Evaluation of the Clinical Pharmacology and Toxicology (CPT) Content in the McMaster Medical School Curriculum

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**Abstract**

Background: There is a high prevalence of prescribing errors because physicians lack the necessary Clinical Pharmacology and Toxicology (CPT) education to formulate a safe prescription. A set of Canadian Prescribing Competencies (CPC) has been developed to indicate physician prescribing responsibilities.

Objective: To evaluate the CPT and therapeutics content in the McMaster medical school’s objectives and competencies.

Methods: We searched the McMaster undergraduate curriculum for competencies and objectives tagged with “pharmacology” and “toxicology”. A gap analysis was used to compare McMaster objectives and competencies to the recently established CPC themes, then the additional coverage from Australia’s National Prescribing Curriculum (NPC).

Results: CPCs are divided into 10 themes with 65 individual competencies. Of McMaster’s relevant objectives, 90 were similar enough to map to the 6/10 CPC themes. Of McMaster’s competencies, 6 fell under 7/10 CPC themes. All of 117 NPC objectives and 12 NPC competencies supplemented 10/10 CPC themes, including the themes missing from McMaster curriculum.

Discussion: The McMaster curriculum does not adequately address CPCs themes (20%) while the NPC items addressed each theme. This suggests that the NPC curriculum has potential to supplement the McMaster CPT education. The study is limited by the flexibility of material covered in tutorials and self-learning during medical school, and the single-person rating system.

Future Directions: The mapping continues with inter-rated reliability testing. The effectiveness of the NPC modules in supplementing CPT knowledge and prescribing skills will be evaluated using a pre-post test design and an online feedback survey via ExamSoft.

**1. INTRODUCTION**

1.1 Background and Rationale

Medical practitioners are presumed to have acquired the necessary pharmacology education, therapeutic knowledge, and communication skills to formulate, write, and monitor a safe, legal and appropriate prescription and therapeutic plan.1-4 Nonetheless, there is a high prevalence of prescribing errors by a range of doctors, whether that be errors, inappropriate, or irrational prescribing.1-4 Medical school graduates expressed dissatisfied feedback and first-year physicians were neither confident nor competent with their prescribing abilities from their own assessment and that of their supervisors.1,2,6

Previous research and feedback have indicated a need for medical education to address this shortcoming.1,3,7 In the current medical curriculum, students do not receive sufficient training in clinical pharmacology knowledge or prescribing skills to support their transition into discipline training or into practice. Many medical schools lack dedicated Clinical Pharmacology and Toxicology (CPT) courses and instead, attempt to integrate it within other subjects thereby decreasing the overall time spent on this content.1,7 A national survey of medical school faculty revealed a high degree of interest in a national effort to improve competence in this area, based on concern regarding their own graduates.8 More than half of Ontario final year medical students were unable to pass a prescribing competence assessment which is routinely passed by British medical students prior to their licensing exams.9 Additionally, a survey of medical schools across Canada suggested widespread unease with the state of prescribing skills of newly graduated medical students.8 The combination of a high rate of prescribing errors amongst new physicians (approaching 10% of prescriptions) and their association with serious clinical outcomes and death, the lack of prescribing competencies and lack of prescribing confidence indicates a need to significantly enhance CPT knowledge and prescribing skills in the medical curriculum.1,8,10,11

*1.1.1 Online Curricula*

eLearning seems to be a viable, cost-effective method to teach content supplementary to lectures, tutorials and clinical exposure while standardizing the content at a high-quality level and allowing student flexibility.12,13,14 Our ongoing systematic review of randomized trials of educational interventions to improve prescribing competence of medical trainees yielded 22 trials, three of which used an electronic intervention. These showed promising improvements in knowledge, calculation skills, and prescribing confidence.15 Results from our recent evaluation of international online curricula resources for CPT, using recommended Medical Education Framework as a quality guide, found that the National Prescribing Curriculum of Australia (NPC) was the highest quality.16,17 This online, readily available resource provides modules that educate and encourage practice in rational and confident prescribing on 24 topics.18 The NPC is a prescribing service that is funded by the Commonwealth of Australia. This service was created to improve the quality of prescribing education, targeting senior physicians and those training for general practice.19

*1.1.2 Canadian Prescribing Competencies (CPCs)*

Recently, a list of professional Canadian Prescribing Competencies (CPCs) was developed that clearly outline a physician’s responsibilities with respect to clinical pharmacology and prescribing.20 This list contains 65 items, divided into 10 themes: assess the patient, consider the options, reach a shared decision, prescribe, provide information, monitor and review, prescribe safely, prescribe professionally, improving prescribing practice, prescribe as part of a team.

