important for data-informed decision-making regarding the direction and effectiveness healthcare services and shows commitment to improving services to communities by clinic teams [30]. The range in MDI scores for the QI and SOC arms shows that all clinics were, to varying degrees, using routine data to monitor and improve the HIV-TB programme (Table 4). This suggests that the QI intervention was implemented in a context where the practice of using data for monitoring programme performance was already embedded and may have contributed to the success of the QI intervention in improving IPT initiation rates. 'Monitoring services for action' was a sub-scale of the COACH tool (Supplementary

Table 1) and the high scores achieved by both study arms at baseline and even after month 12, supports this finding that the study setting had a culture of data use for improvement.

Although statistically significant, we acknowledge that the association between MDI and IPT initiation rates is very weak (low beta coefficient). IPT initiation rates improved by small increments every month. The small monthly differences in improvement and inclusion of several factors (study arm, time, interaction of study arm, and time) in the model produced low beta coefficients.

The importance of MDI is highlighted in other studies. Two systematic reviews that aimed to extract OCFs which predict outcomes in QI interventions, also identified the practice of MDI as key in influencing success of QI interventions [17, 31]. A South African-based study that adopted the Breakthrough Series Collaborative, reduced HIV transmission from mothers to infants from 7.6 to 5.0% in one sub-district [32]. The researchers partially attributed this success to an existing culture of using routine data to reflect on clinic performance which facilitated the adoption of QI and was familiar to front-line staff [32]. Access to good quality routine data that is relevant to front-line staff was a further driver of uptake of the intervention that led to a positive outcome [32].

The low IPT initiation rates at baseline suggest that this indicator was not being monitored or if it was, little was done to improve performance. The FGDs confirmed that the poor performance went undetected until the QI intervention began and IPT initiation rates were presented to clinics. QI interventions to improve IPT initiation rates have been successful in other countries. A national QI programme in Namibia improved IPT by 16 to 28% [33]. In comparison, a Nigerian study made a larger improvement in IPT (11% to 50%); however, their efforts were focused at one busy facility [34]. Both studies attribute this success to QI interventions building skills and confidence among clinic teams to make improvements.

In our study, the FGDs also confirm that QI clinics felt a positive shift in team motivation, in addition, there were other contextual factors that may have influenced the uptake of QI in the study. We observed that at baseline and at month 12, the QI and SOC arms achieved high scores on the degree of integrated HIV-TB services survey, which suggests that clinic teams are well coordinated and prepared to offer integrated services. The high ART initiation rates (> 90%) among co-infected patients (Supplementary Figure 1E) support this finding. The implementation of the integrated HIV and TB electronic data system is an indication of the commitment of the South African Department of Health to HIV-TB integration. Similarly, clinic teams in both study arms perceived high levels of supportiveness (high COACH scores) in their clinic to implement changes and this persisted at month 12 in the study. Given that QI clinics showed high levels of organization to offer integrated services and felt supported to make changes in their clinics, the QI intervention thrived in these clinics, particularly when poor performance was detected.

There were no significant differences in any OCF scores between QI and SOC arms. SOC arm clinics were similar to QI arm clinics for perceived organization to offer HIV-TB integrated services and supportiveness of contexts for change. The FGDs suggest that SOC clinics only lacked improvement "know how". This is promising for any future scale-up of the QI intervention in this context which appears to have the correct conditions to embed a successful QI programme.

Recommendations

Little is known of how best to foster the practice of MDI among clinic teams. Very few systematic reviews and intervention studies have been conducted on this topic [30]. Based on our findings and a small number of studies and systematic reviews that have been conducted, we recommend promoting the practice of MDI through making routine data accessible to clinic staff, ensuring good quality data, and improving the technical skills of clinic staff to use and generate reports from electronic health information systems. A Nigerian study tested the QI collaborative approach in enhancing prevention of mother-to-child services and included data quality as a key indicator for improvement [35]. As data quality improved, clinic teams reported increased levels of confidence in their clinic data and the use of improvement cycles using routine data [35]. Two studies demonstrated that electronic health information management systems are effective in assisting clinic teams and managers in making decisions about health programmes [36, 37]. Effectiveness studies of electronic information systems show that clinic teams will use data from electronic systems provided that the quality of data is accurate and reliable, reports are easily generated, skills and capacity to use the system is present, and no major hardware and software malfunctions occur [36, 37].

In addition, we found rapid assessments of organizational context using structured surveys useful to understanding the setting in which our QI intervention was implemented, and future QI initiatives should consider this approach and add to the knowledge base of how OCFs influence the success of QI.

Limitations

The study has several limitations. The accuracy of data collected on surveys, such as the COACH survey, cannot be guaranteed. Social desirability bias may have influenced some responses particularly those of a sensitive nature, such as leadership and commitment to work. Two studies which tested the reliability of the COACH survey reported similar challenges of eliciting truthful responses and strongly recommend that confidentiality and privacy of data be emphasized to respondents [38, 39]. Despite assuring respondents' confidentiality and anonymity, we received reports from study staff of hesitation among respondents to select answers that may reflect poorly on themselves, leaders, and the clinic team. Thus, COACH scores in this study may be inflated. In addition, we extended the use of the COACH survey to data capturers and lay counsellors, who may not have had some knowledge, such as clinic access to medication.

Using the validated measures repeatedly may not have been the ideal method to engage clinic staff. There were reports of "fatigue" among respondents regarding the time it takes to complete the surveys and being asked the same questions. The small sample size of 16 clusters restricted and affected the analyses. We were unable to perform regression models for each study arm. Secondly, the CPT was not a validated tool and the scoring system was developed by SG and CC. Future studies should consider development of a validated measure to assess aspects of physical infrastructure and resources in low- and middle-income countries. Thirdly, all OCF scores were at the cluster level and therefore highly summarized.

Conclusion

This study has shown that QI interventions are successful in contexts where clinic teams are encouraged and supported to use routine data for improvement. IPT is an important intervention in interrupting the transmission of TB and is seldom prioritized for improvement. Capacitating clinic teams with QI skills and tools, fostering the practice of using routine data to monitor improvement, and removing any threats to using routine data may be the key to improving IPT initiations and other poorly performing indicators.

Abbreviations

ART: Antiretroviral Therapy; COACH: Context Assessment for Community Health; FGD: Focus Group Discussions; IHI: Institute for Healthcare Improvement; IPT: Isoniazid Preventive Therapy; MDI: Monitoring data for improvement; MES: Median Effect Size; OCF: Organizational Contextual Factors; PARIHS: Promoting Action on Research Implementation in Health Services; PHC: Primary Healthcare; QI: Quality Improvement; SD: Standard Deviation; SOC: Standard of Care; SUTHI: Scaling up TB HIV Integration; TB: Tuberculosis; TPT: TB Preventive Therapy

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13012-021-01155-7.

Additional file 1.
Additional file 2.
Additional file 3.
Additional file 4.
Additional file 5.
Additional file 6.

Acknowledgements

• SG is a University of KwaZulu-Natal (UKZN) Developing Research Innovation, Localisation and Leadership in South Africa (DRILL) fellow. DRILL is a NIH D43 grant (D43TW010131) awarded to UKZN in 2015 to support a research training and induction programme for early career academics. The content is solely the responsibility of the authors and does not necessarily represent the official views of DRILL and the National Institutes of Health.
• SG was supported by European and Developing Countries Clinical Trials Partnership (EDCTP) Grant TMA2018SF-2467
• We thank the South African Department of Health, District Management Teams of the Ugu and King Cetshwayo Districts for supporting this study; all the healthcare workers that participated in the trial, and all members of the SUTHI study field team.

Authors' contributions

SG was responsible for the study conduct, development of the first draft of the manuscript, intellectual input, analysis, and interpretation of the results. CC and NYZ provided input on the analysis and interpretation of results, PB provided input on the study design and manuscript. AJN, ML, and MT edited the manuscript and provided intellectual input. KN and NP provided intellectual input, provided oversight of the SUTHI trial, and contributed to the writing of the manuscript. KN is the grant holder. The authors read and approved the final manuscript.

Funding

The research reported in this paper was supported by the South African Medical Research Council with funds received from the South African National Department of Health, and the UK Medical Research Council, with funds received from the UK government's Newton Fund. This UK funded award is part of the EDCTP2 programme supported by the European Union.

Availability of data and materials

Individual participant data for completed studies is available on requests through the CAPRISA website; after approval of a proposal, data can be shared through a secure online platform.

Declarations

Ethics approval and consent to participate

The SUTHI trial was approved by the Biomedical Research Ethics Committee of the University of KwaZulu-Natal (BF108/14). The KwaZulu-Natal (KZN) Health Research and Knowledge Management committee granted permission to access PHC clinics in the study districts of KZN (HRKM309/14). All healthcare workers who agreed to participate in the study signed an ethics-approved informed consent form which was available in English and the local language.

Consent for publication

Not applicable.

Competing interests

The authors declare they have no conflicts of interest.

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Received: 13 April 2021 Accepted: 2 September 2021
Published online: 17 September 2021

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Publisher's Note

4.3.3 Discussion of Paper III

Paper III is responsive to specific objective 3 of the PhD project and is currently under review with BMC Implementation Science. This objective was to determine which organizational contextual factors are predictors of success when using QI to improve HIV-TB services. It was initially envisaged that there would be multiple process indicators that the QI intervention would improve and that these could be used as the outcome variables and the organizational contextual factors measured in the study used as predictor variables to determine which were associated with each improved HIV-TB process indicators. As demonstrated in Paper II, only IPT and HTS were significantly improved.

The PARIHS framework was used to guide our research into which elements of organizational context are likely to influence the uptake of QI. Physical infrastructure, leadership support, monitoring data for improvement, key staff availability, and supportive contexts for change were organizational contextual factors highlighted by the PARIHS framework and were adopted by the study. In addition, the degree to which clinics were organized to offer integrated HIV-TB services and the flexibility of clinic operating hours were OCFs included in the study, based on similar research. At the time of study exit, we conducted exit interviews in the form of focus group discussions with volunteer clinic staff from the QI and SOC group clinics. The exit interviews were intended to describe how the QI and SOC clinic staff understood HIV-TB integration at the end of the study period and to describe the experiences of the QI clinics. The FGDs revealed information which shed some light on the quantitative study findings.

Linear mixed modelling with HTS as the outcome variable was not successful as the model did not merge. The main finding was that monitoring data for improvement was the most significant predictor of increasing IPT initiation rates. There were no differences between the QI and SOC scores for physical infrastructure (78.9% vs 64.7%; p=0.058), key staff (95.8 vs 92;p=0.270), clinic hours (66.9 vs 65.5; p=0.900), MDI (63.3 vs 65;p=0.875, leadership support (46.0 vs 57.4;p=0.265), perceptions of supportiveness of contexts for change (76.2 vs 79.7;p=0.128) and degree of integrated HIV-TB services (74.1 vs 80.1;p=0.916). MDI was a significantly associated with increasing IPT initiation rates [beta coefficient (β)=0.004; p=0.004]. The FGDs showed that the QI intervention created awareness of the low IPT performance at baseline and instilled a sense of shared responsibility and motivation among clinic teams.

The paper concludes by providing recommendations on how MDI maybe fostered and any threats to this practice removed. Recommendations include improving data quality, access to data, enhancing technical capabilities of clinic staff, and minimizing software and hardware malfunctions for electronic databases.

CHAPTER 5: SYNTHESIS

The aim of this PhD project was to determine the influence of organizational contextual factors on a QI intervention to enhance integrated HIV-TB service delivery in rural primary healthcare clinics in KwaZulu-Natal. The QI collaborative approach has been cited as resource intensive, costly, with low to moderate levels of improvement observed.[144] The inextricable role of OCFs in influencing the success of QI projects is increasingly being recognized. [118, 119, 144, 153] The PhD project addressed an important gap in understanding the influence of OCFs on a QI collaborative approach to improve integrated HIV-TB services. The strengths of the PhD project were that process indicators of HIV-TB integration were assessed to monitor improvement in parallel to the collection of various OCFs, hence associations can be made between the improvements observed and the OCFs. Secondly, the presence of a control group (SOC group) provided insights into the performance of typical clinics exposed to standard supervision and support to which the QI group could be compared.

The PhD project assessed several OCFs, informed by the PARIHS framework, that influenced the QI intervention. A few OCFs emerged during the study. Overall, the OCFs that were pertinent to the PhD project were: baseline performance of indicators (Paper I and II); data quality (Paper I); transfer of training knowledge to peers (Paper I); staff motivation (Paper I); leadership (Paper I and III); performance feedback (Paper II), cluster size (Paper II); monitoring data for improvement (MDI) (Paper III); supportiveness of contexts for change (Paper III); and organization and preparedness to offer integrated HIV-TB services (Paper III).

This synthesis comprises five sections: (i) Summary of key findings (ii) OCFs associated with facilitating QI to improve HIV-TB, (iii) OCFs associated with impeding the QI process, (iv) Limitations of the PhD project, and (v) Recommendations for future scale up of QI interventions to enhance integrated HIV-TB services.

5.1 Summary of key findings and observations

The goal of the QI intervention was to improve HIV-TB integration at a PHC level, and eight process indicators were identified to enable monitoring and evaluation of the intervention. HTS, TB screening, IPT initiation, VL testing at month 12, and ART initiation in HIV-TB co-infected patients were indicators addressed by the QI intervention. Cotrimoxazole Preventive Therapy and retention in care for HIV-TB patients were not included as indicators as the extent of missing data for these

indicators was considerable, such that a baseline value could not be determined. An integrated HIV and TB electronic data system was implemented in all study clinics.

The first finding was that the QI intervention was effective in improving IPT initiation and HIV testing rates (Papers I and II). In Paper I, we showed a 5-fold increase in IPT initiation rates from baseline to the withdrawal phase (15.9% versus (vs) 76.4%; p=0.019). In Paper II, the QI and SOC group performance were compared between the baseline and intensive phases and the QI group was 66% higher in IPT initiation rates (61.2% vs 36.8%; Relative Risk (RR)=1.66; 95% CI:1.02-2.72; p=0·044) than the SOC group. In Paper I, HTS rates showed moderate improvement between baseline and the withdrawal phase (84.8% vs 94.5; p=0.110). HTS was 19% higher (94.5% vs 79.6%; RR=1.19; 95% CI:1.02–1.38; p=0.029) in the QI group compared to SOC group (Paper II). The large improvement in IPT initiation rates was attributed to low baseline performance in the QI group clinics which allowed for more room for improvement (Paper I and II). In addition, QI clinic teams identified and addressed several health system's weaknesses, such as, clarifying the timing of IPT initiation, development of an early identification system for IPT-eligible patients and improving data recording (Paper I). In comparison, as the baseline values for HTS were high, there was little room for improvement. Similarly, ART initiation among HIV-TB patients was high (>90%) at baseline and remained high during the study (Paper I and II).

There was room for improvement for TB screening and VL testing, but only modest improvements of 9.0% and 12.6%, respectively, were observed in the QI group (Paper I). Comparison of the QI and SOC groups performance at the intensive phase showed no significant differences, in TB screening or viral load testing rates (Paper II).

The second finding was that the performance feedback initiative implemented by the DMTs, played a role in the improvement observed in the SOC group, due to the improvement in support and supervision. Consistent improvement was noted in the SOC group for IPT initiation (Paper II). We attributed this improvement to 'Nerve Centre Meetings' that were regularly held at the district level with all facilities. These meetings were the main mechanism through which DMTs reviewed clinic data and provided feedback on performance and gaps to be addressed. In Paper II, we acknowledged that the improvement in the QI group should be interpreted bearing in mind that there was a motivated DMT monitoring performance and highlighting gaps in service delivery. We believe that the QI intervention complemented the efforts of the DMT and provided structure, mentorship, and tools to address gaps identified.

The third finding was that cluster size may have played a role in the improvements observed in IPT initiation and HTS rates (Paper II). Cluster size was used, as opposed to clinic patient volume, because the unit of the analyses was the PHC nurse supervisors (the cluster). Small clusters (defined as patient volume <2500) made large improvements in IPT initiation rates in the QI group, ranging from 30.4% - 68.3%. Larger clusters (defined as patient volume >3500) made comparatively smaller improvements ranging from 3.4% - 54.7%. We surmised that small clusters were likely better able to coordinate their efforts in addressing service delivery gaps and implementing complex interventions (Paper II). For HTS, the large clusters in the QI group made larger improvements that ranged from 0.8% - 29.7% and small clusters made improvements that ranged from 3.4% - 9.4% (Paper II). These findings led to recommendations of how facility volume maybe leveraged to promote QI. The large improvements made in small facilities can be used to engage and encourage other facilities to take up QI in the initial stages of scale up. QI interventions for well-established services, such as, HTS should be considered for larger facilities where innovative methods of maximizing high patient volumes are beneficial to increasing HTS rates.

