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Chetty, Devina Preabruth

2024

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EXPLORING THE ATTITUDES, KNOWLEDGE AND PERCEPTIONS OF CLINICAL PHARMACISTS' ON ANTIMICROBIAL STEWARDSHIP (AMS) PARTICIPATION AND THE DISCORD BETWEEN PHARMACY EDUCATION AND ACTUAL CLINICAL PRACTICE.

Devina Preabruth Chetty

981303

Research Dissertation Supervised

By

Ms Stephanie Leigh-De Rapper



Submitted to the Faculty of Health Sciences, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Science in Medicine, Clinical Pharmacy, MSc (Clinical Pharmacy)

Johannesburg, 2022

Declaration

I, Devina Preabruth Chetty, declare that this dissertation submitted to the University of Witwatersrand for the degree of Master of Science in Medicine (Clinical Pharmacy) has not previously been submitted for any degree or examination at any other University. I hereby acknowledge that this submission is in the form of an article submitted to Health SA Gesondheid. This dissertation is my own unaided work, except for cases in which the work of others has been cited and duly acknowledged within the context of the dissertation.



_____ 31 October 2022

Mrs Devina Preabruth Chetty Date

Dedication

This dissertation is dedicated to my beloved husband, my three wonderful children, my precious mom and to my dear late father, Mr Preabruth Saroop Ganga.

Acknowledgements

I would like to express my sincere appreciation and gratitude to a number of people who inspired, motivated and supported me through my studies

1. Our Divine inspiration for helping me maintain my balance through this academic pursuit. Without you, nothing is possible.
2. To my dear and beloved family for their ongoing love, support, patience, guidance and inspiration.
3. Ms Stephanie Leigh-De Rapper for her tremendous support, encouragement, mentorship and assistance in compilation of my research report and article.
4. The South African Society of Clinical Pharmacy (SASOCP) executive committee for distributing the survey to their members.

Abstract

Introduction: Antimicrobial stewardship (AMS) is a critical global intervention aimed at optimising antimicrobial use and decreasing antimicrobial resistance (AMR), with pharmacists playing a pivotal role within AMS teams. However, AMS is not comprehensively taught in pharmacy curricula and little is known about the relevance of pharmacists' training to meet AMS needs in South Africa. This study aimed to determine the attitudes, knowledge and perceptions of clinical pharmacists' towards AMS participation and training in South Africa. This aim will be achieved by determining the attitudes, knowledge and perceptions of pharmacists' towards their role and participation in AMS; in addition to exploring clinical pharmacists' perception on the relevance of pharmacy training on pharmacy practice with regards to AMS.

Methods: A quantitative cross sectional research design was selected for this study. The study was conducted using a self-administered survey. Categorical variables were analyzed using simple descriptive statistics. Mann-Whitney and Kruskal-Wallis tests were applied to determine differences between variables. A p-value of less than 0.05 was considered statistically significant. Reliability coefficient was tested, Cronbach's alpha score of 0.90 for perceptions, 0.91 for participation and 0.91 for factors affecting participation.

Results: Pharmacists demonstrated a good attitude, knowledge and perception towards AMS (median 4.3). There were statistically significant differences in AMS participation between pharmacists of different years of experience (P=0.005), sector of employment (P=0.01), position of employment (P=0.015) and in the presence of AMS programmes (P=0.004). Pharmacists indicated that undergraduate studies less than adequately prepared them for their role in AMS (median 4.3).

Conclusion: Pharmacists show positive attitudes, knowledge and perceptions towards AMS. Education and training in AMS principles is obtained through Master's programmes, short courses, CPDs and workshops. It is insufficiently incorporated in undergraduate programmes.

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List of Abbreviations

AMR	Antimicrobial Resistance
AMS	Antimicrobial Stewardship
ASP	Antimicrobial Stewardship Programme
B. Pharm	Bachelors in Pharmacy
CDC	Centre of Disease Control
CDI	*Clostridium difficile* Infection
DDD	Defines Daily Dose
LOS	Length of Stay
M. Pharm	Masters in Pharmacy
MDT	Multidisciplinary Team
REDCap	Research Electronic Data Capture
SA	South Africa
SANDoH	South African National Department of Health
SAPC	South African Pharmacy Council
SASOCP	South African Society of Clinical Pharmacists
WHO	World Health Organisation

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CHAPTER 1.INTRODUCTION

The introductory chapter explains the background and rationale for the study. It provides context on antimicrobial resistance (AMR), antimicrobial stewardship (AMS) and the role of the clinical pharmacist within an AMS multidisciplinary team. It also provides the research question, aims and objectives of the study.

1.1 Context of the study

Antimicrobial Resistance (AMR) poses a major threat to the health of populations worldwide, puts achievements in medical advancements at risk and increases morbidity, mortality and global economic burden (WHO, 2020). The Centre of Disease Control (CDC) reported 2-million antibiotic resistant infections with 23 000 attributable deaths. These infections have since increased to 2.8 million resistant infections with 35 000 deaths in 2019 (CDC, 2019). The estimated annual deaths associated with AMR amount to 700 000, with this number expected to rise to 10 million in 2050 (WHO, 2015). The antimicrobial resistance global report on surveillance (2014) noted with grave concern, a growing resistance in the following pathogens to last resort antibiotics including; *Klebsiella pneumoniae* resistance to carbapenems, *Escherichia coli* resistance to fluoroquinolones and treatment failure of gonorrhea to third generation cephalosporin's seen in Australia, Canada, France, Sweden, Norway, United Kingdom and South Africa (WHO, 2014). South Africa's problem is compounded as the country faces a quadruple burden of resistant infections including, AMR, drug resistant HIV, MDR-TB and resistant malaria (NICD, 2019). Exacerbating the effects of AMR is the scarcity of new antibiotics, as fewer pharmaceutical companies engage in antibiotic development, the number of new antibiotics over the past three decades has decreased (Ventola, 2015).

In 2015, the World Health Assembly endorsed the Global Action Plan to tackle AMR with antimicrobial stewardship (AMS) as a key strategy to attain this through the promotion of rational use of antimicrobials. Antimicrobial stewardship is a defined set of actions designed to optimise antimicrobial use for the purposes of improving clinical outcomes and patient safety. This is achieved by emphasizing appropriate selection, dosage, duration of antimicrobial therapy and route of administration (Doron &

Davidson, 2011). In order to implement effective AMS programmes (ASP), a specialist team of healthcare professionals is needed. At an institutional level, the AMS team must be multidisciplinary consisting of a physician, clinical pharmacist, microbiologist, infection control representative and epidemiologist (WHO, 2015). There should be effective collaboration across various health sectors with pharmacist's expertise at the centre of this (RPS, 2017). Previous studies have proven the value of pharmacists and their positive contribution to AMS as a result of their diverse role, drug expertise and contribution within this multifaceted multidisciplinary team in hospitals (Brink et al. 2016; Brink et al. 2017; van den Berg et al. 2020).

Despite the valuable and significant role pharmacists play in AMS, pharmacists face numerous barriers that impede their participation, including lack of confidence in recommending antibiotic dose and frequency adjustments and lack of time to participate in AMS rounds (Weier, et al., 2018). Pharmacists in Australia, France, Malaysia and Qatar cited lack of formal AMS and infectious disease education and training as an impediment to their involvement in AMS activities (Khan et al. 2016; Nasar et al. 2019; Rizvi et al. 2019; Weier et al. 2018). Amidst the global health crisis of AMR, the acute respiratory syndrome coronavirus (SARS-CoV2) resulted in the outbreak of the coronavirus (COVID-19) pandemic in 2019 creating unprecedented challenges to health systems globally (Weiner-Lasting et al. 2021). The COVID-19 pandemic overwhelmed healthcare systems, clinical teams focused attention and resources on managing the pandemic, disrupting established services as well as AMS activity (Ashiru-Oredop et al. 2021). Antimicrobial use increased, exceeding the incidence of bacterial coinfections and secondary infections suggesting inappropriate use and raising concerns about the impact on AMR (Grau et al. 2021). The COVID-19 pandemic rekindled the value and importance of AMS (Mayi, et al., 2021). The knowledge and skills of well integrated AMS teams can play a critical role in developing treatment guidelines, optimising antimicrobial use and prescribing during potential drug shortages and diagnostic stewardship (Mazdeyasna, et al., 2020). Stevens (2020) advocates for the inclusion of ASP in disaster planning and discusses the role of AMS and COVID-19 preparation and response in infection and prevention control, diagnostic stewardship and treatment.

Education, training and development of pharmacists and other disciplines forming part of the AMS team is crucial to achieving AMS objectives and reducing AMR (WHO 2015). The World Health Organization (WHO) published a comprehensive guideline for health educators on how to develop learning content concerning AMR, with the ultimate goal of equipping healthcare workers with the skills and competency to manage antimicrobials according to their scope of practice (WHO 2019). The South African National Department of Health (NDoH) recommends the inclusion of AMS in pharmacy undergraduate curricula, however, training of pharmacists in infectious diseases and AMS is not yet formalized (Schellack et al. 2018). Not all universities in South Africa offering a pharmacy programme offer a postgraduate clinical pharmacy programme, however, despite the availability of formal training there is also a lack of acknowledgment of the role and scope of practice of clinical pharmacists by the South African Pharmacy Council (SAPC) (Bronkhorst et al. 2020). Pharmacists with a postgraduate or undergraduate qualification are both registered as a pharmacist with differentiation only in the sector of practice (Gray et al. 2016). Pharmacists with a postgraduate qualification in clinical pharmacy should be registered as a specialist pharmacist with clearly defined roles and responsibilities (Bronkhorst et al. 2020). This lack of differentiation leads to limited focus in undergraduate training requiring pharmacists to be trained in a Master's degree to fill this gap, that too is not regulated in scope and structure of learning. The lack of differentiation in scope of practice between a Bachelors in Pharmacy (B. Pharm) and a Masters in Pharmacy (M. Pharm) graduates has resulted in pharmacists with either qualification performing clinical functions (Bronkhorst et al. 2020) and involved in AMS (Khan et al. 2020).

In South Africa, little is known about the relevance of pharmacists' training to meet AMS needs in South Africa and little is known about clinically practicing South African pharmacists' attitude, knowledge and perceptions on AMS and pharmacy education. Therefore, this study aimed to determine the attitudes, knowledge and perceptions of clinically practicing pharmacists' towards AMS participation and training in South Africa.

1.2 Research Question

What are the attitudes, knowledge and perceptions of clinical pharmacists on AMS participation and training in SA?

1.3 Purpose of the Study

1.3.1 Study Aim

This study aimed to determine the attitudes, knowledge and perceptions of clinical pharmacists' towards AMS participation and training in South Africa. This aim was achieved through the following study objectives:

1.3.2 Study Objectives

Objective one: To determine the attitudes, knowledge and perceptions of clinical pharmacists' towards their role and participation in AMS.

Objective two: To determine clinical pharmacists' perception on the relevance of pharmacy training on pharmacy practice with regards to AMS.

CHAPTER 2. LITERATURE REVIEW

Antimicrobial stewardship programmes (ASP) have been hailed as the solution to combat global AMR. The strategies of these programmes are implemented and monitored by an interprofessional multidisciplinary teams (MDT), with pharmacists playing a critical and unique role within these collaborations. This chapter highlights the importance of an effective ASP and the value of the pharmacist within a MDT. This chapter also establishes the need for further education and training for pharmacists to work effectively as part of the AMS MDT.

2.1 The value of effective antimicrobial stewardship programmes

Antimicrobial stewardship programmes are a health-care strategy to promote the rational use of antimicrobials through the implementation of evidence-based interventions. The aims of these programmes include; to optimise antimicrobial use, promote behavioural change in antibiotic prescribing and dispensing, to improve quality of care and patient outcomes, to save unnecessary health-care costs, to reduce further emergence and spread of AMR, to prolong the life span of existing antimicrobials; and to build best-practices capacity of health-care professionals regarding the rational use of antimicrobials (WHO 2019). Key strategies, or interventions to achieve these aims include formulary restriction and preauthorisation, prospective audit, feedback and intervention, education, clinical pathways, de-escalation and intravenous to oral switch (CDC 2019). Successful and sustainable ASPs are resource intensive, hence, the growing importance of measuring the impact of ASPs and health economic evaluations (Nathwani et al. 2019).

