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Contents

Review

Original Papers

Review

Information and Communication Technologies for the Dissemination of Clinical Practice Guidelines to Health Professionals: A Systematic Review

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Abstract

Background: The transfer of research knowledge into clinical practice can be a continuous challenge for researchers. Information and communication technologies, such as websites and email, have emerged as popular tools for the dissemination of evidence to health professionals.

Objective: The objective of this systematic review was to identify research on health professionals' perceived usability and practice behavior change of information and communication technologies for the dissemination of clinical practice guidelines.

Methods: We used a systematic approach to retrieve and extract data about relevant studies. We identified 2248 citations, of which 21 studies met criteria for inclusion; 20 studies were randomized controlled trials, and 1 was a controlled clinical trial. The following information and communication technologies were evaluated: websites (5 studies), computer software (3 studies), Web-based workshops (2 studies), computerized decision support systems (2 studies), electronic educational game (1 study), email (2 studies), and multifaceted interventions that consisted of at least one information and communication technology component (6 studies).

Results: Website studies demonstrated significant improvements in perceived usefulness and perceived ease of use, but not for knowledge, reducing barriers, and intention to use clinical practice guidelines. Computer software studies demonstrated significant improvements in perceived usefulness, but not for knowledge and skills. Web-based workshop and email studies demonstrated significant improvements in knowledge, perceived usefulness, and skills. An electronic educational game intervention demonstrated a significant improvement from baseline in knowledge after 12 and 24 weeks. Computerized decision support system studies demonstrated variable findings for improvement in skills. Multifaceted interventions demonstrated significant improvements in beliefs about capabilities, perceived usefulness, and intention to use clinical practice guidelines, but variable findings for improvements in skills. Most multifaceted studies demonstrated significant improvements in knowledge.

Conclusions: The findings suggest that health professionals' perceived usability and practice behavior change vary by type of information and communication technology. Heterogeneity and the paucity of properly conducted studies did not allow for a clear comparison between studies and a conclusion on the effectiveness of information and communication technologies as a knowledge translation strategy for the dissemination of clinical practice guidelines.

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KEYWORDS

health information technologies; electronic mail; email; Web 2.0; practice guidelines; health professions; information dissemination

Introduction

Success in regularly transferring research knowledge into clinical practice has been limited [1]. Evidence-based clinical practice guidelines (CPGs) are often not implemented effectively, resulting in the failure to achieve optimal health outcomes for patients [2]. Thus, efforts to reduce the knowledge-to-action gap remain a constant challenge among researchers and health professionals.

Knowledge translation (KT), the process of implementing knowledge into action, can provide methods for closing the knowledge-to-action gap [3]. With the emerging appeal of Web-based KT resources that allow for potential widespread reach through self-paced, self-directed learning, the Internet has become an important platform for KT initiatives such as CPG dissemination [4]. Information and communication technologies (ICTs) are defined as "technologies that provide access to information through telecommunications…[focusing] primarily on communication technologies. This includes the Internet, wireless networks, cell phones, and other communication mediums" [5]. ICTs have the potential to improve accessibility to CPGs. For example, digital CPGs can be continuously reviewed and updated with new evidence, while having the potential to be widely disseminated [6]. Furthermore, these Web-based tools provide both clinicians and consumers with a convenient method to access evidence-based CPGs [6].

Teaching modalities for medical education, including CPG dissemination, have evolved [7]. The development and implementation of novel teaching and dissemination strategies was prompted by research findings showing that traditional didactic seminars do not always modify behavior and learning competency [7]. Grimshaw et al [8] concluded that the evidence to guide choice of KT strategies targeting health professionals is incomplete. While the evidence of traditional KT strategies, such as printed educational materials [9], educational meetings [10], educational outreach [11], local opinion leaders [12], and audit and feedback [13], focusing on practice behavior change targeting health care professionals has been summarized [8], we have limited knowledge of the perceived usability and practice behavior among health professionals when using novel KT strategies such as ICTs for the dissemination of CPGs.

The objective of this systematic review was to summarize the evidence pertaining to the use of ICTs for the dissemination of CPGs to health professionals. Specifically, with this review we sought to provide new knowledge on health professionals' perceived usability and change in practice behavior when using ICTs to disseminate CPGs.

Methods

We conducted this systematic review using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [14]. To summarize the evidence, we used a systematic approach to retrieve relevant articles from the literature. Articles were selected for this review using the following predefined selection criteria guided by the population, intervention, comparison, outcome, and study design (PICOS) process.

We excluded studies if they did not meet the selection criteria (Table 1). We also excluded duplicate publications, narrative reviews, case series, case reports, data presented in abstract form only, conference proceedings, study protocols, and publications not written in English.

