EXPLORING THE ADOPTION AND IMPLEMENTATION OF HEALTHCARE INNOVATION: CASE STUDIES OF TWO ANTIMICROBIAL STEWARDSHIP PROGRAMS IN SASKATCHEWAN

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By
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Dinah Tambalo, candidate for the degree of Master of Public Policy, has presented a thesis titled, *Exploring the Adoption and Implementation of Healthcare Innovation: Case Studies of Two Antimicrobial Stewardship Programs in Saskatchewan*, in an oral examination held on July 29, 2019. The following committee members have found the thesis acceptable in form and content, and that the candidate demonstrated satisfactory knowledge of the subject material.

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Abstract

Health innovations can play an important role in improving quality of care and in reducing healthcare costs. However, even promising innovations are not always successfully implemented because the process can be challenging. Thus, there is a significant gap between healthcare innovations and their application in routine practice. In this study, I explored determinants that influence adoption and implementation of a healthcare innovation, using the Regina Qu’Appelle Health Region (RQHR) and the Saskatoon Health Region (SHR) Antimicrobial Stewardship Programs (ASPs) as case studies. Considering the increasing risks of antimicrobial resistance, international bodies such as the World Health Organization, United Nations, the World Economic Forum and the Government of Canada have called for antimicrobial stewardship. Accreditation Canada has also required acute care facilities, inpatient cancer, inpatient rehabilitation and complex continuing care facilities to implement an ASP. Antimicrobial stewardship activities are focused on appropriate selection, dosing, route, and duration of antimicrobial therapy. I initiated this study prior to the amalgamation of the province’s health regional authorities into the Saskatchewan Health Authority (SHA). Understanding potential challenges and strategies adopted for the two health regions may help inform the development of a provincial antimicrobial stewardship approach as well as other healthcare institutions that are in the process of adopting or implementing their own ASP.

I utilized a qualitative case study approach and conducted semi-structured interviews of eight stakeholders involved in the adoption and/or implementation of the RQHR and SHR ASPs. I included a prescribing physician, ASP implementing team members and organizational champions as study participants. I obtained additional
information from the health regions’ websites, publicly available documents and the ASP teams.

The RQHR and the SHR ASPs demonstrated a complex innovation process. The decision to adopt an ASP required multiple years, and various factors and stakeholders. Accreditation Canada’s requirement appeared to be the key determinant for the decision to adopt a formal ASP for both health regions. There were additional enabling factors for the RQHR: “policy push” from key healthcare institutions (e.g., the World Health Organization, United Nations and the Public Health Agency of Canada) and innovation champions. In terms of implementation, the majority of determinants that I identified for the health regions are shared: (1) dedicated resources and time for the ASP team; (2) data infrastructure; (3) availability of tools and information for prescribing physicians; (4) competencies of the ASP implementing team; (5) fit of the innovation to health professional’s values and goals; and (6) collegial conversations of the ASP team with prescribers. Most of these factors are consistent with published studies suggesting that these commonalities transcend different contexts. Thus, it may be helpful for healthcare organizations, including the newly established SHA, to pay attention to these factors when planning and/or implementing their ASPs.

This study adds to the limited information on the adoption and implementation of ASFs in Canada and internationally. Despite Accreditation Canada’s ASP requirement, there appears to be limited ASP implementation in Canadian healthcare facilities. My study offers lessons and strategies that could facilitate planning and implementation of ASFs. Also, this research contributes to the growing area of implementation research and demonstrates the utility of using a theoretical framework to guide analysis of results.
Acknowledgement

Back in 2015, I decided to make a career change and pursued my Masters in Public Policy at the Johnson-Shoyama Graduate School of Public Policy. I am passionate about antimicrobial stewardship, but science policy was a new research area for me. This work would not have been possible without the support, guidance and patience of my supervisor, Amy Zarzeczny. I am extremely thankful to Amy for being encouraging and accessible, and for her constructive feedback on my work. I am also very grateful to the members of my thesis advisory committee, Drs. Peter Phillips, Cory Neudorf and Tarun Katapally for their valuable time spent on reviewing my proposal and thesis. Their insights and feedback improved this work.

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Dedication

I dedicate this work in memory of my father, Florencio Difuntorum – a man with a big heart and a person of principle.

“We make a living by what we get, but we make a life by what we give.”
– Sir Winston Churchill
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LIST OF ABBREVIATIONS

AMMI - Association of Medical Microbiology and Infectious Disease Canada
AMR – Antimicrobial Resistance
ASP – Antimicrobial Stewardship Program
BC – British Columbia
CAHO - Council of Academic Hospital of Ontario
CDC – Centre for Disease Control
FTE – Full-time equivalent
IT – Information Technology
JURSI - Junior Undergraduate Student Resident Intern
MSH-UHN – Mount Sinai Hospital-University Health Network
n.d. – no date
PHAC – Public Health Agency of Canada
ROP – Required Organizational Practice
RPIW – Rapid Process Improvement Workshop
RQHR – Regina Qu’Appelle Health Region
SHA – Saskatchewan Health Authority
SHR – Saskatoon Health Region
UK – United Kingdom
WHO – World Health Organization
Chapter 1. Introduction

1.1 Aims of the Study

Healthcare innovations include new or improved health policies, systems, products, technologies, services and delivery methods (WHO 2018, Lansisalmi et al. 2006). These are believed to improve efficiency, effectiveness, quality, sustainability, safety and/or affordability of healthcare (WHO 2018). Innovations in healthcare have advanced over time but healthcare systems experience major delays in diffusing novel initiatives (Omanchonu and Einspruch 2010). Often, complex health innovations are adopted with enthusiasm by health sector organizations, but implementation proves to be challenging, time consuming and costly (Helfrich et al. 2007). Failure rate internationally in implementing healthcare innovations is estimated at 30% to 90% (Jacobs 2015, Alexander and Hearld 2011, Alexander et al. 2006, Berlowitz et al. 2003). As a result, there is a substantial gap in time between healthcare innovations and their delivery in routine practice (Powell et al. 2011).

The application of healthcare innovation is often challenging because the tools and practices that are utilized in healthcare are complex and require coordinated use by many individuals and professional groups (Helfrich et al. 2007). Also, the decision of individuals to adopt and use innovations in their daily practice is influenced by many organizational, socio-political and economic factors (Grol et al. 2007, Helfrich et al. 2007, Greenhalgh et al. 2004). A very recent publication from Nova Scotia, Canada demonstrated that budgetary implications, expected impact on patients and equitable access to care are considered by decision-makers with regards to adopting complex innovations in cancer care settings; these issues prevailed regardless of the level where
the adoption decision occurred (i.e., departmental, organizational, or health system) (Urquhart et al. 2019). Further, many of the defining features of healthcare systems (e.g., the range and diversity of stakeholders, professional autonomy of staff, complex governance, resourcing and regulatory arrangements, and complex policy environments) may impact the implementation of healthcare innovations (Urquhart et al. 2015).

Given the increasing demand for healthcare (Babalola 2017) and the rapid pace of advances in medicine and innovation (Omanchonu and Eisnpruch 2010), this is an opportune time to increase understanding of the determinants (barriers and enablers) of the adoption and implementation of healthcare innovations, so as to more effectively move innovations into practice. Existing studies are mostly focused on the adoption and implementation of innovations by individual users; hence, there is limited conceptual guidance for researchers and practitioners looking at implementation of complex healthcare innovations from a broader contextual perspective (Helfrich et al. 2007).

My research focused on the adoption and implementation of Antimicrobial Stewardship Programs (ASPs) in Saskatchewan, as case studies of healthcare innovations. The two case studies are the ASPs at the Regina Qu’Appelle Health Region (RQHR) and at the Saskatoon Health Region (SHR). Since ASPs are adopted and implemented at an organizational level, the decision to adopt a formal program is exercised by hospital administrators, rather than the users of the innovation (e.g., prescribing physicians and pharmacists). Also, the implementation of ASPs requires coordinated work by multiple stakeholders including hospital administrators, physicians, patients, and the implementing group. Further, ASPs may involve more than one specific
intervention (e.g., audit and feedback, restrictive formulary and review of antimicrobial utilization), adding layers of complexity to implementation.

In this study, I explored determinants (both barriers and enablers) of the adoption and implementation of formal ASPs in two university-affiliated health regions in Saskatchewan, as perceived by different medical professionals and managerial actors. Participants were also asked to describe their implementation strategies. In addition to contributing to innovation and implementation research, this study provides lessons and strategies for establishing ASPs in other healthcare organizations.

The public risks of antimicrobial resistance (AMR) and the need for antimicrobial stewardship in healthcare institutions continues to increase. The World Health Organization (WHO) considers AMR to be a major global threat to public health (WHO 2014). Similarly, in 2011, the Public Health Agency of Canada (PHAC) identified AMR as one of the highest public health risks facing Canadians (Office of the Auditor General of Canada 2015) and called for antimicrobial stewardship in human and veterinary medicine as one of the ways to combat this problem (Government of Canada 2015).

In this study, I utilized qualitative thematic analysis to explore the experiences and perceptions of key stakeholders involved in the adoption and/or implementation of the ASPs at the RQHR and the SHR. The use of qualitative case studies allowed in-depth understanding of factors that influenced the innovation process, from the perspectives of key individuals involved in different aspects of it. I conducted the interviews prior to the amalgamation of Saskatchewan’s 12 health regional authorities into one provincial health authority (the Saskatchewan Health Authority, SHA). Understanding the challenges, strengths and implementation strategies for the two health regions not only contributes to
this area of research but could also inform the development of a provincial antimicrobial stewardship approach for the SHA. I used Accreditation Canada’s Required Organizational Practice (ROP) for an ASP as the basis to indicate that a formal ASP has been adopted and implemented by the two organizations. Accreditation Canada accredits healthcare organizations in Canada (Accreditation Canada 2019) and included in its requirements is an ROP, which refers to “essential practice that organizations must have in place to enhance patient/client safety and minimize risk” (Accreditation Canada 2011).

My research questions were:

- What was the process for the adoption (at the organizational level), pre-implementation (planning and design), and implementation of ASPs in the Regina Qu’Appelle Health Region and the Saskatoon Health Region in Saskatchewan;
- What were perceived barriers and enablers of adopting and implementing an ASP from the perspective of key stakeholders of the program; and
- What lessons and implementation strategies can we draw from these case studies that could inform future design and implementation of ASPs?

1.2 Thesis Organization

In Chapter 2, I provided a literature review that presents the theoretical and empirical contexts of this study. I described selected theories and conceptual models of healthcare innovations, including a review of the innovation process and factors that can influence the adoption and implementation of healthcare innovations. The last section under theoretical context presents the theoretical frameworks selected for this study.
For the empirical context, I discussed AMR and antimicrobial usage, both globally and in Canadian context. Then, I described the role of antimicrobial stewardship for addressing AMR. In this chapter, I also outlined Accreditation Canada’s ROP for antimicrobial stewardship. Finally, I provided a review of existing studies on the determinants that impact the implementation of ASPs in Canada and abroad.

In Chapter 3, I described the methodology, including the theoretical framework used for this research. This chapter ended with the limitations of the study.

I presented the results for each of the two case studies in Chapters 4 and 5. Each chapter contains the following: timeline for ASP adoption and implementation; description of the antimicrobial stewardship program including specific interventions; and determinants for the adoption and implementation of the ASP. I presented the determinants by theme and subthemes as guided by my study’s theoretical framework.

I discussed the results in Chapter 6 and the research and policy contributions of this research in Chapter 7.
Chapter 2. Literature Review

2.1 Background on Healthcare Innovation

Innovation refers to an idea, practice or object that is perceived as new by an individual or other unit of adoption (Rogers 2003). In healthcare, innovations include new or improved health policies, systems, products, technologies, services, and delivery methods (WHO 2018, Lansisalmi et al. 2006). According to the WHO, innovation improves efficiency, effectiveness, quality, sustainability, safety and/or affordability of healthcare (WHO 2018). Although healthcare innovation is widely recognized by governments/organizations (WHO 2018, National Health Service 2015, Government of Canada 2014, WHO 2002, UK Department of Health 2011) and healthcare research scholars (Omanchonu and Einspruch 2010, Lansisalmi et al. 2006) to have positive effects, others argue that the development and implementation of healthcare innovation is costly (Dzau et al. 2017). Further, as discussed below, many innovations are not successfully implemented which can translate to the loss of considerable investments. Innovation can also have disruptive effects, e.g., displacing procedures in areas that have been targets of quality improvement (Dzau et al. 2017, Dixon-Woods et al. 2011, Herzlinger 2006).

The need for healthcare innovation has recently intensified due to the increasing demands of an ageing population and the growing incidence of chronic diseases (Babalola 2017). In addition to reducing the enormous healthcare costs imposed by chronic diseases, innovative practices (e.g., focusing on the prevention of chronic diseases) are believed to improve the functioning and quality of life, and the processes of care (WHO 2002). Healthcare also continues to consume a large share of gross domestic
product (GDP) (CIHI 2018). For example, in 2017, countries belonging to the Organisation for Economic Co-operation and Development (OECD) spent an average of 8.8% of their GDP (CAD$5,055 per person) on healthcare. The United States spent CAD$12,865 per person (17.2% of GDP), the highest among 36 selected OECD countries. Canada spent CAD$6,082 per person at 10.4% of GDP in 2017 and the total expenditure was expected to have reached CAD$253.5 billion in 2018 (11.3% of Canada’s GDP). Further, Canada’s health-to-GDP ratio has trended upward in the last 40+ years and since 2014, health spending has increased by an average of 1.7% annually (CIHI 2018). Innovation is proposed as a means to contain healthcare costs (Health Canada 2015), while improving the quality of services (WHO 2018). National and local governments have identified the importance of healthcare innovation in meeting healthcare challenges. The UK acknowledged that innovation needs to be the core business for the National Health Service (NHS), which is the UK’s publicly funded health service (National Health Service 2015, UK Department of Health 2011). Further, the NHS has several key initiatives that promote healthcare innovation. For example, the Innovation and Technology Tariff (ITT) supports England’s medical devices and life science industries to remain innovative and competitive; the NHS Innovation Accelerator provides fellowships to drive the uptake of proven innovations across the NHS; and the Academic Health Science Networks brings together healthcare, academia, and industry on an open innovation platform to lead work on the adoption and diffusion of innovation (Young 2017).
In Canada, Premiers established the Health Care Innovation Working Group (HCIWG; composed of provincial and territorial Ministers of Health) in 2012, in recognition of the need to embrace and push forward innovation to improve quality care while ensuring sustainability for Canada’s health care systems. The HCIWG focuses on innovation to better meet existing and emerging challenges in Canada’s health care systems such as chronic diseases, high pharmaceutical costs, a growing and aging population and the disparities in health outcomes for Indigenous peoples (stated as “Aboriginal peoples” in Canada’s Premiers 2018). Some of the working group’s initiatives include implementing models of good practice in team-based approaches for providing care; promoting guidelines for treating heart disease and diabetes; and creating innovative models for seniors’ care that prioritize home and community care over long-term care institutionalization (Canada’s Premiers 2018). Canada’s federal government also provides funding for innovative health research through the Canadian Institutes of Health Research (Government of Canada 2018). Further, in June 2014, the federal government launched an Advisory Panel on Healthcare Innovation tasked to explore how the Government of Canada can foster innovation and improve patient care and sustainability of the healthcare system. According to then Health Minister Rona Ambrose, “Healthcare innovation is essential to ensure the future sustainability and quality of healthcare for Canadians” (Government of Canada 2014).

Billions of dollars are spent each year internationally to support the development of health innovations (Cooksey 2006). The number of new insights, procedures, programs and techniques that have become available as a result of scientific research and careful development continues to grow. The number of clinical
trials added to Medline annually, a large database of journal in medicine, is enormous. The knowledge about improving patient care is also growing at an increasing rate (Grol et al. 2013). Despite the growing number of potential healthcare innovations, only a small fraction is implemented, and implementation can take many years. Further, implementation may only be partially successful or at times completely unsuccessful. Consequently, the intended results for patients – recovery from an illness, improvement in health, better quality of life, more efficient procedures – are often not realized (Grol et al. 2013 and 2007, Haines et al. 2004, Berwick et al. 2003). Taken at face value, this indicates that the investments on researching and developing clinical guidelines, interventions and programs in healthcare are not being fully realized. It is therefore important to understand barriers and challenges that arise when implementing healthcare innovation to inform strategies for how they might be addressed in order to facilitate more effective implementation.

The introduction of healthcare innovations is a challenging and complex process (Chaudoir et al. 2013, Thakur et al. 2012, Omanchonu and Einspruch 2010, Helfrich et al. 2007, Greenhalgh et al. 2004). The process involves attention to a wide array of multi-level variables related to the innovation itself, the local implementation context, and the behavioral strategies used to implement the innovation (Chaudoir et al. 2013, Greenhalgh et al. 2004). Further, many of today’s innovations are not easily reduced to a decision by a physician but have broader organizational implications, and sometimes require displacement of resources (Denis et al. 2002).
2.2 Theoretical Context

2.2.1 Definitions of Terms

For the purpose of this study, the following definitions are used:

**Innovation** refers to an idea, practice or object that is perceived as new by an individual or other unit of adoption (Rogers 2003).

**Adoption** refers to the formal decision by organisations or individuals to implement and make use of an innovation (Greenhalgh et al. 2004).

**Diffusion** refers to the process through which an innovation is communicated through certain channels over-time among the members of a social system (Rogers 2003).

**Dissemination** refers to planned and active processes intended to increase the rate and level of adoption above that which might have been achieved by passive diffusion (Greenhalgh et al. 2004).

**Efficacy** refers to “the ability of an intervention (for example, a drug or surgery) to produce the desired beneficial effect” (National Cancer Institute, n.d.).

**Implementation** refers to active and planned efforts to mainstream an innovation (Greenhalgh et al. 2004). It is the “critical gateway between an organisational decision to adopt an intervention and the routine use of that intervention” (Damschroder et al. 2009, p.3).