A peer-review synopsis of quality measures for assessing ASP, with focus on patient outcome measures, was conducted by Akan et al. (2019). The authors of this study grouped quality measures in the following categories; impact on antimicrobial use and cost saving; impact on *Clostridium difficile* infection (CDI) and resistance patterns; and lastly, impact on patient outcomes, length of stay (LOS), readmission rate and mortality. The findings of the peer-review concluded that AMS implementation did not incur a cost saving however, there was a reduction in CDI. In addition, the ASP reported a reduction in resistance to ESKAPE organisms (Akpan et al. 2016). ESKAPE

organisms include six nosocomial pathogens that exhibit multidrug resistance and virulence. These micro-organisms include; *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* species (Mulani et al. 2019).

In an analysis of outcome measures by Al-Omari et al. (2020), the consumption of antibiotics using defined daily dose (DDD) and direct cost of antibiotics before and after implementation of an ASP was conducted. The results derived determined that the average DDD of targeted broad-spectrum antibiotics was lower post-ASP implementation and subsequently antimicrobial costs decreased by 28.45%. The secondary objective of this study reported a significant decrease in the rate of healthcare associated infections (Al-Omari et al. 2020). A preceding study by Timbrook et al (2016), reported similar findings in their retrospective analyses of DDD, bacterial susceptibilities and antibiotic costs before and after implementation of ASP. There was a significant decrease of 16.4% in DDD per 1000 patient days and significant changes to bacterial suspectibility, with an 8% increase in *Pseudomonas aeruginosa* susceptibility to tobramycin and a decrease in ASP focus antibiotic cost (Timbrook et al. 2016).

2.2 The role of a pharmacist within a mult-idiscplinary antimicrobial stewardship (AMS) team

Pharmacists are medicine experts who bring a particular skill set and knowledge to a MDT. The presence of a pharmacist in a MDT provides the added value to treatment of patients and has a positive effect on several clinical, pharmaceutical and financial indicators (Cavanaugh et al. 2015; Hisham M, 2016; Al-Jazairi,et al. 2018). The role of clinical and ward pharmacists deviate from traditional pharmacists responsibilities of dispensing and ordering to optimization of medication selection and dosing as well as monitoring (Fortin, 2018).

The inclusion of pharmacists in a palliative care MDT improved patient's medication management, reduced inappropriate use and improved patients pain control (Geum, et al, 2019). A study by Mancini (2012) evaluated the role of a pharmacist in a supportive oncology MDT reported similar benefits, with reduced medication errors

and improved patient adherence to treatment plans. Pharmacists play an important role within Intensive Care MDT to implement and improve quality initiatives, education and training of interdisciplinary personnel, reducing drug costs and providing individualised pharmacotherapeutic care (Magedanz & Silliprandi, 2012; Preslaski, 2013).

The value of a pharmacist within an AMS MDT is also documented in literature (Magedanz & Silliprandi, 2012; Fortin, 2018). A study by Magedanz and Silliprandi, (2012) showed that the pharmacist contributed to an overall adherence rate to ASP recommendations, thus there was a significant reduction in the consumption of fluoroquinolones, clindamycin and ampicillin/sulbactam. There was also a 63% reduction in hospital antibiotic costs. Even in their traditional dispensing role, pharmacists are in an ideal position to intervene using prospective audit and feedback. Pharmacists workflow includes prescription chart review where pharmacists can promote optimal use of antimicrobials through individualised patient dosing, auditing the prescription chart for adherence to ASP guidelines, recommend intravenous to oral switch and cesscation of antimicrobial use where applicable (Fortin, 2018).

Although pharmacists are viewed as intergral members of the health-care team, (Moreno, et al., 2017), the results of a study conducted amongst pharmacists in South African revealed that pharmacists felt the lack of education and training and lack of recognition of the pharmacist within these roles as major barriers that limit their participation in MDT (Manyama, et al., 2020).

2.3 Education and training

Education on AMS is a key endeavor for the containment of AMR (WHO, 2015). The Global Action Plan on AMR (WHO, 2015) set out five strategic objectives for countries to develop national action plans on AMR. Objective one focuses on improving awareness and understanding of AMR through effective communication, education and training. This includes incorporating AMR and principles of AMS as a core component of health care professional education (WHO, 2015). Subsequently studies have shown that AMR and AMS principles are included in undergraduate health programmes, however, AMS education amongst healthcare professionals remains

disparate, with variations in the extent to which learning content is included (Castro-Sánchez et al. 2016; Wasserman, et al. 2017; Nisabwe et al. 2020; Augie et al. 2021; Lubwama et al. 2021) as well as differences in pedagogies (Abubakar et al. 2021; Augie et al. 2021).

A cross-sectional survey of undergraduate programmes in dentistry, pharmacy and nursing in the United Kingdom identified that AMS principles were included in most undergraduate healthcare programmes. However, the majority of programmes did not include all recommended AMS principles and there was a lack of standardisation in pedagogies which resulted in students receiving disparate education (Castro-Sánchez et al. 2016). A study conducted amongst medical students in three medical schools in South Africa found that final year medical students had low-levels of confidence in antibiotic prescribing and students would like more education in appropriate use of antibiotics (Wasserman et al. 2017).

Lubwama et al. (2021) exposed gaps in practical training of medical and pharmacy students in East Africa and recommends a multidisciplinary and practical approach to instilling AMR and AMS concepts. The knowledge gap between medical students in South Africa and Nigeria may be related to the manner in which the curriculum is taught. The South African curriculum is vertically intergrated while Nigeria adopts a discipline based curriculum (Augie et al. 2021). In a vertically intergrated curriculum there is a gradual decrease in the time spent on classroom education and an increase in the amount of time spent on clinical practice thus enhancing practical skills (Brauer & Ferguson. 2015; Wijnen-Meijer et al. 2020).

The undergraduate pharmacy programme is traditionally a scientific based curriculum but as the traditional role of the pharmacist evolves to have a greater clinical role within MDT, incorporating experiential learning in undergraduate pharmacy programmes will ensure pharmacists develop the attitudes, behaviours and skills required to fulfill their roles (Singh et al. 2020). The value of experiential learning in enhancing knowledge, skills and confidence of pharmacists participating in AMS is shown in a study by Abubakar et al. (2021). In this study, final year pharmacy undergraduate students in Malaysia showed a higher knowledge score compared to pharmacy students in Nigeria. The difference in knowledge scores was attributed to the difference in duration

of experiential learning between the two groups, pharmacy students in Malaysia are exposed to three semesters of experiential learning compared to only one semester of experiential learning in Nigeria (Abubakar et al. 2021).

In June 2012, the South African Qualifications Authority (SAQA) mandated that pharmacy schools in South Africa must include 400 hours of experiential learning over the four year programme (SAPC. 2016). In 2018, a study by McCartney & Boschmans aimed to explore actual experiences of final year pharmacy students participating in hospital-based experiential learning in South Africa. This study demonstrated that experiential learning seemed to be well established although limited due to the lack of clinically-orientated pharmacists in some workplaces. However, over time from second year to final year, students developed better insight into the role of a pharmacist in a healthcare team and interprofessional discussions improved self-confidence (McCartney & Boschmans. 2018). It is noted that the clinical activities of the hospital-based experiential plan at the pharmacy school of the aforementioned study did not include specific AMS activities in the ward round component of the plan.

Therefore, this research sets out to gain valuable insight and understanding of the actual experiences of clinically practicing pharmacists with regards to AMS as well as to gain an understanding of their view on the relevance of pharmacy training to meet AMS practice needs.

CHAPTER 3. RESEARCH METHODOLOGY

This chapter outlines the research methodology that was used to conduct this research. It begins with a discussion on the chosen paradigm and method. An explanation on the appropriateness of the method is followed by a brief description on how the research was conducted, including the population, sample, sampling method, the instrument, the process for data collection and analysis.

3.1 Research methodology

A quantitative exploratory research design was selected for this research. Quantitative research involves the collection of numeric data that is analyzed using mathematical methods such as statistics in order to explain a phenomenon (Creswell 2009) or exhibit a view of the relationship between theory and research (Bryman 2006). Surveys are commonly used in quantitative research and are one of the most popular forms of data collection methods in the social sciences (Kalof et al. 2008). The rationale to use a quantitative rather than qualitative methodology is to enable a force ranking selection from a pre-defined list of attributes obtained from literature.

3.2 Study site

A cross sectional quantitative analysis of the attitudes, knowledge and perceptions was conducted amongst clinical pharmacists working in public and private hospitals in South Africa. The sample was not random because the study is exploratory, and the greatest possible coverage and input is required (Bryman 2012).

3.3 Population and sample

3.3.1 Population

Study population is defined as subset of the target population from which a sample is selected (Hu 2014). Inclusion and exclusion criteria are applied to determine the

characteristics of the sample to be included in the study (Connelly 2020). Exclusion criteria are not necessary for this study as the inclusion criteria is quiet specific. The study population consisted of pharmacists employed as clinical pharmacists as well as pharmacists performing clinical functions and involved in AMS in both public and private hospitals in South Africa.

3.3.2 Inclusion criteria

Included in this study are institutional pharmacists employed as clinical pharmacists and pharmacists involved in clinical functions and AMS in public and private institutional sectors between the ages of 20 to 65 years, male and female in gender with any number of years of experience.

3.3.3 Sample and sampling method

Purposive sampling technique was used for this study as this technique allows the researcher to assess a particular subset of people (Bryman 2012), in this case; pharmacists who met the inclusion criteria mentioned above were included. The South African Society of Clinical Pharmacy (SASOCP) was approached to distribute the survey to its members. SASOCP is a society formed in response to the resurgent interest in clinical pharmacy.

3.4 Study design

Surveys are popular forms of data collection methods in social science, which enables easier collection analysis and comparison of data. Surveys are useful in estimating the prevalence of attitudes, behaviours and perceptions in a population (Bryman 2012). The survey instrument was designed specifically for this study incorporating questions from previous instrument designs of similar studies. The study questions used to identify clinical pharmacists' attitudes and perceptions on AMS as well as pharmacists' role in AMS (objective 1) was adapted from the survey tool conducted by Burger, et al. (2016). In order to determine attitudes and perceptions on the level of pharmacist's participation in AMS the survey by Weier et al. (2018) which was conducted amongst hospital pharmacists in France and Australia was used. The study tool used to

determine the attitudes and perceptions of pharmacists towards pharmacy AMS education was adapted from a survey by Khan et al. (2020) and the study by Nasar et al. (2019) was used to meet objective 2. The study tool by Nasar et al. (2019) was adapted to the South African healthcare context. Questions from the aforementioned studies that did not form part of the scope of this study were excluded. Permission was obtained from the respective authors for use of these study tools via email (Appendix A).

The survey designed for this study comprised of nine questions (Appendix B). Question one consisted of demographic questions. Questions two, five and six were 5-point Likert scale questions of varying themes concerning AMS. The 5-point Likert scale depending on the question ranged from strongly agree to strongly disagree and always to never. A 10-point graphic measuring scale was used in questions three, four, seven and nine. A three-point Likert scale used in question eight to rate importance of topics. The instrument was designed on REDCap 12.5.17. REDCap is a web-based application which is used for designing and managing online databases and surveys.

3.5 Ethical considerations

Ethics approval was obtained from Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg, ethics clearance number, M210937, appendix c. A study information sheet explained the study in detail and the benefits and risks of participating in the study. Completion of the questionnaire was anonymous and data was confidentially maintained.

3.6 Procedure for data collection

An executive member of SASOCP distributed the on-line REDCap survey link to SASOCP members. The link opened with a short introductory paragraph detailing the purpose and description of the study, the risks and benefits of participating in the study, the approximate time taken to complete the survey and that all information supplied was treated with the strictest of confidence and complying with the ethical standards of the University of Witwatersrand. Data collected was anonymous as no identifiable

data was collected from participants. The introductory paragraph ended by stating consent was implied by action of opening the emailed link and completing the survey.