Major IPT initiation rate improvements were observed in approximately 6 months. In an Ethiopian study, major improvement in IPT initiation rates were observed in 3 months (from 4% - 81%).[167] In other contexts (which aimed to improve various process indicators) the speed of improvement varied from 0-63 months.[120] The speed at which improvement occurs appears to be slower in very large hospitals, however, no conclusive evidence could be found on the exact role of facility size and speed of improvement.[120] A systematic review of several QI collaboratives suggests that just the participation in a QI initiative positively influences the knowledge, problem-solving skills, attitude, and teamwork of healthcare workers. [168]

The role of cluster size in improvement has implications for future QI initiatives and scale-up initiatives (Paper II). We recommend that smaller clusters that are performing poorly be utilized in the early stages of a QI initiative to showcase the large improvements that are possible using QI and encourage adoption of QI and buy-in from other clinics and contexts. Smaller clusters may have more initial success due to better coordination of efforts, teamwork, and ability to adopt complex strategies.

The fourth finding was that front-line HCWs were a rich source of information on weaknesses and bottlenecks in clinic systems and how these could be addressed (Paper I). Patient flow redesign,

development, and implementation of strategies for early patient identification for services (viz. VL testing and IPT initiation) and monitoring daily data quality, were among the change ideas developed and tested by HCWs in the QI group clinics (Paper I). An average of three PDSA cycles per indicator shows the willingness of HCWs to develop and test new change ideas.

The fifth finding was that HCWs achieved high scores on the COACH tool at baseline and during study follow up in both study groups (Paper III). The COACH tool assessed perceptions of supportiveness of clinic contexts to make changes. This suggests that the study context was one that was receptive to change which likely contributed to the uptake of QI. The very nature of the QI intervention created more opportunities for clinic teams to work together to solve problems and increased communication between team members.[169]The QI intervention did not increase perceptions of supportiveness to make changes among HCWs (Paper III). After 12 months of exposure to the QI intervention, there was no significant difference in the scores in the QI group compared to the SOC [76.2% (range:73.4% - 81.8%) vs 79.7% (range:72.1% -92.0%); p=0.128] (Paper III).

The COACH tool was administered to HCWs by study staff and there is a possibility that responses were influenced by social desirability reporting bias, that is, the tendency of respondents to provide answers that portray themselves in a favorable light.[170] Other studies that adopted the COACH tool reported similar difficulties in obtaining truthful responses from HCWs, particularly on sensitive questions, such as, leadership support and commitment to work. [171, 172] Even though the high scores obtained on the COACH tool may be inflated, the uptake of QI and efforts to test change ideas (Paper I), support the finding of a context that is supportive of change.

The sixth finding was that the practice of MDI was significantly associated with increasing IPT initiation rates (Paper III). This study measured the practice of MDI by scoring the availability and utility of routine HIV and TB programme data to improve facility performance (Paper III). Monitoring programme performance using routine data is inherent to the QI process.[150] Importantly, in the PhD project, MDI was measured at baseline which established its pre-existence before the QI intervention began (Paper III). The range in MDI scores, in the QI and SOC groups, shows that this practice was being implemented in clinics to varying degrees.

We acknowledge that the association between MDI and IPT initiation rates was small (Beta coefficient (β)=0.004; p=0.004). MDI is frequently identified as a key OCF that drives

improvement.[126, 130] In this PhD project, MDI was the only organizational contextual factor that was statistically significantly associated with IPT initiation rates, however, studies have shown that MDI alone is not sufficient to drive improvement.[173-175] Data infrastructure, strong leadership that encourages the use of routine data and a team culture, that is confident in their ability to use data for improvement, are some of the supporting characteristics that need to be present. [175] Scores achieved on the sub-scales of the COACH tool, confirm that a strong team culture, leadership support, and access to resources and sources of knowledge, were present in the QI and SOC group clinics. We made several recommendations for how the practice of MDI maybe fostered, including: making routine data accessible to clinic staff; ensuring good quality data, improving the technical skills of clinic staff to use and generate reports from electronic health information systems, ensuring that no major hardware and software malfunctions occur in data systems. [173, 174]

In the next section, the OCFs that were observed to influence the QI intervention to enhance HIV-TB integration or OCFs that were observed in the SOC group are described.

5.2 Organizational contextual factors that facilitated the QI intervention

In this section, OCFs that facilitated improvement are explored in more detail.

Monitoring Data *for Improvement (MDI)*

MDI is considered an OCF because it is a group practice representing an intentional activity undertaken by a clinic team to improve performance and patient outcomes.[125] Clinic teams that undertake MDI are generally influenced by good leadership that emphasizes use of data, have good data infrastructure, and are confident in their ability to use data to make changes.[125, 136, 175] This PhD project is, to my knowledge, is the only study to have shown a statistically significant correlation between MDI and IPT initiation rates (Paper III). Three systematic reviews have identified MDI as among the top five OCFs that influence QI success or implementation of EBPs. *[125, 126, 130]* Very little is known about how to foster this practice, particularly in LMICs.[125, 130] Poor quality of data is the main threat to MDI.

Quality of routine data

QI is a data-driven activity and data that are available and easy to access facilitates the QI process. [176] We observed that HTS, TB screening and IPT initiations were among the first indicators selected for improvement. These data were recorded in paper-based registers, easily accessed by clinic staff,

completed daily and in real-time. In addition, monthly summaries of these data are routinely reported to the district health office and discussed at Nerve Centre Meetings. Familiarity with these indicators and routine monitoring likely motivated clinic staff to address these indicators first (Paper I).
VL testing was selected for improvement after a six-month long initiative to acquire complete and cleaned VL data (Paper I). This also shortened the amount of study time available to improve VL testing rates. In papers I and II, it was observed that of the seven HIV-TB process indicators that comprised integrated services, only five were addressed in the QI intervention group. Large amounts of missing data for retention in care and cotrimoxazole preventive therapy prevented the QI intervention from addressing these indicators.

Those indicators for which data were stored in electronic databases, viz. viral load data, were deemed 'difficult indicators' by clinic staff who doubted the reliability and accuracy of reports generated from electronic databases. Reasons for this included: backlogs in data capturing, incomplete patient records (outstanding laboratory results), lack of easy access to electronic data records and poor technical skills to operate the software. Data Capturers are the gatekeepers of the electronic databases and on average each clinic had up to two Data Capturers who were heavily relied upon for completeness and accuracy of the database as well as generating reports. Aside from improving data quality, addressing the technical skills of clinic staff to access and use data may create a sense of shared responsibility for the dataset.

Poor data quality is a threat to QI interventions and in this study, it undermined our efforts to effectively address TB screening and VL testing, and completely foiled attempts to improve cotrimoxazole and retention in care for HIV-TB patients.

Technical capabilities of Healthcare Workers

A United States-based qualitative study to identify which OCFs influenced implementation of a QI project, found that data analytic skills among clinic staff played a major role in adoption of QI interventions. [177] The researchers found that even after receiving QI training, staff that were uncertain about how to analyze data were less likely to participate in QI initiatives. In the PhD project we observed similar behavior. Aside from the technical skills needed to generate reports from electronic data systems, there is also skill required to transform raw data into meaningful information that can be used for monitoring performance. In Learning Sessions, we capacitated HCWs with basic data analysis and graph development skills (Paper I). Our study did not measure changes in HCWs perceptions or confidence in data analytic skills, however, in FGDs interviewees in the QI group

mentioned improvement in team motivation to make changes in the clinic (Paper III). Future initiatives to scale up QI to improve HIV-TB integration must invest in improving data analytic skills of HCWs to build confidence in clinic teams and enhance sustainability of the QI method of improvement.

Leadership Support

Leadership support is considered an indispensable OCF in the successful implementation of QI.[125, 126, 130, 177] In Paper III, we report that leadership support was not statistically significantly correlated with IPT performance. A sub-scale of the COACH tool which measured leadership support showed no differences at Month 12 between the QI and SOC group (Paper II), however, leadership support scores were high in both groups at baseline and during the study. The method and scoring for assessing leadership support in the PhD project had limitations. The leadership sub-scale of the COACH tool has been reported as a 'sensitive' topic and it is possible that respondents did not want to portray leaders negatively.[171] We measured leadership support based on the frequency of site visits which is only one aspect of leadership support (Paper III). Despite finding no differences in leadership support between study groups, we strongly believe that leadership played a major role in the study.

During the study the influence of upper management leadership, that is, the DMT played a role in showing their support for the study by attending QI learning sessions at which some DMT members presented District level performance data. This participation demonstrated clear support for the SUTHI trial and the QI intervention to the QI clinic team members present. We believe this assured the QI clinic teams of the legitimacy of the project and reinforced the importance of their involvement.

The DMT members did not play a role in the implementation of the QI at the site level. This should not be viewed negatively. We believe that had senior members of the DMT been present at clinic level meetings, this may have been intimidating to junior level staff who may not have been as participated as much in QI meetings. A study by Sommerbakk et al. (2016) suggests that good leadership is one that is willing to give autonomy to clinic level staff and encourages a bottom-up approach.[136]

Leadership support for the QI intervention from the OM was positive though at times passive. There was no resistance or conflict recorded with clinic-level leaders during the implementation of the QI

and their support for the initiative was shown by giving permission for the QI to continue. Although the senior clinic-level leadership participated in QI meetings, their attendance was infrequent, and it sufficed to keep them abreast of the QI progress.

We did observe that development and implementation of change ideas which involved changing patient flow in the clinic, would often need to be approved by the Nurse-in-Charge. If clinic-level leadership had change ideas or insights into how HIV-TB services could be improved, this study failed to tap into their knowledge or expertise. A major barrier to active clinic-level leadership participation was their workload and attendance at other meetings off site.

The positive aspects of leadership in the study setting were the unreserved permission and support for the QI initiative which they made known to the clinic teams. Their permission to make simple changes to the clinic workflow facilitated the QI initiative. The QI intervention may have benefitted from a different leadership style at the clinic level. The PARIHS framework asserts that 'a transformational leadership style' plays a big role in fostering a clinic culture that adapts to change.[128] Transformational leadership is one that questions the status quo, encourages teamwork, and challenges staff, while being supportive and inspirational, fosters growth and enhances the integration of new evidence or practices.[178] The SA DOH may benefit from promoting this type of leadership style in clinic-level leaders, such as the OM or second-in-charge.

Supportive contexts for change

In this study setting, we observed that the study context was one supportive of implementing changes Paper III. In the SUTHI study, HCWs readily identified problems or weaknesses in the clinics' systems and developed and implemented change ideas to address these shortcomings (Paper I). Although a QI mentor facilitated the change process, the QI clinic teams did not require convincing that the current systems required improvement. According to an evaluation of QI programs conducted by the Health Foundation, one of the first challenges that most QI projects face is needing to convince clinic teams that there is a problem.[176] The authors advise providing hard data to clinic teams to demonstrate the performance problem and secure the emotional engagement of HCWs.[176] We used routine clinic data to achieve this, which further facilitated improvement.

While this setting had a strong sense of supportiveness for change, we did identify threats to this OCF when QI was introduced. The study QI mentors, and the QI clinic team members reported resistance to change ideas from other staff members, particularly those not selected to participate in

the QI workshops (Paper I). In this and in most QI studies which adopted a collaborative learning approach, it was neither possible nor feasible for all clinic staff to attend QI workshops, as clinic operations would be adversely affected.[124] We envisioned that there would be a transfer of knowledge from workshop attendees to clinic peers. In Paper I, it is discussed that the study had not adequately planned or facilitated the transfer of knowledge to those not attending the learning sessions. The study may well have benefitted from strategically selecting HCWs who had the skills, personality, and attributes to communicate training knowledge to their peers (Paper I), instead selection of attendees to the learning sessions was left to the sole discretion of the facility manager. In a systematic review to evaluate QI interventions in nursing homes, the authors determined that little attention is given to how QI trainings are cascaded among HCWs and caution that QI sustainability and long-term effectiveness is threatened if this is not addressed in future QI programmes.[179] At the end of this chapter, there are recommendations for addressing this gap.

Standard of Care Performance Feedback Intervention

The Ugu and KCD District Health offices, initiated a district-wide performance feedback initiative eight months before the start of the SUTHI trial. The performance feedback initiative consisted of monthly meetings of all SA DOH facilities called 'Nerve Center' meetings. The purpose of the meetings was to closely monitor the performance of HIV, TB, and Non-Communicable Diseases programmes to identify service delivery gaps in all provincial facilities. Thereafter, corrective action plans were developed and monitored. Nerve Centre meetings allowed for best practices to be shared among facilities and may have engendered the culture of supportiveness for change we observed in both the QI and SOC clinics.

Performance feedback is an intervention in itself and the QI intervention operated in parallel to this SA DOH-initiated intervention.[180, 181] The extent of the influence of the Nerve Centre meetings in the SOC group are reported in Paper II, where ART initiation in SOC groups was >90% throughout the study and there was improvement in HTS, TB screening, VL testing and IPT initiations. The introduction of this DOH initiative may have benefitted the study, as it created an environment where monitoring data for improvement was supported by the leadership and that created a context where improvement plans were encouraged and normalized. The limitation of the performance feedback was the lack of structure in how to address identified problems, and measurement of progress in addressing the problems and assisting individual clinic teams with a strategy to address their service delivery gaps.

Performance measurement and feedback is an intervention known to produce improvement and this was implemented parallel to the QI intervention.[182] The value of performance measurement and feedback was demonstrated in a Ugandan study that utilized routine TB data to create a monthly report card reflect the TB service delivery performance of facilities. [180] The performance measurement and feedback intervention resulted in a 15% increase in facilities being more adherent to the International Standards of Tuberculosis Care. A Thai-based evaluation of a national QI programme to improve HIV care found that performance measurement and feedback improved TB screening by 75% and was the impetus for many local facilities starting up QI projects.[113]

The strong commitment of the SA DoH to provision of integrated HIV-TB services was apparent throughout the study and likely promoted the uptake of the QI intervention to improve HIV-TB services. First, the roll-out of the single HIV and TB electronic database upgrade in all clinics was initiated by the SA DoH prior to the SUTHI trial and second the high scores noted in the Degree of integrated TB and HIV service delivery measure at baseline and Month 12 showed that all study clinics were organized and prepared to offer integrated services. Third, during the study the SA DOH updated treatment guidelines to make ART and IPT more accessible to larger groups of patients. It is likely that policy changes further strengthened the standard of care and demonstrated the political will of the programme to meet 90-90-90 targets. However, universal test and treat strategy did not result in a substantial improvement in ART initiations in this study. A South African study that described healthcare workers' perspectives of the universal test and treat strategy showed that while nurses appreciated the clinical benefits of early ART initiation, factors such as patient readiness for life-long ART, and lack of human and infrastructure resources to manage the large patient influx, hinder the drive to achieve targets.[68] In the case of IPT initiations in the SOC group, there is an observed increase in initiations during the study (Paper II). Amendment of the IPT guidelines in May 2018, which was released in a nation-wide memo to all health facilities, likely emphasized the commitment of the SA DoH to strengthen the IPT programme and prompted all study clinics to improve this indicator which was performing poorly. In the QI group, the QI intervention likely provided a clear structure and steps to improve IPT initiation which resulted in the significantly higher increase in IPT initiations compared to the SOC group.

5.3 Barriers to implementing QI to improve HIV-TB integration

Hesitancy to question guidelines or seek clarity

One of the factors that contributed to the poor baseline performance of IPT was the confusion and ambiguity of the SA HIV treatment guidelines regarding the timing of IPT initiation in patients

newly initiated on ART. Until our QI intervention, this misunderstanding of the guidelines persisted with no resolution. We observed that HCWs did not reach out to leadership figures for clarity or assistance. There are several reasons for this, namely: (i) not knowing who to contact for clarity on IPT treatment guidelines, (ii) not knowing their clinics' IPT initiation performance, and (iii) a lack of leadership and accountability for the IPT programme. The IPT programme has had a controversial history since its inception regarding whether the HIV programme or the National TB programme takes responsibility for this service.[44] This has affected the ordering of IPT stock and messaging to clinic teams regarding the correct implementation of IPT. [44] The FGDs revealed that HCWs were unaware that IPT performance was so poor (Paper III). When presented with data from their own clinic, there was motivation and drive to improve the IPT performance.

Documenting roles and responsibility for new changes/procedures

It was initially planned that the clinic staff would collect data required to monitor performance of process indicators on a weekly basis. Implementing QI methods is additional work for clinic staff and QI mentors documented having to oversee or collect weekly data themselves. It was a concern that this created a dependence on the QI mentors and was not conducive to sustainability after the study. To address this, the QI mentors documented roles and responsibilities for clinic team members to provide clarity on who is responsible for implementing a change idea and collecting data for tracking performance. This documentation remained at the clinic and was filed as a record for future staff training.

