Antimicrobial stewardship in Australian private hospitals

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Abstract

Background: Current literature on the development of organisation-wide antimicrobial stewardship programs has largely been confined to public hospitals. There is limited information available on how these programs need to be modified to accommodate differences in types of hospitalised care. Private hospitals contribute more than 40% of all hospital beds in Australia, however, it is unknown if antimicrobial stewardship is occurring in these healthcare facilities. Additionally, there is currently no information available on how to tailor antimicrobial stewardship programs to suit the Australian private hospital setting.

Aims: The aim of this thesis is to determine the requirements for successful and sustained implementation of antimicrobial stewardship programs within Australian private hospitals, with specific focus on characteristics unique to the private hospital sector.

Methods: Survey work was undertaken to determine antimicrobial stewardship program activity, governance and resources currently utilised in the private hospital sector, whilst assessment of appropriateness of antimicrobial therapy was carried out through a series of point prevalence surveys of large private hospitals. Given the discovery that private hospitals often lacked local experts, or relied on nursing staff to conduct audits of antimicrobial use, an inter-rater reliability analysis was subsequently conducted to determine if different types of assessors including offsite experts could reliably make appropriateness assessments of prescriptions using the survey tool. Attitudinal surveys were used to explore perceptions and attitudes towards antimicrobial resistance and the motivation to participate in antimicrobial stewardship activities among key healthcare professionals in private hospitals. Finally, qualitative work sought to further explore organisation factors and potential barriers that may limit antimicrobial stewardship implementation in the private hospital sector.

Results: There are limited antimicrobial stewardship activities currently occurring in Australian private hospitals. Additionally, most private hospitals do not currently have the governance structure or resources to implement antimicrobial stewardship programs that mirror those established in the public hospitals. Antimicrobial prescribing practices in private hospitals indicate a large number of prescriptions used for surgical prophylaxis, with a significant proportion of this use being inappropriate, mainly due to prolonged duration. Regular auditing
of antimicrobial prescribing by experienced auditors is needed in the private sector. Results show that pharmacists can reliably assess antimicrobial prescriptions, if these are assessed using national prescribing guidelines, and offsite expert teams can be utilised to make consistent assessments. For antimicrobial stewardship to be successfully implemented, however, nurses and surgeons, in particular, will need to be made aware of the benefits of antimicrobial stewardship. Results also reveal that hospital executives can play an additional role in marketing AMS as best practice to their VMOs and patients, both of whom have been described as customers for private hospitals.

**Conclusions:** As effective hospital-wide antimicrobial stewardship programs need to have multidisciplinary input, engaging all stakeholders involved in the use of antimicrobials needs to be a priority in private hospitals. These hospitals will need to determine the role of nursing staff, pharmacists and hospital management during program implementation. Importantly, once antimicrobial stewardship programs are established, any activities conducted to improve antimicrobial use need to target surgical prophylaxis in particular.
Declaration by author

This is to certify that:

- the thesis comprises only my original work towards the PhD except where indicated in the Preface,

- due acknowledgement has been made in the text to all other material used,

- the thesis is fewer than 100,000 words in length, exclusive of tables, maps, bibliographies and appendices

Signature: [Signature]

IV
Preface

Statement of work carried out in collaboration

Chapter 3 was a nested study of private hospitals that formed part of a larger study of antimicrobial stewardship resources and activities being undertaken by all Victorian hospitals at the time. Dr Kylie McIntosh, Program Manager, Quality Use of Medicines Program, Department of Health, Victorian State Government lead the larger study and assigned data collection and analysis to collaborating research fellows. Menino Osbert Cotta was assigned the data collection and data analyses for the private hospital section of the study, whilst Dr Rodney S James and Ms Susan Luu were assigned the rural and regional hospitals. The larger study entitled, “Antimicrobial stewardship in Victorian hospitals: a statewide survey to identify current gaps” was published in The Medical Journal of Australia (2013; 199(10): 692-695). It does not form a thesis chapter and has been included only in the Appendices of this thesis. Menino Osbert Cotta drafted Chapter 3 of the thesis under the guidance of Associate Professor Caroline Marshall, Professor Danny Liew and senior supervisor Associate Professor Kirsty Buijsing.

Statement of contributions to jointly authored works contained in the thesis

The PhD candidate, Menino Osbert Cotta, undertook the data collection and all data analyses for Chapter 4, 5, 6 and 7 of this thesis. Menino Osbert Cotta drafted these chapters and papers that constitute this thesis under the guidance of the other co-authors.

Chapter 4 led to a published article, entitled: “Using periodic point-prevalence surveys to assess appropriateness of antimicrobial prescribing in Australian private hospitals”. The names and roles of the co-authors are as follows: Dr Megan S Robertson, Dr Lydia M Upjohn, Gerlinnda Amor, Louise Lyons, Vasantha Pather, Cath Savage and Hilary Young assisted with data collection. Dr Lydia M Upjohn assisted with data assessment. Associate Professor Caroline Marshall, Professor Danny Liew and senior supervisor Associate Professor Kirsty L Buijsing oversaw all aspects of the chapter.

Chapter 5 has been accepted and will shortly be published, entitled: “Evaluating antimicrobial therapy: how reliable are remote assessors?”. The names and roles of the co-authors are as follows: Dr Tim Spelman assisted with data analyses with specific input into use of correlational statistics. Ms Caroline Chen and Dr Rodney S James assisted with recruiting
remote assessors and retrieving antimicrobial prescription data. Associate Professor Karin A Thursky, Associate Professor Caroline Marshall, Professor Danny Liew and senior supervisor Associate Professor Kirsty L Buising oversaw all aspects of the chapter.

Chapter 6 led to a published article, entitled: “Attitudes towards antimicrobial stewardship: results from a large private hospital in Australia”. The names and roles of the co-authors are as follows: Dr Megan Robertson assisted with conceptualising the study and recruitment. Mr Mark Tacey assisted with data analyses with specific input into analysis of Likert scales. Associate Professor Karin A Thursky, Associate Professor Caroline Marshall, Professor Danny Liew and senior supervisor Associate Professor Kirsty L Buising oversaw all aspects of the chapter.

Chapter 7 led to a published article, entitled: “Implementing antimicrobial stewardship in the Australian private hospital system: a qualitative study”. The names and roles of the co-authors are as follows: Dr Megan S Robertson assisted with refining structured interview questions and recruitment of participants. Associate Professor Caroline Marshall and Associate Professor Kirsty Buising assisted with facilitating the focus group discussions and interpreting the data. Professor Elizabeth Manias provided advice on qualitative methodology. Associate Professor Karin A Thursky, Associate Professor Caroline Marshall, Professor Danny Liew and senior supervisor Associate Professor Kirsty L Buising oversaw all aspects of the chapter.

**Statement of contributions by others to the thesis as a whole**

I wish to acknowledge the significant contribution made to this thesis by Associate Professor Kirsty L Buising and Associate Professor Caroline Marshall (University of Melbourne). Associate Professor Buising and Associate Professor Marshall had a significant role in the conceptualisation and design of all studies within this thesis. Both supervisors also provided assistance with drafting of thesis chapters.

**Statement of work submitted for other qualifications**

None

**Statement of work carried out prior to PhD candidature enrolment**

None
Published works by the author incorporated into the thesis

Journal articles

Cotta MO, Robertson MS, Upjohn LM, Marshall C, Liew D, Buising KL. Using periodic point-prevalence surveys to assess appropriateness of antimicrobial prescribing in Australian private hospitals. Internal Medicine Journal 2014; 44(3): 240-6. – Incorporated as Chapter 4


Additional published works by the author relevant to the thesis but not forming part of it

Book Chapters


Journal articles


**Cotta MO**, Chen C, Tacey M, James RS, Buising KL, Marshall C, Thursky KA. What are the similarities and differences in antimicrobial prescribing between Australian public and private hospitals? Submitted to *Internal Medical Journal*.

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**Conference publications**

**Invited oral presentations**

**Cotta MO**. “AMS implementation in private hospitals.” Western Australian Committee for Antimicrobials Symposium, Perth, June 2015.

**Cotta MO**. “Implementing stewardship: perceptions among key health professional groups.” Australasian College for Infection Prevention and Control Conference, Gold Coast, October 2013.

**Cotta MO**. “Antimicrobial Stewardship (AMS) in Private Hospitals.” Society of Hospital Pharmacists of Australia Infectious Diseases Seminar, Melbourne, August 2013.


**Oral presentations**


Poster presentations
Cotta MO, Robertson MS, Marshall C, Thursky KA, Liew D, Buising KL. “How antimicrobial stewardship can be introduced to Australian private hospitals: a qualitative study.” Melbourne Health Research Week, Melbourne, June 2014.


**Cotta MO, Robertson MS, Tacey M, Marshall C, Thursky KA, Liew D, Buising KL.** “It’s a matter of attitude! An antimicrobial stewardship survey among visiting specialists, nurses and pharmacists.” Australian Society for Antimicrobials Scientific Meeting, Melbourne, February 2014.


**Cotta MO, Upjohn LM, Robertson MS, Marshall C, Liew D, Buising KL.** A Point Prevalence Study (PPS) measuring surgical prophylactic use of antimicrobials at a large private hospital. Society of Hospital Pharmacists of Australia National Conference, Canberra, November 2012.
I would like to acknowledge funding support provided by the National Health and Medical Council of Australia, the University of Melbourne and the Queensland Infectious Diseases Pharmacist Interest Group.

The work for this thesis has been undertaken under the guidance of senior supervisor Associate Professor Kirsty Buising, Victorian Infectious Diseases Service at the Peter Doherty Institute for Infection and Immunity. Co-supervision has been provided from Associate Professor Caroline Marshall, Department of Medicine, Royal Melbourne Hospital Campus, University of Melbourne and Professor Danny Liew, Chair in Clinical Epidemiology, at the University of Melbourne.

My sincere thanks to Associate Professor Kirsty Buising and Associate Professor Karin Thursky for developing the research topic, and to Professor Michael Richards for his support. I am also very grateful to Dr Megan Robertson for her mentorship during my fieldwork at Epworth HealthCare.

I would like to acknowledge my fellow research colleagues at the Victorian Infectious Diseases Service including Dr Rodney James, Dr Lydia Upjohn, Ms Susan Luu. I am also grateful to have undertaken collaborative work with Dr Kylie McIntosh and Ms Caroline Chen as part of this thesis.

Thank you to Dr David Kong for providing feedback and advice during my PhD confirmation and progress meetings.

I would like to extend my gratitude to Mr Sean McGuigan, Mr Mark Tacey and Dr Tim Spelman for providing statistical support for work undertaken in this thesis.

I wish to thank my parents Odette and Olavo, my sister Amanda and her husband Johann and their children Lachlan and Erica, my brother Oolvic, my parents-in-law Mary Ann and Aurio as well as my brother-in-law John Paul for their unwavering support and encouragement that lead to completion of this work.
I am extremely grateful to my beautiful wife, Virginia, for sharing this journey. Thank you for inspiring, encouraging and, most importantly, being there for me always.

To my wonderful sons, Yannick and André, I dedicate this thesis to both of you and hope it serves as a reminder of how your undoubted potential can be fulfilled through passion and determination.
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<th>Description</th>
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<tr>
<td>ACSQHC</td>
<td>Australian Commission on Safety and Quality in Health Care</td>
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<tr>
<td>AIHW</td>
<td>Australian Institute of Health and Welfare</td>
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<tr>
<td>AMS</td>
<td>Antimicrobial Stewardship</td>
</tr>
<tr>
<td>AMT</td>
<td>Antimicrobial Management Team</td>
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<tr>
<td>APS</td>
<td>Antimicrobial Prescribing Survey</td>
</tr>
<tr>
<td>ASE</td>
<td>Attitude, Social and Self-Efficacy</td>
</tr>
<tr>
<td>AUD</td>
<td>Australian Dollar (currency)</td>
</tr>
<tr>
<td>CDSs</td>
<td>Computerised decision support systems</td>
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<tr>
<td>ESBL</td>
<td>Extended-spectrum β-lactamase</td>
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<tr>
<td>FGD</td>
<td>Focus Group Discussion</td>
</tr>
<tr>
<td>ICP</td>
<td>Infection control practitioners</td>
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<tr>
<td>ICU</td>
<td>Intensive Care Unit</td>
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<tr>
<td>ID</td>
<td>Infectious Diseases</td>
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<tr>
<td>IDSA</td>
<td>Infectious Diseases Society of America</td>
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<tr>
<td>IQR</td>
<td>Inter-quartile range</td>
</tr>
<tr>
<td>ITS</td>
<td>Interrupted Time Series</td>
</tr>
<tr>
<td>MALDITOFF</td>
<td>Matrix Assisted Laser Desorption Ionization Time-of-Flight</td>
</tr>
<tr>
<td>MDR</td>
<td>Multi-drug resistant</td>
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<tr>
<td>MRSA</td>
<td>Methicillin resistant <em>Staphylococcus aureus</em></td>
</tr>
<tr>
<td>MS</td>
<td>Mass Spectrometry</td>
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<tr>
<td>NAPS</td>
<td>National Antimicrobial Prescribing Survey</td>
</tr>
<tr>
<td>NAUSP</td>
<td>National Antimicrobial Utilisation Surveillance Program</td>
</tr>
<tr>
<td>NHMRC</td>
<td>National Health and Medical Research Council</td>
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<td>NHPA</td>
<td>National Health Performance Authority</td>
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<tr>
<td>NSQHS</td>
<td>National Safety and Quality Health Service</td>
</tr>
<tr>
<td>OLT</td>
<td>Operant Learning Theory</td>
</tr>
<tr>
<td>PCR</td>
<td>Polymerase Chain Reaction</td>
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<tr>
<td>SAP</td>
<td>Surgical antibiotic prophylaxis</td>
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<tr>
<td>SD</td>
<td>Standard deviation</td>
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<tr>
<td>SES</td>
<td>Socio-economic status</td>
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<tr>
<td>SHEA</td>
<td>Society of Healthcare Epidemiology of America</td>
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<tr>
<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>TAM</td>
<td>Technology Acceptance Model</td>
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<tr>
<td>TIB</td>
<td>Theory of Interpersonal Behaviour</td>
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<tr>
<td>TPB</td>
<td>Theory of Planned Behaviour</td>
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<tr>
<td>TPN</td>
<td>Total parenteral nutrition</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
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<tr>
<td>US</td>
<td>United States</td>
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<tr>
<td>USD</td>
<td>United States Dollar (currency)</td>
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<tr>
<td>VAP</td>
<td>Ventilator-associated pneumonia</td>
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<tr>
<td>VMO</td>
<td>Visiting Medical Officer</td>
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<tr>
<td>VRE</td>
<td>Vancomycin-resistant enterococci</td>
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THESIS CHAPTERS
Chapter 1  Introduction

1.1  Background
Antimicrobial stewardship (AMS) activities have been associated with improving antimicrobial prescribing practices and to a more limited extent, minimising ecological impact, however, there is still a significant gap in the literature on linking the suitability of AMS strategies to the characteristics of particular hospitals and their delivery of healthcare. Indeed, there may be a form of publication bias whereby only the effective AMS programs are reported, with failures not evaluated on how or why AMS strategies may have been ineffective in certain hospital settings. Thus, there is still a degree of uncertainty on what factors within healthcare and hospital systems may influence success of a hospital-wide AMS program and vice versa.

As AMS programs are increasingly being incorporated in mandatory accreditation standards for hospitals and healthcare institutions, further exploration of these factors is warranted. This may be of particular importance in countries where there are discernible differences between types of healthcare systems within the same country. The public and private hospital systems that co-exist in Australia have noticeable differences in terms of origin, on-going funding, control and regulation, geographical distribution, as well as quantitative differences in health services provided and types of patients treated. These differences have no doubt been influential in how these two types of hospitals function, with stark contrasts in how health services are delivered to patients and how doctors work within each of these systems.

Based on these differences, it is clear that specific work needs to be done to understand the Australian private hospital context and begin to examine what might be barriers and facilitators for AMS in these settings. This work needs to be done to avoid money being spent on AMS programs that are destined to fail largely because of assumptions that programs designed for the Australian public hospital sector will work adequately in private hospitals.

Specific drivers for AMS in the Australian private hospital sector will need to be more clearly defined. Influences such as the impact of mandatory accreditation and the private hospital’s relationship with doctors will need to be further explored along with what AMS resources and governance structure currently exist in the private hospital sector. Investigating private hospital antimicrobial use in order to determine what areas of antimicrobial prescribing will
need to be targeted by AMS initiatives will be an important first step. Additionally, investigating the scope of benchmarking quality-based indicators such as ‘appropriateness’ of antimicrobial prescribing through the use of validity studies may be pertinent towards producing a key performance indicator for AMS.

Surveying attitudes and perceptions towards AMS among clinical stakeholders such as visiting medical officers (VMOs), nurses, pharmacists and hospital managers will also be of relevance in the context of hospital-wide implementation, with the use of qualitative methods potentially providing some meaningful data on how a private hospital model for AMS may look like in the Australian healthcare setting.

1.2 Aims and objectives
The aim of this thesis is to determine the requirements for successful and sustained implementation of AMS programs within Australian private hospitals, with specific focus on characteristics unique to the private hospital sector.

The objective of this thesis is to develop specific recommendations for implementing AMS programs in Australian private hospitals based on these findings.

1.3 Hypothesis
The main hypothesis for this thesis is that strategies for AMS implementation will need to be tailored to take into account the specific and unique characteristics that are intrinsic to the private hospital sector in Australia.

1.4 Overview of thesis
The thesis is structured into eight main chapters: 1) Introduction, 2) Literature review detailing the background for antimicrobial stewardship in the Australian private hospital sector, 3) Investigation of antimicrobial stewardship governance structure, resources and activities in private hospitals across Australia, 4) Surveying and assessing antimicrobial prescribing practices at large private hospitals to describe patterns of use and attempt to evaluate appropriateness of prescribing, 5) Inter-rater reliability analysis of assessments of appropriateness of antimicrobial prescriptions to inform future auditing practice, 6) Survey of
the attitudes, perceptions and willingness to participate in AMS amongst private hospital staff, 7) Focus group discussion exploring organisational factors and barriers as well as potential solutions for antimicrobial stewardship implementation in Australian private hospitals, and 8) Discussion of results presented in this thesis.
Chapter 2  Literature Review

2.1  Aim

The aim of this review is to examine existing literature and concepts that need to be considered for implementation of antimicrobial stewardship (AMS) in Australian private hospitals. This chapter will first discuss what AMS strategies and modalities currently exist in hospitals and briefly review the literature evaluating effectiveness of hospital-wide AMS programs. An overview of the Australian hospital system will be presented, paying specific attention to key differences between the public and private hospital sectors in Australia. This will be followed by a review of any information available regarding AMS in the private hospital sector and what drivers are currently prompting action in this area. Finally, future research direction will be discussed and the need for further work as proposed in this thesis will be summarised.

2.2  Why we need antimicrobial stewardship – the threat of antimicrobial resistance

Optimising therapy to ensure the best clinical outcomes for patients has been a challenge in all medication classes, but the threat of resistance to therapeutic effectiveness has remained firmly with antimicrobial agents since the dawn of the ‘antibiotic era’ over 70 years ago. In fact, there is still associated selection pressure on microorganisms, resulting in emergence of antimicrobial resistant pathogens even when antimicrobial use is considered ‘appropriate’. Clinicians therefore face an ongoing ‘balancing act’; ensuring effectiveness of antimicrobial therapy, which often has to be empiric in the face of unidentified pathogens, while limiting the emergence and spread of such pathogens rendered multi-resistant.

Worryingly, the last 20 years has seen an alarming increase in world-wide prevalence of bacterial pathogens resistant to antimicrobial drugs. Bacterial antimicrobial resistance has now been identified as one of five major threats to mankind by the World Health Organisation as part of its Global Patient Safety Challenge. A situation where some infections can no longer be treated with available antimicrobials has been described as a public health crisis of the
highest order, and has desperately called for the research and development of novel antimicrobial agents by lead organisations such as the Infectious Diseases Society of America (IDSA). However, there is a belief that development of newer antimicrobials is now lagging behind growing clinical need for such agents, and so there has to be either a new paradigm in treating infections, or more realistically in the short term, preservation of current antimicrobial resources.

It is also evident from a number of clinical studies in hospitalised patients that antimicrobial resistance is associated with increased length of hospital stay, mortality and associated healthcare costs. A recent analysis of the economic impact of antimicrobial resistance found costs in the United States to be higher than the initially projected USD $55 billion annually. Costs were attributable to healthcare expenditure as well as lost productivity.

The most concerning aspect of growing antimicrobial resistance is that it is no longer a future threat to mankind. There are now some regions in the world with frequent scenarios of untreatable infections. Thus, preserving current antimicrobial resources, under the banner of ‘stewardship’ currently represents the most effective strategy to stem the tide of accelerating antimicrobial resistance and is now recommended by a number of professional societies worldwide.

### 2.3 Antimicrobial stewardship in hospitals

The term ‘antimicrobial stewardship’ gained prominence after guidelines were published by the Society of Healthcare Epidemiology of America (SHEA) and IDSA joint committee on the prevention of antimicrobial resistance in hospitals. AMS is defined as activities that help optimise antimicrobial therapy; that is, ensuring the best clinical outcome for the patient, while endeavouring to lower the risk of subsequent development of antimicrobial resistance.

AMS programs typically involve a suite of activities that are undertaken in a planned way within an organisation or location. Although these initiatives to combat growing antimicrobial resistance were first grouped under ‘antimicrobial stewardship’ in 1997, activities that have
subsequently been termed as AMS had been taking place in healthcare facilities for a number of years prior.\textsuperscript{14}

AMS programs have historically been utilised in acute care hospitals (termed ‘hospital-wide AMS programs’) and for good reason; there are anywhere between one to two-thirds of patients on antimicrobial therapy at any one time,\textsuperscript{15} and up to half of antimicrobial regimens prescribed may be ‘inappropriate’.\textsuperscript{1,16,17} It is believed that altering antimicrobial use through interventions will help curtail accelerating antimicrobial resistance,\textsuperscript{18} an ever-increasing threat to effectively treating patients in these facilities.\textsuperscript{19,20} It is also in hospitals that much of the consequence of antimicrobial resistance is seen; hence the visible consequences of poor practice can serve as a driver for change. This should not diminish the important role of improving antimicrobial use in the community (such as general practice and residential aged care) and in non-human sectors (such as agricultural use, livestock for food production and domestic animals). It is, however, in hospitals where most AMS activity has initially been centred, and so will be the focus of this review.

\subsection*{2.4 AMS strategies: categorisation and modalities}

Activities or strategies considered part of a hospital-wide AMS program have previously been categorised in terms of when they occur in relation to time of initial antimicrobial prescription, with ‘front-end’ strategies occurring prior to the antimicrobial being prescribed, and ‘back-end’ strategies taking place after initial prescription.\textsuperscript{2,21}

More recently, a Cochrane Collaboration grouped these strategies in terms of how they influenced prescriber autonomy.\textsuperscript{22} AMS strategies were viewed as 1) ‘persuasive’, in which advice or feedback is given about how to prescribe antimicrobials, 2) ‘restrictive’, by placing some sort of limits on prescription of antimicrobials, and 3) ‘structural’, in terms of introduction of new technologies used for diagnostic, prescription and quality monitoring. Figure 2.1 combines the above two categorisations of AMS strategies and has been adapted based on a previous review of AMS in the intensive care unit (ICU).\textsuperscript{23} Importantly, the AMS strategies shown only represent some of the strategies utilised in a hospital-wide program. Strategies in AMS can incorporate use of tools and resources,\textsuperscript{24} as well as changes in rules and
processes and may result in altering what prescribers have available to assist them, and/or their prescribing behaviour.

Figure 2.1: Categorisation of AMS strategies

2.4.1 Restrictive AMS strategies

*Antimicrobial restriction – closed antimicrobial formulary*

Restriction of the hospital antimicrobial formulary is a key pre-prescription strategy utilised by many hospitals and has previously been described as one of two foundational strategies of an AMS program.\(^{25}\) Many hospitals operate with a ‘closed formulary’ for medications, which is governed by the hospital’s medication and therapeutics committee or equivalent. Therapeutic agents are required to be evaluated in terms of efficacy and safety by this committee prior to inclusion onto the formulary, often with restrictions and conditions on their use within the hospital.

A restriction-based antimicrobial formulary provides a hospital-wide mechanism to regulate antimicrobial use and although it has been shown to be effective in controlling nosocomial epidemics,\(^ {26}\) effectiveness in decreasing prevalence rates of select multi-resistant organisms has not been conclusively shown.\(^ {27–29}\)
Antimicrobial restriction – pre-approval

Pre-approval or pre-authorisation is a front-end restrictive strategy that goes hand-in-hand with formulary restriction and allows a healthcare facility to control the level of antimicrobial use. It essentially entails restricting selected antimicrobials by way of an approval process whereby authorised approvers must be contacted prior to prescription of these restricted antimicrobials. As approvers of these restricted agents generally tend to have a background in either infectious diseases (ID) or clinical microbiology, the approval process has an added benefit in that it has the potential to allow for expert review of the clinical indication for antimicrobial therapy and encourages advice based interaction with prescribers. Although pre-approval of antimicrobial therapy may be onerous from a resources point of view, its use has previously demonstrated significant cost savings and may be an effective strategy if approvers have a good working relationship with prescribers at the hospital.\textsuperscript{30,31}

Selective reporting of antimicrobial sensitivities

After culture of clinically isolated microorganisms, microbiology laboratories test for antimicrobial susceptibilities to help guide therapy for treating clinicians. Reporting of these susceptibility results is vital in order for therapy to be targeted. However, as the number of antimicrobials tested can be large and in some cases not ideal as a treatment option due to lack of clinical efficacy at the site of infection or a high propensity to induce antimicrobial resistance, many microbiological laboratories may choose only to report selected antimicrobial susceptibilities.

Commonly called ‘cascade reporting’, susceptibility results for broader spectrum antibiotics are only released if the pathogen has demonstrated resistance to narrower spectrum therapeutic options, according to a pre-determined algorithm or hierarchy. These reported antimicrobial sensitivities should ideally be consistent with hospital treatment guidelines, and appropriate for use in infections relevant to the type of clinical specimen (eg nitrofurantoin for isolates from urine samples but not blood cultures).\textsuperscript{32} This effectively places restriction on what antimicrobials clinicians have information about, but the benefit of this strategy is that it can help simplify treatment choices and direct prescribers towards more appropriate options.\textsuperscript{33}
2.4.2 Persuasive AMS strategies

*Education*
Use of face-to-face teaching sessions, ‘in-services’, email communication and online education packages all form part of a passive education program that can be utilised to inform clinical stakeholders who are involved in day to day use of antimicrobials. However, it is important to note that very few hospital-wide programs have achieved success in improving antimicrobial prescribing practices using education alone. In order for educational initiatives to be effective, they have typically been accompanied by active strategies such as prospective review of antimicrobial prescriptions with direct feedback to prescribers. Medical student curricula with structured elements of teaching on antimicrobial use have increasingly been reported as deficient in preparing junior doctors for real world antimicrobial related issues, and so it is important to continually evaluate educational content to ensure clinically relevance.

*Clinical guidelines and pathways*
Promotion of clinical guidelines and pathways provides a more specific persuasive-based AMS activity than general education. Practice-based guidelines are usually designed for clinical scenarios such as community-acquired pneumonia and are primarily formulated to guide in the management of patient care. Guidelines can be broad or quite specific and are usually developed using the following: review of relevant literature, opinions and experiences of field experts, and clinical judgements of the authors. Prescribing guidelines at a national level, such as in Australia, have been effective in changing prescribing practice. Although use of clinical guidelines may provide better guidance for clinicians to effectively streamline antimicrobial therapy, thus being a viable AMS intervention, clinical information at the patient level must still be considered when determining overall management. Clinical guidelines must be able to permeate to targeted audiences, otherwise they will seldom lead to desired changes in practice. Active dissemination, promotion, and endorsement of guidelines by clinical leaders is important with access and usability at the prescriber level being critical in order for guidelines to be effective.

