KNOWLEDGE, ATTITUDE AND PERCEPTION OF 4TH AND 5TH YEAR UKZN MEDICAL SCHOOL STUDENTS TOWARDS THE USE OF HIV DRUG RESISTANCE INTERPRETATION ALGORITHMS

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LIST OF ACRONYNMS

AIDS	Acquired Immunodeficiency Syndrome
ART	Antiretroviral Therapy
ARV	Antiretroviral
CART	Combination Antiretroviral Therapies
HAART	Highly Active Antiretroviral Therapy
HIV	Human Immunodeficiency Virus
HIVDR	Human Immunodeficiency Virus Drug Resistance
ICT	Information Communication, Technology
KAP	Knowledge, Attitude and Perception
NRMSM	Nelson Rolihlahla Mandela School of Medicine
RSL	Resource-limited Settings
UKZN	University of Kwa-Zulu Natal
WHO	World Health Organization

ABSTRACT

HIV drug resistance (HIVDR) has emerged as a major clinical and public health challenge in many resource poor countries especially in Africa. HIVDR testing has become increasingly important and is of significant value in the management of HIV. The use of low cost technologies and procedures in testing HIVDR is being recommended. HIVDR computer interpretation algorithms make use of artificial intelligence and other computer technologies to predict HIVDR, and are recommended for use in resource poor countries. However, there is little known about the knowledge, attitude and perception of HIVDR computer algorithms by doctors in developing countries who are supposed to use computer algorithms.

This study aimed to determine the knowledge, attitude and perception regarding computer interpretation algorithms of the 4th and 5th year medical students at Nelson R. Mandela School of Medicine, University of KwaZulu Natal in South Africa. Primary data collection was done using a questionnaire administered to a convenience sample of 216 4th and 5th year medical students. The study revealed that 90% of the respondents were aware of HIV drug resistance testing in South Africa but only 4% had knowledge of the computer interpretation algorithms. The study revealed that although the UKZN medical students are not aware of computer interpretation algorithms, majority are willing to use them in the future.

CHAPTER 1: INTRODUCTION

1.1 Introduction

The vast majority of HIV infections occur in resource limited settings (RLS) (Struck et al., 2012). Access to antiretroviral treatment (ART) programs in these settings have been widely improved following WHO recommendations and international funding efforts (Struck et al., 2012). South Africa has the largest population infected with human immunodeficiency virus (HIV) which causes acquired immunodeficiency syndrome (AIDS) (Manasa et al., 2013). All the countries in the world are intensifying measures to fight HIV, in order to reduce its associated morbidity and mortality (Manasa et al., 2013).

There is currently no cure for HIV/AIDS but it can be managed by antiretroviral (ARV) therapy. This has changed the HIV trend significantly (Giddy et al., 2013). ARV drugs disrupt the HIV enzyme's ability for genetic copying, or for making virus that can infect other cells (Tang et al., 2012). The ARV's are usually being managed in the form of highly-active antiretroviral therapy (HAART). This is a combination of drugs that improves therapy and suppresses the viral load (Eberle and Guertler, 2012).

HAART can fail as a result of toxicity, transmitted drug resistance, poor drug adherence, or poor suppression of viral copying resulting in the emergence of HIV drug resistance (HIVDR) (Wallis et al., 2010). HIVDR refers to, 'a reduction in the ability of a drug or combination of drugs to block duplication or replication of HIV' (Tang et al., 2012).

The common factors that leads to antiretroviral drug resistance include high replication rates of the virus, selective pressure caused by the ARV drugs and initial infection by resistant strains of HIV (Singh and Mars, 2012). Therefore HIVDR is inevitable in treatment of HIV infected patients.

The use of ARV's leads to the emergence of resistant viruses which in most occurrences causes treatment failure (Bessong and Nwobegahay, 2013). The occurrence of HIVDR may limit the benefits of ART (Marconi et al., 2008). Continued spread of HIVDR could jeopardize efforts to curtail the epidemic in the developing world. Hence surveillance of HIVDR is justified (Di Giambenedetto et al., 2011).

1.2 Background of Study

The existence of HIVDR complicates HIV management (Kozal, 2009). As ART is scaled up in resource limited countries, the occurrence and transmission of HIVDR remains an international priority. HIVDR has to be treated with high priority as it endangers the effort in curbing HIV (Kozal, 2009). Wherever there are HAART programs in place, there is the possibility of HIVDR existence due to existence of HIVDR in circulation and thus endangering the success of HIV treatment (Struck et al., 2012). Thus ARV drug resistance remain a potential threat to the control of HIV (Manasa et al., 2013).

Efforts to provide access to ART for infected persons in resource limited countries have been enhanced over the past several years (Marconi et al., 2008). South Africa is said to have one of the largest ARV programs in the world, and thus high chances of the

existence of HIVDR (Castillo et al., 2011). It is therefore of paramount importance that HIVDR testing in South Africa be given high priority in order for the HIV treatment programs to be effective. The current expansion of ART in the developing world without routine virological monitoring still raises concerns on the outcome of the strategy in terms of virological success and drug resistance burden (Aghokeng et al., 2013).

1.3 Aim of the study

The aim of the study was to determine the knowledge, attitude and perception (KAP) of fourth and fifth year medical students of Nelson R. Mandela School of Medicine (NRMSM) on HIV drug resistance testing in South Africa using computer interpretation algorithms.

1.4 Research questions

In order to address the aim of the study, this study attempted to answer the following research questions,

1. What is the current scientific literature on HIVDR, HIVDR testing using computer based interpretation algorithms, particularly around KAP of medical students?
2. What is the knowledge of a sample of fourth and fifth year students at NRMSM, on HIV drug resistance computer based interpretation algorithms?
3. What is the attitude of a sample of fourth and fifth year students at NRMSM towards HIV drug resistance interpretation algorithms?

4. What is the perception of a sample of fourth and fifth year students at NRMSM towards the use of HIV drug resistance computer based interpretation algorithms in clinical practice?

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

A vast amount of literature related to HIV has been published as the research community strives to understand and find solutions to one of the worst epidemics affecting the world (Fernandez-Gerlinger et al., 2013; WHO, 2012). One of the focus areas of HIV research is the prevalence and occurrence of HIVDR. Although a significant number of papers have been published concerning HIVDR (Tang et.al. 2012; Fernandez-Gerlinger et al., 2013; WHO, 2012), there is still more work required to understand the issues and challenges around HIVDR.

One major aspect is to increase knowledge on HIVDR especially amongst health practitioners in order to increase their capacity to deal with HIVDR. It is therefore imperative to ascertain the current state of knowledge on HIVDR. As a contribution to this endeavor this literature review has focused on reviewing and summarizing research on HIV, HIVDR, knowledge, attitude and perception of South African medical students on HIVDR testing with a particular focus on the use of computer interpretation algorithms.

