

Assessing third-year medical students' perspective on point of care testing boot camp: from bench to bedside

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ABSTRACT

Background

Point-of-care testing (POCT), which is also known as bed side-testing, has been integrated into the healthcare system, offering faster results that can lead to improved patient outcomes. POCT was missing from the medical education curriculum in our institute.

Objectives

The primary objective of this study was to describe the development and introduce POCT training for medical students in a medical college in Pakistan.

Secondary objectives were to evaluate student performance on POCT content and to assess the impact of POCT training via students' feedback.

Methodology

The boot camp experience was devised, directed, and facilitated by team constituting of Chemical Pathology faculty members, laboratory technologists and teaching assistants. The program included presentations, demonstrations of POCT instrument handling, supervised hands-on individual performance on glucometer using quality control specimens, competency assessment and sign off followed by interactive case-based discussions. A knowledge quiz via Kahoot was administered at the beginning and end of the experience and scores were compared statistically. Online evaluation and feedback were designed via virtual learning environment based on 10 questions regarding the program and methodology using on a five-point Likert Scale. Frequencies were generated and t-tests were employed to determine pre-post differences.

Results

The boot camp was spread over 2 days and ran three hours each day with the third-year medical students class split into two groups (n=80). On knowledge evaluation, the mean group pre and post test scores were 45% and 95% respectively (p-value = < 0.05). On documented structured competency assessment form a score of 95 was achieved by 100% participants. Positive feedback of 4 or more was recorded on the Likert's scale by 100% respondents.

Conclusion

This POCT boot camp experience can be used by other institutions and can be applied at different times during the medical school curriculum and other professional education programs. This bootcamp will be helpful to educate medical students, postgraduate trainees and field workers working in rural areas and in low resource settings to deliver reliable POC tests results. Future research should examine these

students' competence in achieving POCT skills when they enter in clinical practice.



INTRODUCTION

The POCT working group of the International Federation of Clinical Chemistry (IFCC) defines Point-of-care testing (POCT), '*as diagnostic testing undertaken at or near the site of the patient*' (1). Similarly, The College of American Pathologists (CAP) terms POCT as '*testing that does not require permanent dedicated space and it refers to those analytical patient-testing activities provided within the institution but performed outside the physical facilities of the clinical laboratories*' (2). Majority of the medical decisions are made on laboratory investigations (2). POCT can be advantageous in clinical situations requiring rapid turnaround time of test results for clinical decision making. Medical students or the future doctors should understand POCT and its clinical utility as they will eventually be the end users of POCT and hence need knowledge of the issues surrounding POCT compared to testing in a hospital laboratory and should ensure tests performed outside laboratories meet appropriate quality standard. However, there is a gap in pathology teaching related to POCT between what the medical graduates are competent of and what these graduates are required to learn (3). Exit competencies related to POCT in medical education do not exist, neither there is any standardized curriculum for POCT to teach principles of best practice in POCT in medical schools, schools of nursing, pharmacy and medical laboratory technology science.

In medical schools in Pakistan and globally, since long pathology was taught traditionally as a standalone 6- to 12-month course with focus on pathogenesis more from the anatomic pathology perspective, with little emphasis on laboratory

medicine (4). Over the past few decades many medical schools have modified their curricula, in a more-integrated context. As a result, medical students are presented with broader learning concept from bench to bedside (5). Even though laboratory medicine teaching has been on the horizon, POCT remains a neglected area (6). An early practice-based understanding of POCT is essential for medical students before transitioning into patient care (7).

Generally, currently medical curricula are intended to assist medical students to link clinical and basic science knowledge. Taking example of glucometer as a POCT device and diabetes where prior knowledge of basic sciences (like pathophysiology of diabetes) can be integrated with clinical application (like the need of testing, interpretation of glucose levels, importance of accuracy of results) from the early years of medical training. The overall aim of the current study was to develop an integrated POCT curriculum incorporating clinical and basic sciences concepts, choose relevant patient cases and guide student discussions (8).

The primary objective of this manuscript was to describe the development and implementation of POCT training for third-year medical students at the Aga Khan University Medical College. Secondary objectives were to evaluate student performance on POCT content and to assess the impact of POCT training through students' feedback.

MATERIAL & METHODS

This study was conducted at the Aga Khan University Medical College, Pakistan in the year 2021 after approval from ethical review committee of the Aga Khan University (2021-6938-19677). This was conducted in four phases as described below. A hands-on interactive POCT boot camp was developed and conducted in year three of the medical curriculum.

Phase I – team formulation and course content design

The plan was devised and directed by a team lead, and three other chemical pathology faculty members and two laboratory scientists (working as POCT coordinators) who constituted the POCT-medical education team. The team was formulated as such to include a blend of practical, theoretical and clinical skills side by side. Each case scenario was further developed by a faculty with special interest or expertise in the specialty topic. Similarly, the POCT coordinators based on their expertise in procedural skills provided hands on training and conducted the competency assessment.