Table 1. Study selection criteria.

Criterion	Definition
Population	Health professionals (eg, physicians including medical residents, nurses, and physiotherapists)
Intervention	Information and communication technologies for disseminating clinical practice guidelines
Comparator	Information and communication technologies compared with each other or control (eg, no intervention)
Outcomes	Usability (eg, perceived usefulness and perceived ease of use)
	Practice behavior (eg, barriers, knowledge, skills, social/professional role and identity, optimism, beliefs about capabilities, beliefs about consequences, intentions, memory/attention/decision, environmental context and resources, social influences, and emotion)
Study design	Randomized controlled trials
	Nonrandomized comparative controlled trials

The literature search was performed by an information specialist. Published literature was identified by searching the following bibliographic databases up to the end of December 2015: MEDLINE, Cochrane Central Register of Controlled Trials, EMBASE, CINAHL, ERIC, and PsycINFO. The search was performed using terms to identify peer reviewed research in which ICTs and CPG dissemination were important features (Multimedia Appendix 1). A search of gray literature (literature that is not commercially published) was conducted by searching Google and other Internet search engines for additional Web-based publications. In addition, the searches were supplemented by hand searching the bibliographies of key articles. To ensure all ICTs would be captured in the literature search, including those that are older and established (eg, email), we did not place any date limits.

Titles and abstracts of all citations retrieved from the literature search were independently screened by 2 reviewers using Covidence (Veritas Health Innovation Ltd), a Web-based systematic review software. Full-text articles were then independently reviewed based on the selection criteria. Disagreements were resolved through discussion until consensus was reached. Figure 1 presents the study selection process in a PRISMA flow diagram.

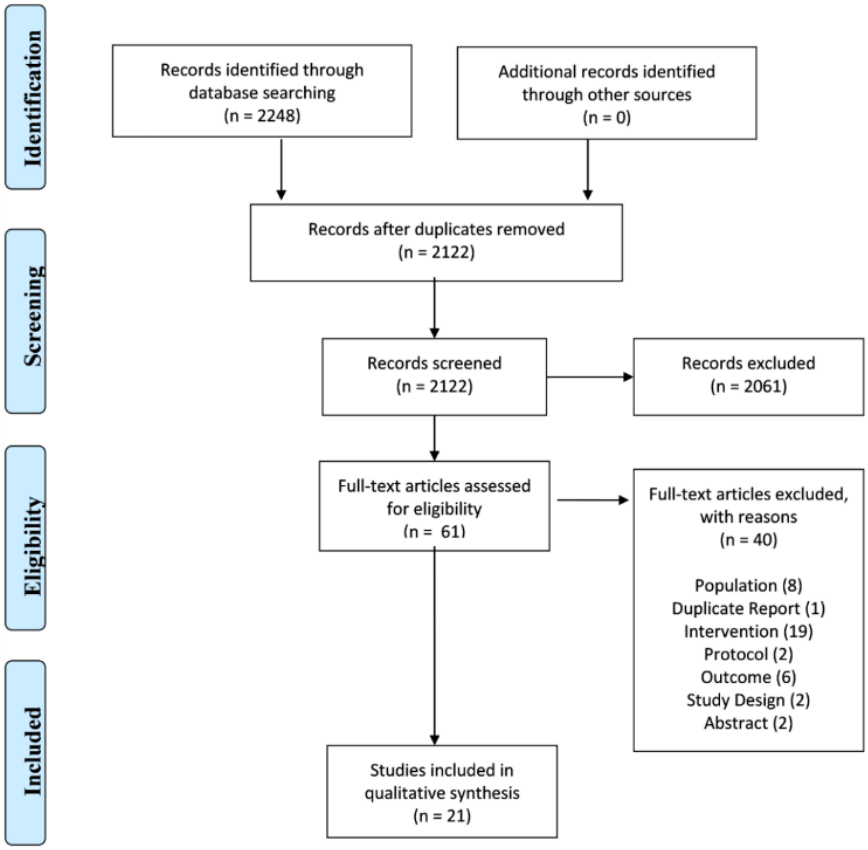
Both descriptive data and results were extracted by 1 reviewer from each eligible article. The extraction was subsequently verified by a second reviewer. Data extraction forms were designed a priori to document and tabulate relevant study and patient characteristics, study findings, and authors' conclusions.

We did not use data from figures if the data were not explicit. Studies were categorized by the type of ICT intervention used.

One reviewer independently assessed the quality of each study using the Cochrane risk of bias tool [15], which was subsequently checked for accuracy by a second reviewer. Disagreements were resolved through consensus. Risk of bias was assessed at the study level.