3.6.1. Validating the tool

A pilot study was conducted on eight clinical pharmacists and the instrument was then amended based on feedback. Research suggests that a population size of 10% of the total sample size is suitable to determine if the design of the interview guide is suitable or if modification and amendments are require d (Connelly, 2008).

3.6.2. Sample size

The response rate is the number of people who completed the survey divided by the number of people who make up the total sample group. Response rates are approximately 25% to 30% indicating a minimum-targeted amount of 20 returned questionnaires (Ficham, 2008). The South African Society of Clinical Pharmacy had 85 paid members at the time the survey was distributed. The response rate was enhanced by sending repeat reminder emails. A sample size of 55 was obtained, yielding a response rate of 64.7%.

3.7. Data analysis and interpretation

Data was analyzed by using StataSE 17. Categorical variables such as demographics, attitudes and perceptions of participants was analyzed using simple descriptive statistics measuring numbers, frequency and percentages. Normality of data was assessed using Kolmogorov-Smirnov and Shapiro-Wilks tests. Mann-Whitney and Kruskal-Wallis tests were applied to determine differences in perceptions, knowledge and participation of pharmacists. Both tests were also used to check differences among gender, age, years of experience, sector of employment, current position of employment and groups. A p-value of less than 0.05 was considered statistically significant. Reliability coefficient was tested, Cronbach's alpha score of 0.90 for perceptions, 0.91 for participation and 0.91 for factors affecting participation.

CHAPTER 4. RESULTS AND DISCUSSION

This chapter presents the results and discussion of the study. The chapter begins with a description and results of the pilot study. The results of the study are presented in the form of an article as it appears for publication following submission to Health SA Gesondheid – Journal of Interdisciplinary Health Sciences. The results section of the article starts with an overview of the demographics characteristics of the study followed by the results obtained to address objective one; exploring the attitudes and knowledge of clinical pharmacists' towards AMS and exploring the perceptions of clinical pharmacists' towards AMS participation and the factors affecting participation. Thereafter the results addressing objective two; exploring the attitudes and perception of clinical pharmacists' on the relevance of pharmacy training on pharmacy practice with regards to AMS. This is followed by a discussion of the results with reference to literature

4.1. Pilot study

A pilot study was conducted on eight pharmacists to determine their understanding of the questions as well as the time to complete the survey. Hertzog (2008) refers to general guidelines that suggest using a sample size of 10%. The population size of this study was 85 hence the appropriate sample size was eight. The survey consisted of nine questions. Question one attained participants demographic information. Questions two, three and four were designed to determine the attitudes, knowledge and perceptions of clinical pharmacists' towards their role and participation in AMS. Questions five to nine were designed to determine clinical pharmacists' perception on the relevance of pharmacy training on pharmacy practice with regards to AMS. The survey questionnaire was emailed to each participant and feedback was obtained via email.

The first three respondents of the pilot study reported that in the demographic section of the survey question 1.6 under position of employment, 'clinical pharmacist' was omitted as a current position of employment option. The survey was amended accordingly and 'clinical pharmacist' added as a current position of employment. All eight participants of the pilot study reported that they found the survey questions to be

easy to understand and that they could complete the survey within 10-15 minutes. This information was then shared with the research supervisor, and the survey amended for continuation of study.

4.2 Article - Original article entitled, "Exploring the attitudes, knowledge and perceptions of clinical pharmacists' on antimicrobial stewardship (AMS) participation and the discord between pharmacy education and actual clinical practice."
At the time of this thesis, this article had been submitted for publication to Health SA Gesondheid - Journal of Interdisciplinary Health Sciences (submitted 27 July 2022). *This article is shown as it appears in submission for publication*

Article

Exploring the attitudes, knowledge and perceptions of clinical pharmacists' on antimicrobial stewardship (AMS) participation and the discord between pharmacy education and actual clinical practice

Devina Chetty[a] and Stephanie Leigh-de Rapper[a]*

[a] Department of Pharmacy and Pharmacology, Faculty of Health Sciences, University of the Witwatersrand, 7 York Road, Parktown 2193, South Africa

*CONTACT Stephanie Leigh-de Rapper: Stephanie.derapper@wits.ac.za

ABSTRACT

Background: Antimicrobial stewardship (AMS) is a critical global intervention aimed at optimising antimicrobial use and decreasing antimicrobial resistance (AMR) with pharmacists playing a pivotal role within AMS teams. However, AMS is not comprehensively taught in pharmacy curricula and little is known about the relevance of pharmacists' training to meet AMS needs in South Africa.

Aim: To explore the attitudes, knowledge and perceptions of clinical pharmacists' towards AMS participation and training in South Africa.

Setting: This study was conducted amongst clinically practicing pharmacists in public and private healthcare sectors.

Methods: A quantitative exploratory research design was selected for this study. The study was conducted using a self-administered structured survey. Categorical variables were analyzed using simple descriptive statistics. Mann-Whitney and Kruskal-Wallis tests were applied to determine differences between variables.

Results: Pharmacists demonstrated good attitudes, knowledge and perceptions towards AMS (median 4.3). There was statistically significant differences in AMS participation between pharmacists of different years of experience (P=0.005), sector of employment (P=0.01), position of employment (P=0.015) and presence of AMS program (P=0.004). Pharmacists indicated that undergraduate studies less than adequately prepared them for their role in AMS (median 4.3).

Conclusion: Pharmacists show positive attitudes, knowledge and perceptions towards AMS. Education and training in AMS principles is obtained through Master's programmes, short courses, CPDs and workshops and insufficiently incorporated in undergraduate programmes.

Contributions: This study confirms that undergraduate pharmacy programmes inadequately prepare pharmacists for their role in AMS**.**

Keywords: Antimicrobial stewardship, knowledge, perceptions, clinical pharmacists, pharmacy, education

1. Introduction

Antimicrobial Resistance (AMR) poses a major threat to the health of populations worldwide, puts achievements in medical advancements at risk and increases morbidity, mortality, and the global economic burden (WHO 2020). In 2015, the World Health Assembly endorsed the Global Action Plan to tackle AMR with antimicrobial stewardship (AMS) as a key strategy to attain this through the promotion of the rational use of antimicrobials. Antimicrobial stewardship is a defined set of actions designed to optimise antimicrobial use for the purposes of improving clinical outcomes and patient safety. This is achieved by emphasizing appropriate selection, dosage, duration of antimicrobial therapy, and route of administration (Doron & Davidson 2011). In order to implement effective AMS programmes, a specialist team of healthcare professionals is needed. At an institutional level, the AMS team must be multidisciplinary consisting of a physician, clinical pharmacist, microbiologist, infection control representative and epidemiologist. There should be effective collaboration across various health sectors with pharmacist's expertise at the center of this (RPS 2017). Previous studies have proven the value of pharmacists and their contribution to AMS as a result of their diverse role, drug expertise and contribution within this multifaceted multidisciplinary team in hospitals (Brink et al. 2016; Brink et al. 2017; van den Berg et al. 2020).

Despite the valuable and significant role pharmacists play in AMS, pharmacists face numerous barriers that impede their participation, including lack of confidence in recommending antibiotic dose and frequency adjustments and lack of time to participate in AMS rounds (Weier et al. 2018). Pharmacists in Australia, France, Malaysia, and Qatar cited lack of formal AMS and infectious disease education and training as an impediment to their involvement in AMS activities (Khan et al. 2016; Weier et al. 2018; Nasar et al. 2019; Rizvi, et al., 2019). Amidst the global health crisis of AMR, the acute respiratory syndrome coronavirus (SARS-CoV2) resulted in the outbreak of the coronavirus (COVID-19) pandemic in 2019 creating unprecedented challenges to health systems globally (Weiner-Lasting et al. 2021). The COVID-19 pandemic overwhelmed healthcare systems, clinical teams focused attention and resources on managing the pandemic, disrupting established services as well as AMS activity (Ashiru-Oredop et al. 2021). Antimicrobial use increased, exceeding the

incidence of bacterial coinfections and secondary infections, suggesting inappropriate use and raising concerns about the impact on AMR (Grau et al. 2021).

Education, training, and development of pharmacists and other disciplines forming part of the AMS team is crucial to achieving AMS objectives and reducing AMR (WHO 2015). The World Health Organization (WHO) published a comprehensive guideline for health educators on how to develop learning content of AMR with the ultimate goal of equipping healthcare workers with the skills and competency to manage antimicrobials according to their scope of practice (WHO 2019). The South African National Department of Health recommends the inclusion of AMS in pharmacy undergraduate curricula, however, training of pharmacists in infectious diseases and AMS is not yet formalized (Schellack et al. 2018). Not all universities in South Africa offering a pharmacy programme offer a postgraduate clinical pharmacy programme, however, despite the availability of formal training there is a lack of acknowledgment of the role and scope of practice of clinical pharmacists within South African Pharmacy Council registration (Bronkhorst et al. 2020). Pharmacists with a postgraduate or undergraduate qualification are both registered as a Pharmacist with differentiation only in the sector of practice (Gray et al. 2016). Pharmacists with a postgraduate qualification in clinical pharmacy should be registered as a specialist pharmacist with clearly defined roles and responsibilities (Bronkhorst et al. 2020). This lack of differentiation leads to limited focus in undergraduate training requiring pharmacists to be trained in a Master's degree to fill this gap, this too is not regulated in scope and structure of learning. The lack of differentiation in scope of practice between B. Pharm and M. Pharm graduates has resulted in pharmacists with either qualification performing clinical functions (Bronkhorst et al. 2020) and involved in AMS (Khan et al. 2020).

In South Africa, little is known about the relevance of pharmacists' training to meet AMS needs in South Africa and little is known about clinically practicing South African pharmacists' attitude, knowledge, and perceptions on AMS and pharmacy education. Therefore, this study aimed to explore the attitudes, knowledge and perceptions of clinical pharmacists' towards AMS participation and training in South Africa.

2. Research methods and design

2.1. Study Design and Sites

A quantitative exploratory cross-sectional research design was selected for this study. The study population consisted of pharmacists employed as clinical pharmacists as well as pharmacists performing clinical functions and involved in AMS in both the public and private hospitals in South Africa.

2.2. Sample Size

The study sample size was determined based on the response rate of questionnaires. Response rates are approximately 25% to 30% indicating a minimum target amount of 20 returned questionnaires. The South African Society of Clinical Pharmacy (SASOCP) was approached to distribute the survey to its members. SASOCP is a society formed in response to the resurgent interest in clinical pharmacy. SASOCP had 85 paid members at the time the survey was distributed. A sample size of 55 was obtained, yielding a response rate of 64.7%. Out of a maximum of 55 responses not all respondents answered and/or rated each variable in questions two to nine. Hence the number of responses received for each variable is reflected. The percentage is calculated based on the number of responses received for that variable.

2.3. Data Collection and Instruments

A self-administered structured survey was designed specifically for this study incorporating questions from previous instrument designs of similar studies (Burger, et al., 2016, Weier, et al., 2018, Nasar, et al, 2019, Khan et al, 2020). The questionnaire was divided into three sections including, (i) participants demographics; (ii) questions relating to participant perceptions and knowledge towards AMS, participation in AMS and factors affecting participation in AMS; and (iii) questions relating to participant acquisition of knowledge on AMS.

2.4. Data Analysis

Data was analyzed by using StataSE 17. Categorical variables such as demographics, attitudes and perceptions of participants were analyzed using simple descriptive statistics measuring numbers, frequency, and percentages. Normality of data was assessed using Kolmogorov-Smirnov and Shapiro-Wilks tests. Mann-Whitney and

Kruskal-Wallis tests were applied to determine differences in perceptions, knowledge and participation of pharmacists. Both tests were also used to check differences among gender, age, years of experience, sector of employment, current position of employment, and groups. A p-value of less than 0.05 was considered statistically significant. Reliability coefficient was tested, Cronbach's alpha score of 0.90 for perceptions, 0.91 for participation and 0.91 for factors affecting participation.