2.2.2 Rogers’ Diffusion of Innovations Theory

Rogers’ Diffusion of Innovations theory, rooted in sociology, has been widely used to explore healthcare innovations (Rogers 2003). These studies include: investigating nurses’ perceptions toward using a computerized care plan system in Taiwan (Lee 2004); patient acceptance and use of consumer e-health innovations in Australia (Zhang et al. 2015); and in-depth case studies of the role of key agents and agencies that facilitate the rapid adoption of innovations in Argentina, England, Nepal, Singapore, Sweden, the United States and Zambia (Parston et al. 2015). Also, several models and frameworks on the introduction of healthcare innovations (Grol et al. 2013,
Omanchonu and Einspruch 2010, Helfirch et al. 2007, Fleuren et al. 2004, Greenhalgh et al. 2004, Glasgow et al. 1999), including the frameworks that guided this study, have been influenced by Rogers’ work.

According to Rogers (2003), there are four main elements in the diffusion of innovations: (1) the innovation; (2) communication channels; (3) time; and (4) the social system. The perceived characteristics of an innovation determine its rate of adoption (this will be discussed in more detail below). Communication channels refer to the means by which messages are shared from one individual to another. Time is also involved in the innovation-decision process. A potential adopter seeks information at various stages of the process to decrease uncertainty about an innovation’s expected consequences. The social system refers to “a set of interrelated units that are engaged in joint problem-solving to accomplish a common goal” (Rogers 1995, p. 37). The social and communication structure influences the diffusion of innovations in the system. This includes system norms (established behavior patterns of members in a social system) and opinion leadership (the degree to which an individual can informally influence other individuals’ attitudes) (Rogers 2003).

**Characteristics of Innovations**

According to Rogers (2003), an innovation’s perceived characteristics explain its adoption rate: relative advantage, compatibility, complexity, trialability and observability.

(1) **Relative advantage.** This refers to the perceived value that the innovation is better than the idea it supersedes. An innovation with a greater perceived relative advantage will have a more rapid rate of adoption.
(2) **Compatibility.** This refers to the degree to which individuals perceive the idea to be consistent with their values, past experiences, and needs. If an innovation is compatible with the values of the potential user, the rate of adoption increases.

(3) **Complexity.** This refers to the perceived difficulty of understanding or learning to use the new idea. In general, complicated innovations, those that require new knowledge and the development of new skills, will be adopted more slowly.

(4) **Trialability.** This refers to the degree to which an individual has an opportunity to experience an innovation on a limited basis. Innovations that can be tried before committing to full adoption are adopted faster than those that require a commitment to full adoption from the beginning.

(5) **Observability.** This refers to the degree to which an innovation’s results are visible to others. According to Rogers (2003), individuals are more likely to adopt an innovation when they can see the results.

*The Innovation-Decision Process*

Rogers (2003) identified five stages in the innovation process: (1) knowledge about innovation; (2) persuasion of the potential adopter by deepening knowledge about the innovation and searching for more information about the same; (3) decision to adopt or reject the innovation; (4) implementation in which the innovation is put into practice; and (5) confirmation where the adopter evaluates and decides whether to maintain or reject an innovation after it has been put into use (Figure 1). Further, various predictors (including the ones described above) exert different effects at different stages. The different stages are described in more detail below.
Figure 1. A Model of Stages in the Innovation-Decision Process. The innovation-decision process is the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation (persuasion), to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision. (Source: Rogers 2003)
**I. Knowledge Stage.** The innovation-decision process starts with the knowledge stage. An individual learns about the existence of innovation and gains understanding of how it functions. At this stage, the characteristics of the individual such as socio-economic status, personality traits and communication behavior (e.g., opinion leadership) have a direct effect on an individual’s knowledge of an innovation (Rogers 2003).

**II. The Persuasion Stage.** The persuasion stage “occurs when an individual forms a favourable or unfavourable attitude towards the innovation” (Rogers 2003, p. 169). The innovation’s perceived attributes (relative advantage, compatibility, simplicity, trialability and observability) affect the individual’s opinions and beliefs about the innovation.

**III. The Decision Stage.** According to Rogers (2003), the decision stage, “takes place when an individual engages in activities that lead to a choice to adopt or reject the innovation” (p. 169). Rejection is possible in every stage of the innovation-decision process. An individual may decide not to adopt the innovation at all or may try an innovation but can later decide to discontinue its adoption.

**IV. The Implementation Stage.** The implementation stage “occurs when an individual puts a new idea into use” (Rogers 2003, p. 169). This stage could be influenced by the individual’s trial experience and uncertainty about the outcomes of innovation even after the trial. Thus, the individual may need technical assistance from change agents and may also continue to seek information to reduce uncertainty. Further, reinvention usually happens at the implementation stage. Reinvention is “the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation” (Rogers 2003, p. 180). The more reinvention takes place, the more rapidly an innovation is adopted and becomes institutionalized (Rogers 2003).
V. The Confirmation Stage. The confirmation stage “takes place when an individual seeks reinforcement of an innovation-decision already made, but he or she may reverse this previous decision if exposed to conflicting messages about the innovation” (Rogers 2003, p. 189). Depending on the support for adoption of the innovation and the attitude of the individual, continuance or discontinuance happens during this stage.

Rogers’ Diffusion of Innovation theory is robust in explaining the adoption of innovation by individuals. Thus, it has been hugely influential and widely adopted by innovation researchers. However, this theory does not adequately explain how organizational and socio-political contexts shape the complex process of innovation adoption at the organizational level. In healthcare, many innovation-decisions are made by organizations and in such cases are more complicated because several individuals are involved. Also, Rogers describes the Innovation-Decision Process as a linear and stage-like model. Other theoretical approaches propose a more complex innovation process, with multi-level factors (Chaudoir et al. 2013, Greenhalgh et al. 2004).

2.2.3 Frameworks for Healthcare Innovations

In the last few years, many researchers have developed frameworks that are focused on the introduction and implementation of healthcare innovations (Chaudoir et al. 2013, Fleuren et al. 2004, Greenhalgh et al. 2004, Helfrich et al. 2004; for a systematic review, please refer to Moullin et al. 2015). Two frameworks, those of Greenhalgh et al. and Fleuren et al., both released in 2004 and based on systematic reviews of literature, are described here. These frameworks recognized the complexity of adopting and implementing innovations in the healthcare sector. Fleuren et al.’s
theoretical framework was adopted in this study while also drawing from Greenhalgh and colleagues’ model for additional determinants.

Greenhalgh et al.’s model of diffusion in service organizations

The conceptual model developed by Greenhalgh and colleagues (2004) is based on a systematic review of nearly 500 published sources across 13 fields of research and is considered a seminal work in healthcare innovation research. The model builds on Rogers’ Diffusion of Innovation theory but adds more recent evidence and importantly, focuses on spreading and sustaining innovations in health service organizations. The Greenhalgh et al. conceptual model includes nine main constructs: (a) the Innovation; (b) Adopter; (c) Assimilation by the System; (d) Diffusion and Dissemination; (e) System Antecedent for Innovation; (f) System Readiness for Innovation; (g) the Outer Context: Inter-organizational Networks and Collaboration; (h) Implementation and Routinization; and (i) Linkage among components of the model (Figure 2).

Similar to Rogers’ Diffusion of Innovation Theory, the conceptual model includes innovation attributes as determinants of innovation (Figure 2a). According to Greenhalgh et al. (2004), innovations are likely to be adopted if: (a) they have clear advantage (relative advantage); (b) are consistent with adopters’ values, norms and perceived needs; (c) are simple to use; (d) can be experimented with on a limited basis; (e) benefits of the innovation are visible; (f) can be adapted, modified or refined; (g) the innovations’ soft periphery (organizational structures/systems required for fully
Figure 2. Conceptual model for considering the determinants of diffusion, dissemination, and implementation of innovations in health service delivery and organization. (Source: Greenhalgh et al. 2004)
implementing an innovation) is adaptive; (h) carry a low level of perceived risk; (i) are relevant to the performance of the intended user’s work and improves performance of task; (j) knowledge required to use the innovation can be codified and can be transferred from one context to another; and (k) innovation includes technical support such as training, help desk and customization. This model re-affirms the five innovation attributes (relative advantage, compatibility, low complexity, trialability, and observability) that Rogers (2003) proposed to predict adoption rate.

Greenhalgh et al. (2004) proposed that adopters are not passive recipients of innovations (Figure 2b). Rather, they seek innovations and they develop diverse feelings and actions towards the innovation – this perspective is markedly different from Rogers’ adopter categories of “early adopters” and “laggards” (pp. 281-284). According to Rogers (2003), some individuals are more apt to adopt the innovation than others, and innovation adopters can be categorized according to their propensity to adopt a specific innovation: innovators, early adopters, early majorities, late majorities and laggards. Greenhalgh et al. (2004) argued that these “stereotypical and value-laden terms fail to acknowledge the adopter as an actor who interacts purposely and creatively with a complex innovation” (p. 18). Adopter characteristics associated with the propensity to trial and use innovations include needs, motivation, values, social networks, and learning style.

The Greenhalgh et al. conceptual model (Figure 2c) points out the difference between product-based innovations (the unit of adoption is the individual) and complex process-based innovations in service organizations (for which the unit of adoption is the team, department, or organization). Assimilation of an innovation in a
system almost always involves a formal decision-making process and does not happen passively. The process is complex requiring various changes in structures or ways of working. Assimilation by an organization does not follow a linear process, but rather a dynamic process between initiation, development, and implementation. Further, complex innovations in service organizations can have a “hard core” (the irreducible elements of the innovation itself) and a “soft periphery” (the organizational structures and systems required for the full implementation of the innovation). The adaptiveness of the “soft periphery” is a key attribute of the innovation (Greenhalgh et al. 2004).

According to Greenhalgh et al. (2004), moving the spread of an innovation from pure diffusion (spread of innovations is unplanned, informal, decentralized and largely mediated by peers) to active dissemination (spread of innovation is planned, formal, and often centralized) is influenced by network structure and quality, homophily (individuals with similar socio-economic, educational, professional and cultural backgrounds), opinion leaders who have particular influence on the beliefs and actions of their colleagues, innovation champions, and boundary spanners (people with significant ties both inside and outside of the organization) (Figure 2d).

System antecedents for innovation (both structural and cultural features of an organization) influence the likelihood that an innovation will be adopted by all relevant individuals and incorporated into routine work (Figure 2e). The determinants include the organization’s size, maturity and resources, as well as its absorptive capacity and receptivity for change.
A system’s readiness for innovation (Figure 2f) is influenced by the following: innovation fitting the organization’s existing norms, values and supporting technologies; power balances (supporters outnumber and are more strategically placed than the opponents); dedicated time and resources, and capacity to evaluate the innovation.

The outer context (e.g., socio-political context, inter-organizational norm-setting and networks) contributes to the decision to adopt, implement and sustain an innovation (Figure 2g). Examples of socio-political determinants are integrative organizational forms (e.g., professionally led networks of health care providers) and political directives (political “must-dos”). The higher socio-economic status of patients may have small positive effects, although evidence to support this relationship is limited (Greenhalgh et al. 2004).

Successful implementation and routinization can be facilitated by factors such as devolved decision-making, management support, and intra-organizational communication (Figure 2h). Routinization of an innovation also depends on the motivation, capacity and competence of individual practitioners. Further, implementation depends on the other factors that are important for the initial adoption decision and the early stages of assimilation. “At the organizational level, the move from considering an innovation to successfully routinizing it is generally a nonlinear process characterized by multiple shocks, setbacks, and unanticipated events” (Greenhalgh et al. 2004, p. 30). The key factors of system readiness for an innovation are also highly relevant to the early stages of implementation.
Greenhalgh et al. (2004) proposed linkages among components of the model (Figure 2i). An innovation that is centrally developed is more likely to be adopted if the developers or their agents are linked with the potential users at the design stage as this allows incorporation of the users’ perspectives. Similarly, “if a change agency is part of a dissemination program, the nature and quality of any linkage with intended adopter organizations will influence the likelihood of adoption and successful implementation” (p. 32). The authors also emphasized that multiple and often unpredictable interactions arising in particular contexts and settings influence the success in disseminating innovations. For example, although innovation champions are key determinants of an organizational innovation, they are not independent of the nature of the innovation, the organizational setting, and the socio-political context.

Greenhalgh et al. (2004) used considerable evidence in developing a comprehensive model of innovation implementation in healthcare organizations. However, this model is not without its limitations, including the absence of explicit and operational definitions for the large majority of its constructs, as well as complex components that do not necessarily map well onto all healthcare contexts. Rather than adopting the model in its entirety, I have utilized its relevant constructs as a guide and adopted some as subthemes during my analysis.

**Fleuren and colleagues’ determinant framework of the innovation process**

Fleuren et al. (2004) carried out a systematic literature review of 57 implementation studies in healthcare organizations. Their framework represents the main stages in the innovation process and related categories of determinants (Figure 3).
Figure 3. Framework representing the innovation process and related categories of determinants (Source: Flereun et al. 2004).
The different stages in the innovation process are considered points where the desired change may not occur. The framework identifies dissemination, adoption, implementation, and continuation as main stages in innovation processes (Fleuren et al. 2004). These are similar with the innovation process outlined in Rogers’ Diffusion of Innovation Theory: knowledge and persuasion (similar to dissemination), decision (to adopt or reject), implementation and confirmation (continuation). Fleuren et al. (2004) proposed that the transition from one stage of the innovation process to the next can be impacted by various determinants that are grouped into categories (left side of Figure 3):

(i) characteristics of the socio-political context (e.g., rules, legislations and characteristics of patients);
(ii) characteristics of the organization (e.g., decision-making process in the organization and available expertise in the organization);
(iii) characteristics of the adopting person/user (e.g., knowledge and skills); and
(iv) characteristics of the innovation (e.g., complexity or perceived relative advantage).

The user of the innovation and the innovation itself play crucial roles in the innovation process. However, the user does not work in isolation and is recognized as part of an organization, which in turn is part of a larger environment (Fleuren et al. 2004). Thus, the characteristics of the organization and the socio-political context should also be considered. Since the development of this framework in 2004, it has been used to study the introduction and implementation of healthcare innovations in the Netherlands, including a web-based self-management application for cancer care, shared care guideline for back pain, and new technologies in nursing care (de Wit 2018, de Veer et al. 2011, Fleuren et al. 2010, Crone et al. 2006, Wiefferink et al. 2005).
For this study, I have adopted the Fleuren et al. (2004) framework for several reasons. First, it is based on 57 empirical studies. It has been validated through a Delphi study involving many implementation experts (researchers, program managers, and consultants/advisors) as well as in separate studies that used other types of healthcare innovations. It also highlights the complexity of implementing healthcare innovations, and determinants are included for the main stages in the innovation process which provides a holistic view of the process. Finally, the framework is simple and easy to apply because it includes a list and description of 51 determinants by category.

2.2 Empirical Context

To be consistent with the literature, I used the terms antimicrobial resistance and antimicrobial stewardship throughout this study. Antimicrobial resistance (AMR) is a broader term than antibacterial, antiviral, antifungal, and antiparasitic resistance. AMR refers to the resistance of a microorganism (including bacteria, viruses, fungi and parasites) to an antimicrobial drug that was originally effective for treatment of infections caused by it (WHO 2015, 2014). “Antimicrobial stewardship is an activity that includes appropriate selection, dosing, route, and duration of antimicrobial therapy” (Accreditation Canada 2014, para.2).

2.2.1 Antimicrobial Resistance and Antimicrobial Utilization

The World Health Organization (WHO) considers AMR a major global threat to public health (WHO 2014). For more than 60 years, antibiotics and similar drugs, collectively called antimicrobials, have been effectively used to treat infectious diseases. However, AMR has emerged and has reduced the efficacy of existing antimicrobials, resulting in increased hospital costs, morbidity (more complex illness), and mortality.
(greater risk of death) (PHAC 2015a, CDC 2013). Microorganisms develop resistance to antimicrobials when they replicate erroneously or when resistant traits are exchanged between them (WHO 2015). Although AMR is a natural phenomenon, the use of antimicrobials (both appropriate and inappropriate) has placed unnatural selective pressure on microorganisms, accelerating the development of AMR (Fair and Tor 2014).

In human medicine, 20% to 50% of antimicrobial prescriptions are inappropriate, e.g., prescribing antimicrobials for self-limiting bacterial or viral infections (Laxminarayan et al. 2013, Levin et al. 2012, Camins et al. 2009, Patel et al. 2009, Dellit et al. 2007). A multi-site study in the United States demonstrated that at least 30% of prescriptions written by US doctors for all indications during 2010–2011 may have been inappropriate; this includes inappropriate antibiotic prescriptions for acute respiratory conditions (Fleming-Dutra et al. 2016). In Canada, a retrospective analysis of administrative health care data in the province of Ontario involving 8,990 primary care physicians revealed inappropriate antibiotics prescriptions to patients with non-bacterial acute upper respiratory tract infections (Silverman et al. 2017). In addition, broad spectrum antimicrobials (effective against a wide range of microorganisms) are also prescribed even when narrow spectrum antimicrobials (targets specific groups of microorganisms) are sufficient (PHAC 2013). Two separate studies involving retrospective review of the use of piperacillin-tazobactam (considered last-recourse antibiotic) in university-affiliated hospitals in British Columbia, Canada (Havey et al. 2015) and in a large urban acute care hospital in Alberta, Canada revealed inappropriate prescriptions (Beahm and Fryters 2018).
Antimicrobial Resistance and Antimicrobial Utilization in Canada

In 2011, PHAC identified AMR as one of the highest public health risks facing Canadians, along with obesity, mental illness, emerging infectious diseases, and the health of Aboriginal people and Northerners (Office of the Auditor General of Canada 2015). It is estimated that 18,000 hospitalized patients in the country contract antimicrobial-resistant infections every year, resulting in medicare costs amounting to one billion dollars (PHAC 2015a). There is limited information on the incidence of AMR in the community (PHAC 2018). A study conducted in 2001 at Sunnybrook Hospital in Toronto, Ontario estimated the annual costs of a specific AMR infection (*i.e.* methicillin-resistant *Staphylococcus aureus*) at $42 million to $59 million (Kim *et al.* 2001).

Increased costs are also incurred if first-line antimicrobials are ineffective at treating infections as more expensive antimicrobial therapy may be needed for a longer period (PHAC 2013). In addition to direct cost, AMR diminishes the quality of life, including earning potential, of individuals who are suffering chronic drug-resistant infection (Canadian Committee on Antibiotic Resistance 2003).