*Specialist review*
Interventions through prospective audit or review of antimicrobial prescriptions together with subsequent intervention and feedback to the prescriber have been a valued component to
hospital-wide AMS programs for a number of years. Specialists in ID, clinical microbiology and pharmacy have all played a role in providing ‘specialised advice’ to prescribers, including guiding empiric antimicrobial choice, stepping-down or de-escalating antimicrobial therapy, targeting therapy to identified or suspected pathogens, and promoting a switch from intravenous to oral therapy. There is also a common view in the literature that use of specialist review provides a mechanism of building rapport with prescribers. While access to specialists may come at a cost, there have been circumstances reported in which the impact of suggestions made by the specialist have enabled significant savings in antimicrobial expenditure, and sometimes shortened the length of patient stay in hospital. This, however, cannot always be assumed. As antimicrobial resistance continues to be a threat to patient care, not to mention the ever present ‘collateral damage’ and potential from adverse events that exists with antimicrobial use, expert review of therapy seems to be an advantageous means of delivering AMS at the patient level.

2.4.3 Structural AMS strategies

*Microbiological surveillance and use of antibiograms*

Use of aggregate data on selected clinical isolate susceptibilities in the form of antibiograms is an important structural AMS strategy, especially in areas where susceptibility patterns may differ significantly from the rest of the hospital, such as the ICU and emergency department.

In order for these data to be accurate, however, hospitals need to have clinical microbiology services completely integrated into existing health delivery and in scenarios where there is more than one contracted laboratory, effective communication and exchange of surveillance data needs to occur between services. These cumulative bacterial susceptibility rates and patterns can then form the basis of determining what antimicrobials should be considered for initial empiric therapy and can effectively guide treating clinicians while awaiting culture results.

*Computerised decision support systems*

Electronic or computerised decision support systems (CDSS) are a relatively new AMS tool that has gained significant momentum in the last two decades. Integrating evidence based guidelines with patient information and laboratory results, these systems can link up with
electronic prescriptions and provide treating clinicians with advice on antimicrobial prescribing and infection management.\textsuperscript{52} CDSS has shown some promise in helping curtail antimicrobial resistance, particularly in the ICU.\textsuperscript{53} However, these systems can be resource intensive and integration into a hospital’s clinical workflow needs to be carefully mapped out to ensure successful uptake by end users. In addition, CDSS should be viewed as an adjunct strategy to improve antimicrobial prescribing rather than provide an all-compelling AMS solution.

\textit{Rapid laboratory testing}

As with the compilation and dissemination of antibiograms, rapid laboratory testing requires clinical microbiology services to work closely with hospitals. Use of real-time polymerase chain reaction (PCR) with amplification and Matrix Assisted Laser Desorption Ionization Time-of-Flight (MALDITOF) with mass spectrometry (MS) have both been ground-breaking in how laboratories detect pathogenic micro-organisms.\textsuperscript{54,55} The follow-on effect of utilising these new diagnostic techniques is that antimicrobial use can be expedited from empiric to targeted therapy. As use of broad-spectrum and combination antimicrobial therapy has been shown to correlate with antimicrobial resistance, collateral infections such as \textit{Clostridium difficile}-associated diarrhoea and patient toxicity,\textsuperscript{56,57} rapid streamlining of antimicrobial therapy is an important principle for good AMS.

\textit{Use of biomarkers}

Biomarkers such as procalcitonin are increasingly becoming important in managing bacterial infections, particularly in the setting of sepsis.\textsuperscript{58,59} In terms of an AMS strategy, trends in serum procalcitonin levels have increasing potential to help reduce duration of antimicrobial therapy,\textsuperscript{60,61} a previously described determinant of antimicrobial resistance.\textsuperscript{62} One example of this was a randomised, multicentre clinical trial conducted across seven ICUs which showed nearly a three-day reduction (23% relative reduction) in antibiotic duration in the group randomised to have procalcitonin guided antibiotic therapy.\textsuperscript{61}

\subsection*{2.5 Influences on antimicrobial prescribing behaviour}

Effective AMS is reliant on changing prescribing behaviour in order to favourably alter the pattern of antimicrobial use. As such, it is important for hospital AMS programs to try to better
understand the underlying intentions of antimicrobial prescribers, so that interventions can specifically be modified to target specific prescriber’s motivations and perceptions. There is also a need to understand possible deficiencies in prescriber knowledge that may contribute to poor prescribing practices.

It is critically important to recognise the way that prescribers’ attitudes can affect decision-making. Issues such as preservation of prescriber autonomy, underlying attitudes towards the threat of antimicrobial resistance, tolerance of uncertainty and risk, and workflow priorities all affect behaviour. These influences may be diverse and often conflicting among clinical stakeholders within a large hospital. For example, there may be distinct differences in knowledge and attitudes that affect prescribing behaviours between different specialities that need to be explored and interventions tailored accordingly. Conversely, there may also be universal themes that are consistent among prescribers, such as improving patient cure rates and limiting harm.

Added to this complexity is that as the threat of antimicrobial resistance is now very much part of the political agenda, engagement with non-clinical stakeholders such as hospital managers and policy makers is increasingly important when developing these types of programs. The motivators for non-clinicians are different from those of clinicians and may include priorities such as improving overall compliance with endorsed guidelines and containing costs. Patient expectations may have a powerful effect on prescribing behaviour. It is recognised that the drive to seek antibiotics to manage the same problem varies considerably between different countries, cultures and patient age groups. This may be important when designing AMS interventions. The key issues in one location and one patient cohort may differ from another site.

2.5.1 Need for qualitative research

Quantitative studies are not designed to capture the depth of this information that informs such strategies and so qualitative studies are of increasing value in designing effective and sustainable behaviour change programs in hospitals.

Charani and colleagues believe that current qualitative research techniques have been underutilised in terms of finding the ‘missing links’ between understanding cognitive biases
that underpin prescribing behaviour and designing effective AMS. An example of this is prescriber autonomy. Exploratory work investigating how this influences prescribing behaviour in hospitals may result in a work environment that maintains a degree of autonomy for doctors, but at the same ensures optimal outcomes. Termed ‘choice architecture’, this work setting guides or ‘nudges’ prescribers towards the desired behaviour of prudent antimicrobial prescribing as the default outcome, rather than pressurising them to do so by restricting behaviour.

2.5.2 Understanding behaviour

In the past, poor antimicrobial prescribing practice has sometimes been solely attributed to a lack of knowledge. It has been assumed that if prescribers are given extensive guidelines and advice then practice will improve. Over time, however, researchers in the healthcare field have come to appreciate that decision making is in fact far more complex. Even with access to guidelines or when given information, prescribers still make choices that may be viewed as non-compliant. It is important to appreciate that decision-making is affected by more than knowledge. It can also be influenced by broader issues such as past behaviour or habits, adversity to risk, interaction with peers and workflow. These underlying attitudes, motivations and fears may be extremely influential in prescribing behaviour but may not often be readily voiced by prescribers.

Qualitative research, through the use of interviews and focus group discussions, can help explore these attitudes; however, as noted by Michie and colleagues, findings need to be underpinned by a supporting theory to understand the underlying behaviour. A systematic review of studies utilising social cognitive theories to predict healthcare professionals’ behaviour found a number of applied theories including the theory of planned behaviour (TPB), the technology acceptance model (TAM), the theory of interpersonal behaviour (TIB), the operant learning theory (OLT) and the attitude, social and self-efficacy model (ASE). The review found that the theory of planned behaviour (TPB) was the most widely used and appropriate for this context.

As with other social cognitive models, TPB proposes that prescriber intention precedes behaviour, and that this is influenced by three main areas: 1) underlying attitudes (eg I cannot afford infections in my patients, there is no harm in prescribing longer courses of
antimicrobials), 2) subjective norms about the behaviour (eg all my colleagues prescribe this way) and 3) perceived behaviour controls (eg there is no one available to give me prescribing advice). Previous studies investigating antimicrobial prescribing have successfully utilised TPB as part of their methodology. A study by Cortoos et al incorporated the three described elements of TPB together with habit strength to help predict intention toward using antibiotic guidelines in a hospital. A questionnaire was sent out to all doctors and utilised Likert scales for the TPB elements and a self-reporting index for habit strength. Although multivariate analysis showed that overall intention to use the guidelines was not very predictable, habit strength was a significant predictor of intention among senior doctors, whilst perceived behavioural controls predominated as a predictor of intention among junior doctors. The investigators noted that this divergence in intentions pointed to different approaches to improving guideline use and adherence.

It is interesting to note that although TPB may be useful when used to survey intention it is not always predictive of the actual prescribing behaviour as shown in a cross-sectional, observational study seeking to identify attitudinal factors associated with the prescribing of oral antibiotics in a managed care setting. Results showed that behavioural intentions were significantly associated with both underlying attitudes and subjective norms, however, elements of TPB and prescribing intention did not always predict the observed antibiotic prescribing behaviour. This led to a logical and important conclusion that prescribing behaviour incorporates patient-specific criteria rather than just general beliefs about antibiotics.

As shown by findings from the above studies, TPB may be useful in helping predict underlying intentions as well as identifying divergent intentions, however, it is not designed to change these intentions, therefore other means must be considered when contemplating changing observed prescribing behaviour.

### 2.5.3 Changing behaviour

Qualitative research is often used to articulate underlying beliefs and attitudes, with persuasion and exposure strategies subsequently developed to guide change. One such form of persuasion is social marketing and it has been used to address a variety of social concerns, with its area of deepest penetration being in health-related behaviour.
The social marketing framework has been distinguished from other types of initiatives using six defining criteria.79

(i) Behaviour change is the benchmark used to design and evaluate interventions
(ii) Projects consistently use audience research
(iii) There is careful segmentation of the target audiences
(iv) Creating attractive motivational exchanges with target audiences is the key to strategy
(v) Strategy relies on a complete marketing mix instead of just communication
(vi) Careful attention is paid to the competition faced by the desired behaviour

A further criterion that may be considered imperative in producing behavioural change is that social marketing campaigns must be sustained over several years to have a prolonged impact.80 To this end, effective social marketing can be characterised as being cyclical in nature; terming it ‘the social marketing wheel’.81

In respect to curtailing the use of antimicrobials and associated resistance, large-scale efforts of social marketing have had mixed results. National campaigns in Belgium and France showed promise in reducing community antibiotic use and improving knowledge about antibiotics and their role in general practice respectively,80,82,83 however, two national efforts, both in the UK, were less successful in increasing awareness.84–86

Perhaps utilising the cyclical approach to the social marketing framework, as suggested by Evans, may bring about more positive results in changing knowledge and behaviour.81 One such study that incorporated elements of the social marketing wheel was conducted by Lecky and colleagues.87 Investigators sought to change knowledge and deliver key messages on reducing the spread of infections and unnecessary antibiotic use among children in three countries via a school education resource called e-Bug. The program consisted of two interactive teacher resource packs designed to be used in two different age groups: children aged between 9 to 11 years (junior) and children aged between 12 to 15 years (senior). Each comprised a booklet of detailed lesson plans covering microbes, hygiene, antibiotics and vaccines, a web site hosting complementary games and graphic presentations all of which were designed by microbiologists in conjunction with health and education professionals. The
program was designed on the basis of a previously applied learning theory and pre-testing of the e-Bug pack was conducted in schoolchildren not included in the study. Using a controlled before-and-after study, the investigators were able to show that the e-Bug learning program displayed a significant improvement in student knowledge that was retained after six weeks. Finally, the investigators were able to use the results of this study to further modify both learning packs to further improve student engagement and knowledge retention. Studies such as the above highlight the benefit of marrying elements of behavioural theory with qualitative research and utilising well-informed social marketing to pilot programs prior to widespread implementation.

As a counterpoint, although there is some momentum on the use of social marketing for behavioural change among the public, it has yet to be extensively applied in the setting of influencing behaviour among clinicians. Advocates for the application of the social marketing framework in improving the uptake of interventions among end users (such as antimicrobial guidelines changing prescribing practices) point out that success via the framework can only be attained through engaging end users during the development of the intervention. The VMO stakeholders involved in antibiotic prescribing in private hospitals are varied and there may be very different concerns and motivations between individuals within that group. Evidence of senior doctors involvement in the development of social marketing campaigns to date is limited, and we do not know how well they would be influenced by such campaigns. There may, for example, be resistance to such campaigns if they are not perceived to address the VMOs particular concerns or if their peer group is not seen to have been involved in its development or to have endorsed the activity. Additionally, there is data that providing incentives to clinicians may also help bring about behavioural change. However, besides the use of financial motivation, there has been little exploration of what other incentives may be provided.

Nevertheless, given that AMS is very much an adaptive challenge, qualitative methods and utilising social science techniques may be of considerable value in designing well-informed innovative AMS programs that can be piloted in Australia and help reduce costs associated with program failure.
2.6 Effectiveness of AMS programs in hospitals

As previously mentioned, AMS programs are primarily designed to improve antimicrobial prescribing practices in hospitals. Thus, in order to evaluate the benefit of AMS, it is important to quantify the associated benefits from optimising patterns of antimicrobial prescribing.

2.6.1 Ecologic outcomes

A prospective interrupted time series (ITS) study conducted by Carling and colleagues in the US designed to minimise inappropriate use of third generation cephalosporins was associated with a sustained reduction in nosocomial infection rates caused by *Clostridium difficile*, *Enterobacteriaceae* and vancomycin-resistant enterococci (VRE). Auditing of antimicrobial prescriptions utilising a multi-disciplinary team consisting of a specialist ID pharmacist and ID physician or clinical microbiologist, termed antimicrobial management team (AMT), resulted in significant decreases in third generation cephalosporin and aztreonam use over the subsequent six-year period. This reduction was offset somewhat with increased consumption of second-generation cephalosporins, aminoglycosides and clindamycin. However, there was an overall decrease in total parenteral antibiotic usage. Although the study design precludes causality, it was interesting to note that the reductions in nosocomial infections were observed despite rising acuity of illness of patients at the study hospital. A more recent UK study confirmed some of these findings, where revision of guidelines promoting prescription of antibiotics with 'low risk' for *C. difficile* infection and utilising an AMT to improve guideline adherence helped significantly reduce fluoroquinolone and cephalosporin use.

Restriction-based AMS studies have also led to reductions in the development of antimicrobial resistance, but sustaining the beneficial effects on microbial resistance over longer periods has been somewhat mixed. Using three hospitals as controls, Charbonneau *et al* in France reported that restricting fluoroquinolone use was significantly associated with lower rates of methicillin resistant *Staphylococcus aureus* (MRSA) isolation at the study hospital. Simultaneously, it was noted that the intervention hospital observed an increased incidence of extended-spectrum β-lactamase (ESBL) producing *Enterobacteriaceae* infections, possibly owing to increased pressure exerted by cephalosporins that were used to replace fluoroquinolones.
A more recent study in Scotland has suggested that antibiotic restriction may be associated with changing resistance patterns for a number of pathogens.\textsuperscript{95} Removal of fluoroquinolones and third generation cephalosporins from all wards of the hospital, together with altering guidelines to minimise empirical use for sepsis and surgical prophylaxis, resulted in significant decreases in hospital-acquired \textit{C. difficile} and longer-term effects on MRSA and ESBL-producing coliform rates. Again, though, there was the ‘squeezing the balloon’ phenomenon\textsuperscript{96} reported by investigators, with compensatory rises in resistance to antibiotics used in lieu of the restricted ones, with amoxicillin resistance among \textit{E. coli} isolates being one such example. Nevertheless, a three-year follow up has shown that resistance rates among targeted microorganisms have been sustained.

One limitation common to all ecological studies is that it is nearly impossible to evaluate time as an independent exposure variable related to the emergence of resistance. Given that most ecological changes are also multifactorial, attributing causality is an unrealistic expectation for any AMS intervention study looking at the impact of changes in antimicrobial prescribing patterns on local antimicrobial resistance. Use of cluster randomised controlled trials perhaps represents the best approach and the literature is currently awaiting these types of studies to help better quantify the effects of AMS strategies on hospital ecology.

\subsection*{2.6.2 Effect of reducing antimicrobial exposure on clinical outcomes}

Although there may be a prevailing view that AMS provides ecologic benefit without adverse patient effect,\textsuperscript{97} it is still important for studies to measure clinical outcomes as part of evaluating AMS interventions.

One area where investigators have been able to marry ecological with clinical outcomes is studies looking at the consequences of early discontinuation of antibiotic therapy. In a widely cited publication, Singh and colleagues conducted a randomised controlled study in the US looking at patients with a low likelihood of pneumonia (ie Clinical Pulmonary Infection Score ≤ 6).\textsuperscript{98} Patients were randomised to either conventional multiple antibiotic therapy for up to 21 days or three days of intravenous ciprofloxacin. Outcomes of the study suggest that duration of therapy in the control group was unnecessary and even inappropriate. The effects of limiting the number and duration of antibiotics in the ciprofloxacin group led to significantly lower incidence of infections caused by multi-drug resistant (MDR) organisms and subsequent
'super-infections’. To the authors’ surprise, it was also noted that length of ICU stay was apparently lower in the ciprofloxacin group, as was 30-day mortality (13% vs 31%, p=0.06).\textsuperscript{99}

Other studies have not been as definitive with respect to improved patient outcomes, although they show promise. An example is a randomised clinical trial conducted in more than fifty French ICUs looking at shortening the duration of ventilator-associated pneumonia (VAP) treatment from 15 days to eight days.\textsuperscript{100} Among confirmed non-fermenting Gram-negative bacilli infections, more pulmonary infection recurrences occurred in patients assigned to the eight-day course and so non-inferiority in this cohort could not be demonstrated. However, it was noted that recurrent infections with MDR pathogens emerged significantly less frequently in patients treated with the shorter course.

\subsection{2.7 Diversity of AMS programs}

As previously mentioned, there are a number of AMS strategies and combinations of these strategies that together contribute to a hospital-wide AMS program. Results of the meta-analysis conducted by the Cochrane Collaboration seems to support the use of restrictive interventions in some circumstances, but also suggest that both persuasive and restrictive AMS interventions can be equally effective over time.\textsuperscript{22}

However, it is unclear why one type of AMS strategy (eg pre-approval) is chosen over another, or what factors may impact on the success of a particular strategy. Indeed, it is critically important to appreciate that AMS strategies cannot globally be transplanted from one hospital to another, and that success in one site does not ensure success elsewhere. Factors such as the mix of antimicrobial prescribing, attitudes among prescribers towards antimicrobial resistance and AMS, differences in terms of health service delivery and cultural and historical influences that predominate within each healthcare organisation may be important when introducing hospital-wide AMS.\textsuperscript{101}

Modern day healthcare systems and hospitals within these systems are diverse and complex,\textsuperscript{102} and accordingly, hospital-wide AMS programs will need to be made up of a heterogeneous selection of strategies, with many strategies differing from site to site.\textsuperscript{103}
Perhaps this diversity reflects the historical, economic, societal and political influences continually shaping healthcare as a whole, resulting in delivery of health that differs from country to country and healthcare system to healthcare system. Additionally, diversification of funding of healthcare within countries into ‘public’ versus ‘private’ may also influence how healthcare is delivered in hospitals and subsequently impact on what type of AMS program can be implemented in these hospitals.

It is proposed in this thesis that the choice of strategies that will be used when introducing a hospital-wide AMS program will depend intrinsically on healthcare delivery factors within that hospital. Furthermore, the overarching healthcare or hospital system that governs how healthcare is delivered at an institutional level requires exploration in order to gauge how a multi-modal AMS program can best be tailored to ensure effective delivery to healthcare facilities within a given hospital system (Figure 2.2). Such effort should help identify factors that predict success.

**Figure 2.2: AMS tailored to hospitals**
2.8 The Australian hospital system

2.8.1 Overview of the Australian Healthcare System

Australia is made up of a political federation of states and territories with differing roles and responsibilities at different levels of government.\textsuperscript{105} Since colonisation, the Australian healthcare system has evolved over time into an inter-related system comprising a national universal insurance scheme, termed ‘public’, existing alongside a smaller, fee-for-services, ‘private’ healthcare system.\textsuperscript{106}

The organisational structure of these two interdependent systems was first established in the 1950s via Federal Government regulation that drove uptake of private health insurance.\textsuperscript{107} Universal health coverage for all Australians was brought in two decades later through the introduction of Medibank, which allowed doctors to bill the Federal Government directly rather than charging patients.\textsuperscript{108} It also funded hospital care via state-controlled ‘public’ hospitals, thus providing free care for patients. Although the scheme was revoked due to change of government soon afterwards, a national universal health insurance program, termed Medicare, was re-established in the mid-1980s and continues to the present day.\textsuperscript{107}

2.8.2 History of hospitalised care in Australia

Hospitals were first established in Australia by charitable organisations to provide care for the poor. However, through the advent of antiseptics and proper hygiene, as well as advancements in patient care, they became places where the sick, not just the poor, were treated.\textsuperscript{109} It was at this stage that the two-tiered system of hospitalised reimbursement started to be defined, with payment made by those who could afford to pay while the poor were treated free of charge.\textsuperscript{110} Since this time, due to increasing healthcare costs, many of the charitable organisations required financial assistance from state governments and hence came under government control, transforming into modern day public hospitals. Other healthcare facilities, however, have remained separate from direct government control and have since continued as private healthcare operators. Many of these private hospital operators are run by not-for-profit organisations so that any surplus funds made through the provision of health services are reinvested in the hospital or organisation itself. Others, however, follow a for-profit business model and are publicly listed companies with shareholders.
2.8.3 Funding of hospitalised care

The latest figures show that Australia spends an estimated AUD $140.2 billion, or 9.5% of gross domestic product, on health.\textsuperscript{111} Of this, approximately a third (an estimated $42 billion) is spent on public hospitals, with 38.2% of this funded by the Australian Federal Government, 53.3% by state and territory governments and the remainder funded from direct out-of-pocket payments by patients. In contrast, private hospital expenditure constitutes significantly less health expenditure (approximately 8% of total health expenditure - around $11.5 billion), with private health insurance and direct out-of-pocket payments making up nearly 60% of this spend, and the Federal Government contributing another 30%. Philanthropy (approximately 6%) and state/territory government funding (approximately 4%) constitute the remaining 10%.

2.8.4 Control and regulation of hospitalised care

Control of public hospitals in Australia is directly linked with the level of government expenditure. That is, public hospitals in the country are largely controlled and held accountable by state and territory governments as specified in the National Healthcare Agreement,\textsuperscript{112} with less Federal Government involvement in how public hospitals are operated and managed. As private hospitals are owned and managed by non-government entities, government control on how these facilities are operated is primarily limited to licensing arrangements which are underpinned by legislative authority.\textsuperscript{113}

Licensing of private hospitals and state government requirements of public hospitals as owners and financiers of public healthcare are not the only mechanisms to ensure quality in the provision of healthcare services. Since the 1970s, accreditation has also been a major strategy to help improve the safety and quality of care in Australia.\textsuperscript{113} Initially utilised as a form of self-regulation, accreditation became a mandatory requirement in the public hospital sector, as well as being linked with funding in private hospitals. A significant development occurred in 2013 with the Australian states and territory governments agreeing that all acute care hospitals and day procedure services would have to be periodically accredited according to the National Safety and Quality Health Service (NSQHS) Standards developed by the (ACSQHC).\textsuperscript{114} As a result, accreditation will most likely grow into an important driver in the delivery of health in both the public and private hospital systems.
2.8.5 Classification of hospitals based on geographical location

Australia’s population has a unique distribution that is reflective of a relatively small population size per square kilometre and dominated by large metropolitan areas. Most of Australia’s population is concentrated in two widely separated coastal regions – the south-east and east, and the south-west. Of the two regions, the south-east and east coast are by far the largest in area and population. The population within these regions is concentrated in urban centres, particularly in capital cities such as Sydney, Melbourne and Brisbane.

In contrast to these urban centres, there are a number of statistical local areas in Australia (estimated at 250) that have less than one person per square kilometre, making access to services such as health a challenge. Classifying geographical areas based on population size has helped policy makers and the general community identify resources and needs, particularly for Australians living outside of urban centres. The Australian Standard Geographical Classification Remoteness Areas adopted by the Australian Bureau of Statistics classifies geographical areas into ‘major cities’, ‘inner regional’, ‘outer regional’, ‘remote’ and ‘very remote’ and has helped define distances from population centres and accessibility to a wide range of goods and services, including access to hospitalised care. Hence, hospitals in Australia are not only categorised in terms of public and private, but are also grouped depending on their proximity to population centres.

2.9 Comparisons between public and private hospital sectors in Australia

As funding and control are significantly different between the public and private hospital sectors in Australia, it is unsurprising that these two sectors also differ in a variety of other ways such as the types of patients treated, services provided, and where and how healthcare is delivered.

2.9.1 At a glance

The latest figures from the Australian Institute of Health and Welfare (AIHW) estimate around 56% of all acute, psychiatric and day hospitals in Australia are public, and the remaining 44%
This report also states that of the 86,700 hospital beds (overnight and same-day treatments) available, around 58,400 beds (67%) are in public hospitals and the remaining 28,300 beds (33%) in private hospitals. In 2011-12, there were 9.3 million patient care episodes (termed ‘separations’) in Australia, with approximately 60% of these occurring in public hospitals and the remainder (ie 40%) in the private hospital sector.

2.9.2 Geographical location

Public hospitals are located in metropolitan, regional, remote and very remote areas, whereas the majority of private hospitals, perhaps due to commercial considerations, are located in metropolitan and inner regional areas. Reflective of this, the number of separations per 1,000 population was highest for patients living in ‘very remote’ areas and lowest for patients living in ‘major cities’ in public hospitals, while this was the exact opposite (ie highest in ‘major cities’ and lowest in ‘very remote’ areas) in private hospitals.

2.9.3 Patients treated

The AIHW has endeavoured to analyse the types of patients, based on socio-economic status (SES), treated in public and private hospitals. Although limited, as SES was determined crudely by where patients live, data showed that for public hospitals, the separation rate was highest for patients living in areas classified as being in the lowest SES group and lowest for patients living in areas classified as being in the highest SES group. In contrast, the separation rate was highest for patients living in areas classified as being in the highest SES group and lowest for patients living in areas classified as being in the lowest SES group.

Thus, geographical location and SES data present a picture of the average private patient treated in Australia as being from a major city or inner regional area and usually of higher socio-economic standing, in contrast to the universal utilisation of hospitalised care seen in public hospitals.

2.9.4 Health services provided

Both public and private hospitals provide a range of services that are qualitatively similar in terms of principal diagnosis, but there are differences in the proportions of services provided.
For example, although private hospitals account for only 40% of all patient episodes in hospitals, they provide nearly half of all procedures, including 64% of all elective procedures, 75% of orthopaedic knee operations and 70% of major eye operations. Recent figures suggest that private hospitals are becoming increasingly procedure-driven, as almost 95% of separations from private hospitals record some form of a procedure being administered, compared with 74% from public hospitals. The public hospital system, on the other hand, seems to be more dominated by a non-procedural mix, with nearly 73% of all acute separations being for medical (ie non-procedural) reasons. It is also noteworthy that the private hospital sector is providing an increasing proportion of services in areas such cardiac medical, cardiac interventional, oncology, obstetrics and gastroenterology.

### 2.9.5 Health service delivery

Thus far, crude figures and statistics have been used to contrast the two hospital sectors in Australia, but perhaps one of the starkest differences between the two hospital systems is how health services are delivered to patients.

Operators within the public hospital sector usually employ all healthcare professionals who work in the facility and in the case of doctors, are employed at all training levels, from first year interns to senior doctors (termed ‘consultants’ in Australia). It is estimated that salaried doctors comprise about 13% of total staff in public hospitals, of which junior doctors (ie interns, residents and registrars) make up the majority.

Provision of medical and surgical services to patients is generally provided by teams consisting of junior doctors, some of whom are training within a speciality. Specialties within public hospitals are divided into ‘units’ through which junior doctors are periodically rotated under the training and supervision of consultants. Clinical microbiology and pharmacy services come under centralised departments that exist within the public hospital facility, with all personnel in these departments usually employed by the public hospital operator.

Patients admitted to public hospitals are not able to choose which doctor looks after them. They are admitted under a unit that coordinates their care in hospital. If necessary, the ‘parent’ unit may refer to other units within the hospital. Patients are not charged for the bulk
of health services received in public hospitals, but they may be charged contributory payments for medications received upon leaving the hospital.

Australian private hospitals operate quite differently to their public counterparts. Although nursing staff make up the majority of employed healthcare professionals in both private and public hospitals (57% vs 46% respectively based on latest figures¹¹⁷), there is a significantly lower proportion of doctors, diagnostic and allied health professionals employed in private hospitals compared to public hospitals (7% vs 27% respectively¹¹⁷). From a diagnostic and allied health perspective, this is primarily due to Australian private hospitals outsourcing many services such as pathology and pharmacy to independent operators, usually on a contract basis. In some circumstances, private hospitals may outsource to more than one contractor for a given service (eg two different laboratory operators may provide pathology services within the same private hospital).

