INSTRUCTIONAL DESIGN AND ASSESSMENT

A Physical Assessment Skills Module on Vital Signs

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Objectives. To implement and evaluate a physical assessment module for pharmacy students.
Design. A physical assessment module focusing on vital signs was incorporated into the curriculum for third-year pharmacy students. This module consisted of an online component, a practical skills workshop, and a clinical practice site.
Assessment. The mean score on the in-class quiz, which evaluated students' knowledge of physical assessment after completion of the online module, was 94%. During the practical skills laboratory, 48% of student-measured systolic blood pressure (BP) readings and 60% of student-measured diastolic BP readings were within 5 mmHg of the machine reading. In the assessment of blood pressure technique, areas of difficulty included detection of Korotkoff sounds; steady deflation of cuff; and hand-eye coordination.
Conclusion. Students more frequently underestimated systolic BP than the diastolic BP when compared to the automated machine readings. Findings from this study will be used to improve existing modules and evaluation methods on the physical assessment of vital signs.
Keywords: blood pressure, physical assessment, pharmacy education, pharmacy students, vital signs

INTRODUCTION

The application of physical assessment skills is recognized as an important part of providing pharmaceutical care.[1-8] Advantages include being able to monitor and optimize medications more effectively, screen patients at risk for chronic disease states, promote better communication among health care practitioners, and improve our overall understanding of patient care.[6,7] As pharmacists' scope of practice continues to expand into more patient-centered roles, pharmacy education will require the incorporation of courses into the curriculum that will develop skills to fulfill such roles.

At present, most Canadian pharmacists have not received training in physical assessment skills. One survey reported 82.4% of Canadian pharmacists never received any type of formal training in conducting physical examinations.[7] The Association of Faculties of Pharmacy of Canada and the American Association of Colleges of Pharmacy's Center for the Advancement of Pharmacy Education have identified the performance and interpretation of physical assessment findings as an educational outcome for pharmacy graduates of entry-to-practice pharmacy programs.[8,9] However, few reports have described strategies for implementing a physical assessment program in pharmacy education.[10-15] More specifically, many of the previous studies used surveys to assess student satisfaction with the implementation of a new program rather than to assess the impact of the program on student learning. Others have described the way in which a physical assessment course is integrated within an existing course. Only one study compared student-measured blood pressure readings to machine-measured readings, and no studies have specifically reported on common areas of difficulty in learning physical assessment skills for new learners in a skills laboratory environment. As a result, the purpose of this study was to implement a physical assessment skills module on vital signs for third-year pharmacy students enrolled in a Bachelor of Science in

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Pharmacy program at the University of Manitoba, and to evaluate student learning of physical assessment skills.

Specific objectives of the study were: to evaluate students' objective knowledge of physical assessment skills based on the information provided in the online module; to compare the difference in blood pressure values obtained between a manual aneroid sphygmomanometer and an automated blood pressure machine when conducted by a third-year pharmacy student; and to identify common areas of difficulty in developing skills in obtaining a blood pressure reading with a manual aneroid sphygmomanometer.

DESIGN

A module on Skills in Physical Assessment focusing on vital signs was integrated into the Pharmacy Skills Laboratory 3 course for third-year pharmacy students (n=48) in the 2013-2014 academic year. The course was designed to apply and develop skills related to pharmacy practice using a wide range of interactive and collaborative learning strategies.

The physical assessment module consisted of 3 components: an online module, a practical skills workshop, and a clinical experiential practice site (at a periodontal clinic). The learning objectives for the module were as follows: (1) to recognize the importance of developing skills in physical assessment; (2) to demonstrate how to measure blood pressure, pulse rate, respiratory rate, and body temperature; (3) to explain and interpret findings obtained from a physical assessment of vitals; and (4) to apply physical assessment skills on selected patients for the purpose of evaluating and monitoring drug therapy response in a clinical setting. All content was developed by a registered clinical pharmacist with experience and formal training in physical assessment, with input on strategies for providing formal training and evaluation of instructors and students provided by the director of the Clinical Learning and Simulation Facility (CLSF) at the University of Manitoba. This study was exempted for full review by the Institutional Review Board.

Online Module

The online module included 3 voice-over PowerPoint lectures (approximately 20 minutes each). The online lectures were hosted on a secured online portal called Desire2Learn. The 3 lectures included: Introduction to Physical Assessment Techniques; Vital Signs: Blood Pressure; and Vital Signs: Pulse Rate, Respiratory Rate, Temperature. A 5-question multiple-choice quiz followed each lecture. Students were required to receive a grade of 60% or greater on each quiz to receive a PASS

standing on the online module. A PASS standing is required of students in order to participate in the practical skills laboratory workshop and clinical practice site. The multiple-choice options were randomized where appropriate to prevent students from circulating the answers. Students also were directed to useful videos demonstrating the measurement of blood pressure and an audio of Korotkoff sounds.