High baseline performance of indicators

The baseline performance of an indicator determined the extent of the improvement that could be made. ART initiation in co-infected patients, was high at baseline (95.8% and 98.9%, in QI and SOC group respectively) and similarly TB treatment initiation rates were 98.5% and 93.8%, in the QI and SOC group respectively (Paper II). In the intensive phase we observed a slight decrease in ART initiation (a decrease of 4.1% and 3.4% in the QI and SOC group respectively) and a large decrease in TB treatment initiation (a decrease of 11% and 5.3% in the QI and SOC group respectively). We believe that the high baseline performance of these indicators suggested that treatment initiation systems needed no further improvement, and more effort was directed toward services to improve access to care (viz. TB screening and HIV testing). The opportunity to improve TB treatment initiation rates were missed in this study. Dixon-Woods et al. (2012), caution that in trying to improve one issue, improvement teams ignore or create other issues elsewhere in the system.[176]

5.4 Limitations of the study

- We had two QI nurse mentors who looked after 20 QI intervention clinics. A lesson from the MERGE trial was that study staff, attempt to "fit in" and gain the cooperation of clinic teams, by adopting the work of SA DOH clinic staff. We wanted to avoid this scenario.[183] In our study, each QI Nurse Mentors conducted fortnightly in-person visits to reinforce knowledge acquired in the training sessions. We do not know if this is the ideal frequency of QI visits. We did not conduct post-study follow up visits to determine if the QI tools or change ideas implemented were sustained.

- The developers of the collaborative learning approach strongly recommend the spread of QI knowledge and successful change ideas.[153] The success of QI is often measured by the extent to which ideas are spread and the number of new clinics joining the initiative. By adopting a randomized controlled design, we had a comparison group to determine if improvements would have occurred anyway. However, the disadvantage is that we prevented the spread of new change ideas and knowledge of QI to other clinics to avoid contamination. This means that a basic and characteristic aspect of the learning collaborative approach could not be undertaken, which is to spread ideas and determine if those change ideas could be further improved upon and then scaled up to other clinics and other settings. Evaluating the spread of ideas and counting the number of new sites that join the QI initiative is a way of assessing effectiveness which we were not able to do in our study.

- Contamination, by exchange of information between the QI and SOC group, could not be ruled out in the SUTHI trial. District level meetings and Nerve center meetings often brought ALL facility leaders and staff together and the study staff did not impose bans on exchanging information or ideas with fellow HCWs. To the best of our knowledge, the implementation and regular follow up of the intervention QI clinics was not replicated in other clinics.

- The study had limited funding and a small roving data team were assigned to ensure data quality in all 40 study clinics. Upon reflection, this was not adequate as each clinic required a data team to ensure backlogs in data capture and high-quality data. However, this would have been an enormous expense to the study.
- Attempts by the QI study staff to link NHLS data to the TB patients and the electronic TB register were very difficult due to the lack of a unique patient identification number. The study team were

therefore unable to track individual patients' laboratory results back to the clinic to determine if patients with laboratory confirmed TB had been initiated onto treatment. Instead, summary data was used.

- Smaller clusters were randomized to the SOC group, and this may have been prevented had the study considered matching PHC nurse supervisors by patient volume prior to randomization. Matching of nurse supervisors by headcount was not possible because the SA DOH allocates nurse supervisors by geographic area and this method would have introduced statistical limitations to make inferences.

5.5 Recommendations

There are several lessons learned from this study which other contexts may find beneficial when implementing QI programmes or in scaling up QI. First, organizational readiness for change needs to be fostered in any context and it should be a continuous effort. In this context, we found that organizational support for change was high in both study groups at baseline and throughout the study. The organizational readiness for change theory suggests that support for change can be fostered by creating opportunities for teams to understand their performance and showing gaps in performance. [146] We are aware that the SA DoH in the study districts strongly emphasize and foster the practice of using data to demonstrate performance gaps. Hence the willingness to make changes was always present in clinics. It is likely that the QI intervention played a role in improving clinic teams' confidence to make changes and provided the necessary sequence of steps, 'know how', and QI resources to make improvement (change) possible. This capacity building is the second factor that is required for organizational readiness.

Second, front-line clinic staff should always be considered for QI training and capacity building. Front-line clinic staff were the recipients of the QI training and mentorship. Top-level management and leaders showed support of clinic-based changes that ultimately met the goals of the HIV and TB programmes. This bottom-up approach is recommended as it provided the opportunity, space and safety for clinic staff to voice their concerns, express their ideas and formulate their change interventions. It is possible that clinic-staff made changes because they felt the sense of shared accountability among their teams. Further considerations for QI training of clinic staff are provided below.

The success of future QI interventions to improve integrated HIV-TB services could be enhanced by removing threats to effective QI and building QI capacity and skills among HCWs. The findings of this PhD project highlight where the SA DoH could strengthen existing systems that could promote and facilitate the use of QI and ultimately embed QI into standard of care supervision and support.

- The role of routine data in improving HIV-TB service delivery is a common theme in the three PhD manuscripts. Routine data is the cornerstone of a successful QI intervention, and the following steps are recommended to enhance the use of data:
    - A concerted effort to improve data quality in registers and electronic information platforms is required by the SA DoH and local NGO partners. Fostering the practice of MDI may improve the demand for better quality data from clinic staff and create a sense of shared responsibility for ensuring completeness and accuracy in data recording.
    - Data infrastructure (both hardware and software) needs to be upgraded to ensure that technical glitches, poor connectivity, and viruses do not affect data systems and facilitate ease of use for clinic staff.
    - Senior nurses need to be trained to navigate the electronic data systems, particularly, generating reports. This will empower nurses and alleviate the burden for the Data Capturers as the only staff who can perform this function.
    - A unique and persistent patient identification number is vitally important to linking databases and tracking key HIV and TB indicators. Future efforts to scale up QI interventions would benefit from the ability to monitor if appropriate actions have been taken for blood and sputum results at the clinic level.

- QI training for all categories of clinic staff must be incorporated into SA DOH orientation or training programmes.
    - To avoid creating resentment and misperceptions of being ‘left out’ of training opportunities, it is recommended that QI training be available to all staff.
    - This can be accomplished by hosting several QI trainings and making these repeated trainings instead of once-off events.
    - QI training manuals and materials should be widely distributed and available.
    - Organizational awards should be considered for clinic teams or individuals who have demonstrated improvement in services using QI methods.
    - Include upper management, middle managers, and clinic team leaders in QI trainings

- Performance feedback from the District Health Offices to the facilities was a powerful improvement initiative and should continue in this setting:
    - In-person visits by District TB and HIV programme managers and PHC supervisors to individual clinics to encourage the use of QI to customize solutions will enhance the performance feedback.
    - Encourage diversity in attendance to district performance feedback meetings. Data Capturers, Lay Counsellors and Nurses may have insights into data inaccuracies or clinic systems and patient-related factors that could enhance the quality of these meetings.
    - Clinic teams will prioritize indicators for improvement as directed by upper management structures. The performance feedback meetings are an opportunity to highlight neglected or often overlooked indicators.
- Encourage diversity in QI teams at a facility level. This will ensure that the perspectives of all staff categories are included.
- Encourage upper, middle, and facility-level leaders to adopt a transformational leadership style. Leaders should be encouraged to participate in QI meetings and normalize their presence in discussions about improvement. Adopting a bottom-up approach where frontline staff take the lead in making improvements but sharing responsibility and accountability for the outcomes maybe a more effective approach than a rigid top-down management style.

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APPENDICES

Appendix I: The SUTHI Protocol paper

Naidoo et al. Implementation Science (2017) 12:129
DOI 10.1186/s13012-017-0661-1

Implementation Science

STUDY PROTOCOL Open Access

Addressing challenges in scaling up TB and HIV treatment integration in rural primary healthcare clinics in South Africa (SUTHI): a cluster randomized controlled trial protocol

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Abstract

Background: A large and compelling clinical evidence base has shown that integrated TB and HIV services leads to reduction in human immunodeficiency virus (HIV)- and tuberculosis (TB)-associated mortality and morbidity. Despite official policies and guidelines recommending TB and HIV care integration, its poor implementation has resulted in TB and HIV remaining the commonest causes of death in several countries in sub-Saharan Africa, including South Africa. This study aims to reduce mortality due to TB-HIV co-infection through a quality improvement strategy for scaling up of TB and HIV treatment integration in rural primary healthcare clinics in South Africa.

Methods: The study is designed as an open-label cluster randomized controlled trial. Sixteen clinic supervisors who oversee 40 primary health care (PHC) clinics in two rural districts of KwaZulu-Natal, South Africa will be randomized to either the control group (provision of standard government guidance for TB-HIV integration) or the intervention group (provision of standard government guidance with active enhancement of TB-HIV care integration through a quality improvement approach). The primary outcome is all-cause mortality among TB-HIV patients. Secondary outcomes include time to antiretroviral therapy (ART) initiation among TB-HIV co-infected patients, as well as TB and HIV treatment outcomes at 12 months. In addition, factors that may affect the intervention, such as conditions in the clinic and staff availability, will be closely monitored and documented.

Discussion: This study has the potential to address the gap between the establishment of TB-HIV care integration policies and guidelines and their implementation in the provision of integrated care in PHC clinics. If successful, an evidence-based intervention comprising change ideas, tools, and approaches for quality improvement could inform the future rapid scale up, implementation, and sustainability of improved TB-HIV integration across sub-Sahara Africa and other resource-constrained settings.

Trial registration: Clinicaltrials.gov, NCT02654613. Registered 01 June 2015.

Keywords: Implementation science, TB-HIV co-infection, TB-HIV integration, Quality improvement

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Background

Tuberculosis (TB) is the commonest opportunistic infection and cause of death among human immunodeficiency virus (HIV)-infected patients in resource-limited countries [1]. In 2015, there were an estimated 10.4 million new (incident) TB cases worldwide, of which 5.9 million (56%) were among men, 3.5 million (34%) among women, and 1.0 million (10%) among children. In addition, people living with HIV accounted for 1.2 million (11%) of all the new TB cases [2]. In 2014, the World Health Organization (WHO) reported 83% incident TB cases worldwide out of which one third of these new TB cases originated from the African continent with high burden countries (HBCs) [3]. A similar trend was documented in the 2016 WHO global TB report which showed that the proportion of TB cases living with HIV was highest in the WHO African Region (31%) and exceeded 50% in parts of southern Africa [2].

The extent of the combined TB and HIV epidemics in South Africa has created enormous operational challenges for healthcare delivery [4]. Prior to the implementation of TB-HIV integration, the South African healthcare system provided separate vertical programmes for TB and HIV services delivered by different healthcare staff, often located in separate clinics [4–6]. The vertical model of delivering TB-HIV care to co-infected patients relied upon referral and linkage to care programmes (between TB and HIV programmes and vice versa). This proved problematic and inefficient as referral between programmes depended chiefly on patients' resources and health-seeking behavior which was unmonitored [4, 6].

Integration according to Uyei et al. (2014) is operationalized by three domains: functional, organizational, and clinical integration [7]. An integrated model of TB and HIV healthcare service delivery is an efficient use of health system's resources that would address the two very important co-epidemics [8]. A number of studies provide evidence of the relationships in the integration framework that applies to TB and HIV healthcare delivery [7, 9–11]. However, the optimum model for integrated TB-HIV services in a clinical setting is unknown.

South African guidelines on TB-HIV integration

The South African Department of Health (SA DoH) has developed guidelines and policies supportive for the integration of TB-HIV services. The key focus areas for TB-HIV integration as standard of care in the most recently updated SA DoH guidelines [8, 12–14] is outlined in Table 1.

Table 1 Focused areas for TB-HIV integration

- Testing and counseling for HIV in all patients with TB.
- Intensified case finding for TB in HIV-infected patients.
- Isoniazid preventative therapy (IPT) for HIV-positive patients that screen TB negative.
- ART initiation for all TB-HIV co-infected patients.
- Cotrimoxazole therapy for TB-HIV co-infected patients.
- Enhanced retention in care strategies including the post-test counseling and use of community-based outreach workers.
- Enhanced ART and TB treatment adherence strategies including the use of community care workers for adherence support and community-based management of selected patients.
- A fully integrated data management system—adopting the approach of one patient, one appointment, one file, and one data management system.

Clinical benefit of known TB-HIV integration interventions

Randomized controlled trials have demonstrated that early initiation of ART during TB therapy improved survival of TB-HIV co-infected patients by 56% [15, 16]. Additionally, initiating ART early during TB treatment (within 2–4 weeks) increased AIDS-free survival by 34–68% among patients with advanced HIV disease [15, 17, 18]. In spite of TB-HIV integration being incorporated into international and South African guidelines, mortality rates in 2015 for TB-HIV co-infected patients in South Africa was 133 per 100,000 population, which is more than three times higher than mortality in HIV-negative TB patients, who had mortality rates of 46 per 100,000 population [2].

Initiation of cotrimoxazole preventive therapy (CPT) before or with ART, irrespective of CD4 count, in co-infected patients has been shown to reduce severe bacterial infections in an observational study [19] and mortality by 27% in a multi-site randomized clinical trial (RCT) conducted in Africa [20]. The clinical benefits associated with the use of CPT was adopted by WHO for use as an adjunctive therapy for improved outcomes in the management of TB and HIV co-infected patients in the 2014 treatment guidelines [20–22]. In addition, findings from a RCT conducted in South Africa showed that 12 months of isoniazid preventive therapy (IPT) conferred a 37% reduction in risk of active TB in ART-naïve patients [23]. The benefit of 6 months of IPT and early ART irrespective of baseline CD4 count was also recently confirmed in the TEMPRANO study that showed 44% lower risk of severe HIV-related illness and a 35% lower risk of death from any cause [24].

Rationale of the study

Despite the inclusion of the evidence above in standard TB and HIV treatment guidelines, implementation of these interventions as part of TB-HIV integration in South Africa remains poor [23, 25, 26]. Premature mortality from TB and HIV in women and men account for 53.7 and 24.2% of deaths in the 15–24 year age group and for 44.4 and 47.2% of deaths in the 25–64 age group, respectively [27]. Cost-effective and sustainable strategies to strengthen integration of known effective TB-HIV interventions in primary health care (PHC) clinics, the main service delivery point for millions of patients, will abrogate the high mortality associated with

TB-HIV co-infection [28]. A systematic review by Uyei and colleagues in 2011 of observational studies using secondary data on TB-HIV integration in sub-Saharan Africa found several benefits from integration and identified the need for additional research to identify barriers to integration as well as strategies to improve TB-HIV integration [26].

Theoretical framework

Models of TB-HIV integration have ranged from TB clinics referring patients to HIV clinics and vice versa to full integration where both services are available at a single facility, on the same day, by the same healthcare worker [5]. A group of South African researchers developed a model to illustrate the critical health system mechanisms that are essential to operationalize TB and HIV service integration [7]. Implementing integration requires *Functional integration* which is the extent to which integration is supported at the policy and budget level; *Clinical integration* which is the extent to which TB and HIV care, treatment, diagnostic testing, and health education activities are taking place concurrently; and *Organizational integration* which is the extent to which facility level resources (e.g., staff, infrastructure, space, patient files, and data systems) and processes (e.g., patient flow) are integrated [7]. While the model efficiently explains *what* is needed to integrate TB and HIV services, it does not illustrate *how* TB and HIV service integration should be integrated. Quality improvement as a method to improve organizational and clinical integration is on the cusp of widespread roll out in South African Department of Health facilities and there is enough support and political will for creating a culture of quality improvement (QI) in facilities [8, 14, 29].