PHAC, through the Canadian Antimicrobial Resistance Surveillance System (CARSS), integrates and synthesizes information on antimicrobial resistance and antimicrobial utilization from PHAC’s surveillance systems and laboratory reference services (Government of Canada 2018). There is on-going surveillance on the AMR patterns of microorganisms that are important in healthcare settings, *i.e.*, those that cause infections acquired during hospitalization or as a result of health care provided in hospitals or alternative settings such as outpatient clinics, physician/dental offices, and long-term care facilities. These bacteria are monitored as they can spread easily from
person-to-person and have been associated with large hospital outbreaks (PHAC 2015a). The microorganisms under surveillance for AMR include *Staphylococcus aureus* (causes infections in the skin, soft tissue, bone, and bloodstream), *Enterobacteriaceae* (causes urinary tract infections, bloodstream infections, and wound infections), and *Enterococci* (causes bloodstream, surgical site, and urinary tract infections) (PHAC 2015a).

*Staphylococcus aureus* strains that are resistant to β-lactam antimicrobials such as oxacillin, methicillin and dicloxacillin are called methicillin-resistant *Staphylococcus aureus* (MRSA). MRSA can cause serious infections (e.g. bloodstream infection) which can be fatal. The incidence of MRSA in Canada has more than doubled from 2001 (1.11 MRSA infections per 1,000 patient admissions) to 2012 (2.35 MRSA infections per 1,000 patient admissions) (PHAC 2015a). Vancomycin-resistant Enterococci (VRE) hospitals infections in the country have also increased from 0.01 per 1,000 patient admissions in 2001 to 0.44 per 1,000 patient admissions in 2013. VRE are strains that have developed resistance to vancomycin, which is the antimicrobial of last recourse in many instances, thereby leaving limited treatment options (PHAC 2015a).

In terms of antimicrobial usage, hospital utilization in Canada represents 8% of antimicrobials used in humans with the vast majority of human use occurring in the community setting, with approximately 92% of defined daily doses dispensed through pharmacies (PHAC 2018). In 2016, pharmacies dispensed 206,262 kilograms of antimicrobial ingredient while Canadian hospitals purchased 40,752 kilograms, totalling 246,014 kg at a combined cost of approximately $766 million (PHAC 2018). The antimicrobial consumption rate has remained stable at around 6,500 defined daily doses per discharge from 2002 to 2014 (Figure 4; PHAC2018). The Chief Public Health
**Figure 4.** Defined Daily Doses (DDDs) per 1,000 inhabitants days in Canada, from hospital purchase and community prescription data, 2010-2016. (*Figure was copied from PHAC 2018*).
Officer of Canada’s 2019 Spotlight Report (Government of Canada 2019) focuses on the reasons for unnecessary antibiotic use in community settings and what can be done by patients (e.g., trying to avoid infections and using antibiotics appropriately when infections occur), healthcare providers (e.g., taking time to talk with patients and shared decision-making) and health system leaders (e.g., sharing knowledge, skills and training).

The consumption rate of critical or last-resort antimicrobials is also high and even increasing for most (Figure 5) (PHAC 2015b). It is suggested that these increases are likely due to increased resistance to the first-choice antimicrobials (PHAC 2015a). Also, a recent report reveals inappropriate use of a last-resort antimicrobial in two hospitals in British Columbia, i.e., the antimicrobial was used to treat mild or moderate infections, and the duration of the antimicrobial therapy was frequently excessive. The two hospitals did not have a formal ASP with dedicated staff at the time of the study, and the authors recommended a prospective audit and feedback program as a strategy to reduce inappropriate antimicrobial use (Havey et al. 2015). The increasing consumption rate and the inappropriate use of last-resort antimicrobials in hospitals needs to be addressed as this could lead to the development of resistance to these critical antimicrobials. Therapeutic failure of the antibiotics of last resort can be fatal, thus critical antimicrobials should only be used when other treatment fails.

Inappropriate use of antimicrobials in primary care, the first point of contact in healthcare (e.g., a visit to a family physician), is also a concern. A majority of respiratory tract infections are of viral etiology and are self-limiting, i.e., given enough time, the person will recover without treatment (Harris et al. 2016). Antimicrobial treatments may not be necessary or even effective in these cases but based on the most recent data.
Figure 5. Patterns in Defined Daily Doses per 1,000 discharges in Canadian hospitals for antimicrobials of last recourse, from 2002 to 2014. Data obtained from PHAC 2015b. (Original in colour)
available in Canada in 2014, the majority (>75 percent) of patients diagnosed with acute bronchitis and acute sinusitis were prescribed with antibiotics (PHAC 2015b). Similar prescription rates for such diagnoses were also reported in 2013 (PHAC 2014b).

In response to the growing problem of AMR, the Canadian government released a Federal Framework for Action in 2014 (PHAC 2014a) and a Federal Action Plan on Antimicrobial Resistance and Use in Canada in March 2015 (Government of Canada 2015). The Federal Action Plan sets out three areas of focus, namely: (a) surveillance of antimicrobial use and resistance in humans and animals; (b) antimicrobial stewardship in human and veterinary medicine; and (c) innovation, i.e. creation of new solutions to counteract loss in antimicrobial effectiveness through research and development. The Action Plan also outlines the responsibilities and target dates for different federal agencies. In terms of funding, the federal government has provided $20 million to the Genomics Research and Development Initiative (involves eight departments and agencies) and $2 million per year to Canadian Institutes of Health Research (CIHR) to help understand and mitigate antimicrobial resistance (CIHR 2015, Government of Canada 2015). In 2017, the Government of Canada released the Pan-Canadian Framework for Action outlining a coordinated approach (One Health Approach) by government, private and public partners, and the public across human, animal and environmental sectors (Health Canada 2017). The components of the Framework include Infection Prevention and Control, and the three areas of focus (surveillance, stewardship, and research and innovation) identified earlier in the Federal Action Plan (Government of Canada 2015).
2.2.2 Antimicrobial Stewardship Programs (ASPs)

As indicated above, antimicrobial stewardship involves appropriate selection, dosing, route, and duration of antimicrobial treatment (Accreditation Canada 2014). The goals of ASPs are to achieve the best patient outcomes, reduce the risk of infections, reduce or stabilize levels of antibiotic resistance, promote patient safety, and reduce medical costs (Accreditation Canada 2016).

A meta-analysis involving 89 studies from 1980 to 2009 concluded that antimicrobial stewardship interventions decrease antimicrobial use, and these can also reduce AMR and the incidence of healthcare-associated infections. In terms of cost-effectiveness, available data suggest that savings arising from antimicrobial stewardship interventions exceed the cost of developing and implementing the interventions (Davey et al. 2013). Assessment of pilot studies involving antimicrobial stewardship interventions in Toronto, Ontario and in Montreal, Quebec demonstrated up to 39% reduction in targeted antimicrobial utilization. Antimicrobial costs were also reportedly reduced by up to 46% (the authors did not include the costs for the interventions) (Lee et al. 2014, Palmay et al. 2014, Leung et al. 2011). Altogether, these studies support the benefits of establishing ASPs in terms of reducing antimicrobial use, hospital-acquired infections, and the prevalence of AMR.

ASP interventions

There are two core strategies for antimicrobial stewardship interventions: (1) formulary restriction and pre-authorization; and (2) prospective audit with intervention and feedback (Dellit et al. 2007). Both strategies are proactive and may be combined. For the first strategy, antimicrobials may be prescribed only for certain approved clinical
conditions (formulary restriction) or by pre-authorization from the ASP Team (Chung et al. 2013, Dellit et al. 2007, MacDougall and Polk 2005). The direct control of antimicrobial use in this approach can effectively reduce antimicrobial use. However, physicians/prescribers may perceive loss of autonomy in making clinical decisions (Drew 2009). The second strategy, prospective audit with intervention and feedback, involves the review of cases by trained ASP team members. Feedback is then provided if the antibiotic prescribed is deemed to be inappropriate, i.e. not the right antibiotic, not the right dose, duration is inappropriate, or antibiotic is not needed, e.g. for viral infections (Chung et al. 2013, Dellit et al. 2007, MacDougall and Polk 2005). Appropriateness of prescription is informed by clinical information such as microbiological results (information regarding susceptibility of the causative organism to the antimicrobial prescribed), radiological results and response to initial therapy (Chung et al. 2013).

Additional interventions may also be included as part of antimicrobial stewardship such as the following: provision of clinical guidelines for prescribing authorities (designed based on local resistance patterns); education for medical staff regarding AMR and stewardship; antimicrobial cycling (scheduled rotation of antimicrobials used in the hospital or unit); and the use of antimicrobial order forms that require physicians to justify the use of antimicrobials (Chung et al. 2013, Dellit et al. 2007, MacDougall and Polk 2005).

**ASP team composition**

Antimicrobial stewardship teams are interdisciplinary and usually include an infectious disease specialist and a clinical pharmacist with infectious disease training (Allerberger et al. 2009, Dellit et al. 2007). There could be additional support from a
clinical microbiologist, an information system specialist, an infection control professional
and a hospital epidemiologist (Dellit et al. 2007). The size of the team and the number of
antimicrobial stewardship strategies employed depend on the size of the hospital, the
intensity of antimicrobial use, and availability of resources and personnel (Accreditation
Canada 2016, MacDougall and Polk 2005).

2.2.3 Accreditation Canada’s Requirement for Antimicrobial Stewardship

Accreditation Canada (formerly called the Canadian Council on Health Services
Accreditation, CCHSA) is a non-profit independent organization that accredits health
care (and social services) organizations in Canada. Accreditation aims to ensure that
healthcare organizations are meeting a shared set of standards (Accreditation Canada
2019). The accreditation process is voluntary with the exceptions of First Nations and
Inuits' substance abuse treatment centres (Government of Canada 2009), university-
affiliated hospitals (Pomey et al. 2010), and since 2005, institutions in the province of
Quebec (Pomey et al. 2010).

In 2008, Accreditation Canada introduced Qmentum as a new accreditation
program. Qmentum includes ROPs that are categorized into six patient safety areas:
Safety Culture (e.g., patient safety incident disclosure and management); Communication
(e.g., medication reconciliation at care transitions and safe surgery checklist); Medication
Use (includes antimicrobial stewardship); Worklife/Workforce (e.g., preventive
maintenance program and workplace violence prevention); Infection Control (e.g., hand-
hygiene compliance, and hand-hygiene education and training); and Risk Assessment
(e.g., falls prevention and suicide prevention) (Accreditation Canada 2019).
In 2013, Accreditation Canada included the implementation of an ASP as ROP for accreditation of acute care facilities (Accreditation Canada 2014). This requirement was then extended to inpatient cancer, inpatient rehabilitation, and complex continuing care (Accreditation Canada 2014). Healthcare organizations are encouraged to design an approach to antimicrobial stewardship that is consistent with their size, service environment, and patient population. As well, organizations need to establish processes for ongoing monitoring and improvement of the program. Further, collaboration and/or support from the antimicrobial stewardship, pharmacy and infection control teams, hospital administrators, medical staff leadership, and healthcare providers are deemed essential (Accreditation Canada 2016). As a minor requirement, the programs should have a system for on-going evaluation and sharing of results to stakeholders. The four major requirements are:

a. An ASP has been implemented.

b. The ASP specifies who is accountable for implementing the program.

c. The ASP is interdisciplinary, *i.e.*, involves pharmacists, infectious diseases physicians, infection control specialists, physicians, microbiology staff, nursing staff, hospital administrators and information system specialists, as available and appropriate.

d. The program includes interventions to optimize antimicrobial use (e.g., audit and feedback, a formulary of targeted antimicrobials and approved indications, education, antimicrobial order forms, guidelines and clinical pathways for antimicrobial utilization, strategies for streamlining or de-escalation of therapy, dose optimization and parenteral to oral conversion of antimicrobials, where appropriate (Accreditation Canada 2016).
2.2.4 Antimicrobial Stewardship Programs in Canada

The importance of antimicrobial stewardship has long been recognized in Canada. During a national conference in 1997 held in Montreal, Quebec, antimicrobial stewardship was identified as one of the three core areas needed to address AMR, along with surveillance (to monitor resistance trends) and infection prevention and control (Health Canada 1997). However, a review of ASPs in the country published in 2012 (15 years after the conference) demonstrated limited stewardship programs; and most of these programs focused on providing guidelines for antimicrobial prescriptions and community education programs (“Do Bugs Need Drugs”) regarding hand washing and responsible use of antimicrobials (Conly 2012). According to published studies, hospitals in Quebec and Ontario began establishing formal hospital ASPs in late 2000s (Nault et al. 2008, Elligsen et al., 2012, Katsios et al. 2012, Leung et al. 2011). However, it is important to note that there may have been, and continue to be, informal stewardship activities in hospitals that are not captured in published research.

The province of Ontario appears to lead the efforts for ASPs in Canada (Leung et al. 2018, Nakamachi et al. 2015). The Mount Sinai Hospital and University Health Network have facilitated the uptake of ASPs in 14 other academic hospitals in Ontario; funding was provided by the Council of Academic Hospital of Ontario (CAHO) (Nakamachi et al. 2015, MSH-UHN 2013). Several community hospitals (e.g., Saint Francis Memorial Hospital, Blue Water Health, Campbellford Memorial Hospital and North Bay Regional Health Centre, among others) have also developed and implemented their own ASPs (Public Health Ontario 2016). In a recent survey of Public Health Ontario in 2016, 93 percent of hospitals that responded have/were building a formal ASP (Leung
et al. 2018). In addition, Ontario has established the Public Health Ontario Antimicrobial Stewardship Advisory Committee, which provides advice on matters related to antimicrobial stewardship (Government of Ontario 2016).

In British Columbia (BC), a number of hospitals/jurisdictions including BC Children’s Hospital, Vancouver Island Health Authority and Vancouver Coastal Health, have on-going ASPs (Accreditation Canada 2014, DeLenardo 2014.). BC has also established the Provincial Antimicrobial Stewardship Clinical Expert Group (BC Critical Care Management 2015b) and in 2014, has included antimicrobial stewardship among the high priority areas for BC Ministry of Health (BC Critical Care Management 2015a). For the province of Alberta, Alberta Health Services has an acute care ASP. This program consists of an Antimicrobial Stewardship Working Group for each of the province’s five zones; the working groups report to the Antimicrobial Stewardship Committee of the Drugs and Therapeutics Committee (Province level) (Alberta Health Services n.d.). As mentioned earlier, Quebec has reported having formal hospital ASPs in late 2000s (Nault et al. 2008); Centre Hospitalier Universitaire de Sherbrooke and Centre de sante et des services sociaux de Rimouski Neigette have well-established ASPs (Parfitt et al. 2015). For the other provinces, there is little published information regarding ASPs.

Saskatchewan has just recently established ASPs for its acute care hospitals. At the start of my study in July 2016, healthcare in the province was being delivered through Saskatchewan’s 12 health regions. A review of the websites for the 12 health regions in the province indicated that, with the exception of the Saskatoon Health Region, the health regions had no formal ASPs, albeit there may have been informal antimicrobial stewardship strategies in place, e.g., the use of antibiograms to provide guidance for
antibiotic therapy (Government of Saskatchewan n.d.). According to interviews conducted for this study, the RQHR passed Accreditation Canada’s requirement for an ASP in September 2016.

**2.2.5 Existing Studies on the Adoption and Implementation of Antimicrobial Stewardship Programs in Canada and abroad**


The studies I have identified above focused on the major barriers in implementing ASPs in Canada, Australia and the US. These factors include: (a) lack of resources including funding, personnel and infrastructure (e.g. information technology); (b) lack of education and training related to antimicrobial usage; and (c) opposition from prescribers (Kapadia et al. 2018, James et al. 2015, Chaves et al. 2014, Pakyz et al. 2014, Pasay et al. 2014, Doron et al. 2013, Elligsen et al. 2012, Bal and Gould 2011, Chen et al. 2011).

The enablers identified for successful implementation of ASPs in Canadian hospitals are the following: (a) building collegial relationships with clinicians; (c) education for hospital staff about the ASP program (Jeffs et al. 2015, Pasay et al 2014, Elligsen et al. 2012, Leung et al. 2001); (c) getting the right people on board (e.g. recruiting a program leader who is respected within the organization); (d) rapidly establishing a track record to gain credibility (Jeffs et al. 2015); and (e) involving staff in the development of antimicrobial stewardship process (Pasay et al. 2014).
All the studies in Canada described above were conducted in Alberta and in large teaching hospitals in Toronto, Ontario, and thus may not be overly representative. Additional research on ASPs in other hospitals/jurisdictions and at different stages of ASP implementation is needed for a better understanding of the determinants of a successful ASP, which in turn can help inform hospitals that are in the process of developing or establishing their ASP. Studying ASPs in other hospitals can also add diversity to the information available, allowing more tailored stewardship strategies/approaches, depending on the type of hospitals and the resources available.

Further, most of the studies mentioned above have focused on the perceptions of physicians and pharmacists (James et al. 2015, Chavez et al. 2014, Pakyz et al. 2014, Elligsen et al. 2012, Bal and Gould 2011, Chen et al. 2011). Interviewing other stakeholders such as hospital administrators and innovation champions can provide different perspectives and can enrich our understanding of this research area as these individuals are also instrumental to the success of ASPs (Jeffs et al. 2015, Pakyz et al. 2014, Elligsen et al. 2012, MacDougall and Polk 2005). Hospital administrators are involved in providing institutional support and funding (MacDougall and Polk 2005). Innovation champions or opinion leaders, on the other hand, can influence other stakeholder’s perception of an innovation (Greenhalgh et al. 2004).

