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Major article

Development and validation of tools for assessing use of personal protective equipment in health care

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Background: Incorrect use of personal protective equipment (PPE) may lead to the spread of infectious agents among health care workers and patients. Although novel education programs show promise, there is no standard evaluation for the competencies developed during training.

Methods: A Delphi methodology was used in which checklist and global rating items for evaluating the performance of PPE skills involving gloves, gowns, masks, eye protection, and hand hygiene were generated and iteratively distributed to a panel of experts. The panel rated the importance of each item until agreement was reached, and the relevant items were used to form the Tools for Assessment of PPE Skills (TAPS), comprising 3 checklist sections (hand hygiene, donning, and doffing) and a global rating scale. Newly trained and experienced PPE users participated in experiments to evaluate the reliability, construct validity, and responsiveness of TAPS.

Results: TAPS demonstrated interobserver reliability, and its global rating scale differentiated the performance of newly trained users and experienced users and was sensitive to changes in performance over time.

Conclusions: Pending further validation studies, the TAPS may facilitate the development and evaluation of educational programs to support learning and retention of PPE skills, leading to enhanced patient and health care worker safety.

The transmission of health care–associated infections (HCAIs) is a major concern for most health care facilities, threatening patient safety by contributing to unnecessary suffering, morbidity, and sometimes mortality. In Britain, 8% of patients admitted to hospitals are affected,[1] in the United States, HCAIs were the leading reportable disease in 2002,[2] and in Canada, an estimated >220,000 HCAIs occur in hospitals, leading to >8,000 deaths annually.[3] HCAIs present physical, social, psychological, and financial costs to patients and their families, as well as financial costs to health care systems.[4]

Two important measures to help prevent and limit the transmission of HCAIs are hand hygiene and the use of personal protective equipment (PPE), including gloves, gowns, masks, and various forms of eye protection. This was confirmed in a survey of required infection prevention and control (IPC) competencies for various hospital-based health care workers, where researchers found that proper hand hygiene, selection of appropriate PPE for each category of transmission-based precautions, and demonstrations of donning and doffing PPE were required objectives for all hospital-based health care workers.[2] Unfortunately, even when PPE is used, errors in technique may reduce or negate its intended effects.[5] Furthermore, a lack of assessment of infection control competencies[6] may suggest to learners that these aspects of clinical competency are less valuable than others.

The proper use of PPE depends on knowledge of infection control techniques as well as an understanding of infection control principles that inform routine and additional precautions, such as route of transmission of infectious agents, clinical activities, and the clinical environment. Infection control audits developed to examine practices and procedures in clinical wards or services from a system perspective have proven beneficial to facility-wide infection control programs.[7,8] However, audits do not directly

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assess a particular educational program and are not able to directly assess the competence of a particular health care worker or trainee. Furthermore, there is currently no widely accepted and standardized metric for assessing IPC competencies, particularly the use of PPE and hand hygiene. Consequently, each study that undertakes evaluation of an IPC education program does so using an evaluation method that is not validated, and the inconsistencies that may result are unknown.

The overall objective of the present study was to produce a validated PPE skills assessment tool in 2 phases. In the first phase, we developed assessment tools, which we call Tools for Assessment of PPE Skills (TAPS), by conducting a Delphi survey of IPC experts across Canada to identify key aspects of PPE skills. The Delphi method has been used for various purposes in health care and other fields.[9] This consensus-building process is meant to enhance the individual opinions of experts and obtain a collective expert opinion about a particular question or issue.[9,10] Delphi panelists remain anonymous, so that the group process is not unduly influenced by the reputation or opinion of any one panelist.[10] In the second phase, we performed validation tests on the novel assessment tools to determine their suitability for evaluating trainees' IPC skills. We hypothesized that the tools would demonstrate that PPE users with more experience perform better than newly trained users, and that newly trained users improve immediately after acquisition and practice but regress over a 1-week period without practice or review.