Due to the nature of how the private healthcare system functions in Australia, private hospitals rarely adopt a team or ‘unit’ based strategy to deliver medical and surgical services. One of the perceived benefits of patients paying private health insurance premiums is that these patients have the ability to choose a consultant who will provide them health services outside of the public hospital sector, thus potentially bypassing waiting lists for elective procedures. This consultant, in turn, is able to choose a private hospital in which to admit the patient for the required health service. Therefore, private hospitals do not have a large proportion of employed doctors at their facilities, with the majority of consultants classified as ‘visiting medical officers’ (VMOs) or ‘private specialists’. As nurses in private hospitals take responsibility of reporting patient progress and results back to VMOs, there is often limited scope for junior doctors to be involved in the day-to-day care of patients in private hospitals. Hence, there are significantly fewer junior doctors employed in private hospitals compared to public hospitals, with those working in private hospitals tending to be well into their speciality training. As private patients are charged for health services provided, both VMOs and the private hospital subsequently bill the private patient and/or their private health insurance fund.
2.9.6 Autonomy of doctors

As there are pronounced differences between the public and private hospital sectors in how doctors work, it has been proposed that the relationship between doctors and the respective hospital sectors also significantly differs. The public hospital sector employs doctors at all training levels. The relationship of employment establishes a certain degree of accountability to the hospital on the part of the doctor and has been eloquently termed as the ‘era of multiple accountabilities’ for healthcare professionals. That is, the clinician does not only have a responsibility to his or her patients within the hospital, but is now also required to take into account the interests of the healthcare facility where the patient is being treated and by whom they are employed.

Australian private hospitals rarely employ or contract doctors to work for them. Doctors who work in the private hospital sector are usually senior, having completed their training prior to commencing private practice. Most of these doctors practice in more than one private hospital. As VMOs, they are permitted to admit patients into private hospitals once the hospital’s medical advisory committee has granted admitting rights. Thereafter, the private hospital is very limited in its scope to influence the clinician in their clinical practice. In fact, anecdotally, there is a view in many of Australia’s private hospitals that VMOs are ‘customers’ of the hospital, thereby making accountability to the hospital much more of a challenge. In this way, there is a perception that a greater degree of autonomy exists among doctors working in private hospitals compared with the public hospital sector.

In summary, a look at the public and private hospital sectors in Australia elicits a variety of comparisons in terms of funding and control, how each hospital system operates, where they are located, the types of patients they treat and the proportions of health services they provide. Importantly, the two hospital sectors differ somewhat in terms of how health services are delivered and the interactions that each sector has with health professions that work in them.

It is proposed in this thesis that successful introduction of a hospital-wide AMS program will need to take into account how health services are delivered by determining what factors within healthcare systems have the potential to influence AMS implementation.
2.10 AMS programs in the private hospital sector – a review of the literature

The Australian private hospital sector varies from its public counterpart in a number of aspects, and so challenges with introducing AMS into this sector could well be considered unique. A literature search looking at AMS implementation in private hospitals did not yield any specific results from an international context, despite private hospitalised care increasing worldwide. A plausible explanation for this may be that countries which have a large or growing proportion of their hospitalised care provided for by private hospitals have thus far have been confined to national consensus statements on AMS, without widespread implementation of hospital-wide programs.

The literature on how public hospitals introduced organisation-wide AMS programs, however, is more developed. It has widely been regarded that clinicians with an ID or clinical microbiology background should be involved in coordinating a public hospital’s AMS program. Investigators also point to clinical pharmacists being well positioned to conduct hospital AMS activities as their role entails review of prescription orders and provision of advice, usually to junior medical staff. Also, pharmacists are well placed to monitor or ‘police’ antimicrobial usage and enforce concordance with local guidelines due to their familiarity with hospital medication formularies. Many AMS programs have spawned directly from cost-savings initiatives and drug usage audits conducted by a hospital’s pharmacy department. The use of inter-departmental collaborations between clinical pharmacists and ID physicians or clinical microbiologists to form multi-disciplinary AMTs that provide expert review of patients’ antimicrobial therapy has been an effective means of improving antimicrobial therapy since the 1980s.

However, these types of AMS models may have limitations in the Australian private hospital sector. First, utilising ID physicians as AMS coordinators may not be straightforward. These physicians are not typically employed by private hospitals and, like most other VMOs in private hospitals, only treat private patients directly under their care or provide a consultation if invited to do so by other VMOs. Therefore, ID physicians are limited in their capacity to provide AMS services across a hospital facility unless employed specifically to do so. Even then,
issues such as encroachment via unsolicited consultations may arise and handicap the ability to deliver effective AMS throughout a private hospital.

Public hospital AMS programs often run under the assumption that a closed or restricted antimicrobial formulary exists and can readily be monitored and managed by clinical pharmacists. However, this is not how antimicrobials are prescribed in the majority of Australian private hospitals. Restrictive formularies seldom exist in the private hospital sector, due mainly to the potential of antagonising relations with VMOs. This has a flow-on effect as a lack of restrictive formularies makes enforcement of clinical or prescribing guidelines very difficult. Even if restrictions on antimicrobials did exist, day-to-day monitoring of compliance could well be handicapped as many private hospitals outsource pharmacy services to external private pharmacy contractors. This is problematic for a two main reasons. First, contractual agreements between hospitals and external pharmacy operators may be limited to mainly a supply function, thus clinical review and evaluating compliance with guidelines is not part of the agreed scope of practice. Second, it may be difficult to deliver ‘best practice’ multi-disciplinary AMS into private hospitals unless there are formal agreements in place between ID VMOs, clinical microbiology and external pharmacy providers. The reasons for this difficulty could arise from differences among stakeholders in AMS governance as well as priorities for these roles not being aligned.

The effectiveness of integrating clinical microbiology with ID and pharmacy services to expedite functions such as rapid organism detection and antimicrobial susceptibility testing has previously been shown.\textsuperscript{129,130} However, the models presented are not necessarily the norm for private hospital microbiology services. Indeed, as with pharmacy services, many private hospitals outsource pathology services to external providers and in some cases, more than one. Collating hospital-wide susceptibility data, such as antibiograms, could thus be an issue in the private hospital sector.

One other aspect of the private hospital sector that has not been fully explored in current AMS literature is that of how to target education interventions to senior medical staff, with the majority of information surveyed from junior prescribers.\textsuperscript{131–134} Although there is potential to generalise these findings to more senior doctors such as VMOs, it is important to realise that
these findings are in the context of a hierarchical structure inherent in the public hospital system and generally absent in private hospitals.

Some AMS programs have been described that function without any expert oversight at all, but instead rely solely on pharmacist led interventions.\textsuperscript{135} While these programs have been reportedly well accepted by staff, the risk with these systems is that pharmacists may be burdened with responsibility that exceeds their training. It also potentially results in these patients not having the advantage of an ID expert being involved in their management when perhaps it is most appropriate for this to occur. Other AMS programs have utilised on site pharmacists supported by regular contact with ID experts offsite.\textsuperscript{136} Interestingly, this mirrors the growing interest in the use of offsite or remote AMS experts located in metropolitan areas, providing support to smaller rural hospitals via use of telephone support and scheduled telemedicine consultations.\textsuperscript{137,138} Private hospitals that do not have ID physicians consulting regularly at their facilities may consider this as an option, (whether they are in a rural or urban setting), however, it is will be important to determine if remote experts can be utilised to conduct AMS activities, such as assessing the quality of antimicrobial prescriptions.

Key issues would also need to be overcome regarding clear communication and documentation of advice. Transparent lines of accountability, consistency of advice and follow up patients would all need to be considered. A willingness and availability for pharmacists to take on this role in the private sector would need to be explored. Similarly, a willingness from VMOs to accept pharmacist led prescribing advice is required, and this may vary depending on whether such advice was endorsed by an ID expert or not.

Finally, as effective AMS is in essence delivering sustainable change in antimicrobial prescribing behaviour, discussing the context of where AMS is being implemented is as important as deciding which AMS interventions to implement. To this end, the literature on AMS implementation has not been as reflective of the heterogeneity of scenarios where it is required to be introduced and so there is a disparity between studies looking at ‘how’ AMS is introduced compared to ‘what’ is introduced, with larger focus on the latter. As models for health service delivery diversify and there is a need to look at all forms of delivery due to AMS being a global concept, further investigations on how AMS can be successfully introduced are needed.
2.11 Drivers for AMS in Australia

2.11.1 Governance and resources

Since the first collaborations between ID and pharmacy took place to form what was then termed an ‘antibiotic-streamlining’ program, AMS programs have progressively grown into complex, multi-pronged activities involving a myriad of hospital stakeholders, both clinical and non-clinical. In fact, in countries such as Sweden and Scotland, AMS has evolved into a national program which oversees implementation at a regional and local level. Importantly in these two examples, private hospital care is not a major part of healthcare delivery as compared to that in Australia. It is likely that governance structure and resources will play a determining role in the introduction of AMS in the Australian private hospital sector.

AMS not only entails clinically-based activities and surveillance, but also liaison with non-clinical stakeholders within the hospital, and so introduction of a multi-disciplinary hospital committee to lead and oversee these initiatives is highly recommended. Often termed an AMS committee or steering group, the committee’s links with other groups within the hospital framework is important given, first, that issues regarding antimicrobial use may appear on many agendas within the hospital, and second, to ensure proper accountability and feedback.

The ACSQHC recommends that at a minimum, core membership of an AMS committee should include an ID physician, or experienced clinician with an interest in ID, together with a suitably trained clinical pharmacist. Also inclusive of this core membership should be a clinical microbiologist, infection control practitioner, information systems specialist, and hospital epidemiologist.

One of the first aims of a newly convened AMS committee is to assess what additional resources and funding will be required to initiate and sustain subsequent AMS activities. Dedicated funding for personnel to oversee the day-to-day running of a hospital’s AMS program (ie an AMT) is an important consideration for all hospital AMS committees to consider.
Another AMS component that may require funding consideration, particularly in an Australian private hospital setting, is access to the nation’s antibiotic prescribing guidelines. Although these guidelines are accessible to Australian public hospital systems at no cost, private hospital access to the guidelines can only occur through annual paid subscription.

Use of CDSS is becoming more commonplace both in Australia and in other developed countries, but development or procurement of these systems can be expensive and resource intensive, particularly during integration into existing hospital systems. Adequate funding and resource allocation is an important consideration if hospitals consider the use of CDSS an integral part of their AMS program.

2.11.2 Accreditation

The introduction of mandatory NSQHS Standards has been an important driver in ensuring safety and quality of health services in both public and private hospitals in Australia. Similar to the National Committee for Quality Assurance standards in the US and the National Institute for Health and Care Excellence in the UK, the ACSQHC brought in these standards to improve the quality of health service provision in Australia. There are now ten NSQHS standards which focus on areas that are considered by the Commission to be essential to improving safety and quality of care, with Standard 3 focusing on preventing and controlling healthcare associated infections.

Every Australian hospital is now required to periodically be evaluated by an accrediting agency to gauge their level of healthcare performance as assessed by their ability to meet the specified standards. The evaluation, termed ‘accreditation’, occurs as per a three- to four-year cycle with some standards evaluated halfway (ie mid-cycle). Standard 3.14 of the NSQHS standards specify that AMS programs be implemented in every Australian hospital.

Although the consequences of not meeting accreditation criteria is still not entirely clear in Australia, internationally, some governments and healthcare funders are actively seeking, and in some cases, providing economic incentives for continuous improvement of services and better quality health outcomes in hospitals. In the US, for example, the universal health insurance program Medicare continues to pay hospitals the standard rates for the original admission diagnosis and treatment, but funding no longer covers hospitals for the additional costs associated with care and treatment of healthcare-associated infections. In the hope of
reducing these types of infections, many US hospitals have subsequently begun investing more resources in their infection control and AMS programs.

These sorts of pecuniary measures may be controversial in the Australian public hospital system, particularly if it results in hospitals ‘risk-skimming’ patients to minimise funding penalties. In the private hospital sector, however, most private health insurers require hospitals to be accredited in order to pay for health services, thus providing incentives for continuous safety and quality improvement initiatives. As AMS is now part of the mandatory national standards, accreditation may be a very powerful driver for its widespread adoption in the Australian private hospital sector.

2.11.3 Doctors

As VMOs, doctors represent a customer base for private hospitals and so they may play a significant role in ensuring AMS programs are incorporated into private patient care. However, for these doctors to be drivers of AMS, they need to be convinced of the benefits of AMS programs. Understanding underlying attitudes and perceptions about the threat of antimicrobial resistance, changing antimicrobial prescribing behaviour and utilising stewardship strategies will therefore be important.

2.11.4 Patients

The concept of patient participation in their own health is one that has gained momentum as a key component in healthcare processes and has been successfully applied to patient care; for example, in decision-making processes and the treatment of chronic illness. There is now a compelling argument that patients are consumers of health services and as such have the ability to demand quality of care. The question of whether patients themselves would like to participate as key players in choices about their health has yielded inconsistent results, with cancer patients often deferring decisions to their doctor while general practice patients wanting to be an equal partner in decision making. Importantly a patient’s decision to play a participatory role, may be very strongly linked to their level of general health literacy as well as any knowledge of the medical subject in question.
2.11.5 Public reporting

There is increasing demand for data about the performance of healthcare providers at a consumer, state and national level.\(^{154}\) Similar to accreditation, mandatory public reporting of key performance indicators adds another layer of accountability. However, public reporting is not entirely without controversy, as there is potential for ‘risk-skimming’ or selective reporting to improve performance scores.\(^{147}\) The other major concern is when trying to benchmark between hospitals, data should be risk-adjusted or stratified to correct for differences in the types of patients admitted (e.g., a cancer hospital will have a completely different case-mix of patients when compared to a small rural hospital). Nevertheless, use of ‘report cards’, ‘provider profiles’ and ‘league tables’ to name a few have gained popularity in healthcare systems, such as in the US and UK, where expectations regarding patient choice and the accountability of health systems has become more topical over time.\(^{155}\) In terms of patient outcome data and healthcare performance, there is limited evidence supporting public reporting,\(^{156}\) with a reduction in *Staphylococcus aureus* infections, in part, being associated with it in the UK.\(^{157}\)

In Australia, the National Health Performance Authority (NHPA) runs the ‘MyHospitals’ website that reports on performance indicators such as length of stay and waiting times in the emergency department and for elective surgery.\(^{158}\) The website also has a safety and quality section that focuses on *S. aureus* bloodstream infections and hand hygiene practices. Public hospitals are required to periodically submit data to NHPA, but there is no such mandate for private hospitals.

The infection control performance indicators described above can be divided into two categories. *S. aureus* bloodstream infections can be described as an ‘outcome’ indicator as it is a definitive endpoint, whereas hand hygiene compliance rates are regarded as a ‘process’ indicator as they relate to best clinical practice and are a measure of risk-reduction.\(^{159}\) In circumstances where public reporting may be used to benchmark hospitals, outcome indicators require stratification based on risk or patient casemix, while process indicators require consistency in how data are collected to ensure fair comparisons. As hospital-wide AMS programs are centred around curtailing antimicrobial resistance through improving antimicrobial prescribing, evaluating the effectiveness of these programs is often achieved by
surveying antimicrobial consumption (volume-based surveillance) as well as the ‘appropriateness’ of antimicrobial prescribing (quality-based surveillance).\(^{32}\)

Measuring antimicrobial consumption over time is an outcome indicator and it requires adjustment based on hospital activity as well as risk-adjustment to account for differences between patient case-mix if used to benchmark between hospitals. The National Antimicrobial Utilisation Surveillance Program (NAUSP) is a antimicrobial consumption surveillance program funded by the Australian government.\(^{160}\) For both public and private hospitals, data submission to the program is voluntary. Contributing hospitals are supplied with bimonthly and annual reports of their antimicrobial usage rates (ie calculated to defined daily dosages and adjusted to patient activity), enabling them to compare their usage over time and with similarly peered hospitals. As consumption represents crude volume-based data, there are caveats in interpreting the data, such as taking into account infection rates or ‘outbreaks’ of certain pathogens during the time consumption data was collected.

‘Appropriateness’ of antimicrobial prescribing represents a more descriptive method of surveying antimicrobial use for the purposes of AMS and is gaining momentum as a key performance indicator both internationally and within Australia.\(^{161-163}\) Hospitals now routinely perform surveys of selected wards and clinical areas, collecting patient specific antimicrobial prescription data that can be appraised according to national or local prescribing guidelines as well as by experts in ID and AMS.\(^{15,164}\) From a public reporting perspective, the major limitation with using such a quality indicator is that it requires assessors to be consistent when measuring ‘appropriateness’ across different hospitals and ability to assess appropriateness will most likely be dependent on the experience and expertise of the assessors.

As Australia is still working its way through the design and implementation of public reporting strategies, with the few that are reported mandatory only for public hospitals, it seems that compulsory reporting of AMS performance indicator data may not yet be a compelling driver for AMS in Australian private hospitals.

### 2.12 Summary

Accelerating antimicrobial resistance in hospitals is resulting in increased patient morbidity, mortality and rising healthcare costs. It is not only clinicians who see the consequences of this
acceleration, with health policy makers also appreciating that the time to act is now. AMS is therefore becoming critical in all hospitals. Reflective of this, countries such as Australia are now making AMS a mandatory requirement to be adopted across healthcare facilities.

There are distinct differences in how hospitalised care is delivered in Australia and current literature predominantly focuses on evaluation of activities often in single sites rather than on improving implementation success broadly across multiple sites. We need to better understand what factors may hinder the practical sustained success of strategies that apparently worked in study sites. This requires an understanding of context. Although Australian policy-makers have been progressive in promoting AMS programs in hospitals, anecdotally, there has been much concern about the potential problems in the private hospital sector. Stated reasons have included that there is a lack of need for AMS in private hospitals due to limited antimicrobial prescribing there, or a view that workflow issues cannot be overcome, or indeed that active resistance among private hospital stakeholders (driven by underlying attitudes and perceptions) will make implementation impossible. Therefore, work needs to be undertaken on how AMS can be introduced and sustained in the private hospital sector as no information has previously been gathered to determine whether these concerns are justified.
Chapter 3  Antimicrobial stewardship governance structure, resources and activities in Australian private hospitals

3.1  Synopsis

The second chapter of this thesis introduced the importance of optimising antimicrobial prescribing and the different modalities and activities that constitute a hospital AMS program. It also proposes that the choice of AMS activities introduced into hospitals will depend on healthcare delivery factors within hospital systems. The Australian hospital system is represented by the public and private hospital sectors that differ in a number of aspects including in terms of funding and control, how they are operated, location, types of patients treated and the proportions of health services provided. It is therefore envisaged that introduction of AMS into Australian private hospitals may differ significantly from the public hospital model that has been described in the literature.

Establishing and maintaining an effective hospital-wide AMS program is resource intensive and requires pre-planning with appropriate consideration given towards the governance structure that will oversee the program and resources required to perform determined AMS activities. Currently, it is unclear what governance structure and resources are available for AMS in the Australian private hospital sector. Moreover, there is no information on what activities and strategies that constitute AMS are currently occurring in these facilities. The purpose of this chapter is to investigate the current level of AMS program activity, governance structure and resources in one of the most populous states in Australia.
3.2 Introduction

Implementing best practice to ensure the best clinical outcomes has been a challenge in all areas of medicine. In the field of antimicrobial prescribing, the issue is particularly critical with inappropriate antimicrobial use being common, while the ever-increasing threat of bacterial resistance to therapy remains. Worryingly, the last twenty years have seen an alarming increase in world-wide prevalence of bacterial pathogens resistant to antimicrobial drugs.3

Initiatives to optimise the use of antimicrobial agents, to improve patient outcomes while combating growing antimicrobial resistance are given the term ‘antimicrobial stewardship’,12 and the implementation of hospital antimicrobial stewardship (AMS) programs has been shown to both improve antimicrobial prescribing practice and limit antimicrobial resistant pathogens.25 In Australia, initial introduction of hospital AMS programs occurred through individual hospital initiatives, with some state funding, (such as the Victorian government’s ‘Start Clean’ infection control strategy),165 with the main focus being on public hospitals. Most of the data on effective AMS programs have come from the public hospital sector.

In 2011, the Australian Commission on Safety and Quality in Healthcare (ACSQHC) released guidelines on developing and introducing hospital-wide AMS programs. The publication described the structure, governance and resources needed for an effective AMS program, along with strategies shown to influence antimicrobial prescribing and reduce inappropriate use.32 Since then, AMS programs have been incorporated into new National Safety and Quality Health Service Standards (NSQHS) drafted by the ACSQHC which in 2013 are part of a new accreditation scheme mandatory for all Australian hospitals. These clinical governance standards have specified the requirement of a hospital-wide AMS program, medical workforce access to endorsed antimicrobial guidelines, regular monitoring of antimicrobial usage and resistance, and ongoing action to improve the effectiveness of AMS.114

The Australian healthcare system consists of a publically funded universal healthcare system and a smaller, fee-for-service private healthcare system.166 Historically, hospitals in Australia were first established by charitable organisations, but due to increasing healthcare costs, many of these organisations required financial assistance from government and hence came under direct state government control, transforming into modern day public hospitals.109 Other
healthcare facilities, however, remained separate from direct government control and continued as private hospitals.

Today, private hospitals in Australia provide approximately one third of all hospital beds and treat 40% of all patients. However, there is a dearth of information about AMS program activities these hospitals are currently undertaking. In early 2012, a survey of AMS activities in Victorian hospitals was undertaken. While the overall study data have been described by James et al 2013 (Appendix 1), the present chapter focuses specifically on the private hospital responses and some of the unique issues encountered in this sector. In addition to drafting the chapter, the PhD candidate, Menino Osbert Cotta, collected and analysed all data pertaining to the private hospital section of the study. The study aims to investigate the current level of AMS program activity, governance and resources within Victorian private hospitals and also to describe potential barriers to the provision of AMS programs. Results will be used to inform private hospital stakeholders in Victoria and to help private healthcare facilities Australia-wide prepare for the new health service AMS standard.

3.3 Methods

A survey tool was developed by a team of researchers based at the Royal Melbourne Hospital in collaboration with Victorian Department of Health staff. Development of the survey received input from infectious diseases (ID) clinicians, microbiologists and specialist pharmacists and was based on AMS program strategies identified by the ACSQHC.

Information was requested on actual resources, including personnel and tools, and current activities that might form part of an AMS program. The second part of the survey sought information on possible barriers to establishing AMS programs in private hospitals as perceived by the person responsible for completing the survey. The respondent was able to select from a checkbox regarding whether they felt each issue was a problem at their hospital.

The resulting 38 item online survey was piloted in six hospitals of differing sizes, with one of these being a private hospital, to ensure content validity, generalisability and usability. As the survey was considered a low risk audit/quality assurance activity, ethics approval was not
sought. All hospital data were de-identified prior to reporting and involvement in the survey was voluntary.

In November 2011, an invitation letter was sent from the state government Department of Health to hospital chief executive officers, asking for nomination of appropriate respondents. The final online survey was then sent via e-mail to nominated representatives at all Victorian hospitals in January 2012. Hospitals providing dedicated mental health services and private day-procedure facilities were excluded from survey distribution. E-mail and phone reminders to the nominated key respondents were subsequently made during the data collection period of three months. The investigators also endeavoured to clarify any inconsistencies with key respondents via telephone or email after initial analysis of the surveys. Participation was voluntary and no specific incentives were provided to participating hospitals.

Data are presented descriptively and were analysed using SAS® version 9.2 (SAS Institute, USA). A two-proportion z-test was performed comparing proportions between public metropolitan and private hospitals. P-values < 0.05 were assumed to be statistically significant.

3.4 Results

Characteristics of respondent private hospitals
The characteristics of participating private hospitals are shown in Table 3.1. Forty-two (67.7%) of 62 eligible private hospitals responded. One hospital out of the original 63 hospitals sent the survey was excluded as it was found to have no inpatient beds. Of the 20 remaining hospitals that did not respond, 13 belonged to a single private hospital group whose executive group made a collective decision not to participate. The reason for this decision was not reported to the researchers. Of note, 64.2% of private hospitals had <100 inpatient beds. Respondents did not differ systematically from non-respondents in terms of geographical location, classification, co-location with a public hospital, or the presence of an intensive care unit (ICU).

Of the private hospitals that responded, 76.2% had the survey filled out by a staff member with a nursing background, most often an infection control practitioner. A medical staff
member filled out the survey in 11.9% of cases, with quality managers and pharmacy staff completing the survey in 9.5% and 2.5% of hospitals respectively.

3.4.1 Summary of results for public metropolitan, public regional and private hospitals

Table 3.2 outlines responses to survey questions among all surveyed public and private hospitals directly relating to the ACSQHC five essential AMS strategies.

Responses among all surveyed public and private hospitals to supplementary AMS strategies recommended by the ACSQHC as well as governance structure for AMS programs are presented in Table 3.3.

3.4.2 Persuasive Strategies

Availability of prescribing guidelines

Thirty-seven (88.1%) hospitals had access to the latest version of the national antimicrobial prescribing guidelines (Therapeutic Guidelines: Antibiotic), but only 33% had electronic access (Figure 3.1). Antimicrobial prescribing guidelines were actively promoted in 19 (45.2%) hospitals.

Post prescription review with direct intervention and feedback

Regular review of antimicrobial prescriptions occurred in 20 (47.6%) of the surveyed hospitals (Figure 3.2). Only one (2.4%) hospital had a dedicated multidisciplinary team involving at least one pharmacist and one ID clinician, termed an antimicrobial management team (AMT). Sixteen (38.1%) hospitals reported giving direct feedback to individual prescribers.

Access to antimicrobial prescribing advice

Twenty (47.6%) hospitals had arrangements for receiving antimicrobial prescribing advice outside of their hospital. Eleven of the 20 hospitals had formal contract-based advice either via remunerated external specialist services or as part of a hospital network. The remaining nine hospitals did not have any formal agreement or contract in place but usually contacted a nominated hospital for advice.
Monitoring of antimicrobial prescribing performance

Twenty-two (52.4%) hospitals regularly monitored antimicrobial prescribing performance via audits (Table 3.4). The most common type of audit was an assessment of the appropriateness of antimicrobial prescribing which was performed at 11 (26.2%) hospitals, while audits of antimicrobial drug consumption and cost were the next most common at 10 (23.8%) hospitals each. Feedback of audit outcomes to prescribers was reported by 15 (35.7%) hospitals (Figure 3.3).

3.4.3 Restrictive Strategies

Existence of a restricted antimicrobial formulary with approval systems

Seven (16.7%) of respondent hospitals had an existing formulary that included antimicrobials. Two (4.8%) hospitals stated that the existing formulary specified restrictions on the use of broad-spectrum antimicrobials. Both of these hospitals had approval systems in place for these restrictions, with one hospital using an electronic approval system and the other hospital a phone-based approval system. In-house ID clinicians had authority to provide approval for the electronic approval system, whilst off-site clinical microbiologists and senior pharmacists were authorised approvers for the phone-based approval system.

Access to microbiology services

All 42 (100%) respondent hospitals reported receiving selective antimicrobial sensitivity reports for clinical isolates from their microbiology service. Provision of local antibiograms occurred in 14 (33.3%) hospitals. Eight (19.0%) hospitals were unsure of the existence of local antibiograms, while 20 (47.6%) stated that their hospital did not receive local antibiograms.

3.4.4 Governance

Nine (21.4%) hospitals had a policy on antimicrobial prescribing. All seven (16.7%) hospitals with a dedicated AMS committee had lines of accountability and reporting within the hospital, with six of these hospitals reporting to the infection control committee.

3.4.5 Dedicated AMS funding

None of the 42 hospitals reported having dedicated funding for a pharmacist or medical staff to coordinate AMS initiatives at the hospital.
3.4.6 Barriers to AMS programs

The two most common barriers to establishing effective AMS programs reported by surveyed hospitals were a lack of education and training for staff in antimicrobial use, and a perceived lack of willingness of prescribers to change existing prescribing practices (Table 3.5).

3.5 Discussion

Since 2013, when the new NSQHS became mandatory, private hospitals will need to implement and sustain AMS programs. It is clear from the results of this 2012 survey that Victorian private hospitals have much work to be done.

Although 88% of respondent hospitals had access to the national antibiotic prescribing guidelines, only 31% of these hospitals had electronic-based access. In contrast, all Victorian public hospitals have electronic access due to a government-funded online clinician’s information portal. The obvious advantage of this is that multiple users can access prescribing advice and are not limited to finite paper-based resources. Private hospital access to the online guidelines is available through paid subscription and it may be a consideration for private hospitals that do not have electronic access as it potentially simplifies the process of managing updates of guidelines. The five private hospitals that did not have either paper- or electronic-based copies of these guidelines all belonged to the same private healthcare operator.

