

Prescribing Competence and Confidence in Pharmacy and Medicine

by

Cassandra Voit

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science

In

Pharmacy Practice

Faculty of Pharmacy and Pharmaceutical Sciences

University of Alberta

© Cassandra Voit, 2019

Abstract

In 2007, Additional Prescribing Authorization (APA) was introduced in Alberta, which allows pharmacists to independently initiate prescriptions and prescribe to manage ongoing therapy. Pharmacist prescribing has also been shown to have positive patient outcomes in a variety of health conditions. For physicians, prescribing is an expected activity, however recent studies show that many prescribing errors are made by junior physicians. It is important to ensure the University of Alberta is producing competent and confident prescribers, from both faculties of pharmacy and medicine.

A scoping review of the literature was completed to explore studies investigating prescribing competence and confidence in pharmacy and medicine. Online databases MEDLINE, EMBASE, and Global Health were used to identify articles from inception to October 2018. Peer-reviewed articles describing either the competence or confidence of physician, pharmacist or student prescribing, including inappropriate prescribing and prescribing errors were included. After applying the inclusion and exclusion criteria and hand searching, 33 eligible articles remained.

Many studies demonstrated that medical students and junior doctors are not competent in prescribing when they enter practice, although their perceived confidence is often higher than their assessed competence. While fewer studies investigate pharmacist competence and confidence, those that do described competent prescribers lacking confidence in their prescribing knowledge. Themes included self-awareness, lack of education and educational improvements, prescribing errors and resources, prescribing culture and barriers to prescribing, gender differences and benefits to prescribing. Results from the scoping review showed that prescribing competence is poorly correlated with prescribing confidence and has questioned whether

undergraduate programs adequately prepare interns and junior practitioners for safe and rational prescribing.

The goal of the research project was to investigate the differences in prescribing competence and self-rated prescribing confidence of fourth year pharmacy and medical students at the University of Alberta. A cross-sectional design was used to measure prescribing competence using five prescribing case scenarios, and explore prescribing confidence using a survey. All fourth-year pharmacy and medicine students at the University of Alberta were eligible to participate. Answers to the cases were graded based on therapeutic appropriateness and inclusion of all legal requirements. The confidence survey assessed confidence of both assessment and prescribing skills.

Results of the study show that pharmacy students had significantly more appropriate prescriptions and fewer inappropriate prescriptions than the medical students. The majority of students from both faculties rated themselves as confident/very confident with prescribing. Pharmacy students were significantly more likely to include over 80% of the required legal elements of a prescription. This shows that there are differences between the two faculties with respect to prescribing and suggests that further investigation into prescribing competence is warranted to ensure the university is producing both confident and competent prescribers.

In conclusion, this research has highlighted a gap in the literature regarding pharmacist confidence and competence with prescribing. Additional studies are needed to provide support for this expanded scope of pharmacy practice and to identify opportunities for improvement. Suggestions for educational initiatives have also been provided based on the findings.

Preface

This thesis is an original work by Cassandra Voit.

A version of Chapter 2 of this thesis has been accepted for publication as Voit, C., Yuksel, N., Charrois, T.L. Competence and confidence with prescribing in pharmacy and medicine: a scoping review. *IJPP* (In print). All authors contributed to the design of the review. I contributed to the conception, data acquisition, abstraction and interpretation of the data, and the drafting and revision of the article. Dr. Nese Yuksel contributed to the drafting and revision of the article. Theresa L. Charrois contributed to the data acquisition, abstraction and interpretation of the data, and the drafting and revision of the article. All authors approved the final manuscript.

Chapter 3 of this thesis received ethics approval from the University of Alberta Research Ethics Board 2, Pro00084637 “Prescribing Competence and Confidence of 4th year Pharmacy and Medicine Students from the University of Alberta,” October 12, 2018. It has also been submitted for publication as Voit, C., Yuksel, N., Charrois, T.L. Pharmacy and medical students’ competence and confidence with prescribing: a cross-sectional study. *CPTL* (manuscript submitted for publication). All authors contributed to the design of the study. I contributed to the conception, data collection, interpretation of the data, and the drafting and revision of the article. Dr. Nese Yuksel contributed to the drafting and revision of the article. Theresa L. Charrois contributed to the data collection, interpretation of the data, and the drafting and revision of the article. All authors approved the final manuscript.

Dedication

I dedicate this thesis to all current and future independent pharmacist prescribers.

Acknowledgments

I sincerely thank Ms. Theresa L. Charrois for taking me on as her first graduate student and allowing me to complete my research. She has provided great support during the duration of my degree, in addition to providing opportunities for both professional and academic growth. I would also like to thank Dr. Nese Yuksel for her time and guidance as my co-supervisor. Her experience with graduate students has been invaluable for the successful completion of this thesis. Further gratitude is extended to Dr. Christine Hughes and Dr. Meagen Rosenthal for their roles on my supervisory committee. Their insight helped guide the research project to be both feasible and meaningful. I am appreciative to Dr. Sherilyn Houle and Dr. Cheryl Sadowski for their participation in my final oral exam as my external committee member and Chair of my exam, respectively. The support from the Faculty of Pharmacy and Pharmaceutical Sciences both in opportunities to present my research in addition to financial support through scholarships was invaluable for the completion of this degree.

I wish to acknowledge the contributions of Ms. Janice Kung to the search strategy for the scoping review, and the contributions of Mr. Jordan Cox to the screening of articles for the scoping review. I would like to acknowledge Ms. Alyssa Shapka for her time and assistance rating the responses for the research project, in addition to providing feedback on the marking rubric. In addition, I would like to thank Mr. Bo Pan and Mr. Yazid Al Hamarneh for their time and guidance related to the statistical analysis and correlational analysis of the research project. I would also like to thank Dr. David Brinkman for being receptive to my emails and sharing the study materials from the EACPT study, which helped guide the research project.

Finally, I am grateful for the ongoing strength and support from my family and my fiancé.

Table of contents

Chapter 1 : Introduction	1
1.1 The act of prescribing	1
1.2 Prescribers in Canada.....	2
1.2.1 Physician education	2
1.2.2 Pharmacist education.....	3
1.3 Overview of pharmacist prescribing	3
1.3.1 Canada	4
1.3.2 Australia.....	6
1.3.3 United Kingdom (UK).....	6
1.3.4 United States of America (US).....	7
1.4 Patient outcomes.....	8
1.4.1 Pharmacist collaboration or intervention.....	9
1.4.2 Pharmacist prescribing outcomes	9
1.5 Prescribing confidence and competence	10
1.6 Rationale	12
1.7 Objectives.....	13
1.8 References	14
Chapter 2 : Scoping review	19
2.1 Introduction	21
2.2 Methods	22
2.2.1 Information sources and search	22
2.2.2 Eligibility criteria.....	23
2.2.3 Screening and data abstraction	23
2.2.4 Data analysis.....	24
2.3 Results	24
2.3.1 Characteristics of studies	24
2.3.2 Emergent Themes.....	25
2.3.2.1 Self-awareness	25

2.3.2.2 Lack of education and educational improvements.....	26
2.3.2.3 Prescribing errors and resources	27
2.3.2.4 Prescribing culture and barriers to prescribing	28
2.3.2.5 Gender differences	29
2.3.2.6 Benefits to prescribing.....	29
2.4 Discussion.....	30
2.5 Conclusion.....	32
2.6 References	50
Chapter 3 : Research Project.....	54
3.1 Introduction	56
3.2 Methods	57
3.2.1 Sample and recruitment.....	58
3.2.2 Population.....	58
3.2.3 Assessment tool: design and validity.....	59
3.2.4 Scoring.....	60
3.2.5 Statistical analysis.....	61
3.3 Results	62
3.3.1 Prescribing Competence.....	62
3.3.2 Prescribing Confidence.....	63
3.3.3 Associations between prescribing competence and confidence	64
3.3.4 Legal aspects of prescribing	64
3.3.5 Factors impacting confidence.....	64
3.4 Discussion.....	65
3.5 Conclusion.....	68
3.6 References	74
Chapter 4 : Discussion and conclusion	77
4.1 Summary	77
4.2 Discussion.....	78
4.2.1 Similarities and differences between the scoping review and research project	78

4.2.2 Educational improvements	80
4.2.3 Issues around studying prescribing competence and confidence	82
4.2.4 Quantitative versus qualitative assessment.....	85
4.3 Limitations	85
4.4 Future directions	86
4.4.1 Future studies.....	86
4.4.1.1 Impact of culture on prescribing.....	86
4.4.1.2 National pharmacy student prescribing competence and confidence level	88
4.4.2 Educational initiatives	89
4.5 Conclusion.....	90
4.6 References	91
Bibliography	94
Chapter 1 References	94
Chapter 2 References	99
Chapter 3 References	103
Chapter 4 References	106
APPENDICES.....	109
Appendix A: University of Alberta Ethics Approval.....	109
Appendix B: Information and Informed Consent Form	110
Appendix C: Supplemental document from cross-sectional study.....	113
Appendix D: Comparison table of the WHO Guide to Good Prescribing, the Patient Care Process and the Prescribing Safely Canada Physician Prescribing Competencies	125

List of Tables

Table 2.1	35
Table 2.2	37
Table 2.3	44
Table 2.4	47
Table 2.5	48
Table 3.1	69
Table 3.2	73

List of Figures

Figure 2.1	33
Figure 2.2	34
Figure 3.1	70
Figure 3.2	71
Figure 3.3	72

Chapter 1 : Introduction

1.1 The act of prescribing

As defined by the Oxford dictionary, a prescription is a written instruction from a medical practitioner, authorizing a medication or treatment for a patient. Coombes et al. published a framework describing the four major stages in the act of prescribing: information gathering, clinical decision-making, communication, monitoring and review.¹ Each stage is vital for the overall safety of prescribing decisions. To begin, information about the patient must be gathered. This includes a history of the present illness, past medical and medication history, allergy history, social and lifestyle factors.² Prescribers accomplish this by asking a variety of open and closed-ended questions to ensure they have collected all the relevant information needed to make a prescribing decision. They must also consider the patient's preferences when selecting a safe and effective treatment plan. This can include either non-pharmacological options, pharmacological options or both.² Communication needs to be clear and unambiguous and can be either verbal or written in the form of a prescription.² It is important that both the patient and other healthcare providers are able to understand the treatment plan to prevent unintentional harm to the patient. Monitoring and review provides prescribers the opportunity to discuss when the patient should see the effect of the medications, as well as possible side effects.² Follow-up discussion with the patient or with other healthcare providers involved in the patient's care can also be done at this time.²

The World Health Organization has published a practical manual titled "Guide to Good Prescribing" that is intended to provide guidance and examples of the process of rational prescribing for undergraduate medical students.³ While the majority of the evidence for this

guide comes from the Netherlands, the principles have been used worldwide.³ This process of rational prescribing has four parts: the process of rational treatment (six steps), selecting your P(ersonal)-drugs (five steps), treating your patients and keeping up-to-date.³ Treating your patient combines the first two parts of the rational prescribing process. Keeping-up-to-date on new medications, changes to treatment guidelines, and evaluating the available evidence is an important part of being a competent prescriber.³ The guide outlines ways to stay informed, where to look for new medication information, and how to appraise the literature. These guides for safe and effective prescribing should also apply to all classes of prescribers.³

1.2 Prescribers in Canada

For decades, the concept of prescribing fell solely under the purview of physicians. As the scope of other health professions has expanded, so has the number of health professionals that have been granted the right to prescribe. In Canada, this now includes dentists, midwives, podiatrists, optometrists, nurses and pharmacists.⁴ Each are governed by their provincial or territorial regulatory bodies and have profession-specific restrictions to their prescribing. Physicians and dentists are the only two professions to have prescribing privileges in all provinces and territories. While each profession has their own educational and licensing requirements to become prescribers, the focus of this dissertation will be physician and pharmacist prescribing.

1.2.1 Physician education

In Canada, the number of years between entering a medical degree program and being granted the unrestricted right to diagnose, treat and prescribe medications for patients varies depending on the faculty of study and sought-after specialization. A minimum of two years of

undergraduate study is required prior to entering a faculty of medicine, however many students complete 3 to 4 years of undergraduate training before medical school.⁵ The Association of Faculties of Medicine of Canada (AFMC) is the accreditation body for all medical schools in Canada.⁶ Most medical programs take four-years to complete, with the exception of McMaster University and the University of Calgary which are 3 year programs.^{7,8} Following receipt of a medical degree, an additional 2 to 6 year residency is completed to gain additional experiential education learning under trained physicians through different clinical rotations, i.e. 2 years for family medicine and 6 years for general surgery.⁹ Physicians also undergo licensing and certifying exams throughout their training to be granted unrestricted licensure.⁵

1.2.2 Pharmacist education

In Canada, it is mandated that all pharmacy schools will have entry-level PharmD curriculum in place by 2020.¹⁰ Prerequisite requirements differ between faculties, however the majority require a minimum of 2 years of undergraduate education before entering the program. The Canadian Council for Accreditation of Pharmacy Programs (CCAPP) requires that all pharmacy programs in Canada are a minimum of 4 years, including a minimum of 16 weeks of experiential education.¹¹ Postgraduate training is not a requirement, however, students are able to apply for post-graduate residency programs. Pharmacists must successfully receive the Certificate of Qualification from the Pharmacy Examining Board of Canada in addition to provincial requirements including jurisprudence examinations and practical experience.¹²

1.3 Overview of pharmacist prescribing

Pharmacists partake in a variety of prescribing practices around the world. In some parts of the world, pharmacists can participate in prescribing either as supplemental prescribers or

independent prescribers.¹³ Supplemental prescribing involves a clinical management plan (or equivalent terminology) with a physician, where therapy can be managed by a pharmacist based on an agreed upon treatment plan.¹³ Independent prescribing allows a pharmacist to take full responsibility for their prescribing decisions and plans, with the expectation that they would communicate these decisions to the patient's physician to ensure continuity of care.^{14,15}

Pharmacist prescribing legislation has also been recommended or is pending in some countries, however the countries with the most established prescribing practices include Canada, Australia, the United Kingdom and the United States of America.¹⁶⁻¹⁹

1.3.1 Canada

Pharmacists' ability to prescribe depends on the province or territory in which they work, and the terminology used to define prescribing in different provinces also varies. Prescriptive authority applies to schedule 1 medications, with all provinces currently excluding prescribing of narcotics and controlled substances. Some pharmacists are able to prescribe for a defined list of conditions, often called minor ailments prescribing, while others are limited to only renewing a prescription for continuity of care.²⁰ As of 2007, Alberta is the only province in which pharmacists that have been granted Additional Prescribing Authorization (APA) from the Alberta College of Pharmacy are able to prescribe independently for all schedule 1 medications (excluding narcotics and controlled substances as noted above).¹⁶ Pharmacists in Alberta with APA are also the only population that are able to independently manage ongoing therapy by making therapeutic substitutions or dosage changes to existing prescriptions.²⁰ All pharmacists in Alberta, regardless of their APA status, are able to make therapeutic substitutions on new

prescriptions, to change drug dosage or formulation on new prescriptions and to renew prescriptions for continuity of care.²⁰

A recent survey of pharmacist prescribers in Alberta showed that 93.4% of the respondents had prescribed in some manner.²¹ Most commonly pharmacists were prescribing to adapt new prescriptions by altering doses or substituting medications due to drug shortages. Pharmacists with APA and able to initiate medications only made up 6.3% of respondents and were more likely to adjust ongoing medications than to initiate something new.²¹ Pharmacists were involved in the prescribing of medications for pain control, anticoagulation and mental health conditions.²¹

To become independent prescribers in Alberta, pharmacists must be granted APA from the Alberta College of Pharmacy.¹⁶ Additional courses are not mandatory to receive APA. The application includes a self-assessment and a form describing their current practice site, preparedness to become independent prescribers, and their prescribing judgment.¹⁶ Three patient cases where the pharmacist provided care within the last 2 years must be documented.¹⁶ The cases must include a patient narrative describing the case, and a record of care documenting the following: “assessment, collaboration, care plan development, implementation, monitoring, and follow-up.”¹⁶ Each case must also have a completed case checklist which documents the inclusion of key activities instrumental to making a prescribing decision.¹⁶ These portfolios are then assessed by two raters trained to use the objective criterion-referenced assessment tool, and the applicant will receive the authorization to prescribe if they meet or exceed the minimum standard.¹⁶

1.3.2 Australia

Pharmacists in Australia can prescribe a subset of over the counter “Pharmacy/Pharmacist only” medications.²²⁻²⁴ Australian pharmacists may also extend a prescription as either an emergency supply or a refill on an existing prescription from a physician. Pharmacists are able to refill these prescriptions monthly for up to 12 months if the prescription is still active.²⁵ Pharmacists have a greater role in some prescribing decisions in hospital practice due to increased access to patient information and more contact with healthcare professionals.^{26,27} Unfortunately, pharmacist prescribing has been perceived both positively and negatively within the Australian healthcare environment.^{22,28} Funding and remuneration for pharmacist services has also been a barrier to an expanded scope of practice in Australia.²² In addition, when interviewed, some pharmacists preferred a supplemental prescribing model instead of independent prescribing.²³

1.3.3 United Kingdom (UK)

Supplemental prescribing was approved for pharmacists in the UK in 2003, and pharmacist independent prescribing was approved in 2006.²⁹⁻³¹ Across the UK, all pharmacists are able to apply to be supplemental or independent prescribers if they meet the requirements, meaning that an independent prescriber in Scotland has the same prescribing privileges as an independent prescriber in England.³² This is in contrast to Canada where prescribing privileges vary by province within the country. Pharmacy practice also differs between hospital and community settings, with hospital pharmacists stepping out of the dispensary and providing clinical services including medication reviews, monitoring patients’ therapy and acting as advisors with respect to drug therapy recommendations.^{33,34} Pharmacists in the UK have been

prescribing for the management of cardiovascular, central nervous system, respiratory, endocrine and gastrointestinal diseases.^{31,35}

In the UK, pharmacists with at least 2 years of clinical experience must complete a prescribing course accredited by the General Pharmaceutical Council to become independent prescribers. This consists of the equivalent of 26 days of learning over 3 to 6 months consisting of face-to-face teaching sessions and self-directed study, in addition to mentorship by a physician for at least 12 days.^{29,32,36,37}

1.3.4 United States of America (US)

In the United States, 49 states allow supplemental, or dependent, prescribing as part of collaborative drug therapy management (CDTM) with a physician, and in 5 of those states it includes the prescribing of controlled substances.^{30,32,38-42} Depending on the CDTM, also known as collaborative practice agreements (CPA), pharmacists are able to prescribe medications, modify existing therapy, perform follow up activities and order laboratory tests.^{32,40,43} Currently, 36 states allow for pharmacists to initiate medications in an outpatient setting through a CPA. An additional 12 states limit the CPA to either only inpatient settings or therapy modification.⁴¹ CPA can also be further broken down to patient-specific (i.e. the agreement is between the physician and pharmacist for an individual patient) or population-specific (i.e. the agreement is for a specified medical condition).⁴¹ In 2016, 19 states were limited to patient-specific CPAs, while 17 had both patient and population-specific CPAs in place.⁴¹

Independent prescribing was first introduced by the Florida Department of Veterans Affairs (VA) outpatient clinic.^{14,30} Since then, the VA employs clinical pharmacy specialists that practice as independent prescribers.^{14,42} Conditions commonly managed by pharmacists within

the VA include diabetes, hypertension, hyperlipidemia, anemia, warfarin management and hepatitis C.^{40,42} Other federal agencies including the US Army and the Indian Health Service have since adopted similar pharmacy specialist models.¹⁴ It is important to note that there are two forms of independent prescribing in the US outside of the VA: state-wide protocols and unrestricted category-specific prescribing.⁴¹ A state-wide protocol is similar to a population-specific CPA, however the prescribing protocol is not negotiated between a pharmacist and a physician, and is instead determined by the state government.⁴¹ Unrestricted category-specific prescribing grants prescriptive authority to pharmacists for medications which are not dependent on a diagnosis (i.e. travel immunizations) and reference clinical practice guidelines instead of set protocols.⁴¹ Adams and Weaver reference Connecticut, New Mexico, Nebraska, and Oregon as states with state-wide protocols in place for specific medications.⁴¹ Florida and Idaho are two states that offer unrestricted category-specific prescribing based on specified formularies.⁴¹

While there are no uniform requirements for pharmacists working in supplemental prescribing roles, many pharmacy schools have specific training in CDTM.³² Additionally, there is no centralized training program for pharmacist prescribers, resulting in each institution having their own credentialing requirements.¹⁴

1.4 Patient outcomes

With pharmacists taking on a new role in prescribing, studies are now investigating the impact of pharmacist involvement in a collaborative team, as well as independent prescribers, on patient outcomes.

1.4.1 Pharmacist collaboration or intervention

Pharmacist's interventions have resulted in positive patient outcomes in many different areas. A systematic review and meta-analysis showed that community pharmacist intervention (not prescribing) significantly improved blood pressure control, which could reduce the risk of coronary heart disease and stroke for these patients.⁴⁴ Saleem et al. also concluded that pharmacist intervention has a positive impact on patients with hypertension with respect to medication adherence and health-related quality of life.⁴⁵ A second systematic review investigating pharmacist intervention in patients with chronic kidney disease found improvements in patient outcomes including parathyroid hormone levels, blood pressure, haemoglobin and kidney function.⁴⁶ Pharmacist intervention has also been shown to improve the health related quality of life for asthma patients and improved diabetic control.^{47,48} Al Raiisi et al also found that pharmacists intervened in almost 3000 patient cases, and that their recommendations were accepted by physicians nearly 95% of the time.⁴⁶ A pharmacist-run anticoagulation clinic in Canada was shown to achieve significantly better INR control when compared to usual care, while following a physician-approved protocol, which reduces the risk of complications due to warfarin therapy.⁴⁹

1.4.2 Pharmacist prescribing outcomes

Pharmacist prescribing through CDTM has been shown to significantly reduce patients generalized anxiety severity scores in addition to optimized benzodiazepine use (either discontinuation or dose adjustment).⁵⁰ Recently, a systematic review of pharmacist prescribing practices in the hospital setting was published by Poh et al.⁵¹ It is important to note that this review did not find any studies using an independent prescribing model. One study showed that

pharmacist prescribers were better at managing hypertension patients when comparing pharmacist and physician prescribing.⁵² Two studies concluded that pharmacist prescribers were equal to or better at prescribing for diabetes management when compared to physicians, and that they were also at least as effective as physicians at managing cholesterol levels.⁵²⁻⁵⁵ A Cochrane review of non-medical prescribers, demonstrated an improvement in blood pressure management, haemoglobin A1c and low-density lipoprotein levels, medication adherence, patient satisfaction and quality of life following pharmacist prescribing.⁵⁶ A study in the UK also commented that prescribing pharmacists may have a role in improving the quality of life of patients with chronic pain, however, the authors believe that a larger study is indicated to better assess these outcomes in patients.⁵⁷

Studies have found that Canadian pharmacists' prescribing improved the control of risk factors in previous stroke patients, as well as improved blood pressure control, glycemic control in type 2 diabetics, reduced cholesterol levels and improved quality of life.⁵⁸⁻⁶² Beahm et al. also showed that pharmacists in New Brunswick, Canada were safely prescribing for patients with urinary tract infections. Similar rates of clinical cure and adverse reactions were found between the pharmacist as prescriber arm when compared to the physician as prescriber arm.⁶³ Outcomes were also greatly improved when pharmacists were involved in treating minor ailments, including cold sores, insect bites and seasonal allergies.⁶⁴

1.5 Prescribing confidence and competence

There are currently no widely accepted definitions for prescribing competence or prescribing confidence, possibly because prescribing is a complex activity, as described by the

work of Lum et al.² This thesis focuses both on the confidence, or the strength of a belief, in prescribing correctly, and the competence or measurement of prescribing knowledge or skills.

In recent years, there has been a push towards competency-based education, both in medical and pharmacy education. The Association of Faculties of Pharmacy of Canada (AFPC) updated their Educational Outcomes for pharmacy programs in Canada in 2017.⁶⁵ While AFPC has based their outcomes from both national and international educational resources, it retains the terminology and many similar concepts from the Royal College of Physicians and Surgeons of Canada's (RCPSC) CanMEDS Framework, last updated in 2015.⁶⁶ The key roles included in both AFPC's Educational Outcomes and the CanMEDS Framework include: communicator, collaborator, health advocate, leader-manager, scholar and professional.^{65,66} The two main differences between the two is that the CanMEDS Framework is centralized around the role of "medical expert," whereas the AFPC Education Outcomes has an additional role of "care provider" and is not centralized around a single role.^{65,66} Each role has its own definition and list of key competencies that graduates should be able to complete upon entrance to their respective professions.

Interestingly, the following terms are not present in either document: "prescriber" nor "prescribe." The term "prescription" is used once in the CanMEDS Handover Toolkit, however this is only used in a case scenario.⁶⁷ This is interesting since there is a growing body of literature surrounding prescribing competence, but it is not being represented in either the Educational Outcomes or the CanMEDS Framework. This is especially important from a pharmacy perspective, as scope of practice continues to include prescribing in a number of

countries; it is not one of the core competencies graduates are expected to be able to perform upon graduation.

In 2018, the RCPSC, through collaboration with the British Pharmacological Society, released “The Prescribing Safely Canada - Physician Prescribing Competencies”, which focuses on the competencies required for prescribing, and embeds the roles included in CanMEDS 2015.⁶⁸ The document and developed assessment utilize the Prescribing Safety Assessment (PSA), which is an online assessment used in the UK to evaluate prescribing competencies of fourth year medical students.⁶⁹ While this is an important step to advance the assessment of prescribing competence, it is not required for practice and has a fee to complete the assessment, which may limit its use by practicing physicians.

1.6 Rationale

Pharmacists have extensive education and licensing requirements and are often described as medication experts and one of the most accessible healthcare practitioners.⁷⁰ Research shows positive patient outcomes both with pharmacist intervention and prescribing, however there is little showing that they are prescribing both confidently or competently. As pharmacists prescribing rights increase in countries around the world, more research needs to be done to ensure pharmacists are practicing within their competencies and meeting a minimum standard of practice. Similar research could be beneficial for physicians as well, considering much of the literature focuses on deficits in physicians’ prescribing.^{71,72} This research will help identify areas that need further development to better educate and support pharmacists and physicians to be both confident and competent prescribers. This may result in educational improvements from an

undergraduate level to better prepare students for their future as prescribers. It can also impact future research initiatives to possibly increase the uptake of pharmacist prescribing in practice.

1.7 Objectives

The goal of this thesis was to investigate the competence and confidence levels of fourth year pharmacy and medical students in Alberta with respect to prescribing. The first project focused on completing a scoping review of the literature surrounding pharmacist and physician prescribing confidence and competence. Thematic analysis was conducted to explore common or emergent themes. The second project was a cross-sectional study using a web-based prescribing assessment to determine whether there are differences in prescribing confidence and competence of fourth year pharmacy and medical students at the University of Alberta. Additional objectives of this study were to determine if self-reported confidence and rated competence were correlated, and if students struggled with including all legal requirements of a prescription.