After completion of the online module, pharmacy students were required to take an in-class quiz based on the content provided in the online module prior to participating in the practical skills laboratory workshop. The in-class quiz was administered to evaluate the students' baseline knowledge of physical assessment skills prior to attending the practical skills workshop. The quiz consisted of 30 multiple-choice questions and 5 short-answer questions. The multiple-choice section comprised questions focused on the technical performance of vital signs (eg, steps on how to perform a blood pressure reading). The short-answer component focused on the clinical application of vital signs measurement (eg, identification of medical conditions that warrant immediate referral). Students had to receive a grade of 60% or greater to receive a PASS standing, and 5% of the grade contributed to their overall grade for the course.

Practical Skills Laboratory Workshop

Students had the opportunity to practice the measurement of vital signs (blood pressure, pulse rate, respiratory rate, and tympanic temperature) on a classmate during a 3½-hour practical skills workshop. Students were divided into groups of 6, and further divided into pairs to practice the measurement of vital signs on their classmate (Appendix 1). The room was set up so that each pair had their own blood pressure station. The room was also equipped with a simulator arm station and a thermometer station. Eight instructors from the faculty of pharmacy were involved in the supervision and evaluation of pharmacy students during this workshop. Each instructor was responsible for the supervision of 1 group of 6 pharmacy students, and each group carried out the activities of the workshop in a tutorial room. These instructors attended 2 training sessions led by the coordinator of the physical assessment module to become familiar with the equipment and proficient in the techniques for measuring vital signs. The instructor's primary role was to provide feedback as students practiced the measurement of vital signs and to provide a final evaluation on blood pressure technique.

Students' assignment to earn their class participation grade for the course was to assess vital signs and document the readings obtained. Students performed 3 manual

blood pressure readings using a manual aneroid sphygmomanometer (Pocket Nurse Proshyg BP Cuff, Monaca, PA) and stethoscope (Littmann Classic II S.E., St. Paul, MN), followed by 1 blood pressure reading with an automated blood pressure machine (American Diagnostic Corporation Semi-Automatic Adult Blood Pressure Monitor 6012, Hauppauge, NY). The average of the 3 manual blood pressure readings was calculated. The ADC Semi-Automatic Blood Pressure Monitor has an accuracy of ±3 mmHg for blood pressure.[15] Students also obtained a heart rate, respiratory rate, and tympanic temperature reading on their classmate.

During the workshop, a simulator arm (Nasco Lifeform, Fort Atkinson, WI) was also present to allow students to practice obtaining accurate blood pressure and pulse readings. The simulator arm allowed the instructor or student to program a specific blood pressure and heart rate reading for the learner to practice on using a manual blood pressure cuff and stethoscope. Students who participated and completed the assignment received a PASS on the assignment.

A final assessment of blood pressure on a simulated patient (classmate) was performed during the workshop. Students were given 15 minutes to demonstrate their ability to perform a blood pressure measurement based on a checklist derived from Bickley's *Bates' Guide to Physical Examination and History Taking*.[17] Evaluation of students' technical skill rather than the accuracy of the blood pressure values they obtained was the focus of this assessment as additional practice would be necessary for some students to become proficient. Students who missed critical steps in obtaining a blood pressure reading or who demonstrated weaknesses in any of these areas (eg, steady coordination of the control valve during cuff deflation) were advised to gain additional practice prior to their Periodontal Clinic exposure. A date was set for students to gain additional practice and to be reevaluated. The second session involved practicing 3 to 4 times on different individuals (classmates and instructor).

EVALUATION AND ASSESSMENT

The mean score on the in-class quiz was 94%. The mean score on the multiple-choice section of the test was 97%, and the mean score on the short-answer component was 84.7%. The distribution of grades in the short-answer component is shown in Table 1.

The mean student-measured (using a manual aneroid sphygmomanometer) systolic blood pressure (SBP) was 121.2±12.4 mmHg (range 92.0 mmHg to 150.7 mmHg) and the mean student-measured diastolic BP was 78.8±9.0 mmHg (range 60.0 mmHg to 98.7 mmHg). The mean systolic and diastolic BP measured by an automated

Table 1. Distribution of Grades on the Short-Answer Component of In-Class Quiz (n=48)

Letter Grade	Students, No. (%)
A+	19 (39.6)
A	21 (43.8)
B+	2 (4.2)
B	3 (6.3)
C+	1 (2.1)
C	2 (4.2)
D	0
F	0

blood pressure cuff were 125.3±13.7 mmHg (range 94.0 mmHg to 153.0 mmHg) and 77.7±9.3 mmHg (range 52.0 mmHg to 97.0 mmHg), respectively. Independent *t* tests were conducted to compare the mean student and automated values for each of the systolic and diastolic readings. The mean student value did not differ significantly from the mean automated value in both the systolic (BP $t(94)=1.55$, $p=0.13$) and diastolic (BP $t(94)=0.57$, $p=0.57$) readings.