Use of restriction-based antimicrobial formularies was uncommon in the private hospitals surveyed. Only two (4.8%) hospitals utilised a restrictive antimicrobial formulary covering broad-spectrum antimicrobials. These two hospitals also had an accompanying approval system. In contrast these systems are commonplace in many public hospitals. Although the NSQHS standards do not have specific advice on the use of antimicrobial approval systems, these systems have previously been shown to improve antimicrobial prescribing and may provide a way forward to increasing the effectiveness of AMS programs in the private hospital sector.\textsuperscript{53,168,169}
Post-prescription review of antimicrobials has been proposed by the ACSQHC and a number of peak bodies internationally as a core strategy in building an effective AMS program. Evidence has shown that a multidisciplinary intervention group is more likely to positively change practice. Of the 20 hospitals reported to provide post prescription review of antimicrobial prescriptions, only five had two or more different healthcare disciplines reviewing antimicrobial prescriptions. Four of these five hospitals were larger metropolitan hospitals with 100 beds or more, suggesting that larger private hospitals may have access to more expertise than smaller private hospitals.

The NSQHS Standards have identified regular monitoring of antimicrobial usage as well as antimicrobial resistance as an important component of a hospital AMS program. More than half of the surveyed hospitals reported regularly auditing antimicrobial usage, with appropriateness of antimicrobial prescribing, antimicrobial cost and antimicrobial consumption being the areas predominantly audited. Of the 22 hospitals that performed regular audits, 15 provided feedback in some form with five of the hospitals surveyed giving direct feedback to individual prescribers.

It was interesting to note that five out of the seven hospitals that were co-located with a public hospital currently receive antimicrobial prescribing advice outside of their immediate facility either through contracted services or an informal arrangement. Although the source of this advice was not investigated in this study, it may be of interest to find out if this service was being sought from the co-located public hospital, where applicable, or from other larger public hospitals in proximity.

These results raise the concept of a shared public-private model for delivery of AMS program based activities, and it may be a consideration for private hospitals that are unable to devote the necessary resources to a stand-alone AMS program in their facility. However, there are important funding and medico legal caveats with this shared model for participating public and private hospitals to consider. Firstly, as public and private hospitals have different streams of funding, resources that are utilised from the public system (which are predominantly funded through Australian taxpayers) cannot be ‘shared’ by private hospitals. There needs to be contractual agreements in place whereby services or resources from the public hospital sector are paid for by private hospitals. The second issue is that of accountability and there needs to
be careful consideration of the medico legal implications of advice provided by doctors employed in the public hospital sector to private specialists treating their patients in private hospitals. Again, formal agreements may provide the means of addressing this, but it both sets of doctors (ie those in the public and private) must be made fully aware of their responsibilities and obligations.

The first action point for AMS programs in the new NSQHS Standards is for an Australian hospital to ‘have an AMS program in place’. AMS programs have progressively grown into complex, multi-pronged activities involving a myriad of clinical and non-clinical hospital stakeholders. Hence, one of the first steps that a healthcare facility should take when planning a hospital-wide AMS program is the introduction of a multi-disciplinary hospital committee to lead and oversee these initiatives. As the results of this survey suggest minimal AMS program activities, it comes as no surprise that less than a fifth of the Victorian private hospitals surveyed had a dedicated committee for AMS and only nine had a policy governing the prescribing of antimicrobials within their facility.

None of the surveyed hospitals reported having dedicated funding for a pharmacist or clinician to coordinate AMS program activities, which suggests that the AMS program activities that are currently taking place in the Victorian private hospital sector, although modest, are being conducted on a voluntary or ad hoc basis.

Ninety-five per cent of surveyed hospitals listed one or more barriers to implementing an AMS program, with lack of education and training of clinicians in antimicrobial use being identified in nearly two-thirds of the hospitals surveyed. Education-based activities have previously been shown to be of benefit in improving antimicrobial prescribing and so should be considered as part of a newly introduced AMS program. Lack of pharmacy, ID and microbiology resources all reflect the wider issue of inadequate funding for a hospital-wide AMS program. Although introduction of AMS program activities have been estimated to be of modest cost compared to the potential benefits, the results of this study as well as findings from the literature suggest that personnel shortages and funding are still one of the main considerations preventing an AMS program successfully being integrated into hospitals.
Lack of willingness from doctors to change their prescribing practice, lack of leadership to promote AMS programs, and lack of support from senior clinicians are all important considerations for private hospitals. One of the starkest differences between the private and public hospital sectors in Australia is defined by their respective relationships with clinicians. The public hospital sector has traditionally employed clinicians at all training levels, from first year interns to senior consultants. In comparison, Australian private hospitals rarely directly employ clinicians to work for them, and instead it is often the visiting consultant who brings patients to the private hospital for care. Hence, the ability for private hospitals to influence individual clinician behaviour may theoretically be more challenging.

The use of ‘link clinicians’ or ‘clinical champions’ within a healthcare organisation has previously been shown to help to provide strong leadership and advocacy for AMS programs, and help gain acceptance amongst recalcitrant prescribers. Private hospitals may consider integrating lead clinicians into the AMS program governance structure so as to advocate AMS program activities to other private hospital clinicians and promote the patient benefits of AMS strategies.

This study represents the first successful statewide survey of AMS program activities, resources, governance as well as barriers conducted in the Australian private hospital sector. Although a previous study attempted to measure barriers to and key performance indicators for AMS programs in all public and private Australian hospitals, a low response rate limited any generalisations from the findings. The response rate was much higher in the current survey and although it was voluntary, as the invitation to participate was sent from the state government to hospital CEOs, this may have been considered an incentive to complete the survey. Given that more than two-thirds of private hospitals in the state responded to the survey and that there were no major characteristic differences between respondents and non-respondents, the investigators believe that results of the survey are representative of the Victorian private hospital sector.

A limitation in this study is respondent bias. As one key respondent was asked to complete the survey, responses could be biased towards their perspective. Also, as the questions covered the breadth of many healthcare disciplines, the key respondent may have not have been able
to make fully informed responses to all questions. The exclusion of private day-procedure facilities is another potential limitation of this study.

3.6 Conclusions

This chapter shows that many Victorian private hospitals are not prepared for implementation of the new NSQHS standards for AMS programs that have now become mandatory for hospital accreditation Australia-wide. It could be argued that the majority of hospitals surveyed do not currently have an AMS program in place as the governance and structure for these programs, in the form of AMS program committees and prescribing policies, are lacking in most of these facilities. Fulfilling these organisational requirements will be an imperative step in implementing hospital-wide AMS programs and ensuring that action can be taken to continually improve the effectiveness of AMS, which is another component of the new standards.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Respondent hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
</tr>
<tr>
<td><strong>Hospital location</strong></td>
<td></td>
</tr>
<tr>
<td>Metropolitan</td>
<td>28 (66.7)</td>
</tr>
<tr>
<td>Regional</td>
<td>9 (16.5)</td>
</tr>
<tr>
<td>Rural</td>
<td>5 (16.5)</td>
</tr>
<tr>
<td>Co-located with a public hospital</td>
<td>7 (16.7)</td>
</tr>
<tr>
<td>Intensive Care Unit (ICU)</td>
<td>12 (28.6)</td>
</tr>
<tr>
<td><strong>Total number of beds</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;15 beds</td>
<td>3 (7.1)</td>
</tr>
<tr>
<td>15–49 beds</td>
<td>9 (21.4)</td>
</tr>
<tr>
<td>50–99 beds</td>
<td>15 (35.7)</td>
</tr>
<tr>
<td>&gt;100 beds</td>
<td>15 (35.7)</td>
</tr>
</tbody>
</table>
Table 3.2: Responses among all surveyed hospitals to questions exploring the ACSQHC essential antimicrobial stewardship program strategies (n = 155)

<table>
<thead>
<tr>
<th>Therapeutic Guidelines: Antibiotic is available (online, paper-based copies or both)‡</th>
<th>Public Metropolitan (n = 32 (%))</th>
<th>Public Regional (n = 81 (%))</th>
<th>Private (n = 42 (%))</th>
<th>Total (n = 155 (%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Therapeutic Guidelines: Antibiotic is available (online, paper-based copies or both)‡</td>
<td>32 (100.0)</td>
<td>81 (100.0)</td>
<td>37 (88.1)</td>
<td>150 (96.8)</td>
</tr>
<tr>
<td>Antibiotic Guidelines are promoted or included in hospital antimicrobial policy*</td>
<td>29 (90.6)</td>
<td>37 (45.7)</td>
<td>9 (21.4)</td>
<td>75 (48.4)</td>
</tr>
<tr>
<td>A formulary covering antimicrobials is available*</td>
<td>30 (93.8)</td>
<td>31 (38.3)</td>
<td>7 (16.7)</td>
<td>68 (43.9)</td>
</tr>
<tr>
<td>The formulary specifies restrictions on the use of broad-spectrum antimicrobials*</td>
<td>30 (93.8)</td>
<td>14 (17.3)</td>
<td>2 (4.8)</td>
<td>46 (29.7)</td>
</tr>
<tr>
<td>Feedback is provided to prescriber following the review of antimicrobial prescription*</td>
<td>24 (75.0)</td>
<td>41 (50.6)</td>
<td>16 (38.1)</td>
<td>81 (52.3)</td>
</tr>
<tr>
<td>The hospital has a dedicated Antimicrobial Management Team*</td>
<td>7 (21.9)</td>
<td>0 (0.0)</td>
<td>1 (2.4)</td>
<td>8 (5.2)</td>
</tr>
<tr>
<td>Regular audits of antimicrobial prescribing are conducted</td>
<td>20 (62.5)</td>
<td>29 (35.8)</td>
<td>22 (52.4)</td>
<td>71 (45.8)</td>
</tr>
<tr>
<td>Feedback is provided to prescribers on outcomes of antimicrobial prescribing audits</td>
<td>13 (40.6)</td>
<td>21 (25.9)</td>
<td>15 (35.7)</td>
<td>49 (31.6)</td>
</tr>
</tbody>
</table>

ACSQHC – Australian Commission on Safety and Quality in Healthcare
‡p ≤ 0.04, *p ≤ 0.01 for comparing proportions between Public Metropolitan and Private
Table 3.3: Responses among all surveyed hospitals to supplementary recommended antimicrobial stewardship program strategies by the ACSQHC (n = 155)

<table>
<thead>
<tr>
<th>Education is provided to:</th>
<th>Public Metropolitan (n = 32 (%))</th>
<th>Public Regional (n = 81 (%))</th>
<th>Private (n = 42 (%))</th>
<th>Total (n = 155 (%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior medical staff*</td>
<td>12 (37.5)</td>
<td>7 (8.6)</td>
<td>2 (4.8)</td>
<td>21 (13.5)</td>
</tr>
<tr>
<td>Junior medical staff*</td>
<td>22 (68.8)</td>
<td>9 (11.1)</td>
<td>0 (0.0)</td>
<td>31 (20.0)</td>
</tr>
<tr>
<td>Pharmacy*</td>
<td>21 (65.6)</td>
<td>6 (7.4)</td>
<td>2 (4.8)</td>
<td>29 (18.9)</td>
</tr>
<tr>
<td>Nursing</td>
<td>8 (25.0)</td>
<td>16 (19.8)</td>
<td>9 (21.4)</td>
<td>33 (21.0)</td>
</tr>
<tr>
<td>No education provided*</td>
<td>5 (15.6)</td>
<td>59 (72.8)</td>
<td>29 (69.0)</td>
<td>93 (60.3)</td>
</tr>
</tbody>
</table>

An electronic clinical decision support or approval system is available*

<table>
<thead>
<tr>
<th>Public Metropolitan (n = 32 (%))</th>
<th>Public Regional (n = 81 (%))</th>
<th>Private (n = 42 (%))</th>
<th>Total (n = 155 (%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 (65.6)</td>
<td>0 (0.0)</td>
<td>1 (2.4)</td>
<td>21 (13.5)</td>
</tr>
</tbody>
</table>

Antibiograms are provided by the microbiology service

<table>
<thead>
<tr>
<th>Yes</th>
<th>Public Metropolitan (n = 32 (%))</th>
<th>Public Regional (n = 81 (%))</th>
<th>Private (n = 42 (%))</th>
<th>Total (n = 155 (%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 (25.0)</td>
<td>8 (9.9)</td>
<td>14 (33.3)</td>
<td>30 (19.4)</td>
<td></td>
</tr>
</tbody>
</table>

Don’t know‡

<table>
<thead>
<tr>
<th>Public Metropolitan (n = 32 (%))</th>
<th>Public Regional (n = 81 (%))</th>
<th>Private (n = 42 (%))</th>
<th>Total (n = 155 (%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (3.1)</td>
<td>23 (28.4)</td>
<td>8 (19.0)</td>
<td>32 (20.6)</td>
</tr>
</tbody>
</table>

There is an antimicrobial prescribing policy in place*

<table>
<thead>
<tr>
<th>Public Metropolitan (n = 32 (%))</th>
<th>Public Regional (n = 81 (%))</th>
<th>Private (n = 42 (%))</th>
<th>Total (n = 155 (%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>29 (90.6)</td>
<td>38 (46.9)</td>
<td>9 (21.4)</td>
<td>76 (49.0)</td>
</tr>
</tbody>
</table>

A dedicated committee to oversee antimicrobial stewardship exists*

<table>
<thead>
<tr>
<th>Public Metropolitan (n = 32 (%))</th>
<th>Public Regional (n = 81 (%))</th>
<th>Private (n = 42 (%))</th>
<th>Total (n = 155 (%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 (68.8)</td>
<td>11 (13.6)</td>
<td>7 (16.7)</td>
<td>39 (25.2)</td>
</tr>
</tbody>
</table>

Funding is available for antimicrobial stewardship activities

<table>
<thead>
<tr>
<th>Public Metropolitan (n = 32 (%))</th>
<th>Public Regional (n = 81 (%))</th>
<th>Private (n = 42 (%))</th>
<th>Total (n = 155 (%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacist*</td>
<td>10 (31.3)</td>
<td>1 (1.2)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Medical staff*</td>
<td>9 (28.1)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

ACSQHC – Australian Commission on Safety and Quality in Healthcare

‡p = 0.04, *p ≤ 0.01 for comparing proportions between Public Metropolitan and Private
Table 3.4: Types of antimicrobial prescribing audits undertaken by private hospitals (n = 42)

<table>
<thead>
<tr>
<th>Audit type</th>
<th>n  (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriateness of prescribing</td>
<td>11 (26.2)</td>
</tr>
<tr>
<td>Antimicrobial cost</td>
<td>10 (23.8)</td>
</tr>
<tr>
<td>Antimicrobial consumption</td>
<td>10 (23.8)</td>
</tr>
<tr>
<td>Dedicated audits of specific clinical conditions</td>
<td>6 (14.3)</td>
</tr>
<tr>
<td>Dedicated audits of specific drugs</td>
<td>4 (9.5)</td>
</tr>
<tr>
<td>Adherence to formulary restriction</td>
<td>2 (4.8)</td>
</tr>
<tr>
<td>Dedicated audits of specific units/wards</td>
<td>1 (2.4)</td>
</tr>
</tbody>
</table>
Table 3.5: Barriers to antimicrobial stewardship programs among all surveyed hospitals

<table>
<thead>
<tr>
<th></th>
<th>Public Metropolitan n = 32 (%)</th>
<th>Public Regional n = 81 (%)</th>
<th>Private n = 42 (%)</th>
<th>Total n = 155 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of training and education in antimicrobial use</td>
<td>23 (71.9)</td>
<td>47 (58.0)</td>
<td>26 (61.9)</td>
<td>96 (61.9)</td>
</tr>
<tr>
<td>Lack of leadership to promote antimicrobial stewardship</td>
<td>11 (34.4)</td>
<td>33 (40.7)</td>
<td>19 (45.2)</td>
<td>63 (40.6)</td>
</tr>
<tr>
<td>Lack of support from senior clinicians</td>
<td>7 (21.9)</td>
<td>12 (14.8)</td>
<td>7 (16.7)</td>
<td>26 (16.8)</td>
</tr>
<tr>
<td>Lack of infectious diseases/clinical microbiology services</td>
<td>15 (46.9)</td>
<td>40 (49.4)</td>
<td>18 (42.9)</td>
<td>73 (47.1)</td>
</tr>
<tr>
<td>Lack of pharmacy resources</td>
<td>18 (56.3)</td>
<td>58 (71.6)</td>
<td>14 (33.3)</td>
<td>90 (58.1)</td>
</tr>
<tr>
<td>Lack of willingness from doctors to change their prescribing practices</td>
<td>12 (37.5)</td>
<td>23 (28.4)</td>
<td>21 (50.0)</td>
<td>53 (34.1)</td>
</tr>
<tr>
<td>Lack of enforcement by hospital management</td>
<td>12 (37.5)</td>
<td>10 (12.3)</td>
<td>15 (35.7)</td>
<td>34 (21.9)</td>
</tr>
<tr>
<td>High level of transient/seconded staff</td>
<td>11 (34.4)</td>
<td>10 (12.3)</td>
<td>5 (11.9)</td>
<td>23 (14.8)</td>
</tr>
</tbody>
</table>
Figure 3.1: Access to national antimicrobial prescribing guidelines\textsuperscript{38} (n = 42) (%)

<table>
<thead>
<tr>
<th>Type</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper-based</td>
<td>24</td>
<td>57.1</td>
</tr>
<tr>
<td>Electronic-based</td>
<td>8</td>
<td>19.0</td>
</tr>
<tr>
<td>Both</td>
<td>5</td>
<td>11.9</td>
</tr>
</tbody>
</table>

Figure 3.2: Post antimicrobial prescription review (n = 42) (%)

- **Antimicrobial Management Team**: 1 (2.4)
- **Clinical Microbiologist**: 1 (2.4)
- **Infection Control practitioner**: 2 (4.8)
- **Infectious Diseases clinician**: 6 (14.3)
- **Ward pharmacist**: 13 (31.0)

NOTE: As some hospitals had more than one form of post prescription review, the total number of forms of post prescription review (n = 23) is greater than the number of hospitals with post prescription review (n = 20).
Figure 3.3: Method of audit feedback (n = 42) (

<table>
<thead>
<tr>
<th>Method of Audit Feedback</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emails / letters to Heads of Unit</td>
<td>1 (2.4)</td>
</tr>
<tr>
<td>Ward / unit meetings</td>
<td>5 (11.9)</td>
</tr>
<tr>
<td>Emails / letters to individual prescribers</td>
<td>5 (11.9)</td>
</tr>
<tr>
<td>Grand rounds / Quality committee meetings</td>
<td>7 (16.7)</td>
</tr>
</tbody>
</table>

NOTE: As some hospitals had more than one method of audit feedback, the total number of methods of feedback (n = 18) is greater than the number of hospitals with audit feedback (n = 15).
Chapter 4  Prescribing of antimicrobials in Australian private hospitals

4.1  Synopsis

Chapter 3 of this thesis investigated current governance structure, resources and AMS activities in a sample of Australian private hospitals. Important results from the study survey were that more than 80% of private hospitals surveyed did not have a dedicated committee to oversee the AMS program and none had dedicated funding for a pharmacist or clinician to coordinate AMS activities in the hospital. This lack of governance structure and resources implies that private hospitals are not adequately equipped to implement and sustain AMS programs. Reflective of this, only a minority of surveyed hospitals were able to provide feedback on antimicrobial prescribing either through post prescription review (38%), or auditing of antimicrobial prescribing performance (36%).

Interpretation of the results of this survey assumes that there is a need for regular assessment and feedback of antimicrobial prescriptions in private hospitals. Although unlikely, it may be plausible that antimicrobial prescribing in these facilities is occurring in concordance with national prescribing guidelines and is appropriate for patients. More importantly, there is no prescription data from these facilities to ascertain how antimicrobials are currently being used. This information may be of significance in determining which areas need to be prioritised in terms of AMS strategies and activities. Thus, the following chapter presents a series of hospital-wide point prevalence surveys of antimicrobial prescriptions conducted in selected large private hospitals so as to ascertain how and where antimicrobials are being utilised.
4.2 Published manuscript entitled, “Using periodic point-prevalence surveys to assess appropriateness of antimicrobial prescribing in Australian private hospitals”

The manuscript entitled, “Using periodic point-prevalence surveys to assess appropriateness of antimicrobial prescribing in Australian private hospitals” has been published in *Internal Medicine Journal* 2014; 44(3): 240-6.

The co-authors contributed to the manuscript as follows: Study design was performed by the PhD candidate, Menino Osbert Cotta, under the supervision of Associate Professor Caroline Marshall, Professor Danny Liew and Associate Professor Kirsty L Buising. Dr Megan S Robertson, Dr Lydia M Upjohn, Gerlinda Amor, Louise Lyons, Vasantha Pather, Cath Savage and Hilary Young assisted with data collection. Dr Lydia M Upjohn assisted with data assessment. The PhD candidate, Menino Osbert Cotta, performed all data analyses. The PhD candidate, Menino Osbert Cotta, took the leading role in manuscript preparation, writing and submission.

The manuscript is presented as submitted with the exception of figures and tables that have been inserted into the text at slightly different positions. The numbering of pages, figures and tables has been adjusted to fit the style and layout of the thesis. References for the published manuscript have been incorporated into the other references of the thesis and can be found in the ‘List of References’ section.
Using periodic point-prevalence surveys to assess appropriateness of antimicrobial prescribing in Australian private hospitals

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4.3 Abstract

**Background:** Appropriateness of antimicrobial use is a measure of key importance in evaluating safety and quality of prescribing, but has been difficult to define and assess on a wide scale. Published work is limited and has generally focused on tertiary public hospitals, whereas the private sector provides a significant proportion of care in many countries. Information on prescribing in the private hospital context is needed to identify where intervention might be required.

**Aim:** An antimicrobial prescribing survey (APS) tool was utilised to assess the appropriateness of antimicrobial prescribing among large private hospitals in Australia.

**Methods:** ‘Appropriateness’ of antimicrobial therapy was evaluated by a team consisting of an infectious diseases (ID) physician and specialist ID pharmacist based on clear criteria.

**Results:** Thirteen hospital-wide point-prevalence surveys were conducted. 3 472 inpatient medication charts were reviewed to identify 1 125 (32.4%) inpatients on 1 444 antimicrobials. An indication was documented in 911 (63.1%) of surveyed prescriptions, and overall 757 (52.4%) of antimicrobials were assessed as appropriate. Antimicrobials prescribed for treatment had a higher proportion of appropriateness when compared to antimicrobials prescribed for surgical prophylaxis (80.4% vs 40.6%). The main reason for a treatment prescription to be considered inappropriate was incorrect selection, while prolonged duration (>24 hours) was the main reason for inappropriate surgical prophylaxis prescriptions.

**Conclusions:** This study provides important data on antimicrobial prescribing patterns in Australian private hospitals. Results can be used to target areas for improvement, with documentation of indication and surgical antibiotic prophylaxis requiring initial attention.

**KEYWORDS**

antimicrobials; point-prevalence; appropriateness; treatment; surgical prophylaxis;
4.4 Introduction

Surveillance of antimicrobial use and ‘appropriateness’ of antimicrobial prescriptions have been identified as central to building effective antimicrobial stewardship (AMS) programs in hospitals.\textsuperscript{1,2} Point-prevalence surveys capture information about antimicrobial use and have been used to assess the effects of AMS interventions at local, national and international levels.\textsuperscript{164,175,176} Appropriateness of a prescription is an important quality measure, yet it can be difficult to define for auditing.

An Antimicrobial Prescribing Survey (APS) tool for Australian hospitals was developed at The Royal Melbourne Hospital in 2011 and has been subsequently described by James et al 2015 (Appendix 2).\textsuperscript{177} This tool was initially based on an international tool,\textsuperscript{15} but required modifications to meet local needs, including clearer definitions and online training for auditors to improve usability. The new tool was tested across four Australian states in 35 public hospitals in 2011, with many of the participating hospitals using it to conduct hospital-wide point-prevalence surveys. The audit tool was specifically designed to allow auditors to judge the appropriateness of the prescription in a consistent manner according to clear criteria.

In Australia, private hospitals provide approximately one third of all hospital beds and treat 40% of all inpatients,\textsuperscript{120} yet no data currently exist on patterns of antimicrobial use in this sector. These hospitals differ from public hospitals in that therapeutic decisions are usually made by visiting specialist clinicians who are not employed by the hospitals. Rather, they have a direct private arrangement with patients for managing their hospitalised care. This contrasts from the public hospital sector where there is management by teams involving employed junior medical staff.

The case-mix in private hospitals can also differ significantly from the public sector in Australia. An example of this is that private hospitals, despite only representing one third of all hospital beds, provide more than three-quarters of all orthopaedic knee procedures.\textsuperscript{178} In terms of AMS resources, there is currently a dearth of information on what activities are currently taking place and what resources are available in the Australian private hospital sector. Although this could potentially be true for some hospitals in the public sector, state-wide public hospital initiatives
such as initial funding for electronic-based antimicrobial approval systems in 2008, has most likely meant that this sector is advancing in the provision of AMS programs.

It is unknown whether in private hospitals there is more appropriate antibiotic use, possibly due to seniority of the prescriber, or perhaps less appropriate prescribing, as private hospitals are perceived to have a very limited scope in influencing visiting specialists in their clinical practice.

The aim of this prospective, multi-centre study was to utilise the newly developed APS tool to examine antimicrobial use and to assess the appropriateness of antimicrobial prescribing in Australian private hospitals.

4.5 Methods

Study setting

Three large private hospitals in Australia participated in a series of point-prevalence surveys. Hospital A has 450 beds, a 15-bed intensive care unit (ICU) and approximately 85 beds dedicated to rehabilitation services. Hospital B has approximately 220 beds, including an 18-bed critical care unit inclusive of an ICU and a 24-bed cardiac unit. Hospital C has approximately 200 beds, including an 8-bed intensive care unit and 44 labour ward beds. Point-prevalence surveys were conducted every three months commencing February 2012 for Hospital A, and May 2012 for Hospitals B and C.

A hospital-wide census was taken on the morning of each point-prevalence survey. Data collectors were assigned beds from a printed list and were asked to review all corresponding patient medication charts. Patients were included in the survey if they were an inpatient on the morning of the survey day. Patient areas excluded from the survey included labour ward beds, emergency department beds and any patients admitted to day-only stay wards such as Day Oncology and dialysis.
Data collected

Experienced clinical research co-ordinators were trained to collect data via provision of an information pack and a training session prior to administering the PPS. Data were collected from all inpatients being prescribed at least one antimicrobial at the time of chart review. Data collectors had access to the admission and progress notes, surgical notes, medication charts, and pathology and microbiology results.

Antimicrobial therapy was deemed to be for surgical prophylaxis if documented as such in any of the medication chart, patient progress notes, pre-operative assessment documents and post-operative surgical prescriptions. If no indication was documented, the antimicrobial was deemed to be for surgical prophylaxis if prescribed intra-operatively or during the immediate post-operative period, and if there was no other indication clearly documented and no relevant microbiology results available. Antimicrobial therapy was deemed for treatment of infection (‘treatment prescriptions’) or non-surgical prophylaxis if documented as such in patient progress notes or on the medication chart. Antimicrobials were categorised as ‘non-assessable’ if no clear indication was documented in the notes and the antimicrobial was not likely to be for surgical prophylaxis.

‘Appropriateness’ of antimicrobial therapy was assessed by an infectious diseases (ID) clinician and a specialist ID pharmacist, who reviewed clinical information against the national Therapeutic Guidelines: Antibiotic. Antimicrobial selection, dose, frequency, duration (for prophylaxis prescriptions only), hypersensitivity contraindication and microbiology investigation results (including antibiotic susceptibilities of any identified pathogens) were considered by the assessors. An “allergy mismatch” was noted if the antimicrobial was contraindicated based on documented hypersensitivity information, while “microbiology mismatch” was documented if the antimicrobial prescribed did not match pathogen susceptibility data. Duration of treatment was not considered for treatment prescriptions, as this is often dependent on clinical variables that were not assessable. If there was a lack of information about the infection purportedly being treated, the treatment order was judged to be ‘non-assessable’.