Lastly, my study is different from the studies described above because it applies a theoretical concept as a guide for research and analysis. As Allen et al. (2017) noted in their recent review of innovation adoption and/or implementation, the application of conceptual models or frameworks for innovation processes research is lacking. A conceptual model or theoretical framework is important as it binds together different
aspects of a research study (*i.e.*, analysis of the context, innovation, and the actors involved in the adoption and implementation of an ASP). It also provides a systematic structure, rationale and justification for how and why a research is undertaken. As well, a clear articulation of theoretical frameworks allows transferability of this research across contexts and settings (Fox *et al.* 2014).
Chapter 3. Research Design

3.1 Theoretical Framework for this Study

I have adopted the Fleuren et al. (2004) model, with a few modifications (Figure 6). I have included an additional category (ASP Team/Implementing group) and utilized some of the constructs/determinants identified in the Greenhalgh et al. conceptual model (2004), i.e., incentives, political “must-dos” and homophily. These factors emerged in the analysis of the interview transcripts but are not covered in the Fleuren et al. framework. I classified the themes and subthemes under different stakeholder levels or categories, i.e., socio-political context; organization; innovation; and adopting persons. The socio-political context includes patients’ attitudes towards the ASP interventions and regulatory requirements for healthcare institutions. The organizations are the RQHR and the SHR, both located in Saskatchewan, Canada. The innovation refers to the ASP and the adopting persons or users are the physicians prescribing antimicrobials.

3.2 Research Approach

I utilized qualitative data collection methods to gather the experiences and perceptions of key stakeholders regarding the adoption and implementation of ASPs. I interviewed individuals working with ASPs in the RQHR and the SHR. I selected case studies as my research method as they allow for in-depth exploration of a current phenomenon (in this case the implementation of an ASP) within its context using a variety of data sources (Yin 2014, Baxter and Jack 2008). My data sources include publications, hospital/regional health region documents and stakeholder interviews. Also, exploring my research questions does not require control of behavioral events, making case studies an appropriate research approach (Yin 2014).
Figure 6. Theoretical framework for this study (modified from Fleuren et al. 2004).
*The modified framework includes the implementing group (the ASP Team) as a category of innovation determinants.
3.3 Selection of Case Studies

I selected two health regions in Saskatchewan as case studies to explore adoption and implementation determinants from an organizational level. My study focused on regional and institutional factors and did not explore factors at the provincial decision-making level. Also, I selected the two health regions to represent different stages of maturity for the ASP. During inception of my study in early 2016, case 1 (RQHR) was in the process of establishing and satisfying this ROP for Accreditation Canada. Case 2 (SHR), on the other hand, had already passed this requirement in 2014. I selected two cases because each ASP may differ from one institution to the other, depending on its size and the resources available. Also, each ASP team may share common challenges and strategies but there could also be considerable differences. Lastly, I used stratified purposeful sampling (Patton 1990, p. 169-186) to strategically select information-rich cases thereby allowing in-depth analysis of the research questions posed above.

3.4 Selection of Participants

Study participants included different types of stakeholders (Table 1). Comparing the perspectives of different stakeholders (triangulation) contributes to my study’s rigour. For case 1, I interviewed five participants including members of the ASP team, an innovation champion from the organization and a prescribing physician. For case 2, I interviewed two members of the ASP team and an executive member/organization innovation champion. I sent out invitations to department heads of relevant units in a hospital through the SHR Office of Interprofessional Practice but there was no response. In addition, I directly emailed a department head at the same hospital and did not receive a response to participate. I conducted all interviews from March 2017 to January 2018.
I obtained the names and contact information for the ASP team members and innovation champions from the health regions' websites. For the prescribing physicians, I used a snowball sampling approach because the health regions’ websites and publicly available documents did not specify all the people involved with the ASPs. With snowball sampling, a small group of people is approached first, and these people are tapped into, to establish contact with other participants (Bryman et al. 2012). My initial contact persons were the ASP co-leads. They were asked to suggest names of prescribers who could be recruited for interviews. For case 2, the executive member/organization innovation champion also suggested prescribers/department heads who could be contacted for this study. I extended invitations to participate in this study to suggested contacts (directly or through the SHR Interprofessional office) but there were no responses received. I did not disclose the names of the prescribers who participated or were invited to participate.
3.5 Data Gathering and Semi-Structured Interviews

I obtained information regarding existing ASP tools and the organizational structure from the health regions’ websites, publicly available government documents (such as annual and community reports, weekly newsletter and health news), and the ASP teams. The website for case 1 contained presentations provided by the ASP team to healthcare practitioners in the RQHR. I also reviewed these materials to obtain further information regarding the ASP and in some cases, to validate the interview transcripts.

I conducted semi-structured interviews to allow flexibility in the flow of the interview and so I could pursue issues in more depth (Kallio et al. 2016). Participants were also able to raise important topics that were not included explicitly in the interview guide. I invited the participants for interviews through email. I provided a description of the project and a copy of the informed consent form in the email invitation. Except for participant B3, I conducted the interviews in person; participant B3 was interviewed by phone. I recorded all interviews (except for participant B1) after obtaining verbal permission from each participant. I was not able to record the interview for participant B1 due to technical failure. I also took field notes during interviews and used a similar set of open-ended questions for all participants. I designed the guide for the interviews (Appendix A) based on my theoretical framework (Figure 6) and my review of relevant literature, including related studies in Canada (Jeffs et al. 2015, Pasay et al. 2014, Elligsen et al. 2012, Leung et al. 2001).
3.6 Data Analysis

I transcribed the recorded interviews verbatim and then reviewed the transcripts against the recorded audio to check for accuracy. I triangulated the interview transcripts by reviewing related documents from the health region’s websites (e.g., annual reports and slide presentations). A large proportion of the details provided by interview participants were consistent with those from other interviewees. These methods of triangulation provided me with confidence in the accuracy and trustworthiness of my study’s observations.

To facilitate data analysis, I used a qualitative data management system (NVivo software, QSR International). I performed repeated line-by-line reading of the transcripts to identify discreet concepts. I grouped similar concepts into themes and subthemes that are similar were connected to form themes. After this stage, I stopped using NVivo and manually worked on a Microsoft Word document that contains the results from NVivo. During the analysis of the results and writing of the manuscript, I regrouped some of the concepts when they were more fitting under another subtheme/theme. My analysis of the coded transcripts and themes was informed by the framework (Fleuren et al., 2004) that I adopted for this study and the Greenhalgh et al. conceptual framework (2004). I present selected and representative interview transcripts in the results section. I minimally edited some of the interview transcripts for easier reading and I used the following notations:

“...” indicates that a section of the text was edited out

[ ] text within square brackets indicates text is edited to remove identity of participants or for clarification.
3.7 Ethics Approval

This study has undergone a harmonized ethics review by the Research Ethics Boards of the University of Regina, University of Saskatchewan and the two health regions. I obtained research ethics approval from the University of Regina Research Ethics Board on November 10, 2016 and renewal of approval in November 2017 and November 2018 (REB 2016-163). I obtained operational approvals from the two health regions in February 2017 and in April 2017 and written informed consent from each participant prior to interviews. I provided a project description (Appendix B) to the study participants and they were given the opportunity to ask questions, decline, or withdraw from the study.

3.8 Limitations of the Study

This was a cross-sectional case study that provided responses from stakeholders who were available at the time of the study. The ability to conduct follow-up interviews (longitudinal study) with the same set of stakeholders a couple of years after the ASPs were established would have resulted in a more robust understanding of the research topic. Also, due to the small sample size, my findings reflected the perspectives of a small number of individuals and may have limited applicability to other contexts. To help address this limitation, I tried to gather rich and deep descriptions from study participants.

There was lack of participation from a physician from the SHR which may have resulted in having determinants that are mainly related to this professional group (classified as user of the innovation) for the RQHR. Also, most of the participants from the SHR were not involved in the early stages of the ASP – this limited my understanding
of the factors that may have been involved and/or considered during adoption and early implementation. Unfortunately, the Director of Pharmacy Services for the SHR who may have been involved in the adoption of the ASP was no longer working in the same capacity during this study. Being able to interview more senior leaders from the SHR could have elucidated the interplay of factors in decision-making (e.g., why was dedicated funding not provided to the ASP). However, I encountered recruitment challenges and was not able to reach this target participant group.

Further, I also had challenges in obtaining relevant documents including accreditation reports, business case, briefing notes and implementation plans. Such documents could have provided more information regarding the early stages (e.g., basis for recommending the adoption of an ASP to senior leadership). The information that I used to analyze the adoption stage was based mainly on interviews and was therefore dependent on what the participants were able to recall. However, the participants’ recollection of events did not differ considerably from each other, and in the case of the RQHR, were also consistent with internal documents from the health regions’ websites.

I transcribed and coded all the interviews and it is possible that my personal perspectives may have influenced the coding process. I tried to address this limitation by using multiple sources (interviews and document reviews) to cross-validate information. Comparing the perspectives of different stakeholders and cross-validating between interview transcripts and documents reviewed (triangulation) also contributed to this study’s rigour.
Lastly, including the following participant groups could have provided more information that may help inform design of future ASP interventions: (a) prescribers in community clinics (this is particularly important given the high utilization of antimicrobials in community pharmacies as reported in PHAC 2018); (b) patients, and (c) public health officials and decision-makers (e.g., to explore how infection prevention strategies link to antimicrobial stewardship).
Chapter 4. Adoption and Implementation of an Antimicrobial Stewardship Program for the Regina Qu’Appelle Health Region

4.1 Background on the Regina Qu’Appelle Health Region

Prior to Saskatchewan transitioning into the Saskatchewan Health Authority in December 2017, the majority of the health services in the province was provided by 12 Regional Health Authorities (as mandated by the Regional Health Services Act 2002). The health authorities received most of their funding from the Ministry of Health. An accountability document was provided by the ministry to set out its expectation for the funding provided, including high-level organizational (governance and directional) expectations and program-specific expectations for the regions (RQHR 2017).

The Regina Qu’Appelle Regional Health Authority (commonly referred to as Regina Qu’Appelle Health Region or RQHR) was established in 2002 and was considered the major health care referral centre for southern Saskatchewan. The health region covered a population of 298,000 and provided tertiary health care services to patients who live outside of the region’s geographic boundary, thereby serving almost half a million patients (RQHR 2017). A President and Chief Executive Officer led the RQHR. A Board was accountable to the Minister of Health to achieve the goals and objectives for health services in the health region. Four committees supported the RQHR: Audit, Finance and Risk Committee; Human Resources Committee; Policy and Governance Committee; and Quality and Safety Committee (RQHR 2017). In 2016-2017, there were close to 8,000 full-time equivalent (FTE) positions (RQHR 2017). According to data available from the Canadian Institute for Health Information (2019a), in 2017, the RQHR had a total of 641 family medicine physicians and specialists.
The RQHR offered a comprehensive range of services: hospital, emergency, rehabilitation, community, mental health, long-term and continuing care, home care, immunization and primary health care services. These services were delivered in two tertiary care hospitals (Pasqua Hospital and Regina General Hospital) and a specialized provincial rehabilitation centre (Wascana Rehabilitation Centre) in Regina, along with five additional acute care facilities located in Moosomin, Indian Head, Wolseley, Broadview and Fort Qu’Appelle. Further, there were 31 region-owned facilities and 11 affiliated long-term care facilities, seven primary health care sites, as well as several public health sites, community health centres, private providers, independent physician offices and private residences (RQHR 2017).

4.2 The RQHR Antimicrobial Stewardship Program

4.2.1 Timeline for Adoption and Implementation

In Table 2, I present the timeline for RQHR’s ASP, which I reconstructed based on the interviews and reviews of documents available from the RQHR’s website. According to a participant, a business case on antimicrobial stewardship was presented by organizational champions to senior leaders in 2012. In 2013, Accreditation Canada began requiring inpatient acute care organizations to implement an ASP (Accreditation Canada 2014). Based on the health region’s July 2015 Chief Executive Officer’s Report, in early 2015, Accreditation Canada requested evidence for an ASP for RQHR by September 2015. The report recognized that although this initiative is already in RQHR’s work plan, it would have been challenging to implement an ASP considering the short timeframe and resource requirements. In September 2015, the health region failed to meet the ROP for an ASP. In October 2015, the design and planning for the health regions’
formal ASP started, which included a Design Rapid Process Improvement Workshop (RPIW). Design RPIW is a week-long event where senior leaders, content experts, staff, and teams of patients and family members focus on a problem and identify solutions. The ASP Design RPIW team was inter-disciplinary and included the following practitioners/departments: Infection Prevention and Control, Medical Microbiology Department, Pharmacy Department, Emergency Department, Saskatchewan Ministry of Health, a primary healthcare physician, patient and family representatives, a nurse, a researcher, a human resources manager and organizational sponsors (at the Vice President level). The team aimed to address all the key requirements identified by Accreditation Canada for antimicrobial stewardship. RQHR officially launched its ASP in June 2016 and it passed Accreditation Canada’s ROP in September 2016.

Table 2. Timeline for the adoption and implementation of RQHR’s ASP.

<table>
<thead>
<tr>
<th>Date</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>A business case recommending the establishment of an ASP for the region was presented to senior leaders.</td>
</tr>
<tr>
<td>January 2013</td>
<td>Accreditation Canada included Antimicrobial Stewardship as ROP for organizations providing inpatient acute care.</td>
</tr>
<tr>
<td>Early 2015</td>
<td>Accreditation Canada requested evidence for an ASP for RQHR by September 2015</td>
</tr>
<tr>
<td>September 2015</td>
<td>Accreditation Canada visited RQHR, but the health region failed to meet the ROP for antimicrobial stewardship.</td>
</tr>
<tr>
<td>October 2015</td>
<td>A Design Rapid Process Improvement Workshop was conducted in October 2015. A draft implementation plan and a draft business case were prepared by the RPIW Team.</td>
</tr>
<tr>
<td>December 2015</td>
<td>Design RPIW was completed. The outcomes were a business case for the Senior Leadership Team, an implementation plan and a communication plan.</td>
</tr>
<tr>
<td>June 2016</td>
<td>RQHR’s ASP was officially launched on June 15, 2016. The roll out involved implementation in selected service lines/units at the Regina General Hospital.</td>
</tr>
<tr>
<td>2016 (The exact month is unknown to this study’s author)</td>
<td>ASP team also focused on 12 community and rural clinics in the RQHR.</td>
</tr>
<tr>
<td>September 2016</td>
<td>RQHR passed Accreditation Canada’s ROP for an ASP.</td>
</tr>
</tbody>
</table>
4.2.2 Design of the Antimicrobial Stewardship Program

To provide context for this study, I describe here the planning process for the RQHR-ASP as well as the different components/interventions implemented as part of the program (section 4.2.3 below). This could also provide useful information for the design and planning of other ASPs. I obtained the information used for this section from the RQHR ASP website (http://www.rqhealth.ca/departments/antimicrobial-stewardship-program) and from the interviews.

a. Broad-sweeping interventions for cross functional physicians and pharmacists

During the initial design of the ASP, the RPIW team recognized that there were many people in designated roles within Saskatchewan and the RQHR that were cross-functional within a facility and between facilities, i.e., physicians and pharmacists were providing services from one hospital to another or from a community clinic to a hospital. One participant pointed out that based on reviews of published studies and consideration of other organizations in Canada, the US and globally, a number of ASPs are able to function in one facility at a time - but this was not feasible for the RQHR. Therefore, the team developed and implemented antimicrobial stewardship interventions that were broad and not focused on just one site.

b. Broader participation from both hospitals and community clinics

Participants pointed out that since AMR is a public health issue, the ASP needed to include broader participation, and it should not just be limited to hospital’s ICUs. Many ASPs focus on the ICU because of high antimicrobial usage for critically ill patients, and where delays in initiating appropriate treatment can result in patient harm (Kollef and Micek 2012). However, in Canada most antibiotics are used in the community (by physicians and dentists), not in the hospital (PHAC 2018 and 2015b,
Government of Canada 2019). The RQHR-ASP team was aware of this fact and has further acknowledged that all patients from the community, at one time or another are going to end up in the hospital and are also going to affect AMR rates. The ASP team also conducted an environmental scan within acute care and community practice in the RQHR and found out that there were many stop measures in place to help with prescribing behavior in acute care. The team recognized that working in the community would be challenging because the region was so widespread, but they also realized that antimicrobial stewardship was lacking in the community. For example, rural areas may not have the Information Technology (IT) support that urban centres or acute care facilities have. Thus, the team designed the program to focus on practitioners both in hospitals/acute care and in community practice.

c. ASP funding and composition of implementation team

The RQHR-ASP had dedicated funding with an annual start-up fund amounting to CAD$ 350,000 and the team was located at the Regina General Hospital. The RQHR has approved a total of 3.5 FTE for the program (Table 3): a project manager (1 FTE), a research scientist (1 FTE), a pharmacist co-lead (1 FTE) and an Infectious Diseases (ID) physician co-lead (0.5 FTE). Except for the physician co-lead, the staff was hired before the program was accredited. There was no ID physician co-lead and at the time of the writing of this manuscript and to my knowledge, recruitment continues. In the interim, all three ID physicians in the RQHR were requested by the ASP team to assist with antimicrobial stewardship. The ASP team reported to the Vice President for Quality and Transformation but has then moved under the Vice President for Physician and Integrated Health Services.
Table 3. Composition of RQHR’s ASP team.