HIVDR testing is becoming an essential tool in managing HIV, thus, it is important to assess the knowledge, attitude and perception of medical students on HIVDR testing in order to identify education gaps, training needs with a view to informing the relevant stakeholders and issues that will aid change management. The gaps in knowledge lead to disparate attitudes and perceptions amongst clinicians leading to unevenness in HIV

treatment across the country. The ubiquitous appearance of drug resistance complicates the global spread of HIV disease, the range of resistance continues to multiply, and thus resistance testing has become increasingly important and very significant in the management of HIV in the country.

2.2 Methods

A comprehensive literature review was carried on using the 'deep web' search targeting published articles using the UKZN library electronic academic resources. Search terms shown in the table below were used to electronically search using EBSCO Host, Science direct and Google scholar. The search was narrowed down by using the Boolean operators 'AND', 'OR', 'NOT'. Advanced search was also used to narrow down the search so that relevant papers were retrieved. KAP studies were narrowed down to Africa and South Africa, to find out how much literature has been published in these areas.

The inclusion criteria was all the articles published in the field of study since the 2008 to date. No articles prior to 2008 were used in the study. The search strategy included narrowing down articles to those that were relevant from African and South Africa in particular.

Table 1: Search terms, articles retrieved and relevant articles used in the study

Search terms	**Articles Retrieved**	**Relevant Articles**
"HIV" and "HIV treatment"	6681	40 (used)
"HIV Drug Resistance"	639	21
"HIV Drug Resistance" and "HIV Drug Resistance testing"	26	9
"HIV Drug Resistance testing methods" and "HIV Drug Resistance testing in South Africa"	15	10
"Genotyping" and "Phenotyping"	160	10
"Genotyping: rule based" and "machine learning algorithms"	30	10
"KAP methods" and "KAP of medical students"	23	5
"KAP studies"	41	5
Total	**7589**	**110**
Unique		**94**

2.3 HIV

The Human immunodeficiency virus (HIV) is the cause of acquired immunodeficiency syndrome (AIDS) (Ammaranond and Sanguansittianan, 2012). It is one of the most infectious diseases to plague the global human population (Nyabadza et al., 2011). About 33 million people are infected with the human immunodeficiency virus (HIV)

worldwide (Fernandez-Gerlinger et al., 2013). South Africa has the largest HIV burden in the world, with an estimated 5.6 million people living with HIV (Manasa et al., 2013). The dual epidemics of HIV and TB remain a leading health care challenge in South Africa (Giddy et al., 2013).

2.4 HIV treatment

There is still no cure for HIV but the disease can be managed and controlled by ART. Treatment of HIV infection consists of HAART, which has shown to be effective in suppressing viral replication in many patients (Quoc-Chinh et al., 2010). HAART comprises of a regimen of three drugs from at least two of the five commercially available antiretroviral drug classes (Singh and Mars, 2013).

ART has converted HIV infection from an almost universally fatal illness to a manageable chronic disease (Conradie and Wilson, 2012). ART has significantly reduced associated morbidity and mortality in HIV positive patients in both developed and resource limited countries (Aghokeng et al., 2013). ART with fully suppressive HAART lowers viral load and significantly decreases the risk of transmission (Iwuji et al., 2013). The introduction of HAART has intensely improved the natural history and diagnosis of HIV infection and AIDS (Di Giambenedetto et al., 2011).

HAART has been set as the standard treatment for HIV infection. It has helped to control HIV infection and the development of AIDS. The availability of new drug classes, such as integrase inhibitors, provide the option of alternative drug

combinations, thereby offering more treatment options (Bessong and Nwobegahay, 2013).

2.4.1 HAART in South Africa

South Africa reacted slowly to the HIV epidemic and only managed to have the full ARV rollout in 2004. The past eight years have seen substantial scale-up of ART in South Africa, which has substantially reduced related population level mortality and increased life expectancy (Manasa et al., 2013). The scaling up treatment was one of the largest in the world, with a 75% increase in treatment services.

2.5 HIV drug resistance

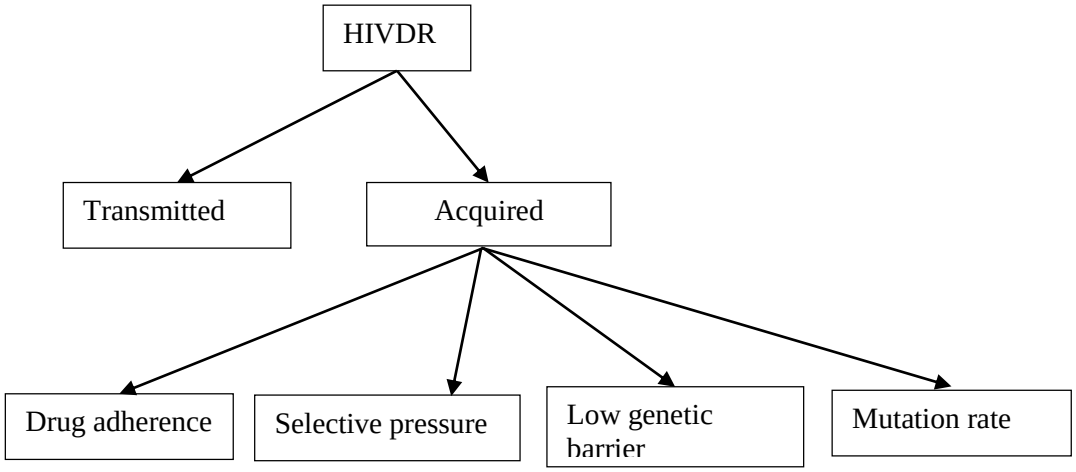

Figure 1: HIV Drug resistance

HIVDR can be categorized as transmitted or acquired as shown in figure one. Transmitted drug resistance occurs when previously uninfected individuals are infected with a drug resistant virus (WHO, 2012). Acquired HIV drug resistance occurs when

resistance mutations are acquired due to drug selective pressure in individuals receiving ARV therapy, suboptimal adherence, treatment interruptions, inadequate plasma concentrations or the use of suboptimal drugs or drug combination (WHO, 2012).

HIVDR refers to, 'a reduction in the ability of a particular drug or combination of drugs to block reproduction or replication of HIV' (Tang et al., 2012). The prolonged use of HAART leads to drug resistance caused by the viral mutations that occur under drug pressure (Quoc-Chinh et al., 2010). Resistance occurs as a result of alterations called mutations in the HIV's genetic structure (RNA) (Tang et al., 2012). These mutations lead to changes in certain proteins, most commonly enzymes that regulate the production of infectious virus (Tang et al., 2012). HIV mutates at a very high rate, and does not contain the proteins required to correct mistakes made during copying of the genetic material (Tang et al., 2012). Interruption of HAART or failure to take ARV drugs on schedule and in the prescribed dosage can encourage the development of drug resistant HIV strains (Kolupajeva et al., 2008).

Access to ART for treatment of HIV infections is increasing throughout the developing world (Castillo et al., 2011). Eight years after the introduction of ARV's in public health facilities in South Africa, the development of resistance and treatment failure has begun to appear (Bessong and Nwobegahay, 2013). HIVDR is emerging and is weakening available treatment options (Castillo et al., 2011). Individuals with ARV drug resistance have a relatively higher risk of virologic failure as they start ART with a lower genetic barrier to resistance (Nwobegahay et al., 2011).