Surgical antibiotic prophylaxis (SAP) was judged to be inappropriate for the following reasons: if antimicrobial selection, dosage or frequency were not concordant with the Therapeutic Guidelines: Antibiotic, if an “allergy mismatch” were present, or if prophylaxis duration was
greater than 24 hours. Antimicrobials could be judged inappropriate for more than one identified reason. If consensus on appropriateness could not be reached by the assessment team, the decision was referred to an independent senior ID clinician. Where applicable, data were also collected regarding site of infection and type of surgery.

Statistical Analysis
As each hospital-wide point-prevalence survey represented a census of all inpatients on the day of the survey, all results were without sampling error. Data are reported descriptively.

4.6 Results

Thirteen hospital-wide point-prevalence surveys were conducted during the study period from February 2012 to February 2013. Hospital A participated in five surveys, while four surveys were conducted at each of Hospitals B and C. A total of 3,472 inpatient medication charts were reviewed with 1,125 patients (32.4%) on 1,444 antimicrobials during the study period. Summary data of all surveyed prescriptions at each hospital is shown in Table 4.1.

Sixty-nine percent of all patients on antimicrobial therapy in Hospital A were admitted under a surgical case mix, while 48% and 37% of all patients on antimicrobial therapy were surgical cases in Hospitals B and C, respectively. Appropriateness of prescriptions for treatment and SAP are shown in Table 4.2. Less than half of SAP prescriptions were documented as such. 47.3% of all prescriptions reviewed were for treatment with the respiratory tract and skin and soft tissue being the most common sites of infection (Table 4.3). 32.6% of prescriptions were classified as SAP and more than half of these were for orthopaedic surgical cases (Table 4.4). Figure 4.1 and 4.2 show the percentage of inappropriate prescriptions for treatment and SAP respectively for each hospital during the study period. The most common reasons for inappropriateness was “incorrect drug/drug combination” for treatment prescriptions and “prolonged duration (>24 hours)” for SAP (Figure 4.3).
4.7 Discussion

These data suggest that the burden of antimicrobial use in large Australian private hospitals is comparable to that described in tertiary public hospitals in the existing published literature, with around a third (32.4%) of inpatients receiving antimicrobials on any given day across the 13 hospital-wide point prevalence surveys. International hospital point prevalence surveys have previously shown the proportion of patients on antimicrobials to range from 16% to 32%,\(^5\,^{\text{6,10–12}}\) while one previous hospital-wide survey in an Australian public hospital recorded 43% of inpatients being on antibiotics.\(^\text{182}\)

This study identified key areas for improvement in antimicrobial prescribing practice in the private hospital setting. One important potential quality indicator for antimicrobial prescribing assessed by this study was whether an indication for antimicrobial therapy was documented in patient notes. Hospitals B and C had a higher documentation rate (72% each) than that reported in a previous international study (64%),\(^\text{15}\) whereas hospital A had a lower rate (58%). For SAP, documentation was particularly poor with only prescriptions for gynaecological surgery having a documentation rate of greater than 50%. The proportion of antimicrobial prescriptions where appropriateness was 'non-assessable' due to poor documentation ranged from 12.8% to 38%. Without adequate documentation, communication between staff members is impeded, and opportunities to evaluate and review medication use are limited. Strategies to encourage or enforce (in the case of mandatory fields in electronic prescribing) such documentation should be further explored.

Of those prescriptions that were assessable, approximately 80% of prescriptions for treatment of infection were judged to be appropriate. Of the 99 treatment prescriptions judged as inappropriate, incorrect antimicrobial selection was the main problem. This suggests that better access to prescribing guidelines and education initiatives may be required to help improve empiric prescribing decisions. In addition, more timely access and response to microbiology results, and perhaps better liaison with clinical microbiologists may also be necessary to improve the adequacy of directed antimicrobial therapy.
SAP accounted for a third (32.6%) of all antimicrobial prescriptions surveyed during the study period. In comparison to treatment prescriptions, the appropriateness of prescriptions for SAP was low. In fact, only SAP for orthopaedic and neurosurgical procedures had appropriateness greater than 50%. The main reason for SAP to be judged as inappropriate was prolonged durations of therapy (greater than 24 hours). The recommendations for SAP in the national guidelines, Therapeutic Guidelines: Antibiotic, are for one to two perioperative doses of antibiotics, with no recommendation for antibiotic therapy to continue beyond 24 hours after surgery for most operations. However, findings in this study suggest that SAP is routinely being continued beyond 24 hours, with no justification documented. A previous study conducted in Australia looking specifically at SAP in public hospitals found a much higher rate of compliance with the national guidelines. However, assessment of appropriateness in that study was made on the basis of antibiotic choice and the timing of the first dose in relation to the time of surgery. Duration of prophylaxis, as an appropriateness criterion, was excluded for the simple reason of poor documentation.

The second most common reason for inappropriate SAP was incorrect antibiotic selection. It was interesting to note that a high proportion of these incorrect selections were due to the use of oral antibiotics, which were used in a high proportion of patients undergoing plastics and urological procedures. Oral antibiotics also significantly contributed to prolonged SAP as all of these were prescribed for greater than 24 hours, sometimes up to a week post operatively. This finding suggests that the use of local SAP guidelines may be an important starting point for private hospitals to consider.

Overall, the rate of inappropriate prescribing over time seemed to remain consistent; however, there was an observed decrease in the percentage of inappropriate treatment prescriptions over time for hospital B, whilst an opposite pattern was observed for hospital C. A trend analysis of this data was not performed, as there are only a limited number of data points for each hospital and no interventions performed during the study period. However, it will be interesting to see if these observations continue in any future point prevalence surveys, particularly after introduction of an AMS program at each of the hospitals.

The results of the present study provide the most detailed picture of contemporary antimicrobial prescribing in Australian private hospitals. Furthermore, accuracy of the data in
representing day-to-day prescribing of antimicrobials has been enhanced by the fact that point prevalence surveys were carried out quarterly over a 12-month period. Use of an assessment team consisting of an ID clinician and a specialist ID pharmacist supports the concept of antimicrobial management teams that contribute to improved quality and safety of antimicrobial prescribing. The regular surveillance of antimicrobial use and appropriateness is important for private facilities seeking to implement AMS programs and interventions in the future.

Limitations to this study include that the information collected was dependent on the training and knowledge of individual data collectors. Although each of these data collectors was provided with an information pack and detailed in-service, variability between data collectors could not completely be eliminated. In addition, assessment of appropriateness was based on data collected at that particular point in time and information that potentially affected antimicrobial use that was not documented could not be taken into account. Also, appropriateness of antimicrobial selection was based on the assumption that the clinician diagnosis was accurate. The duration of therapy was not assessed for prescriptions other than SAP, which might further affect the assessment of appropriateness. It was important to note that analysis of inappropriate selection was not differentiated based on the spectrum of activity (ie either excessively broad or narrow for the intended indication). Future studies should aim to use a more detailed framework in defining appropriateness so as to identify reasons for non-concordant selection of antimicrobials. Finally, although this study gave an in-depth view of antimicrobial prescribing in the three hospitals surveyed, these hospitals represent only a small proportion of all private hospitals in Australia. There is future scope to conduct multiple point-prevalence surveys in a larger group of Australian private hospitals.

In summary, the present study indicates that there may be significant issues with antimicrobial prescribing in the Australian private hospital sector with lack of documentation of indication being one such issue highlighted in this study. Antimicrobials prescribed for treatment were generally appropriate, however, inappropriate therapy was observed to occur frequently in SAP and this should be a major target for any future AMS initiatives.
Table 4.1: Summary data of surveyed prescriptions at each hospital - documentation of indication and appropriateness assessment

<table>
<thead>
<tr>
<th>Patient charts reviewed</th>
<th>Hospital A (n = 2206)</th>
<th>Hospital B (n = 622)</th>
<th>Hospital C (n = 644)</th>
<th>Total (n = 3472)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>Range (%)</td>
<td>n (%)</td>
<td>Range (%)</td>
</tr>
<tr>
<td>Patients on antimicrobial therapy</td>
<td>716</td>
<td>(32.5)</td>
<td>228</td>
<td>(36.7)</td>
</tr>
<tr>
<td></td>
<td>(29.1 to 33.9)</td>
<td></td>
<td>(34.7 to 39.9)</td>
<td></td>
</tr>
<tr>
<td>Antimicrobial prescriptions reviewed</td>
<td>(n = 911)</td>
<td></td>
<td>(n = 299)</td>
<td></td>
</tr>
<tr>
<td>Antimicrobial prescriptions where indication documented</td>
<td>526</td>
<td>(57.7)</td>
<td>216</td>
<td>(72.2)</td>
</tr>
<tr>
<td></td>
<td>(51.2 to 63.4)</td>
<td></td>
<td>(59.7 to 78.8)</td>
<td></td>
</tr>
<tr>
<td>Antimicrobial prescriptions assessed as appropriate</td>
<td>449</td>
<td>(49.3)</td>
<td>175</td>
<td>(58.5)</td>
</tr>
<tr>
<td></td>
<td>(45.3 to 54.8)</td>
<td></td>
<td>(49.3 to 65.0)</td>
<td></td>
</tr>
<tr>
<td>Antimicrobial prescriptions assessed as inappropriate</td>
<td>276</td>
<td>(30.3)</td>
<td>70</td>
<td>(23.4)</td>
</tr>
<tr>
<td></td>
<td>(22.9 to 39.0)</td>
<td></td>
<td>(21.3 to 26.9)</td>
<td></td>
</tr>
<tr>
<td>Antimicrobial prescriptions that were non-assessable</td>
<td>186</td>
<td>(20.4)</td>
<td>54</td>
<td>(18.1)</td>
</tr>
<tr>
<td></td>
<td>(12.8 to 25.1)</td>
<td></td>
<td>(13.8 to 23.9)</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: In Tables 4.1 and 4.2, ‘Range’ refers to the results obtained across point-prevalence surveys undertaken at each hospital.
Table 4.2: Appropriateness of *treatment* and *SAP* prescriptions

<table>
<thead>
<tr>
<th></th>
<th>Total (n = 683)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>Range (%)</td>
<td></td>
</tr>
<tr>
<td>Treatment prescriptions assessed as appropriate</td>
<td>549 (80.4)</td>
<td>(68.2 to 95.2)</td>
<td></td>
</tr>
<tr>
<td>Treatment prescriptions assessed as inappropriate</td>
<td>99 (14.5)</td>
<td>(6.0 to 27.3)</td>
<td></td>
</tr>
<tr>
<td>Treatment prescriptions that could not be assessed</td>
<td>35 (5.1)</td>
<td>(0.0 to 14.8)</td>
<td></td>
</tr>
<tr>
<td>SAP prescriptions (n = 471)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAP prescriptions assessed as appropriate</td>
<td>191 (40.6)</td>
<td>(23.5 to 100)</td>
<td></td>
</tr>
<tr>
<td>SAP prescriptions where indication was documented</td>
<td>204 (43.3)</td>
<td>(8.3 to 100)</td>
<td></td>
</tr>
</tbody>
</table>

SAP – surgical antibiotic prophylaxis
### Table 4.3: Sites of infection and appropriateness of therapy

<table>
<thead>
<tr>
<th>Total (n = 684) (%)</th>
<th>Appropriate %</th>
<th>Non assessable %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respiratory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>214 (31.3)</td>
<td>81.8</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Skin and soft tissue</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>122 (17.8)</td>
<td>79.5</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>Urinary tract</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>83 (12.1)</td>
<td>90.4</td>
<td>6.0</td>
</tr>
<tr>
<td><strong>Bone and joint</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70 (10.2)</td>
<td>74.3</td>
<td>18.5</td>
</tr>
<tr>
<td><strong>Intra-abdominal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>62 (9.1)</td>
<td>83.9</td>
<td>3.2</td>
</tr>
<tr>
<td><strong>Not specified (including febrile neutropenia)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41 (6.0)</td>
<td>70.7</td>
<td>14.6</td>
</tr>
<tr>
<td><strong>Bacteraemia/ fungemia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33 (4.8)</td>
<td>87.9</td>
<td>6.1</td>
</tr>
<tr>
<td><strong>Gastrointestinal (eg salmonellosis, C. difficile infection etc.)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23 (3.4)</td>
<td>82.6</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Cardiovascular</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 (1.9)</td>
<td>92.3</td>
<td>7.7</td>
</tr>
<tr>
<td><strong>Otorhinolaryngology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 (1.6)</td>
<td>81.8</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>CNS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 (1.3)</td>
<td>100</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Gynaecology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 (0.3)</td>
<td>0.0</td>
<td>50</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (0.1)</td>
<td>1</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**NOTE:** The total number of sites of infection (n = 684) is greater than the number of ‘treatment prescriptions’ (n = 683) because some antimicrobials were prescribed for more than one site of infection.
Table 4.4: Types of surgery and appropriateness of SAP

<table>
<thead>
<tr>
<th>Type</th>
<th>Total (n = 471) (%)</th>
<th>Appropriate %</th>
<th>Indication documented %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthopaedic</td>
<td>244 (51.8)</td>
<td>54.9</td>
<td>48.0</td>
</tr>
<tr>
<td>Cardiothoracic</td>
<td>76 (16.1)</td>
<td>25.0</td>
<td>32.9</td>
</tr>
<tr>
<td>General surgery</td>
<td>39 (8.3)</td>
<td>20.5</td>
<td>41.0</td>
</tr>
<tr>
<td>Neurosurgery</td>
<td>35 (7.4)</td>
<td>51.4</td>
<td>31.4</td>
</tr>
<tr>
<td>Plastics</td>
<td>22 (4.7)</td>
<td>13.6</td>
<td>50.0</td>
</tr>
<tr>
<td>Vascular</td>
<td>21 (4.5)</td>
<td>28.6</td>
<td>47.6</td>
</tr>
<tr>
<td>Urology</td>
<td>18 (3.8)</td>
<td>16.7</td>
<td>33.3</td>
</tr>
<tr>
<td>Gynaecology</td>
<td>9 (1.9)</td>
<td>0.0</td>
<td>88.9</td>
</tr>
<tr>
<td>Otorhinolaryngology</td>
<td>6 (1.3)</td>
<td>0.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Maxillofacial</td>
<td>1 (0.2)</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

SAP – surgical antibiotic prophylaxis
NOTE: General surgery includes upper gastrointestinal and colorectal surgery
Figure 4.1: Inappropriateness over time: *treatment* prescriptions

![Graph showing inappropriateness over time for treatment prescriptions across three hospitals.](image)

**Figure 4.2: Inappropriateness over time: SAP prescriptions**

![Graph showing inappropriateness over time for SAP prescriptions across three hospitals.](image)

SAP – surgical antibiotic prophylaxis
Figure 4.3: Reasons for inappropriate treatment and SAP prescriptions

- Incorrect drug/dose combination
- Incorrect dose
- Incorrect frequency
- Allergy mismatch
- Microbiology mismatch
- Oral surgical prophylaxis
- Prolonged duration (>24 hours)

SAP – surgical antibiotic prophylaxis

† - only applicable for treatment prescriptions
‡ - only applicable for SAP prescriptions
Chapter 5  Appropriateness of antimicrobial prescribing in Australian private hospitals: how reliable are assessors?

5.1  Synopsis

Chapter 4 of this thesis reported important findings when describing antimicrobial prescribing patterns in sampled private hospitals. Overall prevalence of antimicrobial use in surveyed hospitals was comparable to public hospitals both overseas and in Australia, with a significant proportion of these being used for surgical antibiotic prophylaxis (SAP). One major issue highlighted from results of the study was that documentation of indication was modest which meant assessing appropriateness of therapy was problematic for assessors. SAP prescriptions, in particular, were not only poorly documented but appropriateness was low when compared to appropriateness of treatment prescriptions from the current study and the literature.

Results indicated that there is need to optimise antimicrobial prescribing and highlighted which areas may need to be targeted when introducing AMS in Australian private hospitals. Importantly, in that study an experienced ID physician and an ID pharmacist made ‘appropriateness’ assessments, which may not be universally feasible.

As shown in results of Chapter 3 of this thesis, only one surveyed hospital had a dedicated specialist assessment team, such as the one described above, who regularly reviewed antimicrobial prescriptions. Of the hospitals that did consistently review therapy, the majority utilised clinical or ‘ward’ pharmacists (31%). Less than half of the hospitals surveyed did not provide regular post prescription review with some form of feedback. Importantly, nearly half (48%) of surveyed hospitals had arrangements for receiving antimicrobial prescribing advice outside of their hospital. This indicates that many private hospitals utilise ID experts offsite (ie remotely) and/or utilise local assessors not experienced in ID such as clinical pharmacists and ICPs. However, it is unclear if appropriateness assessments made by experienced assessors remotely correlate with assessments made by experienced assessors at the bedside. There is also no data on whether there is good inter-rater reliability between assessors experienced in
ID, such as ID physicians, clinical microbiologists and ID pharmacists, and assessor with less experience such as clinical pharmacists and infection control practitioners (ICPs).

The aim of the following chapter was to determine if remote assessors and/or assessors with less experience in ID could be utilised by private hospitals in the review and assessment of antimicrobial prescriptions.
5.2 Accepted manuscript entitled, “Evaluating antimicrobial therapy: how reliable are remote assessors?”

The manuscript entitled, “Evaluating antimicrobial therapy: how reliable are remote assessors?” has been accepted for publication in *Infection, Disease and Health* 2015 (in press).

The co-authors contributed to the manuscript as follows: Study design was performed by the PhD candidate, Menino Osbert Cotta, under the supervision of Associate Professor Karin Thursky, Associate Professor Kirsty L Buising, Professor Danny Liew and Associate Professor Caroline Marshall. Ms Caroline Chen and Dr Rodney James helped recruit participating assessors and retrieved antimicrobial prescription data from the 2013 National Antimicrobial Prescribing Survey (NAPS) initiative. Together with Dr Tim Spelman, the PhD candidate, Menino Osbert Cotta, performed all data analyses. The PhD candidate, Menino Osbert Cotta, took the leading role in manuscript preparation, writing and submission.

The manuscript is presented as submitted with the exception of figures and tables that have been inserted into the text at slightly different positions. The numbering of pages, figures and tables has been adjusted to fit the style and layout of the thesis. References for the published manuscript have been incorporated into the other references of the thesis and can be found in the ‘List of References’ section.
Evaluating antimicrobial therapy: how reliable are remote assessors?

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Rodney S James\textsuperscript{a}
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5.3 Abstract

Introduction: Assessing the quality of antimicrobial prescribing provides hospitals with a means of targeting and measuring the impact of antimicrobial stewardship interventions. There are limited data available on the reliability of these assessments among different types of hospital assessors deployed away from the bedside (ie remotely). Importantly, it is unclear if assessors inexperienced in clinical infectious diseases can reliably evaluate the quality of antimicrobial prescriptions. This study sought to determine the reliability of assessments made by remote hospital assessors with different levels of clinical infectious diseases experience. These assessments were based on (1) concordance with national prescribing guidelines and (2) ‘overall appropriateness’.

Methods: 180 prescriptions were assessed for ‘concordance with guidelines’ and ‘overall appropriateness’ at the bedside (ie locally). Prescription data were then given to fifteen remote assessors. These assessors were blinded to local assessments. Inter-rater reliability was calculated using Fleiss’ kappa statistics.

Results: Higher levels of agreements were achieved for ‘concordance with guidelines’ assessments. Local and remote antimicrobial management teams had the highest level of agreement and this improved when looking at antimicrobial treatment used to treat respiratory tract infections (kappa score = 0.67). Reliability in assessments was moderate for local pharmacist assessments and fair to slight for local infection control assessments.

Conclusions: There is scope to develop tools that will improve assessment reliability of antimicrobial therapy among remote assessors. Clinical pharmacists provide reliability comparable to infectious diseases experts, however, infection control practitioners may require further education and training to improve reliability in assessments.
5.4 Introduction

Hospital antimicrobial use has been implicated in accelerating development of antimicrobial resistance worldwide. Many institutions have targeted improving antimicrobial prescribing through reducing unnecessary use and rationalising therapy by a variety of antimicrobial stewardship (AMS) interventions.

Consumption of antimicrobials has been used as an outcome indicator for AMS; however, use of crude volume-based usage data is often not accurate when evaluating antimicrobial use. Assessing the quality of antimicrobial prescribing represents a more descriptive method. Periodic auditing of antimicrobial prescriptions has the ability to inform AMS program coordinators of prescribing practices that require targeting via a continuous quality improvement process.

Evaluation of antimicrobial therapy can be made solely on the basis of pathogen-antimicrobial susceptibility, however, there are other aspects of the antimicrobial prescription, such as spectrum of activity, dose and duration that need to be considered when assessing antimicrobial prescriptions. Concordance with endorsed prescribing or treatment guidelines provides an alternative method to audit quality of antimicrobial therapy. There are limitations with this approach in that guidelines may not be available for all indications or may be considered insufficient when taking into account patient specific factors, such as patient drug allergies or the risk of drug toxicity.

As a result, the opinion of health professionals trained in clinical Infectious Diseases (ID) may be used to determine ‘overall appropriateness’ of therapy. Multi-disciplinary teams consisting of an ID physician or clinical microbiologist and specialist ID pharmacist (termed antimicrobial management teams [AMTs]) have previously been shown to be effective in reducing antimicrobial use through post-prescription assessment with direct intervention and feedback. Additionally, national consensus statements have recommended the use of AMTs as part of hospital-wide AMS programs.

However, an Australia-wide antimicrobial prescribing survey conducted in 2013 noted that many hospitals lack the capacity, either due to geographical location or funding constraints, to
have local (ie onsite) expert assessors such as AMTs, ID physicians or clinical microbiologists. Results of this survey showed that approximately a quarter of the 151 participating hospitals sought assistance from assessors that only had access to the data collection form, and thus performed the assessment of antimicrobial prescriptions away from the bedside (ie remotely or ‘offsite’). Additionally, of the 334 assessors that participated, a third (33%) were non-specialist ID pharmacists whilst a further 27% of assessors were infection control practitioners (ICPs) from a nursing background.

Taking into account that many assessors of antimicrobial prescriptions may not have formal training in clinical ID and/or may have performed this assessment remotely, there is need to ascertain whether quality assessments of antimicrobial prescriptions are consistent among this heterogeneous group of local and remote assessors.

Therefore, the aim of this current study was to determine the level of inter-rater reliability between assessments made by local and remote health professionals with different levels of clinical ID experience for (1) concordance with national antimicrobial prescribing guidelines and (2) ‘overall appropriateness’ using a newly developed appropriateness assessment tool. It was hypothesised that there would be greater inter-rater reliability among local and remote ID experts compared to those not trained in ID (term ‘non-ID experts’).

5.5 Methods

Antimicrobial prescriptions included in the study were sampled from prescription data collected as part of the 2013 Australia-wide antimicrobial prescribing survey conducted by the National Antimicrobial Prescribing Survey (NAPS) initiative. Data for each prescription were collected using a standard data collection form (available upon request from the authors – see Appendix 3).

Local assessment of antimicrobial prescriptions
Local assessors made assessments at the bedside and had access to the medication chart, patient admission and progress notes, surgical notes (where applicable), pathology and microbiology results. These assessors collected prescription data using the standard data
collection form and made assessments independently. Local assessors constituted one of the following:

Local ID experts
- An AMT assessment team – consisting of either an ID physician or clinical microbiologist and a specialist ID pharmacist

Local non-ID experts
- A non-specialist ID pharmacist assessor (no ID experience/training termed ‘clinical pharmacist’)
- An ICP assessor (nursing background with no ID experience/training)

Local assessors then transferred all data in the data collection form onto an online database, ensuring all codes were consistent and all annotated free text included. This online prescription data were then sent to remote assessors who were blinded to assessments.

Remote assessment of antimicrobial prescriptions
Fifteen remote assessors were purposefully selected by investigators either by phone or email through professional contacts and included the following:

Remote ID experts
- Three AMT assessor teams (consisting of either an ID physician or clinical microbiologist and a specialist ID pharmacist)
- Three ID physicians or clinical microbiologists (termed ‘ID specialist’)
- Three specialist ID pharmacists (> 3 years’ experience working in ID) (termed ‘ID pharmacist’)

Remote non-ID experts
- Three clinical pharmacists with no experience in ID
- Three experienced ICPs (> 5 years’ experience)

Remote assessors could not work in any of the hospitals from where antimicrobial prescriptions were sampled.

Assessment of ‘concordance with guidelines’ and ‘overall appropriateness’
For each antimicrobial prescription, assessors were asked to independently assess:

i) Concordance with the national prescribing guidelines of Australia (Therapeutic Guidelines: Antibiotic38)
‘Overall appropriateness’ (taking into account that guidelines may not cover all situations and/or additional patient specific factors)

A newly developed NAPS appropriateness assessment tool (available upon request from the authors – see Appendix 4) helped guide assessments of ‘overall appropriateness’. This tool was developed via an iterative process involving a panel of ID physicians, clinical microbiologists and specialists ID pharmacists and took into account excessive or overlapping spectrum of activity, severity of patient allergies and risk of toxicity. All local and remote assessors received training via a teleconference and an online slide presentation describing ten examples of how the tool could be used to guide appropriateness assessments.

Sample antimicrobial prescriptions
A sample of 180 prescriptions was deemed large enough to determine ‘fair’ or greater inter-rater reliability (see ‘statistical analyses’ for further detail). These 180 prescriptions were distributed in three batches (Figure 4.1).

Antimicrobial prescriptions for the following indications were included in each batch of 60 prescriptions:
- Community acquired pneumonia (9 prescriptions)
- Chronic obstructive pulmonary disease (3 prescriptions)
- Hospital acquired pneumonia (6 prescriptions)
- Skin and soft tissue infections (9 prescriptions)
- Urinary tract infections (9 prescriptions)
- Intra-abdominal infections (9 prescriptions)
- Surgical antibiotic prophylaxis (9 prescriptions)
- Miscellaneous prescriptions (6 prescriptions)

Statistical analyses
Categorical variables for both ‘concordance with guidelines’ and ‘overall appropriateness’ were regrouped into broader categories (1 – ‘concordant’ or ‘appropriate’, 2 – ‘non-concordant’ or ‘inappropriate’, 3 – ‘not assessable’) to increase sample numbers and rationalize variables into meaningful groups. These were then summarized using frequency and percentage.
Continuous variables were assessed for significant departures from normality using a Shapiro-Wilk test of skew (or equivalent) and summarized using mean and standard deviation (SD) or median and inter-quartile range (IQR) as appropriate. ‘Agreement’ was assessed using Cramer’s phi-prime. Factors contributing to agreement were analysed using predictive modelling.

Kappa scores are correlational statistics commonly used to measure inter-rater reliability. These scores were calculated for each variable and interpreted as follows: 0.01–0.2 as ‘slight agreement’, 0.21–0.4 as ‘fair agreement’, 0.41–0.6 as ‘moderate agreement’, 0.61–0.8 as ‘substantial agreement’, and 0.81–1.0 as ‘almost perfect agreement’. P-values ≤ 0.01 were assumed to be statistically significant, adjusting for multiple comparisons. All analyses were undertaken using Stata version 13 (Statacorp®, College Station, Texas).

Ethics approval

The study had current ethics approval at the research institute where investigators were based. Participating hospitals had previously agreed that de-identified data entered by them into the NAPS database could potentially be utilized for research activities, and so ethics approval at each individual hospital was not sought. Participation was voluntary and no remuneration was given to any of the assessors.

5.6 Results

Prescription data were sampled from 34 hospitals around Australia. Table 5.1 shows the characteristics of these hospitals based on their Australian Institute of Health and Welfare classifications.

Inter-rater reliability for ‘concordance with guidelines’ – aggregate data (Table 5.2)
None of the inter-rater reliability scores achieved almost perfect agreement (kappa scores ≥ 0.81) or substantial agreement (kappa scores between 0.61–0.8), however, moderate agreement (kappa scores between 0.41–0.6) was achieved in three out of the five remote assessor groups for both local AMT and local clinical pharmacist assessments. The highest agreement occurred between local and remote AMT assessments (kappa score = 0.53).
Local ICP assessments only had either fair agreement (kappa score between 0.21–0.4) or slight agreement (kappa score between 0.01–0.2) among the five remote assessor categories, whilst remote ICPs had the lowest Kappa scores among all five remote assessor groups for both local AMT and clinical pharmacist assessments.

Inter-rater reliability for ‘overall appropriateness’ – aggregate data (Table 5.3)
Compared to the level of agreement achieved for ‘concordance with guidelines’, agreement on ‘overall appropriateness’ was much lower. Kappa scores reflected either fair agreement or slight agreement, with none achieving moderate agreement or higher. Nine out of the twenty kappa scores did not achieve statistical significance. The highest level of agreement was seen between local clinical pharmacist and remote AMT assessments (kappa score = 0.33).