1.8 References

1. Coombes I et al. Pilot of a national inpatient medication chart in Australia: improving prescribing safety and enabling prescribing training. *Br J Clin Pharmacol* 2011; 72: 338-49
2. Lum E et al. The competent prescriber: 12 core competencies for safe prescribing. *Aust Prescr* 2013; 36: 13-6.
3. de Vries T et al. Guide to Good Prescribing. Retrieved from: <https://apps.who.int/medicinedocs/pdf/whozip23e/whozip23e.pdf>
4. Sketris I. Extending Prescribing Privileges in Canada, *Canadian Pharmacists Journal*, 2009; 142(1): 17-19
5. The College of Family Physicians of Canada. Position Statement: Prescribing Rights for Health Professionals; 2010. Retrieved from: https://www.cfpc.ca/uploadedFiles/Resources/Resource_Items/CFPC20Position20Statement20Prescribing20Rights20January202010.pdf
6. Accreditation. The Associations of Faculties of Medicine of Canada; 2019. Retrieved from: afmc.ca/accreditation. <https://afmc.ca/accreditation>
7. MD Program. McMaster University; 2015. Retrieved from: <https://mdprogram.mcmaster.ca/mcmaster-md-program>
8. Welcome to the MD Program. University of Calgary; 2019. Retrieved from: <https://www.ucalgary.ca/mdprogram/>
9. Maman-Dogma J et al. Length of training in postgraduate medical education in Canada. Members of the FMEC PG consortium; 2011. Retrieved from: https://afmc.ca/pdf/fmec/10_Maman%20Dogma_Length%20of%20Training.pdf
10. Association of Faculties of Pharmacy of Canada (AFPC). Position Statement and Joint Resolution on the Doctor of Pharmacy (PharmD) for the First Professional Degree at Universities in Canada; 2010. Retrieved from: https://www.afpc.info/sites/default/files/AFPC_ADPC_PharmD_Position_Statement_Resolution_Sept_2010.pdf
11. Canadian Council for the Accreditation of Pharmacy Programs (CCAPP). Accreditation Standards for Canadian First Professional Degree in Pharmacy Programs. Toronto: Ibid; 2018. Retrieved from: <http://ccapp-accredit.ca/wp-content/uploads/2016/01/Accreditation-Standards-for-Canadian-First-Professional-Degree-in-Pharmacy-Programs.pdf>
12. Pharmacist Qualifying Examination - Introduction. The Pharmacy Examining Board of Canada. Retrieved from: https://www.pebc.ca/index.php/ci_id/3147/la_id/1.htm
13. Tonna AP et al. Pharmacist prescribing in the UK - a literature review of current practice and research. *Clin Pharm Ther* 2007; 32(6): 545-56.
14. Tonna AP et al. An international overview of some pharmacist prescribing models. *Journal of the Malta College of Pharmacy Practice* 2008; 14. 20-26.
15. Alberta College of Pharmacy. Standards of Practice for Pharmacists and Pharmacy Technicians; 2014. Retrieved from: https://abpharmacy.ca/sites/default/files/StandardsOfPractice_May2014_v2.pdf

16. Alberta College of Pharmacy. Guide to Receiving Additional Prescribing Authorization; 2013. Retrieved from: <https://abpharmacy.ca/sites/default/files/APAGuide.pdf>
17. Yariv H. The case of pharmacist prescribing policy in Israel. *Israel Journal of Health Policy Research* 2015; 4, 49.
18. Hatah E. et al. General practitioners' views of pharmacists' current and potential contributions to medication review and prescribing in New Zealand. *Journal of Primary Health Care* 2013; 5(3), 223-233.
19. Malangu, N. The future of community pharmacy practice in South Africa in the light of the proposed new qualification for pharmacists: Implications and challenges. *Global Journal of Health Science* 2014; 6(6), 226-233.
20. Canadian Pharmacists Association. Pharmacists' Scope of Practice in Canada; 2019. Retrieved from: https://www.pharmacists.ca/cpha-ca/assets/File/cpha-on-the-issues/Scope%20of%20Practice%20in%20Canada_July2019.pdf
21. Guirguis L et al. Survey of pharmacist prescribing practices in Alberta. *Am J Health Syst Pharm* 2017; 74(2):62-69.
22. Hanna T et al. Using scenarios to test the appropriateness of pharmacist prescribing in asthma management. *Pharmacy Practice* 2014; 12(1), 390.
23. Hoti K et al. An evaluation of Australian pharmacist's attitudes on expanding their prescribing role. *Pharmacy World & Science* 2010; 32(5), 610-621.
24. Hoti K et al. Pharmacy clients' attitudes to expanded pharmacist prescribing and the role of agency theory on involved stakeholders. *International Journal of Pharmacy Practice*, 2011a; 19(1), 5-12.
25. Hoti K et al. An expanded prescribing role for pharmacists – an Australian perspective. *The Australasian Medical Journal* 2011b; 4(4), 236-242. doi:10.4066/AMJ.2011.694
26. Hoti K et al. Expanded prescribing: A comparison of the views of Australian hospital and community pharmacists. *International Journal of Clinical Pharmacy* 2013; 35(3), 469-475.
27. Kamarudin G et al. Preparing hospital pharmacists to prescribe: Stakeholders' views of postgraduate courses. *International Journal of Pharmacy Practice* 2013; 21(4), 243-251.
28. Bajorek BV et al. Preparing pharmacists to deliver a targeted service in hypertension management: evaluation of an interprofessional training program. *BMC Medical Education* 2015; 15(157), 1-10.
29. Abuzour AS et al. Practice makes perfect: A systematic review of the expertise development of pharmacist and nurse independent prescribers in the United Kingdom. *Research in Social & Administrative Pharmacy* 2018; 14(1), 6-17
30. Faruquee CF, Guirguis LM. A scoping review of research on the prescribing practice of Canadian pharmacists. *Canadian Pharmacists Journal* 2015; 148(6), 325-348.
31. Guillaume L. et al. Supplementary prescribing by community and primary care pharmacists: An analysis of PACT data, 2004-2006. *Journal of Clinical Pharmacy & Therapeutics* 2008; 33(1), 11-16.
32. Hoti K et al. Identifying the perceived training needs for Australian pharmacist prescribers. *International Journal of Pharmacy Practice* 2014; 22(1), 38-46.
33. Auta A et al. Perceived facilitators to change in hospital pharmacy practice in England. *International Journal of Clinical Pharmacy* 2015a; 37(6), 1068-1075.

34. Desborough JA et al. A cost-consequences analysis of an adherence focused pharmacist-led medication review service. *International Journal of Pharmacy Practice* 2012; 20(1), 41-49.
35. McCann L et al. Pharmacist prescribing in Northern Ireland: A quantitative assessment. *International Journal of Clinical Pharmacy* 2011; 33(5), 824-831.
36. Stewart DC et al. Pharmacist prescribing in primary care: The views of patients across Great Britain who had experienced the service. *International Journal of Pharmacy Practice* 2011; 19(5), 328-332.
37. McCann L et al. "They come with multiple morbidities": A qualitative assessment of pharmacist prescribing. *Journal of Interprofessional Care* 2012; 26(2), 127-133.
38. McIntosh T et al. A cross sectional survey of the views of newly registered pharmacists in Great Britain on their potential prescribing role: A cautious approach. *British Journal of Clinical Pharmacology* 2012; 73(4), 656-660.
39. Feehan M et al. Qualitative interviews regarding pharmacist prescribing in the community setting. *American Journal of Health-System Pharmacy* 2016; 73(18), 1456-1461.
40. Todd BA et al. Pharmacist prescribing practices in a clinical pharmacy cardiac risk service. *American Journal of Health-System Pharmacy* 2016; 73(18), 1442-1450.
41. Woolf R et al. Pharmacist prescribing within an integrated health system in Washington. *American Journal of Health-System Pharmacy* 2016; 73(18), 1416-1624.
42. Adams AJ, Weaver KK. The Continuum of Pharmacist Prescriptive Authority. *Annals of Pharmacotherapy* 2016; 50(9), 778-784.
43. Ourth H et al. Clinical pharmacist prescribing activities in the Veterans Health Administration. *American Journal of Health-System Pharmacy* 2016; 73(18), 1406-1415.
44. Cheema E et al. The impact of interventions by pharmacists in community pharmacies on control of hypertension: A systematic review and meta-analysis of randomized controlled trials. *British Journal of Clinical Pharmacology* 2014; 78(6), 1238-1247.
45. Saleem F et al. Pharmacist intervention in improving hypertension-related knowledge, treatment medication adherence and health-related quality of life: a non-clinical randomized controlled trial. *Health Expectations* 2015; 18(5): 1270-81.
46. Al Raiisi F et al. Clinical pharmacy practice in the care of chronic kidney disease patients: a systematic review. *Int J Clin Pharm* 2019; 41: 630.
47. Kheir N et al. Can pharmacists influence the health-related quality of life of patients with asthma? *Squ Journal for Scientific Research* 2001; 3: 69-75.
48. Standing J et al. Impact of pharmacist intervention on diabetes patients in an ambulatory setting. *Diabetes Spectrum* 2009; 22: 241-6
49. Bishop L et al. Patients' and physicians' satisfaction with a pharmacist managed anticoagulation program in a family medicine clinic. *BMC Research Notes* 2015; 8, 233
50. Furbish SML et al. A pharmacist-physician collaboration to optimize benzodiazepine use for anxiety and sleep symptom control in primary care. *Journal of Pharmacy Practice* 2016; 30(4), 425-433.

51. Poh E et al. Effects of pharmacist prescribing on patient outcomes in the hospital setting: a systematic review. *JBI Database of Systematic Reviews and Implementation Reports* 2018; 16(9): 1823–1873.
52. Vivian EM. Improving blood pressure control in a pharmacist-managed hypertension clinic. *Pharmacotherapy* 2002; 22(12): 1533–40.
53. Hawkins DW et al. Evaluation of a clinical pharmacist in caring for hypertensive and diabetic patients. *Am J Hosp Pharm* 1979; 36(10): 1321–5.
54. Jacobs M et al. Pharmacist assisted medication program enhancing the regulation of diabetes (PAMPERED) study. *J Am Pharm Assoc* 2012; 52(5): 613–21
55. Weeks GR, Fyfe R. Hospital pharmacist-led lipid clinic for surgical patients with peripheral vascular disease at a regional Australian hospital. *J Pharm Pract Res* 2012; 42(1): 17–21.
56. Weeks G et al. Non-medical prescribing versus medical prescribing for acute and chronic disease management in primary and secondary care. *Cochrane Database of Systematic Reviews* 2016; 11, CD011227.
57. Bruhn H et al. Pharmacist-led management of chronic pain in primary care: results from a randomised controlled exploratory trial. *BMJ Open* 2013; 3:e002361.
58. Al Hamarneh YN et al. Pharmacist intervention for glycaemic control in the community (the RxING study). *BMJ Open* 2013; 3:e003154.
59. Charrois TL et al. Improving hypertension management through pharmacist prescribing; the rural Alberta clinical trial in optimizing hypertension (Rural RxACTION): trial design and methods. *Implement Sci* 2011;6:94
60. McAlister FA et al. Case management for blood pressure and lipid level control after minor stroke: PREVENTION randomized controlled trial. *CMAJ* 2014;186:577-84.
61. Tsuyuki RT et al. A randomized trial of the effect of pharmacist prescribing on improving blood pressure in the community: the Alberta clinical trial in optimizing hypertension (RxACTION). *Can Pharm J (Ott)* 2014;147:S18.
62. Tsuyuki RT et al. A randomized trial of a community-based approach to dyslipidemia management: Pharmacist prescribing to achieve cholesterol targets (RxACT Study). *Can Pharm J (Ott)* 2016; 149(5): 283-292.
63. Beahm NP et al. Outcomes of urinary tract infection management by pharmacists (RxOUTMAP): A study of pharmacist prescribing and care in patients with uncomplicated urinary tract infections in the community. *Canadian Pharmacists Journal* 2018; 151(5), 305–314.
64. Mansell K et al. Evaluating pharmacist prescribing for minor ailments. *International Journal of Pharmacy Practice* 2015; 23(2), 95-101.
65. Association of Faculties of Pharmacy of Canada. AFPC Educational Outcomes for First Professional Degree Programs in Pharmacy in Canada 2017; 2017.
66. Frank JR et al. CanMEDS 2015 Physician Competency Framework. Ottawa: Royal College of Physicians and Surgeons of Canada; 2015.
67. Bismilla Z, Wong B. Handover Toolkit: A resource to help teach, assess and implement a handover improvement program. Royal College of Physicians and Surgeons of Canada; 2018.

68. Brien S et al. The Prescribing Safely Canada Physician Prescribing Competencies. Royal College of Physicians and Surgeons of Canada; 2018.
69. MSC Assessment and British Pharmacological Society. Prescribing Safety Assessment, 2016. Retrieved from: <https://prescribingsafetyassessment.ac.uk>
70. Alberta Pharmacists Association. 2019. Pharmacy in Alberta. Unpublished data.
71. Ashcroft DM et al. Prevalence, nature, severity and risk factors for prescribing errors in hospital inpatients: Prospective study in 20 UK hospitals. *Drug Safety* 2015; 38(9), 833-843.
72. Coombes ID et al. Why do interns make prescribing errors? A qualitative study. *The Medical Journal of Australia* 2008; 188(2), 89-94.

Chapter 2 : Scoping review

Competence and confidence with prescribing in pharmacy and medicine: a scoping review

Cassandra Voit, BSc Pharm¹

Dr. Nese Yuksel, BSc Pharm, PharmD, FCSHP, NCMP¹

Theresa L. Charrois, BSc PharmACPR, MSc¹

Accepted for publication in the International Journal of Pharmacy Practice

Author Affiliations

1. Faculty of Pharmacy and Pharmaceutical Sciences, University of Alberta, Edmonton, Alberta, Canada

Corresponding Author

Theresa L. Charrois, 3-227 Edmonton Clinic Health Academy, University of Alberta Faculty of Pharmacy and Pharmaceutical Sciences, 11405 - 87 Ave, Edmonton, AB, T6G 1C9; Phone: 1-780-248-5669; Email: tcharroi@ualberta.ca

Keywords:

Word Counts: 220 (Abstract)
2,992 (Text)

Figures: 2

Tables: 5

Abstract

Objectives: Prescribing is a growing scope of practice for pharmacists. The objective of this scoping review is to explore themes within the literature related to prescribing competence and confidence in the fields of pharmacy and medicine.

Methods: Online databases MEDLINE, EMBASE and Global Health were used to identify articles from inception to October 2018. Articles describing either the competence or confidence of physician, pharmacist or student prescribing, including inappropriate prescribing and prescribing errors were included.

Key findings: After applying the inclusion and exclusion criteria, 33 eligible articles remained. Many studies demonstrate that medical students and junior doctors are not competent in prescribing when they enter practice, and their perceived confidence is often higher than their assessed competence. There were fewer studies about pharmacist competence and confidence with prescribing, however they described pharmacists that felt competent to prescribe but lacked confidence. Themes from the review included self-awareness, lack of education and educational improvements, prescribing errors and resources, prescribing culture and barriers to prescribing, gender differences and benefits to prescribing.

Conclusions: There is little consensus from the outcomes of these studies related to prescribing competence or confidence. While some reflect positively on prescribing competence and confidence, others show major deficits in competence and lack of confidence. Further research needs to be done to evaluate pharmacist competence and confidence with respect to prescribing.

2.1 Introduction

Pharmacist prescribing has been practiced in many countries including the United States, the United Kingdom (UK), and Canada.¹ In the United Kingdom, supplementary prescribing was introduced in 2003, and independent prescribing was introduced in 2006; meaning a partnership with a prescriber is not required to make prescribing decisions.² In Canada, there are policies in place for many types of prescribing, including the ability to initiate or adapt prescriptions.^{3,4} Specifically in Alberta, pharmacists can apply for Additional Prescribing Authorization (APA), which is required to initiate prescriptions or prescribe to manage ongoing therapy, which are types of independent prescribing.^{5,6}

Pharmacist intervention has been shown to improve patient outcomes in many studies, including outcomes in hypertension, asthma, and diabetes.^{5,7-9} In Canada, pharmacist prescribing resulted in similar improvements in glucose control for diabetic patients when compared to current physician-prescribing.¹⁰ Pharmacist prescribing has also been shown to significantly reduce blood pressure in patients with hypertension.¹¹ While approximately 46% of practicing pharmacists in Alberta have APA as of January, 2019, it has been a slow progression, and it is unclear whether these pharmacists are actively prescribing (S. Morton, personal communication, January 29, 2019). Recent investigation shows confidence of hospital pharmacists as one of the many factors inhibiting their application for APA.¹² Additional research identified other common reasons for delaying the application for APA, which include the time required for the application and concern about increased responsibility and liability.^{12,13} Having a better understanding of competence and confidence with prescribing can help inform educators and pharmacists on how to better prepare and support pharmacist prescribers. Additionally, if the literature shows

similarities between the two professions, it may encourage pharmacist prescribing where uptake is poor.

Physician prescribing is fundamental to their scope of practice. Research into physician prescribing habits has shown that it can be influenced by drug companies and direct to consumer advertising, and may deviate from guideline recommendations.¹⁴⁻¹⁶ Studies also focus on interventions to improve physician prescribing, some being more effective than others.^{17,18} Some of these interventions included support from a pharmacist, which lead to improved physician prescribing and patient outcomes.^{19,20}

Research has investigated the views of healthcare practitioners, patients and the public on pharmacist prescribing; however, few studies investigate the perspective of pharmacists themselves. Fewer still investigate the factors that influence confidence in prescribing, or to compare these with current medical prescribers.²¹⁻²³

The purpose of this review is to explore the literature related to pharmacist and physician competence and confidence with respect to prescribing to better understand prescribing practices in both disciplines. A scoping review was conducted to explore themes within this literature, in addition to the key findings of the studies.

2.2 Methods

2.2.1 Information sources and search

The literature was searched using MEDLINE via OVID, EMBASE, and Global Health for published research from inception to October 2018. Search terms were developed with the assistance of a librarian and were divided into the population of study (pharmacy and medical students and graduates, interns, residents, pharmacists, physicians and doctors), competence and

confidence, and the act of prescribing. Competence was defined as the ability to do something well, the possession of required skills, knowledge or qualifications and confidence was defined as a belief that one can succeed or do something well. The act of prescribing included all forms of pharmacist prescribing, and the selected terms were “prescribing” and “inappropriate prescribing.”¹ The terms for population, competence and confidence and the act of prescribing were run independently, each being combined with “or” then the three were combined using “and” to obtain the final search pool. The detailed search strategy used for MEDLINE is presented in Figure 2.1. The initial search was completed in January 2017, and then updated in March 2018 and October 2018 to include recently published articles. Hand searches of reference lists of relevant review papers were completed.

2.2.2 Eligibility criteria

Articles were included if they described the act of physician, pharmacist, medical student or pharmacy student prescribing, their level of confidence or competence with respect to prescribing, or inappropriate prescribing or prescribing errors. Abstracts, research protocols, literature reviews and letters were excluded. Articles that focused on patient perspectives, an intervention related to prescribing or prescribing education, a specific medication class or medical condition or other health professional prescribing were also excluded. No limits for language were set.

2.2.3 Screening and data abstraction

The articles were screened in a two-step process. First, independent reviewers (two of either CW, TC or JC) screened titles and abstracts. Second, full-text articles were independently reviewed by two reviewers for inclusion. Throughout the screening process, discrepancies were

resolved by consensus. Information gathered and recorded included: author(s) and year of publication, country of origin, populations of study, practice setting, study design or methodology, data collection methods, and themes (Table 2.1).

2.2.4 Data analysis

Qualitative content analysis was completed by one researcher (CW) and confirmed by another researcher independently (TC) to identify themes within the studies, which were coded using NVivo 12 Pro software. The individual nodes were then auto-coded to identify related themes. Following review, some individual nodes were condensed for better interpretation of the data. Studies were broken down by the healthcare field studied: medicine, pharmacy, or both.

2.3 Results

The complete final search yielded 3267 unique records (Figure 2.2). After title and abstract screening, 204 articles were reviewed in full for eligibility. After applying the inclusion and exclusion criteria, 33 eligible articles remained. From these articles, 8 countries were represented, however the majority of the publications were from the UK (Table 2.1). Twenty-two articles were in the medical profession, 9 were in pharmacy, and only two included both professions.

2.3.1 Characteristics of studies

Study characteristics are shown in Tables 2.2 to 2.4, separated by the healthcare field studied. Study population in the medical field included physicians, medical students, and junior doctors defined as medical interns or first- or second-year residents for the purpose of this review. Study populations in the pharmacy field included pharmacists, pharmacy students, and junior pharmacists defined as pharmacy residents or within the first year of practice for the

purpose of this review. Themes, sample codes and examples are described in Table 2.5, and include self-awareness, lack of education and educational improvements, prescribing errors and resources, prescribing culture and barriers to prescribing, gender differences and benefits to prescribing.

2.3.2 Themes related to competence and confidence

2.3.2.1 Self-awareness

The connection between prescribing competence and confidence was described as self-awareness in some studies.^{24,26,27} Study participants in two independent studies of Nigerian medical interns rated prescribing confidence as sufficient, however these results did not correlate with their awareness of prescribing errors.^{24,40} Ryan et al. reported that junior doctors were aware that they were making prescribing errors, however also rated their self-efficacy for all aspects of prescribing as high.⁴³ Starmer et al. reported that junior doctors perceived confidence scores were higher than measured competence scores.⁴⁴ Results showed that although 19 junior doctors stated that they were 100% confident on over half of the prescriptions they wrote, they were actually correct on less than 8% of them.⁴⁴ In a cross-sectional study by Khan et al., medical students were more confident than junior doctors for a multitude of prescribing activities, the authors questioned whether the medical students may be overconfident in their abilities.³⁷ An earlier cross-sectional study by Khan et al. also reported that medical students were more likely to inappropriately prescribe antibiotics for the common cold compared to their intern counterparts, 41.7% vs 11.6% respectively.³⁶

Brinkman et al. found that when prescribing competence was assessed objectively and students were asked to rate their perceived prescribing confidence, there was a significant but

weak correlation between the two.²⁷ In a later study by Brinkman et al., a significant association between prescribing confidence and fewer inappropriate prescriptions was described.²⁸ Studies in this review also suggested that medical students and interns have low insight or low self-awareness of their prescribing competence, including the frequency of their own prescribing errors.^{24,27,30,44} The opposite has been shown for pharmacist prescribers. When pharmacists were asked to take the Prescribing Safety Assessment (PSA), their overall performance scores were aligned with their self-rated confidence.⁵⁴ Additionally, another study showed that while pharmacist respondents mostly perceived themselves to be competent prescribers, fewer were confident about their knowledge of evidence based treatments, often stating the need for further training.⁴⁸

2.3.2.2 Lack of education and educational improvements

In the studies in this review, students were not satisfied with the frequency of prescribing and the assessment of their prescribing skills during their undergraduate education, and viewed teaching in these areas as inadequate.^{24,28,31,32,34,37,39,45} Medical students were unprepared to prescribe during their intern year, and believed that more teaching in prescribing would be beneficial before postgraduate training began.³¹ Only a minority of junior doctors felt they had adequate pharmacology teaching during their internships.^{35,44,45} Keijsers et al. reported differences between medical students and pharmacy students, showing that pharmacy students had better basic pharmacology knowledge, whereas medical students were better at writing prescriptions.⁵⁵ Educational improvements suggested by study participants included hands-on prescribing training, bedside teaching and clinical scenarios, interdisciplinary education with pharmacy, and ongoing feedback on prescribing skills.^{31,36,37,40,41,45} Some medical students even

suggested shadowing experiences with hospital pharmacists to improve prescribing skills.³¹ Authors also suggested improved access to resources like the WHO Guide to Good Prescribing while in undergraduate courses.^{26,39} Similarly, pharmacist prescribers desired more prescribing training, including more emphasis on the diagnosis of conditions, physical examinations, patient monitoring and consultation skills.^{48,52} The raters in the study by Latter et al. also commented on the room for improvement in pharmacists history taking, assessment and diagnosis skills.⁵¹ In the study by Reid et al., the pharmacists that sat the PSA felt like the prescribing courses they took prior to the study focused more on consultation skills and shared decision making, and did not adequately prepare them for the PSA.⁵⁴

2.3.2.3 Prescribing errors and resources

The types and outcomes of prescribing errors were discussed in many studies. The most common prescription errors included dosage errors, omitting duration or length of treatment, route of administration, omitting patient or prescriber information and instructions for use.^{24,29,31,33,36,42} Al Khaja et al. showed that the majority of medical students (96.1%) completed the physician related components of prescriptions (i.e. prescribers name and signature or patient information), whereas the drug-related components (i.e. appropriateness of therapy, quantity to dispense) were only correctly done by half.²⁵ Another cross-sectional study demonstrated that junior doctors frequently made errors while completing discharge orders from hospital as well.³⁵ In some studies, junior doctors shared their experiences with adverse drug reactions and prescribing errors during their internships. Some of these resulted in adverse drug events including drug toxicity and drug-drug interactions, hospitalization, morbidity and death.^{40,45} Prescribing experience decreased the rate of prescription errors in one study.²⁸ Students who had

written over 10 prescriptions during their undergraduate education had a lower rate of inappropriate prescriptions compared to those who had had written less than 10 prescriptions.²⁸ The lack of use, unfamiliarity or limited access to resources, was related to an increased risk in prescribing errors in both the medical and pharmacy fields.^{24,31,32,44,49} Differences in preferred resources (i.e. non official drug formularies, textbooks and the internet) was also studied.^{36,39,40,45} With respect to pharmacists prescribing errors, one study reviewed hospital pharmacists prescriptions and found an error rate of only 0.3%.⁴⁶ Medical students and interns also valued consulting a pharmacist for help with prescribing.^{30,31,34,41}

2.3.2.4 Prescribing culture and barriers to prescribing

Prescribing confidence and competence was influenced by the behaviours of others, defined here as prescribing culture. Ajemigbitse et al. describes a phenomenon where preceptors often omit certain prescription requirements, for example their name or signature on the prescription. This was observed by junior doctors who incorporated these habits into their own prescribing practice.²⁴ Geoghegan et al. reported a culture where workload pressures and hierarchies guided prescribing, rather than the junior doctors knowledge of adverse effects or drug interactions.³¹ Similar cultures of hospital hierarchies, pressures, and fear of consequences also resulted in a negative impact on junior doctor prescribing.^{41,43} A culture with limited support and low morale was also described.^{24,40} Unfortunately, some junior doctors also reported an ongoing culture of blame at their intern sites, often related to negative experiences with prescribing errors.³⁰ Physician prescribers were shown to be influenced by the cost of medications and pharmaceutical company representatives.⁴¹ Barriers to pharmacist prescribing include lack of confidence, lack of funding, lack of resources and administrative support,

inadequate training in diagnosis and a potential conflict of interest of acting as both prescriber and dispenser.^{47,50,52,53,56} There were also differences in perceived barriers to prescribing depending on whether pharmacy was practiced in a hospital or community setting.⁵⁰ Barriers to pharmacist prescribing, as described by physicians, included patient demand and ensuring to work within areas they were competent in.⁵⁶ Barriers to physician prescribing included workload, stress, multitasking and timesaving strategies.^{24,41,43,44}

2.3.2.5 Gender differences

Although differences between male and female medical students and interns was not a predominant theme in the studies identified in this review, some differences were noted. Brinkman et al. found that female students tended to underestimate their level of competence when compared to their male counterparts.²⁷ These differences may be related to the students levels of self-confidence, however their results were not statistically significant.²⁷ Geoghegan et al. also found differences between male and female medical students, including that males felt that their training had better prepared them to prescribe, whereas females reported higher levels of stress around prescribing.³¹

2.3.2.6 Benefits to prescribing

Benefits to prescribing were exclusively discussed in the studies identified in this review pertaining to pharmacist prescribing. George et al. found that pharmacists participating in supplementary prescribing described better patient management and patient satisfaction.⁴⁷ Pharmacists also perceived greater job satisfaction and recognition of the pharmacy profession by other health professionals.^{47,52} Stewart et al. described a similar outcome of improved patient

care with independent pharmacist prescribers, providing faster access and longer appointments for patients.⁵⁶

2.4 Discussion

The articles in this scoping review allowed for the exploration of pharmacist and physician prescribing practices and themes within the literature. There was little consensus from the studies on prescribing competence or confidence, and clear comparisons were difficult to make due to the majority of the literature studying medical students and junior doctors. A major theme was that students have limited insight into their prescribing habits, even showing a disregard for their prescribing errors, while still rating themselves confident and competent to prescribe.^{24,36,43,44} Additional themes included factors leading to a lack of prescribing competence and confidence like inadequate education or lack of knowledge, experiences with prescribing errors, prescribing culture and barriers to prescribing.^{31,32,34,39,40,45} Less common themes included gender differences affecting prescribing, and for pharmacist prescribers the possible benefits to prescribing.^{27,31,47,52,56}

To our knowledge, this is the first review of its kind, which shows that prescribing is a difficult activity for medical students and junior doctors. This highlights the need for additional research for both physicians and the field of pharmacy. Currently in Alberta, roughly 46% of practicing pharmacists have the authority to prescribe independently; while in 2018 only 11% of pharmacists in the UK were independent prescribers.⁵⁷ Alberta is in a unique position to better study pharmacist prescribing due to a higher percentage of prescribing pharmacists. Research in this area can better support both physicians and pharmacist prescribers to improve prescribing competence and confidence, prevent prescription errors, and improve patient outcomes.