2.5.1 Transmitted drug resistance

HIV drug resistance can be categorized as, transmitted resistance, which occurs when previously uninfected individuals are infected with a drug resistant virus (WHO, 2012). A newly infected patient can carry a drug resistant virus even though not on ARV treatment. Transmitted HIVDR is therefore a major concern as it increases the risk of virologic failure, this can be relevant where there are limited treatment options. The transmitted HIVDR infected patient starts therapy with a lower genetic barrier to resistance, higher risk of virologic failure and a higher risk of developing resistance to drugs in the regimen that they were originally susceptible to (Bonney et al., 2013). Surveillance of HIV transmitted drug resistance in recently infected individuals is key to the WHO strategy (Castillo et al., 2011). The prevalence of transmitted drug resistance in middle to low income countries is estimated to be around 7% (Pennings, 2013).

2.5.2 Acquired drug resistance

Acquired resistance, occurs when resistance mutations emerge because of drug selective pressure in individuals receiving ARV's (WHO, 2012). Acquired HIV drug resistance occurs when resistant mutations are acquired due to drug selective pressure in individuals receiving ARV therapy, suboptimal adherence, treatment interruptions, inadequate plasma concentrations or the use of suboptimal drugs or drug combinations (WHO, 2012).

Both acquired and transmitted HIV drug resistance are public health concerns (Kolupajeva et al., 2008). Surveillance of both transmitted and acquired resistance can supply information to support public health bodies in designing preventive action to minimize the development and transmission of drug-resistant viruses (Kolupajeva et al., 2008).

2.5.2.1 Mutation rate

HIV replicates at a high rate in untreated patients. The rate at which mutations accrue in the HIV genome has great implications for the management of individuals with HIV because it impacts the effectiveness and pharmacoeconomics of HAART (Wensing et al., 2010). Resistance to HAART and adherence to HAART determine the level of HAART effectiveness. Although greater HAART effectiveness will suppress viral load more completely, it will also increase selection pressures for particular mutations that could produce resistance to one or more drugs in the round (Braithwaite et al., 2007).

2.5.2.2 Selective pressure

Drug resistant HIV progresses in response to selective pressure applied by the ARV drugs in the patient's system (Wensing et al., 2010). Resistant strains may develop through selective pressure during ART. Specific resistance mutations develop in response to the pressure exerted by specific drugs (Fehr et al., 2008). The presence of viral resistance suggests that a particular drug, and drugs with similar resistance patterns, or cross-resistance, is unlikely to be successful in suppressing viral replication (Ammaranond and Sanguansittianan, 2012).

Greater HAART effectiveness reduces the rate of viral replication and therefore decreases opportunities to produce mutations overall, however, the mutations that do occur are produced in an environment of high selection pressure because of the effectiveness of the therapy against wild type virus. As resistance accrues, the viral replication rate increases, and this in turn increases the probability that subsequent mutations will develop. The effectiveness of HAART influences changes in the viral load and cd4 count and also feeds back to influence the viral replication rate and selection pressures (Shi et. at., 2010).

2.5.2.3 Low genetic barrier

The genetic barrier to resistance development is usually defined by the number of resistance associated mutations necessary to confer virological failure. However, other factors also have to be taken into consideration. If viral copying is incompletely suppressed, the likelihood of selecting a new mutation is high. If a single mutation occurs, sufficient to restore growth, the selective pressure experienced by the virus will be lost and selection of additional mutations will not occur (Wensing et al., 2010).

2.5.2.4 Drug adherence

It is widely accepted that for HIV positive persons on highly active antiretroviral therapy (HAART), high levels of adherence to treatment regimens are essential for promoting viral suppression and preventing drug resistance.

HIV drug resistance can emerge among people on treatment even when appropriate ARV therapy is provided and high levels of adherence are achieved. Optimal adherence to HAART is essential to HIV infected individuals accessing treatment (Musiime et al., 2011). Poor adherence to HAART can lead to HIV disease progression, evolution of drug resistance and subsequent immunological, evolution and clinical failure (Musiime et al., 2011).

Because ART can fail as a result of toxicity, pre-treatment HIV drug resistance, insufficient patient adherence or incomplete suppression of viral replication leading to the emergence of drug-resistant viruses, adequate clinical and biological management can significantly improve treatment outcome and can prevent rapid failure (Aghokeng et al., 2013).

2.6 HIV drug resistance testing

HIVDR testing is used to guide subsequent treatment for patients whose ART is failing and for those whose viral load is not completely suppressed after starting therapy. It is recommended to patients with multiple drug failure, newly infected individuals and for pregnant women who are not on ART and for those who are on ART but have a detectable HIV viral load as transmission of resistant HIV mutants to therapy naïve individuals are a rising concern (Fehr et al., 2008).

It can also be used to select an initial regimen that is likely to be effective for patients who have never been treated, and it is recommended for all patients with HIV infection, both acute and chronic upon entry into care, whether or not ART is to be initiated

(Manasa et al., 2013). In addition, resistance testing is recommended for pregnant women.

The development of drug resistance is one of the major challenges challenging management of effective therapy against HIV (Ammaranond and Sanguansittianan, 2012). South Africa follows the public health approach to ART delivery with standardized drug regimens and simplified decision making, with the inclusion of routine viral load monitoring for the detection of treatment failure (Manasa et al., 2013).

Countries should step up monitoring of HIVDR and take steps to guard against inconsistent taking of medication that fuels the problem. WHO has recommended countries to begin surveillance in areas where ART has been available for years because even where effective ART is available, drug resistance remains a crucial issue (WHO, 2012).

Viral load monitoring should enable early identification of treatment failure and this has been shown to improve survival and health of the HIV infected people (Manasa et al., 2013). There is need for nationwide drug resistance surveillance to be in place to meet the emerging need and be able to detect the resistance pattern. This will assist in the type of drugs to include on the ARV programs and also to eliminate the compromised drugs in the treatment plan and be able to obtain the drugs that will impact the treatment program.

With HIV drug resistance testing in place, the relevant departments will be able to plan ahead and be able to yield good results in HIV management program as a whole and

this will benefit the country at large. HIV drug resistance testing has been shown to improve ARV treatment outcomes and is broadly recommended as standard of care in current treatment guidelines (Pattery et al., 2012). Drug resistance can be directly assessed by phenotypic assays or can be deduced from genotypic assays.

2.6.1 Phenotype

HIV drug resistance testing may be performed by direct measurement of virus susceptibility to drugs, the laboratory testing (Guertler et al., 2012). Phenotype testing works by splicing the HIV reverse transcriptase and HIV protease genes from a patient's virus into a standardized laboratory strain, which is then grown in the presence of escalating concentrations of ARV drugs (Fehr et al., 2008). A phenotype testing takes 2-3 weeks to complete.

Phenotype resistance testing assesses viral expression (Fehr et al., 2008) and virus drug susceptibility. A special form of it, the replicative phenotypic resistance test utilizes several replication cycles of a recombinant infectious virus to follow viral propagation in the presence of antiretroviral drugs (Fehr et al., 2008).