Due to the observed lower levels of agreement, no further analysis was performed for ‘overall appropriateness’ assessments. Local ICP assessments were also excluded from any subsequent analysis for the same reason.

Further analysis was performed for remote AMT concordance with guidelines data as this group had the highest level of agreement.

Inter-rater reliability for ‘concordance with guidelines’ – by indication for antimicrobial therapy (Table 5.4)
Agreement between local and remote AMT assessments reached substantial agreement for respiratory tract infections and moderate agreement for skin and soft tissue infections and surgical antibiotic prophylaxis.

5.7 Discussion

The benefits of assessing appropriateness of antimicrobial therapy are that it has the potential to add depth when describing antimicrobial use and provides hospitals with a means of continuous quality improvement through auditing, targeting and measuring the impact of subsequent interventions. Conducting periodic assessment surveys can, however, be resource...
intensive when compared to collating volume-based usage data. There needs to be more information available on the reliability of assessments in order for these initiatives to be perceived as a robust evaluation method of antimicrobial therapy and hence measuring the impact of AMS interventions.

Previous inter-rater reliability studies assessing appropriateness of pharmacotherapy have found favourable results. A 2008 study seeking to validate a new screening tool of older persons’ prescriptions incorporating criteria for potentially inappropriate drugs found substantial agreement (kappa score = 0.75) among 100 data set evaluations.\textsuperscript{192} Likewise, Hanlon and colleagues found almost perfect agreement (kappa score = 0.83) between a clinical pharmacist and internist-geriatrician when assessing appropriateness of chronic medications taken by ten ambulatory, elderly male patients.\textsuperscript{193} Results of our study indicate that, at best, moderate reliability in the assessment of antimicrobial prescriptions was achieved.

These results, however, are consistent with a previous study on inter-rater reliability among antimicrobial prescriptions conducted in 2005.\textsuperscript{194} In that investigation, Mol and colleagues found fair to moderate agreement among six remote assessors (two hospital pharmacists, two internists and two clinical microbiologists) who were asked to assess adherence of antimicrobial prescriptions to local hospital guidelines.

Interestingly, the investigators noted a comparatively lower level of agreement (kappa score = 0.36) between the two participating clinical microbiologists attributed to one of the clinical microbiologists not following assessment instructions. This may have been a potential reason for the comparatively lower observed kappa (kappa score = 0.23) that was attained for assessments made between local AMTs and remote ID specialists (both considered ID experts), however investigators of the current study were unable to verify this.

In light of consensus statements endorsing AMTs as best practice in the assessment of antimicrobial prescriptions, inter-rater reliability between local AMT assessments were assumed to be significant in determining which remote assessors were most closely aligned with this “gold standard”. Perhaps unsurprisingly, remote AMT had the highest level of agreement, supporting the concept that multi-disciplinary teams of ID experts are best placed to assess antimicrobial prescription data remotely.
Interestingly, the level of agreement for local clinical pharmacist assessments tended to be higher among remote ID experts as seen in Table 5.2, inferring that clinical pharmacists may be able to reliably collect and assess antimicrobial prescriptions. In contrast, local ICP assessments did not reflect this level of agreement. Given that clinical pharmacists and ICPs consisted of 33% and 27% of all assessors for the 2013 NAPS initiative respectively,190 these findings have significant implications for future nation-wide survey activities. It may be plausible to have two tiers of training for assessors who are not considered ID experts. One tier could be for professionals with experience in assessing prescription quality against endorsed prescribing guidelines, such as clinical pharmacists. Another more intensive form of training could be adapted for personnel who may lack prescription-auditing experience and have been recently tasked with evaluating antimicrobial therapy at their respective hospitals, as many ICPs in Australia have anecdotally reported.

It is clear from the results that better reliability in assessments is achieved when assessing concordance with national prescribing guidelines rather than the concept of ‘overall appropriateness’. Perhaps this was because, by endeavouring to take into account additional factors such as excessive spectrum of activity and risk of allergies and toxicity, the appropriateness tool added to the complexity of assessment. A recent analysis by DePestel and colleagues supports this explanation as they highlight a divergence in levels of appropriateness when comparing assessments made according to objective definitions such as susceptibility data versus more subjective assessments based on clinical judgement.195 In contrast to the newly developed NAPS appropriateness tool, the national antimicrobial prescribing guidelines were first established in 1978 and are currently in their 15th version in Australia. Development of these national guidelines has been through an extensive iterative process involving multidisciplinary input and even though they are limited in the ability to incorporate patient-specific factors, they still provide the most robust method guiding antimicrobial prescribing in hospitals. Familiarity with these guidelines and their application may have contributed to the greater reliability observed among assessors.

Given that current evidence suggests that there is less consistency in the evaluation of antimicrobial therapy compared to other forms of pharmacotherapy, further work looking to improve reliability in assessing antimicrobial prescriptions should be made a priority. This is
particularly poignant if ‘appropriateness of antimicrobial therapy’ is to become a valid method when determining the impact of AMS interventions. A potential way forward to improving assessment reliability may be to design data collection and assessment tools that are specific for certain infections, as has been developed by the Centers for Disease Control and Prevention.\textsuperscript{196} Results of the current study also point to this, as levels of reliability were shown to increase when looking at antimicrobial therapy prescribed for specific indications such as respiratory tract infections.

Limitations to this study do exist. The first of which is that purposeful sampling of remote assessors could not eliminate selection bias. Another limitation was there were assumptions that a local assessor would be able to reliably collect and transcribe clinical information online. This may not always be the case. A 2009 study investigating comparisons of assessments of antimicrobial appropriateness made by the same reviewer for 24 computerised vignettes and corresponding paper medical records revealed only fair intra-rater reliability (kappa score = 0.30) despite possible reviewer recall bias.\textsuperscript{197}

Local prescription data were sampled from a variety of hospitals throughout Australia. This is no doubt a strength in study design, however, incorporating hospital-specific information into data collection, such as antibiograms, may have proven useful in terms of how local assessments were made on the basis of locally derived data.

In summary, given the current challenges of accelerating antimicrobial resistance and need to optimise antimicrobial therapy, regular assessment of appropriateness is of great importance for hospitals to consider as part of their AMS program. Results of this study indicate that more work needs to be done in order to improve the reliability of these assessments especially in the context where there is a heterogeneous mix assessors with differing levels of experience and who may be performing these assessments either locally or remotely. Findings may be applicable to other countries where healthcare facilities lack onsite ID experts, perhaps due to being located outside of major urban centres, such as is the case with a significant proportion of hospitals in Australia.
Table 5.1: Characteristics of sampled hospitals
(n= 34) (%)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hospital location</strong></td>
<td></td>
</tr>
<tr>
<td>Metropolitan</td>
<td>20 (58.8)</td>
</tr>
<tr>
<td>Regional</td>
<td>13 (38.2)</td>
</tr>
<tr>
<td>Rural</td>
<td>1 (3)</td>
</tr>
<tr>
<td><strong>Classification</strong></td>
<td></td>
</tr>
<tr>
<td>Principal referral or specialist hospitals</td>
<td>18 (52.9)</td>
</tr>
<tr>
<td>Large hospitals</td>
<td>8 (23.5)</td>
</tr>
<tr>
<td>Medium hospitals</td>
<td>4 (11.8)</td>
</tr>
<tr>
<td>Small hospitals</td>
<td>4 (11.8)</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td>32 (94.1)</td>
</tr>
<tr>
<td>Private</td>
<td>2 (5.9)</td>
</tr>
</tbody>
</table>
Table 5.2: Concordance with guidelines\textsuperscript{38}: kappa scores for local and remote assessments – categorised by TYPE OF ASSESSOR

<table>
<thead>
<tr>
<th>TYPE OF ASSESSOR</th>
<th>Remote assessments</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ID experts</td>
<td>Non-ID experts</td>
<td>ID experts</td>
<td>Non-ID experts</td>
<td>Non-ID experts</td>
</tr>
<tr>
<td>Local assessments</td>
<td>AMT</td>
<td>0.45*</td>
<td>0.24</td>
<td>0.35</td>
<td>0.30</td>
</tr>
<tr>
<td>ID experts</td>
<td>AMT</td>
<td>0.53*</td>
<td>0.23</td>
<td>0.44*</td>
<td>0.41*</td>
</tr>
<tr>
<td>Clinical pharmacist</td>
<td>AMT</td>
<td>0.46*</td>
<td>0.41*</td>
<td>0.45*</td>
<td>0.37</td>
</tr>
<tr>
<td>ICP</td>
<td>0.28</td>
<td>0.12\textsuperscript{NS}</td>
<td>0.18</td>
<td>0.15\textsuperscript{NS}</td>
<td>0.3</td>
</tr>
</tbody>
</table>

(95% Confidence interval)

kappa scores at $p \leq 0.01$ except $\textsuperscript{NS} (p>0.01)$

Moderate or higher agreement in bold and denoted by *
Table 5.3: Overall appropriateness: kappa scores for local and remote assessments – categorised by TYPE OF ASSESSOR

<table>
<thead>
<tr>
<th></th>
<th>ID experts</th>
<th>Non-ID experts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Local assessments</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMT</td>
<td>0.23</td>
<td>0.23</td>
</tr>
<tr>
<td>ID specialist</td>
<td>0.23</td>
<td>0.23</td>
</tr>
<tr>
<td>ID pharmacist</td>
<td>0.17</td>
<td>0.12</td>
</tr>
<tr>
<td>Clinical pharmacist</td>
<td>0.08&lt;sup&gt;NS&lt;/sup&gt;</td>
<td>0.15&lt;sup&gt;NS&lt;/sup&gt;</td>
</tr>
<tr>
<td>ICP</td>
<td>0.14</td>
<td>0.18&lt;sup&gt;NS&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

| **ID experts** | AMT  | 0.23 | 0.26 | 0.30 | 0.08<sup>NS</sup> | 0.15<sup>NS</sup> |
| Non-ID experts  | Clinical pharmacist | 0.33 | 0.26 | 0.22<sup>NS</sup> | 0.19<sup>NS</sup> | 0.05<sup>NS</sup> |
| ICP             | 0.14 | 0.18<sup>NS</sup> | 0.01<sup>NS</sup> | 0.09<sup>NS</sup> | 0.18<sup>NS</sup> |

Kappa scores at p ≤ 0.01 except <sup>NS</sup>(p > 0.01)
Table 5.4: Concordance with guidelines\textsuperscript{38}: kappa scores for local and remote AMT assessments – categorised by ANTIMICROBIAL THERAPY INDICATION

<table>
<thead>
<tr>
<th>Indication for antimicrobial therapy</th>
<th>Agreement among local and remote AMT assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-abdominal infections</td>
<td>0.25\textsuperscript{NS}</td>
</tr>
<tr>
<td>Respiratory tract infections</td>
<td>0.67\textsuperscript{*}</td>
</tr>
<tr>
<td>Surgical antibiotic prophylaxis</td>
<td>0.45\textsuperscript{*}</td>
</tr>
<tr>
<td>Skin and soft tissue infections</td>
<td>0.59\textsuperscript{*}</td>
</tr>
<tr>
<td>Urinary tract infections</td>
<td>0.31\textsuperscript{NS}</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>0.26\textsuperscript{NS}</td>
</tr>
</tbody>
</table>

Note: Respiratory tract infections = community acquired pneumonia, chronic obstructive pulmonary disease and hospital acquired pneumonia
kappa scores at $p \leq 0.01$ except \textsuperscript{NS} ($p > 0.01$)
Moderate or higher agreement in bold and denoted by *
Figure 5.1: Distribution of sample antimicrobial prescriptions among remote assessors

Sample prescriptions x 180:
- AMT x 60
- Clinical pharmacist x 60
- ICP x 60

Batch 1 (60 prescriptions):
- AMT x 20
- Clinical pharmacist x 20
- ICP x 20

Batch 2 (60 prescriptions):
- AMT x 20
- Clinical pharmacist x 20
- ICP x 20

Batch 3 (60 prescriptions):
- AMT x 20
- Clinical pharmacist x 20
- ICP x 20
Chapter 6  Attitudes and perceptions towards AMS in Australian private hospitals

6.1  Synopsis

Thus far, chapters 3, 4 and 5 have determined the following:

- A minority of surveyed private hospitals had an AMS governance structure in place, few had dedicated resources for AMS and there was a general lack of AMS activities.
- There is a need to improve antimicrobial prescribing in private hospitals, with certain areas, such as documentation of indication and surgical antibiotic prophylaxis, requiring particular attention.
- The assessment of the appropriateness of a prescription is somewhat subjective. There is scope to improve reliability in assessments among local and remote assessors, and given an option, assessments at the bedside are preferable given patient information is more readily accessible.
- If remote assessors are utilised, then antimicrobial management teams (AMTs), provide better reliability, than assessors without specialized clinical infectious diseases and auditing experience.
- Clinical pharmacists provide comparable reliability to AMTs may be utilised as remote assessors of antimicrobial prescriptions if local AMTs are not available.

As AMS is currently not implemented in many private hospitals and there is a need for its introduction, the next two chapters focus on how this can take place. It has previously been established that for hospital AMS programs to be effective, they have to be able to alter prescribing patterns and essentially change prescribing behaviour. Social cognitive theories state that for behavioural change to occur, underlying intentions, motivations and attitudes that precede the observed behaviour must first be articulated. It is postulated that once these underlying drivers have been defined, healthcare professionals’ behaviour is easier to predict. In addition, literature suggests that AMS programs are now complex, multi-pronged initiatives that not only involve prescribers but a number of additional stakeholders.
Therefore, to minimise program failure and reduce associated costs, it may be prudent to gauge attitudes and perception about issues surrounding antimicrobial resistance and prescribing as well as motivation to participate in AMS prior to implementing hospital-wide programs. Chapter 6 of the thesis aims to describe perceptions and attitudes towards antimicrobial resistance, antimicrobial use and motivation to participate in AMS activities among all key healthcare professionals at a large Australian private hospital.
6.2 Published manuscript entitled, “Attitudes towards antimicrobial stewardship: results from a large private hospital in Australia”


The co-authors contributed to the manuscript as follows: Study design was performed by the PhD candidate, Menino Osbert Cotta, under the supervision of Associate Professor Caroline Marshall, Associate Professor Karin A Thursky, Professor Danny Liew and Associate Professor Kirsty L Buising. Dr Megan S Robertson assisted in constructing survey questions and disseminating the survey. Mr Mark Tacey assisted with data analyses. The PhD candidate, Menino Osbert Cotta, took the leading role in manuscript preparation, writing and submission.

The manuscript is presented as submitted with the exception of figures and tables that have been inserted into the text at slightly different positions. The numbering of pages, figures and tables has been adjusted to fit the style and layout of the thesis. References for the published manuscript have been incorporated into the other references of the thesis and can be found in the ‘List of References’ section.
Attitudes towards antimicrobial stewardship: results from a large private hospital in Australia

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Australia
Short summary: An effective hospital-wide antimicrobial stewardship (AMS) program requires engagement with all healthcare professionals involved in antimicrobial use, not just prescribers. The aim of this study was to consider attitudes and perceptions among all clinical stakeholders in a large Australian private hospital. Results of the study may be of assistance in introducing AMS to the private hospital sector.
6.3 Abstract

Introduction: An effective hospital-wide antimicrobial stewardship (AMS) program requires engagement with all healthcare professionals involved in antimicrobial use. It is therefore useful to consider attitudes and perceptions among clinical stakeholders in Australian private hospitals prior to introducing AMS in these facilities. The aim of this study was to describe perceptions and attitudes towards antimicrobial resistance, antimicrobial use, AMS interventions, and willingness to participate.

Methods: A 26-item attitudinal survey was distributed to visiting specialists, nurses and pharmacists at a large (500 bed) private hospital in Australia. Survey questions utilised “Yes/No” responses and a 7-point Likert scale ranging from “strongly agree” to “strongly disagree”. Descriptive analyses were performed and chi-squared tests conducted.

Results: There were a total of 331 respondents (80 physicians, 58 surgeons, 78 anaesthetists, 105 nurses and 10 pharmacists). The response rate was 42% among clinicians, 100% among pharmacists and 13% among nurses.

Only half the respondents were willing to participate in proposed AMS interventions. A larger proportion of respondents believed that antimicrobial resistance was more of a serious problem in other Australian hospitals compared to the surveyed hospital (62% vs 45%, p<0.001). Fifty-eight percent agreed that improving prescribing at the hospital would reduce antimicrobial resistance.

Twenty-nine percent of respondents had previous exposure to AMS, with pharmacists and physicians more likely to have heard of AMS compared to surgeons, anaesthetists and nurses (p=0.016 and p<0.001 respectively).

Conclusions: This study highlights the challenge of making antimicrobial resistance a relevant local issue in private hospitals and engaging key health professionals prior to implementing change.
Implications

- Successful implementation of antimicrobial stewardship (AMS) programs requires buy-in from relevant clinical stakeholders.

- A survey of attitudes towards and perceptions about antimicrobial use and antimicrobial resistance may be useful to determine the level of engagement among these clinical stakeholders; helping identify promoters of AMS and which professions may require more awareness and education.
6.4 Introduction

Antibiotics are prescribed to between 19-59% of patients in acute hospitals, yet up to half of these antibiotic prescriptions may be judged to be inappropriate. Inappropriate and excessive use of antimicrobials can accelerate the development of antimicrobial resistance amongst local pathogens. Antimicrobial stewardship (AMS) initiatives have previously been effective in changing prescribing patterns and curtailing inappropriate use of antimicrobials in hospitals.

In order to develop these effective AMS interventions and change antimicrobial prescribing habits, it has been suggested that there is a need to better understand clinicians' underlying perceptions about antimicrobial use and the issue of antimicrobial resistance. There is increasing evidence that an effective hospital-wide AMS program needs to have multidisciplinary input from and engagement with all health professions involved in the use of antimicrobials, not just prescribers. Previous studies have assessed clinicians' knowledge and beliefs about antimicrobial use and resistance, however, only one of these included healthcare professionals outside of medical prescribers, and this study was conducted at a hospital with a pre-existing AMS program.

In Australia, AMS programs have now been incorporated into new National Safety and Quality Health Service (NSQHS) Standards and are part of a new accreditation scheme mandatory for all hospitals, thus there is an imperative to comply with these standards by having an AMS program in place. Although the Australian private hospital sector contributes approximately one third of all hospital beds and treats 40% of all patients, there is currently a lack of AMS activities occurring in this sector. Importantly, there are no data within these facilities on what attitudes currently exist towards antimicrobial resistance and antimicrobial use as well as what perceptions clinical stakeholders may have about the benefit of AMS.

The aim of this study was to describe perceptions and attitudes towards antimicrobial resistance, antimicrobial use and AMS among all key healthcare professionals at a large Australian private hospital.
6.5 Methods

This survey formed the first part of a larger project examining attitudes and perceptions to AMS among private hospital stakeholders. Subsequent components of the project involved focus group discussions, semi-structured interviews and on-site observations.

A 26-item survey was conceptualised and constructed by a multidisciplinary research group (‘the expert panel’) including infectious diseases physicians, clinical microbiologists, intensive care physicians, AMS pharmacists and nurse practitioners (copy of survey available from corresponding author). The survey collected information on respondents’ beliefs about the significance of antimicrobial resistance as a problem, perceptions about factors contributing to antimicrobial resistance, experience with antimicrobial resistance, awareness of AMS, perceptions of antimicrobial prescribing at the hospital and attitudes towards potential AMS interventions.

The sections on significance of antimicrobial resistance as a problem, contributing factors, antimicrobial prescribing at the hospital, potential AMS interventions, and willingness to participate were scored using a seven-point Likert scale. Likert responses ranged from “strongly agree” to “strongly disagree” or “not a problem” to “a very serious problem”. Survey validity, usability and generalisability were established through trials of several iterations of the survey after gaining feedback from the expert panel as well as conducting field tests using subjects from different professional healthcare backgrounds who were not included in the study sample.

The final version of the survey was distributed by email to all visiting specialists, registrars, nurses and pharmacists in a 490-bed private hospital. Approximately 800 employed nurses and 10 contracted pharmacists worked at the hospital. There were 512 clinicians who were considered ‘active visiting specialists’ as they had admitted patients during the previous three year period. To encourage response rate among clinicians and nurses, hard copies of the survey was distributed at clinical meetings, in hospital departments, such as operating theatres and the intensive care unit, as well as most wards in the hospital. These hard copies were
collected periodically by the investigators. The survey was actively promoted by members of hospital executive at regular business meetings to encourage participation.

Although a formal AMS program had yet to be introduced hospital-wide at the study site, formation of an AMS committee and endorsement of AMS by hospital executive had recently been undertaken.

The survey collected data on each respondent’s role, specialty (if applicable) and the number of years of experience post-primary qualification, but the identity of respondents was otherwise kept unknown. Respondents were given six weeks to complete the survey and reminders were regularly sent by email from hospital executive. The current study formed part of a range of AMS activities that had previously been granted ethics approval by the institutional review board.

**Statistical methods**

Categorical data were presented as proportions that were ‘in agreement’ or viewed antimicrobial resistance as a ‘serious problem’ (ie with a ‘6’ and ‘7’ Likert scale response). Differences amongst professions were tested using Pearson’s chi-squared test, or when sample size was smaller than 10 for any category, Fisher’s exact test was used. A two-tailed p-value of 0.05 was considered statistically significant. STATA statistical analysis software (version 12) was used (StataCorp®, College Station, TX, USA).

### 6.6 Results

There were a total of 331 respondents, of whom 80 (24%) were physicians, 58 (18%) surgeons, 78 (24%) anaesthetists, 105 (32%) nurses and 10 (3%) pharmacists. The response rate was 42% among clinicians, 100% among pharmacists and 13% among nurses.

**Antimicrobial resistance**

Sixty-two per cent of respondents viewed antimicrobial resistance as a serious problem in Australian hospitals, whilst only 45% believed it was a serious problem in the surveyed hospital (p<0.001). There were similar proportions of respondents that viewed antimicrobial use in the
Australian community and Australian hospitals as contributing to antimicrobial resistance at the surveyed hospital (51% and 56%, respectively). Fewer respondents (34%), however, believed that antimicrobial use in the Australian animal/agricultural sectors contributed to this resistance (p<0.001).

**Patient care and antimicrobial prescribing**

Thirty-six per cent of respondents believed that antimicrobial resistance affected patients under their care, while less than a third (31%) believed that there was antimicrobial prescribing at the hospital that did not comply with current national antimicrobial prescribing guidelines (Table 6.1).

A significantly higher proportion of physicians and nurses indicated agreement with the statement that antimicrobial resistance affected patients under their care (both 45%), compared to the other professional groups of surgeons, anaesthetists and pharmacists with proportions of 22%, 26% and 30%, respectively. (p<0.001). All of the pharmacists surveyed believed that improving antimicrobial prescribing would help decrease antimicrobial resistance, with this proportion being significantly higher than the other health professions (p=0.006).

**Proposed AMS initiatives and willingness to participate**

Willingness to participate in AMS interventions was equivocal (Table 6.2). In comparison to the other professional groups, there was a significantly higher proportion of pharmacists in agreement to a formal antimicrobial usage policy (p=0.007), introduction of local antimicrobial prescribing guidelines (p=0.006), and the introduction of a specialist team giving antimicrobial prescribing advice (p=0.002). Surveyed pharmacists were also more willing to participate in any AMS interventions introduced at the hospital (p=0.002), and were also in support for an introduction of a decision support computer application, although this was not statistically significant (p=0.053).

**Non-compliance with Therapeutic Guidelines: Antibiotic**

A fifty per cent or greater non-compliance with Therapeutic Guidelines: Antibiotic was estimated by 38% of respondents for all antimicrobial prescriptions and by 41% of respondents for surgical prophylaxis prescriptions (Figure 6.1). The proportions of surveyed pharmacists
who believed this (ie 80% for each set of prescriptions) were significantly higher compared to the other professions (p=0.007 and p=0.019, respectively). Surveyed anaesthetists were more likely to estimate 50% or greater non-compliance for surgical prophylaxis prescriptions when compared to surveyed surgeons (p=0.012).

Experience with antimicrobial resistance and AMS
The proportions of surgeons who responded to have been involved in the care of a patient with a resistant infection and stated noticing an increasing number of antimicrobial resistant infections over the past 10 years were significantly less compared to other respondents (p<0.001 for both) (Table 6.3). A significantly higher proportion of physicians (48%) reported to have worked in healthcare facilities with AMS programs (p<0.001). Pharmacists and physicians were significantly more likely to have heard of AMS compared with the other professions (p=0.016 and p<0.001 respectively).

6.7 Discussion
This attitudinal survey represents the first multi-disciplinary study involving all key health professionals involved in antimicrobial use in the Australian private hospital sector. Survey responses indicate that a great deal of work needs to be undertaken to address these issues prior to implementation of any hospital-wide AMS program.

As with previously reported perception surveys,\textsuperscript{134,201–203} there was a prevailing view among survey respondents that antimicrobial resistance was more of a serious problem in other Australian hospitals compared to the surveyed hospital. In addition, only around a third of respondents believed that antimicrobial resistance directly affected patients under their care. These findings highlight the challenge of making antimicrobial resistance a relevant local issue among health professionals.

Of note, surgeons and anaesthetists were least likely to agree that antimicrobial resistance affect patients under their care. A potential reason for this perception could be that surgical and anaesthetic staff often do not get involved in the management of antimicrobial resistance as they are more likely to seek advice from and transfer care to physicians in circumstances of
infection. Although only a minority of respondents believed there was non-guideline compliant antimicrobial prescribing (ie 31%), the proportion nearly doubled (58%) in the belief that improving prescribing would help decrease antimicrobial resistance. This proportion, however, is somewhat modest when compared to results from a 2004 survey which yielded 97% agreement that better antimicrobial use would help reduce resistance, and suggests that education linking antimicrobial prescribing and antimicrobial resistance will need to be a priority at the hospital.

Importantly only half of respondents were willing to participate in any proposed AMS intervention; these results are perhaps reflective of significant disengagement (either passive or active) to issues revolving around antimicrobial use among clinical stakeholders at the hospital. Employing subsequent qualitative methods in addition to these baseline quantitative data will likely shed more light on what factors are influential in this apparent lack of engagement.

The least favourable intervention among respondents was that of introducing a restriction based policy that limits prescribing via an approval process (52%), while introduction of local guidelines and/or protocols together with a computer application that gives antimicrobial prescribing advice were found to be slightly more acceptable (58% and 60% respectively). These set of results reflect the view that the most favoured interventions are those that provide information and education rather than restrict prescribing behaviour. Interestingly, results in the current study contrast to results obtained in the Australian public hospital sector. In a study of prescribers’ attitudes towards antimicrobial prescribing in three tertiary public hospitals in metropolitan Australian cities, Chaves and colleagues reported a major enabler for improving antimicrobial prescribing practices being support for antimicrobial restriction. This may reflect familiarity with restrictions having already been implemented in the public hospital setting, thus the respondents had already some experience of the impact, whereas those in the private hospital may have been responding without any direct experience of the workflow surrounding antibiotic restriction policies or its impact. A self-reported need for more education about antibiotic use has also been described by groups surveying physicians in other countries.
It is not clear whether the overall low level of willingness to participate is reflective of either a perceived lack of time to contribute to a new intervention or an active refusal. The low level of experience with AMS suggests a degree of unfamiliarity with what it might entail.

Besides pharmacists, the majority of anaesthetists believed that there was 50% or greater non-guideline compliance of surgical antibiotic prophylaxis prescriptions. Surgeons, on the other hand, were the only profession that believed surgical antibiotic prophylaxis had better guideline compliance than antimicrobial prescriptions as a whole. As surgeons and anaesthetists prescribe nearly most surgical prophylaxis prescriptions at the surveyed hospital, using surgeon-specific protocols in some cases, it was interesting to note the significant difference in perception of non-compliance in surgical prophylaxis between the two professions.

Surgeons were also less likely to report being involved in the care of patients with resistant infections and less likely to report noticing an increasing number of resistant infections over the previous decade. This is despite the fact that there is evidence of growing antimicrobial resistance, particularly among Gram-negative bacterial pathogens in Australia, based on data being collected by laboratory surveillance studies that collect data from both public and private hospitals over this time period. Additionally, among the first reported cases in Australia of hyper-virulent Clostridium difficile, a common pathogen associated with antibiotic overuse, was reported at the study hospital, a private hospital, in 2011. This suggests there is an apparent failure for surgeons to be aware of local issues regarding antimicrobial resistance and antimicrobial overuse at the studied hospital. This may be the result of lack of education and poor communication between VMOs.