There are some limitations of this review that should be considered. Unfortunately, more than half of the studies did not define the study design, and while the purpose of this scoping review was not to evaluate the quality of the included studies, this may affect conclusions and themes discussed in this review. Additional limitations include that most of the studies were descriptive, and there were too few studies from the field of pharmacy to make clear comparisons between the two professions. Studies may have also been missed due to the search terms selected, particularly not including the term “general practitioner.” Additional studies may have been missed from not completing a search of grey literature.

Previous studies have explored the culture around prescribing without a direct focus on competence or confidence. In the medical field, research has shown that individuals tend to blame failures on external factors, rather than their own abilities or effort.⁵⁸ Previously reported factors that affect junior doctor prescribing also included relationships with patients, peer pressure and ethics.⁵⁹ Pharmacist prescribing was also influenced by the culture in which they practice, including their role, time pressures and the patient’s condition.⁶⁰ Weiss provided positive support for pharmacist prescribing, showing that being a prescriber improved professional self-worth and accountability, and that pharmacists noted improved patient safety and access to care.⁶¹ These results echo what was found in this review, showing that these themes may not be exclusive to prescribing competence or confidence. Pharmacist prescribers also previously acknowledged the cost of medications and pharmaceutical company representatives as possible prescribing influences, which was not discussed in the studies included in this review.⁶⁰

It was also found that while less experienced physicians were thought to be more prone to prescribing errors, they were also more likely to use resources to verify their information before prescribing.^{58,59} Similarly, pharmacists were reported to use resources like medical notes, laboratory results and prescribing guidelines effectively.⁶⁰ Interestingly, senior physicians have been shown to be nonadherent to prescribing protocols, while interns would want to follow them.⁵⁸ The fact that physicians may not follow prescribing guidelines is not a new finding. Schwartz et al. discussed this in 1989, showing that physicians were likely to ignore recommendations from research literature due to their own clinical experiences guiding their prescribing habits.⁶²

2.5 Conclusion

While some studies had positive results for prescribing competence and confidence, others demonstrated poor prescribing competence and little confidence. There was little consensus from the outcomes in the medical field, and limited research in the field of pharmacist prescribing. Further research should be conducted to determine pharmacist prescribing competence and confidence as the scope of the profession expands to better support future pharmacist prescribers.

<input type="checkbox"/>	1	(Pharmacy adj3 graduat*).mp.
<input type="checkbox"/>	2	(medicine adj3 graduat*).mp.
<input type="checkbox"/>	3	Students, Pharmacy/
<input type="checkbox"/>	4	exp "Internship and Residency"/
<input type="checkbox"/>	5	exp Pharmacists/ or Pharmacist*.mp.
<input type="checkbox"/>	6	physician*.mp.
<input type="checkbox"/>	7	exp Physicians/ or doctor*.mp.
<input type="checkbox"/>	8	exp Students, Medical/
<input type="checkbox"/>	9	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
<input type="checkbox"/>	10	Compenten*.mp.
<input type="checkbox"/>	11	confiden*.mp.
<input type="checkbox"/>	12	exp Competency-Based Education/
<input type="checkbox"/>	13	exp Clinical Competence/
<input type="checkbox"/>	14	exp Self Efficacy/
<input type="checkbox"/>	15	10 or 11 or 12 or 13 or 14
<input type="checkbox"/>	16	exp Inappropriate Prescribing/ or prescribing*.mp.
<input type="checkbox"/>	17	9 and 15 and 16

Figure 2.1: Search strategy used for Medline Ovid.

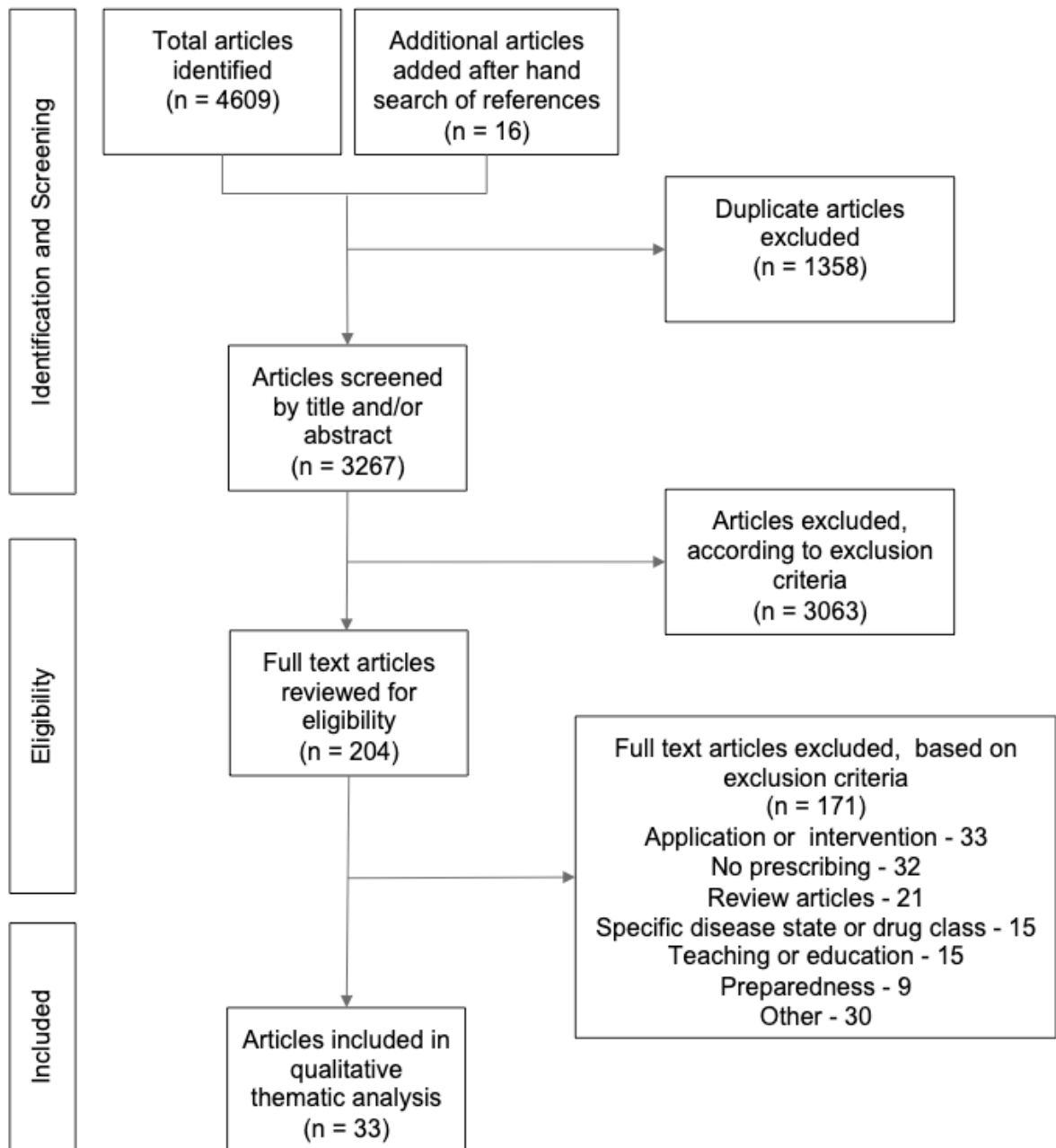


Figure 2.2: PRISMA-ScR Flow Diagram – Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews

Table 2.1: Characteristics of included papers with regard to pharmacist and physician prescribing competence and confidence.

Characteristics	n (%)
Year of publication - 2013-2018 - 2008-2012 - 2002-2007	18 (55) 9 (27) 6 (18)
Country of origin - United Kingdom - Australia - the Netherlands - India - Nepal - Nigeria - Bahrain - Ireland	16 (49) 4 (12) 4 (12) 3 (9) 2 (6) 2 (6) 1 (3) 1 (3)
Study design/methodology - Cross sectional* - Prospective - Case study - Pragmatic - Not defined	9 (27) 3 (9) 2 (6) 1 (3) 18 (55)
Data collection methods** - Survey/questionnaire - Exams (written or oral) - Interview - Chart review	22 (56) 13 (33) 3 (8) 1 (3)
Represented populations** - Junior doctors - Medical students	14 (36) 12 (31)

- Pharmacists	8 (21)
- Junior pharmacists	2 (5)
- Pharmacy students	2 (5)
- Physicians	1 (3)

* One study listed as cross-sectional cohort

** Total out of 39 - some articles studied two different populations or used two study designs

Authors	Country of origin	Population(s) studied	Practice setting	Study design	Data collection methods	Outcome	Themes
Ajemigbitse, AA., et al. 2014 ²⁴	Nigeria	Junior doctors	Hospital	Not defined	Questionnaire	Junior doctors were unaware of making prescribing errors	Barriers Lack of education Prescribing culture Prescribing errors Resources Self-awareness
Al Khaja, KAJ., et al. 2005 ²⁵	Bahrain	Medical students	Not defined	Not defined	Objective structured practical exam	There is limited acquisition of prescribing skills within a problem based learning curriculum	Prescribing errors
Brinkman, DJ., et al. 2014 ²⁶	The Netherlands	Medical students	Not defined	Not defined	1. Therapeutic consultation 2. Questionnaire	Medical students have adequate prescribing skills in their last clerkship and are mostly confident in their prescribing skills.	Educational improvements
Brinkman,	The	Medical	Not defined	Not defined	1. Formative	Overall	Gender

DJ., et al. 2015 ²⁷	Netherlands	students			objective structured clinical examination 2. Questionnaire	prescribing competence was adequate with a weak positive correlation to confidence	differences Self-awareness
Brinkman, DJ., et al. 2017 ²⁸	The Netherlands	Medical students	Not defined	Descriptive, cross-sectional	1. Standardized assessment 2. Questionnaire	Overall lack of prescribing competence linked to inadequate undergraduate teaching	Lack of education
Chapagain, K., et al. 2016 ²⁹	Nepal	Medical students	Hospital	Cross-sectional	Written test	Prescribing skills were unsatisfactory	Prescribing errors
Coombes, ID., et al. 2008 ³⁰	Australia	Medical students	Not defined	Not defined	Survey	Students felt unprepared to prescribe and believed there would be negative outcomes if they committed prescribing errors	Prescribing culture Prescribing errors Resource Self-awareness

Geoghegan, SE., et al. 2017 ³¹	Ireland	Junior doctors	Not defined	Not defined	Survey	Few junior doctors felt their undergraduate education prepared them for prescribing, while the majority felt confident in some aspects of prescription writing	Educational improvements Gender differences Lack of education Prescribing culture Resources
Han, WH., Maxwell, S. 2006 ³²	UK	Junior doctors	Not defined	Not defined	Questionnaire	Graduates did not feel competent to prescribe and described lack of formal teaching and practice of clinical skills related to medications	Lack of education Resources
Harding, S., et al. 2010 ³³	UK	Junior doctors	Hospital	Not defined	Written test	Many junior doctors lacked prescribing knowledge and abilities	Prescribing errors

Heaton, A., et al. 2008 ³⁴	UK	Medical students, junior doctors	Not defined	Not defined	Survey	Few felt confident about writing prescriptions, and the majority felt like education in the safe and effective use of medications was lacking	Lack of education Resources
Hilmer, SN., et al. 2009 ³⁵	UK	Junior doctors	Hospital	Cross- sectional	1. Clinical case 2. Survey	Recent graduates had significant deficits in prescribing skills, and desired more clinical pharmacology training	Lack of education Prescribing errors
Kahn, AKA., et al. 2013 ³⁶	India	Medical students, junior doctors	Not defined	Cross- sectional	Questionnaire	Both students and junior doctors rated their knowledge and attitudes as satisfactory, however antibiotics were prescribed inappropriately and many	Prescribing errors Resources Self-awareness

						prescriptions contained errors and/or omissions	
Kahn, AA, et al. 2014 ³⁷	India	Medical students, junior doctors	Not defined	Cross-sectional	Questionnaire	Respondents were not confident in being able to prescribe and felt that undergraduate education was inadequate	Educational improvements Lack of education Self-awareness
Maxwell, SRJ., et al. 2017 ³⁸	UK	Medical students	Not defined	Not defined	Online assessment	Overall students were able to meet a pre-specified standard of prescribing competence, and prescribing competence may be improving	
Naik, M, et al. 2015 ³⁹	India	Junior doctors	Hospital	Cross-sectional	Questionnaire	Respondents felt that undergraduate education in prescribing was inadequate and were not confident	Educational improvements Lack of education Resources

						in prescribing	
Oshikoya, KA., et al. 2009 ⁴⁰	Nigeria	Junior doctors	Hospital	Not defined	Questionnaire	Undergraduate clinical and therapeutics teaching is inadequate, prescribing confidence was positively linked to the number of clinical rotations completed	Educational improvements Prescribing culture Prescribing errors Resources
Pearson, S-A., et al. 2002 ⁴¹	Australia	Junior doctors	Hospital	Cross-sectional cohort	Interview	Identification of factors that can positively or negatively impact prescribing confidence and competence	Barriers Educational improvements Prescribing culture Prescribing errors Resources
Raunier, GP., et al. 2008 ⁴²	Nepal	Medical students (and dental students - not discussed)	Not defined	Prospective	Objective structured practical examinations	Students had gained few prescribing skills during preclinical teaching resulting in many prescribing errors	Prescribing errors

Ryan, C., et al. 2013 ⁴³	UK	Junior doctors	Not defined	Cross-sectional	Questionnaire	Respondents were confident in prescribing however aware and complacent of their prescribing errors	Barriers Prescribing culture Self-awareness
Starmer, K., et al. 2013 ⁴⁴	Australia	Junior doctors	Hospital	Prospective, exploratory	Questionnaire	Junior doctors felt more confident in their prescribing knowledge compared to their actual knowledge of recently and commonly prescribed medications	Lack of education Resources Self-awareness
Tobaiqy, M., et al. 2007 ⁴⁵	UK	Junior doctors	Hospital	Prospective (but title is a retrospective view)	Questionnaire survey	Junior doctors feel under prepared to prescribe safely and rationally due to limited training in clinical pharmacology and therapeutics	Educational improvements Lack of education Prescribing culture Prescribing errors Resources

Table 2.3: Articles studying prescribing competence and confidence from the pharmacy profession included in the scoping review.							
Authors	Country of origin	Population(s) studied	Practice setting	Study design	Data collection methods	Outcome	Themes
Baqir, W., et al. 2014 ⁴⁶	UK	Pharmacists	Hospital	Pragmatic	Chart review	Hospital pharmacists prescribed for almost 40% of inpatients with a mean prescribing error rate of 0.3%, suggesting they can play a valuable role in safe prescribing	Prescribing errors
George, J., et al. 2006 ⁴⁷	UK	Pharmacists	Hospital Community Primary care medicine	Not defined	Questionnaire	Supplementary prescribing has been implemented and found be beneficial, but more support for integration is needed	Barriers Benefits of prescribing
George, J., et al. 2006 ⁴⁸	UK	Pharmacists	Community	Not defined	Questionnaire	Pharmacists perceived themselves competent in	Educational improvements Self-awareness

						diagnosing and prescribing for common conditions	
Hardisty, J., et al. 2018 ⁴⁹	UK	Pharmacy students, junior pharmacists	Hospital Community	Not defined	Online assessment	Junior pharmacists performed better than undergraduate students, and most respondents felt their education did prepare them for the assessment	Resources
Hoti, K., et al. 2013 ⁵⁰	Australia	Pharmacists	Community Hospital	Not defined	Survey	Differences between hospital and community pharmacists in terms of pharmacist supplementary and independent prescribing	Barriers Prescribing culture
Latter, S., et al. 2012 ⁵¹	UK	Pharmacists (and nurses - not discussed)	GP clinic Walk in clinic Hospital	Case study	Audio recorded consultations	Pharmacists were making clinically appropriate prescribing decisions	Educational improvements

McIntosh, T., et al. 2011 ⁵²	UK	Pharmacists	Community	Not defined	Questionnaire	The majority of respondents were interested in independent prescribing, however felt they needed increased confidence through experience and the need to demonstrate competence as a pharmacist before prescribing	Barriers Benefits Educational improvements
McIntosh, T., Stewart, D. 2016 ⁵³	UK	Junior pharmacists	Community Hospital	Not defined	Interview	Support of pharmacist prescribing, however increased experience felt needed to overcome barriers to prescribing	Barriers
Reid, F., et al. 2016 ⁵⁴	UK	Pharmacists	Primary care	Not defined	1. Online assessment 2. Questionnaire	Pharmacists outcomes were equivalent to medical students	Educational improvements Self-awareness

Table 2.4: Articles studying prescribing competence and confidence from the medical and pharmacy professions included in the scoping review.							
Authors	Country of origin	Population(s) studied	Practice setting	Study design	Data collection methods	Outcome	Themes
Keijsers, CJPW., et al. 2014 ⁵⁵	The Netherlands	Pharmacy students, medical students	Not defined	Cross-sectional	Standardized written test	Pharmacy students had better results in basic pharmacology and medical students had better prescription writing, differences may be due to educational differences	Educational improvements Lack of education
Stewart, DC., et al. 2009 ⁵⁶	UK	Pharmacists, physicians	GP clinic Community Hospital	Qualitative case study	1. Interview 2. Questionnaire	Pharmacists and doctors were supportive of supplementary prescribing while doctors were concerned about independent prescribing	Barriers Benefits of prescribing

Table 2.5: Emergent themes from results of included studies.		
Categories	Sample codes	Example
Barriers	Community, funding, issues, knowledge, patient assessment, patient diagnosis, role, setting, staff, support, time	“Pressures of time, other staff, ‘hospital hierarchies’ and patients are generally believed to have a negative influence on good prescribing practices.” ⁴¹
Benefits to prescribing	Care, patient, satisfaction	“Pharmacists noted benefits of their enhanced job satisfaction, responsibility and autonomy.” ⁴⁷
Educational improvements	Basic pharmacology, clinical practice, common medications, consultation skills, drug dose, drug-drug interactions, prescription writing, resources, scenarios, skills, special patient groups	“When respondents were asked if they had any suggestions to improve prescribing, the emerging theme was that they wanted more teaching in prescribing.” ³¹
Gender differences	Students, female students, male students	“Females were more likely to report feeling stressed than males (P =0.02, 27% vs. 10%).” ³¹
Lack of education	Assessment, basic and clinical pharmacology, errors, formal training, integrated course, knowledge, prescribing skills, scores, teaching, training	“Only 29% of the students felt adequately prepared for their future prescribing task as doctors.” ²⁸
Prescribing culture	Colleagues, doctors, prescribing	“However, their chosen drugs tended to reflect the pattern of ailment they have attended to and their routine prescribing workload, rather than on their knowledge of potential adverse effects of the drugs.” ⁴⁰
Prescribing errors	Discharge, interactions, source	“While 94% of interns documented allergies accurately, including a penicillin allergy, 65% went on to prescribe ticarcillin/clavulanate as instructed by the physician in the case scenario.” ³⁵

Resources	Formularies, guidance, information, knowledge, reasoning, reference, scores	“Their use of reference materials was poor despite measuring low on knowledge scores and confidence scores.” ⁴⁴
Self-awareness	Competence, confidence, knowledge, objective evidence, practice, prescribing, scores, students, trainee doctors, year students	“Interns have a low self-awareness of prescribing errors and would likely benefit from theoretical and practical teaching on what constitutes a properly written prescription.” ²⁴

2.6 References

1. Tonna AP et al. An international overview of some pharmacist prescribing models. *Journal of the Malta College of Pharmacy Practice* 2008; (14): 20-6.
2. Tonna AP et al. Pharmacist prescribing in the UK - a literature review of current practice and research. *Journal of Clinical Pharmacy and Therapeutics* 2007; 32: 545-56.
3. Law MR et al. Independent pharmacist prescribing in Canada. *Can Pharm J (Ott)* 2012; 145(1): 17-23 e1.
4. Canadian Pharmacists Association. Pharmacists' Scope of Practice in Canada. 2016. URL:https://www.pharmacists.ca/cpha-ca/assets/File/pharmacy-in-canada/Scope%20of%20Practice%20in%20Canada_JAN2016.pdf. Accessed: 2019-03-11. (Archived by WebCite® at <http://www.webcitation.org/76njSQ6O6>)
5. Alberta College of Pharmacy. Guide to Receiving Additional Prescribing Authorization. 2013. URL:<https://abpharmacy.ca/sites/default/files/APAGuide.pdf>. Accessed: 2019-03-11. (Archived by WebCite® at <http://www.webcitation.org/76njHZwT9>)
6. Yuksel N et al. Prescribing by pharmacists in Alberta. *Am J Health Syst Pharm* 2008; 65(22): 2126-32.
7. Saleem F et al. Pharmacist intervention in improving hypertension-related knowledge, treatment medication adherence and health-related quality of life: a non-clinical randomized controlled trial. *Health Expectations* 2015; 18(5): 1270-81.
8. Kheir N et al. Can pharmacists influence the health-related quality of life of patients with asthma? *Squ Journal for Scientific Research* 2001; 3: 69-75.
9. Standing J et al. Impact of Pharmacist Intervention on Diabetes Patients in an Ambulatory Setting. *Diabetes Spectrum* 2009; 22: 241-6.
10. Al Hamarneh YN et al. Pharmacist intervention for glycaemic control in the community (the RxING study). *BMJ Open* 2013; 3(9): e003154.
11. Tsuyuki RT et al. Randomized Trial of the Effect of Pharmacist Prescribing on Improving Blood Pressure in the Community. *Circulation* 2015; 132(2): 93-100.
12. Hutchison M et al. Survey of Alberta hospital pharmacists' perspectives on additional prescribing authorization. *American Journal of Health-System Pharmacy* 2012; 69(22): 1983-92.
13. Charrois T et al. Stories from the trenches: Experiences of Alberta pharmacists in obtaining additional prescribing authority. *Can Pharm J (Ott)* 2012; 145(1): 30-4.
14. Zezza MA, Bachhuber MA. Payments from drug companies to physicians are associated with higher volume and more expensive opioid analgesic prescribing. *PLoS One* 2018; 13(12): e0209383.
15. Ezebuenyi MC et al. Evaluation of Physician Prescribing Patterns For Antibiotics in the Treatment of Non-necrotizing Skin and Soft Tissue Infections. *P&T* 2018; 43: 287-92.
16. Becker S, Midoun M. Effects of Direct-To-Consumer Advertising on Patient Prescription Requests and Physician Prescribing: A Systematic Review of Psychiatry-Relevant Studies. *J Clin Psychiatry* 2016; 77: 1293-300.

17. Pinto D et al. Effectiveness of educational outreach visits compared with usual guideline dissemination to improve family physician prescribing—an 18-month open cluster-randomized trial. *Implementation Science* 2018; 13(120).
18. Kamarudin G et al. Educational interventions to improve prescribing competency: a systematic review. *BMJ Open* 2013; 3(8): e003291.
19. Hashimoto Y, Tensho M. Effect of pharmacist intervention on physician prescribing in patients with chronic schizophrenia: a descriptive pre/post study. *BMC Health Services Research* 2016; 16(150).
20. Angalakuditi M, Gomes. Retrospective drug utilization review: impact of pharmacist interventions on physician prescribing. *ClinicoEconomics and Outcomes Research* 2011; 3: 105-8.
21. Hatah E et al. General practitioners' perceptions of pharmacists' new services in New Zealand. *Int J Clin Pharm* 2012; 34(2): 364-73.
22. MacLure K et al. Views of the Scottish general public on non-medical prescribing. *International Journal of Clinical Pharmacy* 2013; 35(5): 704-10.
23. Spencer JA, Edwards C. Pharmacy beyond the dispensary: general practitioners' views. *British Medical Journal* 1992; 304: 1670-2.
24. Ajemigbitse AA et al. Assessment of the knowledge and attitudes of intern doctors to medication prescribing errors in a Nigeria tertiary hospital. *J Basic Clin Pharm* 2013; 5(1): 7-14.
25. Al Khaja KAJ et al. Assessing prescription writing skills of pre-clerkship medical students in a problem-based learning curriculum. *International Journal of Clinical Pharmacology and Therapeutics* 2005; 43: 429-35.
26. Brinkman DJ et al. The Prescribing Performance and Confidence of Final-Year Medical Students. *Clinical Pharmacology & Therapeutics* 2014; 96(5): 531-3.
27. Brinkman DJ et al. Self-reported confidence in prescribing skills correlates poorly with assessed competence in fourth-year medical students. *J Clin Pharmacol* 2015; 55(7): 825-30.
28. Brinkman DJ et al. Essential competencies in prescribing: A first european cross-sectional study among 895 final-year medical students. *Clin Pharmacol Ther* 2017; 101(2): 281-9.
29. Chapagain K et al. Prescribing Skills of First and Second Year MBBS Students of A Teaching Hospital. *J Nepal Med Assoc* 2016; 55(2): 72-5.
30. Coombes ID et al. Safe medication practice: attitudes of medical students about to begin their intern year. *Medical Education* 2008; 42(4): 427-31.
31. Geoghegan SE et al. Preparedness of newly qualified doctors in Ireland for prescribing in clinical practice. *Br J Clin Pharmacol* 2017; 83(8): 1826-34.
32. Han WH, Maxwell S. Are Medical Students Adequately Trained to Prescribe at the Point of Graduation? Views of First Year Foundation Doctors. *Scottish Medical Journal* 2016; 51(4): 27-32.
33. Harding S et al. The performance of junior doctors in applying clinical pharmacology knowledge and prescribing skills to standardized clinical cases. *Br J Clin Pharmacol* 2010; 69(6): 598-606.

34. Heaton A et al. Undergraduate preparation for prescribing: the views of 2413 UK medical students and recent graduates. *British Journal of Clinical Pharmacology* 2008; 66(1): 128-34.
35. Hilmer SN et al. Do medical courses adequately prepare interns for safe and effective prescribing in New South Wales public hospitals? *Intern Med J* 2009; 39(7): 428-34.
36. Khan AKA et al. Assessment of the Prescribing Knowledge, Attitude and Skills of Medical Students and Interns in a Large Teaching Hospital of Southern India. *Biomedical & Pharmacology Journal* 2013; 6(1): 63-9.
37. Khan AA et al. How confident are the students and interns to prescribe - an assessment based on their views and suggestions? *National Journal of Physiology, Pharmacy & Pharmacology* 2014; 4(2): 138-42.
38. Maxwell SRJ et al. Prescribing Safety Assessment 2016: Delivery of a national prescribing assessment to 7343 UK final-year medical students. *Br J Clin Pharmacol* 2017; 83(10): 2249-58.
39. Naik M et al. A questionnaire-based study to assess rational prescribing practice among interns. *National Journal of Physiology, Pharmacy and Pharmacology* 2015; 5(4): 323-7.
40. Oshikoya KA et al. Interns' knowledge of clinical pharmacology and therapeutics after undergraduate and on-going internship training in Nigeria: a pilot study. *BMC Med Educ* 2009; 9(50).
41. Pearson S-A et al. Factors influencing prescribing: an intern's perspective. *Medical Education* 2002; 36: 781-7.
42. Raunier GP et al. Prescription Writing Skills of Pre-Clinical Medical and Dental Undergraduate Students. *J Nepal Med Assoc.* 2008; 47(172): 197-200.
43. Ryan C et al. Junior doctors' perceptions of their self-efficacy in prescribing, their prescribing errors and the possible causes of errors. *Br J Clin Pharmacol* 2013; 76(6): 980-7.
44. Starmer K et al. Blind prescribing: A study of junior doctors' prescribing preparedness in an Australian emergency department. *Emergency Medicine Australasia* 2013; 25(2): 147-53.
45. Tobaiqy M et al. Foundation year 1 doctors and clinical pharmacology and therapeutics teaching. A retrospective view in light of experience. *Br J Clin Pharmacol* 2007; 64(3): 363-72.
46. Baqir W et al. Pharmacist prescribing within a UK NHS hospital trust: nature and extent of prescribing, and prevalence of errors. *European Journal of Hospital Pharmacy* 2015; 22(2): 79-82.
47. George J et al. Supplementary Prescribing: Early Experiences of Pharmacists in Great Britain. *The Annals of Pharmacotherapy* 2006; 40: 1843-9.
48. George J et al. Independent prescribing by pharmacists: a study of the awareness, views and attitudes of Scottish community pharmacists. *Pharm World Sci* 2006; 28(2): 45-53.
49. Hardisty J et al. Exploring the utility of the Prescribing Safety Assessment in pharmacy education in England: experiences of pre-registration trainees and undergraduate (MPharm) pharmacy students. *Int J Pharm Pract* 2018.
50. Hoti K et al. Expanded prescribing: a comparison of the views of Australian hospital and community pharmacists. *Int J Clin Pharm* 2013; 35(3): 469-75.