2.5. Ethical Considerations

Ethics approval was obtained from Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg, ethics clearance number, M210937. A study information sheet explained the study in detail and the benefits and risks of participating in the study. Completion of the questionnaire was anonymous and data was confidentially maintained.

3. Results

3.1. Participants Demographics

Table 1 represents the data derived for participant demographics is represented in table 1. Female participants represented 72.73% (n=40) of the study population and male participants represented 27.27% (n=15). The majority of the participants were between the ages of 30-39 years 45.45% (n=25), have an M. Pharm qualification 65.46% (n=36) with more than 10 years' experience 50.91% (n=28). Pharmacists in the private sector represented 81.82% (n=45) of the responses. The majority of participants were employed as pharmacists 32.73% (n=18), followed by 29.09% (n=16) clinical pharmacists and 27.27% (n=15) ward pharmacists. Forty-one participants (74.55 %) indicated there is an AMS programme at their institution of employment whilst 25.45% (n=14) indicated they work without an AMS programme.

Table 1: Demographics of participants (n=55)

Variable	Category	Frequency (%)
Gender	Male	15 (27.27)
	Female	40 (72.73)
Age (years)	20-29	13 (23.64)
	30-39	25 (45.45)
	40-49	9 (16.36)
	50-59	6 (10.91)
	60	2 (3.64)
Qualification	Dip.Pharm	0 (0)
	B.Pharm	13 (23.65)
	M.Pharm	36 (65.46)
	PhD	6 (10.91)
Years of experience	< 1 year	2 (3.64)
	1-4 years	13 (23.64)
	5-9 years	12 (21.82)
	10 years and more	28 (50.91)
Sector of employment	Private	45 (81.82)
	Public	10 (18.18)
Current Position	Pharmacist	18 (32.73)
	Ward Pharmacist	15 (27.27)
	Senior Pharmacist	1 (1.82)
	Assistant Pharmacy Manager	1 (1.82)
	Pharmacy Manager	4 (7.27)
	Clinical Pharmacist	16 (29.09)
AMS programme at institution of employment	Yes	41 (74.55)
	No	14 25.45)

3.2. *Exploring the attitudes and knowledge of Clinical Pharmacists' towards AMS*

Table 2 displays data derived from participants responses to perception and knowledge towards AMS. Of a maximum score of 5 (100%) for knowledge and perceptions, participants obtained a median score of 4.3 (IQR 4.6-4.0) indicating consistent good knowledge and perception towards AMS. The majority of participants (96.22%, n=51) agreed/ strongly agreed on the definition of AMS, median 5 (IQR 5-5). A total of 47 (88.68%) agreed/ strongly agreed that an AMS team should consist of a multidisciplinary team including a physician, infectious disease specialist, pharmacist, and a microbiologist.

Table 2: Participants perception and knowledge towards AMS and participants median scores

Variable	Responses (%)*					Median (IQR)
	SD	D	N	A	SA	
AMS is a set of coordinated initiatives to promote the appropriate and judicious use of antimicrobials (n=53)	1 (1.89)	0 (0.0)	1 (1.89)	11 (20.75)	**40 (75.47)**	5 (5-5)
AMS team should consist of a multidisciplinary team including a physician, infectious disease specialist, pharmacist and a microbiologist (n=53)	1 (1.89)	4 (7.55)	1 (1.89)	12 (22.64)	**35 (66.04)**	5 (5-4)
A goal of AMS is to increase the use of antimicrobials (n=53)	**40 (75.45)**	5 (9.43)	0 (0.0)	1 (1.89)	7 (13.21)	5 (5-5)
A goal of AMS is to reduce hospital stay (n=53)	1 (1.89)	5 (9.43)	8 (15.09)	15 (28.30)	**24 (45.28)**	4 (5-3)
A goal of AMS is to decrease duration of therapy and ensure therapeutic efficacy (n=53)	1 (1.89)	1 (1.89)	4 (7.55)	11 (20.75)	**36 (67.92)**	5 (5-4)
A goal of AMS is optimize antimicrobial use (n=54)	1 (1.89)	0 (0.0)	3 (3.77)	4 (7.55)	**46 (86.79)**	5 (5-5)
A goal of AMS is to reduce antimicrobial resistance (n=53)	1 (1.89)	1 (1.89)	1 (1.89)	11 (20.75)	**39 (73.58)**	5 (5-4)
Pharmacists play a critical role in AMS to promote optimal use of antimicrobials (n=53)	2 (3.77)	0 (0.0)	1 (1.89)	7 (13.21)	**43 (81.13)**	5 (5-5)
Pharmacists play a critical role in AMS to educate health care professionals (n=53)	1 (1.89)	0 (0)	1 (1.89)	14 (26.42)	**37 (69.81)**	5 (5-4)
Pharmacists play a critical role in AMS to lead and support AMS activities (n=53)	1 (1.89)	0 (0)	2 (3.77)	15 (28.30)	**35 (66.04)**	5 (5-4)
Pharmacists play a critical role in AMS to recommend appropriate therapy or de-escalate (n=53)	1 (1.89)	0 (0)	1 (1.89)	14 (26.42)	**37 (69.81)**	5 (5-4)
Total Perception Score						**4.3 (4.6-4.04)**

***Abbreviations**: SD, strongly disagree; D, disagree, N, neutral; A, agree and SA, strongly agree
*Correct answers in bold font

Table 3: Variation in participants perception, knowledge and practices concerning AMS by characteristic

Variable	Category	Total Perception			Total Participation		
		Median	Rank	P-value	Median	Rank	P-value
Gender *	Male	4.36	426.00	0.909	7	368.50	0.330
	Female	4.45	1114.00		7.95	1171.50	
Age **	20-29	4.27	380.50	0.800	6.3	315.50	0.212
	30-39	4.45	710.00		7.7	688.0	
	40-49	4.27	228.00		8.3	355.00	
	50-59	4,22	144.00		7.5	144.50	
	60	4.63	77.50		7.8	57.00	
Qualification **	Dip.Pharm	0	0.00	0.389	0	0.00	0.422
	B.Pharm	4.27	333.50		6.4	308.00	
	M.Pharm	4.45	1078.50		7.8	1030.50	
	PhD	4.09	128.00		8.3	201.50	
Years of experience **	< 1 year	4.36	93.00	0.087	9.8	106.00	0.005
	1-4 years	4.18	263.00		6.2	216.00	
	5-9 years	4.5	263.00		7.4	343.00	
	10 years and more	4.4	855.50		8	875.00	
Sector of employment *	Private	4.45	1325.50	0.149	8	1377.50	0.010
	Public	4.13	214.50		5.9	162.50	
Current Position **	Pharmacist	4.45	522.50	0.975	5.4	342.50	0.015
	Ward Pharmacist	4.45	439.50		8.3	541.50	
	Senior Pharmacist	4.45	31.00		9.2	48.00	
	Assistant Pharmacy Manager	4.18	17.50		8.9	45.00	
	Pharmacy Manager	4.31	105.50		6.2	73.50	
	Clinical Pharmacist	4.31	424.00		8	489.50	
AMS programme at institution of employment *	Yes	4.27	1124.50	0.647	8	1294.50	0.004
	No	4.5	415.50		5.2	245.50	

* Two-sample Wilcoxon rank-sum (Mann–Whitney) test; ** Kruskal–Wallis equality-of-populations rank test

Forty-five (84.88%) participants disagreed/ strongly disagreed that a goal of AMS is to increase the use of antimicrobials whilst 39 participants (73.58%) agreed/strongly agreed that a goal of AMS is to reduce hospital stay. The majority of participants (n=50, 94.33%) agreed/ strongly agreed that optimizing antimicrobial use and reducing antimicrobial resistance is a goal of AMS. Participants unanimously agreed/strongly agreed that pharmacists play a critical role in AMS to promote optimal use of antimicrobials (median 5; IQR 5-5), educate health care professionals (median 5; IQR 5-4), lead and support AMS activities (median 5; IQR 5-4) and to recommend appropriate therapy or de-escalate (median 5; IQR 5-4). Table 3 shows two-sample Wilcoxon rank-sum (Mann–Whitney) and Kruskal–Wallis equality-of-populations rank that was used to test statistical differences in median total perception, total participation by demographic characteristic. No statistical difference was found.

3.3. Exploring the perceptions of Clinical Pharmacists' towards AMS participation and the factors affecting participation

Table 4 displays data derived from participant's responses to participation in AMS activities and variation in the levels of participation amongst the different positions of employment. Of a maximum score of 10, respondents obtained a total median score of 7.8 (IQR 8.5-6.0) demonstrating that respondents had very good participation in AMS activities. Participants almost always monitored AMS duration (median 9; IQR 10-7), consumption (median 9; IQR 10-7), and participated in AMS ward rounds (median 9; IQR 10-5). Participants mostly communicated with prescribers if unsure about antibiotic appropriateness (median 8; IQR 10-7), felt confident when communicating with prescribers (median 8; IQR 9-6) and sought additional information before deciding to dispense an antibiotic (median 8; IQR 9-5). Majority of participants indicated they take part in AMS campaigns to promote rational use of antimicrobials (median 8; IQR 10-5). To a lesser extent, participants screen antibiotic scripts in accordance with local guidelines (median 7; IQR 10-5), collaborate with other health professionals if need be before dispensing an AMS prescription (median 7; IQR 80-5), and educate patients on appropriate use and resistance related issues (median 7; IQR 9-5). The differences between total overall participation and demographic groups was analysed, results are displayed in table 3. No statistical differences was found between

gender, age, and qualification (*P*=0.33; 0.212 and 0.422 respectively). The various current positions of employment showed statistical differences *P*=0.015 with ward pharmacists, senior pharmacists, assistant pharmacy managers and clinical pharmacists showing higher levels of participation compared to pharmacists (median 5.4) and pharmacy managers (median 6.2). Participants employed as pharmacists show low levels of participation in monitoring AMS duration (*P*=0.015); monitoring antimicrobial consumption (*P*=0.13); AMS rounds (*P*=0.006); participating in AMS campaigns (*P*=0.03), and screening AMS prescriptions in accordance with local guidelines before dispensing, (*P*=0.006), medians =5 compared to clinical pharmacists, ward pharmacists and senior pharmacists. Pharmacists with less than a year of experience showed higher levels of participation (median 9.8; *P*=0.005) followed by pharmacists with more than 10 years of experience (median 8; *P*=0.005). Pharmacists employed in Private sector showed higher participation (median 8; *P*=0.01) compared to those employed in the public sector. Pharmacists working in an institution with an AMS programme demonstrated much higher levels of participation in AMS (median 8) compared to those working without and AMS programme (median 5.2), *P*=0.004. Supplementary Table 1 shows data derived from factors limiting participation. Respondents identified the following factors as factors that greatly impact participation: number of pharmacists, lack of support from hospital administration, poor communication between prescriber and pharmacist, pharmacist's recommendation not seen as credible, prescribers not willing to engage with pharmacists, doctors not caring about antibiotic prescribing or restrictions (median = 9). Time spent on other activities, poorly established AMS committee, limited knowledge on appropriate AMS utilization, lack of confidence and the lack of education and training in AMS showed significant impact on participation (median = 8). The majority of participants (n=11; 22%) rated "Participation won't make a difference" as a factor that somewhat limits participation.