 *1.1.3 Gap Analysis*

A gap analysis is a method primarily used in economics and management, where actual performance is compared to a set of potentials or objectives.21 This would identify gaps that exist between the two, allowing for appropriate allocation of resources to manage and close these gaps.22 This method was developed because of the need for continuous improvement in the marketing curriculum which require period assessments.22 Gap analyses may take on several forms depending on the setting and need. Some include service quality evaluations, where examiners assess gaps with customer expectation and business perceptions and experiences.21 Another example includes administration of business school, including designing a curricula that meets employer’s expectations.23 Finally, a gap analysis was used to measure perceptual differences between practitioners and academicians on curriculum content and research areas in international marketing.24 Gap analyses are gradually emerging in the literature as a method to assess competency developing in a curriculum.25 There is no established methodology to carry out a gap analysis nor a principled approach or framework for in-depth program analysis.26

*1.1.4 Research Goals*

McMaster medical school is undergoing another curriculum renewal to be complete by August 2019. This presents an opportunity to identify areas of strengths and gaps that may exist in CPT content and prescribing competency. Our overall research goals are 2-part: a) to identify how well McMaster medical school curriculum represents the CPCs, and how well does the NPC compensate for McMaster curriculum deficiencies, and b) does implementation of the NPC curriculum improve CPT knowledge and prescribing skills amongst McMaster medical students.

1.2 Objectives

The primary objective of this final paper was to address the first part of the research question: to identify the extent of CPT and therapeutic content covered in the McMaster Medical Program objectives and competencies compared to the 10 CPC themes. Additionally, the list of NPC competencies and objectives were compared to the 10 CPC themes to identify the areas in which the NPC compensates for the McMaster curriculum deficiencies. A secondary objective was to identify dispersion of CPT-related content in the McMaster curriculum.

This study has been approved by the Hamilton Integrated Research Ethics Board (HiREB) and McMaster’s Protocol Review Committee (PRC).

**2. METHODS**

2.1 Methodology

A gap analysis was completed to compare the McMaster curriculum to the CPCs to identify McMaster curriculum gaps.25 Though there is no standardized method to carry out a gap analysis, this methodology was adapted from the study from Queen’s University, “Prescribing Competency in Undergraduate Medical Education.”26 For the purposes of this study, we were comparing the current McMaster curriculum to a given “gold standard,” that being the CPCs. This method consisted of laying out the 10 CPC themes, then going through each McMaster competency and objective to see whether they fell under any of the 10 themes. This was determined by matching each competency and objective to a certain CPC theme if the statement had addressed/or was relevant to the theme. Ultimately, this allowed us to determine gaps – areas the McMaster competencies and objectives did not address the CPC themes –and overlaps in McMaster curriculum content.25,26,27 When performing the comparison, the McMaster competencies and objectives were compared according to the 10 CPC themes. This exercise was repeated by comparing the NPC competencies and learning objectives to the 10 CPC themes. This not only identified areas in which the NPC content supplemented McMaster content that matched with the CPC themes, but also how the NPC compensated for the 10 CPC themes the McMaster curriculum content lacked to address.

McMaster Professional Competencies are broad goals or achievements that is interwoven throughout the 3-year program.28 They are statements that a medical trainee must master to complete the program. However statements of competencies, which are based on an international list of ‘Entrustable Professional Activities’ may be too general to discern requirements to learn CPT content.29 As a result, learning objectives which are more specific to the Medical Foundation units and tutorials were also tabulated.

2.2 Data Collection

McMaster program competencies and learning objectives were retrieved via the open MedPortal Curriculum Database, accessible through https://cdb.medportal.ca.30 MedPortal is organized based on a tagging system, thus competencies and learning objectives were retrieved using tags. Competencies and pre-clerkship and clerkship learning objectives relevant to the field of Clinical Pharmacology and Toxicology were used. The 59 McMaster program competencies were used in gap analysis. Then objectives tagged with “Toxicology (Discipline)”, “Pharmacology (Basic Sciences)”, “Pharmacology (Discipline)”, “Clinical Pharmacology (Curriculum Block)” and MeSH tags “Drug Prescriptions”, “Prescription Drugs”, “Pharmacology”, “Pharmacology, Clinical”, and “Toxicology”, were selected. This yielded 104 relevant McMaster learning objectives, 80 of which are pre-clerkship and 24 of which are clerkship. 30