51. Latter S et al. Are nurse and pharmacist independent prescribers making clinically appropriate prescribing decisions? An analysis of consultations. *J Health Serv Res Policy* 2012; 17(3): 149-56.
52. McIntosh T et al. A cross sectional survey of the views of newly registered pharmacists in Great Britain on their potential prescribing role: a cautious approach. *Br J Clin Pharmacol* 2011; 73(4): 656-60.
53. McIntosh T, Stewart D. A qualitative study of UK pharmacy pre-registration graduates' views and reflections on pharmacist prescribing. *Int J Pharm Pract* 2016; 24(2): 139-41.
54. Reid F et al. Piloting the United Kingdom 'Prescribing Safety Assessment' with pharmacist prescribers in Scotland. *Research in Social and Administrative Pharmacy* 2018; 14(1): 62-8.
55. Keijsers CJPW et al. A comparison of medical and pharmacy students' knowledge and skills of pharmacology and pharmacotherapy. *British Journal of Clinical Pharmacology* 2014; 78(4): 781-8.
56. Stewart DC et al. Views of pharmacist prescribers, doctors and patients on pharmacist prescribing implementation. *International Journal of Pharmacy Practice* 2009; 17(2): 89-94.
57. Robinson, J. The trials and triumphs of pharmacist independent prescribers. *The Pharmaceutical Journal*, 2018; 300(7911), online, DOI: 10.1211/PJ.2018.20204489, Accessed: 2019-08-06
58. Duncan EM et al. Learning curves, taking instructions, and patient safety: using a theoretical domains framework in an interview study to investigate prescribing errors among trainee doctors. *Implementation Science* 2012; 7: 1-13.
59. Upadhyaya P et al. Prescribing knowledge in the light of undergraduate clinical pharmacology and therapeutics teaching in India: views of first-year postgraduate students. *Advances in Medical Education and Practice* 2012; 3: 47-53.
60. Abuzour AS et al. Factors influencing secondary care pharmacist and nurse independent prescribers' clinical reasoning: An interprofessional analysis. *J Interprof Care* 2018; 32(2): 160-8.
61. Weiss MC, Sutton J. The changing nature of prescribing: pharmacists as prescribers and challenges to medical dominance. *Sociol Health Illn* 2009; 31(3): 406-21.
62. Schwartz RK et al. Physician motivations for nonscientific drug prescribing. *Soc Sci Med* 1989; 28: 577-82.

Chapter 3 : Research Project

Pharmacy and medical students' competence and confidence with prescribing: a cross-sectional study

Cassandra Voit, BSc Pharm¹

Dr. Nese Yuksel, BSc Pharm, PharmD, FCSHP, NCMP¹

Theresa L. Charrois, BSc Pharm, ACPR, MSc¹

Author Affiliations

1. Faculty of Pharmacy and Pharmaceutical Sciences, University of Alberta, Edmonton, Alberta, Canada

Corresponding Author

Theresa L. Charrois, 3-227 Edmonton Clinic Health Academy, University of Alberta Faculty of Pharmacy and Pharmaceutical Sciences, 11405 - 87 Ave, Edmonton, AB, T6G 1C9; Phone: 1-780-248-5669; Email: tcharroi@ualberta.ca

Keywords: Confidence, Competence, Medicine, Pharmacy, Prescribing

Word Counts: 245 (Abstract)

3,468 (Text)

Figures: 3

Tables: 2

Abstract

Objective: Previous research has shown that prescribing competence is weakly correlated with prescribing confidence and has questioned whether undergraduate programs adequately prepare students and junior practitioners for safe and rational prescribing. The goal of this project is to investigate whether there are differences in prescribing competence and confidence between fourth year pharmacy and medical students at the University of Alberta.

Methods: A cross-sectional design was used to measure prescribing competence using five case scenarios and confidence with a survey. All fourth-year pharmacy and medical students at the University of Alberta were eligible to participate. Answers to the cases were graded based on therapeutic appropriateness and inclusion of all legal requirements. The confidence survey assessed self-rated confidence of both assessment and prescribing skills. Chi-square tests were used to compare frequencies of prescribing errors and self-rated confidence responses. The Spearman correlation coefficient (r) was used to explore the correlation between prescribing competence and confidence for both cohorts independently.

Results: Thirty-one pharmacy students and 16 medical students (response rate 24% and 10%, respectively) completed the assessment between December 2018 and March 2019. Pharmacy students had significantly more appropriate prescriptions and fewer inappropriate prescriptions than medical students. Both rated themselves as predominantly confident or very confident with prescribing, however both groups struggled with the legal requirements of a prescription.

Conclusion: There are differences in prescribing competence and confidence between pharmacy and medical students. This assessment identified deficits in prescribing skills that could be targeted by future educational initiatives.

3.1 Introduction

Pharmacists in Canada are able to participate in a variety of prescribing activities, ranging from collaborative to independent prescribing.¹ In Alberta, pharmacists with Additional Prescribing Authorization (APA) are able to independently prescribe schedule 1 medications.² Currently, 46% of practicing pharmacists in Alberta have been granted this designation.³ Pharmacists in Alberta also have access to patients laboratory results, consultation reports, and medication history through an electronic health record to facilitate prescribing decisions. Pharmacist intervention and prescribing has also been shown to improve a variety of medical conditions and subsequent patient outcomes including hypertension, diabetes and anticoagulation management.⁴⁻¹⁰

Prescribing is a complicated task that comes with its own risks of errors. Some believe that independent pharmacist prescribing may increase the rate of prescribing errors, as it removes the “double check” of a pharmacist reviewing a physician’s prescription before it is dispensed to a patient.^{11,12} Although pharmacists have been prescribing independently for over a decade, little research has been done to study prescribing competence and confidence in a pharmacist population.^{13,14} Unfortunately, many studies investigate prescribing errors in the medical field. Prescribing errors are commonly studied in a hospital setting, however there are conflicting reports of whether they occur during the hospital admissions process, at initiation during stay or at discharge.¹⁵⁻¹⁹ Errors often occur during patient history taking and assessment, resulting in errors at the prescribing stage.^{20,21} Certain classes of medications are related to higher rates of prescribing errors, including antihyperglycemics, antibiotics, narcotics, cardiovascular and gastrointestinal medications.^{15,17,22,23} Some studies suggest the most frequently reported type of

prescribing error is under or over dosing, followed by incorrect directions for administration or omission of therapy.^{20,24,25}

A scoping review we recently completed exploring prescribing in the fields of pharmacy and medicine found varying degrees of prescribing competence and confidence.²⁵ The majority of studies focused on medical students and doctors within two years of graduation, with some showing favourable results and others demonstrating a deficit in prescribing competence and confidence.²⁵ We found that upon entrance to practice, medical students are not prescribing competently, and that they may have inflated levels of confidence in prescribing.²⁵ Many medical students also reported a lack of preparation during their undergraduate education, specifically around the act of prescribing. While there were few studies investigating pharmacist or pharmacy student prescribing, their findings suggest that pharmacists felt they would be competent prescribers but lacked confidence.²⁵

Based on the results of the scoping review, a cross-sectional study was carried out to determine if there are differences in prescribing confidence and competence among fourth year pharmacy and medicine students at the University of Alberta. Additional objectives of the study were: to determine if there is a correlation between prescribing competence and confidence; to determine if students struggle more with certain aspects of prescribing such as the clinical aspects or legal aspects; and to explore the factors that impact prescribing confidence.

3.2 Methods

We completed a cross-sectional study looking at the competence and confidence of pharmacy students from the Faculty of Pharmacy and Pharmaceutical Sciences and medical students from the Faculty of Medicine and Dentistry at the University of Alberta using a

standardized online assessment consisting of five clinical case scenarios, each followed by a confidence survey.

3.2.1 Sample and recruitment

All fourth-year students from the Faculty of Pharmacy and the Faculty of Medicine were invited to participate in the study. From December 2018 to March 2019, students were recruited on a voluntary basis. One researcher (CW) contacted class and faculty representatives with the request to share the study information, including the information sheet, informed consent form, and link to the confidential assessment powered by Qualtrics.²⁶ Reminders were sent monthly, first through the classes Facebook pages, then by faculty email when possible. Students were able to complete the assessment at a time that was convenient for them and using any references they preferred as they would in practice. There was no time limit set for the completion of the assessment. The study was approved by the University of Alberta Research and Ethics Board.

3.2.2 Population

There are expected differences between the two cohorts due to the individual program requirements, including the amount of schooling completed before entering their current degree and the program structure. Program requirements for the 2015-2016 year for the Faculty of Pharmacy and Pharmaceutical Sciences (the year of admission for the study population) included a minimum of 30 prerequisite credits. The program outline included lectures and laboratories in the first three years of the program, with the fourth year consisting of 4 months of clinical rotations and specialization electives. There were also two streams of the pharmacy program represented; the BSc. Pharmacy program and the PharmD program. The PharmD students completed an additional 4 months of clinical rotations compared to the BSc. Pharmacy students.

Additional rotations included a one-month rotation in community pharmacy completed after the first year, and a two-week rotation in hospital pharmacy completed after the second year.

Program requirements and experiential education opportunities have changed following the introduction of the Entry to Practice PharmD Program in 2018.²⁷

For entry into the Doctor of Medicine Program, there are no prerequisite courses, as students can be enrolled in any baccalaureate degree program. In the 2015-2016 academic year, a minimum of 60 credits was needed to be completed prior to applying, twice as many as their pharmacy counterparts. The first two years include system-based course-work, elective credits, skills labs and two clinical rotations termed physicianships (one per year). Years 3 and 4 are comprised of a variety of physicianships, also known as clerkship, which vary in specialization and duration.²⁸ Prerequisites have changed now to require either the completion of an undergraduate degree or the for students to be in the final year of their degree.

3.2.3 Assessment tool: design and validity

The web-based assessment tool was created by the study team using previously published cases and confidence survey tools. Five case scenarios were selected and modified. These scenarios were identified from cases used in the European Study of Prescribing Competencies, the Faculty of Pharmacy and Pharmaceutical Sciences practice skills courses, and Patient Interview Competition from the Canadian Association of Pharmacy Students and Interns.²⁹ The confidence survey was adapted from the European Study of Prescribing Competencies and assessed the students' confidence in three areas: their prescribing assessment, the prescription itself and the legal aspects of prescribing.²⁹ The confidence survey utilized a four-point scale from very unconfident to very confident. (Appendix C - supplemental document)

The case scenarios were selected based on content students in both programs would have covered in their studies or during experiential learning. The information was presented in the same format and a working diagnosis was provided, as the goal of the assessment was to test students' ability to prescribe, not to diagnose. Students were able to write two prescriptions per case including discontinuation prescriptions, for a possible total of 10 prescriptions per student. Students were asked to complete a confidence survey for each written prescription.

The face and content validity of the clinical case scenarios and the confidence survey were established by expert reviewers (n = 4 pharmacists, 1 physician). To ensure the functionality of the web-based assessment software, one full case scenario was piloted on pharmacy students in their fourth year of study prior to full launch of the assessment (n = 4).

3.2.4 Scoring

The marking scheme published by Brinkman et al., adapted from the EQUIP classification scheme, was chosen a priori to be used to rate each prescription.²⁹ Using this marking scheme, choice of therapy was classified as either appropriate, suboptimal or inappropriate based on the previously developed marking rubric. Inappropriate had three subcategories including not immediately harmful, potentially harmful and potentially lethal.²⁹ An appropriate prescription would include the correct drug, dose, dosage frequency, duration, and route. Any prescription that did not include all of these requirements was defined as a prescribing error. The marking rubric for the cases was based on corresponding Canadian and American resources and prescribing guidelines (Appendix C - supplemental document).³⁰⁻³² Two blinded, independent raters (CW, AS) assessed each prescription, and discrepancies were resolved by a third rater (TC). The proportion of absolute agreement between CW and AS was 91%.

Two raters (CW, AS) also assessed each prescription for the legal requirements using a checklist, developed by the investigators based on the Alberta College of Pharmacy's standards of practice.³³ The modified checklist included 9 of the 11 items from the standards of practice. For this study, it was decided to merge "prescriber's name and phone number" and "prescriber's signature." This item was considered complete if the student wrote the prescriber's name. Based on the standards of practice, a prescription requires the patient's name and address, however we considered this item complete if the prescription had the patient's name. Due to the lack of legal guidance for writing a discontinuation prescription, discontinuation prescriptions were not considered when evaluating including the legal requirements of a prescription.

The only required question on the online assessment was whether students had read the information and informed consent forms and agreed to participate in the study. Students were not prompted throughout the assessment to complete the confidence survey if they had written a prescription. If a student wrote a prescription but did not complete the associated confidence survey, that prescription was removed from the analysis. If a student did not complete the full assessment, their responses were also removed from the analysis. These partial responses could not be included because the demographic section, including which faculty the student was in, was at the end of the assessment.

3.2.5 Statistical analysis

Descriptive statistics were used to characterize the cohorts. The competence and confidence ratings of each prescription were summed per respondent per case, and then summed for an overall total for each of the pharmacy and medical student cohorts. Chi-square tests or Fisher's exact test (when any cell had an expected count <5) were used to calculate p-values

associated with frequencies of prescribing errors and self-rated confidence levels with profession as the independent variable. The Spearman correlation coefficient (r) was used to explore the relationship between rated competence and self-rated confidence across all prescribing skills. A p -value < 0.05 was considered significant. The data was analyzed using Stata/IC 15.1. A qualitative content analysis was performed to explore the factors influencing confidence. The data was coded and managed using NVivo software.

3.3 Results

Thirty-one pharmacy students and 16 medical students (response rate 24% and 10%, respectively) completed the assessment between December 2018 and March 2019 (Table 3.1). Nine additional students began the assessment however it was not completed, therefore their partial answers were excluded from the analysis. The median age of participants was 24 years (age range of 21 to 29), 65% were female and 53% had completed a degree prior to starting their current program. The mean time to complete the assessment was 47 minutes and 21 seconds ($\pm 35:34$) and the median number of resources used per participant was 2.

Pharmacy students wrote 231 out of a possible 310 prescriptions, while medical students wrote 111 out of a possible 160 prescriptions. Three prescriptions written by pharmacy students and 7 prescriptions written by medical students were excluded from the final analysis due to missing confidence surveys, resulting in a total of 228 and 104 prescriptions, respectively.

3.3.1 Prescribing Competence

Pharmacy students wrote significantly more prescriptions rated as “appropriate” (170/228 vs 56/104, $p < 0.001$) and significantly fewer prescriptions rated as “inappropriate” (38/228 vs 19/104, $p = 0.002$) in comparison to medical students (Figure 3.1). Compared to pharmacy

students, medical students had more prescriptions rated as “inappropriate, potentially harmful” (2/228 vs 6/104, $p = 0.016$) and “inappropriate, potentially lethal” (4/228 vs 9/104, $p = 0.006$).

For results from each individual case see Appendix C - supplemental document.

Due to the working diagnosis in cases 4 and 5, students were expected to discontinue an inappropriate medication if they prescribed a new appropriate medication. In case 4, when students prescribed a new antibiotic, only 68% of pharmacy students and 44% of medical students discontinued the previous antibiotic (21/31 vs 7/16, $p = 0.112$). In case 5, when students initiated a novel oral anticoagulant, 71% of pharmacy students and 47% of medical students also wrote a prescription to discontinue warfarin (22/31 vs 7/15 $p = 0.069$).

Evaluating the total number of prescribing errors, 25% of pharmacy students’ prescriptions contained prescribing errors, compared to 46% of medical students’ prescriptions (58/228 vs 48/104, $p < 0.001$) (Figure 3.1). The most common prescribing error for pharmacy students was that the prescription lacked a route of administration (16/228, 7%, Appendix C - supplemental Table 3.3), whereas the most common prescribing error for medical students was not adjusting a medication dose for the patient’s renal function which could result in serum drug levels likely to be toxic and cause patient harm (9/104, 9%, Appendix C - supplemental Table 3.3).

3.3.2 Prescribing Confidence

Figure 3.2 shows the cumulative results of all the confidence surveys for both pharmacy and medical students. The majority of pharmacy and medical students rated themselves as confident/very confident across all prescribing skills (89% and 75%, respectively). The statement with the highest proportion of responses of very confident and confident for pharmacy students

was for “assessing the safety of medication options based on the patient’s allergies”, and for medical students it was “assessing the patient’s presenting symptoms” (Figure 3.3). The proportion of responses of very unconfident and unconfident for pharmacy students was equal between “prescribing the correct duration of therapy” and “considering possible contraindications or warnings,” and for medical students it was “considering possible contraindications or warnings” (Figure 3.3).

3.3.3 Associations between prescribing competence and confidence

For pharmacy students, there was a positive weak correlation between competence and confidence ($r = 0.1386$). For medical students, there was negative weak correlation between competence and confidence ($r = -0.2325$). Neither resulted in statistically significant correlations ($p = 0.4572$ and $p = 0.3862$, respectively).

3.3.4 Legal aspects of prescribing

All students included the drug name for every prescription, however this was the only component completed on every prescription. With the exception of providing a route of administration, pharmacy students were significantly more likely to include each of the other legal requirements of a prescription. Only 59% of pharmacy students and 23% of medical students had at least 80% of the required elements on every prescription (108/183 vs 21/90, $p < 0.001$) (Table 3.2).

3.3.5 Factors impacting confidence

Analysis of the written responses to “What factors impacted your confidence in these assessment/prescribing skills (i.e. related to the case, your education, etc.)?” identified two factors that improved confidence and two factors that decreased confidence. Education was a

common factor identified by the students that improved confidence, with students stating they had worked on similar cases during their program. Clinical experience was another factor that improved confidence, which included the completion of clinical rotations and participation in teaching clinics. Lack of experience in certain therapeutic areas or disease states was identified as a factor that decreased confidence, and also applied to uncertainty around writing discontinuation prescriptions. The second factor that decreased students reported confidence was the feeling that additional information was required to make a prescribing decision, even though it was stated throughout the assessment that all the pertinent information had been provided in the case scenario.

3.4 Discussion

The main objective of this study was to determine if there were differences in prescribing competence and confidence between pharmacy and medical students. This study found that pharmacy students wrote more prescriptions that were classified as appropriate and fewer inappropriate prescriptions than the medical students. Pharmacy students were also more likely to rate themselves as very confident with respect to their prescribing decisions. Interestingly, pharmacy students took more time to complete the assessment and used a variety of resources (Table 3.1). Results from our scoping review showed that unfamiliarity with available resources was associated with increased prescribing errors, which may be related to the higher proportion of prescribing errors committed by medical students.²⁵

An emergent theme in the literature surrounding prescribing competence and confidence is a lack of self-awareness around prescribing. This has been described as either inflated confidence with lower assessed competence, or a lack of awareness of prescribing errors in

practice.^{25,34-36} In our study, pharmacy and medical students were quite confident in their prescribing, however the rate of prescribing errors was higher than previously published work for both disciplines.^{35,37,38} The fact that neither groups resulted in significant correlations between prescribing competence and confidence also differs from previous studies. For example, Brinkman et al. found a weak but significant association between prescribing competence and confidence for fourth year medical students.³⁹

With respect to the awareness of the legal requirements of prescriptions, 91% of pharmacy students and 78% of medical students were confident or very confident that they included the legal requirements of a prescription (206/227 vs 81/104). This was not mirrored in the results, as many required elements were missing from the students' prescriptions. Pharmacy students are introduced to the legal requirements of a prescription in their first year and focus on assessing prescriptions for appropriateness and completeness throughout their degree, however they have limited experience writing prescriptions. Medical students are provided with one online module on the legal and regulatory guidelines of prescription writing before beginning clinical placements in their third year. Further review and assessment of the legal requirements of prescriptions could be beneficial for both populations.

Al Khaja previously published that medical students were more efficient at completing the prescriber portions of prescriptions like prescribers name and signature when compared to the drug components of prescriptions (i.e. appropriateness of therapy).⁴⁰ In contrast, our results show that medical students completed the prescribers name or signature in only 19% of the prescriptions, compared to 69% of pharmacy students' prescriptions (Table 3.2). With respect to the drug components of prescriptions, Al Khaja concluded that medical students completed these

correctly only half of the time.⁴⁰ Our results were similar for medical students, with roughly 54% of their prescriptions deemed appropriate, whereas 75% of pharmacy students' prescriptions were deemed appropriate (Figure 3.1).

This study had many limitations, including a low response rate resulting in a small sample of pharmacy and medical students from a single university. While our response rate for both groups was low, low survey completion rate is common for emailed or web-based surveys.⁴¹ Our study was also limited by not being able to compute an a-priori sample size since there was no previous study to base an estimated effect size. There is also a risk of self-selection bias for the students who decided to participate in the study. Students that participated may believe they are more confident or competent at prescribing, which could inflate our results.

The number of partial responses is unfortunate since they would have resulted in a more robust sample size. We were also unable to conclude whether the partial responses were due to survey fatigue or issues with the online assessment. Some of the prescriptions we had to exclude due to missing confidence surveys were discontinuation prescriptions. Again, we cannot conclude whether this was due to confusion about the directions for the confidence survey or a general lack of understanding of the requirements for discontinuation prescriptions. Finally, we cannot conclude that the time to complete the assessment is accurate as the web browser may have been open prior to starting the assessment, resulting in potentially longer times.

In contrast, strengths of this study include patient cases that students could see in practice. It also offered the students the opportunity to complete the assessment on their own time, without the possible effect of test anxiety on their results. They were also able to use resources that they were familiar with, which would mimic what they would do in practice. We

also believe our sample of students is a good representation of both medical and pharmacy students based on previous literature. The cases were previously trialled in previous research studies or assessments, and the rating scheme and confidence survey were based on published tools. Having a second rater also increased assessment consistency of the written answers.

3.5 Conclusion

To the best of our knowledge this is the first study of its kind to compare prescribing confidence and competence between pharmacy and medical students. Pharmacy and medical students differed both in assessed competence, the types of prescribing errors made, and their self-rated confidence. Both groups of students had difficulties including all the legal requirements of a prescription. The differences in prescribing confidence and competence between the two cohorts are likely multifactorial, including differences in educational and practical experiences. This assessment offers a real-world application of prescribing knowledge and skills that can help identify areas of prescribing deficits in pharmacy and medical students. It could also be further applied to medical residents, in addition to practicing physicians and pharmacists.

Table 3.1: Demographic characteristics of respondents on an online assessment of prescribing competence and confidence of fourth year pharmacy students (N = 31) and medical students (N = 16) at the University of Alberta.		
	Pharmacy	Medicine
Median Age (in years)** (range)	23 (21-28)	26 (23-29)
Gender ⁺		
- Female <i>n</i> (%)	20 (67)	11 (69)
Years in university prior to current degree, <i>n</i> (%)		
- Number of years** mean (median)	2.9 (2)	3.9 (4)
- 1	1 (3)	0
- 2	15 (48)	2 (13)
- 3	2 (7)	2 (13)
- 4	12 (39)	9 (56)
- Other <i>n</i> (%)	1 (3)	3 (19)
Previous degree, <i>n</i> (%)		
- No previous degree***	28 (58)	4 (25)
- Undergraduate	13 (42)	10 (63)
- Graduate	0	2 (13)
For pharmacy students only: stream of program, <i>n</i> (%)		
- BSc Pharm	7 (23)	
- PharmD	24 (77)	
Average number prescriptions written (mean ± SD)	7.35 ± 1.47	6.5 ± 1.75
Average time to complete assessment (min:sec) (mean±SD)	58:29 ± 38:58	27:11 ±14.18
Resources used, <i>n</i>		
- Median number of resources used per student	3	1
- Total number of references used	11	3

Mann Whitney U test used for comparison of means, Chi-square test or Fisher's exact test (when any cell had an expected count <5) used to calculate p-values associated with frequencies, significant at ** p-value < 0.01 and *** p-value <0.001.

⁺ for pharmacy Total out of 30 - 1 respondent did not specify gender.