We propose a theoretical framework which is an adaptation of the Uyei et al. (2014) model that demonstrates the central role of QI as a catalyst to operationalizing integration. The SUTHI study intervention has targeted PHC supervisors and frontline clinic staff as the recipients of the QI intervention. Figure 1 illustrates that through continuous QI activities, we theorize that organizational and clinical integration can be improved and strengthened and lead to improved patient and organizational outcomes. Using the collaborative breakthrough series approach, developed by the Institute of Healthcare Improvement (IHI) [30–33], we propose that a series of timed collaborative learning sessions that brings intervention clinics together coupled with mentorship visits at the facility level will impact clinical and organizational integration activities. Our framework

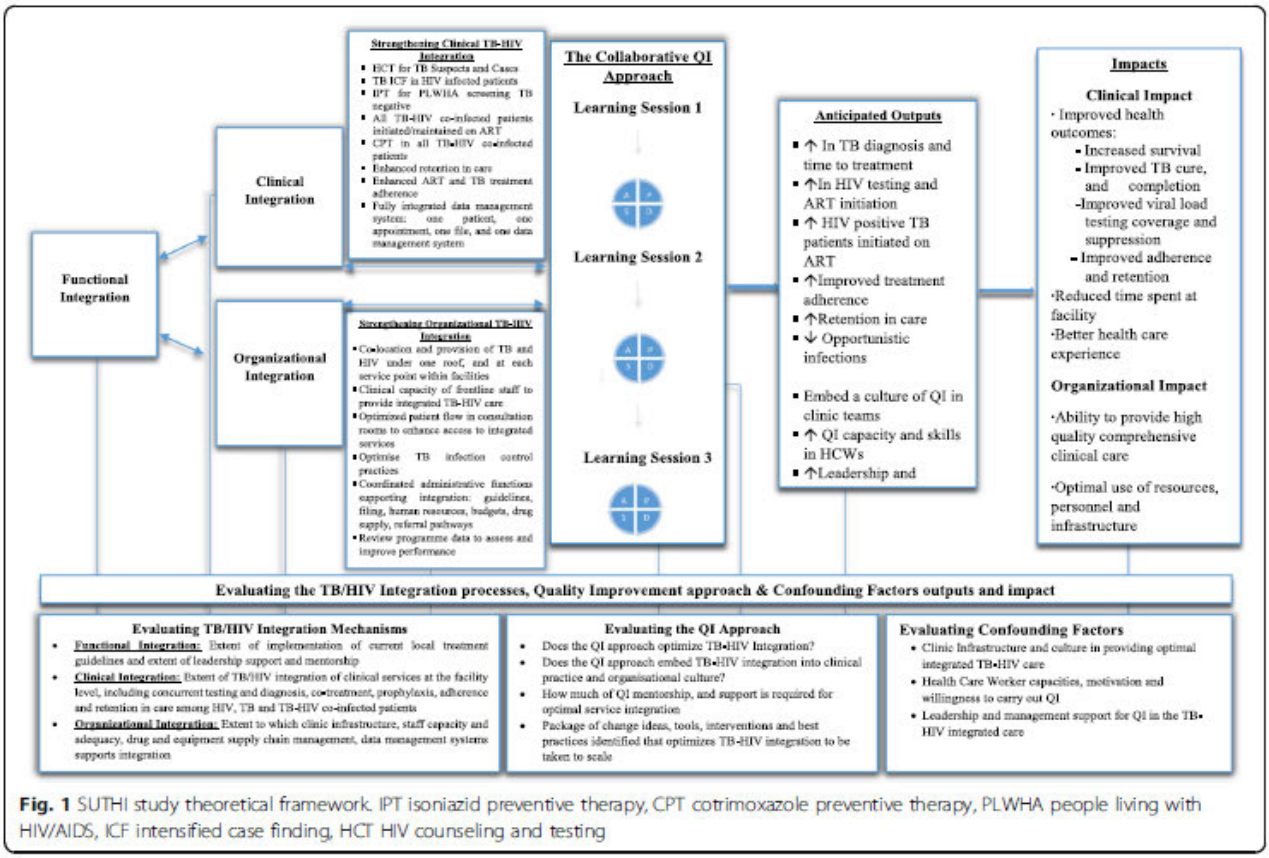

Fig. 1 SUTHI study theoretical framework. IPT isoniazid preventive therapy, CPT cotrimoxazole preventive therapy, PLWHA people living with HIV/AIDS, ICF intensified case finding, HCT HIV counseling and testing

proposes that QI alone may not be sufficient to bring about improvements in integrated service delivery hence evaluating, measuring, and monitoring environmental and contextual factors (confounders) as well as delivering a good quality QI intervention is key to improving TB, HIV, and integrated TB-HIV services.

Methods

Aims and objectives

This study aims to reduce mortality due to TB, HIV, and TB-HIV co-infection through a QI strategy for scaling up of TB and HIV treatment integration in rural PHC clinics in South Africa. The hypothesis is that survival rates will be lower in TB, HIV, and TB-HIV co-infected patients accessing health care at clinics implementing the study intervention to deliver integrated TB-HIV care, compared to survival in patients accessing health care at clinics that provide only the standard of care for people with TB and or HIV.

Specific objectives include:

1. To determine the impact of a QI-mediated TB-HIV care integration on patient mortality.
2. To determine the effectiveness of peer-led QI approach to enhance integration of TB-HIV healthcare delivery.
3. To identify clinic-level factors that impact on the implementation of integrated TB-HIV services.
4. To determine the cost-effectiveness of implementing TB-HIV integration using the QI approach.
5. To develop an intervention, comprising QI-based change ideas, tools, and approaches for the scale up, implementation, and sustainability of integrated TB-HIV services across South Africa and in other resource-constrained settings.

Study setting and design

This is an open-label cluster randomized controlled trial where the cluster is defined as the group of clinic(s) under the same PHC clinic supervisor, where each of the 16 PHC clinic supervisors may oversee between 3 and 5 PHC clinics. Cluster randomization was chosen for practical reasons because the study will be carried out in pragmatic settings involving 40 PHC clinics within the King Cetshwayo district (formerly called uThungulu) [34] and Ugu districts in KwaZulu-Natal, South Africa. A total of 11.1 million people (19.9% of the South African population) live in KwaZulu-Natal [35]. The province has the highest TB-HIV disease burden in South Africa with an estimated TB-HIV co-infection rate of 70% [12, 36]. The two districts were selected because they are rural with high burden of TB, HIV, and TB-HIV co-infection, despite TB and HIV treatment services in accordance with current guidelines being available [13, 14, 37]. In 2016, 82.3% of TB-HIV co-infected patients were initiated on ART in KwaZulu-Natal, slightly lower than the national ART initiation rate of 84.5% [38]. King Cetshwayo district, located on the northern coast of KwaZulu-Natal, has a population of 937,793, with approximately 80% living in rural settings [39]. Similarly, Ugu district, situated in southern KwaZulu-Natal has 86% of its population of 750,214 living in rural areas [38, 40]. The in-hospital case fatality rate due to TB-HIV co-infection in both King Cetshwayo district (38.4%) and Ugu district (38.8%) remains high despite ART availability [27]. In 2015, over a quarter of all deaths in KwaZulu-Natal, irrespective of age or gender, were caused by TB (15.5%) or HIV (12.2%). PHC clinics offer community level frontline services and chronic care for all health ailments, including TB and HIV. Patient level data for these diseases are routinely captured electronically [41].

Study population

Anonymized clinical and programme outcome data for all TB, HIV, and TB-HIV co-infected patients accessing services in the 40 clinics will be included in the study analysis. According to estimation from the clinic headcount data, an average of 4500 patients are seen in the two districts each month. In addition, the healthcare workers (HCWs) including PHC supervisors will be interviewed to collect clinic level information after obtaining informed consent for participation in interviews. These interviews will be collated and analyzed together with patient level data.

Randomization and study groups

Randomization will occur at the level of the PHC supervisor. This is being done to avoid contamination of intervention effects into control clinics since each supervisor routinely supports multiple clinics. Each PHC clinic supervisor will be randomly assigned in a 1:1 ratio to the intervention or control arm. The study investigators would provide a list of facilities and supervisors to be randomized using a computer-generated randomization list generated by study statistician. In South Africa, a PHC clinic supervisor fulfills a management role at PHC clinics [42], and are mandated to ensure smooth clinic operations through oversight of clinic performance against set targets including patient clinical outcomes and programme performance targets, and oversees the implementation of clinical guidelines. Each PHC clinic supervisor may oversee between three and five PHC clinics within one district. Therefore, through randomization of 14–16 PHC clinic supervisors working in both the Ugu district and King Cetshwayo district, 40 clinics (20 in each arm) will be enrolled into this study as each supervisor oversees on average three to five medium-sized clinics. Not all clinics under the purview of the PHC clinic supervisors

randomized will be enrolled into the study. Clinics will be excluded if ART services are not offered on site, services are run by a single nurse, and if they are mobile clinics or clinics located within hospitals. All eligible clinics enrolled in the control arm of this trial will receive the prevailing standard-of-care for TB-HIV integration (Fig. 2) in accordance with the DoH guidelines. While the study team will not interfere with any additional benefit that control clinics may receive (for example, support from other NGOs), changes to the background standard of care will be recorded systematically and accounted for in the final analysis.

The quality improvement intervention

Quality improvement is described as a set of continuous actions through coordinated effort of HCW teams aimed at accelerating improvements to patient care and health outcomes [43]. This is done through iterative changes and peer-to-peer learning about successful changes and has been demonstrated to significantly improve HCW performance and lead to sustainable delivery of quality care with improved health outcomes [30, 43, 44]. The Institute for Healthcare Improvement (IHI) Breakthrough Series (BTS) is an example of quality improvement through learning collaborative, demonstrated to successfully impact health outcomes in developing-country

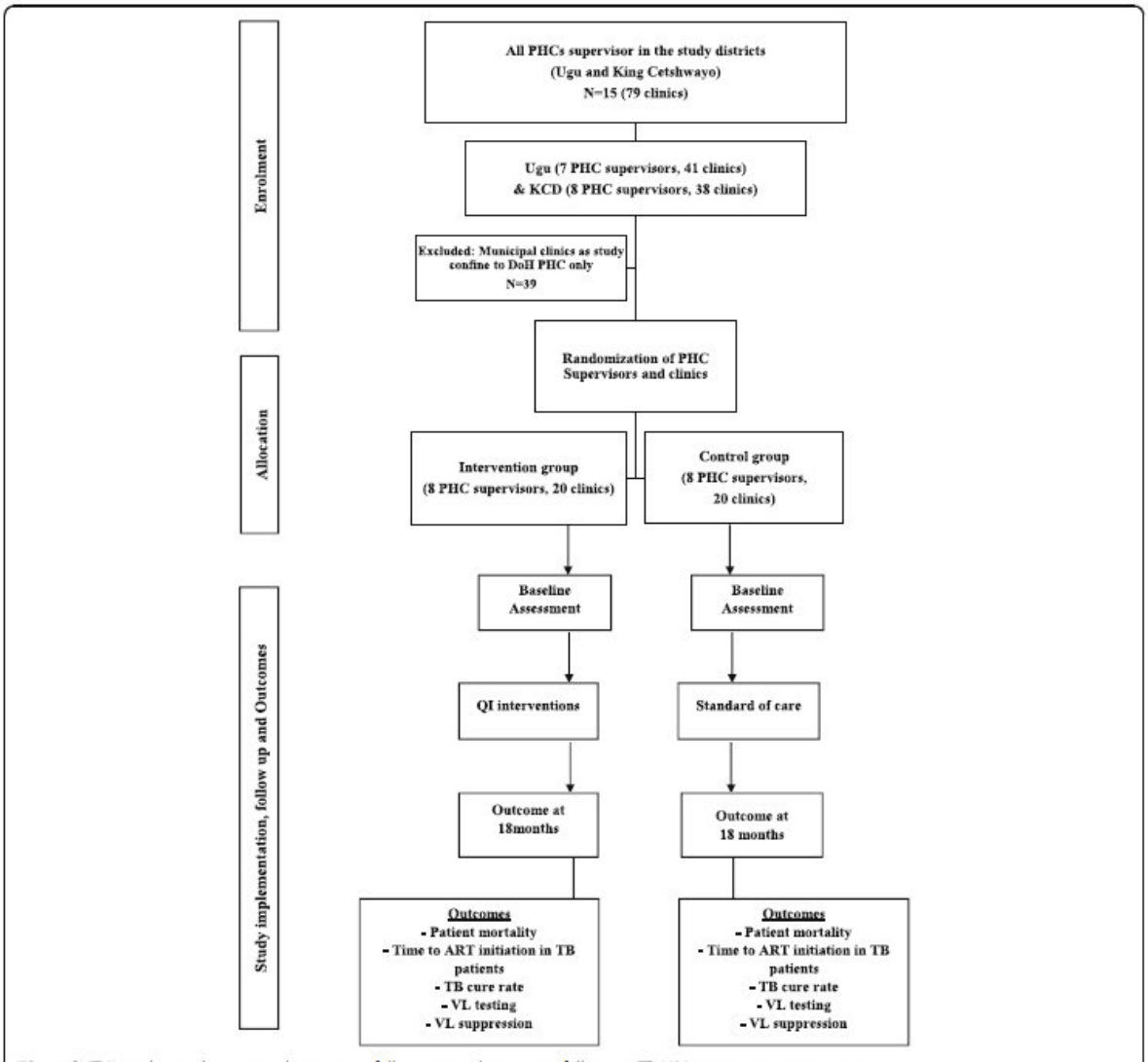

Fig. 2 SUTHI study enrolment, randomization, follow-up, and outcome following TB-HIV integration intervention

settings [30, 45]. The learning collaborative brings together clinic teams at regular intervals to learn QI methods and exchange challenges and successes in efforts to implement the TB-HIV care pathway (learning sessions). Each clinic will form a QI team that will work with the PHC supervisor and QI mentors between these learning sessions to develop local ideas for implementing a specific area of care, regularly measure performance using agreed-upon indicators, and bring back those results and emerging best practices to other clinic teams through periodic learning sessions. We aim to use this structured implementation approach to improve reliable delivery of published evidence-based interventions known to decrease morbidity and mortality in patients with TB and HIV. The main measure of the collaborative's success will be measurable improvement in the magnitude, maintenance, and speed of specific steps of TB-HIV integration, ascertained through time-series analyses. These analyses will be collected and acted upon in real-time and will include process and outcome indicators. The magnitude of TB-HIV integration implementation will be measured by the extent to which interventions provide measurable improvements in PHC process indicators from baseline (e.g., coverage of HCT and IPT services among eligible patients, improvements in quality of services, proportion of HIV-infected patients offered IPT following a negative TB screening). We will also track the speed at which each of the eight TB-HIV integration interventions are implemented (e.g., the number of months taken to reach 90% implementation of individual integration interventions) and factors affecting speed of intervention uptake in the clinics.

Systematic testing of change ideas will be evaluated through a rapid sequence of steps called the Plan-Do-Study-Act (PDSA) cycle. The PDSA cycle is a sequential framework for examining problems, deriving solutions, measuring progress, and embedding changes leading to positive outcomes [46, 47]. Selected HCWs from the study intervention clinics will be trained on QI methodology. This training will enable establishment of QI teams in intervention clinics to work test and implement change ideas to advance implementation of the TB-HIV integration interventions in rapid cycle (Fig. 1) and exchange successful ideas for change with other intervention sites through the learning collaborative. Furthermore, measures will be taken to prevent inadvertent cross-contamination of change ideas (e.g., by avoiding any convening of intervention and control clinics or personnel).

Training, coaching, and mentorship for HCWs implementing QI in clinics randomized to the intervention arm

The QI approach promotes front-line staff engagement in the identification of problems affecting performance and catalyzing rapid cycle testing of possible solutions in each of the eight identified TB-HIV integration indicators (Table 1). The QI team at each of the intervention clinics will include the PHC supervisor from the District Health Management team, the QI clinic champion, the clinic's operation manager, selected clinic staff members, and a QI coach/mentor represented by a member of the study team. The QI champion, usually a clinic's most senior nursing staff, will be trained to lead and support QI teams in their facilities using QI methods including the PDSA model, systems thinking, and the use of data for improvement.

The QI mentor and champion will be capacitated by the research team to provide peer-leadership and mentorship for implementation of QI methodology. In addition, they will also be capacitated to monitor the weekly performance of their clinics in achieving key successes on the indicators being targeted for improvement. The QI teams will be established through training of selected health workers to become fully fledged QI leaders and implementers within their facilities. Only HCWs experienced in both TB-HIV management and implementation of national TB and HIV guidelines would be eligible for QI training.