NPC competencies and learning objectives were retrieved via the NPC modules and the National Prescribing Service Professional Competencies.31 The NPC modules are built based upon the National Prescribing Professional Competencies. A total of 117 NPC objectives from all 24 available modules, and all of 12 NPC competencies were evaluated.18

2.3 Data Analysis

The competencies and learning objectives for both McMaster and the NPC was mapped based on whether the statement addressed the CPC items in an excel chart. The 10 CPC themes were listed under different rows. There were different columns corresponding to McMaster competencies, McMaster objectives, NPC competencies, and NPC objectives. Additional columns named discipline and module number was added to identify where in the curriculum the statement addresses. If a statement matched, it was put under the correct row and column (refer to table 1) A descriptive analysis was performed to summarize key competencies, learning objectives, and gaps identified in the McMaster medical curriculum. This was done by looking at competencies and learning objectives that are concordant versus discordant, identifying patterns and trends in both the McMaster curriculum and NPC curriculum.

**3. RESULTS**

3.1 Descriptive Data

90 McMaster learning objectives and 6 McMaster competencies were similar enough to map based on the given CPC items and themes. Some McMaster competencies were repeated as they may have covered more than 1 theme in their statement. All of the NPC items were similar enough to map as at least one addressed each CPC theme. As a result of the gap analysis, it was evident that though some CPC themes were covered in the McMaster curriculum, 20% of the themes were not addressed by either McMaster competencies or objectives, including “improving prescribing practice” and “prescribing as part of a team” (refer to table 1). More specifically, the McMaster competencies addressed 70% and McMaster objectives addressed 60% of the CPC themes.

*3.1.1 Competencies*

With respect to the McMaster competencies, which are broad statements that address what a medical student should know by the end of their education, only 6 of 59 competencies were related to the CPC themes. Not all 10 CPC themes were addressed in the McMaster competencies; 3 CPC themes were not addressed, including “prescribe safely,” “improve prescribing practice,” and “prescribe as part of a team.” Additionally, only 2 McMaster competencies directly mention the pharmacology-related terminology “therapeutics” in their statement (e.g. 2.3: Apply principles of clinical sciences to diagnostic and therapeutic decision-making…). When looking at the NPC competencies, it was found that all 12 competencies matched to a CPC theme. As a result, each CPC theme was addressed, including the ones that McMaster failed to address.

*3.1.2 Objectives*

A total of 90 McMaster learning objectives was similar enough to map to the CPC themes. Some of the CPC themes were well-covered by learning objectives, including “consider the options.” However, there were 4 CPC themes that were not addressed by the objectives, including “assess the patient,” “provide information,” “improve prescribing practice,” and “prescribe as part of a team.” When looking at the NPC learning objectives covered in the modules, it was found that all 117 objectives mapped to a CPC theme. Overall, each CPC was addressed through the NPC modules, including the ones McMaster failed to address.