Pharmacists seemed to be more engaged with issues around antimicrobial resistance and AMS. They were more agreeable than any other profession to the majority of proposed AMS interventions and more willing to participate in AMS interventions introduced at the hospital. A significantly higher proportion of pharmacists believed there was 50% or greater non-compliance with national prescribing guidelines for all antimicrobial prescriptions including surgical prophylaxis, and that improving antimicrobial prescribing at the hospital would help decrease resistance.
Unlike physicians, who may have heard of AMS (64%) because of having worked in healthcare facilities with AMS programs (48%), pharmacists may have become aware of AMS through other means, as although 80% of pharmacists had heard of AMS, only 20% had previously worked in facilities with existing AMS programs. On the other hand, a low proportion of nursing respondents were aware of AMS. This is an important consideration for implementers of AMS at the hospital as nursing staff are beginning to play an important role in AMS interventions, such as switching from intravenous to oral antimicrobial therapy.\textsuperscript{210}

It should be noted that the majority of private hospitals in the same state as the study private hospitals still do not have formal AMS committees and so the study hospital could be viewed as more progressive. However, even though established governance structure existed, results of the survey show that clinical stakeholders are not easily engaged in issues pertaining to antimicrobial use at the hospital.

Hence, the first step of a newly introduced AMS program will be to make all five professions more aware of the significance of antimicrobial resistance in the overall care of their patients as well as the importance of judicious antimicrobial prescribing and use. Given that a large proportion of these will be visiting specialists who transiently attend at the private hospital to see their admitted patients, highlighting the importance of AMS will be all the more challenging.

Limitations to this study do exist. Selection bias may exist in the results due to the voluntary nature of the study, particularly among nursing staff where the response rate was low. Thus, it is difficult to generalise outcomes to the wider study population. No demographic information was collected to test for bias between responders and non-responders, and as such, the investigators can only speculate on whether there were any important differences between these two groups.

In summary, as hospital-wide AMS programs progressively grow into resource intensive, multi-pronged activities involving a myriad of both clinical and non-clinical stakeholders, attitudinal surveys such as these may prove to be useful. Identifying healthcare professions that require specific strategies to improve appropriateness of antimicrobial use and highlighting proponents of AMS within the hospital are important potential outcomes. Results of this study
suggest that private hospitals may have an ongoing challenge in increasing awareness and engagement among clinical stakeholders whilst also providing interventions to ensure judicious use of antimicrobials.
Table 6.1: Responses by profession to statements on patient care, antimicrobial prescribing and antimicrobial resistance

<table>
<thead>
<tr>
<th>Statement</th>
<th>Physicians</th>
<th>Surgeons</th>
<th>Anaesthetists</th>
<th>Nurses</th>
<th>Pharmacists</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimicrobial resistance affects patients under my care</td>
<td>45</td>
<td>22</td>
<td>26</td>
<td>45</td>
<td>30</td>
<td>36 (119)</td>
</tr>
<tr>
<td>There is antimicrobial prescribing that does not comply with current national antimicrobial prescribing guidelines</td>
<td>44</td>
<td>26</td>
<td>37</td>
<td>15</td>
<td>60</td>
<td>31 (101)</td>
</tr>
<tr>
<td>Improving antimicrobial prescribing at the hospital will help decrease antimicrobial resistance</td>
<td>63</td>
<td>57</td>
<td>60</td>
<td>50</td>
<td>100</td>
<td>58 (192)</td>
</tr>
</tbody>
</table>
### Table 6.2: Responses by profession to proposed AMS interventions and willingness to participate

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Physicians</th>
<th>Surgeons</th>
<th>Anaesthetists</th>
<th>Nurses</th>
<th>Pharmacists</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A formal policy for the use of antimicrobials should be introduced</td>
<td>56</td>
<td>48</td>
<td>62</td>
<td>63</td>
<td>100</td>
<td>60 (197)</td>
</tr>
<tr>
<td>A policy that limits the prescribing of selected antimicrobials to certain clinical indications via an approval process should be introduced</td>
<td>51</td>
<td>43</td>
<td>53</td>
<td>54</td>
<td>80</td>
<td>52 (172)</td>
</tr>
<tr>
<td>Local antimicrobial guidelines and protocols should be introduced</td>
<td>54</td>
<td>48</td>
<td>62</td>
<td>59</td>
<td>100</td>
<td>58 (191)</td>
</tr>
<tr>
<td>A computer application which gives advice on selection and duration of antimicrobial therapy for patients should be introduced</td>
<td>58</td>
<td>59</td>
<td>54</td>
<td>63</td>
<td>90</td>
<td>60 (197)</td>
</tr>
<tr>
<td>A team consisting of a Specialist Physician and Pharmacist providing individualised antimicrobial prescribing advice and feedback should be introduced</td>
<td>54</td>
<td>45</td>
<td>58</td>
<td>54</td>
<td>100</td>
<td>55 (181)</td>
</tr>
<tr>
<td>I would be willing to participate in any clinical interventions involving antimicrobial use</td>
<td>55</td>
<td>48</td>
<td>51</td>
<td>43</td>
<td>100</td>
<td>50 (167)</td>
</tr>
</tbody>
</table>
### Table 6.3: Experience with antimicrobial resistance and AMS

<table>
<thead>
<tr>
<th></th>
<th>Physicians</th>
<th>Surgeons</th>
<th>Anaesthetists</th>
<th>Nurses</th>
<th>Pharmacists</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previously involved in care of patient with resistant infection</td>
<td>91</td>
<td>63</td>
<td>82</td>
<td>92</td>
<td>88</td>
<td>84 (254)</td>
</tr>
<tr>
<td>Have noticed increasing number of antimicrobial resistant infections over past 10 years</td>
<td>74</td>
<td>40</td>
<td>71</td>
<td>84</td>
<td>100</td>
<td>70 (174)</td>
</tr>
<tr>
<td>Heard of AMS</td>
<td>64</td>
<td>37</td>
<td>36</td>
<td>22</td>
<td>80</td>
<td>41 (121)</td>
</tr>
<tr>
<td>Worked in healthcare facilities with AMS programs</td>
<td>48</td>
<td>25</td>
<td>32</td>
<td>11</td>
<td>20</td>
<td>29 (71)</td>
</tr>
</tbody>
</table>

Note: Analysis only included ‘Yes’ or ‘No’ responses (ie excluded ‘unsure’ responses)
Figure 6.1 Estimation of fifty per cent or greater non-compliance with Therapeutic Guidelines: Antibiotic\textsuperscript{38}

![Bar chart showing compliance rates across different categories: Physicians, Surgeons, Anaesthetists, Nurses, Pharmacists, and Total. The chart compares all antimicrobial prescriptions and surgical antibiotic prophylaxis.]
Chapter 7 Integrating AMS into the health delivery structure of Australian private hospitals

7.1 Synopsis

Results for chapter 6 show that similar to other studies in the literature, surveyed healthcare professionals view antimicrobial resistance as a problem in hospitals, however there was an inherent belief that it more of a problem in other Australian problems than in their own. Coupled with this, approximately only a third of respondents believed that antimicrobial resistance affected patients under their care, while a similar proportion believed that there was antimicrobial prescribing at the hospital that did not comply with current national antimicrobial prescribing guidelines. It was also interesting to note that motivation to participate in any proposed AMS program was low in the private hospital.

Although these results cannot be extrapolated to all private hospitals in Australia, they do indicate that much groundwork needs to be done in changing underlying attitudes and perceptions prior to seeing changes in prescribing practices. Pharmacists may prove to be protagonists in facilitating this process, however, it is unknown how they and other stakeholders can be utilised to integrate AMS within private hospitals. Chapter 7 aims to further explore organisational factors and barriers that currently limit implementation of AMS and to determine potential solutions for AMS implementation in light of these unique challenges faced by the private hospital sector. Studies presented in chapters 6 and 7 of this thesis were conducted in the same hospital.
7.2 Published manuscript entitled, “Implementing antimicrobial stewardship in the Australian private hospital system: a qualitative study”

The manuscript entitled, “Implementing antimicrobial stewardship in the Australian private hospital system: a qualitative study” has been accepted for publication by Australian Health Review 2015; 39(3): 315-322.

The co-authors contributed to the manuscript as follows: Study design was performed by the PhD candidate, Menino Osbert Cotta, under the supervision of Associate Professor Caroline Marshall, Associate Professor Karin A Thursky, Professor Danny Liew and Associate Professor Kirsty L Buisinig. Dr Megan S Robertson assisted with refining structured interview questions and recruitment of participants. Associate Professor Caroline Marshall and Associate Professor Kirsty Buisinig assisted with facilitating the focus group discussions and interpreting the data. Professor Elizabeth Manias provided advice on utilising the framework analysis. The PhD candidate, Menino Osbert Cotta, took the leading role in manuscript preparation, writing and submission.

The manuscript is presented as submitted with the exception of figures and tables that have been inserted into the text at slightly different positions. The numbering of pages, figures and tables has been adjusted to fit the style and layout of the thesis. References for the published manuscript have been incorporated into the other references of the thesis and can be found in the ‘List of References’ section.
Implementing antimicrobial stewardship in the Australian private hospital system: a qualitative study

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7.3 Abstract

Objective: To explore organisational factors and barriers contributing to limited uptake of antimicrobial stewardship in Australian private hospitals and to determine solutions for antimicrobial stewardship implementation.

Methods: A qualitative study utilising a series of focus group discussions was conducted in a large private hospital utilising a semi-structured interview guide to facilitate discussion among clinical and non-clinical stakeholders. A multi-disciplinary team of researchers then mapped and interpreted emergent themes surrounding antimicrobial stewardship implementation using a thematic analysis consisting of five sequential components.

Results: The analysis revealed that autonomy of consultant specialists was perceived as being of greater significance in private hospitals compared to public hospitals. Use of an expert team providing antimicrobial prescribing advice and education without intruding on existing patient-specialist relationships was proposed by participants as an acceptable method of introducing antimicrobial stewardship in private hospitals. There was more opportunity for nursing and pharmacist involvement, as well as empowering patients. Opportunities were identified for the hospital executive to market an antimicrobial stewardship service as a feature that promoted excellence in patient care.

Conclusions: Provision of advice from experts, championing by clinical leaders, marketing by hospital executives and involving nurses, pharmacists and patients should be considered during implementation of antimicrobial stewardship in private hospitals.

Key Question Summary

1. What is known about the topic?

Hospital-wide antimicrobial stewardship programs have been shown to be an effective means to address the problem of accelerating antimicrobial resistance. However, current literature predominantly focuses on evaluation of antimicrobial stewardship activities rather than on improving implementation success. Additionally, most research on hospital antimicrobial
stewardship programs is from the public hospital sector. Antimicrobial stewardship is now part of new National Safety and Quality Health Service (NSQHS) accreditation standards mandatory for all Australian hospitals; however, uptake of AMS in private hospitals lags behind public hospitals. Australian private hospitals are fundamentally different to public hospitals and there is more information needed to determine how antimicrobial stewardship can best be introduced in these hospitals.

2. What does this paper add?
Further investigation on how antimicrobial stewardship can be implemented into private hospitals is urgently required. The qualitative work detailed in this study provides a means of tailoring AMS strategies on the basis of organisational factors that may be considered unique to Australian private hospitals.

3. What are the implications for practitioners?
Clinical and hospital executive stakeholders in the private hospital sector will be able to utilise solutions presented in this paper as a blueprint for designing sustainable antimicrobial stewardship programs within their private healthcare facilities.
7.4 Introduction

Bacterial resistance to antibiotics has been identified as one of the five major threats to mankind by the World Health Organisation. Inappropriate and excessive use of antibiotics worldwide has accelerated the generation of antibiotic resistance, and antibiotic use particularly in healthcare facilities is believed to have significantly contributed to this problem.

‘Antimicrobial stewardship’ (AMS) is a term used to describe activities that serve to optimise antimicrobial therapy, with the aim of ensuring the best patient outcome while minimising unintended consequences of antimicrobial use such as adverse drug events and the emergence of antimicrobial resistance among local pathogens. Typically, AMS has been introduced as a multifaceted hospital-wide program in many individual healthcare facilities, with studies showing these programs improving care of patients, being cost-efficient, and assisting in curtailing antimicrobial resistance. Given that AMS programs utilise a number of different strategies in order to successfully optimise antimicrobial prescribing in hospitals, these programs rely on extensive multidisciplinary collaboration and coordination, with governance structure provided by hospital executives.

The introduction of new national healthcare standards in 2013 has made AMS programs a mandatory accreditation requirement for all hospitals in Australia. Thus far, AMS programs have predominately been introduced in larger tertiary public hospitals, with limited uptake of AMS initiatives by private hospitals. The reasons for this remain largely unknown and could be due to differences in the way health services are delivered between the two hospital systems.

In Australia, private hospitals provide approximately 40% of inpatient care and are operated by organisations for both profit and not-for-profit. The primary source of revenue for private hospitals comes from private health insurance funders as well as direct out-of-pocket payments from patients (termed ‘private patients’). These private patients generally choose their own consultant specialist (a doctor who has completed speciality training), who, in turn chooses a private hospital in which to admit the patient for the required health service. Both
consultant specialist and private hospital then bill the patient and/or their health insurance fund for services provided.

Public hospitals, on the other hand, rely directly on government funding.\textsuperscript{109} Day-to-day care in public hospitals is generally provided by teams consisting of junior medical staff, some of whom are training to be specialists. Consultant specialists are employed by public hospitals to provide a senior role and their primary responsibility is to supervise and consult with junior medical staff.

The qualitative research presented in this article formed part of a larger project examining antimicrobial use, attitudes towards AMS and current resources in the Australian private hospital sector.\textsuperscript{167,214,215} The aim of this current study was to explore organisational factors and barriers that currently limit implementation of AMS in a large Australian private hospital and to determine potential solutions for AMS implementation.

### 7.5 Methods

This qualitative study involved participants employed, contracted or affiliated with one of the largest private hospital operators in Australia. Over 500 consultant specialists currently consult at the main hospital, including thirteen infectious diseases (ID) physicians. There are 800 employed nurses, three employed infection control practitioners (ICPs) and contracted external pathology and pharmacy service providers. The hospital has a 15-bed intensive care unit, a day oncology facility, and busy orthopaedic, cardiology and neurosurgical services. No paediatric, obstetric or solid organ transplant services are provided. There was no formal AMS program at the hospital during the time of the study.

A focus group discussion (FGD)\textsuperscript{216} study was deemed the most appropriate qualitative research method to explore factors requiring consideration when implementing AMS in the private hospital system. As this method entailed group interaction, it potentially provided deeper insights through shared experiences between participants.
Participants
Participants were purposively sampled on the basis of being key stakeholders of a future AMS program. They were then sent an invitation letter by email from the executive director of research explaining the aim of the study and requesting their involvement. Focus groups were held on three separate days and lasted approximately one and a half hours each. Refreshments were provided but no other incentives were used. Participants were allocated to three groups according to professional category (Table 7.1) to maximise interaction and encourage opinions to be shared freely. Ethical approval was granted by the institutional review board and informed consent was obtained from all participants prior to each FGD. Participation was voluntary and participant identity was kept confidential from hospital employers and supervisors.

Data collection
In February 2013, three FGDs with two facilitators at each discussion were conducted utilising a semi-structured interview guide. The guide consisted of open-ended questions and scenarios to be considered by participants (Table 7.2 - original version available upon request from the authors). These questions were formulated on the basis of a previous analysis of health service delivery in the Australian private hospital sector. This analysis highlighted differences between the private and public hospital systems as well as the impact of prescriber autonomy in private hospitals. All interviews were audio recorded and transcribed verbatim by an independent, professional transcribing service. Participants were de-identified and transcripts were verified against audio recordings.

Analysis
A framework analysis utilising five sequential components was undertaken for each FGD transcript. Data were coded for both \textit{a priori} defined themes and emergent themes. The five components of the analytic methodology were: (i) familiarisation with data collected; (ii) identifying a thematic framework; (iii) indexing (coding the data) into themes; (iv) charting by rearranging indexed data according to the thematic framework; and (v) mapping and interpreting the data. A multi-disciplinary team of three researchers mapped and interpreted data so that emerging themes could be discussed and debated. This process allowed for each researcher within the team to become more aware of any biases or prejudices that could influence their own analysis of the data.
The theory of planned behaviour\(^{221}\) informed the thematic analysis. Researchers looked for evidence of themes related to (1) underlying attitudes of consultant specialists (2) subjective norms in their peer group related to antimicrobial use and (3) perceived behaviour control that might influence their intentions around antimicrobial prescribing. Researchers also considered elements of social marketing\(^{81}\) when analysing themes related to promoting antimicrobial stewardship. These included what barriers existed, how to best engage the target audience (ie consultant specialists) and what messages would be most acceptable and effective.

### 7.6 Results

Twenty-one stakeholders were invited to participate in this study and 17 agreed to take part. Non-participants constituted one anaesthetist, one physician and two hospital executives with all four citing a lack of availability as the primary reason for non-participation. Group 1 had five participants: three surgeons and two non-ID physicians. Group 2 had five participants: one hospital executive, two nurse unit managers and two pharmacy managers. Group 3 had seven participants: three ID physicians, two clinical microbiologists, one hospital executive in charge of infection control and one ICP. Nine out of ten participating specialists reported working at more than one private hospital, and eight out of ten had concurrent public hospital appointments. The executives, nurses and pharmacists all worked at the one private hospital.

Themes that emerged from the FGDs were broadly classified into two main categories:

1) Themes associated with current antimicrobial prescribing behaviour (Table 7.3)
   - Attitudes of prescribers
   - Subjective norms
   - Perceived behaviour control

2) Themes associated with introduction of an AMS program
   - Barriers to AMS (Table 7.4)
   - Potential AMS solutions (Table 7.5)
7.6.1 Themes associated with current antimicrobial prescribing behaviour

Attitudes of prescribers

Autonomy and accountability of consultant specialists

There was consensus among all three FGDs that consultant specialists practised with significantly more autonomy in private hospitals than in public hospitals in Australia, as they were practising as individual contractors (Table 7.3, Q1 – 2). Given this independence, there was a view expressed that the private hospital lacked ability to influence antimicrobial prescribing. Some participants said that it was difficult to expect a specialist to be accountable to anyone else in this environment. (Table 7.3, Q3 & 4). Further discussion prompted one participant to state that most private hospitals viewed consultant specialists as their ‘customers’ (Table 7.3, Q5) and so were apprehensive about enforcing guidelines and hospital policies and procedures.

Specialist attitudes towards infections

All participating specialists said they were very concerned about avoiding hospital-acquired infections. Some saw these infections as evidence of clinical failure, which they were held personally responsible for and thus infection needed to be avoided at all costs (Table 7.3, Q6 & 7).

Subjective norms

Interactions within the same speciality

Participating nurses reported that there was a certain degree of competitiveness among consultant specialists (particularly surgeons) within the same speciality (Table 7.3, Q8). They said that many specialists wanted to know what their colleagues were prescribing and whether they were consistent with the practice of others. Participants from hospital executive believed that competitiveness could be utilised, in the form of perceived peer pressure, to promote uniformity in clinical practice (Table 7.3, Q9 & 10).

Perceived behaviour control

Referral to ID physicians

Consultant specialists said they were willing to refer patients to ID physicians when appropriate, however, there was discussion that sometimes these referrals required
prompting by nursing or pharmacy staff (Table 7.3, Q11 & 12). Participants said that specialised advice given by an ID physician was readily accepted and consultant specialists expected the ID specialist to have ongoing involvement in patient management (Table 7.3, Q13). Some reported a lack of access to ID specialists as a potential problem.

### 7.6.2 Themes associated with introduction of an AMS program

**Barriers to AMS**

*Limited scope for restricting antimicrobials*

All participants said that limiting antimicrobial use through restrictive hospital-wide antimicrobial pre prescription approval systems would be difficult to enforce in the private sector (Table 7.4, Q1).

*Limited scope for introducing prescribing guidelines*

There were divergent opinions among specialists about the benefit of introducing prescribing guidelines. Some participants said that although prescribing guidelines were useful in principle, incorporating these guidelines into specialists’ practice would be problematic (Table 7.4, Q2).

*Lack of antimicrobial knowledge*

Particularly among more senior participating specialists, participants reported that they lacked up-to-date knowledge regarding antimicrobial use. This was mainly reported to be because the majority of their knowledge on antimicrobials was gained during their training as junior doctors and since then they had not received much education and training (Table 7.4, Q3 & Q4).

*Limited resources – ID physician, pharmacy and junior medical staff*

The participating non-ID specialists said that ID physician support for referrals was not at the same level as that in the public system and that ID physicians in the private hospital were currently inundated (Table 7.4, Q5). There were polarised views on the level of pharmacy involvement in clinical practice, with some non-ID specialists saying this was lacking (Table 7.4, Q6), whilst ID physicians, pharmacists and nursing staff reported that pharmacists were involved, enthusiastic and helpful (Table 7.4, Q7). There was consensus, however, in all three
FGDs that increasing junior medical staff support at the hospital would help implement AMS successfully.

Potential AMS solutions

Communication

Diplomatic communication with consultant specialists was identified as central to implementing effective AMS (Table 7.5, Q1 & Q2), and needed to focus on education and the significant benefits to patient care rather than restricting prescribing (Table 7.5, Q3). One hospital executive said that it was imperative to modify communication strategies based on which specialist group was being targeted (Table 7.5, Q4).

AMS champions and executive leadership

All participants advocated leadership as an important factor to drive AMS. Specialists said that this leadership should come from hospital executives (Table 7.5, Q5), whilst participating hospital executives held the view that credibility would only come if ‘champions’ existed within each speciality (Table 7.5, Q6).

Clinical AMS service and computerised decision support systems

When one participating surgeon proposed the idea of a clinical AMS service providing education and advice it was met with broad support from other participants in the FGD. It was likened to existing services that provided clinical advice for patients requiring expert pain management (‘the pain management service’) and for patients receiving total parenteral nutrition (‘the TPN service’) (Table 7.5, Q7). An important caveat to this service agreed by all participants was that the AMS service could only make changes to patient’s antimicrobial therapy after consulting the consultant specialist.

Some specialists seemed keen about the idea of using computerised decision support systems to deliver education on antimicrobial therapy and improve clinical practice (Table 7.5, Q8). However, other participants said there would be resistance from some specialists to using a computer (Table 7.5, Q9).

Roles for pharmacists, nurses and patients
There were mixed views among participants regarding the role of pharmacists in AMS. The majority of non-ID specialists said that pharmacists were not able to understand the clinical problem itself, thus limiting their utility in an AMS program. Participating ID physicians, nurses and pharmacists however, expressed the view that they had an important role (Table 7.5, Q10 & Q11).

All participants believed that nursing staff in the private hospital were well equipped to pass on information and highlight any documented prescribing advice to consultant specialists. This was mainly due to nurses having regular contact with specialists when they visited their patients, thus building rapport and facilitating continuity of care (Table 7.5, Q12 & 13).

Consumer engagement via empowering patients to ask questions of their specialists about management of their infection was identified by participants as potentially useful (Table 7.5, Q14).

### 7.7 Discussion

This study provides the first qualitative work investigating how AMS can be implemented in the Australian private hospital system. While the findings of this study might be considered to be relevant for one private hospital operator only, nearly all participating consultant specialists had experience working in several other private and public hospitals. As the study private hospital operates similarly to many other metropolitan private hospitals, the findings of this study are likely to be applicable to much of the private hospital sector in Australia. Moreover, many of the proposed solutions may help inform private hospitals outside of Australia in countries with similar systems such as in Europe, Asia-Pacific and the Americas.\(^{222}\)

Autonomy of consultant specialists has been described as important in influencing antimicrobial prescribing,\(^{223,224}\) and as the private hospital was viewed as treating specialists as ‘customers’, it was perceived that fostering accountability to ensure appropriate antimicrobial use was going to be more of a challenge. To this end, peer pressure emerged as a potentially useful strategy. Other researchers have found that senior medical staff are extremely influential in forming attitudes, motivation and clinical practices among more junior
It is interesting to note that in the Australian private hospital setting, where there is an absence of formal hierarchical structures, few junior doctors, and where specialists have a greater degree of autonomy in treating their patients, that peer to peer pressure still has a powerful impact. This comparison was sometimes occurring via information transferred by intermediaries such as nursing staff. Prescribers seemed to want information about colleagues in order to compare and benchmark their own practice. They appeared to be learning by observing others. This might imply that auditing and reporting to provide transparent comparisons of prescribing practice might be seen to be of value.

Patient outcomes in the private hospital system have the potential to directly affect specialists’ private practice in terms of reputation and income. This view was particularly emphasised among surgeons, who identified avoiding post-operative complications such as infections as critical. In terms of AMS implementation, this is a significant consideration, as increased antibiotic use has been shown to positively correlate with avoiding uncertainty in patient outcomes. In cases where there is great uncertainty, such as empiric therapy and prophylaxis for invasive procedures, there is usually a corresponding greater exposure to antimicrobial therapy. An AMS program will therefore need to focus on convincing prescribers that rationalising antimicrobial use will not adversely affect patient outcomes.

Education was highlighted as important, but views on delivery of education through computerised decision support systems provided more of a mixed response. Literature suggests that strategies such as computer-based algorithms that assist the prescriber in selecting the most appropriate antimicrobial therapy work, but in order for them to be widely used, it is imperative that these systems are optimally integrated into current work flow processes. Private hospitals may need to decipher how best to utilise these systems in the near future as lack of up-to-date knowledge of antimicrobials was identified as a significant barrier by participating specialists. These specialists suggested that a dedicated AMS team providing feedback and advice on targeted antimicrobials would be an acceptable strategy so long as this team did not encroach on the existing patient-specialist relationship by making unsolicited changes to therapy.
This work suggested that hospital executives could play a lead role in marketing antimicrobial stewardship as best practice and that provision of an AMS service could be marketed to both patients and specialists.

Non-ID specialists did not perceive pharmacists as having an important role in AMS services. It was unclear whether this was more of a reflection of non-familiarity with the work done by clinical pharmacists, or the direct objection to pharmacists being involved in antimicrobial management of patients. Clinical pharmacists in Australian public hospitals are well positioned to be involved in AMS because of their role in regularly reviewing antimicrobial prescriptions and ensuring compliance with hospital antimicrobial formularies. However, as there is limited scope for these types of formularies in private hospitals, the role of pharmacists in AMS programs within these facilities may need to be revisited; with the role most likely to be aligned with providing clinical support to a central AMS service at the hospital. There may be an opportunity for other professions to be more involved with AMS strategies as an alternative to increasing numbers of junior medical staff during AMS implementation. Participants believed that nurses could play a more active role in AMS and there are suggestions in the literature that these could entail promoting intravenous to oral switches and prompting stop dates for antimicrobials.

A strength of utilising FGDs is that they allow for in-depth views to be conveyed through group interaction on perceived issues as well as approximating each issue’s relative significance. In addition, focus groups have the potential to create an environment conducive to participants being able to share their experiences with each other as well as with facilitators not connected with the participating organisation. It is for this reason that discussions were separated into different professional and craft groups. As sampling of participants was purposeful and participation voluntary, there was inherent selection bias in this study. However, given the variety of opinions to the issues presented, it is unlikely that this bias was of any significance to overall outcomes.
7.8 Conclusion

The qualitative work detailed in this study has provided private hospitals with a means of implementing AMS based on taking into account factors and barriers that can be considered unique to the sector.

Results indicate that it will be important to highlight AMS as a means of providing best practice in the infection management of patients and certainly introduction of new Australian healthcare standards has helped legitimise this.