To build on ideas for the content design and delivery, in the first phase brain-writing process was carried out in multiple small group discussions. After thorough literature review the team lead developed the curriculum and laid down the course content. Due to the Covid pandemic, the discussions were mostly virtual and through emails. Team members devised the objectives of the POCT boot camp centred across a vision to incorporate adequate comprehension of the needs and utility of POCT. The aim was to enable medical students to learn clinical observation, examination and reasoning skills taking POCT for diabetes as an example. Through this activity students will learn to integrate basic science concepts with their clinical experience to nurture their diagnostic reasoning skills (9, 10). Clinical cases with POCT data were added in the boot camp so that the students can make sense of the clinical information they gather. A plan was laid down to instil interactive discussions on clinical cases and make them relate potential pathophysiological mechanisms with the clinical and POCT data findings (11).

The team decided to use the Sawyer et al. simulation-based framework for POCT devices and procedural skill training which includes six

steps: learn, see, practice, prove, do and maintain (12). In this framework, participants will be offered deliberate practice and instructor feedback to achieve procedural competency. In line with the theory, the team developed content to support each outlined step.

Phase II – course delivery

The POCT training was implemented in a required clinical skills course for third year medical students. Based on our previous experience of regular training of health care professionals in the POCT program, the intensive and condensed course was planned to be conducted as a boot camp, spread over 2 days and lasted three hours each day with the third-year medical students' class split into two groups (2). The team members trained five teaching assistants to facilitate the boot camp along with them and were instructed to act as master trainers and assessors for the boot camp. The teaching assistants at our institute are fresh graduates of the medical school serving as aid for faculty. The pre training of teaching assistants was conducted on the glucometers using quality control specimens and competencies were documented.

Phase III – evaluation & feedback

A key component was simulation-based mastery learning i.e., learners must prove their procedural competency by passing a summative assessment (13). To aid this a predefined competency assessment checklist was formulated. A knowledge quiz via 'Kahoot!' was developed for administration at the beginning and end of the experience (14). *Kahoot!* is a free cloud based digital learning platform that uses quiz-style games to help students learn by making the information engaging in a competitive way. Using Kirkpatrick's suggested framework for evaluating the results of training based on four important levels of training evaluation: reaction, learning, behavior and results, a feedback questionnaire

was designed. Online evaluation and feedback were designed via virtual learning environment using Moodle, a virtual course management system provided by the university based on 10 questions regarding the program and methodology using on a five-point Likert Scale. This scale is a type of psychometric response scale in which responders specify their level of agreement to a statement typically in five points (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree) (15).

Data collection, analysis, and ethical approval

The data entry and statistical analysis was performed using the Microsoft Excel 2013 and Statistical Package of Social Sciences (SPSS) version 19. Descriptive results based on the responses were also recorded. A chi-square test of independence was performed to examine the relation between pre- and post-test scores. Two-tailed p-values < 0.05 were considered significant.

RESULTS

Based on the intense and vivid brain writing session, the ideas generated for imparting the addition in curriculum were further weighted upon in the group meeting, before implementation. The content design was laid in perspective of the Sawyer et al. simulation-based framework for procedural skill training as outlined in table 1 (12). The content was reviewed and approved by the third-year curriculum review committee of the Aga Khan University Medical College.

POCT boot camp was conducted on April 7 & 8, 2022 for 3rd year medical graduates in two groups of 80 students each day. The learning objectives and the program of the session are enlisted in Tables 2 and 3.

On knowledge evaluation, the mean group pre- and post-test scores were 45% and 95%, respectively (p-value= <0.05).

Table 1 Content design and delivery strategy	
Teaching element	Teaching strategy
Learn	Presentation on utility of POCT, in-depth overview of POCT operations with key quality control measures. Presentation on diagnostic criteria of diabetes mellitus, critical results reporting and sentinel events avoidance.
See	4.5 minutes video clip detailing step by step procedure of POC test performance using glucometer. Demonstration of use of glucometer by POC Coordinator of the clinical laboratory.
Practice	Supervised hands-on individual performance on glucometer using quality control specimens.
Prove	Competency assessment via check list enlisting all essential steps including preanalytical, analytical and postanalytical. Pre- and post-test via Kahoot.
Do	Each student performed glucose or QC analysis and recorded their results.
Maintain	Skills imparted will be beneficial in clinical rotations in the clinical years and in clinical practice.

On documented structured competency assessment form filled by the facilitator supervising, a score of 95 was achieved by 100% of the participants. Feedback of 4 or more was recorded on the Likert's scale based on 10 questions by 100% of the respondents. Twenty students provided additional comments.