Although the differences between the mean student and automated values for systolic and diastolic BPs were not significant, there were other differences worth noting related to the use of a manual vs an automated blood pressure machine. The mean absolute difference between the student-measured and automated blood pressure machine for the systolic and diastolic BPs was 6.6±6.1 mmHg (range 0.3 mmHg to 35.3 mmHg) and 5.0±3.8 mmHg (range 0 mmHg to 14.0 mmHg), respectively. The manual aneroid blood pressure cuff operated by the students appeared to underestimate the systolic BP more frequently than the diastolic BP when compared with readings obtained using the automated blood pressure machine (Table 2). Conversely, students tended to overestimate diastolic BP more often than systolic BP. Figure 1 shows the distribution of absolute differences in systolic and diastolic BPs in 5 mmHg increments starting from 0 to 5 mmHg to over 20 mmHg. Most of the students were able to achieve a manual reading within 5 mmHg of the automated reading. However, the majority of the students who under- or overestimated the blood pressure readings by greater than 5 mmHg, fell in the 5 mmHg to 10 mmHg range. From a clinical standpoint, a blood pressure reading that is more than 5 mmHg either under or over a person's true systolic or diastolic BP can increase the likelihood of a misdiagnosis or an inaccurate measurement of medication efficacy.

DISCUSSION

Designing a physical assessment course is a relatively new and important area of interest to many educators in

Table 2. Proportion of Students Underestimating or Overestimating the SBP and DBP by Greater than 5 mmHg Using a Manual Device in Comparison to the Automated Machine

	SBP		DBP	
	No. (%)	Range (mmHg)	No. (%)	Range (mmHg)
Underestimating	20 (41.7)	-5.3 to -35.3	8 (16.7)	-6.7 to -13.0
Overestimating	5 (10.4)	5.3 to 14.0	11 (29.9)	5.3 to 12.7

pharmacy and other health care professions. In this study, students demonstrated baseline knowledge of physical assessment through an in-class test prior to attending the practical skills laboratory workshop. However, a pretest on content presented in an online module was not administered and therefore student learning as a result of the online module could not be evaluated.

The practical skills workshop revealed that new learners of blood pressure assessment technique using a manual cuff more frequently underestimated systolic BP. In contrast, student-measured diastolic BP more closely reflected the readings obtained from an automated blood pressure machine. These observations might be expected of new learners given their initial unfamiliarity with Korotkoff sounds and skill in achieving a steady deflation rate. However, it could be argued that the diastolic BP should be more difficult to detect since it is potentially more difficult to determine the disappearance or muffling sounds of the diastolic BP. McCall and colleagues reported that among BP assessments taken by 83 second-year pharmacy students, 51% of systolic readings and 47% of diastolic readings were within 5 units of the machine reading,[14] compared to 48% and 60%, respectively, in our study. McCall and colleagues noted final digit bias, inappropriate cuff size, and variability in deflation rate as common errors leading to an inaccurate diastolic BP readings. In our study, the accuracy of the blood pressure readings could also have been influenced by inappropriate

cuff size (only standard and large cuff sizes were available), ambient room noise during the exercises, and improperly calibrated equipment (ie, new equipment not tested for accuracy). In addition, students commented on how the release valves on the new equipment were initially difficult to adjust, which could have affected students' ability to deflate the cuff at a steady rate.

The final assessment of students on their blood pressure technique using a manual cuff identified common major and minor issues (Table 3). Major areas of difficulty required considerably more practice to master blood pressure technique. Minor issues, on the other hand, were easily addressed and corrected on the subsequent trial. Identification of common major and minor areas of difficulty during the study allowed instructors to develop future strategies for teaching and evaluating new learners of manual blood pressure technique.