Supplementary T: Participation in AMS and variation in participation amongst different positions of employment

Variable	Median (IQR)	Variation amongst different positions of employment												
		Pharmacist		Ward Pharm*		Senior Pharm		Assistant PM*		PM*		Clinical Pharm		P-value
		Median	Rank	Median	Rank	Median	Rank	Median	Rank	Median	Rank	Median	Rank	
I screen antibiotic prescriptions in accordance with local AMS guidelines before dispensing	7 (10-5)	5	323.50	8	533.50	10	46.00	10	46.00	5	52.50	7	431.50	0.006
I collaborate with other health care professionals if need be before I dispense an AMS prescription	7 (8-5)	5	330.00	8	498.00	8	38.00	10	48.50	5	48.00	7	468.50	0.013
I communicate with the prescriber if I am unsure about the appropriateness of an antibiotic prescription	8 (10-7)	7	372.50	8	453.50	8	25.50	8	25.50	7	79.00	9	475.00	0.407
I am confident when I communicate with prescribers regarding and AMS prescription	8 (9-6)	8	442.00	8	447.50	9	38.00	8	30.00	6.8	73.50	8	400.00	0.783

Supplementary T: Participation in AMS and variation in participation amongst different positions of employment

Variable	Median (IQR)	Variation amongst different positions of employment												
		Pharmacist		Ward Pharm*		Senior Pharm		Assistant PM*		PM*		Clinical Pharm		P-value
		Median	Rank	Median	Rank	Median	Rank	Median	Rank	Median	Rank	Median	Rank	
I sought additional clinical information (drug interactions; ADRS, allergies) before deciding to dispense the Antibiotic prescribed	8 (9-5)	8	405.00	8	415.50	10	47.00	8	29.00	5	70.00	8	464.50	0.397
I take part in AMS campaigns to promote rational use of antimicrobials	8 (10-5)	5	336.00	9	495.50	10	45.00	8	25.50	6	58.00	8	471.00	0.036
I educate patients on appropriate use and resistance related issues	7 (9-5)	7	466.50	7	438.00	8	33.00	7	28.00	7	118.00	6	347.50	0.907
I monitor antimicrobial duration	9 (10-7)	5	287.50	10	516.00	10	42.50	10	42.50	8.5	106.00	9	436.50	0.015
I monitor antimicrobial consumption	9 (10-7)	5	277.50	10	519.50	9	28.50	10	43.50	8.5	110.00	9	452.00	0.013
I participate in AMS rounds	9 (10-5)	5	273.00	10	509.50	10	44.00	10	44.00	5.5	91.50	9	469.00	0.006

Supplementary T: Participation in AMS and variation in participation amongst different positions of employment

Variable	Median (IQR)	Variation amongst different positions of employment												
		Pharmacist		Ward Pharm*		Senior Pharm		Assistant PM*		PM*		Clinical Pharm		P-value
		Median	Rank	Median	Rank	Median	Rank	Median	Rank	Median	Rank	Median	Rank	
Total Participation Score	**7.8 (8.5-6.0)**													

Participants were asked to rate their level of participation in the following AMS activities where 0 = Never; 5=Occasionally and 10=Always

Abbreviation Assistant PM* = Assistant Pharmacy Manager; Pharm*=Pharmacist and PM*= Pharmacy Manager

3.4. Exploring the attitudes and perception of Clinical Pharmacists' on the relevance of pharmacy training on pharmacy practice with regards to AMS

Table 5 shows data from participant's perceptions on the relevance of pharmacy training on pharmacy practice with regards to AMS.

Table 5: Where are you most likely to acquire knowledge on AMS

Variable	Responses (%)				
	Never	**Rarely**	**Occasional**	**Often**	**Always**
Undergraduate programme (n=50)	7 (14.00)	11 (22.00)	18 (36.00)	8 (16.00)	6 (12.00)
Master's programme (n-49)	4 (8.16)	2 (4.08)	7 (14.29)	17 (34.69)	19 (38.78)
Short Courses initiated by self (n=50)	0 (0.00)	2 (4.00)	12 (24.00)	22 (44.00)	14 (28.00)
Short courses initiated by employer (n-49)	5 (10.20)	9 (18.37)	16 (32.65)	15 (30.61)	4 (8.16)
CPD activities (n=50)	0 (0.00)	7 (14.00)	12 (24.00)	26 (52.00)	5 (10.00)
Conferences, workshops or other educational activities are required (n=50)	1 (2.00)	5 (10.00)	4 (8.00)	21 (42.00)	19 (38.00)

Participants indicated that they are most likely to acquire knowledge on AMS at conferences, workshops, or other educational activities (often/always n=40; 80%) and least likely to acquire this knowledge in undergraduate programmes (often/always n=14; 28%). Table 6 displays data were participants rated the extent to which their undergraduate studies and or postgraduate studies prepared them for their role in AMS. Participants indicated that undergraduate studies less than adequately prepared them for their role in AMS (median 4.5). Whereas M. Pharm studies adequately prepared them for their role in AMS (median 8). Table 7 shows data displayed from where participants think a comprehensive course in AMS and infectious disease would be most beneficial. Participants unanimously agreed that a comprehensive course in AMS and infectious disease would be most beneficial in undergraduate programmes (agree/strongly agree n=48; 100%).

Table 6: How did your studies during university prepare you to for this role?

Variable	Responses											Median (IQR)
	0	1	2	3	4	5	6	7	8	9	10	
Undergraduate B. Pharm studies (n=48)	10 (20.83)	6 (12.50)	1 (2.08)	4 (8.33)	3 (6.25)	10 (20.83)	2 (4.17)	5 (10.42)	5 (10.42)	1 (2.08)	1 (2.08)	4.5 (5.5)
Postgraduate M. Pharm studies (n=43)	3 (6.98)	0 (0.00)	0 (0.00)	1 (2.33)	0 (0.00)	7 (16.28)	1 (2.33)	6 (13.95)	7 (16.28)	3 (6.98)	15 (34.88)	8 (5)

Participants were asked to rate how university teaching prepared them for their role in AMS activities where 0 = Never; 5=occasionally and 10=Always

Table 7: Where do you think a comprehensive course in AMS and Infectious Diseases would be most beneficial

Variable	Responses (%)				
	SD	D	N	A	SA
Undergraduate programme (n=48)	0 (0.00)	0 (0.00)	0 (0.00)	25 (52.08)	23 (47.92)
Master's Programme (n=48)	2 (4.17)	1 (2.08)	1 (2.08)	15 (31.25)	29 (60.42)
CPDs (n=48)	0 (0.00)	2 (4.17)	2 (4.17)	28 (58.33)	16 (33.33)
Short courses (n=48)	0 (0.00)	1 (2.08)	2 (4.17)	22 (52.08)	23 (47.92)

***Abbreviations**: SD, strongly disagree; D, disagree, N, neutral; A, agree and SA, strongly agree

Supplementary table 2 shows data derived from participants' rating the importance of AMS topics as low, moderate or highly important. All participants agreed that dose optimization is highly important (n=48; 100%). Followed by infectious disease (n=43; 89.58%), patient individualization and surgical prophylaxis (n=39; 81.25%). All participants viewed agent of choice as moderately important (n=48; 100%). Only 28 participants (58.33%) rated standard treatment guideline compliance and team dynamics as a highly important, and 25 participants (52.08%) rated standard treatment guideline compliance as highly important. Supplementary table 3 shows data derived from rating teaching approaches for improving AMS. All teaching approaches were rated on the upper end of the scale towards highly rated. Participants scored integrated case base and problem-based learning as a median of 9. Participants scored the remaining 3 approaches: didactic lectures, early clinical internship, and small group class assignments and case study analysis a median of 8.

Supplementary table 2: If an AMS module were to be included in an undergraduate program, how would you rate the importance of the following topics?

Variable	Responses		
	Low	Moderate	High
Infectious diseases (n=48)	0 (0.00)	5 (10.42)	43 (89.58)
Choice of Agent (n=48) *	0 (0.00)	48 (100.00)	0 (0.00)
Standard treatment guideline compliance (n=48) *	1 (2.08)	22 (45.83)	25 (52.08)
IV to Oral switch (n=48) *	0 (0.00)	15 (31.25)	33 (68.75)
Dose optimization (n=48) *	0 (0.00)	0 (0.00)	48 (100)
Patient individualization (n=48) *	1 (2.08)	8 (16.67)	39 (81.25)
Therapeutic Drug Monitoring (n=48) *	0 (0.00)	11 (22.92)	37 (77.08)
Surgical Prophylaxis (n=48) *	0 (0.00)	9 (18.75)	39 (81.25)
Diagnostic stewardship (n=48) *	2 (4.17)	9 (18.75)	37 (77.08)

Infection and prevention control (n=48) *	0 (0.00)	13 (27.08)	35 (72.92)
Case Study analysis (n=48) *	3 (6.25)	8 (16.67)	37 (77.08)
Quality improvement and documenting (n-48) *	2 (4.17(	18 (37.50)	28 (58.33)
Antimicrobial Stewardship teams and ward rounds (n=48) *	0 (0.00)	10 (20.83)	38 (79.17)
Team dynamics (n=48)	1 (2.08)	19 (39.58)	28 (58.33)
Interpersonal and communication skills development (n=47)	2 (4.26)	9 (19.15)	36 (76.60)

Notes: AMS topics included from study by Khan, et al., 2019*

Supplementary table 3: How would you rate the following approaches for improving undergraduate AMS coverage?

Variable	Responses											Median (IQR)
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Didactic lectures (n=48)	0 (0)	0 (0)	0 (0)	1 (2.08)	1 (2.08)	7 (14.58)	1 (2.08)	8 (16.67)	12 (25.99)	4 (8.33)	14 (29.17)	8 (2.00)
Integrated case based learning	0 (0)	0 (0)	1 (2.08)	0 (0)	0 (0)	3 (6.25)	1 (2.08)	6 (12.50)	11 (22.92)	4 (8.33)	22 (45.83)	9 (2.00)
Problem based learning sessions	1 (2.08)	0 (0)	0 (0)	0 (0)	0 (0)	4 (8.33)	1 (2.08)	2 (4.17)	6 (12.50)	14 (29.17)	20 (41.67)	9 (2.00)
Early clinical internships	0 (0)	0 (0)	1 (2.08)	1 (2.08)	0 (0)	9 (18.75)	0 (0)	10 (20.83)	8 (16.67)	7 (14.58)	12 (25.00)	8 (2.50)
Small group class assignments and case study analysis	0 (0)	0 (0)	0 (0)	3 (6.25)	1 (2.08)	8 (16.67)	2 (4.17)	9 (18.75)	11 (22.92)	3 (6.25)	11 (22.92)	8 (3.50)

Scale 0=do not include; 5=somewhat included and 10=highly rated must be included

Discussion

Pharmacists have a responsibility to take a prominent role in AMS programmes at institutional level. Previous studies found that lack of education and training are key barriers to pharmacist's participation in AMS programmes and activities (Weier et al. 2018; Nasar et al. 2019). To the best of our knowledge this is the first study to explore the attitudes, knowledge, and perceptions of clinical pharmacists' on AMS participation and the discord between pharmacy education and actual clinical practice in South Africa.

Numerous studies have shown the growing awareness, positive perceptions and good knowledge of pharmacists towards AMS (Khan et al. 2016; Sarwar et al. 2018; Erku 2020, Saleh et al. 2020, Tang et al. 2020). This study shows that South African pharmacists employed as clinical pharmacists as well as pharmacists performing clinical functions and involvement in AMS in both the public and private hospitals had equally good attitudes, perceptions and knowledge towards AMS. There was overwhelming evidence that participants identify with the critical role pharmacists play in all facets of AMS. Similarly, a study by Saleh et al. (2020) showed that public sector hospital pharmacists agreed that pharmacists have a responsibility to take a prominent role in AMS. These findings are encouraging as positive perceptions of pharmacists reinforces the concept of developing awareness of AMS programmes, (Khan et al. 2016) and enhance adherence to AMS guidelines (Kalungia et al. 2019).

The South African Society of Clinical Pharmacy position statement on the pharmacist's role in AMS 2018 defines the antibiotic stewardship pharmacists' role which includes the preservation of antibiotics through monitoring, evaluation, and guidance of appropriate antibiotic use, (Schellack et al. 2018). Hence it is reassuring that the result of this study confirms South African pharmacists focused their attention on monitoring antimicrobial duration and consumption and participated in AMS ward rounds. The findings of this study strengthen the preceding work confirming the growing

involvement and value pharmacists in AMS participation (Kalungia et al. 2019; Saleh et al. 2020 and Tang et al. 2020).