However phenotyping, is performed in laboratories. The laboratory testing, requires sophisticated laboratories and can be very expensive to run and maintain, time consuming, easily susceptible to error and each test detects resistance pertaining to a single drug. The limitations of phenotypic include, longer turnaround time, expense, and biological cut off for clinical resistance has not been developed for all antiretroviral agents (Pattery et al., 2012).

2.6.2 Genotype testing

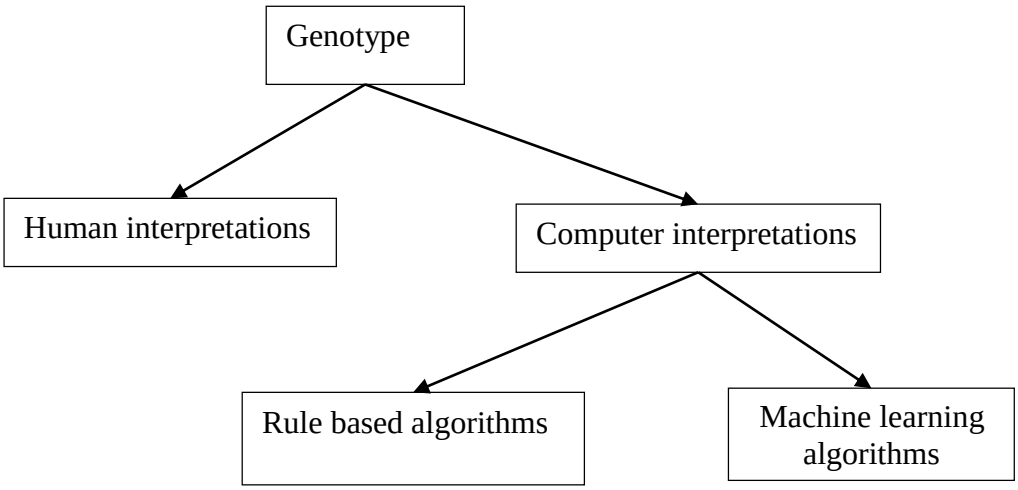

Figure 2: Genotype testing

Interpreting the results of HIV genotypic drug-resistance tests is one of the most difficult challenges facing clinicians who care for HIV infected patients. The results can be human or computer interpreted. The currently developed computational algorithms to assist physicians in interpreting the results seems to be more capable in assisting physicians in selecting the most suitable treatment regimen. There are two methods available to computationally interpret the HIV drug resistance results, rule-based approach and machine learning (Quoc-Chinh et al., 2010) (figure 2).

Rule based algorithms were deduced by experts in the field, by making use of literature data on correlations between geno and phenotype as well as correlations with treatment history and clinical response (Soo-Yon, et. al., 2009). On the other hand, bioinformatics techniques (machine learning algorithms) are being developed for generation of

mathematical models for prediction of phenotypic drug resistance and therapy response from genotype.

Other examples of bioinformatics approaches based on analyses of large databases are the artificial neural networks that can predict resistance from complex mutation patterns and virological response from treatment and resistance history or the Bayesian networks that can predict individual *in vivo* evolution towards resistance under drug selective pressure (Soo-Yon, et. al., 2009).

A genotypic test takes a week to perform and the results are reported as a list of detected mutations (Pattery et al., 2012). The genotypic assay is the preferred assay at the moment for practical reasons. Genotypic assays are less expensive, have a shorter turnaround time and are superior at detecting evolving resistance (Tang et al., 2012). Bioinformatics algorithms have been developed for the interpretation of resistance from sequence submission, which supports clinical decision making (López-Lopes et al., 2013).

Genotype testing is faster and cheaper than phenotype testing, and it can detect emerging resistance, that is, virus with a mixture of strains of which some may be sensitive and some may be resistant to a given drug, as long as they are present in sufficient quantity (López-Lopes et al., 2013).

2.6.2.1 Rule based algorithms

HIV-GRADE is an algorithm that presents the option of seeing the rules and results of other drug resistance algorithms for a given sequence simultaneously (Obermeier et al., 2012). These systems employ rule based algorithms with rules derived from literature or expert opinion to interpret the results. The rules for HIV-GRADE are taken from the literature, clinical follow-up data and from a bioinformatics-driven interpretation system (geno2pheno).

Today several unique rule based algorithms are very well established, these include systems such as Stanford HIVDB http://hivdb.stanford.edu, ANRS (National Agency for AIDS Research, France), and RegaDB http://www.rega. kuleuven.be/cev/regadb.

HIV drug resistance data are updated with resistance data manually gleaned from scientific publications by experts in this field (Quoc-Chinh et al., 2010). Some of these algorithms are freely available, namely the HIV Stanford Resistance Database (HIVdb) and the geno2Pheno (G2P). These are two of the algorithms most commonly used by researchers and physician worldwide (López-Lopes et al., 2013).

2.6.2.2 Machine learning algorithms

Machine learning algorithms learn from a training data set and then test their performance using a test data set (Quoc-Chinh et al., 2010). They contain mathematical models developed by a computer program that analyses data linking genotype to phenotype or clinical outcome. This process is necessary to prevent these algorithms

from learning concepts that are too specific to the training set and thus not applicable to other sets of data.

Several interpretation algorithms of the interpretation of the genotyping of HIV viral strain have been developed to better understand and characterize resistance in clinical samples (López-Lopes et al., 2013). They are cheaper, faster, less technically challenging and can yield multi-drug resistant profiles, and thus preferred and recommended for use in the developing countries where resources are still limited (Aitken et al., 2012)**.**

Alongside patient's treatment history, the genotypic algorithms may be employed to predict resistance to ARV drugs and help physicians with a fast and reliable method of determining the most adequate HAART option for each individualised salvage regimen (López-Lopes et al., 2013).

However correct interpretation of the mutational patterns is not straightforward, and consensus is still lacking on this matter. It remains a challenge to keep those interpretation systems up to date and improve their usefulness for clinicians treating HIV-infected patients. Development of new knowledge on resistance related mutation is still accumulating and new classes of drugs and drugs are still being implemented in clinical practice (Vercauteren, et. al., 2013). Guidelines stressing regular updating and proper clinical evaluation of interpretation algorithms is definitely needed so that they can be uniform.

2.7 KAP of HIV drug resistance

No literature on KAP of HIVDR was retrieved. This shows a gap in literature that needs to be filled through further studies.

2.8 KAP method

Knowledge, attitude, and perception (KAP) surveys are widely used to gather information for planning public health programs in countries (Launiala, 2009). Before beginning the process of creating awareness in any given community, it is first necessary to assess the environment in which awareness creation will take place. Questionnaires are the primary method that can be used to collect measureable data. A KAP survey uses quantitative questionnaires that provide access to quantitative and qualitative information (Launiala, 2009). The specific objective of this the KAP study was to assess the level of knowledge, attitude and perception of NRMSM medical students on the use of HIVDR computer interpretation.

A structured questionnaire with easy to answer questions on demographic data, basic knowledge on information communication technology, knowledge on HIVDR and HIVDR testing methods was used. Understanding the levels of knowledge, attitude and perception will allow for a more efficient process of awareness creation as it will allow the program to be tailored more appropriately to the needs of the community.