While the instructor could observe and evaluate technique in measuring blood pressure, it was difficult for the instructor to decipher whether the student heard and correctly interpreted the Korotkoff sounds, which is necessary to accurately obtain the true blood pressure value of an individual. Students who expressed the inability to detect the Korotkoff sounds were told to practice obtaining a reading on a simulator arm and on different classmates. The simulator arm can be programmed to assess the student's ability to obtain an accurate blood pressure value. However, the Korotkoff beats produced by the simulator
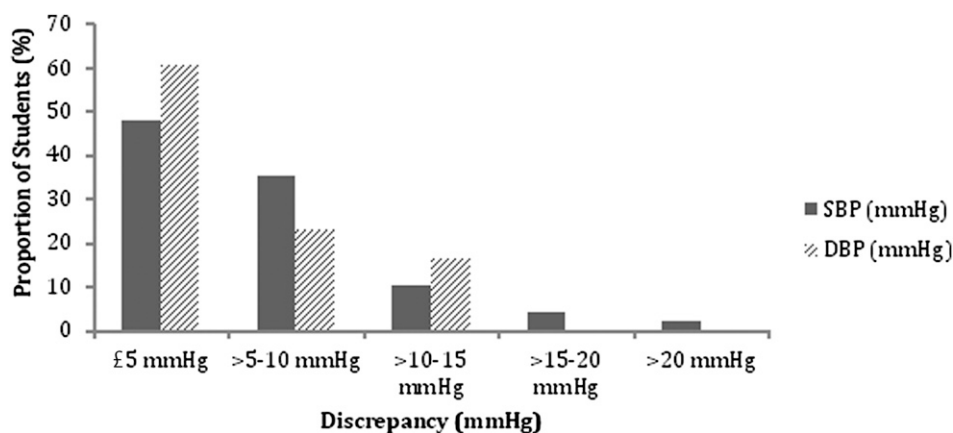

Figure 1. Absolute difference between student and machine measurements (N=48).

Table 3. Major and Minor Areas of Difficulty Experienced by the Student While Learning Blood Pressure Technique

Major Areas of Difficulty
Korotkoff sounds could not be heard
Cuff could not be deflated at a steady rate of 2 to 3 mmHg per second
Overall hand-eye coordination in operating the manual device was poor
Minor Areas of Difficulty
Patient was not properly positioned
Stethoscope was donned incorrectly
Stethoscope was not "turned on"
Stethoscope was not placed correctly over the brachial artery
Cuff was not deflated completely after estimating the SBP

arm were perceived by students and instructors as "obvious" (ie, easy to identify) compared to those of a real patient. Additional practice on different individuals would allow for more exposure and familiarity with Korotkoff sounds. In addition, teaching stethoscopes (with 2 sets of ear prongs) could provide a means for the instructor to listen to the Korotkoff sounds with the student. In our experience, these stethoscopes were unable to produce clearly audible sounds when compared with those produced by the Littmann Classic II S.E. stethoscopes. While having each pair of students perform a blood pressure reading in a separate room to minimize environmental noise is ideal, it is not always a practical solution for many program coordinators. However, a separate room could be feasible if only used to conduct the final assessment of blood pressure technique. In the future, using standardized patients and comparing student- and clinician-measured blood pressure readings will be considered.

Despite these areas for improvement, there were a number of factors that contributed to the success of the physical assessment module. Having one instructor per group of 6 students appeared to be an appropriate student-to-instructor ratio for supervising and evaluating blood pressure technique. In addition, providing immediate feedback to the students and allocating 3½ hours for the workshop allowed students with enough time to practice and develop their technique.

SUMMARY

A physical assessment skills module for third-year pharmacy students at the University of Manitoba was successfully implemented and evaluated. Pharmacy student knowledge of pharmacy assessment skills was evaluated, the values between student-measured and machine-measured blood pressure readings were compared, and common areas of difficulty for new learners of blood pressure measurement technique using a manual aneroid sphygmomanometer were identified. Identifying common issues observed during the performance of blood pressure assessment and recognizing how student-measured readings compared to machine-measured readings allowed the instructors to tailor strategies for improving existing models and evaluation methods for teaching physical assessment skills. These findings have important clinical implications as they relate to teaching pharmacy students to identify accurately patients with high blood pressure and to monitor effectively those on antihypertensive therapy.

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Appendix 1. Physical Assessment of Vitals Laboratory Agenda

Instructions: By the end of the Practical Skills Workshop, students are expected to:
1. Complete and submit the <u>Physical Assessment of Vitals Laboratory Assignment</u>
2. Demonstrate the ability to perform a blood pressure measurement on a simulator arminstructor (<u>Final Assessment</u>)

Each pair of students should have:
(1) ONE stethoscope (unless student has brought his/her own)
(2) ONE manual aneroid sphygmomanometer
(3) ONE automated blood pressure monitor
(4) Alcohol swabs

Each room will have:
(1) ONE simulator arm
(2) ONE teaching stethoscope
(3) ONE measuring tape
(4) ONE tympanic thermometer

Expected timeframe to complete each component of the workshop:

Component	Expected time to complete
Blood pressure reading with an aneroid sphygmomanometer	5 to 10 minutes
Blood pressure reading with an automated BP machine	1 to 2 minutes
Heart rate or respiratory rate	30 seconds to 1 minute
Tympanic temperature	1 to 2 seconds