Although pharmacists overall participation in AMS activities was good, it is important to take note of the varying degrees of participation within the demographic groups with statistical significant differences. Pharmacists in private sector reported higher levels of particpation in AMS activites compared to pharmacists in the public sector. This is most likley due to the overwhemling presence of an AMS programme in the private sector (92.68%) compared to only 7.32% in the public sector. Well established AMS programmes offers a structured, guided approach to AMS activties (Majumder et al. 2020). The support and collaboration amongst the AMS multi-discplinary team also enhances a pharmacists participation in AMS activities (Weier et al 2018). Studies reveal that the private sector shows a more co-ordinated implementation of AMS activities across hospital groups whereas the public sector shows successful impelmentation of AMS activities across a few hospitals (Chetty et al. 2019). The main reasons for poor implentation of AMS activities in public sector were lack of stewardship resources, IT, microbiology, and infectious disease specialists support (Chetty 2021; Engler et al. 2020).

Job specific profiles with clearly defined roles and responsibilities vary amongst the different positions of employment. Ward and clinical pharmacists have a more focused role in AMS activities and are responsible for delivering on key performance indicators in clinical pharmacy processes, amongst other clinical pharmacy functions, however, AMS activities should not be limited to AMS team members but also include dispensary pharmacists (Schellack et al. 2018). Therefore it is encouraging to note that participants in this study who were employed as pharmacists show satisfactory participation in AMS activities albiet to a lesser extent compared to ward and clinical pharmacists.

Despite good attitudes, knowledge, perception and participation in AMS, pharmacists indicated that various prescriber organisational and educational factors may

significantly limit their levels of particpation. Prescriber factors (poor communication, pharmacists recommendation not creditable/not well received by doctors, prescribers not willing to engage with pharmacists, and Doctors not caring about antibiotic prescribing or restriction) was a highly rated factor limiting pharmacists' particpation. This could be due to doctors lack of knowledge and understanding about pharmacists' roles, competencies and activties (Bechet et al. 2016). Mutual appreciation, trust and respect of each health professionals' competence are factors that can foster effective collaboration between pharmacists and doctors, (Löffler et al. 2017). Pharmacists need to invest sufficient time during ward rounds to create more face to face opportunities to build and enhance professional relationships with prescribers. However, organisational factors of limited time and resources allocated to AMS activties has been cited as a factor impeding pharmacists participation in AMS, (Ji et al. 2021; Kalungia et al. 2019; Saleh et al. 2020; Tang et al. 2020). Likewise, pharmacists of this study rated similar organisational factors; number of pharmacists, lack of support by hospital administration, time spent on other activities (paper-work, dispensing and stock management), and a poorly established AMS committee as factors impeding their participation. Evidence has shown that dedicated and sustained funding and hospital leadership support are predictors for an effective Antimicrobial Stewardship Programme (ASP) (Abubakar et al. 2020). Hospital leadership and AMS committees in South Africa should review the core elements of hospital the ASP as defined by the CDC, leadership committement should be enhanced to dedicate the necessary human and financial capital to AMS programmes. Pharmacists reports of inadequate time to particpate in AMS activities due to other daily tasks such as dispensing and stock management implies that human and financial capital is insufficiently distributed within pharmacy departments to enable sustained work on AMS activities. Re-enforcing core elements of a ASP, hospital leadership, and accountability (e.g. idenitifying a single leader responsible for programme outcomes) can inspire clinicians to play a crucial role on AMS (Brink 2015). The other relevant core element is education, health professionals should be educated about disease state management, antimicrobial resistance, and optimal prescribing. There is scope within this core element to educate doctors of the roles, responsibilities and core

competence of the AMS committee members. This form of interprofessional education improves health care professionals understanding of each others role and responsibilities which significantly improves interprofessional knowlegde and attitudes towards collaborative AMS, (MacDougall et al. 2017).

The importance of incorporating AMS training within undergraduate health care programmes has been emphasized by the WHO, Global Action on Antimicrobial Resistance, (WHO 2015). Universities have heeded this call and incorporated AMS training in undergraduate and postgraduate health care programmes, however there is variation in the extent to which AMS training is included as well as differences in pedagogies (Weier et al. 2018; Kalungia et al. 2019; Abubakar et al. 2020; Saleh et al. 2020; Ji et al. 2021. In studies were there was some inclusion of AMS concepts in undergraduate programmes, however there was reports of misallignment in the form of irrelevant syllabus to AMR, no courses on AMS practice (Khan 2021), difference in elements of stewardship, (Castro-Sánchez et al. 2016), and inconsistent application of content by different pharmacy schools in the same country (Justo et al. 2014). A study by Burger et al, (2016) showed a similar finding amongst pharmacy schools in South Africa. This study showed that eight univeristies across South Africa included some form of AMS education however there were significant differences in AMS education between the universities (P <0.001).

The study by Burger et al. (2016) further reported significant differences in AMS knowledge between students from the various universities. The results of this study support the findings of the aformentioned study by Burger et al (2016). The participants of this study indicated that they acquire most of their AMS knowledge from conferences, work shops, masters programmes and short courses. Although only 14% of paticipants indicated they acquire AMS knowledge from undergraduate programmes, this is an indication that undergraduate pharmacy programmes in South Africa include some form of AMS training. The results of this study also show that pharmacists with less than a year of experience have higher levels of participation in

AMS activties compared to pharmacists with more than 10 years of experience, this further substantiates the positive influence by the undergraduate curriculum.

Pharmacy schools should note that pharmacists were all in agreement that a comprehensive course in AMS and infectious disease would be most beneficial if taught in undergraduate programmes. Highly rated topics for inclusion in AMS curricula were infectious disease, dose optimization, patient individualisation, and surgical prophylaxis. The agent of choice was rated as moderately important. In order to be effective members of the AMS team pharmacists require skills and knowledge in antimicrobial use, infectious disease as well as leadership skills to implement AMS programmes and work effectively within a multidisciplinary team, (Weier et al. 2018). Majority of pharmacists rated interpersonal and communication skills development and team dynamics as a topic of high importance. Pharmacists rated all teaching approaches, didactic lectures, intergrated case based learning, problem-based learning, early internship and small group assignments as highly benefical in improving undergraduate AMS coverage. Internships offer the opportunity for practical experiential learning which helps provide holistic view and application of knowledge and skills, (Teoh et al. 2020).

Though it is important to create a solid foundation of AMS knowledge at undergraduate level, AMS education and training should also continue throughout health professional careers to shape and reaffirm their attitudes and behaviours to AMS, (Majumder et al. 2020). The importance of continuous professional development to keep abreast with the latests antimicrobial practices and recommendation is highligthed in a study by Teoh in 2020 (Teoh et al. 2020). AMS education should be available as continuing medical education (CME) which provides evidence based information in the form of lectures, tutorials, and grand rounds, (Majumder et al. 2020).

The findings of this study suggest that clinical pharmacists, pharmacists involved in clinical work, and AMS in South Africa have good attuditudes, knowledge, and perceptions towards AMS and have good levels of participation in AMS activtities.

Despite the presence of AMS programmes, pharmacist indicated that many factors could limit their level of participation in AMS activities suggesting the need to enhance and develop AMS programmes. Furthermore the study findings confirm that AMS principles are insufficiently incorporated in undergraduate pharmacy programmes. However, informal educational and training in the form of short courses, CPD activities, conferences, and workshops are available which pharmacists utilize to improve their knowledge and AMS.

Limitations

There are a few limitations to this study. Firstly, the study was conducted amongst SASOCP members which consisted of 85 paid members at the time of this study. There may be clinical pharmacists and pharmacists involved in clinical work and AMS who are not SASOCP members who did not get an opportunity to participate in this study. Secondly, there was only a small representation from the public sector. The results from the public sector may differ with greater representation.

Implications and recommendations

As this study targeted SASOCP members and had minimum representation from the public sector, further large scale studies are warranted to validate these results by including a greater number of pharmacists. This study highlighted that pharmacy schools in South Africa incorporate some form of AMS training, it is recommended that a study is done to determine what pharmacy schools are teaching with regards to AMS. The findings from this study support the recommendation to Pharmacy schools to implement systematic education and training for pharmacists, starting from instilling basic principles of AMR, AMS, infectious disease and interpersonal skill development in undergraduate programmes, to continuous education and development in the form of short courses and CPD. The Department of Health should redirect resources to improve AMS programmes in public sectors. Hospital administrators in private and public sector are encouraged to monitor and support AMS programmes within their institutions. There is strong evidence that doctors are unwilling to work with clinical

pharmacists hence a study should be conducted to evaluate the factors that influence inter-professional collaboration between doctors and clinical pharmacists.

Conclusion

This study found that clinical pharmacists, pharmacists involved in clinical work and AMS in South Africa have good attitudes, knowledge, and perception towards AMS. Pharmacists of all positions of employment participate in AMS with pharmacists employed as clinical and ward pharmacist's showing greater levels of participation. Masters programmes, short courses, CPDs, conferences, and workshops are avenues available for pharmacists to acquire AMS knowledge however, pharmacists are of the view that an undergraduate AMS programme will be most beneficial to bridge the current gap between education and practice**.**

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Supporting Information

Exploring the attitudes, knowledge and perceptions of clinical pharmacists' on antimicrobial stewardship (AMS) participation and the discord between pharmacy education and actual clinical practice

Devina Chetty[a] and Stephanie Leigh-de Rapper[a]*

[a] Department of Pharmacy and Pharmacology, Faculty of Health Sciences, University of the Witwatersrand, 7 York Road, Parktown 2193, South Africa

Correspondence
Ms. Stephanie Leigh-de Rapper[a]
Department of Pharmacy and Pharmacology,
Faculty of Health Sciences,
University of the Witwatersrand,
7 York Road,
Parktown 2193,
South Africa
Phone: +27 11 717 2268
FAX: +27 11 643 5415
Stephanie.derapper@wits.ac.za

Supplementary Information:

Supplementary table 1: Factors Limiting Participation

Supplementary table 2: If an AMS module were to be included in an undergraduate program, how would you rate the importance of the following topics?

Supplementary table 3: How would you rate the following approaches for improving undergraduate AMS coverage?

Supplementary table 1: Factors Limiting Participation

Variable	Responses											Median (IQR)
	0	1	2	3	4	5	6	7	8	9	10	
Number of pharmacists	0 (0)	0 (0)	0 (0)	1 (2.00)	1 (2.00)	11 (22.00)	1 (2.00)	4 (8.00)	6 (12.00)	5 (10.00)	21 (42.00)	9 (10;5)
Participation won't make a difference	2 (4.00)	3 (6.00)	1 (2.00)	1 (2.00)	0 (0.00)	11 (22.00)	3 (6.00)	8 (16.00)	3 (6.00)	8 (16.00)	10 (20.00)	7 (9;5)
Lack of support from hospital administration	0 (0)	3 (6.00)	0 (0)	2 (4.00)	1 (2.00)	3 (6.00)	4 (8.00)	2 (4.00)	7 (14.00)	9 (18.00)	19 (38.00)	9 (10;6)
Time spent on other activities (paper-work, dispensing, stock)	0 (0)	0 (0)	1 (2.00)	0 (0)	0 (0)	7 (14.00)	2 (4.00)	7 (14.00)	9 (18.00)	6 (12.00)	18 (36.00)	8 (10;7)
Poor communication between prescriber and pharmacists	0 (0)	0 (0)	2 (4.00)	1 (2.00)	0 (0)	5 (10.00)	2 (1.00)	7 (14.00)	5 (10.00)	8 (16.00)	20 (40.00)	9 (10;7)
Poorly established AMS committee	0 (0)	1 (2.00)	3 (6.00)	2 (4.00)	0 (0)	6 (12.00)	3 (6.00)	5 (10.00)	6 (12.00)	9 (18.00)	15 (30.00	8 (10;6)
Limited knowledge on appropriate AMS utilization	0 (0)	0 (0)	2 (4.00)	1 (2.00)	1 (2.00)	4 (8.00)	3 (6.00)	5 (10.00)	13 (26.00)	8 (16.00)	13 (26.00)	8 (10;3)
Lack of confidence	0 (0)	1 (2.00)	2 (4.00)	0 (0)	0 (0)	10 (20.00)	5 (10.00)	4 (8.00)	12 (24.00)	6 (12.00)	10 (20.00)	8 (9;5)
Pharmacist's recommendation not creditable and/or not well received by doctors	0 (0)	0 (0)	2 (4.00)	3 (6.00)	0 (0)	5 (10.00)	2 (4.00)	4 (8.00)	9 (18.00)	8 (16.00)	17 (34.00)	9 (10;7)
Prescribers not willing to engage with pharmacist regarding antibiotic prescribing	0 (0)	0 (0)	1 (2.00)	2 (4.00)	0 (0)	3 (6.00)	3 (6.00)	1 (2.00)	10 (20.00)	13 (26.00)	17 (34.00)	9 (10;2)

Doctors not caring about antibiotic prescribing or restriction	0 (0)	0 (0)	1 (2.00)	5 (10.00)	0 (0)	3 (6.00)	1 (2.00)	2 (4.00)	9 (18.00)	6 (12.00)	23 (46.00)	9 (10;8)
Lack of education and training in AMS	1 (2.00)	0 (0)	1 (2.00)	1 (2.00)	0 (0)	9 (18.00)	0 (0)	5 (10.00)	9 (18.00)	10 (20.00)	14 (28.00)	8 (10;7)

Participants were asked to rate the extent to which the following factors may limit participation in AMS. 0= no impact; 5=Some impact and 10=Great Impact

Supplementary table 2: If an AMS module were to be included in an undergraduate program, how would you rate the importance of the following topics?