Implementation of the intervention

Three collaborative learning sessions and additional QI support (mentoring and coaching) visits at specific time points during the study period (Fig. 1) will be prearranged. Collaborative learning session one will coach teams in the use of a range of QI methods and tools (process mapping, fishbone system analysis, PDSA cycles, use of line graphs, and other data for improvement). Areas requiring improvement will be identified and prioritized, and aim statements encompassing specific aims and targets will be developed. Brainstorming by the QI team and process mapping will be done to define a strategy to effect positive change ("a change idea"). The PDSA cycles tracking a set of predefined indicators will be reviewed bi-weekly by the QI team to test if the recently adopted change idea resulted in performance improvement, throughout the study period. This will enable the generation of new ideas for improvement, iterative testing of these ideas, and monitoring of progress attained through use of run charts and graphs. Learning session two, scheduled 6 months later will review learnings for all successful change ideas and challenges against overall clinic performance, with the goal of scaling back on frequency of QI support meetings for clinics that are undertaking reliable improvement work. Learning session three, scheduled at month 12, will be focused on review and scalability of the final successful change package. It is anticipated that after learning session three, the clinic's QI teams would sustain successful change ideas. Lessons learned will also be shared and

Table 2 Data collection tools, sources, and outcome measures

Data to be collected	Data source	Outcomes measure
TB-HIV integration indicators		Clinical outcomes
	TIER.Net, community care givers, autopsy reports	- Mortality rates—number of deaths among TB and HIV patients accessing care in study clinics from date clinic enrolled to 18 months post enrolment.
	TIER.Net	- Proportion of patients retained in care—proportion of HIV-infected patients enrolled in care at clinics and alive 12 months.
	TIER.Net	- Viral load testing coverage—proportion of patients on ART with viral loads test done among those eligible for viral load test at requested time points.
	TIER.Net	- Viral load suppression—proportion of patients with undetectable viral load tests among those receiving 12 monthly viral load test.
	TIER.Net and clinic TB registers	- TB treatment outcomes at end of study period— - Cure rates: proportion of new smear-positive patients that are smear-negative in the last month of treatment and on at least one other occasion at least 30 days prior. - Loss to follow-up rates: proportion of new smear-positive patients that interrupted TB treatment for 2 consecutive months or more. - Treatment failure rates: Proportion of new smear-positive patients that are smear-positive at the end of TB treatment period. - Death rate: proportion of new smear-positive patients that died during TB treatment. - Transfer-out rate: proportion of new smear-positive pulmonary TB patients registered that were transferred to another district and for whom the TB treatment outcome is unknown.
		Process outcome
	TIER.Net, DHIS and clinic-based registers	- HCT Coverage—proportion of patients with unknown HIV status tested for HIV
	TIER.Net, DHIS and clinic-based registers	- Co-infection—proportion of TB patients co-infected with HIV
	TIER.Net, DHIS and clinic-based registers	- Time to ART initiation (in days)—time in days between diagnosis of HIV infection diagnosis and ART initiation.
	TIER.Net, DHIS and clinic-based registers	- TB screening coverage among HIV-infected patients— a) Proportion of HIV-infected patients receiving TB screening and b) Frequency of TB screening during follow-up
	TIER.Net, DHIS and clinic-based registers	- IPT initiation— a) Proportion of HIV-infected TB negative patients initiated on IPT and b) Proportion of patients completing IPT course.
	TIER.Net, DHIS and clinic-based registers	- CPT uptake among co-infected patients—proportion of eligible HIV-positive patients initiated on CPT

Table 2 Data collection tools, sources, and outcome measures *(Continued)*

Data to be collected	Data source	Outcomes measure
TB-HIV service integration in the facility macro-environment	Survey instrument developed by Uyei et al. 2014 [7]	Measured TB-HIV integration in terms of: ➢ Organization—such as co-location of services, combined patient records, information management, and joint training ➢ Structure—existent practice of joint service delivery, ➢ Process—behavior and practice of delivering services ➢ Culture—work place culture and personal identification with integrated service delivery
Clinic profile tool aimed at assessing clinics' infrastructure, capacity, and systems in place to implement TB-HIV integration services	A CAPRISA designed tool	- Resources inventory and needs for implementation of TB-HIV integration services, e.g., available guidelines, protocols, policies, trained staff. - Existing quality improvement interventions, processes and measurements - District level leadership and support
Clinic culture, leadership, resources, etc.	The COACH tool designed by Bergstrom et al. 2015 [56]	- Clinic leadership and support - Staff knowledge and skills - Perceptions of work culture at PHC
Staff Work-related Quality of Life	WHO Work-related Quality of Life Scale	Work-related quality of life for staff at PHC

documented across the intervention teams. At the successful conclusion of the projects, the intention is to scale up a reliable "change package" of successful, tested changes across all clinics in the two districts, if not across the entire district.

Standard of care in the control clinics: description of TB, HIV, and integration services

Since the 2009 endorsement of integrated TB-HIV services by the South African National AIDS Council (SANAC) [48], and adoption of TB-HIV service integration into policy and practice by the National Department of Health (NDoH) [29], South African guidelines recommend integration of TB and HIV services by a single service provider [8, 49].

Data collection

Data on TB-HIV integration indicators will be obtained from patient files and existing standard customized electronic data management systems supported by SA DoH [4, 41]. Routine clinical information is recorded in paper-based registers and patient clinic folders housed in clinics and subsequently captured onto the relevant TB or HIV electronic system supported by SA DoH. Baseline patient level data will be collected retrospectively for the 12 months prior to study start and will continue prospectively throughout the study period (Tables 2 and 3). In addition, HCW interviews will be conducted, using case report forms, at specific time points during study period from consenting health workers in both the intervention and control clinics. Table 2 summarizes the data to be collected, data source, and outcome measures while Table 3 presents the study's schedule of activities.

Study outcome measures

The primary outcome of this study will be all-cause mortality rate among patients newly diagnosed with TB and/or HIV. Secondary outcomes will include time to ART initiation, retention in care, IPT and CPT uptake as per the current SA DoH guidelines, TB cure rates, viral load testing rates, and viral load suppression rates.

Sample size estimation

We anticipate that about 6000 HIV-positive patients will be diagnosed with active TB in the study population during a 12-month period. This is based on the assumption that between 100 and 200 new TB-HIV co-infected patients are seen in each of the 40 clinics per year. This translates to an average of 350 patients per cluster (assume unequal cluster sizes). Assuming a case fatality rate of 15% in the control arm, coefficient of variation between 0.25 and 0.35, and a type I error rate of 5%, we will have 80% power to detect a 30% reduction in mortality. The chances of detecting other levels of effectiveness are shown in Table 4.

Data management

Anonymized TB, HIV, and TB-HIV co-infected patient data obtained from electronic software systems supported by the DoH and clinic-based registers will be collated for quality control and for evaluation of impact made by the intervention in data quality. Also, iDataFax version 2014.1.1 which is clinical data management

Table 3 Study schedule of activities

Study activity	Study time points			
	Baseline (0–1 month)	6–7th month	12–13th month	Monthly (1st–18th month)
Retrospective collection of 12 months data on TB-HIV indicators from TIER.Net*, DHIS** and clinic-based registers	X			
***QI Learning Collaborative (Intervention Clinics Only)	X	X	X	
Monthly downloads of data on TB-HIV indicators from TIER.Net*, DHIS** and clinic-based registers				X
Clinic Profile Survey	X	X	X	
TB/HIV Service Integration Survey	X	X	X	
Work-related Quality of Life Survey	X	X	X	
Context Assessment Survey	X	X	X	
Quality Improvement Survey (Intervention Clinics Only)	X	X	X	

*TIER.Net—Three Inter-Linked Electronic Register for Tuberculosis
**DHIS—District Health Information System
***QI Learning Collaborative—use of PDSA cycles, run charts, process mapping

software will be used for the design of case reporting forms for the HCW interviews and its data entry into the study's database. Both intervention and control clinics will have data mentoring by the study data management team to ensure that quality of data obtained are improved, standardized, reliable, and valid. The study database files will be password-protected, and access to the files will be limited to authorized study staff members. Quality control measure will be carried out periodically throughout the study period prior to the data analysis.

Statistical analysis

The primary outcome of mortality and secondary outcomes will be analyzed using cluster-summary methods. The primary outcome will be analyzed among TB-HIV co-infected patients only while the secondary outcomes will be analyzed among TB-HIV co-infected, HIV-only, and TB-only patients. Mortality rate per arm will be calculated as geometric mean of cluster-level summaries and will be compared using unpaired t test. The same technique will be applied to secondary outcomes. The t test applied in cluster-level summaries is one of the robust methods of analyzing unmatched trials especially when there are small number of clusters per arm [50]. Since we have 16 clusters and 40 sub-clusters, multilevel regression will be used as secondary analyses.

Table 4 Power to detect different levels of effectiveness (keeping number of events constant)

Reduction in mortality (%)	Power to detect an effect (%)
10	13
20	42
30	80
40	98

Proportional hazard regression with random effects (frailty models) will be used for analyses of time-to-event outcomes. Generalized estimating equations and mixed effects linear models will be used for binary and quantitative outcomes, respectively. These models will take the clustering by PHC supervisor and clinic into account through the random effects. They will also allow us to adjust for baseline variables, especially those with imbalance between arms, as this is likely when clusters are fewer. The HCW interviews will be summarized using descriptive statistics such as means and frequencies. Adjusted baseline descriptive statistics will be calculated as the means of the cluster-level summaries and characteristics of the two arms will be compared using t test or rank sum tests. Individual-level summaries at baseline will be compared using t test or rank sum tests and Fisher's exact test. Data will be analyzed with SAS version 9.4 (or higher) (SAS Institute INC., Cary N.C, USA).

Discussion

Findings from this trial are expected to provide information on a scalable strategy (a "change package") to address shortcomings in the implementation of integrated TB-HIV treatment and services. If successful, the strategy could make a contribution to reducing TB-HIV-associated mortality and morbidity in South Africa and other regions of the world where co-infection with TB and HIV is a concern. In 2013, WHO performed a joint review of HIV, TB, and prevention of mother to child transmission (PMTCT) programmes in South Africa, which recommended the need for context-specific mechanisms for the delivery of integrated TB-HIV services at PHC and community level, with particular focus on improving access to TB and HIV services for children, adolescents, and key populations. Some studies

undertaken in the South African PHC clinic setting have shown that the QI strategy can be effective as an intervention for PMTCT care [51–54]. To date, there have been no studies that have explored the use of the QI model as an intervention to improve integration of TB and HIV treatment. An important component of the QI model is the PDSA cycle, comprising learning cycles to test and revise theory-based predictions as recommended by Taylor et al. (2014) in their systematic review on the application of the PDSA method to improve quality in healthcare [55]. We anticipate that the findings from this trial will offer an affordable and sustainable strategy through use of the QI model to effectively improve the integration of TB-HIV programmes. The study results will be communicated to stakeholders through dissemination meetings, conferences, and publication in peer-reviewed journals. Recommendations would be made based on the study findings for appropriate actions to be considered and taken by the department of health and relevant authorities in areas with high burden of TB and HIV.

Trial status

Data collection is currently on-going.

Abbreviations

ART: Antiretroviral therapy; BREC: Biomedical research ethics committee; CAPRISA: Centre for the AIDS programme of research in South Africa; COACH: Context assessment for community health; CPT: Cotrimoxazole preventive therapy; DHIS: District Health Information System; DoH: Department of Health; GEE: Generalized estimation equations; HBC: High burden countries; HCT: HIV counseling and testing; HCWs: Healthcare workers; HIV: Human immunodeficiency virus; IPT: Isoniazid preventive therapy; PDSA: Plan-Do-Study-Act; PHC: Primary health care; PMTCT: Prevention of mother to child transmission; QI: Quality improvement; SA: South Africa; SUTHI: Addressing challenges in scaling up TB and HIV treatment integration in public health settings in South Africa; TB: Tuberculosis; TIERNet: Three interlinked electronic register for tuberculosis and human immunodeficiency virus; WHO: World Health Organization

Acknowledgements

We wish to acknowledge BroadReach for their supportive role at the study clinics as specified in the current health systems strengthening (HSS) grant awarded to them by USAID (Cooperative Agreement No. AID-674-A-12-00016). The authors acknowledge Dr. Anneke Grobler for her input into the clinic selection and Ms. Kelechi Oladimeji for her assistance with editing the manuscript.

Funding

The research reported in this publication is supported by the South African Medical Research Council with funds received from the South African National Department of Health, and the United Kingdom (UK) Medical Research Council with funds received from the UK Government's Newton Fund (Grant/Contract No: BR-C 13/0056). The funders have no role in the study design and will have no role in the execution of the study, analyses and interpretation of data, or decision to submit results for publication.

Availability of data and materials

Please contact the corresponding author for further information.

Authors' contributions

KN and SG conceived and designed the protocol. KN is the grant holder. SG will lead the study implementation. NY provided statistical input in the protocol design and will be conducting the statistical analysis with her team. All authors revised the protocol critically for important intellectual content. All authors approved the final version of the paper for publication.

Ethics approval and consent to participate

Trial was registered (NCT02654613) and subsequently approved by the biomedical research ethics committee (BREC), University of Kwa-Zulu Natal (BF108/14). Gateway permission from the Department of Health to conduct the study at the clinics and also access patient records has been obtained. Signed written informed consent will be obtained from the participants to be interviewed. These participants include the health staff working at the clinics. This study will not require any direct patient contact with research staff; rather, the research staff will work with the clinic staff to implement the interventions. Data collected for analysis purposes will be de-identified and not contain personal information. This is in order to protect the privacy of the study participant by maintaining anonymity and ensuring confidentiality is achieved so that no harm comes to the study participants. Beneficence will be attained through provision of study findings for improved TB-HIV integration and reduced burden of the aforementioned diseases. The database and program files will be made available for review by authorized persons, e.g., study statisticians, institutional review board, study investigators, etc. Also, during the study period and few years after, cabinets containing study administered forms will remain locked. Access will be enabled if needed to allow responsible staff perform required data management and any other relevant function.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Publisher's Note

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Received: 29 August 2017 Accepted: 1 November 2017
Published online: 13 November 2017

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Appendix I(a) : PhD Candidates' contribution to the SUTHI Protocol Paper

Student name: Santhanalakshmi Gengiah **Student number:** 204507742

Title of the article: Addressing challenges in scaling up TB and HIV treatment integration in rural primary healthcare clinics in South Africa (SUTHI): a cluster randomized controlled trial protocol

Authors: Naidoo K., Gengiah S., Yende-Zuma N., Padayatchi N., Barker P., Nunn A., Subrayen P., Abdool Karim S.S.

Journal: BMC Implementation Science

Status: Published 13 November 2017

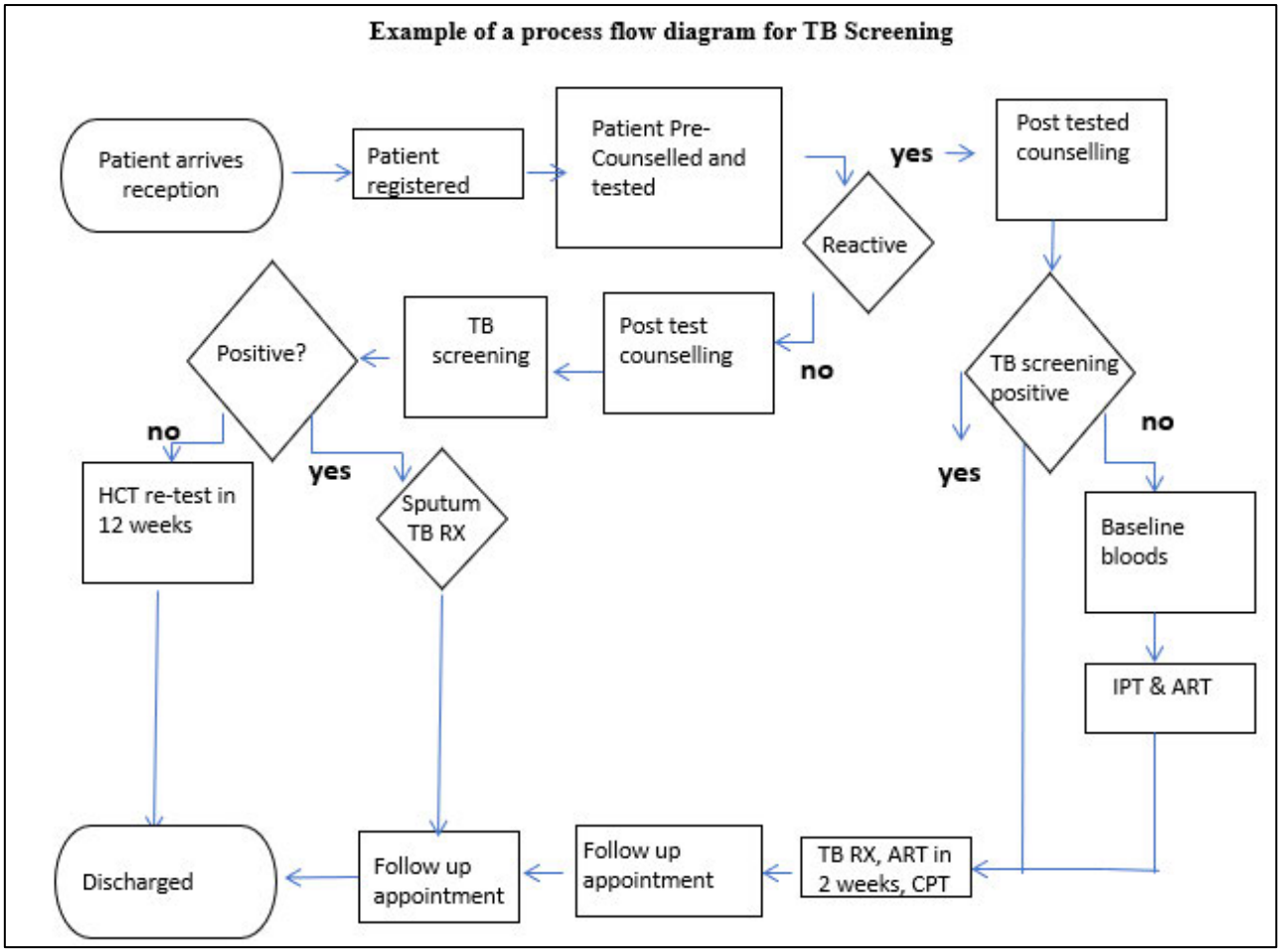
Doctoral student's contribution to the journal article:

I was involved in developing the SUTHI protocol and assisted with the write up of the SUTHI protocol paper. My role in the write up of the manuscript was to provide a first draft of the theoretical framework, describe the implementation of the QI intervention, describe the data collection strategy and tools, and study outcomes. I edited the manuscript and provided feedback and input to the first author.