Given the broad inclusion criteria and heterogeneity of the interventions and methodological characteristics of included studies (guided by PICOS), we deemed a meta-analysis to be inappropriate, and we therefore conducted a narrative synthesis and summary of study findings. The outcomes of interest were the usability of the ICT intervention and practice behavior change.

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of included studies.



Usability

The usability outcomes were guided by the technology acceptance model (TAM2) [16], which illustrates that behavior intention to use a system is determined by perceived usefulness and perceived ease of use. Perceived usefulness is defined by Venkatesh and Davis [16] as "the extent to which a person believes that using the system will enhance his/her job performance" (pg 187), and perceived ease of use is defined as "the extent to which a person believes that using the system will be free of effort" (pg 187).

Practice Behavior

The theoretical domains framework (TDF) guided the practice behavior change outcomes [2]. The TDF identifies numerous behavior constructs and consists of 12 domains: (1) knowledge, (2) skills, (3) social or professional role and identity, (4) beliefs about capabilities, (5) beliefs about consequences, (6) motivation and goals, (7) memory, attention, and decision processes, (8) environmental context and resources, (9) social influences, (10) emotion regulation, (11) behavioral regulation, and (12) nature of the behavior. We categorized practice behavior outcomes by the domains listed above.

Results

We identified a total of 2248 citations through the initial search. After removing duplicates, we screened 2122 publication abstracts and titles. We assessed the full texts of 61 articles; of these, we excluded 40 for the following reasons: irrelevant

population (8 studies), duplicate report (1 study), irrelevant intervention (19 studies), study protocol (2 studies), irrelevant outcome (6 studies), inappropriate study design (2 studies), and presented as abstract only (2 studies). The excluded studies are listed in Multimedia Appendix 2. Figure 1 shows the PRISMA flow diagram.

Of the 21 studies that we included in our systematic review, 20 were randomized controlled trials (95%) and 1 was a controlled clinical trial (5%) [17-37] (Table 2). There were 7 primary ICT interventions that were used to disseminate CPGs: websites [17,22-25], computer software [26-28], Web-based workshops [20,29], computerized decision support systems (CDSSs) [30,31], electronic educational game [21], email [19,32], and multifaceted interventions that consisted of at least one ICT component [18,33-37].

Table 2. Type of information and communication technology (ICT) used in each included study.

ICT intervention	Number of studies	Studies
Website	5	Balamuth et al [22]; Bell et al [23]; Schroter et al [17]; Sassen et al [24]; Wolpin et al [25]
Computer software	3	Bullard et al [26]; Butzlaff et al [27]; Jousimaa et al [28]
Web-based workshops	2	Epstein et al [20]; Fordis et al [29]
Computerized decision support system	2	Gill et al [30]; Peremans et al [31]
Electronic educational game	1	Kerfoot et al [21]
Email	2	Lobach [19]; Stewart et al [32]
Multifaceted[a]	6	Bernhardsson et al [33]; Chan et al [34]; Desimone et al [35]; McDonald et al [36]; Fretheim et al [18]; Shenoy [37]

[a]Multifaceted intervention that consisted of at least one ICT component.

Multimedia Appendix 3 presents the study characteristics. Of the included studies, 11 (52%) involved only physicians [20-24,27-30,32,37], 3 (14%) involved only medicine residents and fellows (family or internal) [23,25,35], 3 (14%) involved only nurses [31,34,36], and 1 (5%) involved physiotherapists [33]. A total of 2 studies (10%) assessed both nurses and physicians [17,18], and another study (5%) assessed the combination of physicians, nurses, and medical residents [19].

In 8 studies, there was no comparison with an intervention [19,27,30,31,33,34], usual care [36], or usual education [35]. Another 2 studies were compared with a waiting list [24,32], 10 studies were compared with active interventions [17,18,21-23,25,26,28,29,37], and 1 study was a pre-post design where assessments were conducted before and after the ICT intervention [20]. In terms of location, 10 studies were conducted in the United States [19,20,22,23,25,29,30,35-37], 3 were in Canada [26,32,34], 7 were in Europe [17,18,24,27,28,31,33], and 1 was an international study conducted in 63 countries [21]. Study durations and follow-up ranged from immediate posttest to 1 year postintervention.