Variable	Responses		
	Low	Moderate	High
Infectious diseases (n=48)	0 (0.00)	5 (10.42)	43 (89.58)
Choice of Agent (n=48) *	0 (0.00)	48 (100.00)	0 (0.00)
Standard treatment guideline compliance (n=48) *	1 (2.08)	22 (45.83)	25 (52.08)
IV to Oral switch (n=48) *	0 (0.00)	15 (31.25)	33 (68.75)
Dose optimization (n=48) *	0 (0.00)	0 (0.00)	48 (100)
Patient individualization (n=48) *	1 (2.08)	8 (16.67)	39 (81.25)
Therapeutic Drug Monitoring (n=48) *	0 (0.00)	11 (22.92)	37 (77.08)
Surgical Prophylaxis (n=48) *	0 (0.00)	9 (18.75)	39 (81.25)
Diagnostic stewardship (n=48) *	2 (4.17)	9 (18.75)	37 (77.08)
Infection and prevention control (n=48) *	0 (0.00)	13 (27.08)	35 (72.92)
Case Study analysis (n=48) *	3 (6.25)	8 (16.67)	37 (77.08)
Quality improvement and documenting (n-48) *	2 (4.17(	18 (37.50)	28 (58.33)
Antimicrobial Stewardship teams and ward rounds (n=48) *	0 (0.00)	10 (20.83)	38 (79.17)
Team dynamics (n=48)	1 (2.08)	19 (39.58)	28 (58.33)
Interpersonal and communication skills development (n=47)	2 (4.26)	9 (19.15)	36 (76.60)

Notes: AMS topics included from study by Khan et al. 2020

Supplementary table 3: How would you rate the following approaches for improving undergraduate AMS coverage?

Variable	Responses											Median (IQR)
	0	1	2	3	4	5	6	7	8	9	10	
Didactic lectures (n=48)	0 (0)	0 (0)	0 (0)	1 (2.08)	1 (2.08)	7 (14.58)	1 (2.08)	8 (16.67)	12 (25.99)	4 (8.3)	14 (29.17)	8 (2)
Integrated case based learning	0 (0)	0 (0)	1 (2.08)	0 (0)	0 (0)	3 (6.25)	1 (2.08)	6 (12.50)	11 (22.92)	4 (8.33)	22 (45.83)	9 (2)
Problem based learning sessions	1 (2.08)	0 (0)	0 (0)	0 (0)	0 (0)	4 (8.33)	1 (2.08)	2 (4.17)	6 (12.50)	14 (29.17)	20 (41.67)	9 (2)
Early clinical internships	0 (0)	0 (0)	1 (2.08)	1 (2.08)	0 (0)	9 (18.75)	0 (0)	10 (20.83)	8 (16.67)	7 (14.58)	12 (25.00)	8 (2.5)
Small group class assignments and case study analysis	0 (0)	0 (0)	0 (0)	3 (6.25)	1 (2.08)	8 (16.67)	2 (4.17)	9 (18.75)	11 (22.92)	3 (6.25)	11 (22.92)	8 (3.5)

Scale 0=do not include; 5=somewhat included and 10=highly rated must be included

CHAPTER 5. CONCLUSION

This chapter summaries the results and key findings of the study. It also discusses limitations and provides recommendations for further studies.

5.1. Conclusion

This study found that clinical pharmacists, and pharmacists involved in clinical work and AMS in South Africa, have good attitudes knowledge and perception towards AMS. Pharmacists of all positions of employment participate in AMS with pharmacists employed as clinical and ward pharmacist's showing greater levels of participation. T Masters programmes, short courses, CPDs, conferences and workshops are avenues available for pharmacists to acquire AMS knowledge however, pharmacists are of the view that an undergraduate AMS program will be most beneficial to bridge the current gap between education and practice.

5.2. Limitations

There are a few limitations to this study. Firstly, the study was conducted amongst SASOCP members which consisted of 85 paid members at the time of this study. There may be clinical pharmacists and pharmacists involved in clinical work and AMS who are not SASOCP members who did not get an opportunity to participate in this study. Secondly, there was a limited representation from public sector, and therefore, the results from public sector may differ with greater representation. Lastly, the study was voluntary in nature and pharmacists with an interest in clinical work and AMS were more likely to participate in this study.

5.3. Recommendations

As this study targeted SASOCP members and had minimum representation from public sector, further large scale studies are warranted to validate these results by including a greater number of pharmacists. The findings from this study support the

recommendation to SA Pharmacy schools to implement systematic education and training for pharmacists, starting from instilling basic principles of AMR, AMS, infectious disease and interpersonal skill development in undergraduate programmes. Based on the positive evidence of experiential learning, AMS should be incorporated in undergraduate work based learning activities. Continuous education and development should be offered in the form of short courses and CPD. The Department of Health should redirect resources to improve AMS programmes in public sectors. Hospital administrators in private and public sector are encouraged to monitor and support AMS programmes within their institutions.

5.4. Future studies

This study highlighted that pharmacy schools in South Africa incorporate some form of AMS training in their undergraduate programmes, it is recommended that a study is done to determine what pharmacy schools are teaching with regards to AMS. There is strong evidence that doctors are unwilling to work with clinical pharmacists hence a study should be conducted to evaluate the factors that influence inter-professional collaboration between doctors and clinical pharmacists.

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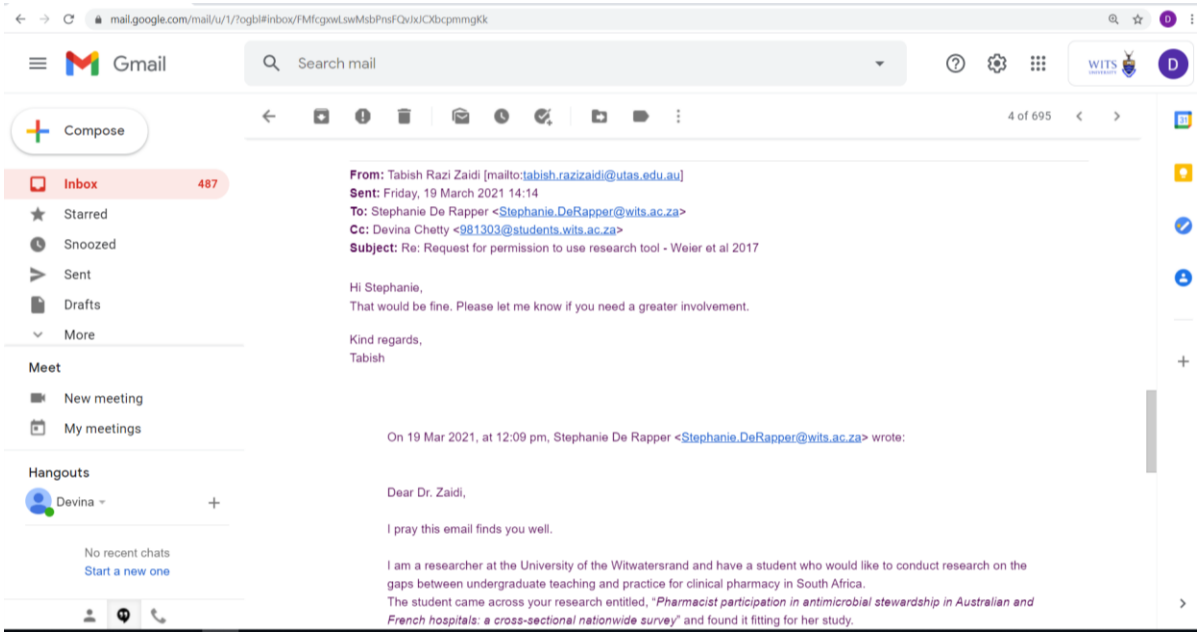
Appendix A: Permission to make use of surveys



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4 of 695

From: Tabish Razi Zaidi [mailto:tabish.razizaidi@utas.edu.au]
Sent: Friday, 19 March 2021 14:14
To: Stephanie De Rapper <Stephanie.DeRapper@wits.ac.za>
Cc: Devina Chetty <981303@students.wits.ac.za>
Subject: Re: Request for permission to use research tool - Weier et al 2017

Hi Stephanie,
That would be fine. Please let me know if you need a greater involvement.

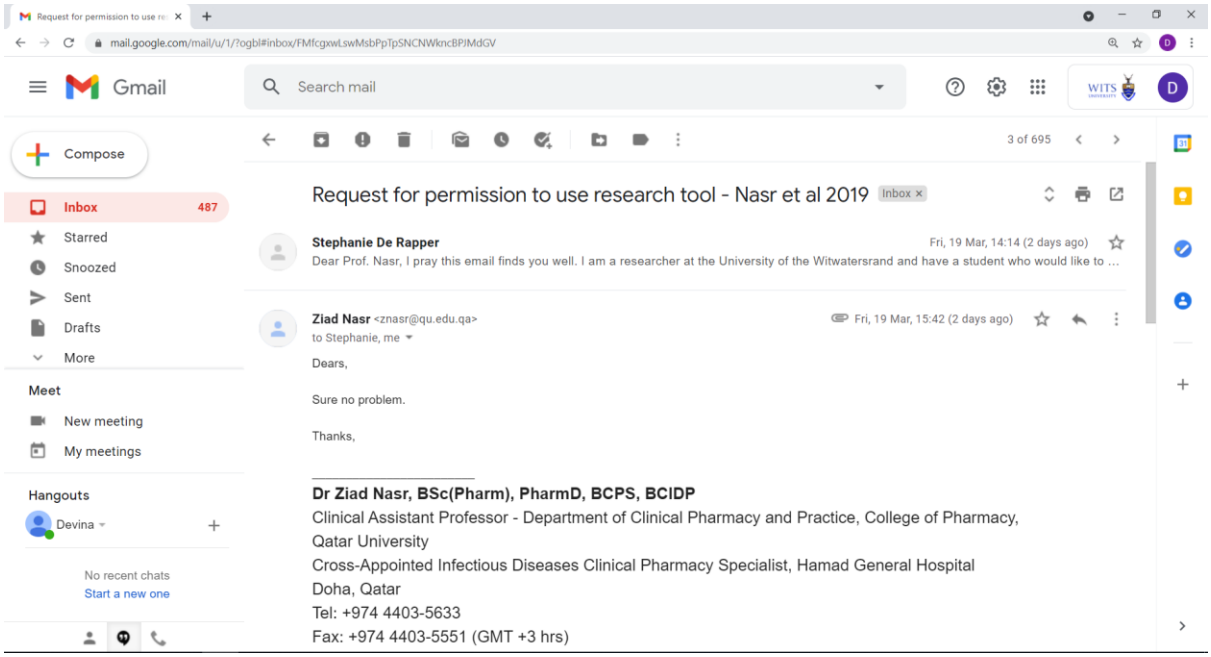
Kind regards,
Tabish

On 19 Mar 2021, at 12:09 pm, Stephanie De Rapper <Stephanie.DeRapper@wits.ac.za> wrote:

Dear Dr. Zaidi,

I pray this email finds you well.