2.9 Conclusion

Literature explained the existence of HIV drug resistance and the importance of HIVDR testing when managing HIV patients. The importance of computer technologies in performing HIVDR testing has been supported. No literature was found on the KAP of clinicians or the use of these computer technologies in South Africa and Africa at large.

Despite their existence, there are gaps in the literature on KAP of South African medical student doctors on the use of the computer interpretation algorithms in the management of HIV treatment. In order to cope with the HIV guidelines being published by World Health Organization (WHO), it is important for medical students to be knowledgeable about HIVDR testing with the use of computer interpretation algorithms, thus adhering to universal HIV clinical guidelines in order to maintain quality care in HIV patients in the country.

CHAPTER 3: RESEARCH PAPER

Knowledge, attitude and perception of 4th and 5th year UKZN Medical School students towards the use of HIV Drug Resistance Interpretation Algorithms

3.1 Introduction

South Africa has the largest HIV burden in the world, with an estimated 5.6 million people living with HIV (Manasa et al., 2013). The emergence of drug resistant viral strains is an obstacle in the effective management of HIV infection and AIDS (Bonney et al., 2013). Hence HIV drug resistant testing is an international priority.

3.2 Study Objectives

The aim of this study was to provide baseline data on knowledge, attitude and perception of undergraduate medical students at NRMSM on the use of genotyping interpretation algorithms already available for use either freely or commercially for HIV drug resistance testing.

3.3 Paper publication

Rule MR9c of the University of KwaZulu Natal allows for a masters dissertation to be in the format of a paper for submission to a journal with additional interactive material.

Some of the findings of this study was presented and published at the ICT 4 Health 2013 conference (Zhandire, T. and Singh, Y. Knowledge of 4th and 5th year UKZN medical school students regarding HIV drug resistant interpretation algorithms. ICT4Helath 2013, Cape Town, South Africa. September 2013). The presentation is attached as appendix B and is being prepared for submission to the journal of Health Med.

Knowledge, attitude and perceptions of 4th and 5th year UKZN Medical School students towards the use of HIV drug resistance interpretation algorithms

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Abstract

HIV drug resistance (HIVDR) has emerged as a major clinical and public health challenge in many resource poor countries, especially in Africa. HIVDR testing has become increasingly important and is of significant value in the management of HIV. The use of low cost technologies and procedures in testing HIVDR is being recommended. HIVDR computer interpretation algorithms make use of artificial intelligence and other computer technologies to predict HIVDR and are recommended for use in resource poor countries. However, there is little known about the knowledge, attitude and perception of doctors in developing countries of HIVDR computer algorithms. This study aimed to determine the knowledge, attitude and perception regarding computer interpretation algorithms of the 4th and 5th year medical students at Nelson R. Mandela School of Medicine, University of KwaZulu-Natal in South Africa. Primary data collection was by a questionnaire administered to a convenience sample of 216 fourth and fifth year medical students. The study revealed that 90% of the respondents were aware of HIV drug resistance testing in South Africa but only 4% had knowledge of the computer interpretation algorithms, and although the UKZN medical students are not aware of computer interpretation algorithms they are willing to use them in the future.

Introduction

South Africa has the largest HIV burden in the world, with an estimated 5.6 million people living with HIV (Manasa et al., 2013). HAART comprises a regimen of three drugs from at least two of the five commercially available antiretroviral drug classes, and is used to manage HIV infection (Singh and Mars, 2013).

There is an on-going rapid scale up of access to ARV therapy in countries where there is high prevalence incidence of HIV infection (Kozal, 2009). Access to antiretroviral treatment in resource-limited-settings is inevitably paralleled by the emergence of human immunodeficiency virus drug resistance (HIVDR) (Struck et al., 2012).

When mutations or changes to the genetic structure of HIV have occurred, making the virus resistant to HIV medication regimen, it is referred to as HIVDR. The genetic changes that would have occurred allow the HIV virus to reproduce despite the presence of HIV medications (Nwobegahay et al., 2011). HIVDR is facilitated through high replication rates, selective pressure, poor drug adherence levels, and initial infection with a drug resistant strain of the virus (Rusine et al., 2013).

HIVDR can be categorized as, transmitted resistance, which occurs when previously uninfected individuals are infected with a drug-resistant virus, and acquired resistance, which occurs when resistant mutations emerge because of drug-selective pressure in individuals receiving antiretroviral therapy (WHO, 2012). The prevalence of transmitted HIVDR is recorded highest in countries with early ART roll out and high ART coverage (Rusine et al., 2013).

HIVDR complicates standard HAART treatment, and thus testing of HIV resistance before initiation of any therapy may be beneficial (Nwobegahay et al., 2011). HIVDR testing has become a significant diagnostic tool in the management of HIV infections (Struck et al., 2012). Routine surveillance of transmitted and acquired HIVDR is crucial. Monitoring treatment effectiveness and HIVDR testing are therefore of increasing importance in resource-limited settings (Struck et al., 2012).

There are two principal methods for assessing resistance to antiretroviral drugs which are genotyping and phenotyping.

Phenotypic resistance assays measure the ability of a virus to grow in different concentrations of ARV drugs. These consist of culturing the HIV from a patient's blood sample in a laboratory setting. This method is expensive, time consuming, prone to error, requires skilled staff, and can only measure resistance to one ARV drug at a time (Singh and Mars, 2013). This laboratory testing method requires sophisticated laboratories which can be very expensive to setup, run and maintain in countries with limited resources. This has limited routine monitoring of patients receiving ARV's in resource limited countries.

Computer generated interpretation algorithms based on genotyping have proved to be effective in performing these tests and are being recommended for use. There are rule based and machine learning algorithms. They are quicker, less technically challenging, and less expensive than phynotypive and can be directly interpreted for clinical application (Aitken et al., 2012).

Many of these genotypic interpretation algorithms are available freely and commercially for use in South Africa but their use is limited.

HIVDR management should be an important public health goal in countries with limited resources (Rusine et al., 2013). Knowledge gaps can only be identified when KAP of a sampled group is identified. When the right people are equipped with the correct knowledge then perception and practice will increase. If medical students are taught about HIVDR testing using computer interpretation algorithms, they will use them when managing HIV patients. It is also vital to understand the KAP of a population so as to draw effective intervention strategies. There is no literature on the knowledge, attitude and perception towards the use of these algorithms by medical students who on completion will be expected to use them in clinical practice.

This will assist in noting the gaps in development towards a goal that needs to be achieved as a country, in this case controlling and curbing HIVDR and improving the lives of HIV positive patients.

The aim of this study was, to provide baseline data on the knowledge, attitude and perception of undergraduate medical students at NRMSM on the use of genotyping interpretation algorithms in the assessment of HIV drug resistance.

Materials and Methods

The study population consisted of all registered 4th and 5th year students of 2013.The students are on a five year of academic programme. Convenience sampling was used and everyone in the targeted group had an equal chance of participating. Primary data were collected through the use of a structured questionnaire derived from knowledge, attitude and perception (KAP) framework. The questionnaire was tr with students to and correct any ambiguity. The questionnaire was used to identify and advise the knowledge, attitude and perception of 4th and 5th year NRMSM medical students.