Ensuring specialists are included in discussions and decisions pertaining to AMS implementation and avoiding strategies that can be perceived as restrictions on autonomy will be a priority. Identifying specialists who serve as clinical leaders has the potential to improve uptake of AMS, particularly in larger private hospitals. Use of advisory and education-based initiatives and incorporating roles for both nursing and pharmacy staff may provide the most effective means to implement AMS and help improve antimicrobial prescribing. Patients may play an important role in helping embed AMS into specialist practice and there may be opportunities for private facilities to market AMS as enhancing excellence in patient care.
Table 7.1: FGDs and participating groups

| Group 1: Non-ID physicians, surgeons and anaesthetists (ie non-ID specialists) |
| Group 2: Hospital executive, nurse unit managers (NUMs) and pharmacy managers |
| Group 3: ID physicians, clinical microbiologists and ICPs |

Table 7.2: Interview guide

1. What is your understanding of antimicrobial stewardship (AMS)?
2. Can you provide reasons why private hospitals may need an AMS program? Are there any reasons why they might not require an AMS program?
3. What differences between the two hospital systems (private and public) do you think may need to be considered when introducing a hospital-wide AMS program to private hospitals?
4. There are currently not many clinical policies or guidelines that relate to antimicrobial prescribing and use at the hospital. Can you think of why this is?
5. What do you think the main challenges are going to be in introducing a hospital-wide AMS program to private hospitals?
Table 7.3: Organisational factors that impact upon AMS

<table>
<thead>
<tr>
<th>Autonomy and accountability of consultant specialists</th>
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<tbody>
<tr>
<td>Quote 1) S¹: The people [consultant specialists] are effectively individual contractors and ....any [specialist] can prescribe pretty much any way they want.</td>
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<tr>
<td>Quote 2) ID²: Each [consultant specialist] is really acting completely independently, doesn’t have any registrar support, and is likely to bring the prescribing habits of the other places that they practice.</td>
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<tr>
<td>Quote 3) ID¹: ...well in the public system, there’s enough weight from a medical advisory committee, an executive, the person [consultant specialist] becomes the odd one out. But in a private system, up until now, there has not been...an authority within the hospital that says, “Yes, you have to conform to this”.</td>
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<tr>
<td>Quote 4) P¹: A big problem here [private hospitals] is...it is not well equipped [to impact on quality and safety] because it doesn’t have the back bone.</td>
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<tr>
<td>Quote 5) PM¹: ...it would be true to say that the customer in a private hospital is actually the specialist.</td>
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<th>Specialist attitudes towards infections</th>
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<tr>
<td>Quote 6) S²: if that [metal prosthesis] gets infected, the cost.....is enormous. It can ruin the patient’s life.</td>
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<tr>
<td>Quote 7) ID¹: They (orthopaedic surgeons) hate their patients getting infections.</td>
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<tr>
<th>Interactions within the same speciality</th>
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<tr>
<td>Quote 8) N²: It [interaction between specialists in the same speciality] is quite competitive. From my experience, we have some surgeons in particular who always want to know what others surgeons length of stay (is) etc.</td>
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<tr>
<td>Quote 9) N²: [consultant specialists will say] “The other doctors are all doing this, I’ll start doing it too then.”</td>
</tr>
<tr>
<td>Quote 10) E²: ...that’s where we get the change. There’ll be that group [of consultant specialists] that say, “Well bugger you I’m not moving”. The next group they’ll go “Oops! I’m different and I’m embarrassed about that”. They’ll drift in [line] just by virtue of peer pressure or perceived pressure.</td>
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<tr>
<th>Referral to ID physicians</th>
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<tr>
<td>Quote 11) IC¹: The majority of specialists we talked to and we would say, “Hey, what do you think of an ID consult here because we’re looking at the pathology and the antibiotics and it just doesn’t cross over?”  We don’t get much push back. We’re finding most of the doctors will</td>
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say, “Who would you recommend?”

Quote 12) N¹: Actually, a lot of the [consultant specialists] we have to deal on the ward, always defer to an ID physician...

Quote 13) ID¹: ... they want to do everything possible to make sure that the [patient] outcome is as good as possible, so they refer and are happy for [ID physician] to manage the infection.

In Tables 3, 4 and 5: E= Hospital executive, IC= Infection Control Practitioner, ID= ID physician, N= Nurse, P= Non-ID physician, PH= Pharmacist, PM= Pharmacy Manager, S= Surgeon
Table 7.4: Barriers to AMS

<table>
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<tr>
<th>Limited scope for restricting antimicrobials</th>
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<tbody>
<tr>
<td>Quote 1) P¹: ...a private hospital doesn't have a formulary...there's a lot of differences compared to a public system where you have a system where you can be responsible for it. Here [private hospitals] you can't have a formulary.</td>
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<th>Limited scope for introducing prescribing guidelines</th>
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<tr>
<td>Quote 2) S¹: Antibiotic guidelines are fantastic...... but how would you permeate that into the prescribing habits of all colleagues?</td>
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<tr>
<th>Lack of antimicrobial knowledge</th>
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<tr>
<td>Quote 3) S²: And half the antibiotics I use weren’t there when I was a medical student and I am aware of that at times...</td>
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<tr>
<td>Quote 4) E¹: quite often people [specialists] don’t know what they don’t know and I think that’s probably half the problem with some of our doctors; they’ve been around the traps for a long time.</td>
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<tr>
<th>Limited resources – ID physician, pharmacy and junior medical staff</th>
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<tr>
<td>Quote 5) P¹: You don't have the involvement of infectious diseases on the same level [as the public health system] so, you know, people have to make a referral to infectious diseases for that to take place. And there aren’t many infectious disease physicians in private [practice].</td>
</tr>
<tr>
<td>Quote 6) P¹: ...we've got no pharmacy as such...they do some sort of job but their systems aren’t such to be able to give you the records [of clinical interventions].</td>
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<tr>
<td>Quote 7) ID¹: They’re [pharmacists] really keen to be involved, actually. They ring up and make helpful suggestions at times too.</td>
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Table 7.5: Potential AMS solutions

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<th>Communication</th>
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<tr>
<td>Quote 1) S¹: There has got to be portals for education and I think at the end of the day, it should be about education. And if you can educate them, you’re not going to need a restriction. You’re going to provide education backed up with advice and then monitoring.</td>
</tr>
<tr>
<td>Quote 2) ID¹: it’s going to be really clear that people who pioneer some of these things [AMS] are diplomatic. There will be major personality issues [with some consultant specialists]...people need to establish credibility with the people that they're making recommendations to.</td>
</tr>
<tr>
<td>Quote 3) S¹: So it’s a matter of selling the bigger picture [of antimicrobial resistance] rather than the picture of “We are going to tell you what to prescribe”.</td>
</tr>
<tr>
<td>Quote 4) E¹: With some specialities...“It’s my way or the highway”. So you’re going to have to tailor to each speciality group... I don’t think there’s one way of communicating that’s going to be the panacea for everyone.</td>
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**AMS champions and executive leadership**

| Quote 5) ID¹: if [the executive/hospital management] make a good news story out of it, that might actually help get buy in from the specialists who are going to try and come here [to the hospital] who want that sort of thing. |
| Quote 6) E¹: ..getting people who believe in it and have credibility — it’s great hearing it from the pharmacists and it’s great hearing it from the executive but unless you have a colleague who kind of champions it.. |

**Clinical AMS service and computerised clinical decision support**

| Quote 7) S¹: We can’t use TPN without it [the service]. So previously, I would just have a bash at it but not anymore. But I guess you could look at antibiotics in the same way... |
| Quote 8) S²: ..the 85% who do come to educational things and who are capable of learning, they would benefit greatly, and I include myself in this, from any sort of help in terms of an electronic facility. |
| Quote 9) E²: I think there’s going to be resistance from consultants of actually having to go on to a computer. |

**Roles for pharmacists, nurses and patients**

| Quote 10) ID¹: ...lots of them [pharmacists] are super enthusiastic and would like to be doing more interesting stuff, they may well buy into the whole antimicrobial stewardship and have a role to play. |
Quote 11) ID\textsuperscript{2}: ...in the private hospitals where there aren’t ID physicians, I think there might be a greater role for pharmacists in communicating with some sort of central ID service

Quote 12) PH\textsuperscript{2}: Especially if they’re [nurses] doing the rounds with the doctors. They probably have that relationship with the doctors so they might be able to make that call [to the consultant specialist].

Quote 13) E\textsuperscript{1}: And often times it’s less threatening as well when the nurse says to the specialist, “Why did you do this?”. It’s not the same as someone from the executive saying “I have decreed that we will not order more high-cost drugs”.

Quote 14) ID\textsuperscript{1}: Let’s not forget the patient in this. There may be a role for them to ask the question [about AMS]
Chapter 8 Discussion

8.1 Synopsis

Chapter 8 forms the discussion of this thesis and has been written as a stand-alone chapter of which elements have been accepted for publication as a book chapter entitled “Antimicrobial Stewardship in Private Hospitals” Duguid & Cruickshank (Eds.) (In press) Antimicrobial Stewardship in Australian Hospitals, 2nd Edition. Australian Commission on Safety and Quality in Healthcare. Sydney, Australia (see Appendix 5). The PhD candidate, Menino Osbert Cotta, took the leading role in book chapter preparation, writing and submission. Associate Professor Kirsty L Buising assisted with editing and overseeing preparation of the book chapter manuscript.
8.2 The importance of antimicrobial stewardship in Australian private hospitals

There is urgency for antimicrobial stewardship (AMS) implementation in all hospitals. Multi-drug resistant (MDR) Gram-positive and Gram-negative infections are associated with an important rise in morbidity, mortality and hospitalisation costs.\textsuperscript{229,230} Due to accelerating antimicrobial resistance, some of these infections are now treatable.\textsuperscript{10} Additionally, transmission of MDR organisms such as methicillin-resistant \textit{Staphylococcus aureus} (MRSA), vancomycin-resistant enterococci (VRE) and highly resistant enterobacteriaceae are difficult to control in settings with high endemicity.\textsuperscript{231} Even if novel antimicrobials become available to treat resistant infections in the near future, preservation of our existing antimicrobial resources through strategies that come under the banner of AMS is still the key.\textsuperscript{11}

For AMS to be effective, however, it requires all hospitals to be engaged and involved. Australian private hospitals are responsible for a large proportion of hospitalised care in the country, accounting for 44\% of all beds.\textsuperscript{117} As such, it is a national health priority that private healthcare facilities join with their public counterparts in participating in AMS strategies, so that there is concerted effort to curtail the on going threat of antimicrobial resistance. How this can be done effectively and efficiently is a challenge. It requires acknowledgement and proper appraisal of differences between the public and private hospital systems that currently exist.

8.3 What has this thesis work added?

The work presented in this thesis has helped answer a number of important questions regarding how AMS can be introduced in the Australian private hospital sector, an area in which there has previously been very little information to guide decisions. As noted in Chapter 2, a significant gap in the literature exists on linking the suitability of AMS strategies to the characteristics of particular hospitals and their methods of delivering healthcare.
8.3.1 Summary of findings

The thesis has fulfilled the aims and objectives as outlined in the introduction chapter. There are now specific recommendations in implementing AMS for Australian private hospitals. Work presented in the thesis has provided a mechanism for AMS implementation by way of 1) surveying antimicrobial usage and appropriateness and determining which assessors can be utilised to perform these activities, 2) determining what barriers in attitudes and perceptions need to be overcome and stakeholders to target, 3) provide a means to tailor existing AMS strategies to organisational factors inherent in the Australian private hospital sector.

Importantly, the thesis has illustrated a need for AMS in private hospitals. It has shown that the burden of antibiotic use in private hospitals is high, and inappropriate prescribing is just as common as it is in the public sector. The studies in this thesis have shown that private hospital stakeholders understand the need for AMS programs and are generally willing to accept them. This work has also suggested workflow solutions to help guide successful implementation of AMS programs. VMOs reported that they wanted access to ongoing education, they looked favourably on point of call assistive tools to guide prescribing where possible, and they wanted access to ID experts. Nurses and pharmacists were identified as having opportunities to meaningfully contribute to AMS activities in the private sector. VMOs also reported that they appreciated the role of hospital executive in providing a robust AMS program as a key quality and safety activity that was important to them, and important to their patients. The findings help to address the main justifications that were given prior to beginning this work for why AMS had not previously been introduced in this hospital sector.

The main hypothesis of this thesis was that AMS strategies would need to be tailored to take into account the unique characteristics found in the private hospital sector in Australia. Some of the recommendations may be specific to private hospitals, such as targeting surgical prophylaxis as the main indication when seeking to improve antimicrobial use. However, other strategies, such as developing governance structure and utilising key personnel for AMS activities such as pharmacists to help audit antimicrobial use, can be regarded as universal strategies, of value to both public and private hospitals.
8.4 Summary of chapters

Chapter 3 of this thesis sought to describe the current AMS infrastructure available in a broad sample of private hospitals in Australia. The following research, presented in Chapter 4, investigated the need for AMS by describing antimicrobial use in private hospitals to identify areas of prescribing that would benefit from introduction of AMS. The research presented in Chapter 5 endeavoured to determine how we might reliably assess the appropriateness of antimicrobial prescribing, and specifically to find out if assessments by remote assessors and/or assessors with less experience in clinical infectious diseases (ID) represented a viable alternative for private hospitals. Results from a multi-disciplinary attitudinal survey were presented in Chapter 6 to help determine the underlying perceptions and attitudes towards antimicrobial resistance, antimicrobial use and willingness to participate in AMS activities among staff working in private hospitals. Finally, the work presented in Chapter 7 explored what organisational factors and barriers currently limit implementation of AMS and sought to determine potential solutions for AMS introduction into private hospitals.

The following discussion in this chapter aims to summarise and interpret key findings utilising the three main themes of ‘governance structure and AMS resources’, ‘appropriateness of antimicrobial use’ and ‘leadership and championing of AMS’. It is envisaged that it will help direct Australian private hospitals to:

- address key resource and governance deficiencies,
- specify target prescribing areas with a viable plan for on-going assessment of antimicrobial use,
- motivate change by addressing underlying attitudes towards antimicrobial resistance and AMS,
- devise a solution for AMS implementation taking into account key features unique to the Australian private hospital sector

8.5 Governance structure and AMS resources

It was previously unclear whether private hospitals in Australia had existing resources and appropriate governance structures to successfully implement hospital-wide AMS, a resource-
intensive initiative involving a multitude of stakeholders. Results from the state-wide survey indicate that many private hospitals are deficient in a number of areas that have been described as critical to successful adoption of AMS. An example is the presence of a hospital-wide policy on antimicrobial prescribing that helps to establish standards of practice on the judicious use of antimicrobials, with an expectation that all prescribers comply with these standards. Without such a policy, hospitals may experience difficulty tackling inappropriate antimicrobial prescribing. The majority of surveyed private hospitals do not appear to have addressed this issue. A similarly small proportion had established a dedicated committee to oversee AMS. The absence of these important tools for appropriate governance, as well as a lack of dedicated funding to coordinate AMS initiatives, means that the rest of the survey results are somewhat unsurprising.

The lack of accessible resources in antimicrobial expertise was also a concern voiced among participants in the focus group discussions (FGDs), where it was felt that ID physician support for referrals and advice was not at the same level as that in the Australian public hospital system. The perceived shortfall in onsite ID resources most likely means that private hospitals will need to find other methods of obtaining expert input. Some facilities are already utilising off-site services such as formal contract-based advice via remunerated external specialist services, this may include private ID physicians at other hospitals, public hospital based ID specialists (both physicians and pharmacists) as part of a hospital network, or advice from clinical microbiologists based in the laboratory. The absence of on-site ID specialists should not preclude detailed auditing activity in the private hospital sector. Findings from the inter-rater reliability study suggest that ID experts can be utilised to conduct off-site assessments of antimicrobial prescriptions. There is, however, significant scope to improve reliability in assessments by exploring the potential to target specific indications such as respiratory tract and skin and soft tissue infections, which are, interestingly, the two most common sites of infection seen in surveyed private hospitals.

As far as resources within pharmacy are concerned, previous literature has shown that pharmacists often play an important role in AMS, with many AMS programs originating directly from clinical and auditing activities led by pharmacy departments. Private hospitals will need to pay attention to integrating pharmacy into the AMS process. A way this might be achieved is for private hospitals to consider dedicated funding for a specialist ID pharmacist who,
together with an ID physician or clinical microbiologist, can coordinate AMS implementation and provide on-going support through provision of education and prescribing advice. Work from the FGD suggests that as long as this service is strictly advisory and does not encroach on existing patient-specialist relationships, then it would be an acceptable AMS strategy.

An alternative pathway for pharmacy involvement was elucidated from the inter-rater reliability study. If local AMTs are viewed as best practice in the review and assessment of antimicrobial use as suggested in the literature,\textsuperscript{25,42,43} then findings propose that local pharmacists (who did not have specialist training in AMS) can achieve comparable reliability in assessments of antimicrobial prescriptions, with caveats being that assessments are made using well established prescribing guidelines, that pharmacists receive some training in assessment, and that they use standardised data collection methods.

### 8.6 Appropriateness of antimicrobial use

Improving antimicrobial prescribing in private hospitals will need a multipronged approach. Although concerns regarding the ability of prescribing guidelines to permeate into VMO clinical practice were voiced by some participants in the FGD study, availability of, and accessibility to, endorsed prescribing guidelines is a mandatory accreditation requirement for hospitals in Australia.\textsuperscript{145} Fortunately in Australia, the national antimicrobial prescribing guidelines (Therapeutic Guidelines: Antibiotic\textsuperscript{38}) are a well established reference to either adopt in their entirety or derive specific local guidelines from. Availability of electronic versions of these national guidelines needs to improve in the private hospital sector.

Importantly, results from the series of point prevalence surveys have further been validated by more robust data presented in Appendix 6 of this thesis. Results from this study of 202 hospitals (166 public and 36 private) confirm that antimicrobial prescribing for surgical prophylaxis accounts for nearly half of all antimicrobials prescribed in private hospitals and a large proportion of this is not compliant with national prescribing guidelines due to prolonged
duration. Hence, if private hospitals seek to tackle the issue of antimicrobial overuse, then addressing inappropriate surgical prophylaxis will be critical.

Continuing on the theme of electronic based AMS, computerised decision support systems (CDSS) are gaining significant traction as useful education tools as well as being utilised as an approval system. CDSS may be utilised as an educational tool in the private hospital sector to guide prescribers on selecting appropriate antimicrobial therapy. The FGD indicated that VMOs would welcome this. Equally, results indicate that VMOs would not be averse to having one-on-one education and prescribing advice, and so utilising CDSS as a referral based system to highlight antimicrobial prescriptions requiring further expert input seems a logical step.

8.7 Leadership and championing of AMS

Private hospitals need to consider improving awareness of the threat of antimicrobial resistance and the potential benefits of implementing AMS. Underlying attitudes of prescribers will need to be a critical consideration when introducing AMS in the private hospital sector. Results of this thesis indicate that if a few influential specialists can be convinced to champion the benefits of AMS, then perceived peer-to-peer pressure may exert a ‘domino effect’ among remaining specialists at the hospital. In private hospitals, where VMOs may be ambivalent to the rationale for AMS programs, this may be a valuable strategy.

Pharmacists have been ascribed as an important AMS resource both in the literature and earlier in the discussion. They may also play a broader role as protagonists for change. There is significant scope for pharmacists to promote principles of good AMS through initiatives such as monitoring for appropriate antimicrobial dosing, alerting VMOs of overlapping spectrums of activity, and identifying the use of a prescribed antimicrobial agent to which the microorganism being targeted may be resistant. Certainly with the assistance and guidance of a lead AMS pharmacist there is opportunity to incorporate pharmacists as important custodians of a private hospital-wide AMS program.

It is evident that from the latter chapters of this thesis that nursing staff in private hospitals have an important role in AMS. The main obstacle preventing more widespread use of nurses
in private hospital AMS may be a lack of awareness and engagement. Whether this is due to active resistance or more a result of ambivalence is unclear. However, as many nurses reported not having heard of AMS, it is clear that private hospitals should make increasing awareness of AMS a priority. Marketing AMS as improving excellence in patient care and enhancing patient safety might be a valuable strategy for making nurses important advocates within a private hospital.

While VMOs, pharmacists and nursing staff should be considered important personnel to help deploy effective AMS at a clinical level, it is critical that leadership and formal endorsement of program roles and responsibilities comes from hospital management from the very outset. Hospital executives are primarily responsible for governance, such as establishing lines of accountability for the AMS committee as well as the allocation of appropriate resources. Data shown in Chapter 6 also reveal that hospital executives can play an additional role in marketing AMS as best practice to their VMOs and patients, both of whom have been described as customers for private hospitals.

In terms of how patient participation fits into the private hospital system in Australia, there are good opportunities for private patients to take on an increasingly active role in management of their health. As advocacy groups, such as the National Prescribing Service, have begun raising awareness of increasing antimicrobial resistance to the general population, consumers may become more cognisant of the need to avoid overuse of antimicrobial therapy.

Additionally, the AMS Clinical Care Standard defines the clinical care that patients can expect. Patients may therefore feel more informed about the need for rational antimicrobial use and thus facilitate AMS strategies such as specialist review and de-escalation of therapy by prompting their private specialist through a few questions about their own therapy.

8.8 Limitations

One of the important limitations from results of this thesis is that of sample size. Latest hospital census data indicate that there are approximately 280 private hospitals (excluding private day-procedure facilities) in Australia, and so the sample sizes presented in this thesis only represent a small proportion of all private hospitals. Having said this, Chapter 3 of this
thesis sampled from the second most populous state in Australia, with a response rate of nearly 70%. Findings from this study were then used to inform subsequent research in other chapters of this thesis, so as to help triangulate findings and gain depth into factors unique to the private hospital sector. Chapter 4 of this thesis provided an in depth look into antimicrobial use sampled from three large private hospitals within Victoria. This was a small number of hospitals to sample from, but findings such as the high proportion of SAP use reiterated previously published figures suggesting that private hospitals are increasingly procedure-driven.\textsuperscript{117}

Many of the chapters utilised survey-based or qualitative study designs due to the exploratory work being conducted. As such, there was a risk of bias in the outcomes presented. For example, Chapter 6 only sampled from one private hospital with response rates low among certain healthcare professions such as nursing staff. Although this low response rate may have prevented definite conclusions being made for the Australian private hospital sector as a whole, it did highlight that engagement may be a challenge for private hospitals to consider and so it was an important outcome in itself in context of AMS implementation. Responder bias was also a concern in Chapters 3 and 7, where responders were not de-identified. However, given that there were a number of deficiencies and barriers to AMS identified in Chapter 3 and a variety of opinions to the issues presented in Chapter 7, it is unlikely that responder bias was of any significance to overall outcomes and conclusions.

Finally, as Chapters 4 and 5 utilised a standard data collection form to gather antimicrobial prescription information, both were reliant on the training and knowledge of individual users. To minimise the variability in data collection, investigators provided an information pack and detailed in-service for all data collectors and assessors. In addition, data collected for the inter-rater reliability study were from hospitals that had participated in National Antibiotic Awareness Week in previous years, so it was anticipated that these facilities were experienced with using the data collection form. There was, of course, the broader issue of whether the data collection form reliably captured data required to accurately evaluate antimicrobial therapy. Results from Chapter 5 reflect that although reliability using the newly developed data collection form was comparable to results from a previous inter-rater analysis of antimicrobial prescriptions,\textsuperscript{194} there is still some way to go to improve reliability to those levels seen with other medications.\textsuperscript{192,193}
8.9 Recommendations for AMS implementation in Australian private hospitals

Australian private hospitals need to consider the unique methods of how healthcare is delivered within their facilities when introducing hospital-wide AMS programs. Newly established national accreditation standards detailing the mandatory requirement for AMS introduction into all Australian hospitals has meant that there is urgency for private hospitals to plan implementation now.

More importantly, the growing incidence of antimicrobial resistant infections is driving urgency in recognition of the need for change. As stated previously, hospitals are increasingly being scrutinised by the public on the delivery of healthcare and are now held accountable for attributable risks such as healthcare-associated infections.\textsuperscript{157} Private hospitals in Australia are not immune to this, and in fact, given that a large proportion of their income is from private health insurance and direct out-of-pocket payments, there is likely to be scrutiny from funders as well as healthcare regulators. Therefore, there is significant onus on private hospitals to ensure AMS best practice occurs within their facilities. This thesis can serve as an important guide to direct the private hospital sector through this process.

The following key areas have been explicitly identified as requiring dedicated attention:

- **Governance** – It is already clear from the national standards that all private hospitals must establish sustainable governance structures through a dedicated committee to oversee AMS. Hospital executive must formally endorse this committee via a ratified hospital-wide antimicrobial prescribing policy. Incorporated into this policy should be an expectation of VMOs adherence and the hospital’s medical advisory committee should incorporate this policy as part of VMOs gaining or renewing patient admitting rights to the private hospital.

- **Advocacy** – Use of marketing strategies to outline the benefit of AMS in improving patient care is urgently required. Marketing should target all health professionals,
paying close attention to VMOs and nursing staff with a view to changing attitudes to make quality and safety a priority, and AMS part of core business. One low cost strategy that may be highly effective is to recruit ‘AMS champions’ from core VMO specialities and also from within nursing groups that are considered leaders among peers so as to provide leadership for others to engage in AMS activities. This may link very well with infection control activities (such as hand hygiene) and medication safety activities. Co-ordinated national or state campaigns to align key messages would ensure that expectations in the public sector carry over to the private sector seamlessly.

There should also be a concerted effort to market AMS to private hospital patients as a means to improving the excellence of their care while in hospital.

- **Restriction** – It is recognised that AMS strategies based on restriction may be perceived to encroach on VMO autonomy. Nevertheless, this should not preclude restriction strategies being introduced to private hospitals. The hospital antimicrobial prescribing policy should describe an antimicrobial formulary. This formulary in turn should specify criteria for which certain antimicrobials may be prescribed, and describe when expert advice should be sought. As an example, antimicrobials that are reserved for the treatment of MDR organisms should be classified as ‘highly restricted’ and require consultation with ID experts prior to use. VMOs have expressed a willingness to involve ID experts in the care of complex patients, so these ‘restrictions’ will likely have little impact on perceptions of encroachment on VMO autonomy. The workflow around documenting approvals for ‘restricted’ antimicrobial use will need to be considered in each hospital context, but systems should be established that ensure close links with pharmacy services.

- **Education** – Lack of education and lack of access to prompt antimicrobial prescribing advice have been identified as major barriers in private hospitals. Therapeutic Guidelines: Antibiotic, the Australian national guideline should be made available online through an easily accessible electronic hospital network. Nurses should specifically be involved in AMS educational activities as they take on a more active role in communicating concerns to VMOs in private hospitals. VMOs have expressed a
preference for on demand online education that can be accessed in their own time and from locations external to the hospital if possible.

- Audit and communicate – Regularly evaluate antimicrobial use so as to firstly identify areas that may benefit from interventions, and secondly, assess the impact of implemented AMS strategies on the appropriateness of antimicrobial prescribing. Given that many private hospitals are procedure-driven, antimicrobial therapy for procedural prophylaxis and treatment of associated complications will most likely be a significant area requiring periodic auditing. Assessments of appropriateness need to be made by appropriately trained people, either local or remote ID experts or clinical pharmacists. The results of these audits need to be communicated to prescribers in a timely manner.

- Access to experts – Use of outreach services where advice is given at the time of antimicrobial prescription is a proven method to influence prescribing patterns and sustain judicious use of antimicrobials. Each private hospital should identify where its VMOs can access expert advice on the management of infections and antimicrobial prescribing. In some cases microbiology laboratories may provide such patient specific advice on demand. In other settings hospitals may have arrangements with co-located public hospitals to access expert advice through infectious diseases physicians and/or ID trained pharmacists. Some hospitals may have VMOs who are ID physicians and are willing to provide a consultative service. For large private hospitals, direct employment of an AMT may be appropriate, and can serve a dual purpose, with this team offering post-prescription advice and feedback as well as co-ordinating other activities (such as auditing and education) that constitute important parts of a hospital-wide AMS program as discussed earlier.

- Tools – Use of CDSS as a means to guide antimicrobial prescribing-based clinical information and disease state is gaining popularity and should be promoted. These electronic based advisory tools have previously been shown to improve antimicrobial prescribing in hospitals. Importantly, data collected from private hospitals have shown that clinical stakeholders would not be opposed to using these types of programs to deliver education on antimicrobial therapy.
8.10 Future research

Research conducted in this thesis has helped articulate previously unknown factors that need to be taken into account when implementing AMS into Australian private hospitals. Outcomes relating to human resourcing for AMS have largely focused on VMOs, nurses and clinical pharmacists as well as ID experts such as ID physicians, clinical microbiologists and specialist ID pharmacists. Further research, however, is required to ascertain the role of infection control practitioners (ICPs) in AMS program implementation. As more than half of respondents to the statewide survey detailed in Chapter 3 were ICPs, this is important for the private hospital sector to decipher. Further, results from the inter-rater reliability study in Chapter 4 indicate that ICP assessed prescriptions both locally and offsite have poor agreement with clinical ID experts. It is important to delve further into the reasons for this, as it is clear that ICPs are currently performing some kind of role in hospitals and perhaps further training in AMS is necessary. This further research may be of significant importance among private hospitals located in rural and remote settings where ICPs have traditionally carried out numerous functions.
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Appendix 1