I declare this to be a true reflection of my contributions to this manuscript.

Signature :  Date: 08 August 2021

Appendix II: Example of a process flow diagram



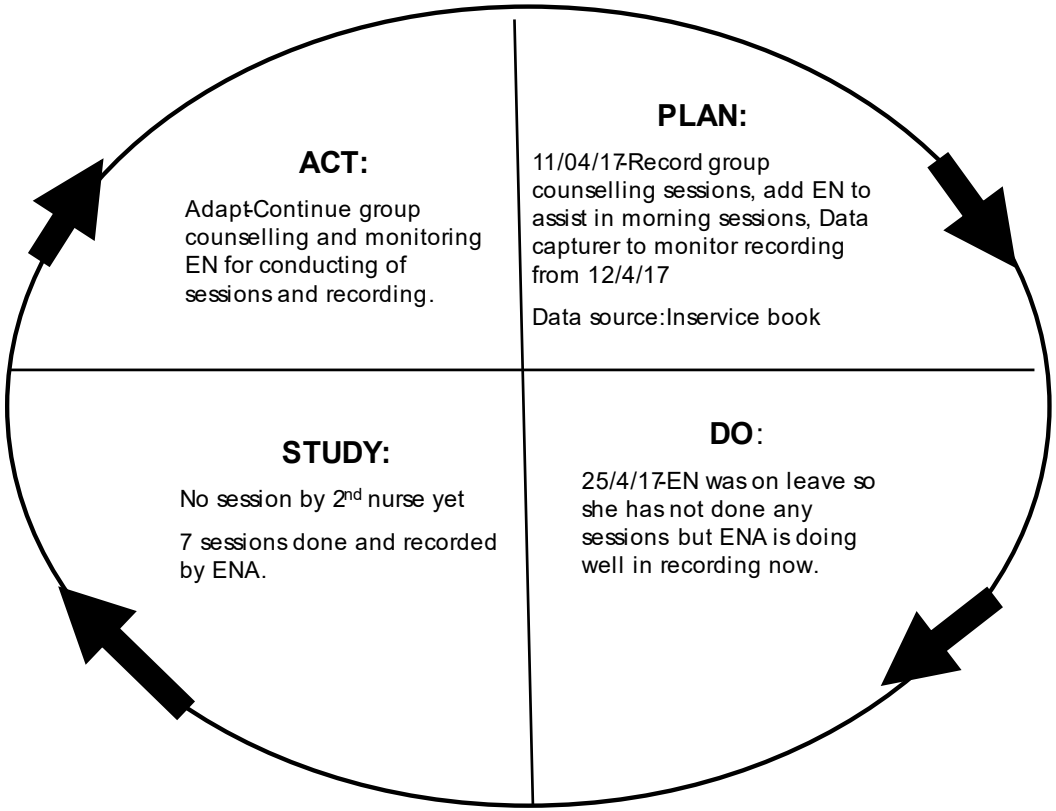
Appendix III: Example of a completed Plan-Do-Study-Act template

PDSA1B:Problem : Low HIV testing rates

Aim for this change: To improve HIV testing from 200 to 350 patients per month by June 2017

The Change Idea(s):

- Group counselling at waiting area



Measures:

Outcome:

Number of patients counselled and tested for HIV

Process:

No of done and recorded group counselling sessions in the waiting area.

Prediction: Group counselling motivates client willingness to test and less time is spent in consulting room during testing.

EN: Enrolled Nurse; ENA: Enrolled Nurse Assistant

Appendix IV : Clinic Profile tool

013 - SUTHI CPBAQ - 1

CAPRISA 013 Plate # 015 Visit Code 1 . Phase Month Interin

Participant ID 0 1 3 - Study - Site - Participant

Visit Date dd MMM yy

Scaling up TB / HIV Integration (SUTHI)

Clinic Profile and Baseline Assessment Questionnaire - 1

A. Clinic Operating Hours :

Mon - Fri :	hr : min	To	hr : min	
Sat :	hr : min	To	hr : min	
Sun :	hr : min	To	hr : min	
Public Holidays :	hr : min	To	hr : min	

B. Infrastructure and Environment :

Instruction for the interviewer - As you probe for response to these questions, also look around the vicinity and fill in appropriate answers.

B1) Does the facility have any of the following?

	Yes / No	How many?	Yes / No They are been utilized	Yes / No They are clean and organized	Comments
1) Consultation rooms?	☐ ☐	☐☐	☐ ☐	☐ ☐	
2) Designated patient waiting room	☐ ☐	☐☐	☐ ☐	☐ ☐	
3) Private space vital signs check	☐ ☐	☐☐	☐ ☐	☐ ☐	
4) Rooms for privacy during consultation	☐ ☐	☐☐	☐ ☐	☐ ☐	
5) Private space for vital signs check	☐ ☐	☐☐	☐ ☐	☐ ☐	
6) Pharmacy:	☐ ☐	☐☐	☐ ☐	☐ ☐	
7) Cough Area ***Describe area***	☐ ☐	☐☐	☐ ☐	☐ ☐	
8) Bathrooms	☐ ☐	☐☐	☐ ☐	☐ ☐	
9) Staff kitchen	☐ ☐	☐☐	☐ ☐	☐ ☐	
10) Toilets	☐ ☐	☐☐	☐ ☐	☐ ☐	
11 Storage rooms	☐ ☐	☐☐	☐ ☐	☐ ☐	
12) Other, specify : _____	☐ ☐	☐☐	☐ ☐	☐ ☐	

C. Communication and basic services availability :

	Yes / No		Comments
1) Is there always electricity in this clinic ?	☐ ☐		
2) Is there a back-up system in case of power failure ?	☐ ☐		
3) Is there an internet connection ?	☐ ☐		
4) Is there good water supply ?	☐ ☐		
5) Are there functional photocopying services in this clinic ?	☐ ☐	If ***NO,*** what then is being used ? _____ _____	
6) Is there a functional telephone service ?	☐ ☐	If ***NO,*** what then is being used ? _____ _____	

D. Staffing :

D1. Does this clinic have any of the following ?

	Yes / No	If Yes, please state number	Comments
1) Medical officer	☐ ☐	☐☐	
2) Operational Manager	☐ ☐	☐☐	
3) PHC supervisors	☐ ☐	☐☐	
4) Registered nurses (RNS)	☐ ☐	☐☐	
4.1) RNS NIMART trained	☐ ☐	☐☐	
4.2) RNS initiated ARVS	☐ ☐	☐☐	
4.3) RNS TB trained	☐ ☐	☐☐	
5) Enrolled nurse	☐ ☐	☐☐	
5.1) ENS TB trained	☐ ☐	☐☐	
5.2) Enrolled nursing assistant	☐ ☐	☐☐	
6) Pharmacist	☐ ☐	☐☐	
7) Pharmacist assistant	☐ ☐	☐☐	
8) Data capturer	☐ ☐	☐☐	
9) Clinical support officer (CSO), Admin / Clerk	☐ ☐	☐☐	
10) Social worker	☐ ☐	☐☐	
11) Nutritional advisor	☐ ☐	☐☐	
12) Lay councilors	☐ ☐	☐☐	
13) Community care givers	☐ ☐	☐☐	
14) Cleaners	☐ ☐	☐☐	
15) Security	☐ ☐	☐☐	
Others, Specify :	☐ ☐	☐☐	
	☐ ☐	☐☐	

D2. Are the routine duties rotated among nurses in this clinic ? Yes ☐ ☐ No

If ***YES*** to D2, complete questions below :	Weekly	Bi-Monthly	Monthly	Quarterly	Comments if any
1) How often are rotation among the nurses carried out ?	☐	☐	☐	☐	
2) How frequent does the PHC supervisor visit the clinic ?	☐	☐	☐	☐	
2.1) What does he/she do when they visit?					
3) How frequent does the district TB co-ordinator visit the clinic ?	☐	☐	☐	☐	
3.1) What does he/she do when they visit?					
4) How frequent does the district QA manager visit the clinic ?	☐	☐	☐	☐	
4.1) What does he/she do when they visit?					
5) How frequent does the district HAST co-ordinator visit the clinic ?	☐	☐	☐	☐	
5.1) What does he/she do when they visit?					
6) How frequent does the M&E team manager or M&E manager from the hospital visit the clinic ?	☐	☐	☐	☐	
6.1) What does he/she do when they visit?					
7) How frequent does the OM attend meetings arranged by the district DoH ?	☐	☐	☐	☐	

E. Clinical stationery, infection control and equipment supplies :

E1. Are any of the following available ?

	Yes / No		How many?	Are they been utilized			Comments
				Yes	No	None at all	
1) Weighing scales (Adults& Paediatric)	☐	☐	☐☐	☐	☐	☐	
2) Blood pressure machines	☐	☐	☐☐	☐	☐	☐	
3 Stethoscope	☐	☐	☐☐	☐	☐	☐	
4) Thermometer	☐	☐	☐☐	☐	☐	☐	
5) Height measurement	☐	☐	☐☐	☐	☐	☐	
6) BMI Wheel	☐	☐	☐☐	☐	☐	☐	
7) Examination bed	☐	☐	☐☐	☐	☐	☐	
8) Wall mounted thermometer	☐	☐	☐☐	☐	☐	☐	
9) HIV test kits	☐	☐	☐☐	☐	☐	☐	
10) Stop watch	☐	☐	☐☐	☐	☐	☐	
11) Surgical masks	☐	☐	☐☐	☐	☐	☐	
12) N95 masks	☐	☐	☐☐	☐	☐	☐	
13) Vacutainer holders and needles	☐	☐	☐☐	☐	☐	☐	
14) Blood specimen bottles	☐	☐	☐☐	☐	☐	☐	
15) Sputum bottles	☐	☐	☐☐	☐	☐	☐	
16) Blood forms	☐	☐	☐☐	☐	☐	☐	
17) Sputum forms	☐	☐	☐☐	☐	☐	☐	
18) Clinical charts - Adults & Paeds	☐	☐	☐☐	☐	☐	☐	
19) Running water	☐	☐	☐☐	☐	☐	☐	
20) Liquid soap	☐	☐	☐☐	☐	☐	☐	

E1 continued .....

	Yes / No		How many?	They are been utilized			Comments
				Yes	No	None at all	
21) Hand washing reminder posters	☐	☐	☐☐	☐	☐	☐	
22) Disposable gloves	☐	☐	☐☐	☐	☐	☐	
23) Colour coded waste bins	☐	☐	☐☐	☐	☐	☐	
24) Bin liners	☐	☐	☐☐	☐	☐	☐	
25) Disinfectants	☐	☐	☐☐	☐	☐	☐	
26) Sharps container	☐	☐	☐☐	☐	☐	☐	
27) Antiseptics	☐	☐	☐☐	☐	☐	☐	
28) Disposable aprons	☐	☐	☐☐	☐	☐	☐	

E2) How would you describe the information available in the clinic to patients from the charts, posters, pamphlets and leaflets on days of operation, basic health care prevention and management ?

Charts, posters, pamphlets and leaflets for basic prevention and management awareness of TB, HIV and TB-HIV co-infection at the clinic.	Please mark with a cross the appropriate box below 1 - Excellent 2 - Very good 3 - Good 4 - Fairly good 5 - Poor					Comments if any
	1	2	3	4	5	
1) Content	☐	☐	☐	☐	☐	
2) Pictorial illustrations	☐	☐	☐	☐	☐	
3) Correct Vocabulary, Grammar and Usage	☐	☐	☐	☐	☐	
4) Clarity	☐	☐	☐	☐	☐	
5) Translation in Zulu	☐	☐	☐	☐	☐	
6) Additional (Optional)	☐	☐	☐	☐	☐	

F. Pharmacy :

Items	Yes / No	Any of the drugs out of stock in the past 3 months? *(Please provide response with reasons)*	Comments if any
1) Temperature monitoring device available	☐ ☐		
2) Fridge available for temperature sensitive drugs ?	☐ ☐		
3) Are these ARVS drugs below available ?	☐ ☐		
3.1) Atroiza	☐ ☐		
3.2) Tenofovir	☐ ☐		
3.3) Lamivudine / Emtricitabine	☐ ☐		
3.4) Fixed dose combination	☐ ☐		
3.5) Zidovudine	☐ ☐		
3.6) Abacavir	☐ ☐		
3.7) Lopinavir / Ritonavir	☐ ☐		
3.8) Efavirapine	☐ ☐		
3.9) Nevirapine	☐ ☐		
4) Are these TB drugs below available ?	☐ ☐		
4.1) Rifafour	☐ ☐		
4.2) Rifinah	☐ ☐		
4.3) Streptomycin	☐ ☐		
5) Is Cotrimoxazole for adults and paeds available ?	☐ ☐		
6) Testing kits for HIV available ?	☐ ☐		
7) Any stock out of the testing kits in the past 3 months ?	☐ ☐	If Yes, comment of why - _____	
8) Any expired ARV / TB drugs ?	☐ ☐	If Yes, how long ? - _____	

G. Guidelines and Protocols :

Which of the GUIDELINES listed among these item are available in this clinic ?	Available Yes / No	If available, give the year available	Are the available documents been utilized ? Yes / No	Comments
1) Consolidated HIV / PMTCT guidelines	☐ ☐	☐☐☐☐	☐ ☐	
2) Adult TB guidelines	☐ ☐	☐☐☐☐	☐ ☐	
3) Pediatric TB guidelines	☐ ☐	☐☐☐☐	☐ ☐	
4) MDR TB guidelines	☐ ☐	☐☐☐☐	☐ ☐	
5) Infection prevention and control guidelines	☐ ☐	☐☐☐☐	☐ ☐	
6) Clinical mentorship guidelines	☐ ☐	☐☐☐☐	☐ ☐	
7) Quality Improvement SOP	☐ ☐	☐☐☐☐	☐ ☐	
8) Data Management guidelines	☐ ☐	☐☐☐☐	☐ ☐	

H. Data Collection Tools and Statistics :

Data Collection Tools	Available Yes / No	Utilized Yes / No	Comments
1) Individual patient folders and sheets	☐ ☐	☐ ☐	
2) Registers :			
2.1) PHC Tick register	☐ ☐	☐ ☐	
2.2) IPT register	☐ ☐	☐ ☐	
2.3) HCT register	☐ ☐	☐ ☐	
2.4) TB suspect register	☐ ☐	☐ ☐	
2.5) TB treatment register	☐ ☐	☐ ☐	
2.6) Manual art register	☐ ☐	☐ ☐	
3) Tier.NET	☐ ☐	☐ ☐	
4) DHIS	☐ ☐	☐ ☐	

H. Data Collection Tools and Statistics :

Data Collection Tools	Available Yes / No	Utilized Yes / No	Comments
5) Tallies and statistics used	☐ ☐	☐ ☐	
5.1) Daily tally book	☐ ☐	☐ ☐	
5.2) Weekly tally book	☐ ☐	☐ ☐	
5.3) Monthly summary	☐ ☐	☐ ☐	
5.4) Quarterly statistics	☐ ☐	☐ ☐	
6) Are TB and HIV files placed together-one filing system	☐ ☐	☐ ☐	
7) Is there an electronic single file system for HIV/TB co-infected clients ?	☐ ☐	☐ ☐	
8) Is the clinic signed off (live site able to produce monthly and quarterly reports) ?	☐ ☐	☐ ☐	
9) Does the clinic use TIER.net to obtain mortality data ***NB - Please probe for any other than TIER and document it (them)***	☐ ☐	☐ ☐	
10) Is there a system in place to ensure quality of data on TIER.net ?	☐ ☐	☐ ☐	
11) Does the clinic use data capture for anything ?	☐ ☐	☐ ☐	***If Yes, explain what for....*** _____
12) Does the clinic hold information meetings (evidence) ?	☐ ☐	☐ ☐	

I. Clinical services :

Are these TB / HIV services offered :	Yes / No	Comments
1) TB / HIV education (evidence based)	☐ ☐	
2) ARV first line management	☐ ☐	
3) ARV second line management	☐ ☐	
4) DNA PCR	☐ ☐	
5) VCT	☐ ☐	
6) PICT	☐ ☐	
7) TB SCREENING	☐ ☐	
8) Genexpert	☐ ☐	
9) Sputum microscopy	☐ ☐	
10) MDR TB treatment initiation	☐ ☐	
11) MDR TB treatment for clients initiated in MDR facilities	☐ ☐	
12) PMTCT	☐ ☐	
13) Tracing of TB contacts	☐ ☐	
14) Initiation of children into ARV	☐ ☐	

CLINIC SUPPORT :

Data Collection Tools	Available Yes / No	Utilized Yes / No	Comments
1) Is there an active clinic committee	☐ ☐	☐ ☐	
2) Is there any supporting organization in HIV and TB programs	☐ ☐	☐ ☐	***If Yes, name of organization*** _____
3) Is there any NGO / FBO / CBO that supports / assists in HIV and TB programs in this clinic ?	☐ ☐	☐ ☐	***If Yes, name of organization*** _____
4) Is there any NGO / FBO / CBO that supports / assists in HIV and TB programs in this community ?	☐ ☐	☐ ☐	***If Yes, name of organization*** _____
5) Is there support from the district office in HIV and TB programs ?	☐ ☐	☐ ☐	***If Yes, name of organization*** _____

J. Existing Quality Improvement (QI) structure and initiatives in the clinic :

Questions :	Yes / No	Comments
1) Has there been any QI initiative in this clinic in the past 1 year ?	☐ ☐	***If Yes, provide brief details or list of the initiatives*** _____ _____
2) Is there a QI team in the clinic ? (If Yes, please list the designations of the team members - use comment section)	☐ ☐	
3) How frequently does the team meet ? Weekly ☐ ☐ Bi-monthly Monthly ☐ ☐ Quarterly Other : _____		
4) What current ideas is been tested by the team ? _____ _____		
5) Is there an external organization or unit supporting the QI work in your clinic ?	☐ ☐	***If Yes, provide name(s) and when.*** _____ _____
6) Has any of the staff been on QI ?	☐ ☐	***If Yes, mention role.*** _____ _____ _____

Appendix V: The Context Assessment for Community Health (COACH) Tool

CAPRISA 013 - SUTHI COACH -1

CAPRISA 013 Plate # 012 Visit Code 1 . (Phase) (Month) (Interim)

Participant ID: 0 1 3 - (Study) (Site) - (Participant)

Visit Date: (dd) (MMM) (yy)

Scaling up TB / HIV Integration (SUTHI)

Context Assessment for Community Health (COACH) - 1

Name of Interviewer :

Interviewer code :

Name of District :

Name of Sub - District :

Name of Facility :

Participant code :

NB for the interviewer, kindly read to the participant : Thank you for agreeing to participate in this survey. We appreciate your cooperation in sharing your perceptions to enable us identify factors in your work place that might influence the way knowledge is used.