<table>
<thead>
<tr>
<th>Role</th>
<th>Number of FTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Project Manager</td>
<td>1.0 FTE</td>
</tr>
<tr>
<td>2. Pharmacist co-lead</td>
<td>1.0 FTE</td>
</tr>
<tr>
<td>3. Research Scientist</td>
<td>1.0 FTE</td>
</tr>
<tr>
<td>This position started at 0.2 FTE and as a data analyst. As data gathering, analysis and presentation became a key component for the program, the ASP team requested for a 1.0 FTE and for the job to be at a Research Scientist level (One of the responsibilities of the Research Scientist was to lead the research component of the ASP.)</td>
<td></td>
</tr>
<tr>
<td>4. Infectious Disease (ID) Physician co-lead</td>
<td>0.5 FTE</td>
</tr>
<tr>
<td>At the time of data collection, there was no dedicated ID physician co-lead. At the time of the interviews the ASP team was considering an interim solution, <em>i.e.</em>, to draw from the health region’s three ID specialists.</td>
<td></td>
</tr>
</tbody>
</table>

d. Timing for staff recruitment

The RQHR was deliberate in its timing for staff recruitment. The Project Manager and the Research Analyst were hired early on so the Manager could start outlining the basic components of the program, while the Research Analyst could start collecting data and information to understand the system and data usages. The pharmacist co-lead was hired thereafter, for antimicrobial stewardship activities within the pharmacy department and for networking with other departments. The ID physician co-lead was the last member for recruitment. According to a study participant, the funding required for hiring an ID specialist was expected to be substantial, and so it would be more cost-effective to have the main components of the program established first. One participant pointed out that when the data is available, the ID specialist could then start designing and/or conducting more specific interventions.
4.2.3 Components of the Antimicrobial Stewardship Program

a. **Education and engagement**

To raise awareness and to encourage antimicrobial stewardship among healthcare practitioners, the ASP team conducted webinars for RQHR healthcare workers, including physicians, nurses and pharmacists. The ASP’s website also contained information and resources for healthcare workers to help inform decision-making (e.g., viral prescription pads, educational videos, posters) and for the general public (e.g., information pamphlets). The project manager met with physicians throughout a year to investigate how clinicians can practice antimicrobial stewardship in their clinics. The ASP team also delivered lectures to undergraduate students in a university located in the region.

b. **Interventions (Random indication audits and retrospective review of antimicrobial utilization)**

The ASP team conducted random indication audits in a medical ward at the Regina General Hospital. Indications refer to the reason for antimicrobial use. Since physicians were not required to document indications for their prescriptions, the ASP team encouraged prescribers to write indications and their names/identification on prescriptions. Without such information, it would have been difficult to determine whether antimicrobial prescription or dosage is necessary. Including an indication also improves communication between physicians, nurses, pharmacists, and other healthcare providers who are involved in a single patient’s care. For example, documenting indication allows pharmacy staff to provide appropriate counseling to the patient regarding proper use of the prescribed antimicrobial. Having an identifier for prescribing physicians was also pointed out to be essential to providing prospective audit and feedback. As well, physicians’ failures to identify themselves could result in unnecessary
delays in patient care or antimicrobial prescriptions being attributed to the wrong physician.

The team also conducted retrospective review of antimicrobial utilization with prescribing physicians in acute care (intensive care unit, medical ward and surgical ward) for the Regina General Hospital as well as with 12 community and rural clinics (this is done quarterly). The team gathered data on antimicrobial utilization and presented them to prescribers – this approach allowed prescribers to investigate any trends in their prescribing habits and identify inappropriate use of antibiotics, if any. The data (de-identified) were presented to physicians in a group setting to allow for peer-to-peer comparison and discussions.

c. **Research**

According to the program’s website, “the Antimicrobial Stewardship Program is committed to discovering new and better ways to promote the best patient outcomes with respect to antimicrobial use and to disseminate our findings to health care practitioners, health care researchers and the general public” (Regina Qu’Appelle Health Region 2018, para.1). The research component involved the ASP team and student researchers. Examples of research topics were knowledge and attitudes of community healthcare workers towards antimicrobial stewardship; evaluation of antimicrobial stewardship community interventions in the region; and retrospective chart audit for assessing antimicrobial stewardship for the treatment of pneumonia in the ICU.
4.3 Perceived Determinants of the RQHR-ASP Adoption and Implementation

In this section, I present the results of the interviews, mainly focusing on the determinants that were perceived by the participants to facilitate/enable the innovation process (Table 4). I grouped the determinants by themes based on the five categories in my framework, i.e., characteristics of the socio-political context, organization, innovation, implementing group and users of the innovation.

4.3.1 Adoption

Theme 1: Determinants related to the socio-political context

Subtheme A: Role of accreditation requirement (enabler)

Based on my interviews with the study participants and document reviews, Accreditation Canada’s ROP for antimicrobial stewardship was a significant policy instrument for the formalization of the RQHR-ASP. As I stated in the review of literature section, this requirement started for Canadian inpatient health care institutions in 2013 (Accreditation Canada 2015). Back in 2012, organizational champions presented a business case to senior leaders in the RQHR recommending the establishment of an ASP. It was around 2015 when the implementation of an ASP was included in the RQHR’s work plan. In September 2015, RQHR failed the accreditation ROP, after which there was a ramp-up in the design and planning for a program.

“If we did not have accreditation standards to push that agenda, I can be optimistic and say that eventually they would have listened and cared. It’s not that they were not listening and not caring, they don’t have any money and they can only do so much, and they’ve got a whole bunch of other people that equally have good causes.” Participant A1
## Table 4. Summary of determinants for RQHR’s ASP.

<table>
<thead>
<tr>
<th>ADOPTION</th>
<th>IMPLEMENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Theme 1: Determinants related to the socio-political context</strong></td>
<td><strong>Theme 1: Determinants related to the socio-political context</strong></td>
</tr>
<tr>
<td>Subtheme A: Role of accreditation requirement (enabler)</td>
<td>Subtheme A: Patient’s attitude and knowledge of antimicrobial resistance and stewardship (barrier or enabler)</td>
</tr>
<tr>
<td>Subtheme B: Influence from national and international key institutions (enabler)</td>
<td><strong>Theme 2: Determinants related to the organization</strong></td>
</tr>
<tr>
<td><strong>Theme 2: Determinants related to the organization</strong></td>
<td>Subtheme A: Limited funding as a hindrance to program adoption (barrier)</td>
</tr>
<tr>
<td>Subtheme A: Role of innovation champions and support from senior leadership (enabler)</td>
<td>Subtheme B: Role of innovation champions and support from senior leadership (enabler)</td>
</tr>
<tr>
<td><strong>Theme 2: Determinants related to the organization</strong></td>
<td><strong>Theme 3: Determinants related to the innovation (Antimicrobial Stewardship Program)</strong></td>
</tr>
<tr>
<td>Subtheme A: Limited funding as a hindrance to program adoption (barrier)</td>
<td>Subtheme A: Availability of tools and information for prescribing physicians/users of innovation (barrier)</td>
</tr>
<tr>
<td>Subtheme B: Role of innovation champions and support from senior leadership (enabler)</td>
<td><strong>Theme 4: Determinants related to the implementing group</strong></td>
</tr>
<tr>
<td><strong>Theme 4: Determinants related to the implementing group</strong></td>
<td>Subtheme A: Competencies of the ASP team (enabler)</td>
</tr>
<tr>
<td>Subtheme A: Limited funding as a hindrance to program adoption (barrier)</td>
<td><strong>Theme 5: Determinants related to the user of innovation/health professionals</strong></td>
</tr>
<tr>
<td>Subtheme B: Role of innovation champions and support from senior leadership (enabler)</td>
<td>Subtheme A: Fit of the innovation to health professional’s experiences, values and goals (enabler)</td>
</tr>
<tr>
<td><strong>Theme 5: Determinants related to the user of innovation/health professionals</strong></td>
<td>Subtheme B: Physician’s autonomy (barrier)</td>
</tr>
<tr>
<td>Subtheme A: Fit of the innovation to health professional’s experiences, values and goals</td>
<td>Subtheme C: Work factors (e.g., more time required to perform stewardship work) (barrier)</td>
</tr>
<tr>
<td>(enabler)</td>
<td>Subtheme D: Challenge in changing a prescribing habit (barrier)</td>
</tr>
<tr>
<td>Subtheme B: Physician’s autonomy (barrier)</td>
<td>Subtheme E: Role of data in having collegial conversations with prescribers (enabler)</td>
</tr>
<tr>
<td>Subtheme C: Work factors (e.g., more time required to perform stewardship work) (barrier)</td>
<td>Subtheme F: Homophily (enabler)</td>
</tr>
<tr>
<td>Subtheme D: Challenge in changing a prescribing habit (barrier)</td>
<td></td>
</tr>
<tr>
<td>Subtheme E: Role of data in having collegial conversations with prescribers (enabler)</td>
<td></td>
</tr>
<tr>
<td>Subtheme F: Homophily (enabler)</td>
<td></td>
</tr>
</tbody>
</table>

**Subtheme B: Influence from national and international key institutions (enabler)**

Participant A1 commented that national and international institutions such as the WHO and the UN may have influenced the province’s uptake of the program.

“Really it comes all the way back to international stage, with the WHO, the World Economic forums, those reports that got the attention of very high level people. We can’t give them enough credit, that’s what they need to hear and that’s what that level of people need to get on board with. That bringing it to the UN and to those forums and to those stages and really, then you become not just one of the many platforms screaming about your cause; it has been elevated to - “No, this is bad guys we really need to take this seriously” - and that has created a top-down pressure through government.” **Participant A1**
Theme 2: Determinants related to the organization

Subtheme A: Limited funding in the RQHR as a hindrance to program adoption (barrier)

Participant A1 mentioned conflicting priorities and limited resources as barriers to adopting a formal ASP. The respondent recommended that in preparing any business case, it is important to highlight the benefits of adopting an initiative, i.e., focusing on upstream processes can decrease the costs compared with dealing with expensive emergencies downstream.

Subtheme B: Role of innovation champions and support from senior leadership (enabler)

Champions refer to individuals who dedicate themselves to supporting, marketing, and ‘driving through’ an innovation (Schon 1963). The Fleuren et al. model (2004) does not include innovation champions as determinants for the adoption and implementation of innovations in healthcare. In contrast, according to Greenhalgh et al. (2004), champions are a key determinant for successful assimilation of an innovation in an organization. Study participants commented that having innovation champions and support from senior leadership provided advantage for the adoption and implementation of the ASP.

“And for myself, when I was brought into the group, we did have a champion, Dr. B and Dr. C (pseudonyms)…. They through [their department] and the work that they do around antimicrobial stewardship, and other communication and networking with our regions, or other health authorities that they have engaged with, the fact that [the health region] did not have a functioning Antimicrobial Stewardship Program, was one of their desires to be really champions for, to getting a program initiated within the [health region]. Without their continuous support, I think, we may have ended up with an optimal Antimicrobial Stewardship Program.” Participant A3
Innovation champions have helped shaped the design of the ASP. Instead of continuing an Antimicrobial Utilization Committee, they pressed for a dedicated program. Participant A1 pointed out that a committee includes volunteers with normal jobs who get together to discuss antimicrobial utilization – this is different from having dedicated FTE persons conducting antimicrobial stewardship.

Participants pointed out that having buy-in from senior leadership was an important determinant because senior leaders decide on funding and staffing. For example, the Research Analyst position started working part-time at 0.2 FTE. When the Program Manager reached out to the senior leadership team requesting one FTE for the Analyst position and explained what could be done more with a full-time position, the senior leaders were supportive. Participant A4 commented that this was because the senior leaders recognized the importance of antimicrobial stewardship and what it can do for the hospital, the patient and the health region.

“So having people in that senior leadership realm who understand the importance of antimicrobial stewardship, in general understand what it can do for the hospital, the patient, the health region, whatever level they’re at is important because those are the people who dole out the fund, who decides who gets to work on that program, and for that reason, how successful it can be.”

Participant A4

4.3.3 Implementation

**Theme 1: Determinants related to the socio-political context**

**Subtheme A: Patient’s attitude and knowledge of antimicrobial resistance and stewardship (barrier or enabler)**

A majority of the participants pointed out that the patient’s attitude influences a physician’s decision to prescribe antibiotics even where such treatment may be unnecessary or ineffective. There was expectation and pressure from patients that
physicians should be prescribing antibiotics even for viral illnesses such as colds and acute sinusitis for which antibiotics are ineffective. Participants mentioned that managing pressure from patients was even more challenging when dealing with sick children as parents may be more likely to demand antibiotics.

Participant A5, a prescriber, also commented that patient’s demands for antibiotic prescription could be due to difficulty in accessing healthcare services. According to the participant, since many people may not have the ability to come back immediately to see a primary care provider especially in case they deteriorate, the patients thought that it would be safer to have an antibiotic prescription and to begin their treatment right away.

“And then of course just the difficulty of on occasion, we encountered people who believe that an antibiotic is required and no matter what you say it’s very difficult to change their opinion. Certainly, it’s not very often in my experience, but it does happen from time to time. This is one of the things that other physicians have highlighted, prescribers have highlighted, is that some patients will “demand” antibiotics and it’s our job to help to educate and advocate for our patients.” – Participant A5

Patients may lack knowledge regarding ineffectiveness of antibiotics against viral infections and the growing problem of AMR. Almost all the respondents pointed out the importance of public education and raising awareness on these issues. If the public is more aware, they would be more accepting of physicians’ prescribing practices and there would less pressure on practitioners to provide antibiotic prescription. Participants A1 and A5 raised the role of celebrities and mass media as platforms for raising awareness. They suggested that public education should include responsible use of antimicrobials, i.e., when not to use antimicrobials and the importance of following prescribed dosage and duration.
Theme 2: Determinants related to the organization

Subtheme A: Dedicated time/resources for the ASP team members (enabler)

Greenhalgh et al. (2004) included dedicated resources (e.g., time, personnel and money) as a sub-theme under system readiness for innovation.

Dedicated time (enabler)

Dedicated time may also be categorized under “Implementing Group”. However, to be consistent with the Greenhalgh et al. model (2004), I included this subtheme under ‘‘Organization’’. The ASP team commented that having dedicated time, especially for their Pharmacist co-lead and the Research Analyst facilitated the implementation of the program. As mentioned above, other ASPs in Canada (including case 2 in this study) do not have a dedicated Research Analyst and instead a Pharmacist Lead performs stewardship activities while also collecting and analyzing a lot of data. The latter uses up a lot of their time, which could even be limited if they are not working full time (i.e., their appointment for their stewardship role is 0.5 FTE while also performing as a hospital pharmacist). Participant A2 commented that having limited hours would have made it difficult to perform different roles.

“So, I think definitely having somebody in the role of whether you’re the physician, you’re the pharmacist or you’re the research analyst, it’s important for you to have dedicated time to the program that is uninterrupted and you can focus on the work that you need to do for stewardship.” Participant A2
Participant A3 pointed out that pharmacists are not necessarily trained for data analytics and performing such duties is not the most efficient use of their time and expertise.

“Managing the data is really, it is a full-time component. We are probably one of very few areas, we are not the only, we found very few other programs that would have a research department attached to them or a research analyst, data analyst attached to them, but those that did have that reported greater success that we saw. And we believe, especially, that it allowed our pharmacist to focus on pharmacist’s duties and for [the program manager] to focus on the operational management duties versus having to make that part of [their] job and spending time devoted to accumulating the data, and where that’s not [their] speciality. If you’re a pharmacist, it’s not your specialty to create analytics and to put everything into graphs and measure, so that I think has really been a really quick catalyst for us to seeing the success that we’ve seen and the amount of engagement that we’ve seen with the program.” Participant A3

Despite the need to employ more full-time ASP team members, funding may be limited. The RQHR’s ASP team tapped into students as additional resources, e.g., for conducting research and collecting data. Students in biological science (e.g., nursing, pharmacy, general science) have the technical background to understand the nature of an antimicrobial stewardship and can contribute to the program. Participant A4 mentioned that this is beneficial for both the students and the ASP team – students were exposed to different areas in the hospital while providing a huge amount of information for the ASP team to help design specific interventions. This was also a great opportunity to expose future healthcare workers to the importance of antimicrobial stewardship.

“I think making use of student resources too. Summer students have been a powerful resource to get first of all, research projects going ....” “And for us, to potentially have someone who could help us with audits and monitoring patients and things like that so there’s a lot of resources that you can use that you don’t necessarily have to throw money out, as long as you have people willing to put in the time to help organize students and have things going.” Participant A4
Dedicated funding (enabler)

The availability of funding has allowed the team to implement a program that targets both acute care and community clinics. The program received dedicated funding that included salary for 3.5 FTEs. Without dedicated funding and full-time staff, it would be challenging to conduct the wide-ranging interventions that the team provides to acute care and the 12 community and rural clinics.

Subtheme B: Logistical procedures related to the innovation: availability of data infrastructure (enabler)

Four participants raised the importance of data infrastructure as it enables evidence-based interventions. Retrospective review of antimicrobial utilization and physician engagement were key components of RQHR-ASP and these interventions required data.

“It was very evident that when dealing with physicians and encouraging prescribing behaviors and changes to those and improvements with those prescribing behaviors, that data would be an important element... And again, with the data and the need for data in order to support everything really when you’re dealing with physicians or clinician groups, or health care in itself, really data is what you need to do evidence-based”. Participant A3

The ASP team pointed out that one of the challenges encountered at the beginning of the program was the lack of established data infrastructure for antimicrobials. Information regarding how many and how much antimicrobials are being used in the hospital was missing. Rough estimates were available, but the following information were lacking: which areas of the hospital use antimicrobials the most and why they do so; which physicians or physician groups are ordering the most; and are prescriptions and usage appropriate. Further, the information needed (i.e., data from pharmacy, clinical information and health information management) were housed under different systems.
(eHealth, EMR, HIMS, SCM, BDM, LISM CPOE) that were not integrated. It was therefore difficult to obtain information as to why a certain antibiotic was prescribed since pharmacy information is not linked to clinical information. In such cases, the Research Analyst needed to manually combine the data, e.g., prescribing information from BDM and infection information from LIS system. Patients’ charts and physicians’ orders, which contained indications for antibiotics, were also paper-based and therefore took a considerable amount of time to process. Participant A4 indicated that having a computerized physician order entry could facilitate gathering of information. Electronic data are ideal for clean and consistent capture of data.

So, I think, I mean, right off the bat, getting access to data can be an issue. So one of the pieces was, for example within the RQHR, we have different systems; so pharmacy has a system, any patient’s chart, like the summarized clinical manager that kind of thing has its own system, and so on and so forth, the HIM has its own stuff. On their own, each one of them is a great system. You can go in pharmacy, you can go to the BBM system, and you can look at all kinds of great information. But to get that to talk to something in SCM, that tells you more clinical things about why the indication might be. So rather than that here is the antibiotic that was prescribed, then I have to go to this other system to find out what it was prescribed for. And if it’s not there electronically, then I have to physically go to the paper chart to find that. So, first, the biggest barrier I think was getting access to high quality reliable data basically, the information that we were looking for. Some systems are better than others, some can talk to others; some you need IT people, people with sort of the right computer background to be able to make the systems talk to each other or to know of other programs that can pull that data into one database.” Participant A4
**Theme 3: Determinants related to the innovation (Antimicrobial Stewardship Program)**

**Subtheme A: Availability of tools and information for prescribing physicians/users of innovation (barrier)**

A component of the ASP that was identified to contribute to a better implementation of the program was the availability of tools and information for healthcare providers.