A KAP study is a representative study of a specific population to collect information on what is known, believed, and done in relation to a particular topic (Badran, 1995), in this case HIV drug resistance testing with the use of genotyping computer generated interpretation algorithms. It is important to understand the KAP of a community to be able to launch, or improve on programmes.

To have maximum coverage, a combination of physical distribution of questionnaires and the use of a Web based survey was used. The questionnaire was posted on the University Website which is accessed by all the students in the NRMSM, thus those willing to participate would do so. Ethical approval for the study was obtained from the UKZN Humanities and Social Science Research Ethics committee, (Ethics number HSS/0094/013M). The permission to perform the study was also obtained from the UKZN Registrar's Office. This study was conducted with the participants' consent.

The questionnaire included questions probing whether the students were aware of the use of information communication technology (ICT) and if they support ICT use in their clinical practice. The knowledge section contained questions on awareness of HIV drug resistance in South Africa, if they had been taught about HIV drug resistance, whether they had ordered or seen staff ordering drug resistance tests, types of resistance testing used, whether results influenced changes in patient management, how respondents viewed the issue of drug resistance testing, and if they intend to practice HIV drug resistance testing with the use of genotyping interpretation algorithms in the future.

Question responses were either dichotomous, (Yes, No) or five point Likert terms (unimportant, of little importance, moderately important, important, very important). Descriptive statistics were used to show respondents demographic characteristics. Categorical variables were measured as percentages. The raw data were entered into Microsoft Excel 2010 spread sheet and subsequently analysed. Pivot tables were used to study the correlation with alpha set at five percent. The Chi-squared one sample test was applied to test the dichotomous responses. The Chi squared test was used to determine if there was a difference between the respondents' answers. This was done by using the goodness of fitness tests, where it was assumed that an equal distribution of the dichotomous response indicates that no difference was present.

Results

Demographic characteristics

Two hundred and sixteen responses were received out of the four hundred and sixteen eligible participants. The gender distribution was almost equal with 106 males and 110 females. The majority of the respondents 82% were in the 18-25 age range, while 9.7% were in the 26-35 age range and 8.3% were between the ages of 36-45. In total 39% respondents were black, 3% were colored, 34% were Indian and 24% were white. Of the 216 respondents, 54% were in 4^{th} year.

Information, Communication and Technology

The respondents' responses on the information, communication technology section displaying the probability values are shown in Table 1.

Table 1: Responses to the questionnaire on the respondents' awareness of information communication and technology

Questions	**Yes**	**%**
Do you support the use of information communication technology (ICT) in clinical practices?	203*	94
Are you aware of computer based clinical decision support systems (CDSS) in clinical practices?	192*	89
Do you think the use of computer based CDSS will assist in any clinical decision making?	181*	84
Will you use computer based CDSS in the future in your practice?	181*	84

*p value <0.001

Knowledge

The respondents' responses on the knowledge section displaying the probability values are shown in Table 2.

Table 2: Responses to the questionnaire on the respondents' knowledge of HIVDR testing

Questions	**Yes**	**%**
Are you aware of HIV drug resistance testing in South Africa?	195*	90
Have you learnt about HIV drug resistance testing in your studies?	194*	90
Have you covered topics on the importance of HIV drug resistance testing?	173*	80
Have you covered topics on why drug resistance testing should be done?	168*	78
Have you covered topics on when drug resistance testing should be requested?	179*	83
Have you covered topics on who should do drug resistance testing?	175*	81
Have you covered topics on the relevancy of HIV drug resistance in HIV management?	173*	80
Have you learnt about using computer generated artificial intelligence machine learning interpretation algorithms in your studies?	9*	4
Do you think it is important to test for HIV drug resistance when managing an HIV patient?	181*	84
Have you ever dealt with an HIV drug resistant patient?	7*	3
➢ Have you ever seen the clinician managing an HIV case order HIV drug resistance tests?	210*	97
➢ If yes, was it phenotypic methods?	205*	95
➢ If yes, was it genotypic method?	11*	5
Did they use interpretation algorithms to assist in choosing an optimal drug combination?	11*	5
Did the results cause the clinician managing the case to change the treatment regimens?	108	50
Do you think the clinical guidelines are being followed in South Africa?	164*	76

Question	**No Testing at all**	**Very little testing**	
How much resistance testing do you think is being done in South Africa	6 %	94 %	

*p-value <0.001

Attitude

The respondents' responses to the attitude section are shown in the Table 3.

Table 3: Attitude responses to the issue of HIVDR testing

Questions	Unimportant	Of little importance	Moderately important	Important	Very important	P-Value
How important do you see the issue of drug resistance testing in reference to what you have encountered in clinical practice or your knowledge	14 (7%)	32(15%)	0	71 (33%)	99 (46%)	<0.001
How important do you consider HIV drug resistance testing with the use of interpretation algorithms when virological failure has occurred?	39 (18%)	48(22%)	19 (9%)	25(12%)	85 (39%)	<0.001
Question					**Yes**	
Do you think it is important to perform HIV drug resistance testing when managing an HIV patient who is responding to ART?					4 %	<0.001

Perception

The responses to the perception section of the questionnaire are shown in table 4.

Table 4: Perception of respondents about HIVDR testing

Question	**Yes**	**%**
Do you think HIV drug resistance testing should be done in all hospitals in South Africa?	199*	92
Would you support the use of computer based interpretation algorithms when testing for HIV drug resistance here in South Africa?	164*	76
From your experience, do you think doctors in South Africa managing HIV patients are performing HIV drug resistance testing as recommended by international HIV clinical guidelines?	37*	17
Do you intend to practice the use of HIV drug resistance testing using computer based interpretation algorithms when managing HIV positive patients in the future?	138*	64
Do you agree to this statement, 'Resistance testing has been advanced as a valuable tool in the management of HIV infected individuals?'	192*	89

*P value <0.001

Discussion

Knowledge on HIV drug resistance

A significant proportion of students 90% ($p < 0.001$) were aware of HIV drug resistance testing in South Africa. The same respondents confirmed they had learnt about HIV drug resistance testing in their studies at the university. HIVDR is part of the undergraduate curriculum at UKZN medical school and coupled with the burden of HIV in South Africa, it is of concern that 10% of the students were not aware of HIVDR. More emphasis is required to ensure that students understand the issue of HIVDR testing, and the risks of treatment failure. This is important in the context of limited treatment options, common in the developing countries like South Africa (Parkin et al., 2012).

Eighty percent of the respondents confirmed having covered topics on the importance of HIV drug resistance 80% ($p < 0.001$). 80% ($p < 0.001$) confirmed having covered topics on relevancy of HIVDR in HIV management. 84% ($p < 0.001$) confirmed that it is very important to test for HIVDR when managing an HIV patient. However these results indicated that approximately 20% of the subset of students do not fully understand what is being taught on HIVDR in the curriculum.