[∇] Two pharmacy students times were excluded as outliers (over 24 hours)

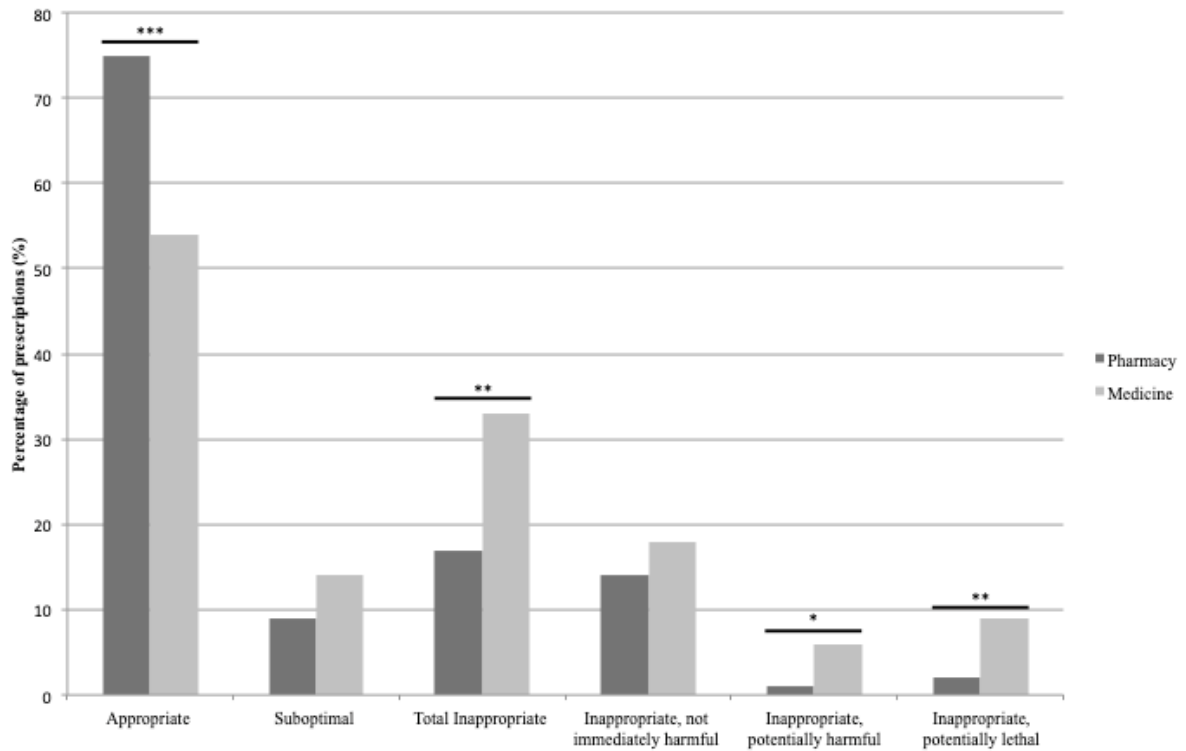


Figure 3.1: Percentage of prescriptions rated based on their appropriateness using a marking scheme adapted from Brinkman et al. 2017.²⁹ Total number of prescriptions included (N = 228 for pharmacy, N = 104 for medicine). Chi-square test or Fisher’s exact test (when any cell had an expected count <5) used to calculate p-values associated with frequencies. * p-value < 0.05, ** p-value < 0.01 and *** p-value <0.001

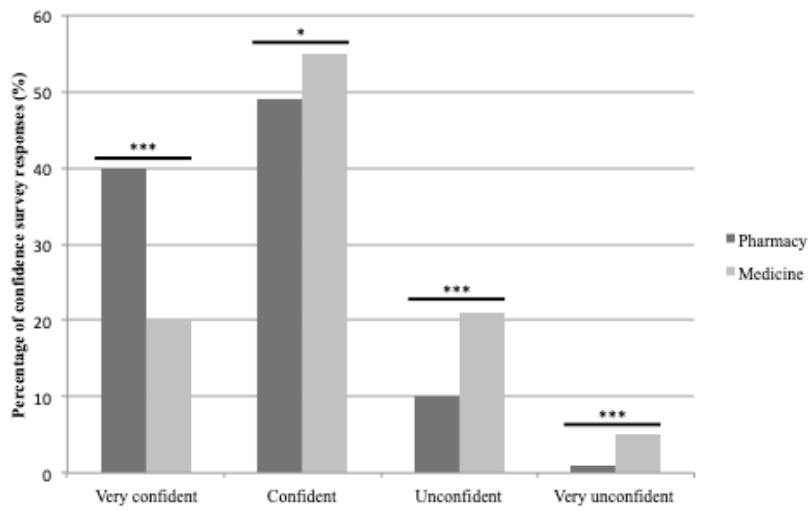


Figure 3.2: Results from the confidence surveys following each prescription. Pharmacy (N = 1822 (228 prescriptions x 8 questions on confidence survey)) Medicine (N = 832 (104 prescriptions x 8 questions on confidence survey)). Chi-square test used to calculate p-values associated with frequencies. * p-value < 0.05, ***p-value <0.001

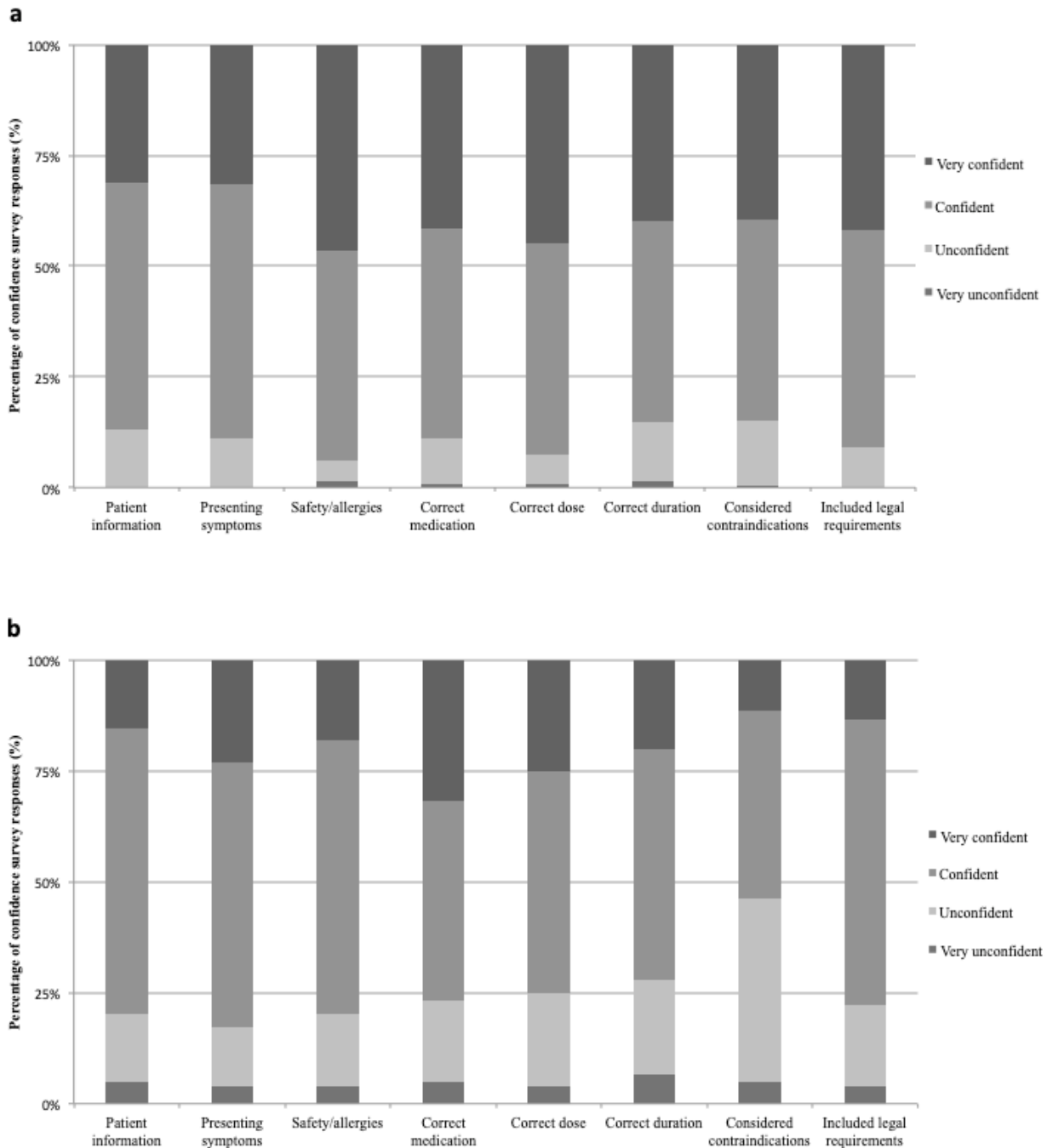


Figure 3.3: Responses from the confidence survey, categorized by survey questions. a) Pharmacy students. b) Medical students. Complete survey questions are as follows: Considered all the relevant patient information; assessed the patient’s presenting symptoms; assessed the safety of medication options based on the patient’s allergies; prescribed the correct medication; prescribed the correct dose; prescribed the correct duration of therapy; considered possible contraindications or warnings; included all the legal requirements for a prescription.

Table 3.2: Legal requirements included on the prescriptions controlling for discontinuation prescriptions (N = 183 for pharmacy, N = 90 for medicine).

	Pharmacy n (%)	Medicine n (%)	p-value ⁺
Name and/or address of the patient	116 (63)	21 (23)	<0.001
Drug name	183 (100)	90 (100)	N/A
Drug strength	183 (100)	84 (93)	0.001
Route	156 (85)	83 (92)	0.101
Quantity	178 (97)	80 (89)	0.008
Directions for use	182 (99)	84 (93)	0.006
Number of refills	77 (42)	26 (29)	0.035
Prescriber's name and/or signature	127 (69)	17 (19)	<0.001
Date	119 (65)	21 (23)	< 0.001
Met at least 80% of requirements	108 (59)	21 (23)	<0.001
Met 100% of requirements	55 (30)	8 (9)	<0.001

⁺ Chi-square test or Fisher's exact test (when any cell had an expected count <5) used to calculate p-values associated with frequencies.

3.6 References

1. Canadian Pharmacists Association. Pharmacists' Scope of Practice in Canada. 2019. Retrieved from: https://www.pharmacists.ca/cpha-ca/assets/File/cpha-on-the-issues/Scope%20of%20Practice%20in%20Canada_July2019.pdf
2. Alberta College of Pharmacy. Guide to Receiving Additional Prescribing Authorization. 2013. Retrieved from: <https://abpharmacy.ca/sites/default/files/APAGuide.pdf>
3. Saleem, F., Hassali, M. A., Shafie, A. A., Ul Haq, N., Farooqui, M., Aljadhay, H., Ahmad F. U. Pharmacist intervention in improving hypertension-related knowledge, treatment medication adherence and health-related quality of life: a non-clinical randomized controlled trial. *Health Expect.* 2015;18(5): 1270-81
4. Standing, J., Herrmann, J., Walters, R., Destache, C., Chock, A. Impact of pharmacist intervention on diabetes patients in an ambulatory setting. *Diabetes Spectrum.* 2009;22: 241-6
5. Bishop L., Young, S., Twells, L., Dillon, C., Hawboldt, J. Patients' and physicians' satisfaction with a pharmacist managed anticoagulation program in a family medicine clinic. *BMC Res Notes.* 2015;8, 233
6. Charrois, T. L., McAlister, F. A., Cooney, D., Lewanczuk, R., Kolber, M. R., Campbell, N. R., . . . Tsuyuki, R. T. Improving hypertension management through pharmacist prescribing; the rural Alberta clinical trial in optimizing hypertension (rural RxACTION): Trial design and methods. *Implement Sci.* 2011;6, 94.
7. McAlister, F. A., Majumdar, S. R., Padwal, R. S., Fradette, M., Thompson, A., Buck, B., Dean, N., Bakal, J. A., Tsuyuki, R., Grover, S., Shuaib, A. Case management for blood pressure and lipid level control after minor stroke: PREVENTION randomized controlled trial. *CMAJ.* 2014;186: 577-84.
8. Tsuyuki, R. T., Houle, S. K. D., Charrois, T. L., Kolber, M. R., Rosenthal, M. M., Lewanczuk, R., . . . RxACTION Investigators*. Randomized trial of the effect of pharmacist prescribing on improving blood pressure in the community: The Alberta clinical trial in optimizing hypertension (RxACTION). *Circulation.* 2015;132(2), 93-100.
9. Tsuyuki, R. T., Rosenthal, M., Pearson, G. J. A randomized trial of a community-based approach to dyslipidemia management: Pharmacist prescribing to achieve cholesterol targets (RxACT Study). *Can Pharm J (Ott).* 2016;149(5): 283-292.
10. Kelly, K., Vaida, A. J. Double checks are worth the time they take. *Pharmacy Times.* 2003. Retrieved from: <https://www.pharmacytimes.com/publications/issue/2003/2003-09/2003-09-7375>
11. Feehan, M., Durante, R., Ruble, J., Munger, M. A. Qualitative interviews regarding pharmacist prescribing in the community setting. *Am J Health Syst Pharm.* 2016;73(18), 1456-1461. doi://dx.doi.org/10.2146/ajhp150691
12. Cope, L. C., Abuzour, A. S., & Tully, M. P. Nonmedical prescribing: where are we now?. *Ther Adv Drug Saf.* 2016;7(4), 165-172.
13. Law, M. R., Ma, T., Fisher, J., & Sketris, I. S. Independent pharmacist prescribing in Canada. *Can Pharm J (Ott).* 2012;145(1), 17-23.e1.

14. Ashcroft, D. M., Lewis, P. J., Tully, M. P., Farragher, T. M., Taylor, D., Wass, V., . . . Dornan, T. Prevalence, nature, severity and risk factors for prescribing errors in hospital inpatients: Prospective study in 20 UK hospitals. *Drug Saf.* 2015;38(9), 833-843.
15. Coombes, I. D., Stowasser, D. A., Coombes, J. A., Mitchell, C. Why do interns make prescribing errors? A qualitative study. *Med J Aust.* 2008;188(2), 89-94.
16. Dean, B., Schachter, M., Vincent, C., & Barber, N. Prescribing errors in hospital inpatients: Their incidence and clinical significance. *Qual Saf Health Care.* 2002;11(4), 340-344.
17. Hilmer, S. N., Seale, J. P., Le Couteur, D. G., Crampton, R., Liddle, C. Do medical courses adequately prepare interns for safe and effective prescribing in New South Wales public hospitals?. *Intern Med J.* 2009;39(7), 428-434.
18. Tully, M. P., Buchan, I. E. Prescribing errors during hospital inpatient care: Factors influencing identification by pharmacists. *Pharm World Sci.* 2009;31(6), 682-688.
19. Benkirane, R. R., Abouqal, R., Haimeur, C. C., S Ech Cherif El Kettani, Salma S, Azzouzi, A. A., Mdaghri Alaoui, A. A., . . . Soulaymani, R. R. Incidence of adverse drug events and medication errors in intensive care units: A prospective multicenter study. *J Patient Saf.* 2009;5(1), 16-22.
20. Patanwala, A. E., Warholak, T. L., Sanders, A. B., Erstad, B. L. A prospective observational study of medication errors in a tertiary care emergency department. *Ann Emerg Med.* 2010;55(6), 522-526.
21. Abramson, E. L., Malhotra, S., Fischer, K., Edwards, A., Pfoh, E. R., Osorio, S. N., . . . Kaushal, R. Transitioning between electronic health records: Effects on ambulatory prescribing safety. *J Gen Intern Med.* 2011;26(8), 868-874.
22. Ajemigbitse, A. A., Omole, M. K., Osi-Ogbu, O. F., & Erhun, W. O. A qualitative study of causes of prescribing errors among junior medical doctors in a Nigeria in-patient setting. *Ann Afr Med.* 2013;12(4), 223.
23. Bordman, R., Bajcar, J., Kennie, N., Fernandes, L., Iglar, K. Curriculum to enhance pharmacotherapeutic knowledge in family medicine: Interprofessional coteaching and web-based learning. *Can Fam Physician.* 2013;59(11), 493.
24. Lexchin, J. Improving the appropriateness of physician prescribing. *Int J Health Serv.* 1998;28(2), 253-267.
25. Voit, C., Yuksel, N., Charrois, T. L. Competence and confidence with prescribing in pharmacy and medicine: a scoping review. In print, 2019.
26. Qualtrics. [Computer software]. 2019. Provo, Utah, USA. Available from: <https://www.qualtrics.com>
27. Faculty of Pharmacy and Pharmaceutical Sciences. Doctor of Pharmacy (PharmD) Admission Requirements. Retrieved from: <https://www.ualberta.ca/pharmacy/programs/pharmd-doctor-of-pharmacy/prospective-students-2018/admission-requirements>
28. Faculty of Medicine and Dentistry. Curriculum. Retrieved from: <https://www.ualberta.ca/medicine/programs/md/curriculum>
29. Brinkman, D. J., Tichelaar, J., Schutte, T., Benemei, S., Bottiger, Y., Chamontin, B., . . . Working Group Research on CPT Education of the European Association for Clinical Pharmacology and Therapeutics (EACPT). Essential competencies in prescribing: A first

- European cross-sectional study among 895 final-year medical students. *Clin Pharmacol Ther.* 2017;101(2), 281-289.
30. CPS [Internet]. Ottawa (ON): Canadian Pharmacists Association; c2016. Available from: <http://www.e-therapeutics.ca>. Also available in paper copy from the publisher.
 31. Lexi-Drugs. In Lexicomp Online [Internet]. Hudson, Ohio: Wolters Kluwer Clinical Drug Information, Inc. 2019. Available from <https://online.lexi.com/lco/action/home>. Registration and login required.
 32. DynaMed [Internet]. Ipswich (MA): EBSCO Information Services. 1995. Available from <http://www.www.dynamed.com>. Registration and login required.
 33. Alberta College of Pharmacy. Standards of Practice for Pharmacists and Pharmacy Technicians, Standard 6. 2014. Retrieved from: https://abpharmacy.ca/sites/default/files/StandardsOfPractice_May2014_v2.pdf
 34. Oshikoya, K. A., Senbanjo, I. O., & Amole, O. O. Interns' knowledge of clinical pharmacology and therapeutics after undergraduate and on-going internship training in Nigeria: A pilot study. *BMC Med Educ.* 2009;9, 50.
 35. Ryan, C., Ross, S., Davey, P., Duncan, E. M., Fielding, S., Francis, J. J., . . . Bond, C. Junior doctors' perceptions of their self-efficacy in prescribing, their prescribing errors and the possible causes of errors. *Br J Clin Pharmacol.* 2013;76(6), 980-987.
 36. Starmer, K., Sinnott, M., Shaban, R., Donegan, E., & Kapitzke, D. Blind prescribing: A study of junior doctors' prescribing preparedness in an Australian emergency department. *Emerg Med Australa.* 2013;25(2), 147-153.
 37. Cousins, D., Crompton, A., Gell, J., Hooley, J. (2019). The top ten prescribing errors in practice and how to avoid them. *The Pharmaceutical Journal*, 302(7922), online | DOI: 10.1211/PJ.2019.20206123
 38. Baqir W et al. (2015). Pharmacist prescribing within a UK NHS hospital trust: nature and extent of prescribing, and prevalence of errors. *European Journal of Hospital Pharmacy*; 22(2): 79-82
 39. Brinkman, D. J., Tichelaar, J., van Agtmael, M. A., de Vries, Theo P G M, & Richir, M. C. Self-reported confidence in prescribing skills correlates poorly with assessed competence in fourth-year medical students. *J Clin Pharmacol.* 2015;55(7), 825-830.
 40. Al Khaja, K A J, Handu, S. S., James, H., Mathur, V. S., & Sequeira, R. P. Assessing prescription writing skills of pre-clerkship medical students in a problem-based learning curriculum. *Int J Clin Pharmacol Ther.* 2005;43(9), 429-435
 41. Yun GW, Trumbo CW. Comparative response to a survey executed by post, e-mail, & web form. *J Compu-Mediated Com.* 2000;6.

Chapter 4 : Discussion and conclusion

4.1 Summary

This thesis investigated prescribing competence and confidence in the fields of pharmacy and medicine. The two projects that were completed included a scoping review and a cross-sectional study. The first project consisted of a scoping review of the literature surrounding prescribing confidence and competence to explore themes in the literature¹. Major themes from the review included self-awareness, lack of education and educational improvements, prescribing errors and resources, prescribing culture and barriers to prescribing. Minor themes included benefits to prescribing (specific to the pharmacy profession) and gender differences.¹ The majority of the research was conducted with medical students or junior doctors, and there was limited evidence for pharmacy students or pharmacists. With respect to the included literature on prescribing competence or confidence, there was little consensus from the outcomes of these studies, indicating a need for additional research in this area.¹

The second project consisted of a cross-sectional study using a web-based prescribing assessment to determine whether there were differences in prescribing competence and confidence of fourth year pharmacy and medical students at the University of Alberta.² The results showed that both pharmacy and medical students rated themselves as mostly confident, although there were varying levels of prescribing competence between the two groups. Pharmacy students wrote more appropriate prescriptions, had fewer prescribing errors, and rated themselves as more confident with prescribing than the medical students.² There were no significant correlations between competence and confidence scores. Additionally, medical students struggled more with including all the legal aspects of a prescription.²

4.2 Discussion

Four main topics will be discussed based on the findings of the scoping review and research project. First, the results from the scoping review and research project will be reviewed to explore similarities and differences. Second, the results of the research project will be used to discuss potential educational improvements at the University of Alberta and beyond. Third, issues around studying prescribing competence and confidence will be reviewed. Finally, a brief comment on theoretical concepts often used to assess prescribing will be made.

4.2.1 Similarities and differences between the scoping review and research project

There were both similarities and differences between the results from the scoping review and the research project. One similarity was related to prescribing competence and confidence in the field of pharmacy. The studies related to pharmacists' competence in the scoping review found that pharmacists felt they would be competent prescribers, and one study found that prescribing competence and confidence were positively aligned.¹ Findings from the research study mirrored the results of the scoping review, which showed that pharmacy students were rated as more competent at prescribing compared to the medical students. The pharmacy students also rated themselves as confident prescribers.²

One finding that differed between the scoping review and research study was how the medical students rated their self-confidence. The majority of the studies from the scoping review found that medical students were not confident in their prescribing skills.¹ However, in our research project the medical students rated themselves as mostly confident in prescribing. They also linked their confidence to their education and clinical experiences.² This is in contrast to studies in the scoping review which reported low confidence due to a lack of prescribing

education during their undergraduate degrees.¹ Pharmacy students from our study also stated education and experience as positive influences on prescribing confidence, however the scoping review found that pharmacists were unhappy about content of prescribing courses offered in their respective country.^{1,2}

Additionally, the scoping review found that there was an increased risk of prescribing errors due to the lack of use or unfamiliarity of resources for both junior doctors and pharmacy students.¹ In contrast, many pharmacy students in our study reported the use of and familiarity with resources as a positive impact on their prescribing confidence.² We found that pharmacy students used a wider variety of resources compared to the medical students, however it also took more time for the pharmacy students to complete the assessment.² The use of multiple resources could have affected the pharmacy students competence and confidence with prescribing, however in practice it may not be feasible to spend extended periods of time consulting references.

None of the medical students commented on the use of resources in the study. Although it is not known how medical students are taught to use resources, they have similar access to resources as the pharmacy students through the online university library system. One resource that medical students have access to, and which almost half of the study participants used during the assessment, is the software system UpToDate³. At this time, pharmacy students do not have free access to UpToDate. Medical students may be relying on the single resource as it presents a comprehensive synthesis of evidence followed by therapeutic recommendations, therefore they may not have felt the need to utilize additional resources.

Finally, both pharmacy and medical students struggled with including the legal requirements of a prescription in the study. This differed from the scoping review findings, where studies found that medical students were proficient at including the prescriber information on prescriptions.^{1,2} While pharmacy students have more experience assessing prescriptions, both pharmacy and medical students have few opportunities for formal education and assessment of the legal requirements of prescriptions. Pharmacy students have a lecture-based component to learn the legal requirements in addition to some small group activities during their program to assess these skills. Medical students have only one online module to recognize the legal and regulatory guidelines of prescription drugs, with no formal assessment of their learning (Coumont, Personal communication, August 8, 2019). Prescribers are now also using computerized systems to generate prescriptions, although the required elements are the same regardless of whether prescriptions are written or printed. This should be further addressed during both their undergraduate degrees as missing elements on a prescription can lead to confusion and errors.

4.2.2 Educational improvements

Pharmacy and medical students commented that a lack of experience with prescribing decreased their confidence.² This lack of experience could also impact their prescribing competence. One intervention that has shown to improve prescribing competence in medical students is the use of the World Health Organization's Guide to Good Prescribing.⁴ Upon review of this guide, there are many similarities to the Patient Care Process used to teach pharmacy students a systematic and standardized approach to patient assessment, which could also extend to making prescribing decisions (Appendix D).⁵ To the best of our knowledge, no similar tool or

process is taught to medical students at the University of Alberta. Within the CanMEDS Framework, the steps of taking a patient history, establishing goals of therapy and determining appropriate procedures or therapies are discussed, however there is no additional guidance for how to successfully complete these steps.⁶ They are discussed broadly and describe both medical procedures and therapies; they do not specify whether these are medications or prescription therapies.

Looking at the frequency of prescribing errors in our study, 25% of pharmacy students prescriptions and 46% of medical students prescriptions included prescribing errors.² While we cannot conclude that pharmacy students committed fewer errors because of the education they receive, it may be an area of improvement for the medical students curriculum to include something similar to either the Guide to Good Prescribing or the Patient Care Process to improve prescribing. In addition, although it may look promising that pharmacy students are committing fewer prescribing errors than the medical students, these rates are both higher than previously published studies in both medicine and pharmacy.⁷⁻⁹ It is important to note that studies assessing medication errors vary in design, prescribing or medication errors often go unreported and the definitions of prescribing errors can vary.^{1,10,11} This makes it difficult to come to a consensus on the frequency of prescribing errors or level of prescribing competence in practice. It is also unclear what would be considered an “acceptable” or “expected frequency” of prescribing errors in practice. Sondalini discusses human error rates in a variety of situations.¹² I believe prescribing could fall between a routine task with care needed and a complicated non-routine task, depending on the complexity of the patient.¹² Sondalini reported the respective error rates for these tasks as 1 error in 100 to 1 error in 10, which is similar to values reported in previous

literature.¹² This error rate could be used as a benchmark for future prescribing competency assessments.

The Royal College of Physicians and Surgeons of Canada released a document titled “The Prescribing Safely Canada Physician Prescribing Competencies” in May 2018, in conjunction with the Prescribing Safely Canada online assessment.¹³ This document has similarities to both the Guide to Good Prescribing and the Patient Care Process (Appendix D). I would argue that these competencies should be introduced during the first two years of medical students’ undergraduate education, to better prepare them to prescribe independently in their future practice. AFPC could also look to this competency document to guide the development of an Educational Outcome for prescribing.

4.2.3 Issues around studying prescribing competence and confidence

Literature in Alberta has been exploring the implementation of pharmacist prescribers in various settings, in addition to assessing the positive impact that pharmacist intervention and prescribing can have on patient outcomes.¹⁴⁻¹⁸ This type of research is different than the research studying physician prescribing, which often focuses on prescribing errors and concerns about deficiencies in medical education.¹ This makes it difficult to compare these two professions with respect to prescribing competence and confidence. One systematic review has shown that there were no differences between supplemental pharmacist prescribers and physicians prescribing of warfarin or thromboembolism prophylaxis, and that pharmacists were more likely to adhere to prescribing guidelines.¹⁹ Additionally, it showed that pharmacists made fewer prescribing errors and medication omissions.¹⁹ These results are consistent with our research project that found that pharmacy students made fewer prescribing errors than the medical students.² A limitation of this

systematic review is that it did not include studies comparing physicians with independent prescribers. Supplemental pharmacist prescribers are required to follow prescribing agreements or collaborative practice agreements. These often guide prescribing decisions or limit prescribing to a subset of conditions or medications. This could increase the pharmacists prescribing competence or confidence in the included studies and limit the generalizability of the study findings to pharmacy practice in Alberta.

The literature also shows that prescribing is more than just writing instructions on paper and involves effective clinical reasoning to make a prescribing decision.²⁰⁻²² An additional recommendation to improve prescribing includes more hands-on prescribing experiences. A study by Tichelaar investigated the effect of different levels of realism of learning context on prescribing competency.²³ The students were exposed to three levels of realism and were then asked to write prescriptions. The minimal context included a basic chart review, the medium context included the development of a treatment plan to be used in a future patient consultation, and the optimal context involved the student preparing a treatment plan which they themselves would perform.²³ The WHO six step plan was used to assess the students written treatment plans. The step that is of interest for this thesis is the improvement they found in step 4, “write a prescription.”²³ As the level of realism increased, so did the students prescribing competence.²³ When this study is compared to our research project, our online assessment would be classified as a minimal context. It would be interesting to see the differences in prescribing decisions and the prescription writing skills if the same cases were used in observed structured clinical examinations. This study highlights the effect of different education and learning styles on

prescribing outcomes and suggests that more “hands on” education could help improve prescribing competence.

In contrast, another study found that the majority of prescribing errors committed by junior doctors in Scotland were unintentional, often described as a slip due to a failure of attention.²⁴ The authors argued that since most errors were unintentional, there would be less impact from educational improvements compared to improving the working conditions causing the prescribing errors.²⁴ Prescribing culture discussed in the scoping review that could lead to prescribing errors included workload pressures and limited support.¹ Additional studies have found that junior doctors were less concerned about committing prescribing errors because they believed their mistakes would be identified by pharmacists or other healthcare practitioners before they reached the patient.²⁴⁻²⁶ This concept has been discussed by junior doctors in a hospital setting as having a “safety net” when they are prescribing.²⁶ It is concerning that junior doctors in these studies did not feel responsible for preventing prescribing errors or for writing appropriate prescriptions. Even with proper education and work environments, it may be difficult to prevent prescribing errors if junior doctors do not feel responsible for the outcomes of their prescriptions.

These findings reinforce that differences in assessment styles and study types can result in ambiguous conclusions with respect to prescribing competence and confidence. They also indicate that prescribing habits and skills can be influenced by both the education received and the culture in which new graduates practice. Both undergraduate education and work culture may need to be targeted by interventions to improve prescribing.

4.2.4 Quantitative versus qualitative assessment

There are a number of theoretical constructs used to study both prescribing competence and confidence. One theoretical construct that is often used when studying confidence is Albert Bandura's theory of self-efficacy.²⁷ Bandura defines self efficacy as the belief in one's capability to produce effects.²⁷ Bandura stated that individuals with a strong sense of efficacy often set challenging goals and are able to stay committed to them in the face of adversity.²⁷ While the students participating in our study may have a higher level of self-efficacy, as demonstrated by challenging themselves with the prescribing assessment, this was not the intended purpose of the confidence survey. Our goal was to quantitatively assess prescribing competence and confidence, not explore student's perceived self-efficacy of prescribing in general. For this reason, a theoretical framework was not used in the development of the research project.