“But what I have seen which is very encouraging, is that there has been a lot of information given to prescribers in the region, through the written media, you know communications, verbal communications, presentations, official support, printed materials, such as antimicrobial prescriptions pads, information leaflets, fliers, and that to me has been very encouraging.” **Participant A5**

**Theme 4: Determinants related to the implementing group**

**Subtheme A: Competencies of the ASP team (Enabler)**

Accreditation Canada requires ASP teams to be interdisciplinary, involving pharmacists, infectious diseases physicians, infection control specialists, physicians, microbiology staff, nursing staff, hospital administrators and information system specialists, as available and appropriate. The study participants supported this structure and recognized that each member of the team has distinct roles. For RQHR, the core team was envisioned to have an ID physician and a Pharmacist as co-leads, a Program Manager and a Research Analyst. As mentioned earlier, a Research Analyst maintains data analytics, while a Program Manager plays a critical role for oversight and networking. During the start of the program, the health regions’ Medical Microbiologists have served as Interim Medical Leads because of their expertise in clinical microbiology.
Participant A4 pointed out that the knowledge and skill sets of the ID physician and Pharmacist co-leads complement each other, i.e., pharmacist and physician are equipped with pharmacology and clinical knowledge, respectively.

“...So, the idea is, most programs are set up where they have a pharmacist and a physician as co-leads. Because their skill sets complement each other. The pharmacist has maybe detailed pharmacology knowledge and the physician has that sort of sign off on clinical decisions or recommending changes and stuff like that, therapy, sort of front-line activities that may happen.” Participant A4

Also, co-leads need to be seen by prescribers as experts. Participant A1 mentioned that without the appropriate expertise, it would have devolved into a personality problem – this has crippling effects resulting in problems with communications, divisions of responsibility, and setting up collaborative relationships. However, the health region had some challenges with recruiting an ID physician for its ASP. A Physician co-lead needed to have a background in infectious diseases or clinical microbiology and so other physicians (e.g., with a general practitioner background) would not have met the criteria to take on the role. Previously, an ID Physician accepted the offer to be a co-lead but after residency, ended up getting another position at a different hospital.

To address the limited expertise in Infectious Diseases, the ASP team considered having an ID specialist from the RQHR function as the ASP’s co-lead. However, there were only three ID specialists in the region. Thus, it was difficult to have one ID specialist spend half of their time entirely to the stewardship program. In fact, one of the ID specialists also accepted the position as physician co-lead but eventually was unable to commit due to many clinical duties. As an interim solution, the ASP team reached out to all three ID specialists for them to participate in the program whenever they can. This
approach could also be considered by other ASPs and institutions that may have limited ID expertise.

**Theme 5: Determinants related to the user of innovation/health professionals**

*Subtheme A: Fit of the innovation to health professional’s experiences, values and goals (enabler)*

Almost all respondents recognized that prescriber’s judgement and experiences influence their decision to participate in the program. In general, physicians have been receptive to the program. One main factor identified by participant A5 (a prescribing physician) to facilitate the implementation of the ASP was the perceived fit of this initiative with prescriber’s ideology. Participant A5 commented that intuitively, physicians want to do the right things and when the program is formalized and there are tools made available for them, they tend to gravitate towards supporting the program.

“I can’t say everyone is trained but I would like to think that all prescribers are trained about the importance of antimicrobial stewardship. And so intuitively people want to do the right thing and know, and when it’s formalized, and there are tools made available and it becomes the norm to do that, people gravitate to that, tend to, because it’s the right thing to do, and people generally want to do the right thing in this case.” **Participant A5**

Further, one participant pointed out that physicians may be in a difficult position to balance health of the general public and the health of their patient. According to the participant, physicians are responsible for patient care and they need to make a decision that is best for their individual patient. As patients, they need to know that their physician has their best interests in mind and is not more concerned about restricting the use of antibiotics. Limiting the prescription of antibiotics may hinder patients from developing a
trusting relationship with their physician, as this could be interpreted as caring more for the general public than the life and health of the patient.

Subtheme B: Physician’s autonomy (barrier)

Two participants mentioned that physicians may view an ASP as impeding their autonomy. Physicians may think that they should not be required to write down indications for their prescriptions because they do not need to justify their practice.

“We’ve met with negativity or what is seen as sort of a negative response to it. You’re here just to take away my prescribing autonomy; you’re here to tell me what I’m supposed to write. And again, it’s the re-enforcement of the message that no, that’s not why I’m here. I’m here to provide you with the information so that you can make the best decisions and the best choices for the patients that we serve; that’s what we’re here for.” Participant A3

Subtheme C: Work factors (e.g., more time required to perform stewardship work) (barrier)

Participant A5 recognized that the lack of time for practitioners may also hinder the adoption of the program’s specific interventions. For example, it takes more time to explain and discuss AMR to a patient than to write a prescription. Another practice that was promoted by the RQHR-ASP is to write indications for antibiotic prescription – but even this task would have required more time from physicians.

Subtheme D: Challenge in changing a prescribing habit (barrier)

It may be also hard to break usual prescribing habits for physicians.

“I think that don’t under-estimate the challenge, AS is like many projects – it’s about changing behavior, people’s change is never easy, and it needs support and re-enforcement. So, it’s something that needs to be worked on continuously to see results.” Participant A5
The ASP team recognized that the best uptake of the program comes from medical JURSI (Junior Undergraduate Student Resident Intern) and residents in the RQHR, who were newer learners and they took up the message a lot more quickly. According to this study’s participants, although the more seasoned practitioners were supportive and willing to participate, it was more challenging for them to change their prescribing habit because they have been doing it for a while. Also, more seasoned prescribers may have viewed the ASP as just another innovation and that the organization could have just focused on better ways of spending resources.

“What I do see with many people is, I think this is just sort of a healthcare thing is practitioners if you have been around for a while, you sort of have that jaded view of healthcare; or well, here’s just another program that’s gonna tell us something different, it’s one more add on and is this the best way to spend our money when we are short of nurses, we’re short of physicians?” **Participant A2**

**Subtheme E. Learning style: role of data in having collegial conversations with prescribers (enabler)**

The ASP team noted that physicians would like to know their antibiotic prescription patterns. The ASP team observed these both in acute care and in community clinics. Physicians in clinics expressed to the team that they would like to know how they compare among prescribers within their clinic and across the regions. The ASP team pointed out that data are presented anonymously to avoid public shaming and blaming.

Indeed, participant A5 who was a physician commented that physicians, in general, tend to respond well to data, especially if these are de-identified. This also avoids misconception about policing antibiotic prescription among prescribers. Further,
the team noted that presenting metrics to prescribers allowed focused and engaging discussions with physicians.

“So, we went in, we pulled out some of our data, put it up on the screen, we put up some graphs and charts, we had a fantastic, fantastic engagement session with them. Forty-five minutes of uninterrupted, dedicated, focused with an entire physician group around what do those statistics mean, some hairs were raised at the very beginning of the conversation but again, we reinforced, we’re not here to take away your prescribing autonomy. We had somebody said, so we’re way up, if I’m prescribing here that’s bad. Way down here, if I am not prescribing much, that’s good. And we said, absolutely not, maybe way up here is what exactly you need to be doing.” Participant A3

“The second thing is use data wherever possible. Prescribers, just as a generalization, tend to respond well to data as opposed to anecdotes, especially if the data is de-identified. So, it’s not a climate of blame and it’s a climate of support and showing people how their practices, what those practices look like compared to their peers, is very powerful.” Participant A5

Subtheme F. Homophily (enabler)

Participant A2 commented that having both a physician and a pharmacist in the team is crucial for interaction with the same types of professionals (i.e., physician-to-physician interaction and pharmacist-to-pharmacist interaction).

“...Initially when we started up the program and we didn’t have a physician yet, we were cautioned against going into certain areas, like, well, it might be hard for you guys to go in and work with pediatrics, ICU or emergency, if you don’t have a physician on ...” “They need that physician to physician communication and interaction before they really uptake your message and start running with it. It’s kinda one of those funny things where you know, unfortunately, my word or somebody else’s word is not good enough, but it does help to have somebody in the same role to be able to support those practitioners.” Participant A2
5.1 Background on the Saskatoon Health Region

The Saskatoon Health Region (SHR) was a provincial referral centre and the largest health region in the province serving about 360,000 local residents in more than 100 cities, towns, villages, rural municipalities and First Nation communities. As an integrated health delivery agency, SHR provided a comprehensive range of services and programs including but not limited to hospital and long-term care, public health and home care, mental health and addiction services, prenatal and palliative care. There were more than 70 facilities, including nine hospitals (with three tertiary hospitals), 33 long-term care homes, numerous primary health care sites, public health centres, mental health and addiction centres, and community-based settings. There were more than 14,000 employees (SHR 2017). In 2017, the health region had a total of 1,048 family medicine physicians and specialists (CIHI 2019a).

A President and Chief Executive Officer led the health region and the Board was accountable to the province’s Minister of Health. The operation of the health region was supported by seven committees and one council: Executive Committee; Audit, Finance and Risk Committee; Human Resources Committee; Partnership Committee; Policy and Governance Committee; Quality and Safety Committee; Stakeholder Relations Committee; and Practitioner Liaison Council (SHR 2017).
5.2 The SHR Antimicrobial Stewardship Program

5.2.1 Timeline for SHR’s Antimicrobial Stewardship Program

In contrast to case 1 (RQHR-ASP), there was limited information available regarding the development of the SHR-ASP. The health region’s website (https://www.saskatoonhealthregion.ca/locations_services/Services/antimicrobial-stewardship/Pages/Home.aspx) did not contain detailed information, and the ASP team members interviewed for this study were not involved in the early stages of the ASP. As described below, the program was under the Pharmacy Department. Unfortunately, the Director of Pharmacy Services who may have been involved in the adoption of the ASP was no longer working in the same function when this study was initiated. The results that I presented below is limited to the information that I obtained from the three study participants. I was unable to obtain relevant grey literature including business cases and implementation plan, which could have provided more information on the factors that influenced the decision to adopt an ASP for the health region.

Briefly, in September/October 2013, the health region failed to meet Accreditation Canada’s ROP for an ASP. The Accreditation Report (Accreditation Canada 2013) indicated that the health region had a program for antimicrobial stewardship to optimize antimicrobial use. However, the health region did not meet the minor requirement of having mechanisms for ongoing evaluation of the program, and for sharing results with stakeholders in the organization. It is unclear to the researcher what the ASP composition was in 2013. I requested internal documents (e.g., business case and planning documents) but participants did not have access to these documents. The ASP identified at the time of the Accreditation Canada’s visit was presumably linked to the
Antimicrobial Utilization Committee that is composed of several ID physicians, microbiologists and other medical specialists. According to interview participants, the pharmacist co-lead was only hired in fall 2014 and the health region passed the requirement in mid-2014. After which, the ID physician co-lead was hired.

5.2.2 Funding and Team Composition of the SHR-Antimicrobial Stewardship Program

There was no dedicated funding provided for the SHR-ASP. The ASP team consisted of a Pharmacist co-lead (1.0 FTE) and an ID Physician co-lead (0.5 FTE). The Pharmacist (through pharmacy) and the ID Physician co-leads were paid for by the health region. The ASP was under the Pharmacy Department and consequently the Vice-President for Allied Health Services.

5.2.3 Components of the Antimicrobial Stewardship Program

Similar to the previous chapter, I describe here different components of the SHR-ASP to provide context for this case. I obtained this information from the interviews of study participants. The information that I present here is current to the time period covered in my research, but antimicrobial stewardship practices may have evolved since.

a. Audit and feedback

The ASP team conducted audit and feedback at the ICU, and the medical and surgical wards of the Royal University Hospital. The audit and feedback intervention involved verbal and face-to-face discussions with prescribers. This model was informed by initial discussion with intensivists who were presented with different models of antimicrobial stewardship in the ICU. According to a study participant, some ASPs may simply review a patient on their own and then they provide recommendations in the progress notes or the patient’s chart. Participant B2 pointed out that the majority of
physicians preferred having verbal, face-to-face interactions because often there may be things that are not documented on the patient’s chart and some nuances about how the patient is doing clinically.

The Physician and Pharmacist co-leads met with intensivists at the Royal University Hospital ICU three times a week. All patients in the ICU who were actively receiving antibiotics were discussed. Based on the patient’s clinical status, radiology investigations and microbiology results (e.g., antimicrobial susceptibility profile), the ASP pharmacist and physician co-leads provided the intensivists with suggestions on the type of antibiotic to use and the duration of antibiotic treatment.

The ASP team selected the ICU as the starting place for ASP interventions because it was a closed unit (i.e., patients are admitted under the full responsibility of a trained intensivist, as opposed to an “open” format where patients are under the care of another attending physician and intensivists are just available for consultation), with only 17 beds. Participant B2 mentioned that considering the severity of illness at the ICU, the rate of antibiotic usage would also be very high compared with other units in a hospital. The same participant also indicated that the ASP team started their interventions at the ICU because this was where the ASP can have a significant impact while also building relationships. They pointed out that it was more difficult to demonstrate impact in a surgical or medical ward where there were more physicians, a larger number of patients and these were not closed units.

The ASP team also conducted audit and feedback at the medical and surgical wards of the Royal University Hospital. On day 3, the ASP team reviewed any patient receiving broad spectrum antibiotics and they provided suggestions to clinicians. The
intent is to limit the use of broad-spectrum antibiotics (effective against a wide range of microorganisms) and to identify the correct antibiotic for treatment.

b. Education

The Royal University Hospital, where the ASP team was located, is a teaching hospital hence medical residents are on rotations as part of their training program. Once every two months, the ASP team met with medical residents who were on their clinical unit teaching rotation. The meeting involved a 30-minute discussion on how to treat common clinical syndromes that occur in the medical wards. The ASP team was also planning to conduct similar types of teaching with residents rotating through the ICU. The Pharmacist and Physician co-leads also spoke on educational days for ICU nurses.

c. Future interventions

At the time of my interviews in June 2017, the ASP team was considering the development of local clinical guidelines and pathways for antibiotic treatments. Such guidelines and pathways would contain recommendations for appropriate antibiotic use based on local antibiotic resistance patterns in the region. According to the team the availability of these documents can promote antimicrobial stewardship without them being present in all cases. Also, the prescribing physician would not need to wait until day 3 for their antimicrobial prescription to be reviewed. Further, one participant pointed out that these tools empower physicians in making their own decisions.

5.3 Perceived Determinants of the SHR-ASP Adoption and Implementation

In this section, I described the determinants that were perceived by the participants from the SHR to facilitate or enable the innovation process (Table 5). Similar to the previous chapter, I grouped the determinants into themes based on the five
categories in my study’s framework, *i.e.*, characteristics of the socio-political context, organization, innovation, implementing group and users of the innovation.

Table 5. Summary of determinants for SHR-ASP

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5.3.2. Adoption

*Theme 1: Determinants related to the socio-political context*

*Subtheme A: Role of accreditation requirement (enabler)*

Similar to case 1, the adoption of SHR’s formal ASP appeared to be largely driven by the requirement from Accreditation Canada. The SHR failed to pass this requirement in 2013. Based on the interviews, the Pharmacist co-lead started working for the program at 1.0 FTE to satisfy Accreditation Canada’s requirement for an ASP.

“*Right, so Accreditation Canada basically outlined that all hospitals need to have an ASP as part of their ROPs. So, once that was announced then I think that’s when [the pharmacist co-lead] did a lot of work in terms of trying to try to build our data and gather a lot baseline information on antimicrobial usage within our hospitals in SHR.*” *Participant B2*
Participant B2 also pointed out that having antimicrobial stewardship as an ROP through Accreditation Canada gets a lot of buy-in and support from senior leadership. Even in the absence of the accreditation requirement, hospital staff which included clinicians, physicians and pharmacists, recognized the need for antimicrobial stewardship. However, despite buy-in from practitioners, it appeared that the main driver for the adoption of a formal ASP was Accreditation Canada’s ROP.

5.3.3 Implementation

Theme 1: Determinants related to the organization

Subtheme A: Lack of dedicated time/resources for the ASP Team members (barrier)

Dedicated funding

Unlike case 1, the SHR-ASP did not have dedicated funding. The Pharmacist and Physician co-leads were paid through the SHR. According to study participants, the lack of specific allocation for the program limited the intervention that the ASP team could have delivered. They have indicated that funding was needed to hire an Epidemiologist/Data Analyst and that without adequate funding, it was challenging for the program to continue its on-going initiatives and to evolve. According to study participants, another challenge that resulted from the lack of funding was the limitation for the ASP team to attend conferences to share their experiences, and more importantly to learn about other antimicrobial stewardship initiatives and what strategies could be adopted for the health region. To address the lack of funding to attend conferences, the ASP team utilized published documents to learn from other programs.
“I think having funding would help us as we continue to evolve, to have that funding in place. In terms of our specific roles, we’re paid through the health region. So any funding that we’re looking for would be potentially to support an epidemiologist as another core member of our stewardship program or to be used for disseminating and acquiring knowledge, so opportunities for [the pharmacist and physician co-leads] to go to different conferences, learn about other antimicrobial stewardship initiatives, what other people are doing, different strategies that we could adopt, is absolutely critical, especially in the early stages of a stewardship program to make a plan, a strategic plan about where we want our program to go over the next 5-10 years.” Participant B2

Participant B3 mentioned that there was a request to provide funding for an epidemiologist to help the ASP team with data analytics (the role of an Epidemiologist will be discussed below). Reallocation of deferred resource from the Infection Prevention and Control Program (IPC Program) was approved. Participant B3 mentioned that the Saskatchewan Ministry of Health has required all deferred revenues to go to the “bottom line”, impacting the ability of the SHR to utilize the funding. And with Saskatchewan being in the middle of the amalgamation process, there was a delay in the funding request. Also, at the time of the interview, there was no clear information yet whether the ASP would continue to have a connection and alignment with the SHA IPC Program.

Dedicated time for ASP team

The ASP program had allocation for 1.5 FTE (1.0 FTE for a Pharmacist co-lead and 0.5 FTE for a Physician co-lead). At the time of the interviews, both co-leads were involved in providing audit and feedback to physicians. However, according to study participants, a lot of their time was also spent gathering and analyzing data which impeded them from performing their stewardship roles. There could have also been conflicting priorities for the Pharmacist co-lead as they may have been pulled out of ASP work for pharmacy duty (the Pharmacist co-lead reported to the Pharmacy Department).
Participant B2 pointed out that the small number of FTE was a challenge for the program to evolve.