In a nutshell, the comments were positive; centered across inclusion of more similar activities in medical curriculum, hands-on experience was beneficial and interesting, competency assessment documentation was useful, and the cases were full of learning.

DISCUSSION

The COVID-19 pandemic highlighted the importance of laboratory medicine at the forefront (16). POCT is another arm of the subject that rose on the cutting edge (17). However, the foreseeable challenge is the capacity building of health care professionals who can deliver POCT services (18). Medical students if trained in this arena during the early phases of professional education can lead to development of public health advocates who can be utilized for the "train the trainers" modality and also for quality practice in physician office (19).

Figure 1 Content proposal based on deliberated discussions amongst team members

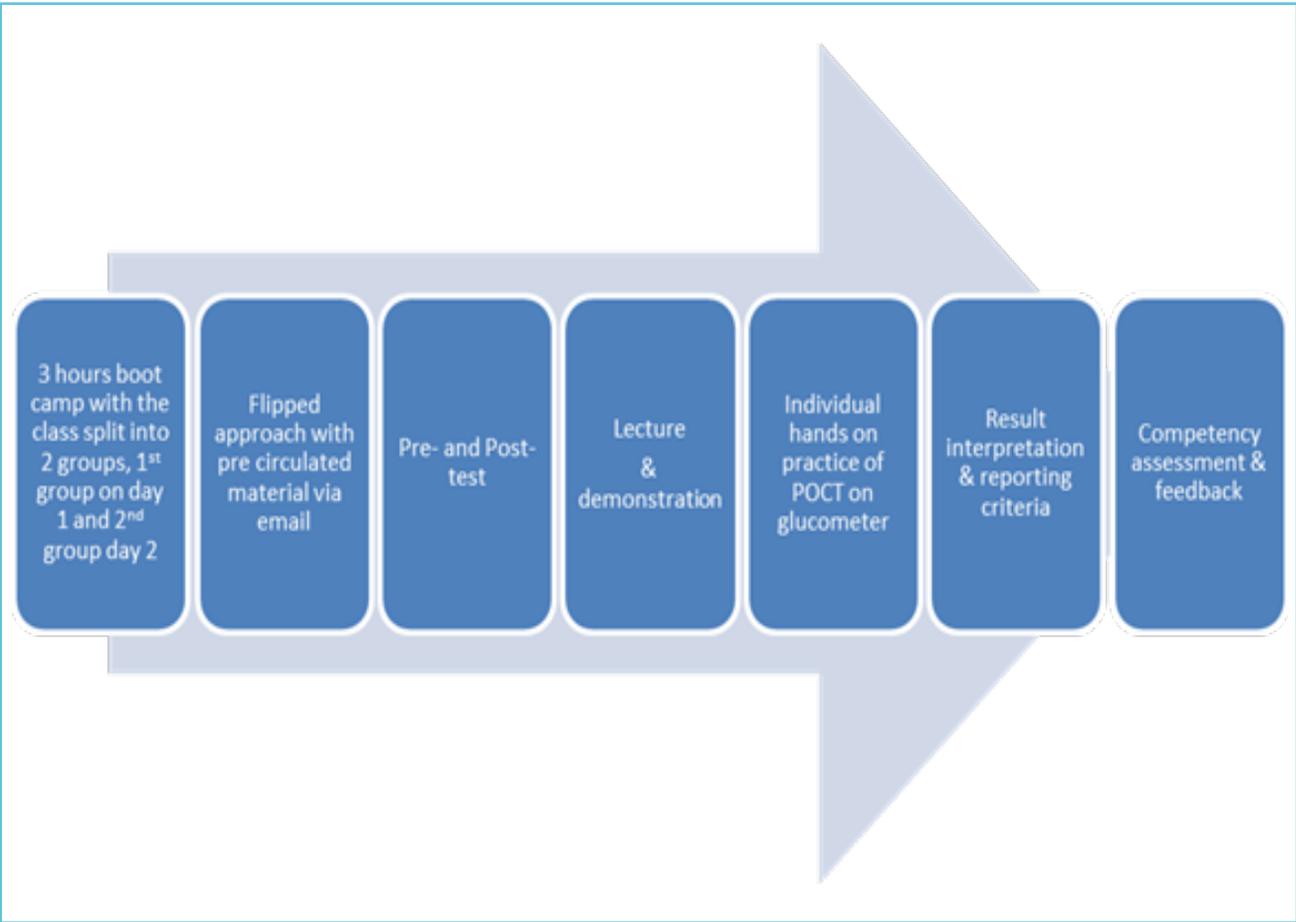


Table 2 Learning objectives of the POCT boot camp

Knowledge	Skills
To understand the functioning, organization and set up of POCT program	To perform glucose testing on glucometer (skill)
To comprehend pre-requisites specimen collection/preservation	To learn effective communication skills for critical laboratory results information and documentation
To interpret the glucose results according to American Diabetes Association guidelines	