4.3 Limitations

Limitations of the scoping review included the fact that over half of the included studies did not define the study design used. This makes it difficult to draw clear conclusions from their results. The limited number of studies in the field of pharmacy also hindered our ability to compare prescribing confidence and competence between the two professions. Finally, we may have missed relevant studies from not completing a grey literature search, and by not including the term general practitioner in our search strategy.

Limitations of the research project include a low response rate, inability to calculate the sample size a priori due to lack of an existing effect size, as well as the risk of self-selection bias. Additionally, there were a number of partial responses that could not be included in the final assessment and some prescriptions had to be excluded due to the lack of an accompanying

confidence survey. The use of competence and confidence tools that were not validated in our study population is another limitation. The face and content validity of the cases from the European Study of Prescribing Competencies was established for a medical student population in the Netherlands, however the cases had to be altered to represent Canadian practice.²⁸ Both the cases from the Faculty of Pharmacy and Canadian Association of Pharmacy Students and Interns had been previously used in a pharmacy student population in Alberta, and both had been reviewed by practicing pharmacists before use, however neither had been used in a medical student population. While the face and content validity of the competence and confidence tools for the study were established by expert reviewers, no statistical analysis had been completed to confirm internal consistency prior to study commencement.

4.4 Future directions

The results from the scoping review and research project were used to create the following recommendations for both future research and educational initiatives. Two future research projects that could utilize the online assessment from the research project include a study of the impact of culture on prescribing and a study on the national level of prescribing competence and confidence of Canadian pharmacy students. There are also a number of suggested educational initiatives that could be implemented to improve prescribing competence of both pharmacy and medical students at the University of Alberta.

4.4.1 Future studies

4.4.1.1 Impact of culture on prescribing

Our study found that fourth year pharmacy and medical students viewed themselves as confident prescribers, however their prescriptions still contained a high proportion of prescribing

errors compared to previous literature.^{2,7-9} This is concerning because studies from the scoping review found that prescribing culture can negatively impact prescribing competence and confidence. The scoping review showed that medical students learned inappropriate prescribing habits from watching experienced prescribers following graduation.¹ From discussions with current medical students at the University of Alberta, they indicate that the majority of their prescribing habits come from watching doctors write prescriptions during their clerkships.

In contrast, pharmacy students are introduced to assessing prescriptions for accuracy and appropriateness early on in their undergraduate careers. While they may learn the tools to prescribe, they have less time to watch practicing pharmacists write prescriptions. Medical students have 83 weeks (or roughly 21 months) of clerkship followed by at least a two-year residency where they practice while supervised by licensed physicians.²⁹⁻³⁰ In comparison, the current PharmD students will have a total of 40 weeks (or roughly 10 months) of experiential education in their undergraduate degree to practice while supervised, however this is not always by a pharmacist with APA.³¹ Following graduation the majority of pharmacy students enter directly into practice. There are limited learning opportunities following graduation, as there is often little overlap between pharmacists during the same shift in practice, especially in community pharmacy. This is an important distinction as up to 70% of pharmacy graduates practice in a community setting.³²

The web-based assessment tool could be used at different time points to see the effect of these two work cultures (supervised versus unsupervised) on prescribing competence and confidence, either in a longitudinal cohort study or a cross-sectional cohort study. Following the same population of students over time would allow to see changes in their prescribing

competence and confidence due to additional practical experiences. There are many limitations to this type of study including the need for a large sample size and participant dropout; therefore, a cross-sectional study may be more feasible. It would still provide insight into differences in prescribing competence and confidence at different time points, which would add to the limited body of evidence comparing both professions.

4.4.1.2 National pharmacy student prescribing competence and confidence level

The skills that pharmacy students should possess at the time of graduation are reflected in the AFPC Educational Outcomes, however there is no outcome specifically related to prescribing.³³ Alberta is the only province with the ability to independently prescribe to initiate or manage ongoing therapy, therefore it is an ideal place to study prescribing confidence and competence.³⁴ Unfortunately, the results of one small study in Alberta does not provide adequate guidance for the development of an educational outcome related to prescribing. As prescribing varies greatly depending on the provincial legislation, the level of prescribing education received also varies.³⁴ A larger study using the web-based assessment tool and involving pharmacy students across Canada would show where there are differences and similarities in prescribing competence and confidence. The results of these studies could be two-fold. First, positive outcomes could be shared with pharmacy regulatory authorities and colleges of pharmacy to further support the expansion of prescribing rights in other provinces. Second, it could provide information to AFPC to help in the development of a new Educational Outcome related to prescribing.

4.4.2 Educational initiatives

There are several educational initiatives that could be implemented using the results of this thesis. There is one suggestion for both pharmacy and medicine individually, one suggestion that could be applied to both faculties, and one suggestion for a joint initiative.

Pharmacy students used a variety of resources during the research project, but they also took longer to complete the assessment. They may benefit from additional activities targeting the efficient use of resources. Medical students used fewer resources, and also committed more prescribing errors than the pharmacy students. They may benefit from additional guidance on the use and availability of additional resources including those accessible through the library website and other clinical guidelines.

A suggestion that would target both of these initiatives would be a document outlining the types of resources available to each faculty, when one would be used over another, and how to access them. In addition, both pharmacy and medical students struggled to include all the legal requirements of a prescription; therefore, additional review or teaching in this area would benefit both faculties. A recommendation would be an annual review of the legal requirements and additional practice and assessment of written prescriptions.

Interprofessional collaboration, both during undergraduate education and in practice between pharmacists and physicians, has been recommended to improve patient outcomes.^{35,36} Currently the only mandatory interprofessional course offered for both pharmacy and medicine students at the University of Alberta is the Interprofessional Health Team Development (INT D) course. This course focuses on working on an interdisciplinary team with other healthcare professions including nursing, occupational therapy and physical therapy. While it is important

to develop these interprofessional skills, there are few additional opportunities for pharmacy and medical students to interact during their undergraduate degrees. An initiative from the UK implemented an interprofessional seminar where pharmacy, medicine and nursing students worked through a variety of patient cases to improve medication safety.³⁷ The initiative was well received by the participants.³⁷ Our assessment could easily be modified into a facilitated seminar for pharmacy and medical students to learn new skills to make appropriate prescribing decisions. Medical students could also be introduced to the Patient Care Process at this time, which may help them with prescribing in their future practice.

4.5 Conclusion

There is a growing body of evidence that pharmacist intervention and prescribing improves patient outcomes, however there is limited evidence comparing the prescribing skills of pharmacists and physicians. This research shows that both pharmacy and medicine graduates from the University of Alberta are confident with prescribing at the point of graduation, which differs from many of the studies included in the scoping review. The results also show that pharmacy students wrote more appropriate prescriptions and were more likely to include most of the legal requirements of a prescription. Future directions include further research on both a provincial and national level. Suggestions for local educational initiatives for both pharmacy and medicine include additional learning activities to access and use resources effectively, to learn and practice the legal requirements of a prescription, and an interprofessional seminar focusing on prescribing. Suggestions for a local educational initiative for medicine specifically would be to incorporate an assessment tool during the first two years of the undergraduate degree to help medical students improve their prescribing competence prior to clerkship.

4.6 References

1. Woit, C., Yuksel, N., Charrois, T. L. (2019a). Competence and Confidence with prescribing in pharmacy and medicine: a scoping review. *International Journal of Pharmacy Practice*, In print.
2. Woit, C., Yuksel, N., Charrois, T. L. (2019b). Pharmacy and medical students' competence and confidence with prescribing: a cross-sectional study. Manuscript submitted for publication.
3. UpToDate. [Internet] Available from: <https://www.uptodate.com/home/product>. Registration and login required.
4. de Vries T et al. Guide to Good Prescribing. Retrieved from: <https://apps.who.int/medicinedocs/pdf/whozip23e/whozip23e.pdf>
5. Faculty of Pharmacy and Pharmaceutical Sciences. (2018). Patient Care Process. University of Alberta, Version 2.
6. Frank JR et al. (2015). CanMEDS 2015 Physician Competency Framework. Ottawa: Royal College of Physicians and Surgeons of Canada.
7. Ryan, C., Ross, S., Davey, P., Duncan, E. M., Francis, J. J., Fielding, S., . . . Bond, C. (2014). Prevalence and causes of prescribing errors: The PRescribing outcomes for trainee doctors engaged in clinical training (PROTECT) study. *PLoS ONE [Electronic Resource]*, 9(1), e79802.
8. Cousins, D., Crompton, A., Gell, J., Hooley, J. (2019). The top ten prescribing errors in practice and how to avoid them. *The Pharmaceutical Journal*, 302(7922), online | DOI: 10.1211/PJ.2019.20206123
9. Baqir W et al. (2015). Pharmacist prescribing within a UK NHS hospital trust: nature and extent of prescribing, and prevalence of errors. *European Journal of Hospital Pharmacy*; 22(2): 79-82
10. Dean B. (2002). Learning from prescribing errors. *BMJ Quality & Safety*;11:258-260.
11. Dean B, Barber N, Schachter M. (2000). What is a prescribing error? *BMJ Quality & Safety*;9:232-237.
12. Sondalini, M. Unearth the answers and solve the causes of human error in your company by understanding the hidden truths in human error rate tables. Lifetime Reliability Solutions. Retrieved October 10, 2019 from: https://www.lifetime-reliability.com/cms/tutorials/reliability-engineering/human_error_rate_table_insights/
13. Brien S et al. (2018). The Prescribing Safely Canada Physician Prescribing Competencies. Royal College of Physicians and Surgeons of Canada.
14. Saunders, S., Dersch-Mills, D., Mysak, T., Romonko-Slack, L., Chernick, A., Lazarenko, G., & Zuk, D. (2019). CAPABLE: Calgary zone usage of additional prescribing authorization by pharmacists in an inpatient setting: Review of the prescribing landscape and environment doi://doi.org/10.1016/j.sapharm.2019.05.021
15. Au, B., Dersch-Mills, D., Ghosh, S., Jupp, J., Chambers, C., Cusano, F., & Danilak, M. (2019). Implementation of additional prescribing authorization among oncology pharmacists in Alberta. *Journal of Oncology Pharmacy Practice*, 25(3), 584–598.

16. Al Hamarneh, Y.N., Charrois, T.L., Lewanczuk, R., Tsuyuki, R.T. (2013). Pharmacist intervention for glycaemic control in the community (the RxING study). *BMJ Open*; 3:e003154.
17. Charrois, T.L., McAlister, F.A., Cooney, D., Lewanczuk, R., Kolber, M.R., Campbell, N.R., Rosenthal, M., Houle, S.K., Tsuyuki, R.T. (2011). Improving hypertension management through pharmacist prescribing; the rural Alberta clinical trial in optimizing hypertension (Rural RxACTION): trial design and methods. *Implement Sci*;6:94
18. Beahm, N.P., Smyth, D.J., Tsuyuki, R.T. (2018). Outcomes of urinary tract infection management by pharmacists (RxOUTMAP): A study of pharmacist prescribing and care in patients with uncomplicated urinary tract infections in the community. *Canadian Pharmacists Journal*; 151(5), 305–314.
19. Poh, E. W., McArthur, A., Stephenson, M., & Roughead, E. E. (2018). Effects of pharmacist prescribing on patient outcomes in the hospital setting: A systematic review. *JBI Database of Systematic Reviews and Implementation Reports*, 16(9), 1823-1873.
20. Coombes, I., Reid, C., McDougall, D., Stowasser, D., Duiguid, M., Mitchell, C. (2011). Pilot of a national inpatient medication chart in Australia: improving prescribing safety and enabling prescribing training. *Br J Clin Pharmacol* 2011; 72: 338-49
21. Lum, E., Mitchell, Coombes, I. (2013). The competent prescriber: 12 core competencies for safe prescribing. *Aust Prescr*; 36: 13-6.
22. Abuzour, A. S., Lewis, P. J., & Tully, M. P. (2018). Factors influencing secondary care pharmacist and nurse independent prescribers' clinical reasoning: An interprofessional analysis. *Journal of Interprofessional Care*, 32(2), 160-168.
23. Tichelaar, J., van Kan, C., van Unen, R. J., Schneider, A. J., van Agtmael, M. A., de Vries, Theo P G M, & Richir, M. C. (2015). The effect of different levels of realism of context learning on the prescribing competencies of medical students during the clinical clerkship in internal medicine: An exploratory study. *European Journal of Clinical Pharmacology*, 71(2), 237-242.
24. Ryan, C., Ross, S., Davey, P., Duncan, E. M., Fielding, S., Francis, J. J., . . . Bond, C. (2013). Junior doctors' perceptions of their self-efficacy in prescribing, their prescribing errors and the possible causes of errors. *British Journal of Clinical Pharmacology*, 76(6), 980-987.
25. Lewis, P. J., Ashcroft, D. M., Dornan, T., Taylor, D., Wass, V. and Tully, M. P. (2014), Exploring junior doctors' prescribing mistakes. *Br J Clin Pharmacol*, 78: 310-319.
26. Dornan, T., Ashcroft, D., Heathfield, H., Lewis, P., Miles, J., Taylor, D., T... (2009). An in depth investigation into causes of prescribing errors by foundation trainees in relation to their medical education. EQUIP study. [Online] Retrieved October 3, 2019 from: http://www.badmed.net/docs/Final_Report.pdf
27. Bandura, A. (1994). *Self-efficacy*. New York: Freeman.
28. Brinkman, D. J., Tichelaar, J., Schutte, T., Benemei, S., Bottiger, Y., Chamontin, B., . . . Working Group Research on CPT Education of the European Association for Clinical Pharmacology and Therapeutics (EACPT). (2017). Essential competencies in prescribing: A first european cross-sectional study among 895 final-year medical students. *Clinical Pharmacology & Therapeutics*, 101(2), 281-289.

29. University of Alberta Calendar. (2019). MD Degree. Retrieved from:
https://calendar.ualberta.ca/preview_program.php?catoid=29&poid=28330&returnto=7413
30. Maman-Dogma, J., Rousseau, M., Dove, M., Rodriguez, C., Meterissian, S. (2011). Length of training in postgraduate medical education in Canada. Members of the FMEC PG consortium. Retrieved from:
https://afmc.ca/pdf/fmec/10_Maman%20Dogma_Length%20of%20Training.pdf
31. University of Alberta Calendar. (2019). Doctor of Pharmacy (PharmD). Retrieved from:
https://calendar.ualberta.ca/preview_program.php?catoid=29&poid=28618&returnto=7416
32. Alberta Pharmacists' Association. (2019). Pharmacy in Alberta. Unpublished data.
33. Association of Faculties of Pharmacy of Canada. AFPC Educational Outcomes for First Professional Degree Programs in Pharmacy in Canada 2017; 2017
34. Canadian Pharmacists Association. Pharmacists' Scope of Practice in Canada; 2019. Retrieved from: https://www.pharmacists.ca/cpha-ca/assets/File/cpha-on-the-issues/Scope%20of%20Practice%20in%20Canada_July2019.pdf
35. Brinkman, D. J., Tichelaar, J., Okorie, M., Bissell, L., Christiaens, T., Likic, R., . . . Education Working Group of the European Association for Clinical Pharmacology and Therapeutics, (EACPT). (2017). Pharmacology and therapeutics education in the european union needs harmonization and modernization: A cross-sectional survey among 185 medical schools in 27 countries. *Clinical Pharmacology & Therapeutics*, 102(5), 815-822.
36. Gallagher, R., & Gallagher, H. (2012). Improving the working relationship between doctors and pharmacists: Is inter-professional education the answer? *Advances in Health Sciences Education*, 17(2), 247-257.
37. Hardisty, J., Scott, L., Chandler, S., Pearson, P., and Powell, S. (2014). Interprofessional learning for medication safety. *Clin Teach*, 11: 290-296.

Bibliography

Chapter 1 References

1. Coombes I et al. Pilot of a national inpatient medication chart in Australia: improving prescribing safety and enabling prescribing training. *Br J Clin Pharmacol* 2011; 72: 338-49
2. Lum E et al. The competent prescriber: 12 core competencies for safe prescribing. *Aust Prescr* 2013; 36: 13-6.
3. de Vries T et al. Guide to Good Prescribing. Retrieved from: <https://apps.who.int/medicinedocs/pdf/whozip23e/whozip23e.pdf>
4. Sketris I. Extending Prescribing Privileges in Canada, *Canadian Pharmacists Journal*, 2009; 142(1): 17-19
5. The College of Family Physicians of Canada. Position Statement: Prescribing Rights for Health Professionals; 2010. Retrieved from: https://www.cfpc.ca/uploadedFiles/Resources/Resource_Items/CFPC20Position20Statement20Prescribing20Rights20January202010.pdf
6. Accreditation. The Associations of Faculties of Medicine of Canada; 2019. Retrieved from: afmc.ca/accreditation. <https://afmc.ca/accreditation>
7. MD Program. McMaster University; 2015. Retrieved from: <https://mdprogram.mcmaster.ca/mcmaster-md-program>
8. Welcome to the MD Program. University of Calgary; 2019. Retrieved from: <https://www.ucalgary.ca/mdprogram/>
9. Maman-Dogma J et al. Length of training in postgraduate medical education in Canada. Members of the FMEC PG consortium; 2011. Retrieved from: https://afmc.ca/pdf/fmec/10_Maman%20Dogma_Length%20of%20Training.pdf
10. Association of Faculties of Pharmacy of Canada (AFPC). Position Statement and Joint Resolution on the Doctor of Pharmacy (PharmD) for the First Professional Degree at Universities in Canada; 2010. Retrieved from: https://www.afpc.info/sites/default/files/AFPC_ADPC_PharmD_Position_Statement_Resolution_Sept_2010.pdf
11. Canadian Council for the Accreditation of Pharmacy Programs (CCAPP). Accreditation Standards for Canadian First Professional Degree in Pharmacy Programs. Toronto: Ibid; 2018. Retrieved from: <http://ccapp-accredit.ca/wp-content/uploads/2016/01/Accreditation-Standards-for-Canadian-First-Professional-Degree-in-Pharmacy-Programs.pdf>
12. Pharmacist Qualifying Examination - Introduction. The Pharmacy Examining Board of Canada. Retrieved from: https://www.pebc.ca/index.php/ci_id/3147/la_id/1.htm
13. Tonna AP et al. Pharmacist prescribing in the UK - a literature review of current practice and research. *Clin Pharm Ther* 2007; 32(6): 545-56.
14. Tonna AP et al. An international overview of some pharmacist prescribing models. *Journal of the Malta College of Pharmacy Practice* 2008; 14: 20-26.
15. Alberta College of Pharmacy. Standards of Practice for Pharmacists and Pharmacy Technicians; 2014. Retrieved from: https://abpharmacy.ca/sites/default/files/StandardsOfPractice_May2014_v2.pdf

16. Alberta College of Pharmacy. Guide to Receiving Additional Prescribing Authorization; 2013. Retrieved from: <https://abpharmacy.ca/sites/default/files/APAGuide.pdf>
17. Yariv H. The case of pharmacist prescribing policy in Israel. *Israel Journal of Health Policy Research* 2015; 4, 49.
18. Hatah E. et al. General practitioners' views of pharmacists' current and potential contributions to medication review and prescribing in New Zealand. *Journal of Primary Health Care* 2013; 5(3), 223-233.
19. Malangu N. The future of community pharmacy practice in South Africa in the light of the proposed new qualification for pharmacists: Implications and challenges. *Global Journal of Health Science* 2014; 6(6), 226-233.
20. Canadian Pharmacists Association. Pharmacists' Scope of Practice in Canada; 2019. Retrieved from: https://www.pharmacists.ca/cpha-ca/assets/File/cpha-on-the-issues/Scope%20of%20Practice%20in%20Canada_July2019.pdf
21. Guirguis L et al. Survey of pharmacist prescribing practices in Alberta. *Am J Health Syst Pharm* 2017; 74(2):62-69.
22. Hanna T et al. Using scenarios to test the appropriateness of pharmacist prescribing in asthma management. *Pharmacy Practice* 2014; 12(1), 390.
23. Hoti K et al. An evaluation of Australian pharmacist's attitudes on expanding their prescribing role. *Pharmacy World & Science* 2010; 32(5), 610-621.
24. Hoti K et al. Pharmacy clients' attitudes to expanded pharmacist prescribing and the role of agency theory on involved stakeholders. *International Journal of Pharmacy Practice*, 2011a; 19(1), 5-12.
25. Hoti K et al. An expanded prescribing role for pharmacists – an Australian perspective. *The Australasian Medical Journal* 2011b; 4(4), 236-242. doi:10.4066/AMJ.2011.694
26. Hoti K et al. Expanded prescribing: A comparison of the views of Australian hospital and community pharmacists. *International Journal of Clinical Pharmacy* 2013; 35(3), 469-475.
27. Kamarudin G et al. Preparing hospital pharmacists to prescribe: Stakeholders' views of postgraduate courses. *International Journal of Pharmacy Practice* 2013; 21(4), 243-251.
28. Bajorek BV et al. Preparing pharmacists to deliver a targeted service in hypertension management: evaluation of an interprofessional training program. *BMC Medical Education* 2015; 15(157), 1-10.
29. Abuzour AS et al. Practice makes perfect: A systematic review of the expertise development of pharmacist and nurse independent prescribers in the United Kingdom. *Research in Social & Administrative Pharmacy* 2018; 14(1), 6-17
30. Faruquee CF, Guirguis LM. A scoping review of research on the prescribing practice of Canadian pharmacists. *Canadian Pharmacists Journal* 2015; 148(6), 325-348.
31. Guillaume L. et al. Supplementary prescribing by community and primary care pharmacists: An analysis of PACT data, 2004-2006. *Journal of Clinical Pharmacy & Therapeutics* 2008; 33(1), 11-16.
32. Hoti K et al. Identifying the perceived training needs for Australian pharmacist prescribers. *International Journal of Pharmacy Practice* 2014; 22(1), 38-46.
33. Auta A et al. Perceived facilitators to change in hospital pharmacy practice in England. *International Journal of Clinical Pharmacy* 2015a; 37(6), 1068-1075.

34. Desborough JA et al. A cost-consequences analysis of an adherence focused pharmacist-led medication review service. *International Journal of Pharmacy Practice* 2012; 20(1), 41-49.
35. McCann L et al. Pharmacist prescribing in Northern Ireland: A quantitative assessment. *International Journal of Clinical Pharmacy* 2011; 33(5), 824-831.
36. Stewart DC et al. Pharmacist prescribing in primary care: The views of patients across Great Britain who had experienced the service. *International Journal of Pharmacy Practice* 2011; 19(5), 328-332.
37. McCann L et al. "They come with multiple morbidities": A qualitative assessment of pharmacist prescribing. *Journal of Interprofessional Care* 2012; 26(2), 127-133.
38. McIntosh T et al. A cross sectional survey of the views of newly registered pharmacists in Great Britain on their potential prescribing role: A cautious approach. *British Journal of Clinical Pharmacology* 2012; 73(4), 656-660.
39. Feehan M et al. Qualitative interviews regarding pharmacist prescribing in the community setting. *American Journal of Health-System Pharmacy* 2016; 73(18), 1456-1461.
40. Todd BA et al. Pharmacist prescribing practices in a clinical pharmacy cardiac risk service. *American Journal of Health-System Pharmacy* 2016; 73(18), 1442-1450.
41. Woolf R et al. Pharmacist prescribing within an integrated health system in Washington. *American Journal of Health-System Pharmacy* 2016; 73(18), 1416-1624.
42. Adams AJ, Weaver KK. The Continuum of Pharmacist Prescriptive Authority. *Annals of Pharmacotherapy* 2016; 50(9), 778-784.
43. Ourth H et al. Clinical pharmacist prescribing activities in the Veterans Health Administration. *American Journal of Health-System Pharmacy* 2016; 73(18), 1406-1415.
44. Cheema E et al. The impact of interventions by pharmacists in community pharmacies on control of hypertension: A systematic review and meta-analysis of randomized controlled trials. *British Journal of Clinical Pharmacology* 2014; 78(6), 1238-1247.
45. Saleem F et al. Pharmacist intervention in improving hypertension-related knowledge, treatment medication adherence and health-related quality of life: a non-clinical randomized controlled trial. *Health Expectations* 2015; 18(5): 1270-81.
46. Al Raiisi F et al. Clinical pharmacy practice in the care of chronic kidney disease patients: a systematic review. *Int J Clin Pharm* 2019; 41: 630.
47. Kheir N et al. Can pharmacists influence the health-related quality of life of patients with asthma? *Squ Journal for Scientific Research* 2001; 3: 69-75.
48. Standing J et al. Impact of pharmacist intervention on diabetes patients in an ambulatory setting. *Diabetes Spectrum* 2009; 22: 241-6
49. Bishop L et al. Patients' and physicians' satisfaction with a pharmacist managed anticoagulation program in a family medicine clinic. *BMC Research Notes* 2015; 8, 233
50. Furbish SML et al. A pharmacist-physician collaboration to optimize benzodiazepine use for anxiety and sleep symptom control in primary care. *Journal of Pharmacy Practice* 2016; 30(4), 425-433.

51. Poh E et al. Effects of pharmacist prescribing on patient outcomes in the hospital setting: a systematic review. *JBI Database of Systematic Reviews and Implementation Reports* 2018; 16(9): 1823–1873.
52. Vivian EM. Improving blood pressure control in a pharmacist-managed hypertension clinic. *Pharmacotherapy* 2002; 22(12): 1533–40.
53. Hawkins DW et al. Evaluation of a clinical pharmacist in caring for hypertensive and diabetic patients. *Am J Hosp Pharm* 1979; 36(10): 1321–5.
54. Jacobs M et al. Pharmacist assisted medication program enhancing the regulation of diabetes (PAMPERED) study. *J Am Pharm Assoc* 2012; 52(5): 613–21
55. Weeks GR, Fyfe R. Hospital pharmacist-led lipid clinic for surgical patients with peripheral vascular disease at a regional Australian hospital. *J Pharm Pract Res* 2012; 42(1): 17–21.
56. Weeks G et al. Non-medical prescribing versus medical prescribing for acute and chronic disease management in primary and secondary care. *Cochrane Database of Systematic Reviews* 2016; 11, CD011227.
57. Bruhn H et al. Pharmacist-led management of chronic pain in primary care: results from a randomised controlled exploratory trial. *BMJ Open* 2013; 3:e002361.
58. Al Hamarneh YN et al. Pharmacist intervention for glycaemic control in the community (the RxING study). *BMJ Open* 2013; 3:e003154.
59. Charrois TL et al. Improving hypertension management through pharmacist prescribing; the rural Alberta clinical trial in optimizing hypertension (Rural RxACTION): trial design and methods. *Implement Sci* 2011;6:94
60. McAlister FA et al. Case management for blood pressure and lipid level control after minor stroke: PREVENTION randomized controlled trial. *CMAJ* 2014;186:577-84.
61. Tsuyuki RT et al. A randomized trial of the effect of pharmacist prescribing on improving blood pressure in the community: the Alberta clinical trial in optimizing hypertension (RxACTION). *Can Pharm J (Ott)* 2014;147:S18.
62. Tsuyuki RT et al. A randomized trial of a community-based approach to dyslipidemia management: Pharmacist prescribing to achieve cholesterol targets (RxACT Study). *Can Pharm J (Ott)* 2016; 149(5): 283-292.
63. Beahm NP et al. Outcomes of urinary tract infection management by pharmacists (RxOUTMAP): A study of pharmacist prescribing and care in patients with uncomplicated urinary tract infections in the community. *Canadian Pharmacists Journal* 2018; 151(5), 305–314.
64. Mansell K et al. Evaluating pharmacist prescribing for minor ailments. *International Journal of Pharmacy Practice* 2015; 23(2), 95-101.
65. Association of Faculties of Pharmacy of Canada. AFPC Educational Outcomes for First Professional Degree Programs in Pharmacy in Canada 2017; 2017.
66. Frank JR et al. CanMEDS 2015 Physician Competency Framework. Ottawa: Royal College of Physicians and Surgeons of Canada; 2015.
67. Bismilla Z, Wong B. Handover Toolkit: A resource to help teach, assess and implement a handover improvement program. Royal College of Physicians and Surgeons of Canada; 2018.