Websites

The use of a website for the dissemination of CPGs to health professionals was assessed in 5 studies [17,22-25] (Table 3). Balamuth et al [22] compared a Web-based 1-page summary sheet of guidelines (n=128) with a weblink to guidelines (n=109) among physicians after 6 weeks. Schroter et al [17] compared an interactive Web-based tool combined with Web-based didactic material (n=527) with Web-based didactic material alone (n=527) among physicians and nurses after 4 months. Sassen et al [24] compared a website with educational modules (n=48) with a waiting list group (n=33) among orthopedic surgeons after 12 months. A further 2 studies involved only medicine residents and fellows [23,25]. Bell et al [23] compared self-study Web-based guidelines (n=79) with print-based guidelines (n=83) among family and internal medicine residents at immediate posttest and at 4 to 6 months postintervention. Wolpin et al [25] compared a website with enhanced learning modules (n=33) with a website containing usual care instructions (n=36) among medicine residents and fellows at 12 weeks postintervention.

Table 3. Summary of findings of included studies by primary information and communication technology (ICT) intervention.

ICT intervention	Study	Interventions	Outcome(s)	Effect size	Conclusion
Website					
	Balamuth, 2010 [22]	Web-based 1-page summary sheet of guidelines (n=128) Weblink to guidelines (n=109)	*Knowledge*: correctly diagnosed patients OR[a] (95% CI)	0.82 (0.49-1.4)	No statically significant difference between 2 groups in correctly diagnosing patients according to guidelines. Participants using the Web-based 1-page summary reported that the supplemental materials were more simple to use when compared with the weblink group.
			Perceived ease of use: simplicity of supplemental materials OR (95% CI)	6.1 (2.8-13.6)	
	Bell, 2000 [23]	Self-study Web-based guidelines (n=79) Print-based guidelines (n=83)	*Knowledge*: median (95% CI) score (out of 20) after immediate posttest	Web-based: 15.0 (14.0-15.0) Print based: 14.5 (14.0-15.0) *P*=.20	No statistically significant difference in knowledge at immediate posttest or after 4-6 months. Web-based guideline users were more satisfied with learning.
			Knowledge: median (95% CI) score (out of 20) after 4-6 months	Web-based: 12.0 (11.0-13.0) Print based: 11.0 (10.0-12.0); *P*=.12)	
			Perceived ease of use: median (95% CI) learner satisfaction scores (range 5-20, higher = better)	Web-based: 17.0 (16.0-18.0) Print-based: 15.0 (15.0-16.0); *P*<.001	
	Schroter, 2011 [17]	Website with educational modules (n=48) Waiting list (n=33)	*Knowledge*: mean % change (SD) from baseline knowledge at 4 months	Web-based plus Web material: 47.4% (12.6) to 66.8% (11.5) Web-based material only: 47.3% (12.9) to 67.8% (10.8); *P*=.19	No statistically significant differences in knowledge change or usability between the 2 groups. Participants in Web-based tool plus Web material group found it to be useful. Usefulness was not measured in the other group.
			Perceived usefulness: % of participants who reported the tool to be very useful/useful	Web-based plus Web material: 77% Web-based material only: NR[b]	
	Sassen, 2014 [24]	Website with educational modules (n=48) Waiting list (n=33)	*Intention* to use material to educate patients: mean (SD) score out of 7 (higher = easier) at baseline and 12 months	Website: 6.25 (1.00), 6.06 (1.11) Waiting list: 5.87 (1.15), 6.02 (0.91), *P*=.12	No statistically significant differences in intention to use and barriers between interventions groups at 12 months.
			Barriers to using the material to educate patients: mean (SD) score out of 7 (higher = easier) at baseline and 12 months	Website: 3.11 (1.17), 3.18 (1.12) Waiting list: 2.78 (1.01), 2.63 (0.96), *P*=.46	
	Wolpin, 2011 [25]	Website enhanced learning (additional case studies) (n=33) Website with usual care instructions (same content, without case studies) (n=36)	*Knowledge*: mean (SD) score % on knowledge content of CPGs[c] pretest and immediate posttest	Overall (pooled both groups): 79.28% (12.17), 82.32% (13.84), *P*=.10 Website (enhanced) 78.18% (11.1), 79.39% (15.0) Website (usual): 80.28% (13.2), 85.0% (12.3)	No statistically significant difference in knowledge or satisfaction at posttest between intervention groups. No statistically significant differences were seen between interventions groups for both outcomes.