“So, an epidemiologist or a data analyst is absolutely critical, someone that can look at trends over time, antimicrobial usage trends that we are seeing in the ICU, medical and surgical wards is really important. [The ASP co-leads] do some of that work right now but then, that certainly impedes [them] from doing the work in the wards and providing care for patients. So, having that support from a data analyst or an epidemiologist would be very important in having that data infrastructure.” Participant B2

Subtheme B: Logistical procedures related to the innovation: Availability of data infrastructure (enabler)

The two ASP team members mentioned the role of data infrastructure for evidence-based interventions. For example, to be able to develop local guidelines and pathways for antimicrobial prescription, there is a need for data regarding local antimicrobial resistance patterns and antimicrobial usage within the health region. Data infrastructure would also be important to demonstrate how the ASP contributes to overall quality and reduction of costs in the organization.

“I think what they are doing right now is able to show and evaluate a case for why this program is important, how this program contributes to overall quality and cost in any organization. So, having methods of tracking and setting of data early is important.” Participant B3

Theme 2: Determinants related to the innovation (ASP)

Subtheme A: Availability of tools and information for prescribing physicians/users of innovation (barrier)

Participants B1 and B2 talked about the development of local clinical guidelines and pathways as the next task for the ASP team. According to the study participants, this decision was informed by an earlier survey with ICU intensivists. Clinical guidelines and pathways are decision support tools designed to assist prescribers in determining whether
an antibiotic should be prescribed, the optimal antibiotic choice, and the shortest
appropriate duration of antibiotic therapy. Provision of such tools would allow physicians
to make decisions based on available data and information. Other perceived advantages
of having these tools is for sustainability of the ASP (minimizes the need for providing
audit and feedback) and the information would be available right away for prescribers, as
opposed to waiting until around day 3 for the audit and feedback process to start.

“... I think there’s now a need for local clinical guidelines and pathways. So [the
ASP co-leads] are going to start to develop some of that information, because we
want to be able to provide the intensivists information about why we’re making
the recommendations we are making and if they have a pathway for the ICU
about how to treat community acquired pneumonia or hospital acquired
pneumonia or catheter-associated UTI, all these different syndromes, and which
antibiotics to use based upon our resistance patterns in the ICU, then, they’ll be
further engaged and empowered to use the right antibiotic. And I think there is
a need for that from them. ’Participant B2

Theme 3: Determinants related to the implementing group

Subtheme A: Competencies of the ASP team (enabler)

The participants reiterated the importance of having a Physician and a Pharmacist
as co-leads (this was also pointed out for case 1). A physician’s knowledge (clinical
syndrome and the evidence around different treatment strategies) and pharmacist’s
knowledge (pharmacokinetics and pharmacodynamics) are complementary. The
importance of having an epidemiologist/data analyst to analyze antimicrobial trends has
also been emphasized by all participants.

“I think [the pharmacist’s] knowledge in terms of the pharmacokinetics and
pharmacodynamics, and then [the ID physician’s] knowledge in terms of clinical
syndrome and the evidence around different treatment strategies complement
each other, and I think that helps [the ASP Team] in terms of making the right
recommendation and also then will help [the ASP Team] now, moving towards
those clinical guidelines and pathways. But I think for any stewardship program,
you need to have at a minimum, a physician and a pharmacist as core
requirements of that program to ensure success.” Participant B2
Theme 4: Determinants related to the user of innovation/health professionals

Subtheme A: Fit of the innovation to health professional’s experiences, values and goals (enabler)

My study lacked participation from prescribing physicians in the SHR. As stated in Chapter 3, I contacted physicians but there was no response. The determinant that I identified under this section was based on my interviews with the ASP team members who described their interactions with ICU physicians. According to participant B2, ICU intensivists viewed the ASP as an important initiative for improving patient care.

“With the ICU, the feedbacks that we received so far have been very positive. Just in terms of surveying the intensivists about their perceptions of antimicrobial stewardship, the majority of people that participated in our survey said that they felt that this was an important initiative to improve the quality of care in patients in the ICU, and the majority also did not feel that what we are doing was impeding upon their autonomy, which is all great feedback to receive.”

Participant B2

Subtheme B. Learning style: verbal face-to-face interaction and shared decision-making (enabler)

According to one participant, the majority of ICU intensivists preferred verbal face-to-face interaction to ensure bi-directional communication regarding the patient. Therefore, the ASP team adopted this approach for audit and feedback, and this appeared to have resulted in a higher rate of buy-in and reception for the program.
Chapter 6. Discussion

My study explored barriers and enablers of adopting and implementing an ASP as perceived by key stakeholders in two health regions in Saskatchewan: the RQHR and the SHR. The two health regions both demonstrated complexity in the innovation process and revealed multiple determinants influenced implementation of the ASP innovation across different categories including socio-political context, organization, innovation, users of the innovation and the implementing group.

Adoption

Incentives can encourage individuals or organizations to do or not to do a certain action (Baker 2016), and these can include awards (monetary or in-kind), peer competition and prestige (e.g., being accredited for a particular service) (Custers et al. 2008). In the case of both the RQHR and the SHR, the decision to adopt an ASP appeared to be primarily driven by Accreditation Canada’s requirement. Being accredited indicates that an organization meets certain performance standards hence it is recognized as a symbol of quality (Tabrizi et al. 2011). Accreditation authorities also affect an organization’s public image (Feldstein and Glasgow 2008) and can therefore influence healthcare organizations to take action. Political directives or political “must-dos” (categorized under “socio-political context”) can also increase an organization’s predisposition or motivation to adopt an innovation (Greenhalgh et al. 2004). This is demonstrated in my study, where there was a build-up of policy push for the adoption of ASPs. Over the last several years, there has been increased attention from key health policy institutions both at the international (WHO, United Nations and World Economic Forum) and federal levels (Public Health Agency of Canada) – all of which endorsed the
role of antimicrobial stewardship (Government of Canada 2015, WHO 2014). For the RQHR, organizational factors such as the presence of innovation champions and support from senior leadership may have also facilitated the adoption process. Prior to the accreditation requirement, senior health professionals in the RQHR were already championing antimicrobial stewardship – this may have early on influenced the senior leaders’ perception of an ASP.

It is notable that the other three categories of determinants (characteristics of the innovation, the user and the implementing group) did not appear to be as important during the adoption stage. This could be because the adopter in this case is an organization (as opposed to individuals), where external factors and availability of resources may have more influence. Also, as discussed later, these three factors emerged at the later stage of the innovation process, i.e., during planning and implementation.

Implementation

Several determinants facilitated the implementation process for the two cases, and all the five categories (socio-political context, organization, innovation, implementing group and users of innovation) are represented in the themes identified in my study. There are a few case-specific determinants, but the majority of the enablers and barriers identified for the RQHR and the SHR are shared. These results are not surprising given the similarities between the two cases: RQHR and SHR are located in the same province; they may have similar organizational culture given their proximity; the same type of innovation was implemented; and key stakeholders (e.g., pharmacists, physicians and other healthcare professionals) were similar. Most of these determinants are also consistent with previous studies of ASPS in other jurisdictions in Canada and in the
United States. Considering that these commonalities transcended the different contexts underlying the two cases (organizational setting, individuals and innovation design) and their concurrence with previous studies, it may be helpful for healthcare organizations to pay attention to these factors when designing and planning their antimicrobial stewardship programs.

I classified the common determinants under the following key themes/findings:

1. dedicated resources and time for the ASP team;
2. data infrastructure;
3. availability of tools and information for prescribing physicians;
4. competencies of the ASP Implementing Team;
5. fit of the innovation to health professional’s values and goals;
6. collegial conversations with prescribers.

**Key finding 1: Dedicated resources and time for the ASP team**

The implementation of any antimicrobial stewardship intervention requires human, financial and IT resources. For the RQHR, implementation of the program was supported with a dedicated annual budget. Considering the amount of the start-up fund ($350,000) this was most likely primarily for remuneration of the 3.5 FTEs, and there may have been fewer resources for IT infrastructure. Also, although the RQHR had an allocated FTE for an ID specialist, the ASP team was lacking this expertise. This appeared to have prevented the stewardship team from conducting audit and feedback interventions. Nevertheless, according to the RQHR ASP team, having a dedicated program with dedicated resources allowed them to focus on delivery of their ASP interventions. On the other hand, the SHR’s ASP did not have dedicated funding resulting in a smaller number of FTEs (the number of FTEs will be discussed in more details below). The ASP team perceived this lack of dedicated funding as a challenge to
the continued delivery of stewardship activities and for the program to evolve. In addition, since the Pharmacist co-lead was under the Pharmacy Department, there may have been conflicting priorities between stewardship and pharmacy duties.

A very recent survey of the current state of hospital ASPs in Ontario demonstrated that similar to the SHR, half of the programs (45 out of 90) did not have designated resources for antimicrobial stewardship. Also, those that did are under-resourced with respect to physician and pharmacist staffing (Leung et al. 2018). As noted in the introduction, Ontario is already more advanced that other Canadian provinces in terms of antimicrobial stewardship (Nakamachi et al. 2015). The findings of this study along with the current survey of ASPs in Ontario (Leung et al. 2018) demonstrate the need for improving resource allocation for ASPs to continue to grow in scope and in impact.

It is also worth noting that the RQHR ASP team reported directly to a Vice-President. This reporting and accountability structure is in contrast to other programs that report to medical advisory committees (Alberta Health Services n.d., Nakamachi et al. 2015) or under a hospital department (e.g., pharmacy department as is the case for the SHR-ASP). Nakamachi et al. (2015) pointed out that although these committees are important advocates for antimicrobial stewardship, they may lack the authority to access resources required for the programs. Similar to the RQHR ASP, the Mount Sinai Hospital–University Health Network ASP, a robust and well-resourced program, reports to a Vice-President, who is viewed as an organizational champion with credibility, authority and discretionary budget (Nakamachi et al. 2015).
Key finding 2: Availability of data infrastructure

Both health regions identified data infrastructure availability as an enabler in implementing antimicrobial stewardship. This is not surprising since tracking and reporting antimicrobial use is a core component of any hospital ASP (CDC 2014). SHR’s audit and feedback intervention and its future local guidelines and pathways for antimicrobial prescription, as well as RQHR’s retrospective review of antimicrobial utilization require information regarding the kind of antibiotics that are used, their indication, dosage and the length of therapy. However, this type of information was identified by the RQHR-ASP team to be lacking.

To help facilitate gathering of stewardship information, the use of computerized physician order entry such as those reported for Calgary, Alberta (Rowan and Thompson 2016) may be useful. Ideally, these automated order forms would be connected to microbiology results, pharmacy data and electronic medical records. However, such integration of systems is identified by the ASP team to be lacking at the RQHR. Interestingly, even leading ASPs in the United States pointed out to the poor interoperability between software systems as a barrier, not to mention the additional effort to duplicate documentation in multiple places (Kapadia et al. 2018). Integrated IT systems are in place in Canadian centres with more established stewardship programs. Examples are: the Antimicrobial Prescription Surveillance System (APSS) that has been developed and validated at the Université de Sherbrooke, and fully implemented at the Centre Hospitalier Universitaire de Sherbrooke in 2010; the ANTIBIOKOS software, implemented at the Centre de santé et des services sociaux de Rimouski-Neigette, Québec, which includes algorithms also designed to facilitate audit and feedback and a
real-time integrated database; and the Stewardship Program Integrating Resource Information Technology (SPIRIT) at Sunnybrook Health Sciences Centre in Toronto, Ontario (Parfitt et al. 2015). However, the development (i.e., customization) and on-going maintenance of integrated IT platforms would require significant time, financial and personnel investment (Parfitt et al. 2015) and may not be the most efficient use of limited resources for ASPs that are just beginning.

**Key finding 3: Availability of tools and information for prescribing physicians (users of innovation)**

The implementation of ASP interventions can be challenging because these practices are complex and require coordination between the ASP Team and prescribing physicians. For the RQHR, the provision of tools such as prescription pads and regular presentations to healthcare practitioners and pamphlets that could be distributed to patients are perceived to facilitate antimicrobial stewardship. Further, at the time of the interviews, the SHR-ASP team was planning to design local guidelines that include recommendations for appropriate antibiotic use. According to the ASP team, these efforts can promote sustainability (prescribing physicians can use these tools even without the ASP team being physically present) and empower physicians.

This finding is consistent with the Greenhalgh et al. model (2004), which indicates that technical support such as training and providing a help desk can facilitate implementation. Alberta Health Services has also pointed out the importance of education for physicians, pharmacists and nurses in improving antimicrobial stewardship (Pasay et al. 2014). These are the target groups for RQHR’s education and awareness strategies.
Key finding 4: Adequate staff with appropriate competencies

The availability of adequate human resources with the right skill set is necessary for delivery of appropriate stewardship activities. The Infectious Diseases Society of America (IDSA) recommended the following ASP team composition: a core-team of an ID physician and a clinical pharmacist with ID training; and a clinical microbiologist, an information system specialist, an infection control professional and hospital epidemiologist for an optimal program. Antimicrobial stewardship is a component of patient safety and is considered a medical staff function. Hence, the IDSA recommended an ASP to be co-led by an ID physician and a clinical pharmacist with training in infectious diseases (Dellit et al. 2007) – such is the case for the RQHR and the SHR ASPs. Study participants from the two health regions acknowledged the strength of having the complementary skills of an ID Physician and a Pharmacist co-leads. The ID Physician provides clinical expertise (monitoring and managing patients with infections) and leadership (ability to influence prescribing physicians). The Pharmacist co-lead on the other hand, contributes expertise in medication (e.g., selection of optimal antimicrobials, dosing and duration of therapy) and co-leadership (providing antimicrobial stewardship education). In terms of staffing, the Association of Medical Microbiology and Infectious Diseases (AMMI) Canada released the following minimum requirement for acute care facilities per 1,000 beds: 1 FTE physician; 3.0 FTE pharmacists; 0.5 FTE Project/Program Administrative and Coordination Support; 0.4 FTE Data Analyst (AMMI 2016). Considering that the RQHR-ASP was focused on the Regina General Hospital which had 468 acute beds (CIHI 2019b), the health region has met the number of FTE allocation as per AMMI recommendation. The SHR-ASP which
functioned primarily for the Royal University Hospital with 385 beds (CIHI 2019b) also had a sufficient FTE for a Pharmacist and a Physician co-leads but was lacking a Research Analyst and a Program Administrative/Coordination Support. However, the two ASPs were envisioned to serve each of the health regions and with this in consideration, both the RQHR-ASP and the SHR-ASP would have had insufficient staff (Table 6). In 2017-18, the RQHR had 868 acute beds (CIHI 2019b) which would have required 1.0 FTE ID Physician specialist, which was lacking at the time of the interviews. The number of pharmacist (1.2 FTE per 1000 beds) was also slightly less than what is recommended. On the other hand, the SHR had 878 acute beds (CIHI 2019b) which would have required 4.3 FTE (compared with the existing 1.5 FTE). The FTE for the Pharmacist co-lead (1.1 FTE per 1000 beds) is less than recommended, and since the duties for the pharmacist and the physician also involved data analytics and program coordination, the time that they were spending on their actual roles as physicians and pharmacist were even less.

Table 6. Number of FTEs for the RQHR and SHR ASPs in comparison with AMMI’s recommendation.

<table>
<thead>
<tr>
<th>Staff</th>
<th>AMMI’s minimum requirement (FTE/1,000 acute beds)</th>
<th>RQHR-ASP’s current FTE/1,000 acute beds*</th>
<th>SHR-ASP’s current FTE/1,000 acute beds*</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID Physician</td>
<td>1.0</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Pharmacist</td>
<td>3.0</td>
<td>1.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Data Analyst</td>
<td>0.5</td>
<td>1.2</td>
<td>0</td>
</tr>
<tr>
<td>Program Coordinator</td>
<td>0.4</td>
<td>1.2</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td><strong>4.9</strong></td>
<td><strong>4.0</strong></td>
<td><strong>1.7</strong></td>
</tr>
</tbody>
</table>

*This is based on 868 acute beds for the RQHR and 878 acute beds for the SHR. The information on the number of beds was obtained from CIHI (2019b).
Insufficient workforce was also reported in Ontario. Acute teaching hospitals with designated resources reported an average of 0.57 physician and 2.16 pharmacist FTEs per 1,000 beds while large community hospitals with designated resources reported an average of 0.65 physician and 2.55 pharmacist FTEs per 1,000 beds (Leung et al. 2018). The reason for insufficient ID physician expertise at the RQHR and in Ontario is unclear – this could be due to a short supply of Infectious Disease-trained expertise. In 2018, there were only 673 ID physicians in Canada with 13 in Saskatchewan (Canadian Medical Association 2018) and most of these ID-trained physicians would have been working outside of antimicrobial stewardship including Infection Prevention and Control, Epidemiology and Research. This topic may be worth further investigation considering the crucial role of ID specialists in hospital ASPs. Also, other facilities such as inpatient care, inpatient rehabilitation and complex continuing care are expected to comply with Accreditation Canada’s ROP for antimicrobial stewardship (Accreditation Canada 2014a). If there is indeed a short supply of ID-trained physicians, this would not match AMMI Canada’s proposed composition and expertise for an ASP team.

Key finding 5: Fit of the innovation to health professional’s values and goals

An innovation’s compatibility with the values of the potential users is considered a key determinant in the innovation literature (Fleuren et al. 2004, Greenhalgh et al. 2004, Rogers 2003). This factor was also demonstrated in my study. According to a study participant, since antimicrobial stewardship is about improving quality of patient care and improving patient safety, physicians are generally supportive of these kinds of programs. Thus, it may be useful for any ASP team or antimicrobial stewardship champions to emphasize the important role of antimicrobial stewardship in patient care as well as to
link their initiative to overall organizational values. This may facilitate obtaining support from healthcare practitioners and from the organization’s senior leadership.