68. Brien S et al. The Prescribing Safely Canada Physician Prescribing Competencies. Royal College of Physicians and Surgeons of Canada; 2018.
69. MSC Assessment and British Pharmacological Society. Prescribing Safety Assessment, 2016. Retrieved from: <https://prescribingsafetyassessment.ac.uk>
70. Alberta Pharmacists Association. 2019. Pharmacy in Alberta.
71. Ashcroft DM et al. Prevalence, nature, severity and risk factors for prescribing errors in hospital inpatients: Prospective study in 20 UK hospitals. *Drug Safety* 2015; 38(9), 833-843.
72. Coombes ID et al. Why do interns make prescribing errors? A qualitative study. *The Medical Journal of Australia* 2008; 188(2), 89-94.

Chapter 2 References

1. Tonna AP et al. An international overview of some pharmacist prescribing models. *Journal of the Malta College of Pharmacy Practice* 2008; (14): 20-6.
2. Tonna AP et al. Pharmacist prescribing in the UK - a literature review of current practice and research. *Journal of Clinical Pharmacy and Therapeutics* 2007; 32: 545-56.
3. Law MR et al. Independent pharmacist prescribing in Canada. *Can Pharm J (Ott)* 2012; 145(1): 17-23 e1.
4. Canadian Pharmacists Association. Pharmacists' Scope of Practice in Canada. 2016. URL:https://www.pharmacists.ca/cpha-ca/assets/File/pharmacy-in-canada/Scope%20of%20Practice%20in%20Canada_JAN2016.pdf. Accessed: 2019-03-11. (Archived by WebCite® at <http://www.webcitation.org/76njSQ6O6>)
5. Alberta College of Pharmacy. Guide to Receiving Additional Prescribing Authorization. 2013. URL:<https://abpharmacy.ca/sites/default/files/APAGuide.pdf>. Accessed: 2019-03-11. (Archived by WebCite® at <http://www.webcitation.org/76njHZwT9>)
6. Yuksel N et al. Prescribing by pharmacists in Alberta. *Am J Health Syst Pharm* 2008; 65(22): 2126-32.
7. Saleem F et al. Pharmacist intervention in improving hypertension-related knowledge, treatment medication adherence and health-related quality of life: a non-clinical randomized controlled trial. *Health Expectations* 2015; 18(5): 1270-81.
8. Kheir N et al. Can pharmacists influence the health-related quality of life of patients with asthma? *Squ Journal for Scientific Research* 2001; 3: 69-75.
9. Standing J et al. Impact of Pharmacist Intervention on Diabetes Patients in an Ambulatory Setting. *Diabetes Spectrum* 2009; 22: 241-6.
10. Al Hamarneh YN et al. Pharmacist intervention for glycaemic control in the community (the RxING study). *BMJ Open* 2013; 3(9): e003154.
11. Tsuyuki RT et al. Randomized Trial of the Effect of Pharmacist Prescribing on Improving Blood Pressure in the Community. *Circulation* 2015; 132(2): 93-100.
12. Hutchison M et al. Survey of Alberta hospital pharmacists' perspectives on additional prescribing authorization. *American Journal of Health-System Pharmacy* 2012; 69(22): 1983-92.
13. Charrois T et al. Stories from the trenches: Experiences of Alberta pharmacists in obtaining additional prescribing authority. *Can Pharm J (Ott)* 2012; 145(1): 30-4.
14. Zezza MA, Bachhuber MA. Payments from drug companies to physicians are associated with higher volume and more expensive opioid analgesic prescribing. *PLoS One* 2018; 13(12): e0209383.
15. Ezebuenyi MC et al. Evaluation of Physician Prescribing Patterns For Antibiotics in the Treatment of Non-necrotizing Skin and Soft Tissue Infections. *P&T* 2018; 43: 287-92.
16. Becker S, Midoun M. Effects of Direct-To-Consumer Advertising on Patient Prescription Requests and Physician Prescribing: A Systematic Review of Psychiatry-Relevant Studies. *J Clin Psychiatry* 2016; 77: 1293-300.
17. Pinto D et al. Effectiveness of educational outreach visits compared with usual guideline dissemination to improve family physician prescribing—an 18-month open cluster-randomized trial. *Implementation Science* 2018; 13(120).

18. Kamarudin G et al. Educational interventions to improve prescribing competency: a systematic review. *BMJ Open* 2013; 3(8): e003291.
19. Hashimoto Y, Tensho M. Effect of pharmacist intervention on physician prescribing in patients with chronic schizophrenia: a descriptive pre/post study. *BMC Health Services Research* 2016; 16(150).
20. Angalakuditi M, Gomes. Retrospective drug utilization review: impact of pharmacist interventions on physician prescribing. *ClinicoEconomics and Outcomes Research* 2011; 3: 105-8.
21. Hatah E et al. General practitioners' perceptions of pharmacists' new services in New Zealand. *Int J Clin Pharm* 2012; 34(2): 364-73.
22. MacLure K et al. Views of the Scottish general public on non-medical prescribing. *International Journal of Clinical Pharmacy* 2013; 35(5): 704-10.
23. Spencer JA, Edwards C. Pharmacy beyond the dispensary: general practitioners' views. *British Medical Journal* 1992; 304: 1670-2.
24. Ajemigbitse AA et al. Assessment of the knowledge and attitudes of intern doctors to medication prescribing errors in a Nigeria tertiary hospital. *J Basic Clin Pharm* 2013; 5(1): 7-14.
25. Al Khaja KAJ et al. Assessing prescription writing skills of pre-clerkship medical students in a problem-based learning curriculum. *International Journal of Clinical Pharmacology and Therapeutics* 2005; 43: 429-35.
26. Brinkman DJ et al. The Prescribing Performance and Confidence of Final-Year Medical Students. *Clinical Pharmacology & Therapeutics* 2014; 96(5): 531-3.
27. Brinkman DJ et al. Self-reported confidence in prescribing skills correlates poorly with assessed competence in fourth-year medical students. *J Clin Pharmacol* 2015; 55(7): 825-30.
28. Brinkman DJ et al. Essential competencies in prescribing: A first european cross-sectional study among 895 final-year medical students. *Clin Pharmacol Ther* 2017; 101(2): 281-9.
29. Chapagain K et al. Prescribing Skills of First and Second Year MBBS Students of A Teaching Hospital. *J Nepal Med Assoc* 2016; 55(2): 72-5.
30. Coombes ID et al. Safe medication practice: attitudes of medical students about to begin their intern year. *Medical Education* 2008; 42(4): 427-31.
31. Geoghegan SE et al. Preparedness of newly qualified doctors in Ireland for prescribing in clinical practice. *Br J Clin Pharmacol* 2017; 83(8): 1826-34.
32. Han WH, Maxwell S. Are Medical Students Adequately Trained to Prescribe at the Point of Graduation? Views of First Year Foundation Doctors. *Scottish Medical Journal* 2016; 51(4): 27-32.
33. Harding S et al. The performance of junior doctors in applying clinical pharmacology knowledge and prescribing skills to standardized clinical cases. *Br J Clin Pharmacol* 2010; 69(6): 598-606.
34. Heaton A et al. Undergraduate preparation for prescribing: the views of 2413 UK medical students and recent graduates. *British Journal of Clinical Pharmacology* 2008; 66(1): 128-34.

35. Hilmer SN et al. Do medical courses adequately prepare interns for safe and effective prescribing in New South Wales public hospitals? *Intern Med J* 2009; 39(7): 428-34.
36. Khan AKA et al. Assessment of the Prescribing Knowledge, Attitude and Skills of Medical Students and Interns in a Large Teaching Hospital of Southern India. *Biomedical & Pharmacology Journal* 2013; 6(1): 63-9.
37. Khan AA et al. How confident are the students and interns to prescribe - an assessment based on their views and suggestions? *National Journal of Physiology, Pharmacy & Pharmacology* 2014; 4(2): 138-42.
38. Maxwell SRJ et al. Prescribing Safety Assessment 2016: Delivery of a national prescribing assessment to 7343 UK final-year medical students. *Br J Clin Pharmacol* 2017; 83(10): 2249-58.
39. Naik M et al. A questionnaire-based study to assess rational prescribing practice among interns. *National Journal of Physiology, Pharmacy and Pharmacology* 2015; 5(4): 323-7.
40. Oshikoya KA et al. Interns' knowledge of clinical pharmacology and therapeutics after undergraduate and on-going internship training in Nigeria: a pilot study. *BMC Med Educ* 2009; 9(50).
41. Pearson S-A et al. Factors influencing prescribing: an intern's perspective. *Medical Education* 2002; 36: 781-7.
42. Raunier GP et al. Prescription Writing Skills of Pre-Clinical Medical and Dental Undergraduate Students. *J Nepal Med Assoc.* 2008; 47(172): 197-200.
43. Ryan C et al. Junior doctors' perceptions of their self-efficacy in prescribing, their prescribing errors and the possible causes of errors. *Br J Clin Pharmacol* 2013; 76(6): 980-7.
44. Starmer K et al. Blind prescribing: A study of junior doctors' prescribing preparedness in an Australian emergency department. *Emergency Medicine Australasia* 2013; 25(2): 147-53.
45. Tobaiqy M et al. Foundation year 1 doctors and clinical pharmacology and therapeutics teaching. A retrospective view in light of experience. *Br J Clin Pharmacol* 2007; 64(3): 363-72.
46. Baqir W et al. Pharmacist prescribing within a UK NHS hospital trust: nature and extent of prescribing, and prevalence of errors. *European Journal of Hospital Pharmacy* 2015; 22(2): 79-82.
47. George J et al. Supplementary Prescribing: Early Experiences of Pharmacists in Great Britain. *The Annals of Pharmacotherapy* 2006; 40: 1843-9.
48. George J et al. Independent prescribing by pharmacists: a study of the awareness, views and attitudes of Scottish community pharmacists. *Pharm World Sci* 2006; 28(2): 45-53.
49. Hardisty J et al. Exploring the utility of the Prescribing Safety Assessment in pharmacy education in England: experiences of pre-registration trainees and undergraduate (MPharm) pharmacy students. *Int J Pharm Pract* 2018.
50. Hoti K et al. Expanded prescribing: a comparison of the views of Australian hospital and community pharmacists. *Int J Clin Pharm* 2013; 35(3): 469-75.
51. Latter S et al. Are nurse and pharmacist independent prescribers making clinically appropriate prescribing decisions? An analysis of consultations. *J Health Serv Res Policy* 2012; 17(3): 149-56.

52. McIntosh T et al. A cross sectional survey of the views of newly registered pharmacists in Great Britain on their potential prescribing role: a cautious approach. *Br J Clin Pharmacol* 2011; 73(4): 656-60.
53. McIntosh T, Stewart D. A qualitative study of UK pharmacy pre-registration graduates' views and reflections on pharmacist prescribing. *Int J Pharm Pract* 2016; 24(2): 139-41.
54. Reid F et al. Piloting the United Kingdom 'Prescribing Safety Assessment' with pharmacist prescribers in Scotland. *Research in Social and Administrative Pharmacy* 2018; 14(1): 62-8.
55. Keijsers CJPW et al. A comparison of medical and pharmacy students' knowledge and skills of pharmacology and pharmacotherapy. *British Journal of Clinical Pharmacology* 2014; 78(4): 781-8.
56. Stewart DC et al. Views of pharmacist prescribers, doctors and patients on pharmacist prescribing implementation. *International Journal of Pharmacy Practice* 2009; 17(2): 89-94.
57. Robinson, J. The trials and triumphs of pharmacist independent prescribers. *The Pharmaceutical Journal*, 2018; 300(7911), online, DOI: 10.1211/PJ.2018.20204489, Accessed: 2019-08-06
58. Duncan EM et al. Learning curves, taking instructions, and patient safety: using a theoretical domains framework in an interview study to investigate prescribing errors among trainee doctors. *Implementation Science* 2012; 7: 1-13.
59. Upadhyaya P et al. Prescribing knowledge in the light of undergraduate clinical pharmacology and therapeutics teaching in India: views of first-year postgraduate students. *Advances in Medical Education and Practice* 2012; 3: 47-53.
60. Abuzour AS et al. Factors influencing secondary care pharmacist and nurse independent prescribers' clinical reasoning: An interprofessional analysis. *J Interprof Care* 2018; 32(2): 160-8.
61. Weiss MC, Sutton J. The changing nature of prescribing: pharmacists as prescribers and challenges to medical dominance. *Sociol Health Illn* 2009; 31(3): 406-21.
62. Schwartz RK et al. Physician motivations for nonscientific drug prescribing. *Soc Sci Med* 1989; 28: 577-82.

Chapter 3 References

1. Canadian Pharmacists Association. Pharmacists' Scope of Practice in Canada. 2019. Retrieved from: https://www.pharmacists.ca/cpha-ca/assets/File/cpha-on-the-issues/Scope%20of%20Practice%20in%20Canada_July2019.pdf
2. Alberta College of Pharmacy. Guide to Receiving Additional Prescribing Authorization. 2013. Retrieved from: <https://abpharmacy.ca/sites/default/files/APAGuide.pdf>
3. Saleem, F., Hassali, M. A., Shafie, A. A., Ul Haq, N., Farooqui, M., Aljadhay, H., Ahmad F. U. Pharmacist intervention in improving hypertension-related knowledge, treatment medication adherence and health-related quality of life: a non-clinical randomized controlled trial. *Health Expect.* 2015;18(5): 1270-81
4. Standing, J., Herrmann, J., Walters, R., Destache, C., Chock, A. Impact of pharmacist intervention on diabetes patients in an ambulatory setting. *Diabetes Spectrum.* 2009;22: 241-6
5. Bishop L., Young, S., Twells, L., Dillon, C., Hawboldt, J. Patients' and physicians' satisfaction with a pharmacist managed anticoagulation program in a family medicine clinic. *BMC Res Notes.* 2015;8, 233
6. Charrois, T. L., McAlister, F. A., Cooney, D., Lewanczuk, R., Kolber, M. R., Campbell, N. R., . . . Tsuyuki, R. T. Improving hypertension management through pharmacist prescribing; the rural Alberta clinical trial in optimizing hypertension (rural RxACTION): Trial design and methods. *Implement Sci.* 2011;6, 94.
7. McAlister, F. A., Majumdar, S. R., Padwal, R. S., Fradette, M., Thompson, A., Buck, B., Dean, N., Bakal, J. A., Tsuyuki, R., Grover, S., Shuaib, A. Case management for blood pressure and lipid level control after minor stroke: PREVENTION randomized controlled trial. *CMAJ.* 2014;186: 577-84.
8. Tsuyuki, R. T., Houle, S. K. D., Charrois, T. L., Kolber, M. R., Rosenthal, M. M., Lewanczuk, R., . . . RxACTION Investigators*. Randomized trial of the effect of pharmacist prescribing on improving blood pressure in the community: The Alberta clinical trial in optimizing hypertension (RxACTION). *Circulation.* 2015;132(2), 93-100.
9. Tsuyuki, R. T., Rosenthal, M., Pearson, G. J. A randomized trial of a community-based approach to dyslipidemia management: Pharmacist prescribing to achieve cholesterol targets (RxACT Study). *Can Pharm J (Ott).* 2016;149(5): 283-292.
10. Kelly, K., Vaida, A. J. Double checks are worth the time they take. *Pharmacy Times.* 2003. Retrieved from: <https://www.pharmacytimes.com/publications/issue/2003/2003-09/2003-09-7375>
11. Feehan, M., Durante, R., Ruble, J., Munger, M. A. Qualitative interviews regarding pharmacist prescribing in the community setting. *Am J Health Syst Pharm.* 2016;73(18), 1456-1461. doi://dx.doi.org/10.2146/ajhp150691
12. Cope, L. C., Abuzour, A. S., & Tully, M. P. Nonmedical prescribing: where are we now?. *Ther Adv Drug Saf.* 2016;7(4), 165-172.
13. Law, M. R., Ma, T., Fisher, J., & Sketris, I. S. Independent pharmacist prescribing in Canada. *Can Pharm J (Ott).* 2012;145(1), 17-23.e1.

14. Ashcroft, D. M., Lewis, P. J., Tully, M. P., Farragher, T. M., Taylor, D., Wass, V., . . . Dornan, T. Prevalence, nature, severity and risk factors for prescribing errors in hospital inpatients: Prospective study in 20 UK hospitals. *Drug Saf.* 2015;38(9), 833-843.
15. Coombes, I. D., Stowasser, D. A., Coombes, J. A., Mitchell, C. Why do interns make prescribing errors? A qualitative study. *Med J Aust.* 2008;188(2), 89-94.
16. Dean, B., Schachter, M., Vincent, C., & Barber, N. Prescribing errors in hospital inpatients: Their incidence and clinical significance. *Qual Saf Health Care.* 2002;11(4), 340-344.
17. Hilmer, S. N., Seale, J. P., Le Couteur, D. G., Crampton, R., Liddle, C. Do medical courses adequately prepare interns for safe and effective prescribing in New South Wales public hospitals?. *Intern Med J.* 2009;39(7), 428-434.
18. Tully, M. P., Buchan, I. E. Prescribing errors during hospital inpatient care: Factors influencing identification by pharmacists. *Pharm World Sci.* 2009;31(6), 682-688.
19. Benkirane, R. R., Abouqal, R., Haimeur, C. C., S Ech Cherif El Kettani, Salma S, Azzouzi, A. A., Mdaghri Alaoui, A. A., . . . Soulaymani, R. R. Incidence of adverse drug events and medication errors in intensive care units: A prospective multicenter study. *J Patient Saf.* 2009;5(1), 16-22.
20. Patanwala, A. E., Warholak, T. L., Sanders, A. B., Erstad, B. L. A prospective observational study of medication errors in a tertiary care emergency department. *Ann Emerg Med.* 2010;55(6), 522-526.
21. Abramson, E. L., Malhotra, S., Fischer, K., Edwards, A., Pfoh, E. R., Osorio, S. N., . . . Kaushal, R. Transitioning between electronic health records: Effects on ambulatory prescribing safety. *J Gen Intern Med.* 2011;26(8), 868-874.
22. Ajemigbitse, A. A., Omole, M. K., Osi-Ogbu, O. F., & Erhun, W. O. A qualitative study of causes of prescribing errors among junior medical doctors in a Nigeria in-patient setting. *Ann Afr Med.* 2013;12(4), 223.
23. Bordman, R., Bajcar, J., Kennie, N., Fernandes, L., Iglar, K. Curriculum to enhance pharmacotherapeutic knowledge in family medicine: Interprofessional coteaching and web-based learning. *Can Fam Physician.* 2013;59(11), 493.
24. Lexchin, J. Improving the appropriateness of physician prescribing. *Int J Health Serv.* 1998;28(2), 253-267.
25. Voit, C., Yuksel, N., Charrois, T. L. Competence and confidence with prescribing in pharmacy and medicine: a scoping review. *International Journal of Pharmacy Practice*, in print. 2019.
26. Qualtrics. [Computer software]. 2019. Provo, Utah, USA. Available from: <https://www.qualtrics.com>
27. Faculty of Pharmacy and Pharmaceutical Sciences. Doctor of Pharmacy (PharmD) Admission Requirements. Retrieved from: <https://www.ualberta.ca/pharmacy/programs/pharmd-doctor-of-pharmacy/prospective-students-2018/admission-requirements>
28. Faculty of Medicine and Dentistry. Curriculum. Retrieved from: <https://www.ualberta.ca/medicine/programs/md/curriculum>
29. Brinkman, D. J., Tichelaar, J., Schutte, T., Benemei, S., Bottiger, Y., Chamontin, B., . . . Working Group Research on CPT Education of the European Association for Clinical

- Pharmacology and Therapeutics (EACPT). Essential competencies in prescribing: A first european cross-sectional study among 895 final-year medical students. *Clin Pharmacol Ther.* 2017;101(2), 281-289.
30. CPS [Internet]. Ottawa (ON): Canadian Pharmacists Association; c2016. Available from: <http://www.e-therapeutics.ca>. Also available in paper copy from the publisher.
 31. Lexi-Drugs. In Lexicomp Online [Internet]. Hudson, Ohio: Wolters Kluwer Clinical Drug Information, Inc. 2019. Available from <https://online.lexi.com/lco/action/home>. Registration and login required.
 32. DynaMed [Internet]. Ipswich (MA): EBSCO Information Services. 1995. Available from <http://www.dynamed.com>. Registration and login required.
 33. Alberta College of Pharmacy. Standards of Practice for Pharmacists and Pharmacy Technicians, Standard 6. 2014. Retrieved from: https://abpharmacy.ca/sites/default/files/StandardsOfPractice_May2014_v2.pdf
 34. Oshikoya, K. A., Senbanjo, I. O., & Amole, O. O. Interns' knowledge of clinical pharmacology and therapeutics after undergraduate and on-going internship training in Nigeria: A pilot study. *BMC Med Educ.* 2009;9, 50.
 35. Ryan, C., Ross, S., Davey, P., Duncan, E. M., Fielding, S., Francis, J. J., . . . Bond, C. Junior doctors' perceptions of their self-efficacy in prescribing, their prescribing errors and the possible causes of errors. *Br J Clin Pharmacol.* 2013;76(6), 980-987.
 36. Starmer, K., Sinnott, M., Shaban, R., Donegan, E., & Kapitzke, D. Blind prescribing: A study of junior doctors' prescribing preparedness in an Australian emergency department. *Emerg Med Australa.* 2013;25(2), 147-153.
 37. Cousins, D., Crompton, A., Gell, J., Hooley, J. (2019). The top ten prescribing errors in practice and how to avoid them. *The Pharmaceutical Journal*, 302(7922), online | DOI: 10.1211/PJ.2019.20206123
 38. Baqir W et al. (2015). Pharmacist prescribing within a UK NHS hospital trust: nature and extent of prescribing, and prevalence of errors. *European Journal of Hospital Pharmacy*; 22(2): 79-82
 39. Brinkman, D. J., Tichelaar, J., van Agtmael, M. A., de Vries, Theo P G M, & Richir, M. C. Self-reported confidence in prescribing skills correlates poorly with assessed competence in fourth-year medical students. *J Clin Pharmacol.* 2015;55(7), 825-830.
 40. Al Khaja, K A J, Handu, S. S., James, H., Mathur, V. S., & Sequeira, R. P. Assessing prescription writing skills of pre-clerkship medical students in a problem-based learning curriculum. *Int J Clin Pharmacol Ther.* 2005;43(9), 429-435
 41. Yun GW, Trumbo CW. Comparative response to a survey executed by post, e-mail, & web form. *J Compu-Mediated Com.* 2000;6.

Chapter 4 References

1. Woit, C., Yuksel, N., Charrois, T. L. (2019a). Competence and Confidence with prescribing in pharmacy and medicine: a scoping review. *International Journal of Pharmacy Practice*, In print.
2. Woit, C., Yuksel, N., Charrois, T. L. (2019b). Pharmacy and medical students' competence and confidence with prescribing: a cross-sectional study. Manuscript submitted for publication.
3. UpToDate. [Internet] Available from: <https://www.uptodate.com/home/product>. Registration and login required.
4. de Vries T et al. Guide to Good Prescribing. Retrieved from: <https://apps.who.int/medicinedocs/pdf/whozip23e/whozip23e.pdf>
5. Faculty of Pharmacy and Pharmaceutical Sciences. (2018). Patient Care Process. University of Alberta, Version 2.
6. Frank JR et al. (2015). CanMEDS 2015 Physician Competency Framework. Ottawa: Royal College of Physicians and Surgeons of Canada.
7. Ryan, C., Ross, S., Davey, P., Duncan, E. M., Francis, J. J., Fielding, S., . . . Bond, C. (2014). Prevalence and causes of prescribing errors: The PRescribing outcomes for trainee doctors engaged in clinical training (PROTECT) study. *PLoS ONE [Electronic Resource]*, 9(1), e79802.
8. Cousins, D., Crompton, A., Gell, J., Hooley, J. (2019). The top ten prescribing errors in practice and how to avoid them. *The Pharmaceutical Journal*, 302(7922), online | DOI: 10.1211/PJ.2019.20206123
9. Baqir W et al. (2015). Pharmacist prescribing within a UK NHS hospital trust: nature and extent of prescribing, and prevalence of errors. *European Journal of Hospital Pharmacy*; 22(2): 79-82
10. Dean B. (2002). Learning from prescribing errors. *BMJ Quality & Safety*;11:258-260.
11. Dean B, Barber N, Schachter M. (2000). What is a prescribing error? *BMJ Quality & Safety*;9:232-237.
12. Sondalini, M. Unearth the answers and solve the causes of human error in your company by understanding the hidden truths in human error rate tables. Lifetime Reliability Solutions. Retrieved October 10, 2019 from: https://www.lifetime-reliability.com/cms/tutorials/reliability-engineering/human_error_rate_table_insights/
13. Brien S et al. (2018). The Prescribing Safely Canada Physician Prescribing Competencies. Royal College of Physicians and Surgeons of Canada.
14. Saunders, S., Dersch-Mills, D., Mysak, T., Romonko-Slack, L., Chernick, A., Lazarenko, G., & Zuk, D. (2019). CAPABLE: Calgary zone usage of additional prescribing authorization by pharmacists in an inpatient setting: Review of the prescribing landscape and environment doi://doi.org/10.1016/j.sapharm.2019.05.021
15. Au, B., Dersch-Mills, D., Ghosh, S., Jupp, J., Chambers, C., Cusano, F., & Danilak, M. (2019). Implementation of additional prescribing authorization among oncology pharmacists in Alberta. *Journal of Oncology Pharmacy Practice*, 25(3), 584–598.

16. Al Hamarneh, Y.N., Charrois, T.L., Lewanczuk, R., Tsuyuki, R.T. (2013). Pharmacist intervention for glycaemic control in the community (the RxING study). *BMJ Open*; 3:e003154.
17. Charrois, T.L., McAlister, F.A., Cooney, D., Lewanczuk, R., Kolber, M.R., Campbell, N.R., Rosenthal, M., Houle, S.K., Tsuyuki, R.T. (2011). Improving hypertension management through pharmacist prescribing; the rural Alberta clinical trial in optimizing hypertension (Rural RxACTION): trial design and methods. *Implement Sci*;6:94
18. Beahm, N.P., Smyth, D.J., Tsuyuki, R.T. (2018). Outcomes of urinary tract infection management by pharmacists (RxOUTMAP): A study of pharmacist prescribing and care in patients with uncomplicated urinary tract infections in the community. *Canadian Pharmacists Journal*; 151(5), 305–314.
19. Poh, E. W., McArthur, A., Stephenson, M., & Roughead, E. E. (2018). Effects of pharmacist prescribing on patient outcomes in the hospital setting: A systematic review. *JBI Database of Systematic Reviews and Implementation Reports*, 16(9), 1823-1873.
20. Coombes, I., Reid, C., McDougall, D., Stowasser, D., Duiguid, M., Mitchell, C. (2011). Pilot of a national inpatient medication chart in Australia: improving prescribing safety and enabling prescribing training. *Br J Clin Pharmacol* 2011; 72: 338-49
21. Lum, E., Mitchell, Coombes, I. (2013). The competent prescriber: 12 core competencies for safe prescribing. *Aust Prescr*; 36: 13-6.
22. Abuzour, A. S., Lewis, P. J., & Tully, M. P. (2018). Factors influencing secondary care pharmacist and nurse independent prescribers' clinical reasoning: An interprofessional analysis. *Journal of Interprofessional Care*, 32(2), 160-168.
23. Tichelaar, J., van Kan, C., van Unen, R. J., Schneider, A. J., van Agtmael, M. A., de Vries, Theo P G M, & Richir, M. C. (2015). The effect of different levels of realism of context learning on the prescribing competencies of medical students during the clinical clerkship in internal medicine: An exploratory study. *European Journal of Clinical Pharmacology*, 71(2), 237-242.
24. Ryan, C., Ross, S., Davey, P., Duncan, E. M., Fielding, S., Francis, J. J., . . . Bond, C. (2013). Junior doctors' perceptions of their self-efficacy in prescribing, their prescribing errors and the possible causes of errors. *British Journal of Clinical Pharmacology*, 76(6), 980-987.
25. Lewis, P. J., Ashcroft, D. M., Dornan, T., Taylor, D., Wass, V. and Tully, M. P. (2014), Exploring junior doctors' prescribing mistakes. *Br J Clin Pharmacol*, 78: 310-319.
26. Dornan, T., Ashcroft, D., Heathfield, H., Lewis, P., Miles, J., Taylor, D., T... (2009). An in depth investigation into causes of prescribing errors by foundation trainees in relation to their medical education. EQUIP study. [Online] Retrieved October 3, 2019 from: http://www.badmed.net/docs/Final_Report.pdf
27. Bandura, A. (1994). *Self-efficacy*. New York: Freeman.
28. Brinkman, D. J., Tichelaar, J., Schutte, T., Benemei, S., Bottiger, Y., Chamontin, B., . . . Working Group Research on CPT Education of the European Association for Clinical Pharmacology and Therapeutics (EACPT). (2017). Essential competencies in prescribing: A first european cross-sectional study among 895 final-year medical students. *Clinical Pharmacology & Therapeutics*, 101(2), 281-289.