To understand the importance of quality control in interpreting glucose results	
To relate the utility of POCT to patient management in Emergency Department and critical care areas	
To understand what sentinel events are and how can they be prevented while conducting POCT	
To understand the importance of correct identification and barcode system to prevent preanalytical error	

Table 3 Course program layout and contact time for each component

Component	Time allocated (minutes)
1. Knowledge assessment via pretest	20
2. Lecture I: POCT utility, implementation, analyzers and techniques available	15
3. Lecture II: POCT quality control, accreditation and key performance indicators	15
4. Demonstration via video and practical performance	10
5. Hands on individual performance	60
6. Competency assessment and sign off	20
7. Case based discussion in four groups emphasizing upon critical results alerts and avoidance of sentinel events	20
8. Post Test-Quick Assessment of data interpretation skills based on diagnostic case challenges of diabetes mellitus	20

Finding the time to teach laboratory medicine principles in an already packed medical school curriculum has proven challenging (20). Keeping this in perspective, the faculty through a force field analysis speculated that the introduction of POCT in medical curriculum will be beneficial which led to the addition of this boot camp to the condensed third year medical students' class at Aga Khan University Medical College in Pakistan.

Pathology and laboratory medicine is not amongst the core clinical rotations at most medical institutes globally (21). Moreover, hands on training in the form of laboratory rotations which can bridge the gap between theory and practice is not routinely included. Eventually most schools do not have any required clinical experiences in pathology for their graduate. This 3-hours long module, with intensive hands-on experience has shown to increase medical students' comfort in performing POCT. All students achieved excellent competency on the pre-designed practice check list on the first attempt. Developing future doctors who are competent and knowledgeable with POCT may lead to increased opportunities to gain real-world experience performing these skills at bedside, and specifically field testing in unanticipated times if required, ensuring optimal quality checks. The POCT boot camp also highlighted the integral role of laboratory medicine in patient management and provided opportunity for questioning and interaction with laboratory personnel and faculty. Besides POCT application and interpretation, the module created understanding for the use, interpretation and limitations of laboratory tests for various clinical purposes like screening, risk assessment, establishing diagnosis, prognosis, etc. It also emphasized on how to order tests necessary and medically useful for patients and seeking consultation from pathologists to maximize patient care (22).

The significant difference noted on post test results speaks for itself, as regards to knowledge imparted within a short span. However, the assessment was able to quantify a limited amount of knowledge attained recently, nevertheless, it was encouraging that improvement could be observed by devoting a short period to learning POCT principles. The test was not mandatory and was not intended to pass or fail a student, neither was it counted as an incentive for completing the module, which may perhaps account for lack of motivation to score well.

Through continuous discussions and deliberations over email and small group meetings, we ensured close contact between team members despite COVID pandemic in a concentrated period. All the cases developed were tailored to the glucose evaluation at POCT to keep the clinical interest of the medical students alive, and the laboratory medicine core foundations were presented alongside. Moreover, the faculty team has planned to review the knowledge examination content annually to ensure the course structure is allowing adequate opportunity for delivery of information.

In addition to its merit of being a first of its kind plan for POCT in medical curriculum, there are limitations to this initiative. This project involved only one program at one university. Future research should involve incorporating POCT training into additional medicine programs to provide comparative data for broadscale evaluation. Also, a follow-up study of these students using satisfaction survey methodology should be planned to assess their ease with POCT usage when they enter clinical practice. There is a growing consensus in medical education about the value of formal competencies for medical students and this program provided structural basis for documented competency assessment of POCT based on the describe measurable and observable behaviors.

CONCLUSION

To conclude this boot camp, our experience can be used by other institutions and can be applied at different stages during the medical school curriculum and other professional education programs including nursing, pharmacy and medical technology. This POCT Boot camp is now an annual activity at Aga Khan University Medical College for third-year students and is part of the new module (Back to Basics) offered during the initial eight weeks of Year 3, MBBS Program. This competency-based program will allow for easy adoption of POCT into existing clinical courses and rotations. Widespread use of sub-standard POC tests is common in resource limited setups with no formal accreditation and quality oversight. This boot camp model has the potential for replication in under-graduation and post-graduation medical education, including nursing, pharmacy and medical technology. as well as training of the field force for POCT community-based projects.



Data availability statement

The data that support the findings of this study are available from the author on request

Ethics statements

The study was approved by the ethical review committee of the Aga Khan University (2021-6938-19677).

Author Contribution

SA performed the literature search, data analysis and write-up of the work in the first draft. HM, AHK were faculty member, part of the core project team and assisted with manuscript writing, literature search and critical review of the final draft. SS and SJS as POCT coordinators who provided technical support and training. LJ

conceived the idea, supervised the project, coordinated the writing of the paper and reviewed the final draft. All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.



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