**Table 1. Chart of curriculum mapping with 1 example of concordant competency and objective if available.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Canadian Prescribing Competency Theme | McMaster Competencies | McMaster Objectives | Discipline for Objective | NPC Competencies | NPC Learning Objectives | NPC Module for Objective |
| 1. Assess the patient | 1.1 Gather essential and accurate information about patients and their health through history-taking, physical examination, and the use of laboratory data, imaging, and other tests. | N/A | N/A | 1.2 Performs a comprehensive medicines assessment to obtain information to understand the person's clinical needs and context | Understand the importance of considering a full history to put into context a presentation of depression | Depression in adolescents |
| 2. Consider the Options | 2.3 Apply principles of clinical sciences to diagnostic and therapeutic decision-making, clinical problem-solving, and other aspects of evidence-based healthcare | To understand the nutritional and metabolic recommendations for renal failure patients, including diet to manage complications such as vascular disease, renal metabolic bone disease and diabetic nephropathy | MF3, Renal | 2.1 Considers non-pharmacological treatment options suitable for treating the person and their condition | Identify effective non-pharmacological management options recommended for all patients | Hypertension |
| 3. Reach a Shared Decision | 4.1 Communicate effectively with patients, families, and the public, as appropriate, across a broad range of socioeconomic and sociocultural backgrounds | To appreciate the patterns of natural health product use in the population | MF4, Clinical Pharmacology | 3.2 Works in partnership with the person and other health professionals to select medicines and to tailor and implement a treatment plan | Highlight CVD risk discussion points and encourage lifestyle modifications | Lipid and CVD risk management |
| 4. Prescribe | 1.4 Make informed decision about diagnostic and therapeutic interventions based on patient information and preferences, up-to-date scientific evidence, and clinical judgment | Review medications, both OTC and prescribed, used in pregnancy and their potential side effects | MF3, Reproduction | 4.1 Provides clear instructions to other health professionals who dispense, supply, or administer medicines prescribed for the person | Write a prescription for the medicine you wish to prescribe | Seizure |
| 5. Provide Information | 1.7 Counsel and educate patients and their families to empower them to participate in their care and enable shared decision-making | N/A | N/A | 4.2 Provides information about medicines and the treatment plan with the person's consent to other health professionals who provide care to the person | Adequately communicate the proposed treatment plan and potential medicine–related adverse effects to the child’s parent(s) or carer(s) and the healthcare team | A child with acute otitis media |
| 6. Monitor and Review | 2.3 Apply principles of clinical sciences to diagnostic and therapeutic decision-making, clinical problem-solving, and other aspects of evidence-based healthcare | To know what actions to do when an adverse drug event is suspected | MF4, Clinical Pharmacology | 5.1 Obtains information to access the person's response to treatment | Select appropriate parameters to monitor treatment response during both acute and maintenance phases of bipolar I disorder | Acute mania in bipolar disorder |
| 7. Prescribe Safely |  | To understand some of the mechanisms by which drug-drug interactions occur | MF2, Clinical Pharmacology | 4.1 Provides clear instructions to other health professionals who dispense, supply, or administer medicines prescribed for the person | Identify contraindications and drug interactions for medicines used for the treatment of low back pain | Analgesia for low back pain |
| 8. Prescribe Professionally | 1.4 Make informed decision about diagnostic and therapeutic interventions based on patient information and preferences, up-to-date scientific evidence, and clinical judgment |  |  | 4.1 Provides clear instructions to other health professionals who dispense, supply, or administer medicines prescribed for the person | Adequately communicate the proposed treatment plan and potential medicine–related adverse effects to the child’s parent(s) or carer(s) and the healthcare team | A child with acute otitis media |
| 9. Improve Prescribing Practice | N/A  | N/A | N/A | 4.2 Provides information about medicines and the treatment plan with the person's consent to other health professionals who provide care to the person | Identify aspects of care that need to be communicated to the patient and the healthcare team | Acute pulmonary oedema |
| 10. Prescribe as Part of a Team | N/A | N/A | N/A | 1.1 Establishes a therapeutic partnership with the person and a collaborative relationship with other health professionals | Identify the important components of hospital discharge, including the provision of information to the patient and health professionals responsible for the patient’s care | Polypharmacy |

\*\*Note: Each CPC theme is further split into more specific statements that clearly define each theme.

**Figure 1a: Number of McMaster competencies and objectives concordant with the CPC themes.**

**Figure 1b: Number of NPC competencies and objectives concordant with the CPC themes.**

Furthermore, seeing how learning objectives are specific to MFs, it was found that the learning

objectives relevant to pharmacology was not equally represented amongst different MFs during

pre-clerkship, and different rotations during clerkship.

**4. DISCUSSION**

4.1 Summary of Results and Addition to Literature

The gap analysis identified key competencies and learning objectives that were concordant with the 10 CPC themes. In doing so, gaps in the medical curriculum that did not address the CPC themes were clearly identified. Though McMaster does not address 20% of the CPC themes, the NPC curriculum addressed each of the CPC themes, including those that were not encompassed in the McMaster curriculum.

Though pharmacological considerations, prescribing medication, and monitoring a patient’s progress is important, there are other important aspects to prescribing such as self-assessment and prescribing in the context of an interdisciplinary team that is overlooked by the McMaster curriculum. The McMaster curriculum also does not have any additional competencies beyond the 10 CPC themes. Furthermore, there is an unequal distribution of pharmacology related learning objectives throughout the pre-clerkship MFs and clerkship rotations. Though this could be due to the nature of some topics covered in each MF and rotation, it is important to ensure that all the pharmacological needs and skills are met for each topic covered.

These identified gaps in the McMaster curriculum are all addressed by certain NPC competencies and learning objectives. All the NPC items were similar enough to map to the CPC themes, and each theme was addressed when looking at the NPC curriculum as a whole. However, it is important to differentiate that a single NPC module does not address each CPC theme, rather all of 24 modules as a whole provides a comprehensive overview of the 10 themes. As such, this suggests potential use for NPC modules to be used as a supplemental resource in the McMaster curriculum to better address the CPC themes.