Of the 90% who confirmed having learnt about HIV drug resistance testing, only 4% ($p <0.001$) indicated that they had learnt about computer generated genotyping interpretation algorithms in their studies. The curriculum does not encompass computer based genotyping interpretation algorithms which are however highly recommended

for use in countries like South Africa (Parkin et al., 2012). This topic is covered during the clinical training component of the degree. It is important that computer generated genotyping interpretation algorithms are made part of the South African undergraduate medical school curriculum as these are important in the HIVDR testing. The undergraduate medical students should be educated and exposed to the concept of these algorithms so that they are familiar with their existence, importance and significance in managing HIV patients.

While 95% of the respondents had seen senior clinicians order phenotypic testing during their practical exposure in hospitals with HIV patients, only 5% had seen the senior clinician ordering HIVDR tests with computer based interpretation algorithms. This demonstrates lack of use, exposure to and knowledge of NRMSM medical students about computer based interpretation algorithms. They are familiar with the sophisticated laboratory testing which is not affordable for routine monitoring of HIV drug resistance testing in South Africa considering the burden of the disease.

Clinicians need to become knowledgeable regarding the use of resistance patterns associated with specific antiretroviral resistance so that they may appropriately select treatment regimens, which will maximise the likelihood of viral suppression and this is only be possible if they have knowledge on how to perform these HIVDR tests. HIVDR testing is of vital importance in managing HIV positive patients, yet knowledge to low-cost technologies and procedures suited to the resource limited context is still lacking even though regular viral load monitoring and resistance testing in the case of virological failure are recommended.

Majority of the students, 94% believed that very little HIVDR testing is currently being done in South Africa yet HIV drug resistance testing has been made part of HIV management. This continues to support the opinion that medical students need to be made aware of and knowledgeable on HIVDR technological testing methods recommended such that more HIVDR testing will be done when managing HIV patients. This will have a direct positive influence on the management of patients with HIV.

Knowledge on computer interpretation algorithms

While 79% ($p < 0.001$) of the respondents perceive the issue of HIVDR testing as important, it is worrying that 21% of these students feel that HIVDR testing is unimportant. This could be because of the students' lack of exposure or encounter with HIVDR testing and the testing methods, and the failure of the curriculum to emphasise its importance. Table 4 question 2 shows that 18% ($p < 0.001$) of these respondents see HIVDR testing with the use of computer interpretation algorithms as unimportant even when virological failure has occurred.

Lack of knowledge of existence of HIVDR testing with computer interpretation algorithms by these NRMSM undergraduate medical students continues to affect their decisions. Computer interpretation algorithms provide essential information for guiding treatment in HIV infected patients and it may be used for identifying patients with transmitted drug resistance or to clarify reasons for treatment failure and to check remaining treatment options. These computer based interpretation algorithms are being highly recommended for use in the resource limited countries.

Attitude

The majority of the students (78%) support that HIVDR should be done in all hospitals in South Africa; this could have been influenced by the attained knowledge on HIVDR testing even though they are not well knowledgeable on HIVDR testing methods. Although 96% did not know about computer based interpretation algorithms, 76% recommend HIVDR testing with the use of computer interpretation algorithms after reading a statement about what it is. The respondents knowledge and awareness of the use of information communication technology (ICT) in clinical practices could have influenced their recommending the use of computer based interpretation algorithms in HIVDR testing even though they had limited or no knowledge on such imparted during the theoretical component of their studies.

Most of the respondents, 94%, support the use of ICT in clinical practices, and 89% were aware of computer based clinical decision support systems (CDSS) in clinical practice, and 84% will use CDSS in the future in their practice. Therefore thus seems to be general enthusiasm in using technology in clinical practice, however they need to be devoted and made aware of the possibilities, hence education is required.

83% ($p < 0.001$) of the respondents felt that the current doctors managing HIV patients were not performing HIVDR testing as recommended by HIV clinical guidelines which now recommends that resistance testing be made part of the HIV patient management. This may be due to the lack of knowledge and awareness associated with HIVDR testing. It may also be due to lack of knowledge and awareness of HIVDR testing with computer based genotyping interpretation algorithms. Further studies should be

undertaken on why doctors do not perform HIVDR testing as stated in the clinical guidelines for HIV, HIV with invasive HIVDR continues to complicate the global spread of HIV disease.

Perception

89% ($p < 0.001$) of the respondents agreed to the statement that, 'resistance testing has been advanced as a valuable tool in the management of HIV infected individuals'. This continues to display the importance of knowledge in affecting one's attitude and perception. A significant number of the respondents had a good understanding of the existence of HIVDR in the country. The current results may provide valuable reference data for national interventions to emphasize on the importance of drug resistance testing in South Africa and reduce the incidence of drug resistance in HIV patients, and thus improve the country's health.

Collectively these observations in this study underscore the need to introduce topics on HIVDR testing with the use of computer genotyping interpretation algorithms in the curriculum and exposes students to the practical use of these algorithms. It is important to expose undergraduate medical students to HIVDR testing with the recommended computer genotyping interpretation algorithms in order to protect the efficacy of first and second line regiments in HIV management. The accumulation of acquired HIVDR mutations underscores the need to reinforce HIVDR prevention strategies, such as increasing HIVDR testing and the availability and appropriate use of vilologic testing to monitor ART response. The scale up of HIVDR testing measurers is already treated as an international priority.

70% of the respondents that think it is important to test for HIVDR when managing an HIV patient, intend to practice HIVDR testing using computer based interpretation algorithms in the future. The limited knowledge and, exposure to the importance of HIVDR testing when managing an HIV patient using computer based interpretation algorithms affects their perception and recommendation of their use in the future. This shows that these medical students have knowledge on the importance of HIVDR testing but they have limited knowledge on HIVDR testing using computer based interpretation algorithms. However, with more knowledge and exposure on computer algorithms, their perception will be different. They are willing to use them in the future, which shows the need for their curriculum to educate them on these computer based interpretation algorithms.

Lack of knowledge and exposure affects attitude and perception of a person. There is need in enhancing knowledge level of a people in certain subjects of their concern such that attitude and perception remain positive. Since HIVDR testing is a priority when managing HIV patients, there is need in enhancing knowledge of the medical students on HIVDR testing with the recommended genotypic interpretation algorithms.

From these results, it can be concluded that knowledge and exposure on HIVDR testing using computer based interpretation is of vital importance to the medical students who intend to use these in the future of their career. It is of paramount importance that much is done in encompassing both theoretical and practical lessons on computer based interpretation algorithms.

Conclusion

Monitoring treatment efficacy and HIV drug resistance testing are therefore of increasing importance in resource-limited settings. Yet low-cost technologies and procedures suited to the particular context and constraints of such settings are still lacking. The results of this paper showed that medical students have knowledge on drug resistance existence in South Africa but had little knowledge or exposure on drug resistance testing with genotyping computer interpretation algorithms. However the study demonstrated the willingness to learn and use artificial intelligence computer algorithms by the respondents.