To what extent do you agree with the following ? *Please mark the appropriate box with an X*		Rating Scale						
	Items	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree	Don't Know	Refused to Answer
Resources	1. My unit has enough workers with the right training and skills to do everything that needs to be done.	☐	☐	☐	☐	☐	☐	☐
	2. My unit has enough workers with the right training and skill to do their job in the best possible way. .	☐	☐	☐	☐	☐	☐	☐
	3. My unit has enough space to provide healthcare services. .	☐	☐	☐	☐	☐	☐	☐
	4. My unit has access to the transport and fuel that are needed to provide healthcare services	☐	☐	☐	☐	☐	☐	☐
	5. My unit has access to the communication tools (eg : telephone or radios) that are needed to provide healthcare services.	☐	☐	☐	☐	☐	☐	☐
	6. My unit has enough medicine to provide healthcare services	☐	☐	☐	☐	☐	☐	☐
	7. This facility has enough functional equipment to provide healthcare services.	☐	☐	☐	☐	☐	☐	☐
	8. My unit has enough disposable medical equipment such as facemask, N95, glove, needle and syringes to provide HIV and TB medication and HIV tests kits.	☐	☐	☐	☐	☐	☐	☐

To what extent do you agree with the following ? ***Please mark the appropriate box with an X***		Rating Scale						
	Items	**Strongly Agree**	**Agree**	**No Opinion**	**Disagree**	**Strongly Disagree**	**Don't Know**	**Refused to answer**
	9. If the workload increases, my unit can get additional resources such as personnel, medicine and equipment.	☐	☐	☐	☐	☐	☐	☐
Community Engagement	10. In my unit, we ask community members what they think about the healthcare service that we provide.	☐	☐	☐	☐	☐	☐	☐
	11. In my unit, we listen to what community members think about the healthcare services we provide.	☐	☐	☐	☐	☐	☐	☐
	12. In my unit, we have meetings with community members to discuss health matters.	☐	☐	☐	☐	☐	☐	☐
	13. In my unit, we encourage community members to contribute to improving the health of the community facility.	☐	☐	☐	☐	☐	☐	☐
	14. In my unit, we encourage other organizations to contribute to the improving the health of the community.	☐	☐	☐	☐	☐	☐	☐
Monitoring services for action	15. I receive regular updates about my unit's performance based on information / data collected from this facility.	☐	☐	☐	☐	☐	☐	☐
	16. My unit discusses information / data from the facility in a regular, formal way, such as in regular schedule meetings.	☐	☐	☐	☐	☐	☐	☐
	17. My unit regularly uses its unit information / data to make plans for improving its healthcare services.	☐	☐	☐	☐	☐	☐	☐
	18. My unit regularly monitors its work by comparing it with the unit's action plans.	☐	☐	☐	☐	☐	☐	☐
	19. My unit regularly compares its work with national or other guidelines.	☐	☐	☐	☐	☐	☐	☐
	20. I have access to clinical practice guidelines.	☐	☐	☐	☐	☐	☐	☐
	21. I have access to other printed material for work (eg. textbooks, journals)	☐	☐	☐	☐	☐	☐	☐
	22. I have access to in-service training / workshop / courses.	☐	☐	☐	☐	☐	☐	☐

To what extent do you agree with the following ? *Please mark the appropriate box with an X*		Rating Scale						
	Items	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree	Don't Know	Refused to answer
Sources of Knowledge								
	24. I have access to the Internet.	☐	☐	☐	☐	☐	☐	☐
	25. I have access to electronic decision support (eg. mobile phone applications or other electronic devices to assist with care and decision making)	☐	☐	☐	☐	☐	☐	☐
Commitment to work	26. I am proud to work in this facility.	☐	☐	☐	☐	☐	☐	☐
Work culture	27. My unit is willing to use new healthcare practices such as guidelines and recommendations.	☐	☐	☐	☐	☐	☐	☐
	28. My unit helps me to improve and develop my skills	☐	☐	☐	☐	☐	☐	☐
	29. I am encouraged to seek new information on healthcare practices.	☐	☐	☐	☐	☐	☐	☐
	30. My unit works for the good of the patients and puts their needs first.	☐	☐	☐	☐	☐	☐	☐
	31. Members of the unit approach patients with respect.	☐	☐	☐	☐	☐	☐	☐
Leadership	32. I trust the unit leader	☐	☐	☐	☐	☐	☐	☐
	33. The leader handles stressful situations calmly.	☐	☐	☐	☐	☐	☐	☐
	34. The leader actively listens, acknowledges, and then responds to requests and concerns.	☐	☐	☐	☐	☐	☐	☐
	35. The leader effectively resolves any conflicts that arise.	☐	☐	☐	☐	☐	☐	☐
	36. The leader encourages the introduction of new ideas and practices.	☐	☐	☐	☐	☐	☐	☐
	37. The leader makes things happen.	☐	☐	☐	☐	☐	☐	☐
Correction of malpractices	38. Efforts are made to address any illegal practices by the care workers (moonlighting, taking money from patients)	☐	☐	☐	☐	☐	☐	☐

Appendix VI: Degrees of integrated HIV and TB services

CAPRISA 013 - SUTHI SIS- 1

CAPRISA 013 Plate # 050 Page number 2

Participant ID

0 1 3 - Study - Site - Participant

Visit Date dd MMM yy

Scaling up TB / HIV Integration (SUTHI)

Service Integration Survey - 1

Name of Interviewer :

Name of District :

Name of Sub - District :

Name of Facility :

Participant code :

For the interviewer - Please read the statements to the participant and let them say how they agree or disagree.

Section 1 : Integration measures :

	Strongly Agree	Agree	No Opinion	Disagree	Strongly disagree	Don't Know	Refused to answer
1.1 At this clinic/CHC, TB and ARV patient records are always kept together in one folder.	☐	☐	☐	☐	☐	☐	☐
1.2 The patient folders provided to clinicians (i.e.,doctors and nurses) always indicates a patient's TB/HIV co-infection status.	☐	☐	☐	☐	☐	☐	☐
1.3 The system for scheduling appointments allows patients to schedule TB and pre-ARV consultations on the same day.	☐	☐	☐	☐	☐	☐	☐
1.4 The system for scheduling appointments allows patients to schedule TB and ARV consultations on the same day.	☐	☐	☐	☐	☐	☐	☐
1.5 All TB, pre-ARV, and/or ARV clinical staff are provided training on how to manage TB/HIV co-infected patients. Training can be provided by the clinic or an outside source (e.g., NGO or national training)	☐	☐	☐	☐	☐	☐	☐
1.6 The clinic space is ideally configured for effective TB infection control. *(For the Interviewer -Examples of TB infection control measures include proper air* circulation, providing coughing patients with masks, and safe sputum collection.)	☐	☐	☐	☐	☐	☐	☐
1.7 I think the organizational components of TB and ARV services at this clinic are well integrated. **NB FOR THE INTERVIEWER :** *Organizational components refers to patient's records, location of TB and HIV clinics...whether its separate or in one* space.	☐	☐	☐	☐	☐	☐	☐

Section 2 : Clinical Integration - Structure :

	Strongly Agree	Agree	No Opinion	Disagree	Strongly disagree	Don't Know	Refused to answer
2.1 I am aware of a written guideline that stipulates that all TB patients must be tested for HIV.	☐	☐	☐	☐	☐	☐	☐
2.2 I am aware of a written policy for screening all HIV positive patients for TB.	☐	☐	☐	☐	☐	☐	☐
2.3 I am aware of a written protocol for referring ARV eligible patients to an ARV site.	☐	☐	☐	☐	☐	☐	☐
2.4a I am aware of written guidelines on how to manage patients who are co-infected with TB and HIV.	☐	☐	☐	☐	☐	☐	☐
2.4b I was provided a copy of the South African National Treatment guidelines.	☐	☐	☐	☐	☐	☐	☐
2.5a I am aware of a written protocol at this clinic/CHC that promotes coordinated or collaborative TB and ARV services.	☐	☐	☐	☐	☐	☐	☐
2.5b I was provided a copy of these guidelines.	☐	☐	☐	☐	☐	☐	☐
2.6 I am aware of a written TB infection control plan for this clinic that aims to reduce the spread of TB to patients and staff.	☐	☐	☐	☐	☐	☐	☐

Section 3 : Clinical Integration - Process : (TB and pre-ARV services)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly disagree	Don't Know	Refused to answer
3.1 At this clinic/CHC, both TB and pre-ARV services are available	☐	☐	☐	☐	☐	☐	☐
3.2 All TB suspects are always offered on-site HIV testing.	☐	☐	☐	☐	☐	☐	☐
3.3 At this clinic/CHC, all known HIV-positive persons are always screened for TB at every clinic visit.	☐	☐	☐	☐	☐	☐	☐
3.4 A co-infected person can always receive TB and pre-ARV services in one visit.	☐	☐	☐	☐	☐	☐	☐
3.5 TB/HIV co-infected patients always go to two separate doctors: One for their TB and one for their HIV services.	☐	☐	☐	☐	☐	☐	☐
3.6 TB/HIV co-infected patients always go to two separate nurses: One for their TB and one for their HIV services.	☐	☐	☐	☐	☐	☐	☐

Clinical Integration - Process : (TB and ARV services)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly disagree	Don't Know	Refused to answer
3.7 At this clinic/CHC, both TB and ARV services are always available.	☐	☐	☐	☐	☐	☐	☐
3.8 A patient can always receive TB and ARV services in one visit at this clinic.	☐	☐	☐	☐	☐	☐	☐
3.9 Co-infected patients always go to two separate doctors : One for their TB and one for their ARVs.	☐	☐	☐	☐	☐	☐	☐
3.10 TB/HIV co-infected patients on TB treatment and ARVs always go to two separate nurses : One for their TB and one for their HIV services.	☐	☐	☐	☐	☐	☐	☐
3.11 Every single HIV-positive patient on ARVs at this clinic is routinely screened for TB.	☐	☐	☐	☐	☐	☐	☐
3.12 Co-infected patients follow two separate adherence and support protocols : One for TB treatment adherence and one for ARV adherence.	☐	☐	☐	☐	☐	☐	☐

Clinical Integration - Process / General

	Strongly Agree	Agree	No Opinion	Disagree	Strongly disagree	Don't Know	Refused to answer
3.13 For each and every one of my patients, I always know if s/he is co-infected with TB and HIV.	☐	☐	☐	☐	☐	☐	☐
3.14 For each and every one of my patients, I always know of s/he is taking ARVs.	☐	☐	☐	☐	☐	☐	☐
3.15 For each and every one of my patients, I always know of s/he is on TB treatment.	☐	☐	☐	☐	☐	☐	☐
3.16 This clinic fully implements TB infection control practices.	☐	☐	☐	☐	☐	☐	☐

Section 4 : Clinical Integration - Culture :

	Strongly Agree	Agree	No Opinion	Disagree	Strongly disagree	Don't Know	Refused to answer
4.1 I see my role as part of a joint TB/HIV effort and not just providing HIV or TB services only.	☐	☐	☐	☐	☐	☐	☐
4.2 The TB epidemic cannot be controlled without integrating HIV and TB services.	☐	☐	☐	☐	☐	☐	☐
4.3 If trained, I am willing to provide both TB and ARV services to patients.	☐	☐	☐	☐	☐	☐	☐
4.4 I think patients should follow different TB and ARV adherence and support guidelines : One for TB and one for ARVs	☐	☐	☐	☐	☐	☐	☐
4.5 Cooperation between TB and pre-ARV HIV clinical staff is highly encouraged at this clinic/CHC	☐	☐	☐	☐	☐	☐	☐
4.6 Cooperation between TB and ARV clinical staff is highly encouraged at this clinic/CHC.	☐	☐	☐	☐	☐	☐	☐

Appendix VII: HIV-TB process indicators data collection tool

CAPRISA 013 - SUTHI TB/HIV-IDI - 1

CAPRISA 013 Plate # 001 Visit Code 1 . (Phase) (Month) (Interim)

Participant ID 0 1 3 - (Study) (Site) - (Participant) Visit Date (dd) (MMM) (yy)

Scaling up TB / HIV Integration (SUTHI)

TB / HIV Integration Data Indicators

Name of Data Collector : Interviewer code :

Name of District :

Name of Sub - District :

Name of Facility :

Integration Data Indicators - 1

1. HCT coverage	**Numerator :** Male and Female clients tested for HIV per month.	
	Denominator : Clinic's headcount	
	Clinic Target :	
	***Number refused to test*:**	
2. HIV testing for TB patients	**Numerator :** Number of new and moved TB patients tested for HIV	
	Denominator : Number of new and moved TB patients.	
3. HIV / TB Co-infected patients	**Numerator :** Number of new and moved TB patients tested positive for HIV	
	Denominator : Number of new and moved TB patients tested for HIV	
4. TB screening coverage (< 5 years)	**Numerator :** Number of patients screened for TB (< 5 years)	
	Denominator : Clinic headcount (<5 years; minus patients with active TB)	
5. TB screening coverage (> 5 years)	**Numerator :** Number of patients screened for TB (≥ 5 years)	
	Denominator : Clinic headcount (≥ 5 years; minus patients with active TB)	

Integration Data Indicators - 2

6. TB screening for new HIV positive patients	**Numerator :** Number of new HIV positive patients screened for TB ☐☐☐☐☐ **Denominator :** All new HIV positive patients ☐☐☐☐☐
7. ART coverage for HIV / TB co-infected clients	**Numerator :** Number of new and moved TB / HIV co-infected on ART ☐☐☐ **Denominator :** Number of new and moved TB patients tested positive for HIV ☐☐☐
8. TB treatment coverage for HIV co-infected clients	**Numerator :** Number of new and moved TB / HIV co-infected on TB treatment ☐☐☐ **Denominator :** Number of new HIV patients tested positive for TB ☐☐☐
9. IPT coverage (Newly diagnosed HIV clients)	**Numerator :** Number of new HIV positive patients initiated on IPT ☐☐☐ **Denominator :** Number of new HIV positive patients eligible for IPT ☐☐☐
10. IPT coverage (New on ART)	**Numerator :** Number of new ART patients initiated on IPT ☐☐☐ **Denominator :** Number of new ART patients eligible for IPT ☐☐☐
11. IPT completion rate	**Numerator :** Number of patients completed IPT ☐☐☐ **Denominator :** Number of patients due for IPT completion ☐☐☐
12. CPT coverage on HIV / TB co-infected clients	**Numerator :** Number of patients initiated on CPT ☐☐☐ **Denominator :** Number of new HIV / TB co-infected ☐☐☐