**Key finding 6: Collegial engagement with prescribers**

Study participants from both health regions indicated the importance of having collegial engagement with prescribing physicians. This is particularly relevant since physicians may perceive antimicrobial stewardship to impede physician autonomy and interfere with clinical decision-making (Stach et al. 2012). In the case of the RQHR-ASP, physicians were included in the program design, *i.e.*, during the RPIW process. A physician who participated in this study pointed out that engaging people early in the program provided them with a sense of ownership, resulting in better buy-in. Also, the RQHR-ASP team used de-identified data when discussing current practices with prescribing physicians – this according to a study participant provided a “climate of support” rather than a “climate of blame”. For the SHR, the ASP team also included physicians in their decision-making process. The ASP team surveyed intensivists for their preferred approach for the audit and feedback intervention at the Royal University Hospital. Also, the ASP team has adopted face-to-face interactions with individual critical care physicians to provide audit and feedback – this, in contrast to implementing formulary restrictions, is viewed as a collaborative and patient-centered approach (Elligsen et al. 2012).

Previous studies highlighted a collaborative approach as beneficial in other antimicrobial stewardship initiatives in Ontario (Elligsen et al. 2012) and in Alberta (Pasay et al. 2014). The Sunnybrook Health Services Centre ASP involved their critical care staff in the development of their program, and they have acknowledged that critical
care staff had ultimate responsibility for and authority in the care of their patients (Elligsen et al. 2012). Therefore, regardless of the organizational context, collegial engagement and collaboration is crucial to obtaining support from other healthcare professionals.

**Case-specific determinants**

The case-specific determinants were raised only for the RQHR and these are categorized under the users of the innovation (prescribing physicians). As mentioned earlier, one of the limitations of my study is the lack of a prescribing physician as a study participant for the SHR-ASP. It is therefore unclear whether a similar study participant from the SHR would have also raised these determinants. For the RQHR, participants perceived homophily as a determinant, and that this is important in terms of having physician-to-physician interaction. Clinicians maybe considered a homophilous group because of their shared clinical knowledge and pharmacists would be a different homophilous group due to their shared pharmacological knowledge. During the time of the interviews, the RQHR-ASP team did not have an ID physician, which according to one participant is necessary in conducting audits and feedback. If the ASP team is to provide recommendations about the care of a patient, they need to be seen as experts in infectious diseases and antimicrobial stewardship. Study participants pointed out that a physician-to-physician interaction is necessary for uptake of the program. However, this assumption may need to be verified with clinicians who are working in these units. A previous study of an ASP in a tertiary teaching hospital in Toronto, Ontario indicated that the program’s ID physicians played a pivotal role in obtaining support from their critical
care staff – it is unclear whether another healthcare professional (e.g., Pharmacist co-lead) could have achieved similar support (Elligsen et al. 2012).

For the SHR, the study participants did not explicitly raise homophily as an issue. This could be because the program had an ID specialist as a co-lead. Interestingly, prior to the ID specialist joining the ASP team, the Pharmacist co-lead had not yet conducted audit and feedback as an ASP intervention, but had instead focused on rotating with the health region’s ID consultation services to establish working relationships and to build on their clinical skills. Another case-specific factors that participants perceived as a barrier to implementing antimicrobial stewardship interventions was the availability of time for stewardship work. The newly released “Handle with Care: Preserving Antibiotics Now and Into the Future: The Chief Public Health Officer of Canada’s Spotlight Report 2019” also indicated that saving time can be a motivating factor for both patients and healthcare providers (Government of Canada 2019). Another factor I found in my study is the difficulty in achieving physicians’ behavior. According to one study participant from the RQHR, newer staff such as medical residents adapted more easily to the change in the workflow/prescribing habit (e.g., writing indications for prescriptions). It may be beneficial to provide more education and engagement opportunities for all prescribing physicians as well as to understand the factors that can effectively influence their prescribing behavior. Finally, according to participants from the RQHR, a patient’s attitude and knowledge of antimicrobial resistance and stewardship influences a physician’s decision to prescribe antibiotics. Unfortunately, my study did not include patients as study participants. Future research that explores patients’ perspectives on these topics may help inform future antimicrobial stewardship interventions.
Implications of findings for the Saskatchewan Health Authority

Since all regional health authorities in Saskatchewan are now merged into the SHA, it may be useful to analyze my findings in relation to this new structure. I invited a Saskatchewan Ministry of Health representative to participate in this study but unfortunately did not receive a response. The information I used in this section is therefore limited and is based solely on what is available on the SHA website (https://www.saskhealthauthority.ca/) and the RQHR website (http://www.rqhealth.ca/).

In November 2017, Saskatchewan Ministry of Health and the RQHR-ASP team co-organized a provincial Antimicrobial Stewardship Symposium. Participants included the RQHR-ASP and the SHR-ASP teams, as well as speakers from the University of Saskatchewan, the Alberta Health Services, the Nova Scotia Health Authority (NSHA) and the PHAC. An outcome of the symposium was a compilation of information on the current state and desired future state of antimicrobial stewardship in Saskatchewan. Not surprisingly, the key themes identified for considerations for a future state are analogous/consistent to the findings in this study, i.e., dedicated ASP funding in the SHA budget; consideration of the ratios suggested by AMMI; funding for IT, research, communication and centralized data infrastructure to support an ASP; collaborative partnerships between community and acute care; a united provincial leadership structure providing guidance to local healthcare workers; and an ASP to report directly to a Vice-President, and not through a chain (RQHR 2017b).

Since the SHA now provides oversight for all acute care facilities in Saskatchewan, they would need to consider how to efficiently and effectively deliver antimicrobial stewardship interventions in the whole province. The SHA may consider
investing in technology-based approaches and tools that can improve efficiency and sustainability of ASP operations. Currently, a mobile app called Spectrum is available for healthcare professionals in the Saskatoon region. The Saskatoon version of the app was developed by the SHR-ASP to provide clinical decision support including local guidelines (to provide information on how to assess patients, treatment options and monitoring of patient) and pathogen information (information regarding the causative agent and susceptibility to antibiotics) (SHA 2019). It may be worthwhile to study the cost-benefit of providing Spectrum to other regions in Saskatchewan as well as adopting an integrated IT system (similar to what is being used in Ontario and Quebec) that can facilitate delivery of stewardship activities even in smaller communities and hospitals. Further, the SHA would need to increase the number of FTEs for the ASP teams. If AMMI Canada’s recommendation is considered, Saskatchewan would require the following for approximately 3,000 acute beds in the entire province (CIHI 2019b): 3 FTEs ID physicians; 9 FTE pharmacists; 1.5 FTE data analysts; and 1.2 FTE Administrative Coordinator/Support. The challenge will likely be with employing dedicated physicians and pharmacists with ID training. Alternatively, the SHA-ASP may be structured similar to those in other provinces. One example is Ontario’s “hub and spoke” model (Figure 7) which was designed to leverage existing knowledge and expertise to help community hospitals implement ASPs without in-house ID specialists. The central site, Mount Sinai-University Health Network ASP provides overall leadership and guidance. Four established ASP “hub” sites are led by pharmacist and physician leaders who mentor the community hospitals (the “spoke” sites). It is unclear if
Figure 7. Ontario’s hub and spoke model for ASP. (Source: Nakamachi et al. 2015)
the pharmacist and physician leads have formal training in ID and antimicrobial stewardship (Nakamachi et al. 2015).

Another interesting model is the ASP organizational structure for Nova Scotia (Figure 8) which, similar to Saskatchewan, amalgamated its district health authorities into the Nova Scotia Health Authority (NHSA 2018a). The NHSA-ASP includes four zonal subcommittees with oversight by the NHSA-ASP Steering Committee. Each subcommittee has an ASP pharmacist who has been receiving ID and antimicrobial stewardship training through online courses and observerships with the NHSA and abroad. The Steering Committee is multi-disciplinary and includes pharmacists, physicians, microbiology, nursing, infection prevention and control, and quality improvement, and is co-led by an ID physician and a pharmacist. The Committee reports to the NSHA’s antimicrobial stewardship leads (Senior Director for Pharmacy Services, Senior Medical Director for Pharmacy Services and Senior Director for Quality Improvement, Safety, Patient Relations). The NHSA-ASP team is supported by an Administrative Assistant (NHSA 2018b, 2018c).

Regardless of the SHA’s future ASP organizational structure, it would be valuable to take advantage of existing expertise from the RQHR and the SHR ASPs, i.e., RQHR’s data analytics and SHR’s ID physician expertise. Also, prior to requesting dedicated funding for the entire province, the SHA may consider replicating the planning process that the RQHR and/or the SHR conducted for their ASPs. It is suggested that the planning process include a review of the resources needed for the program as well as the resources and expertise available. Finally, the province may adopt a collaborative approach and involve stakeholders from the early stages of planning up to implementation.
Figure 8. The ASP Structure for the Nova Scotia Health Authority.
(Source: Nova Scotia Health Authority 2018b). AMS- Antimicrobial Stewardship
Chapter 7. Research and Policy Contributions

My research has demonstrated the applicability of the Fleuren et al. (2004) framework in a different country and using a different healthcare innovation. A majority of the studies that validated this framework were conducted in the Netherlands. As well, the findings in my study can strengthen this framework because some of the factors identified in this study are not included in Fleuren et al.’s list of 51 determinants (Flereun et al. 2004). Examples are the influence of international and national organizations such as the WHO, UN and the Canadian government (considered as political “must-dos”), role of incentives (i.e., accreditation requirement for adoption of ASPs) and homophily of professional practitioners (particularly prescribing physicians) as facilitators of the implementation process. Also, the Fleuren et al. framework does not include the “Implementing Group” as a main category, and yet my research suggests that the ASP team for each health region played an important role in the design, planning and implementation of specific ASP interventions. Organizational innovations may require an implementing group to support sustained implementation and assimilation of the innovation. It is therefore recommended that this main category and the additional determinants identified above be included in the framework.

My research also indicates that the determinants should not be viewed as single influences but rather as being interactive, such that one determinant could impact or influence another. An example of this relationship is the availability of dedicated funding, which is classified under the organizational context. As demonstrated here, financial factors can impact a number of things including staffing, dedicated time for stewardship activities and availability of tools for healthcare professionals (users of the innovation).
The two case studies in this research also provide more evidence to support the suggestion that healthcare innovation is a complex and non-linear innovation process (Greenhalgh et al. 2004, Van de Ven et al. 1999). The ASP adoption process for the health regions took multiple years and involved various factors and stakeholders. For the implementation stage, the RQHR-ASP team repeatedly went through a reinvention stage, whereby the associated interventions for the program were modified to suit the organization’s needs. For example, it appears that the inclusion of 12 community clinics in the antimicrobial utilization review came at a later stage after the initiation of the ASP, and not as a direct result of the Design RPIW. For the SHR, the ASP team was planning on developing local guidelines/clinical pathways for antimicrobial utilization and the use of a mobile app to deliver antimicrobial stewardship resources - this also demonstrates an on-going process of adjustments in ASP practices. Therefore, the SHA and other healthcare organizations that are in the process of setting up their own ASRs need to be flexible and aware of potential adjustments that could facilitate implementation.

Further, innovation researchers and practitioners need to recognize the socio-political context and organizational factors that can facilitate the adoption of a healthcare innovation. Healthcare organizations and innovation champions can leverage incentives such as recognition from an accreditation body to facilitate the introduction of an innovation. However, other confounding factors such as availability of resources in an organization are also important considerations. There are still a number of acute care facilities/hospitals in Canada that have not adopted their own formal ASRs despite Accreditation Canada’s requirement and influence from international and federal
organizations. Future research is required to understand why different healthcare organizations respond to external incentives and political ‘must-dos’ differently.

Finally, my findings contribute to understanding the challenges and experiences in implementing ASPs, which is a relatively new area of research in Canada. The few published studies in the country are from ASPs in large teaching hospitals in Ontario, which may have more resources than in other jurisdictions. My research provides additional information from a different context and offers lessons for other healthcare institutions. First, the RQHR and the SHR demonstrate that the amount of resources should not impede the implementation of an ASP. The ASP teams developed their interventions based on the resources available. Second, regardless of the size of the ASP, having collaborative engagement and collegial relationships with other healthcare professionals is important. Involving stakeholders in the early stages of the program provides a sense of ownership and facilitates buy-in. Third, any stewardship program needs access to reliable and timely data. Thus, my research suggests there is value in including staff who will have dedicated time for data analytics. Fourth, there are innovative approaches to address lack of staffing. For example, the RQHR-ASP team engaged summer students to provide support with research and data gathering and were considering tapping into the expertise of the ID physicians in the health region. Finally, there may be value in having increased antimicrobial stewardship conferences similar with the 2017 Saskatchewan Antimicrobial Stewardship Symposium and the 2019 Western Canadian One Health Antimicrobial Stewardship Conference (RQHR 2019), or even at a national scale. These events may provide valuable opportunities for
practitioners to share and learn of ASP interventions and implementation strategies that could help further this important initiative.

**Concluding Remarks**

My study contributes to the growing research on implementation of healthcare innovations. My findings reveal that multiple factors across different categories (*i.e.*, socio-political context, organization, innovation, user of the innovation and the implementing team) influenced the implementation of ASPs in the two case studies, with six determinants that were common. To facilitate uptake of healthcare innovations, organizations need to consider having a more holistic perspective, taking into account various factors that influence the innovation process.

The key roles of dedicated resources and time for the implementing team, availability of data infrastructure and tools for potential user, and adequate staff with appropriate competencies of innovation are important considerations for organizations and individuals who are responsible for the design and implementation of healthcare innovations. Also, strengthening collaboration and collegial relationships could help organizations obtain support from healthcare practitioners. Further, the two case studies demonstrated the value of understanding the specific context (*e.g.*, resources available and existing culture in the organization) to be able to plan implementation strategies accordingly. Finally, other healthcare organizations may learn from the implementation strategies that the RQHR and the SHR have adopted to address certain challenges in the innovation proves.
Literature Cited


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Appendix A. Interview Guide

Part I. General Information Regarding ASP:

1. Please tell me about yourself, e.g. name, role in the ASP and other responsibilities in the hospital.
2. Could you describe the ASP in your hospital?

Follow up questions:
- What kind of antimicrobial interventions are in place in your hospital?
- When was your hospital ASP established?
- Could you describe how was your ASP developed? e.g. gathering and analyzing antimicrobial usage and antimicrobial resistance pattern, determining membership and reporting structure for ASP; developing guidelines/protocols including support from microbiology/testing laboratory
- Who are involved in the ASP? Do they receive additional compensation?
- Do you think the antimicrobial stewardship strategies implemented in your hospital improved the antimicrobial usage and patient’s quality of life?
- From your perspective, what are the most important components of your hospital ASP?

Part II. Barriers and Enablers of ASPs

1. Could you please describe the implementation process for your hospital ASP? Was it a smooth process or were there difficulties?

2. Were there any barriers or challenges when your ASP was being developed?
- Availability of resources (funding and diagnostic facilities)
- Education and training (knowledge and of staff and training opportunities)
- Staff support
- Communication among stakeholders

Follow up questions for hospital administrators or RHA representatives:
- Has there been a challenge in recruiting an ID consultant for your hospital and for recruiting other members for the ASP Team?
- What was/were the driving force/s for establishing the ASP in your hospital/jurisdiction? (Probe whether there was a local champion or was the need recognized from within the organization or was it due to accreditation requirements?)
3. What strategies have you tried to address the barriers and challenges that you encountered?

*Follow up question:*

- What advice would you provide to others who are just embarking on the process?

4. What do you think are the significant factors that contribute to the success of an ASP?

*Follow up question on the following: specific examples if respondents answer in a general fashion, e.g. importance of dedicated personnel (time/knowledge) and would staff be supportive?*

5. Are there external stakeholders who influence the success of your hospital ASP?

6. Is there any information that you would like to add?

7. Would you be available for follow-up questions, if there is any?
Appendix B – Project description provided to prospective study participants

Project Title: Exploring Enablers and Barriers to Implementing an Antimicrobial Stewardship Program: Case Studies of Regina Qu'Appelle Health Region and Saskatoon Health Region, Saskatchewan

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Project Description:

The Public Health Agency of Canada (PHAC) considers antimicrobial resistance (AMR) as one of the greatest public health risks facing Canadians, along with obesity, mental illness, emerging infectious diseases, and the health of Aboriginal people and Northerners (Office of the Auditor General of Canada 2015). It is estimated that 18,000 hospitalized patients in the country contract antimicrobial-resistant infections every year, resulting in medicare costs amounting to one billion dollars (PHAC 2015a). In addition to this direct cost, AMR diminishes the quality of life, including earning potential, of individuals who are suffering chronic drug-resistant infection (Canadian Committee on Antibiotic Resistance 2003). The use of antimicrobials, both appropriate and inappropriate, has placed unnatural selective pressure on bacteria, accelerating the development of AMR (Fair and Tor 2014). One way to help reduce the emergence of AMR is through the appropriate use of antimicrobials, which is called antimicrobial stewardship.

Antimicrobial stewardship is a multi-disciplinary initiative that refers to the appropriate selection, dosing, route, and duration of antimicrobial therapy. In Canada, the implementation of an antimicrobial stewardship program (ASP) became a Required Organizational Practice for acute care facilities accreditation in 2012 (Accreditation Canada 2012). National surveys reveal that a large number of acute care hospitals in Canada lack antimicrobial stewardship programs (Steinberg 2016, Accreditation Canada 2015). To facilitate the establishment of antimicrobial stewardship in Canadian hospitals, it is important to identify enablers and barriers to ASPs; however, there are limited studies on these factors to date. Thus, case studies of Regina Qu’Appelle Health Region (RQHR) and Saskatoon Health Region (SHR) will be conducted. The organizational structure and policy tools of each Health Region will be identified. Semi-structured interviews will be conducted with representatives from the Government, Regional Health Regions and/or Provincial Advisory Committees, hospital administrators, with ASP team members (including Infectious Disease specialists/physicians and pharmacists), and frontline workers (critical care physicians or critical care nurses). This study will highlight the strategies that were adopted in each Health Region to overcome
implementation barriers. Common lessons and recommendations will be provided to guide in the implementation and improvement of ASPs across Canadian hospitals. This can help address the problem of antimicrobial resistance and consequently protect the health of Canadians. In a broader policy perspective, this study can also help understand the decision-making and implementation processes in the adoption of complex policies, such as a collaborative antimicrobial stewardship program.