I am a researcher at the University of the Witwatersrand and have a student who would like to conduct research on the gaps between undergraduate teaching and practice for clinical pharmacy in South Africa.
The student came across your research entitled, "*Pharmacist participation in antimicrobial stewardship in Australian and French hospitals: a cross-sectional nationwide survey*" and found it fitting for her study.



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3 of 695

Request for permission to use research tool - Nasr et al 2019 Inbox ×

Stephanie De Rapper Fri, 19 Mar, 14:14 (2 days ago)
Dear Prof. Nasr, I pray this email finds you well. I am a researcher at the University of the Witwatersrand and have a student who would like to ...

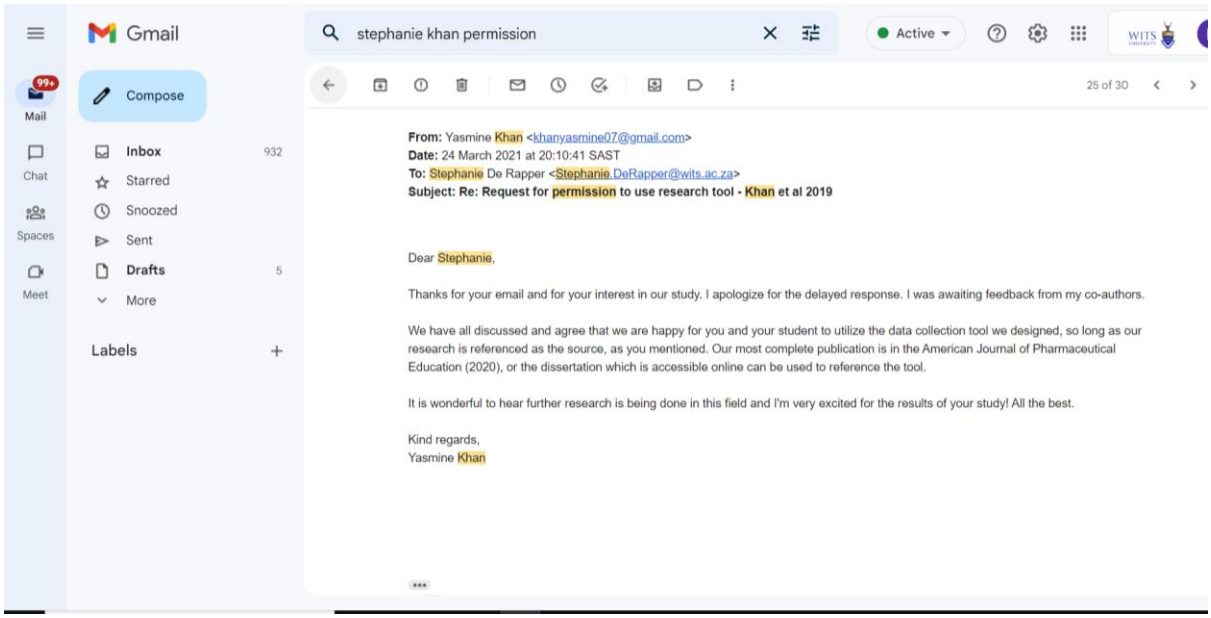
Ziad Nasr <znasr@qu.edu.qa> Fri, 19 Mar, 15:42 (2 days ago)
to Stephanie, me

Dears,

Sure no problem.

Thanks,

Dr Ziad Nasr, BSc(Pharm), PharmD, BCPS, BCIDP
Clinical Assistant Professor - Department of Clinical Pharmacy and Practice, College of Pharmacy, Qatar University
Cross-Appointed Infectious Diseases Clinical Pharmacy Specialist, Hamad General Hospital
Doha, Qatar
Tel: +974 4403-5633
Fax: +974 4403-5551 (GMT +3 hrs)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25 of 30
From: Yasmine Khan <khanyasmine07@gmail.com>
Date: 24 March 2021 at 20:10:41 SAST
To: Stephanie De Rapper <Stephanie.DeRapper@wits.ac.za>
Subject: Re: Request for permission to use research tool - Khan et al 2019
Dear Stephanie,
Thanks for your email and for your interest in our study. I apologize for the delayed response. I was awaiting feedback from my co-authors.
We have all discussed and agree that we are happy for you and your student to utilize the data collection tool we designed, so long as our research is referenced as the source, as you mentioned. Our most complete publication is in the American Journal of Pharmaceutical Education (2020), or the dissertation which is accessible online can be used to reference the tool.
It is wonderful to hear further research is being done in this field and I'm very excited for the results of your study! All the best.
Kind regards,
Yasmine Khan

Appendix B: Study tool: Exploring the attitudes knowledge and perceptions of clinical pharmacists' towards AMS participation and training in South Africa

Question 1 - Demographics

1.1 What is you sex?

- ☐ Male
- ☐ Female

1.2 What is your age?

- ☐ 20-29 years old
- ☐ 30-39 years old
- ☐ 40-49 years old
- ☐ 50-59 years old
- ☐ 60 years and older

1.3 What is your qualification?

- ☐ Dip.Pharm
- ☐ B.Pharm
- ☐ M. Pharm
- ☐ Pharm

1.4 How many years of experience do you have?

- ☐ < 1 year
- ☐ 1-4 years
- ☐ 5-9 years
- ☐ 10 years and more

1.5 In which sector are you employed?

- ☐ Private sector
- ☐ Public sector

1.6 What is your current position?

- ☐ Pharmacist
- ☐ Ward Pharmacist
- ☐ Senior Pharmacist
- ☐ Clinical Pharmacist
- ☐ Assistant Pharmacy Manager
- ☐ Pharmacy Manager

1.7 Is there an antimicrobial stewardship program were you work?

- ☐ Yes
- ☐ No

Objective 1: To determine the attitudes knowledge and perceptions of clinical pharmacists' towards their role and participation in AMS.

Question 2: Perceptions and knowledge towards AMS

Please select the extent to which you agree or disagree with the following statements

SD=strongly disagree; D=disagree; N-neither disagree or agree; A=agree; SA= strongly agree

	SD	D	N	A	SA
1. AMS is a set of coordinated initiatives to promote the appropriate and judicious use of AMS					
2. Goals of AMS is to seek to achieve;					
a. Increased use of AMS					
b. Reduce hospital stay					
c. Decrease duration of therapy to ensure therapeutic efficacy					
d. Optimize AMS use					
e. Reduce AMR					
3. AMS team should consist of a multidisciplinary team including a physician, infectious disease specialist, pharmacist and a microbiologist					
4. Pharmacists play a critical role in AMS					
a. To promote optimal use of AMS					
b. Educate health care professionals					
c. Lead and support AMS					
d. Recommend appropriate therapy or de-escalate					

Question 3: Participation in AMS

3.1 Please rate the level of participation in the following AMS activities

(Sliding scale 0-10; 0=never and 10=always)

	0	1	2	3	4	5	6	7	8	9	10
1. I screen antibiotic prescriptions in accordance with local AMS guidelines before dispensing											
2. I collaborate with other health care professionals if need be before I dispense an AMS prescription											
3. I communicate with the prescriber if I am unsure about the											

appropriateness of an antibiotic prescription											
4. I am confident when I communicate with prescribers regarding and AMS prescription											
5. I sought additional clinical information (drug interactions; ADRS, allergies) before deciding to dispense the Antibiotic prescribed											
6. I take part in AMS campaigns to promote rational use of AMS											
7. I educate patients on appropriate use and resistance related issues											
8. I monitor antibiotic duration											
9. I monitor antibiotic consumption											
10. I participate in AMS rounds											

Question 4: Factors Limiting Participation

Please rate the extent to which the following factors may limit participation in AMS

(0 = no impact and 10=great impact)

	0	1	2	3	4	5	6	7	8	9	10
1. Number of pharmacists											
2. Participation won't make a difference											
3. Lack of support from hospital administration											
4. Time spent on other activities (paper-work, dispensing, stock management)											
5. Poor communication between prescriber and pharmacists											

6. Poorly established AMS committee											
7. Limited knowledge on appropriate AMS utilization											
8. Lack of confidence											
9. Pharmacists advise not creditable and/or not well received by doctors											
10. Prescribers not willing to engage with pharmacist regarding antibiotic prescribing											
11. Doctors not caring about antibiotic prescribing or restriction											
12. Lack of education and training in AMS											

Objective 2: To explore clinical pharmacists' perception on the relevance of pharmacy training on pharmacy practice with regards to AMS.

Question 5: Acquire Knowledge on AMS

Where are you most likely to receive knowledge and training on infectious diseases and AMS?

	Never	Rarely	Occasionally	Often	Always
1. Undergraduate program					
2. Master's program					
3. Short Courses initiated by self					
4. Short courses initiated by employer					
5. CPD activities					
6. Conferences, workshops or other educational activities are required					

Question 6: Where do you think a comprehensive course in AMS and infectious disease would be most beneficial

SD=strongly disagree; D=disagree; N-neither disagree or agree; A=agree; SA= strongly agree

	SD	D	N	A	AS
1. Undergraduate program					
2. Master's Program					
3. CPDs					
4. Short courses					

Question 7: How did your studies during university prepare you to for this role?

(Sliding scale: 0=did not prepare me at all; 10=adequately prepared me

	0	1	2	3	4	5	6	7	8	9	10
Undergraduate B. Pharm studies											
Postgraduate M. Pharm studies											

Question 8: If an AMS module were to be included in an undergraduate program, how would you rate the importance of the following topics? From Khan, et al., 2016

	LOW	MODERATE	HIGH
1. Infectious diseases			
2. Choice of Agent			
3. Standard treatment guideline compliance			
4. IV to Oral switch			
5. Dose optimization			
6. Patient individualization			
7. Therapeutic Drug Monitoring			
8. Surgical Prophylaxis			
9. Diagnostic stewardship			
10. Infection and prevention control			
11. Case Study analysis			
12. Quality improvement and documenting			
13. Antimicrobial Stewardship teams and ward rounds			
14. Team dynamics			
15. Interpersonal and communication skills development			

Question 9: How would you rate the following approaches for improving undergraduate AMS coverage?

(Sliding Scale: 0= do not include; 10: highly rated must be included

	0	1	2	3	4	5	6	7	8	9	10
Didactic lectures											

(A didactic lecture is a scientific oral delivery of information in a systematic and organized manner by an individual who is competent in the field)											
Integrated case based learning											
Problem based learning sessions											
Early clinical internships											
Small group class assignments and case study analysis											

Appendix C: Ethics Approval

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG	HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

Office of the Deputy Vice-Chancellor (Research and Innovation)

TO: Ms D Chetty
School of Therapeutic Sciences
Department of Pharmacy and Pharmacology
Medical School
University

E-mail: 981303@students.wits.ac.za

CC: Supervisor: Ms S de Rapper
<Stephanie.deRapper@wits.ac.za>
and <HREC-Medical Research Office@wits.ac.za>

FROM: Mr Iain Burns
Human Research Ethics Committee (Medical)
Tel: 011 717 1252

E-mail: Iain.Burns@wits.ac.za

DATE: 2021/12/07

REF: R14/49

PROTOCOL NO: **M210937** (This is your ethics application reference number. Please quote it in all enquiries, oral or written, relating to this study.)

PROJECT TITLE: *Exploring the attitudes knowledge and perceptions of clinical pharmacists on AMS participation and the discord between pharmacy education and clinical practice*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to Government funding of the University.

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Devina

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On Sat, 21 Jan 2023 at 19:48, Stephanie De Rapper <Stephanie.DeRapper@wits.ac.za> wrote:

Hi Devina,

Please include this email below as an appendix in your final write up.

Thanks and regards,

Dr. Stephanie Leigh-de Rapper BPharm, MPharm, PhD
Head of Division and Lecturer: Pharmacy Practice| Department of Pharmacy and Pharmacology

e: stephanie.derapper@wits.ac.za

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