In the McMaster Undergraduate Medical Education curriculum, professional competencies are abilities that a medical student must master to become a competent practitioner.28,32 These are evaluated through a student’s Reflective Physician Portfolio and through Professional Competencies Integrative Exercises (PIEs).33 Learning objectives are specific to MFs and are much smaller milestones that students are evaluated in achieving on a regular basis via assessments (e.g. Concept Application Exercises (CAEs)).33 This structure makes up the Competency-Based Medical Education (CBME) that many Ontario medical schools have adapted to. However, there are implications and little agreement amongst experts regarding this paradigm.32 Some reasons relate to the simplicity of competencies and a focus on outcome assessment.32,34 As such, it is vital to consider whether evaluating a medical curriculum through their competencies and objectives is the most accurate method.

In the current literature, there is very minimal studies done on competency-based medical education, especially those that focus on CPT content. Recognizing that prescribing errors are continuously arising, evaluating medical education with respect to prescribing knowledge and skill acquisition is crucial. This is gradually being recognized in Ontario; for example, a study was performed looking at prescribing competency in Queen’s University undergraduate medical education in 2018.26 The aim of this study was to identify gaps in the Canadian medical undergraduate curricula using a similar method of curriculum mapping by matching learning events to the relevant competencies using the UK’s Britain’s Royal Pharmaceutical Society prescribing competency framework. 35 Our study adds to the literature by specifically evaluating the CPT content in the McMaster undergraduate medical curriculum with respect to the new, emerging CPCs. Additionally, there is no established framework for a program analysis.Though a gap analysis was historically used for management curriculum improvement, there is emerging use of a gap analysis method for program and curriculum evaluation.25,26,27 Though the gap analysis method is not standardized, this demonstrates the growing potential to develop and use this method to effectively compare and improve curricula.

4.2 Limitations & Considerations

There are a few limitations to consider with this project. One of which includes the flexibility of McMaster’s learning objectives and competencies. These are guidelines to the McMaster curriculum and the content that the students learn. Given the problem-based nature of tutorials and the variation of clerkship experiences, the amount of CPT content that each student encounters may vary.

Furthermore, a main limitation to this study arises from the single-person rating. A single-rater system is not as effective as a multi-rater system as it lacks accuracy.36 The multi-rater system increases accuracy and uses the judgements of several knowledgeable people in arriving at a decision. There is a possibility of bias that may arise from a single individual involved with matching, especially since matching statements to a CPC theme requires qualitative judgement. Therefore, a way to improve this would be to improve participation from different medical students and faculty members that would show reproducible results, accompanied with an inter-rater reliability analysis.

Additionally, the McMaster learning objectives that were analyzed were those tagged with relevant CPT terms. Some of the CPC themes are very general and not specific to just prescribing, such as “assess the patient.” As such, some learning objectives may have been missed because they lacked the necessary pharmacology tags. Thus, looking into additional tags that may contain learning objectives that may address this CPC theme may be beneficial. Furthermore, in the case that there missed learning objectives, it is recommended that they are tagged with the necessary CPT terms to highlight their important in prescribing and provide a comprehensive view of CPT content in the curriculum.

Finally, the CPCs are presented as 65 specific items that are organized into broad 10 CPC themes. As such, this study does not look at whether each of the 65 items are addressed. Though specific competencies and objectives may address themes, they may not address each of the items that are grouped into that theme. Thus, a future consideration for this study would be to increase the accuracy and detail of analysis by mapping to the 65 CPC items.

4.3 Future Steps

Next steps with this project include continuing with inter-rater reliability in a team comprised of medical student co-investigators and faculty members. This will be done by delegating certain learning objectives to different medical students and facilitating a gap analysis, then comparing with other raters to evaluate reliability. Additionally, a more detailed mapping of the learning objectives with all 65 CPC items as opposed to the 10 general CPC themes is in consideration. This will provide a more directive overview of the McMaster curriculum (as when CPC themes are addressed, this does not necessary represent all the items under that theme is addressed).

Moving forward, the effectiveness of the NPC modules for supplementing CPT knowledge and prescribing skills in McMaster medical students will be evaluated using a pre-post test design and an online feedback survey. This will be administered via ExamSoft {https://examsoft.com/exam-login}, the online assessment platform used by McMaster medical school. The results will be used to determine the use for NPC modules to supplement CPT knowledge and prescribing in the McMaster curriculum.

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