Appendix VIII: Example of thematic coding

Quotes/texts	Theme
that if you begin on ART, if there are no signs of TB, it is important for the patient to go on IPT so that they can prevent from TB. It is also important to check the patients close contacts, for example, the children	Acknowledgement of IPT initiation for prevention
Every patient that goes through TB testing should also be referred to HIV counsellors	TB screening and HIV testing important together
Yes, I think it is when a person that has TB should be tested for HIV as well so that they can get treatment and also that they get both HIV/TB treatment in the same room instead of them moving around to get medication	Single HCW, emphasis on Screening and testing and ART, TB rx
That there's one file for both TB/HIV so that we can give one holistic service to the patient when they come in	One integrated system
it is that the patient coinfected should have one file and also be given one date to collect both their medication	One integrated system
For the patient to be treated by one nurse holistically	Single HCW
That there's one file, one folder, one service in place	Integrated data system
There is one file for the coinfected patients	Integrated data system
I understand that if a person is HIV positive, they must ne screened for TB. TB HIV is a 90/90 thing, they go together and the coinfected patients are attended by one nurse	TB screening and HIV testing important together
A coinfected person should be assessed by one person and proper guidelines are followed.	Single HIV-TB HCW
if a person only has HIV they should be initiated on IPT for a year to prevent them from contracting TB	Acknowledgement of IPT initiation for prevention
If a patient is coinfected they should have one file and one folder and they should have one treatment date	One integrated system
If a patient is HIV they must be checked for TB and if they have TB, they should be tested for HIV	HIV and TB screening and testing
Every client that comes in the facility should be screened for TB/HIV	HIV and TB screening and testing
If a HIV positive patient does not have TB, it is important that they must be regularly screened for TB. If patient is co-infected they get Cortromaxizole to prevent opportunist infections	CPT
There is a one stop shop service, one file and the patient does not move around to get medication for different chronic disease. They do not go to a TB room and different room for HAST	Single HIV-TB HCW
if a patient has tested negative for HIV but has TB that they be tested regularly for HIV	Regular HIV testign
There is one file for coinfected patients and a coinfected patient gets one date to collect both medications for TB/HIV. The patient gets treated by one nurse and does not go to different rooms to get treatment. Their return dates are also the same	One intgerated ssytem , one HCW

Appendix IX : Focus Group Discussion Interview Guide

RM to introduce the focus group members to CAPRISA staff present
Everyone needs to say what their designation is at the clinic & How long they worked at the clinic
Assure staff that their information will be confidential. Give them ICF to sign (English or isiZulu – depending on their preference)
Introduce purpose of focus group interviews

1. When did you first hear about quality Improvement? From Whom?
   - What does quality improvement mean to you?
   - For control clinics Do you think this clinic is implementing quality improvement?
   - If yes, when did they start implementing? Is the clinic getting support or advice to implement QI? From whom? What have you learned about Quality Improvement /QI skills?
   - Do you think the training you received on Quality Improvement was adequate?
2. What is your understanding of TB/HIV service integration?
   - Can you list the essential services that make up integrated TB/HIV service delivery?
   - For intervention clinics: Do you believe that the QI, will indeed improve TB/HIV service integration?
   - For control clinics: Have you and your team at the clinic undertaken any initiatives to ensure that there is integration of TB/HIV services? What have you done?Who started the initiative ?
3. For control clinics: What strategies does the clinic use to integrate TB and HIV services?
   - Patient flow
   - Staff training
4. Do you think that TB/HIV service integration can be improved in this clinic? What prevents the clinic from integrating these services to the standards you would like to see? Explore: staff knowledge, resources, human resource, infrastructure.
5. Do you think TB/HIV coinfected patients are managed effectively in this clinic?
   - Does every HIV patient get screened for TB?
   - Does every TB suspect get a GXP test?
6. What do you think might have caused this?
7. **For control clinics:** IF QI not mentioned, has your TB/HIV service delivery got worse / better after implementing QI? How has this affected daily routine activities? (work culture, stock, waiting times, patient staff relations)
8. **For control clinics:** Did you receive support from management to deliver effective TB/HIV management?

   If yes, from whom? What kind of support were you given?
   If no support from management, would you like to be supported? What kind of support do you need?
9. For intervention clinics Do you need more training on QI?
10. Would you encourage other clinics to do QI?
11. There is anything you think we should have talked about in this discussion and we did not mention?
12. Is there any element that you would add to the QI that you felt was missing?
13. Would you recommend that more clinics be initiated to the QI (why)?

14. Do you believe that the support you received from the QI is sufficient to last you even after the intervention has been completed?
15. Do you have intentions to follow all training received throughout the QI intervention period?

Appendix X: SUTHI Trial Ethics approval and latest recertification

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

13 November 2014

Dr Kogieleum Naidoo
CAPRISA
Nelson R Mandela School of Medicine
2nd Floor, K-Rith Tower Building
UKZN
Naidook45@ukzn.ac.za

PROTOCOL: Addressing challenges in scaling up TB and HIV treatment integration in public settings in South Africa. REF: BF108/14

The Biomedical Research Ethics Committee (BREC) has considered the abovementioned application.

The study was provisionally approved by a quorate meeting of BREC on 08 April 2014 pending appropriate responses to queries raised. Your responses dated 15 May and 10 November 2014 to queries raised on 30 April and 11 July 2014 have been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given full ethics approval and may begin as from 13 November 2014.

This approval is valid for one year from **13 November 2014.** To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2004), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

Biomedical Research Ethics Committee
Professor D R Wassenaar (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 2486 **Facsimile:** +27 (0) 31 260 4609 **Email:** brec@ukzn.ac.za
Website: http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx

The following Committee members were present at the meeting that took place on 08 April 2014:

Prof D Wassenaar	Chair
Prof R Bhimma	Paediatrics & Child Health
Prof A Coutsoudis	Paediatrics & Child Health
Dr T Hardcastle	Surgery - Trauma
Prof TE Madiba	General Surgery
Ms T Maistry	External
Dr RN Naidoo	Family Medicine
Dr S Paruk	Psychiatry
Prof V Rambiritch	Pharmacology
Dr A Sathar	External
Dr D Singh	Critical Care
Dr S Singh	Dentistry

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely

[redacted]

PROFESSOR D R WASSENAAR
Chair: Biomedical Research Ethics Committee

UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI
RESEARCH OFFICE
BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604769 - Fax: 27 31 260-4609
Email: BREC@ukzn.ac.za
Website: http://research.ukzn.ac.za/ResearchEthics/BiomedicalResearchEthics.aspx

10 October 2019

Dr Kogieleum Naidoo
CAPRISA
Nelson R Mandela School of Medicine
2nd Floor, K-RithTower Building
UKZN
Naidook45@ukzn.ac.za

PROTOCOL: Addressing challenges in scaling up TB and HIV treatment integration in public settings in South Africa. REF: BF108/14

RECERTIFICATION APPLICATION APPROVAL NOTICE

Approved:	13 November 2019
Expiration of Ethical Approval:	12 November 2020

I wish to advise you that your application for Recertification received on 04 September 2019 for the above protocol has been **noted and approved** by a sub-committee of the Biomedical Research Ethics Committee (BREC) for another approval period. The start and end dates of this period are indicated above.

If any modifications or adverse events occur in the project before your next scheduled review, you must submit them to BREC for review. Except in emergency situations, no change to the protocol may be implemented until you have received written BREC approval for the change.

The committee will be notified of the above approval at its next meeting to be held on 12 November 2019.

Yours sincerely

[redacted]

Prof S Rambiritch
Chair: Biomedical Research Ethics Committee

Appendix XI: KwaZulu Natal health research committee approval

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

Health Research & Knowledge Management sub-component
10 – 103 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg
3200
Tel.: 033 – 3953189
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference : HRKM309/14
NHRD Ref: KZ_2014RP53_802
Enquiries: Mrs G Khumalo
Telephone : 033 – 395 3189

Dear Dr K Naidoo

Subject: Approval of a Research Proposal

1. The research proposal titled '**Addressing challenges in scaling up TB and HIV treatment integration in public health settings in South Africa**'was reviewed by the KwaZulu-Natal Department of Health (KZN-DoH).

The proposal is hereby **approved** for research to be undertaken at selected clinics at Ugu and Uthungulu Districts.

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mrs G Khumalo on 033-395 3189.

Yours Sincerely

[redacted]
Dr. E Lutge
Chairperson, KwaZulu-Natal Health Research Committee
Date: 19/11/14

Appendix XII: BREC approval for the PhD project and latest recertification

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

08 February 2018

Ms S Gengiah (204507742)
School of Nursing and Public Health
College of Health Sciences
Santhana.Gengiah@caprisa.org

Protocol: The association between organizational contextual factors and TB-HIV service integration following exposure to Quality Improvement (IQ) interventions in Primary Health Care (PHC) Clinics in rural KwaZulu-Natal
Degree: PhD **BREC Ref No: BE673/17 sub study of BF108/14**

EXPEDITED APPLICATION

A sub-committee of the Biomedical Research Ethics Committee has considered and noted your application received on 16 November 2017.

The study was provisionally approved pending appropriate responses to queries raised. Your response received on 21 January 2018 to BREC correspondence dated 15 January 2018 has been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given **full ethics approval** and may begin as from 08 February 2018.

This approval is valid for one year from **08 February 2018.** To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2015), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be **RATIFIED** by a full Committee at its next meeting taking place on **13 March 2018.**

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely

[redacted]

Professor V Rambiritch
Deputy Chair: Biomedical Research Ethics Committee

cc postgraduate administrator: ramlalm@ukzn.ac.za
cc supervisor: marian.loveday@mrc.ac.za Taylor@ukzn.ac.za

Biomedical Research Ethics Committee
Professor J Tsoka-Gwegweni (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 2486 **Facsimile:** +27 (0) 31 260 4609 **Email:** brec@ukzn.ac.za
Website: http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx

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UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

20 October 2020

Ms S Gengiah (204507742)
School of Nursing and Public Health
College of Health Sciences
Santhana.Gengiah@caprisa.org

Dear Ms S Gengiah

Protocol: The association between organizational contextual factors and TB-HIV service integration following exposure to Quality Improvement (IQ) interventions in Primary Health Care (PHC) Clinics in rural KwaZulu-Natal
Degree: PhD
BREC Ref No: BE673/17 sub study of BF108/14

RECERTIFICATION APPLICATION APPROVAL NOTICE

Approved:	08 February 2021
Expiration of Ethical Approval:	07 February 2022

I wish to advise you that your application for Recertification received on 16 October 2020 for the above protocol has been noted and approved by a sub-committee of the Biomedical Research Ethics Committee (BREC) for another approval period. The start and end dates of this period are indicated above.

If any modifications or adverse events occur in the project before your next scheduled review, you must submit them to BREC for review. Except in emergency situations, no change to the protocol may be implemented until you have received written BREC approval for the change.

The committee will be notified of the above approval at its next meeting to be held on 10 November2020.

Yours sincerely

[redacted]

Ms A Marimuthu
(for) Prof D Wassenaar
Chair: Biomedical Research Ethics Committee

Appendix XIII: Letter of Support

CAPRISA
CENTRE FOR THE AIDS PROGRAMME OF RESEARCH IN SOUTH AFRICA

UNAIDS
CAPRISA is the UNAIDS Collaborating Centre for HIV Research and Policy

Doris Duke Medical Research Institute (2nd floor), 719 Umbilo Road, Private Bag X7, Congella, 4013, Durban, South Africa
tel: +27 31 2604555 | fax: +27 31 2604549 | email: caprisa@caprisa.org | www.caprisa.org

10 November 2017

Tivani P Mashamba-Thompson
Academic Leader: Research
School of Nursing and Public Health
George Campbell Building
King George V Avenue
Durban

Dear Dr Mashamba-Thompson

Letter of Support for PhD candidate Ms Santhanalakshmi Gengiah (Student No.# 204507742) to access CAPRISA 013 trial data

I am writing, in my capacity as the Principal Investigator of the CAPRISA 013 trial, to grant permission for the above mentioned student to access CAPRISA 013 trial data for the purposes of her PhD research. The CAPRISA 013 trial is a cluster randomized controlled trial to determine the effectiveness of implementing a Quality Improvement model to enhance the integration TB and HIV services in Primary Healthcare Clinics in 2 rural districts in KwaZulu-Natal (KZN). This trial received ethics approval from the University of KwaZulu-Natal Biomedical Research Ethics Committee on 13 November 2014 (BF:108/14).

A sub-objective of the trial is to determine which clinical-level factors impact TB/HIV service integration and the data collection for the primary study is well under way. Ms Gengiah has indicated that that her research interest lies in investigating the organizational behavioral component of the primary study. Her PhD will determine the association between organizational contextual factors and TB/HIV service integration in the presence and absence of a Quality Improvement intervention.

Ms Gengiah has been granted permission to access and analyze the organizational behavioral data collected in the CAPRISA 013 study for the purposes of her PhD research.

Please do not hesitate to contact me should you have any queries about this letter.

Your sincerely,

[redacted]

Dr Kogieleum Naidoo
Principal Investigator
Head of HIV-TB Treatment Research
CAPRISA
Tel: 031 260 4687
Fax: 031 260 4549
E-mail: Kogie.Naidoo@caprisa.org

Appendix IV: Study informed consent

INFORMATION SHEET/CONSENT FORM FOR PARTICIPATION IN A STUDY
Centre for the AIDS Programme of Research in South Africa (CAPRISA)

Title of Study: Addressing challenges in scaling up TB and HIV treatment integration in public health settings in South

Research Ethics Committee's approval number: BF108/14
Sponsor(s) of research: The United Kingdom and South African Medical Research Council

PART A: Information Sheet

Dear Healthcare Practitioner,

Introduction:

You are requested to be part of a research project. Research is a way to find solutions and answers to questions. We are researchers from the Centre for the AIDS Programme of Research in South Africa (CAPRISA). The main investigator for this study is Dr Kogieleum Naidoo. We are conducting this study to better understand how clinic teams can be assisted to provide integrated TB and HIV services.

Why we have invited you to participate in this study:

You have been selected because you play an important role in the integration of HIV-TB service delivery at this primary care health clinic (PHC). Please feel free to ask questions as we go through this information with you.

Your participation in this study is voluntary. You can choose not to be part of this study or withdraw consent during the study. There will be no consequences for not wanting to participate in the study.

Procedure: One of our well trained staff will approach you for permission to ask questions about yourself and your work at this clinic. There are a couple of questionnaires on your socio-demographics, training, experience and TB/HIV integrated services that we require you to complete.

Participation in the study: This study team should not take more than an hour and half of your time to complete these questions. Please be as honest as possible in your answers. No information that can identify you will be collected (i.e. staff number, SA ID number, name)

Risks and Benefits of participating in the research: There is no direct benefit to you for being part of this study. Your participation in this research will enable us identify challenges to TB/HIV service integration as well as impact in public health settings and address program weaknesses. There is little risk to you for participating in the study. There are some questions regarding your thoughts and mood in the workplace that may cause you some feelings of embarrassment. You are free to refuse to answer questions that make you uncomfortable. You will be treated the same no matter what you decide.

Cost and voluntariness of joining the research: Your participation in this research will not cost you anything, aside from your time, and is completely voluntary. Thus you are free to withdraw your consent to participate in the study.

Compensation: There is no monetary compensation for being a part of this study. You may be provided with very light refreshments after the interview process.

Confidentiality: All information you provide in this study will be kept confidential in accordance to rules governing medical professionals. Every caution will be taken to ensure your details are confidential. We can't guarantee privacy. Your information can be disclosed if required in a court of law. The interview forms will not contain information that could identify you (e.g. Staff numbers, SA ID, addresses etc). Researchers from CAPRISA and the University of KwaZulu-Natal ethics committee providing oversight to the study are the only people who will know your identity.

Sharing the results when the research is over: The knowledge gained from this research will be shared with the department of health, stakeholders other relevant health bodies. Confidential information about you will not be shared. Only a summary of the data that we collect is distributed. We also intend to publish the results to showcase best practices and improve on identified gaps.

PART B: Certificate of consent

I have fully explained this research to _____ and have given sufficient information, including about risks and benefits, to make an informed decision.
DATE: _____ SIGNATURE: _____
NAME:_____

Statement of consent from participant:

I have read the description of the research or have had it explained in a language I understand. I understand that my participation is voluntary. I have received a copy of document to keep for myself.
I hereby consent to take part in the study. Components marked "yes" and refuse to consent to participate in the components marked "no".

Interview at start - YES NO
Interview during periodic visits - YES NO
DATE: _____ SIGNATURE/THUMBPRINT: _____
NAME: _____
WITNESS' SIGNATURE (if thumbprint): _____
WITNESS' NAME (if thumbprint): _____

Ethics approval: This research has been reviewed and approved by the Research Ethics Committee of University of Kwazulu-Natal, Durban-South Africa. Any inquiries can be directed to the contact(s) below.

Dr. Kogieleum Naidoo
Principal Investigator
CAPRISA
Tel: 031 260 4555 Fax: 031 2604549
Email: Kogie.Naidoo@caprisa.org
OR
Santhanalakshmi Gengiah
Study Coordinator
Tel: 031 260 4704 Fax: 031 260 4549
Email: Santhana.Gengiah@caprisa.org
OR
Biomedical Research Ethics Administration
Research Office, Westville Campus
Govan Mbeki Building
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