METHODS

Development of assessment tools

The Delphi process, described in detail below, was classified as a program evaluation activity by our institution's Office of Research Ethics and did not require ethics approval. The primary investigator generated an initial list of items describing the procedures for hand hygiene as well as donning and doffing PPE for routine practices from 3 sources: (1) the Infection Prevention and Control Core Competency Education module in Routine Practices developed by the Ontario Ministry of Health and Long-Term Care,[11] (2) federal and provincial guidelines for IPC in acute and long-term care facilities, and (3) published academic and nonacademic literature, media, and online forums on the topic of PPE use. The initial list included 27 technique-specific checklist items and 3 rating scale items describing global or holistic performance measures. Two local IPC experts (the advisory committee) reviewed the list, which was then uploaded to Survey Monkey (http://www.surveymonkey.com). Delphi panelists were recruited via electronic mail from the following groups in Canada: IPC instructors in teaching hospitals or universities, allied health or medical professionals who regularly practice IPC, leaders in provincial and/or national health policy development regarding IPC, and authors of relevant articles in peer-reviewed journals.

Item evaluation and analysis of Delphi data

Thirty Delphi panelists responded to the first round, 25 responded to the second round, and 23 responded to the third round (76.7% overall retention). The respondents were quite experienced and represented a range of IPC perspectives; 19 (63%) had been practicing IPC for >10 years, 13 (43%) were involved in clinical practice, 25 (83%) were in education, 15 (50%) were involved in policy making, and 16 (53%) were in research.

In each Delphi round, the panelists rated and commented on the checklist and global rating items, identified any additional performance indicators for PPE use, and revised any items that were ambiguous or inadequate. For each checklist and global rating item, participants used a 5-point Likert scale (1, completely unimportant to 5, extremely important) to rate the importance of that item for assessing PPE skills. In the second round, the results were resent to the group, with the items that had achieved consensus highlighted and the group median, mode, and range of responses provided. Each panelist received a file outlining his or her response to each item in the previous round. The panelists then rerated the items, after which new responses to items were recorded. This process was repeated for a third round.

The results were analyzed using median and mode responses to determine which items achieved positive or negative consensus.[12] Positive consensus was defined as ≥80% of respondents choosing 4 (somewhat important) or 5 (extremely important), and negative consensus was defined as ≥80% of respondents choosing 1 (completely unimportant) or 2 (somewhat unimportant). Eight checklist items and all 3 global rating items were accepted in round one. Panelists requested a separate checklist section to assess hand hygiene, 3 new global rating items, and a pass/fail assessment item. They also expressed concerns about the consistency of results that would be generated from global rating evaluation, as well as the quality and usefulness of feedback that users would receive. At the end of round three, 43 checklist items and 6 global rating items were accepted. The final assessment tools are summarized in Figure 1 (a copy of the tools is available on request from the corresponding author).

Cronbach's α, providing an estimated reliability of the sum of the panelists' responses,[10] was calculated to measure the group's consistency for each round. Alpha values >0.7 are adequate for research purposes, whereas values >0.9 are required for clinical applications.[13] Cronbach's α values across all 3 rounds ranged from 0.82 to 0.99 (Table 1). There was no α value for hand hygiene in round one or global rating in round three, because hand hygiene was introduced as a separate section in round two and all global rating items achieved consensus at the end of round two.

Scoring

The scoring system gave credit for the selection, donning, and doffing of each item of PPE, as well as the sequence in which multiple items were donned and doffed. For all sections of the TAPS, tasks that are not relevant or not assessed because of the test scenario or environment are marked "not applicable" (NA). For the hand hygiene, donning, and doffing checklists, 1 point is awarded for each task done correctly and 0 points are awarded for each task not done or done incorrectly (dichotomous scoring). The total hand hygiene score is the sum of all points awarded. The donning checklist also includes a score for PPE item selection, with 5 points added for each required PPE item selected and 5 points subtracted for each required PPE item not selected. Both the donning and doffing checklists also include a sequence score awarded for donning or doffing all required items in the correct order, with 5 points awarded for each required PPE item in a perfect sequence. If there are any errors in sequence, 0 points are awarded for the sequence score. The total donning score is the sum of the dichotomous checklist scores, the selection score, and the donning sequence score. The total doffing score is sum of the dichotomous checklist scores and the doffing sequence score. For each item on the global rating scale, the participant receives NA or a numerical score on a Likert scale of 1-5. The total global rating score is the sum of the numerical scores.

Validation of assessment tools

Our institution's Research Ethics Board approved the validation protocol, and all participants provided voluntary informed consent before participating, in accordance with the guidelines set out by the 1964 Declaration of Helsinki and our institution's Office of Research Ethics.