29. University of Alberta Calendar. (2019). MD Degree. Retrieved from:
https://calendar.ualberta.ca/preview_program.php?catoid=29&poid=28330&returnto=7413
30. Maman-Dogma, J., Rousseau, M., Dove, M., Rodriguez, C., Meterissian, S. (2011). Length of training in postgraduate medical education in Canada. Members of the FMEC PG consortium. Retrieved from:
https://afmc.ca/pdf/fmec/10_Maman%20Dogma_Length%20of%20Training.pdf
31. University of Alberta Calendar. (2019). Doctor of Pharmacy (PharmD). Retrieved from:
https://calendar.ualberta.ca/preview_program.php?catoid=29&poid=28618&returnto=7416
32. Alberta Pharmacists' Association. (2019). Pharmacy in Alberta. Unpublished data.
33. Association of Faculties of Pharmacy of Canada. AFPC Educational Outcomes for First Professional Degree Programs in Pharmacy in Canada 2017; 2017
34. Canadian Pharmacists Association. Pharmacists' Scope of Practice in Canada; 2019. Retrieved from: https://www.pharmacists.ca/cpha-ca/assets/File/cpha-on-the-issues/Scope%20of%20Practice%20in%20Canada_July2019.pdf
35. Brinkman, D. J., Tichelaar, J., Okorie, M., Bissell, L., Christiaens, T., Likic, R., . . . Education Working Group of the European Association for Clinical Pharmacology and Therapeutics, (EACPT). (2017). Pharmacology and therapeutics education in the european union needs harmonization and modernization: A cross-sectional survey among 185 medical schools in 27 countries. *Clinical Pharmacology & Therapeutics*, 102(5), 815-822.
36. Gallagher, R., & Gallagher, H. (2012). Improving the working relationship between doctors and pharmacists: Is inter-professional education the answer? *Advances in Health Sciences Education*, 17(2), 247-257.
37. Hardisty, J., Scott, L., Chandler, S., Pearson, P., and Powell, S. (2014). Interprofessional learning for medication safety. *Clin Teach*, 11: 290-296.

Appendices

Appendix A: University of Alberta Ethics Approval

Notification of Approval

Date:	October 12, 2018	
Study ID:	Pro00084637	
Principal Investigator:	Theresa Charrois	
Study Title:	Prescribing Competence and Confidence of 4th year Pharmacy and Medicine Students from the University of Alberta	
Approval Expiry Date:	Friday, October 11, 2019	
Approved Consent Form:	Approval Date 10/12/2018	Approved Document Informed Consent Form (1).pdf
Sponsor/Funding Agency:	Research Fund Allocation Committee Faculty of Pharmacy and Pharmaceutical Sciences	

Thank you for submitting the above study to the Research Ethics Board 2. Your application has received a delegated review and has been approved on behalf of the committee.

A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

Approval by the Research Ethics Board does not encompass authorization to access the staff, students, facilities or resources of local institutions for the purposes of the research.

Sincerely,

Ubaka Ogbogu, LLB, BL, LL.M, SJD
Chair, Research Ethics Board 2

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Appendix B: Information and Informed Consent Form

Investigators:

Cassandra Voit, BScPharm
MSc Student
Faculty of Pharmacy and Pharmaceutical Sciences
University of Alberta
voit@ualberta.ca
Theresa Charrois, BScPharm, ACPR, MSc

Clinical Associate Professor
Faculty of Pharmacy and Pharmaceutical Sciences
University of Alberta
tcharroi@ualberta.ca

Dr. Nese Yuksel, BScPharm, PharmD, FCSHP, NCMP
Professor
Faculty of Pharmacy and Pharmaceutical Sciences
University of Alberta
nese.yuksel@ualberta.ca

Study Title: Healthcare student competence and confidence with prescribing: a mixed methods study

Background

As future prescribers it is important to look at the factors that can affect prescribing competence, and we believe confidence is largely associated with that. The objective of the study is to investigate whether there is a correlation between the competence and confidence with respect to prescribing. Studying fourth year students competence and confidence in prescribing may help educators to develop supportive curriculum changes to increase these factors, producing better prescribers.

Participation

You are being asked to participate in an online assessment and survey. You will be asked to provide answers to competency assessment cases to assess your ability to prescribe for a variety of conditions and medications. The survey will then assess how confident you were in providing the correct answers to the assessment questions. Your participation will take approximately 1 to 2 hours.

Purpose

The purpose of this project is to evaluate whether there is a correlation between competence and perceived confidence of fourth year pharmacy and medicine students.

Study Procedures

Once you have made the decision to participate, you will need to complete and submit the informed consent form attached to this letter. The assessment will be emailed to you as a link, to access whenever is convenient for you. You will have a two-hour window to complete the assessment once started. Reminder emails will be sent every two weeks to complete the assessment.

Benefits

Participating in this study will not directly benefit you, but your participation will help us determine various influences on prescribing in practice and how curriculum can be developed to address any areas of concern. As such, you may feel personally rewarded for contributing to the future of your profession.

Risk

There is no known risk associated with this study. There may be risks to being in this study that are not known. If we learn anything during the research that may affect your willingness to continue being in the study, we will tell you right away.

Incentive

A \$10 gift card will be given as an incentive to participate in the study, to be sent either electronically or by mail. Please note that even if you withdraw early from the study you are still entitled to receive a gift card.

Voluntary Participation

Your participation in this research is entirely voluntary and you may opt out of the study at any time without penalty. You are under no obligation to participate in this study and you are not obliged to answer any specific questions even if you've chosen to participate. You may withdraw at any time during the assessment/survey. Once the assessment/survey is complete, you may have up to 1 month to withdraw your results/responses from the study if you wish to do so.

Confidentiality & Anonymity

The researchers will maintain the confidentiality of all responses. All data will be kept confidential and all identifiers will be removed prior to analysis. The information collected about you will be associated with a number rather than your name. You will not be identified in any future presentations or publications of this research. As we are using Qualtrics software, you should know that while we will keep the information you give us confidential - in the United States under US privacy laws, the government has the right to access all information held in electronic databases.

Further Information

If you have any further questions regarding this study, please contact Cassandra Voit [voit@ualberta.ca, (587) 926-6155], Theresa Charrois [tcharroi@uablerta.ca, (780) 248-7669] or Dr. Nese Yuksel [nese.yuksel@ualberta.ca, (780) 494-4442].

The plan for this study has been reviewed for its adherence to ethical guidelines by a Research Ethics Board at the University of Alberta. For questions regarding participant rights and ethical conduct of research, contact the Research Ethics Office at (780) 492-2615.

Study Title: Healthcare student competence and confidence with prescribing: a mixed methods study

Principal Investigators: Cassandra Voit, Theresa Charrois, Dr. Nese Yuksel

	<u>Yes</u>	<u>No</u>
Do you understand that you have been asked to be in a research study?	<input type="checkbox"/>	<input type="checkbox"/>
Have you read and received a copy of the attached Information Sheet?	<input type="checkbox"/>	<input type="checkbox"/>
Do you understand the benefits and risks involved in taking part in this research study?	<input type="checkbox"/>	<input type="checkbox"/>
Have you had an opportunity to ask questions and discuss this study?	<input type="checkbox"/>	<input type="checkbox"/>
Do you understand that you are free to leave the study at any time, without having to give a reason and without penalty?	<input type="checkbox"/>	<input type="checkbox"/>
Has the issue of confidentiality been explained to you?	<input type="checkbox"/>	<input type="checkbox"/>
Do you understand who will have access to your study records, including personal identifying information?	<input type="checkbox"/>	<input type="checkbox"/>

Who explained this study to you?

I agree to take part in this study:

Signature of Research Participant _____

(Printed Name) _____

Date: _____

THE INFORMATION SHEET MUST BE ATTACHED TO THIS CONSENT FORM AND A COPY GIVEN TO THE RESEARCH PARTICIPANT

Appendix C: Supplemental document from cross-sectional study

Appendix 1: Example of case scenario and confidence survey

To participate in this study, you have to complete 5 patient cases, each followed by a confidence survey.

Competence assessment: Each case consists of a brief description of a patient with a working diagnosis. Your job is to decide what to prescribe for the patient. You will be asked to fill in the “drug name”, “drug dose”, “dosing frequency”, “duration” and “route of administration” for each drug individually, in addition to the legal requirements for a prescription, under the blank prescription template (max. 2 prescriptions per patient). You can also stop a drug that the patient is already using by writing a discontinuation prescription. You can use resources as you would in practice.

For pharmacy students: You have Additional Prescribing Authorization

Confidence survey: In this section, you will be asked to read the statements regarding your confidence in the required assessment skills and prescribing skills, and select your level of confidence with each statement. If you write two prescriptions, please complete the survey for each individual prescription. You may also choose to provide further explanation for your answers at the end of the assessment, however this is not required.

I have read the information and consent forms and agree to participate in this study:

- Yes (1)
- No (2)

Case 1:

Mr Singh

Age: 54

Medical history: osteoarthritis in both knees

Current medication: Ibuprofen 200 tablets, 1-2 tablets three times daily as needed

Allergy: none

Habits: 15 cigarettes per day, no alcohol

One month ago, Mr Singh came to your clinic with a history of acid reflux. Besides a body mass index of 29 kg/m², there were no abnormal findings on physical examination. You advised him to lose weight, quit smoking and avoid foods that induce reflux.

Today, Mr Singh comes back to your clinic because the acid reflux is getting worse. About half an hour after every big meal, he complains about regurgitation (“taste of acid in the throat”), dysphagia and a burning pain in the epigastric region. He tells you that he quit smoking and also tried to lose some weight, and uses ibuprofen 1-2 times per day.

He is still overweight with a body mass index of 28 kg/m². No abnormal findings were found on further physical examination.

Upper gastrointestinal endoscopy shows non-erosive gastroesophageal reflux disease (GERD).

Your working diagnosis is: **gastroesophageal reflux disease, not sufficiently responding to lifestyle changes**

*Only relevant information about the patient is given above. You may think you need more information by further history taking or other examinations. If this information is not mentioned, you may assume that the findings are not relevant.

Your job is to decide what to prescribe for the patient. You will be asked to fill in the “drug name”, “drug dose”, “dosing frequency”, “duration” and “route of administration” for each drug individually, in addition to the legal requirements for a prescription, under the blank prescription template (max. 2 prescriptions per patient). You can also stop a drug that the patient is already using by writing a discontinuation prescription. You can use resources as you would in practice. For pharmacy students: You have Additional Prescribing Authorization

<p style="text-align: center;">Prescriber's Name Clinic Address Edmonton, AB Postal Code Phone: 780-123-4567 Fax: 780-123-5678</p> <p>Date:</p> <p>Patient Name:</p> <p>Rx:</p> <p style="text-align: center;">No substitution Refills:</p> <p>PROVIDER SIGNATURE: PROVIDER ID:</p>

Case 1, Prescription 1: Please write your prescription as you would in practice, including any legal requirements.

Please read the statements regarding your confidence in the required assessment skills and prescribing skills, and select your level of confidence with each statement. You may also choose to provide further explanation for your answers at the end of the assessment, however this is not required.

Case 1, Confidence Survey for Prescription 1

	Very Unconfident (1)	Unconfident (2)	Confident (3)	Very Confident (4)
Considered all the relevant patient information (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assessed the patient's presenting symptoms (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assessed the safety of medication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

options based on
the patient's
allergies (3)

Prescribed the
correct

medication (4)

Prescribed the

correct dose (5)

Prescribed the

correct duration

of therapy (6)

Considered

possible

contraindications

or warnings (7)

Included all the

legal

requirements for

a prescription (8)



Appendix 2: Example of marking scheme

Appropriate:

Pantoprazole (or other PPI) 40mg po once daily x 30 days up to 8 weeks

Suboptimal:

If <30 and >15 days or > 56 and < 90 days

2nd line agent = H2Ra or prokinetic agent

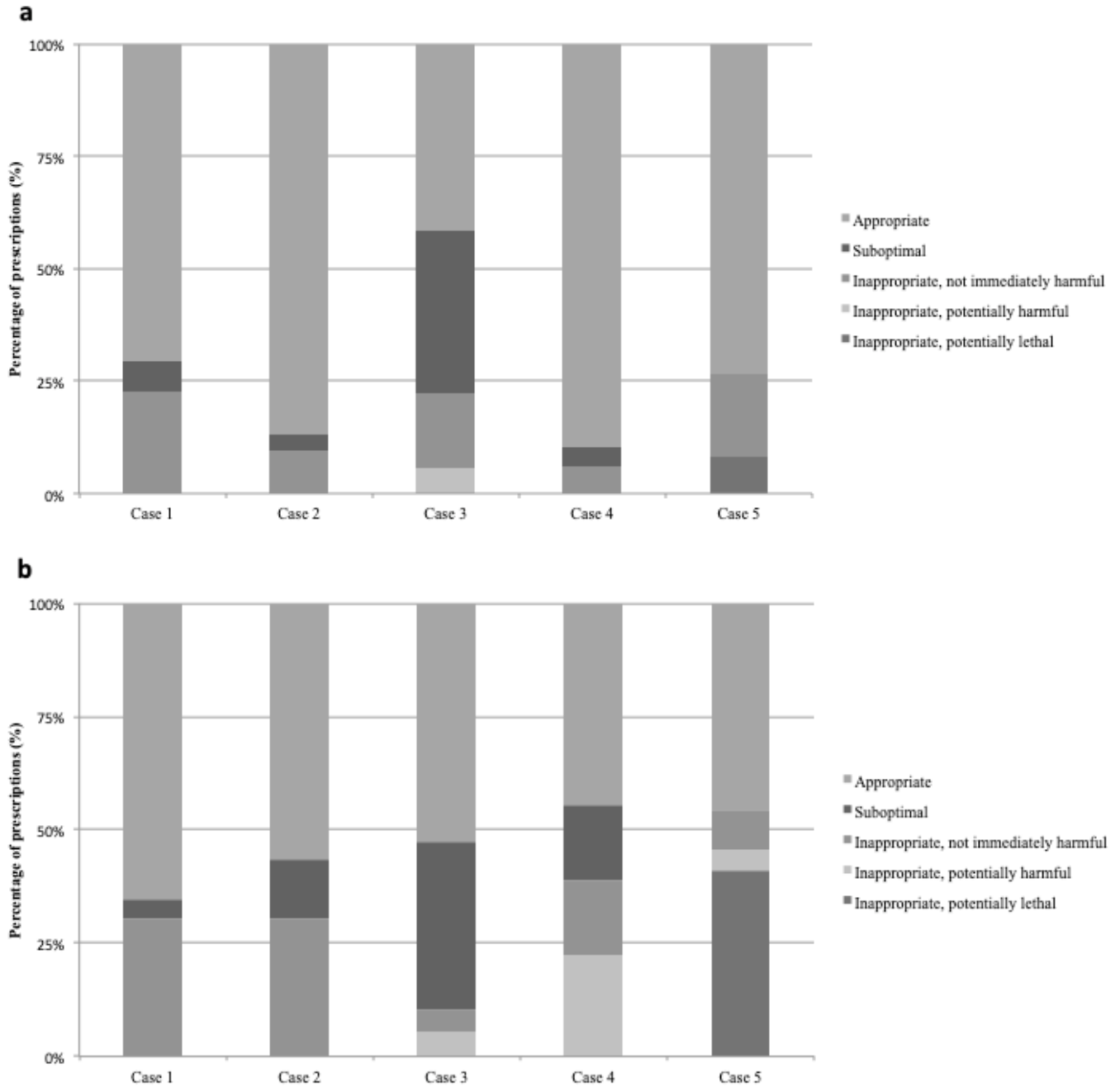
Inappropriate, not immediately harmful:

If </= 15 days or >/= 90 days duration

Appendix 3: Supplemental results

Supplemental Table 3.1: Number of prescriptions divided by case, rated based on their appropriateness using a marking scheme adapted from Brinkman et al. 2017.³⁰ The number of prescriptions per case for pharmacy students is as follows: Case 1 n = 43, Case 2 n = 53, Case 3 n = 36, Case 4 n = 49, Case 5 n = 47. The number of prescriptions per case for medical students is as follows: Case 1 n = 23, Case 2 n = 22, Case 3 n = 19, Case 4 n = 18, Case 5 n = 22. Pharmacy is abbreviated to “pharm.” and medicine is abbreviated to “med.” Chi-square test or Fisher’s exact test (when any cell had an expected count <5) used to calculate p-values associated with frequencies. Significant p-values (anything <0.05) bolded.

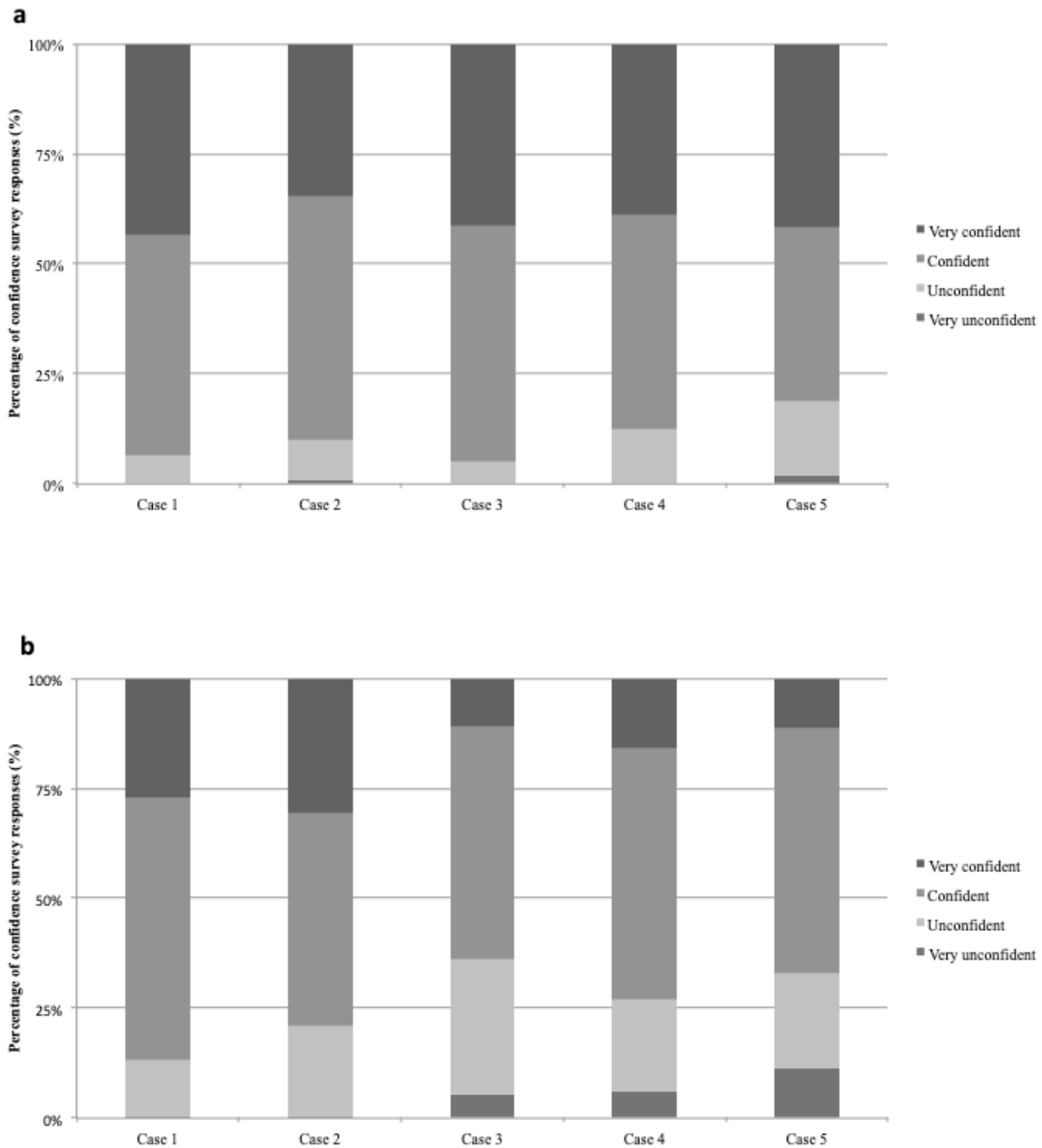
	Case 1			Case 2			Case 3			Case 4			Case 5		
	Pharm	Med	P-value	Pharm	Med	P-value	Pharm	Med	P-value	Pharm	Med	P-value	Pharm	Med	P-value
Appropriate	30 (70)	15 (65)	0.661	46 (87)	13 (57)	0.004	15 (42)	10 (53)	0.437	44 (90)	8 (44)	0.000	35 (75)	10 (46)	0.022
Suboptimal	3 (7)	1 (4)	1.000	2 (4)	3 (13)	0.134	13 (36)	7 (37)	0.957	2 (4)	3 (17)	0.116	0	0	N/A
Inappropriate, not immediately harmful	10 (23)	7 (30)	0.809	5 (9)	6 (27)	0.957	6 (17)	1 (5)	0.401	3 (6)	3 (17)	0.331	8 (17)	2 (9)	0.483
Inappropriate, potentially harmful	0	0	N/A	0	0	0.116	2 (6)	1 (5)	0.345	0	4 (22)	0.004	0	1 (5)	0.310
Inappropriate, potentially lethal	0	0	N/A	0	0	N/A	0	0	NA	0	0	NA	4 (8)	9 (41)	0.002



Supplemental Figure 3.1: Percentage of prescriptions divided by case, rated based on their appropriateness using a marking scheme adapted from Brinkman et al. 2017.³⁰ The number of prescriptions per case for pharmacy students is as follows: Case 1 n = 43, Case 2 = 53, Case 3 n = 36, Case 4 n = 49, Case 5 n = 47. The number of prescriptions per case for medical students is as follows: Case 1 n = 23, Case 2 n = 22, Case 3 n = 19, Case 4 n = 18, Case 5 n = 22. A) Pharmacy students, B) Medical students

Supplemental Table 3.2: Results from the confidence surveys following each prescription, divided by case. The total number of confidence ratings for pharmacy students is as follows Case 1 n = 344, Case 2 n = 423, Case 3 n = 288, Case 4 n = 392, Case 5 n = 144. The number of confidence ratings for medical students is as follows: Case 1 n = 184, Case 2 n = 176, Case 3 n = 152, Case 4 n = 144, Case 5 n = 176. Pharmacy is abbreviated to “pharm.” and medicine is abbreviated to “med.” Chi-square test or Fisher’s exact test (when any cell had an expected count <5) used to calculate p-values associated with frequencies. Significant p-values (anything <0.05) bolded.

	Case 1			Case 2			Case 3			Case 4			Case 5		
	Pharm	Med	P-value	Pharm	Med	P-value	Pharm	Med	P-value	Pharm	Med	P-value	Pharm	Med	P-value
Very confident	149 (43)	50 (27)	0.000	147 (35)	54 (31)	0.337	119 (41)	17 (11)	0.000	152 (39)	23 (16)	0.000	156 (42)	20 (11)	0.000
Confident	173 (50)	110 (60)	0.037	233 (55)	85 (48)	0.129	154 (53)	80 (53)	0.867	191 (49)	82 (57)	0.092	149 (40)	98 (56)	0.000
Unconfident	22 (5)	23 (13)	0.017	39 (9)	36 (21)	0.000	15 (5)	47 (31)	0.000	49 (13)	30 (21)	0.016	63 (17)	38 (22)	0.194
Very unconfident	0	1 (1)	0.348	4 (1)	1 (1)	1.000	0	8 (5)	0.000	0	9 (6)	0.000	7 (2)	20 (11)	0.000



Supplemental Figure 3.2: Percentage of confidence survey responses divided by case. The total number of confidence ratings for pharmacy students is as follows: Case 1 n = 344, Case 2 = 423, Case 3 n = 288, Case 4 n = 392, Case 5 n = 144. The number of confidence ratings for medical students is as follows: Case 1 n = 184, Case 2 n = 176, Case 3 n = 152, Case 4 n = 144, Case 5 n = 176. A) Pharmacy students, B) Medical students

Supplemental Table 3.3: Detailed breakdown of the number of evaluated prescriptions by type using a marking scheme adapted from Brinkman et al. 2017			
		Pharmacy <i>n</i>	Medicine <i>n</i>
Appropriate	A drug therapy is defined as appropriate if the correct drug, dose, dosage, duration, and route is chosen (according to the local or (inter)national guidelines)	170	56
Suboptimal	The dose of drug therapy is slightly too high (half to two times the normal dose) for the condition being treated	10	2
	The dose of drug therapy is slightly too low for the condition being treated to produce the desired outcome	1	1
	The duration of drug therapy is slightly too long for the condition being treated	2	2
	The duration of drug therapy is slightly too short for the condition being treated to produce the desired outcome	3	3
	Second or third choice of drug is prescribed instead of first-choice drug for the condition being treated	4	6
Inappropriate - not immediately harmful	The drug dose is too low for the condition being treated to expect a beneficial outcome	2	0
	The duration of the drug therapy is too long for the condition being treated resulting in drug overuse	2	6
	The duration of the drug therapy is too short for the condition being treated to produce the desired outcome	3	3
	No drug therapy is prescribed although the condition requires initiation of drug therapy	4	0
	Omission of protective or preventive drug therapy	2	1
	Unnecessary drug therapy is prescribed for which there is no valid medical indication	3	2
	Duplicate drug therapy is prescribed without benefits	0	1

	for the patient		
	The prescription lacked drug name, dose, dosage, duration, route, or included inappropriate abbreviations, or drug class instead of generic name, or was illegible	16	6
Inappropriate - potentially harmful	The drug dose is too high (four to ten times the normal dose) for the condition being treated with increased risk of adverse effects	1	1
	Unnecessary drug therapy is prescribed for which there is no valid medical indication and with increased risk of adverse effects	1	1
	Intravenous drug therapy is prescribed while not medically necessary	0	3
	Duplicate drug therapy is prescribed with increased risk of adverse effects	0	1
Inappropriate - potentially lethal	Serum drug levels are likely to be toxic based on common dosage guidelines	4	9

Appendix D: Comparison table of the WHO Guide to Good Prescribing, the Patient Care Process and the Prescribing Safely Canada Physician Prescribing Competencies

Table D.1: Comparison of prescribing and assessment guides		
WHO Guide to Good Prescribing	Faculty of Pharmacy and Pharmaceutical Sciences: Patient Care Process	The Prescribing Safely Canada Physician Prescribing Competencies
Define the patient's problem	Determine type of drug related problem	Perform a comprehensive assessment
Specify the therapeutic objective	Goals of therapy	
Verify the suitability of your p-treatment	Alternatives	Consider optimal pharmacological and nonpharmacological options
Start the treatment	Recommendation/plan	Prescribe medications appropriate to the patient's diagnoses
Give information, instructions and warnings	Monitoring parameters	Provide medication relevant information
Monitor (and stop?) treatment	Follow-up	Reach a shared decision on medication use and monitoring and monitor and review the patient's medications and adherence