Genotyping computer interpretation algorithms are being recommended to be essential in managing HIV drug resistance in the developing countries. It is recommended that the use of HIV computer interpretation algorithms be included in the curriculum of medical students. The World Health Organization (WHO) has developed a global laboratory network to support human immunodeficiency virus drug resistance genotyping for public health surveillance in resource-limited countries (Parkin et al., 2012), thus HIVDR testing should be treated with much determination.

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CHAPTER 4: CONCLUSION

Reviewed literature has described the significance of HIVDR and HIVDR testing in managing HIV. No literature was found relating to KAP of medical students in South Africa and other African countries regarding HIVDR testing with the use of computer interpretation algorithms. Much literature supports the use of computer interpretation algorithms in managing HIVDR. HIVDR testing has been shown to improve antiretroviral treatment outcomes and is broadly recommended as standard of care in current treatment guidelines, particularly for patients with prior treatment experience (Guertler et al., 2012). The study has shown that the majority of the sampled medical students at UKZN were aware if HIV resistance but had no knowledge on the use of computer interpretation algorithms, currently recommended for HIVDR testing.

The KAP study was to assess the current level of knowledge amongst the fourth and fifth year medical students, their attitude and perception in performing HIVDR testing with the use of computer interpretation algorithms. The general perception of the participants was that they would use information communication technology in making clinical decisions in future practice even though they lacked knowledge on computer interpretation algorithms.

The World Health Organization (WHO) global strategy for prevention and assessment of HIVDR consists of a coordinated plan for HIVDR surveillance in countries where ART has been scaled up, to guide population based selection of ART regimens (Parkin et al., 2012). Medical students need to be exposed to HIVDR testing using computer interpretation algorithms. Understanding the KAP of a community can be the only

strategy to the success of introducing a new program suitably. The study recommends the inclusion and emphasis on HIVDR testing topics in the medical students' curriculum. The medical students should be equipped with all the knowledge regarding the HIVDR testing with the use of affordable computer technologies such that they will be able to request and interpret routine virological results when managing an HIV.

There is need to compare KAP of medical students at other medical schools in South Africa or even across Africa so as to have a comprehensive cross-sectional detailed understanding of the use of HIVDR interpretation algorithms. Comparisons of the syllabus n different universities can also be one, in order to achieve the goal of eradicating HIVDR. Gaps can be identified and rectified regarding knowledge of HIVDR testing. The main finding of this study was that the medical school students lacked any knowledge of computer based interpretation algorithms. A limitation was that the research was restricted to fourth and fifth year medical students, and could have benefitted from the inclusion of academic staff to give a broad explanation on why students are not aware of HIVDR testing with the interpretation algorithms.

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APPENDICES

Appendix A

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

6 March 2013

Mrs Tracey Zhandire 211536756
School of Nursing and Public Health
Department of Telehealth
Medical School Campus

Dear Mrs Zhandire

Protocol reference number: HSS/0094/013M
Project title: Knowledge Attitude and Perceptions of 4th and 5th year Medical students towards the use of HIV drug resistance testing using interpretation algorithms

EXPEDITED APPROVAL

I wish to inform you that your application has been granted Full Approval through an expedited review process.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. Please note: Research data should be securely stored in the school/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....
Professor Steven Collings (Chair)

/pm

cc Supervisor: Yashik Singh
cc Academic Leader: Professor M Mars
cc School Admin.: Ms Devi Arumgam

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

24 April 2013

Mrs Tracey Zhandire
School of Nursing & Public Health
Department of Telehealth
NRMSM

Email: 211536756@stu.ukzn.ac.za

Dear Mrs Zhandire,

RE: PERMISSION TO CONDUCT RESEARCH

Gatekeeper's permission is hereby granted for you to conduct research at the University of KwaZulu-Natal towards your postgraduate studies. It is noted that Ethical clearance has been obtained and the title of your research project is:

> "Knowledge Attitude and Perceptions of 4th and 5th year Medical students towards the use of HIV drug resistance testing using interpretation algorithms"

It is noted that you will be constituting your sample with a request for responses on the website and by randomly handing out questionnaires to 4th and 5th year medical students on the NRMSM Campus.
The questionnaire must be placed on the notice system http://notices.ukzn.ac.za. A copy of this letter (Gatekeeper's approval) together with the ethical clearance must be attached when requesting the services. You are not authorized to distribute the questionnaire to staff and students using Microsoft Outlook address book.

Data collected must be treated with due confidentiality and anonymity.

Yours sincerely

Professor J J Meyerowitz
REGISTRAR

Appendix B

Knowledge of 4th and 5th year UKZN Medical Students regarding the use of HIV Drug resistant Interpretation Algorithms

Tracy Zhandire and Yashik Singh
Discipline of TeleHealth, UKZN

UNIVERSITY OF KWAZULU-NATAL
Nelson R Mandela School of Medicine

What is HIVDR?

- HIVDR is the reduction in the ability of a drug or combination of drugs to block HIV reproduction in the body.

HIV in South Africa

- South Africa is home of the largest populations of HIV infected individuals in the world.
- It is estimated that 5.7 million people in South Africa are infected with HIV

HIV treatment in South Africa

- HIV infection is effectively managed with antiretroviral (ARV) drugs, usually in the form of highly-active antiretroviral therapy (HAART).
- South Africa has one of the largest ARV programmes in the world.

Causes of HIVDR

- selective pressure,
- poor drug adherence levels, and
- initial infection with a drug resistant strain of the virus.

Why is HIVDR significant?

- It can cause treatment failure.
- It can complicate HAART.
- Limits options for further therapy
- Very expensive for the government to manage HIVDR failing patients

HIVDR testing

- Methods for HIVDR testing include
- Laboratory based techniques
- Computer based techniques (rule based and machine learning)

Why computer based techniques?

- Shorter turnaround time
- Easier implementation
- Less expensive and widely available thus suit the limited resource setup
- Highly recommended for use in limited resource countries.

Research objectives

- To assess the knowledge of 4th and 5th year medical students on HIVRD
- To assess the knowledge of 4th and 5th year medical students on HIVDR using computer based techniques.

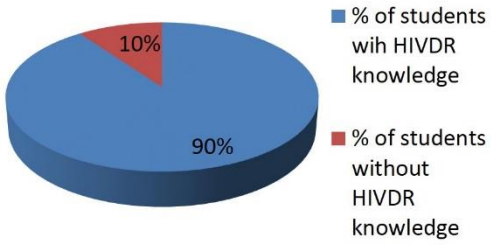
Methods and materials

- Study population was all 4th and 5th year UKZN medical students.
- Cross sectional survey was used.
- A web based questionnaire was used
- Sent to all students

Awareness and willingness to use ICT in clinical practice by medical students

	Willingness to use		
Awareness of CDSS	Yes	No	Total
Yes	179	24	203
No	13	0	13
Total	192	24	216

Knowledge of students on HIVDR



Knowledge on HIVDR testing using the computer algorithms

- Of the 90% students with knowledge on

Conclusion

- It is important for medical students to be exposed to HIVDR testing using computer algorithms.

Conclusion

- Surveillance of HIVDR should be scaled up now that computer algorithms are available for use in developing countries like South Africa.
- Medical students showed awareness and willingness to use ICT in clinical practices.