ICT intervention	Study	Interventions	Outcome(s)	Effect size	Conclusion
			Perceived ease of use: overall satisfaction with learning experience, mean (SD) score (1-5, higher = very satisfied), pretest and immediate posttest	Overall (pooled both groups): 4.08 (0.860) Website (enhanced) 78.18 (11.1), 79.39 (15.0) Website (usual): 80.28 (13.2), 85.0 (12.3), *P*=.13	
Computer software					
	Bullard, 2004 [26]	Wirelessly networked mobile computer program (n=10)[d] Desktop computer program (n=10)[d]	*Perceived usefulness*: "impact on efficiency" mean (95% CI) score out of 7	Wireless: 3.2 (2.6-3.8) Desktop: 4.3 (4.0-4.6), *P*=.02	Statistically significant greater satisfaction for several items ("impact on efficiency," "increase use of CPGs," and "saving time") when using the wireless computer compared with the desktop computer. Other satisfaction items such as "configuration," "availability," "reduced communication with staff and patients," and "accessibility" did not show statistically significant differences (results not shown). Participants appeared to be indifferent regarding the usability of the wireless computer for their efficiency.
			Perceived usefulness: "increased use of CPGs" mean (95% CI) score out of 7 (7 = excellent)	Wireless: 4.1 (3.6-4.6) Desktop: 3.5 (2.9-4.0), *P*=.03	
			Perceived usefulness: "wireless computer program made participant more efficient," mean (95% CI) score out of 7 (7 = strongly agree)	Wireless: 3.30 (2.33-4.27) Desktop: NR	
	Butzlaff, 2004 [27]	CPGs via CD-ROM/Internet (n=53) No intervention (n=66)	*Knowledge*: median (IQR[e]) score out of 25 at baseline	CD/Internet: 13 (12-16) No intervention: 13 (10-15.25), *P*=.40	There was no statistically significant difference between intervention groups at baseline and ~70 postintervention in knowledge scores.
			Knowledge: median (IQR) score out of 25 at ~70 days posttest	CD/Internet: 15 (12-17) No intervention: 13 (11-15.25), *P*=.10	
	Jousimaa, 2002 [28]	CD-ROM computer-based guidelines (n=72) Textbook-based guidelines (n=67)	*Skills*: compliance with CPGs, "laboratory examinations," OR (95% CI)	1.07 (0.79-1.44)	There was no statistically significant difference between intervention groups for compliance with CPGs for laboratory, radiological, or physical examinations.
			Skills: compliance with CPGs, "radiological examinations," OR (95% CI)	1.09 (0.81-1.46)	
			Skills: compliance with CPGs, "physical examinations," OR (95% CI)	0.74 (0.51-1.06)	

ICT intervention	Study	Interventions	Outcome(s)	Effect size	Conclusion
Web-based workshops					
	Epstein, 2011 [20]	Web-based didactic education session/workshop (n=27) No intervention (received intervention after 6 months) (n=22)	*Skills*: compliance with CPGs, "use of parent ratings of ADHD[f] during assessment," mean % change from baseline at 6 months	Web: 23.8% No intervention: 5.7%, *P*=.03	Statistically significant changes from baseline to 6 months were seen among participants complying with CPG-recommended ADHD care practices, with the exception of 1 recommendation, "Use of parent ratings of ADHD to monitor treatment responses" (results not shown).
			Skills: compliance with CPGs, "use of teacher ratings of ADHD during assessment," mean % change from baseline at 6 months	Web: 22.6% No intervention: 6.0%, *P*=.04	
			Skills: compliance with CPGs, "use of [*Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition)] ADHD criteria during assessment," mean % change from baseline at 6 months	Web: 47.3% No intervention: 17.9%, *P*=.03	
			Skills: compliance with CPGs, "use of outside provider for ADHD diagnosis," mean % change from baseline at 6 months	Web: –60.7% No intervention: –10.7%, *P*<.001	
			Skills: compliance with CPGs, "use of teacher ratings of ADHD to monitor treatment responses," mean % change from baseline at 6 months	Web: 38.7% No intervention: 6.3%, *P*=.003	
	Fordis, 2005 [29]	Live Web-based CME[g] workshop (n=51) Web-based CME workshop (n=52) No intervention (n=20)	*Knowledge*: the 2 active CME interventions combined: mean % change (95% CI) from baseline to immediate posttest	31.0% (95% CI 27.0%-35.0%), *P*<.001	A statistically significant improvement in knowledge was seen over time for both Web-based interventions groups. A statistically significant decrease in appropriately screening patients was seen in the live Web-based CME group at 12 weeks posttest compared with baseline. No statistically significant differences were seen for screening patients between interventions groups. There was a statistically significant increase in the proportion of patients appropriately treated by the Web-based CME group compared with the live CME and control groups. Participants in the Web-based interventions were satisfied with the learning experience.
			Knowledge: the 2 active CME interventions combined: mean % change (95% CI) from baseline to 12 weeks posttest	36.4% (95% CI 32.2%-40.6%), *P*<.001	

ICT intervention	Study	Interventions	Outcome(s)	Effect size	Conclusion
			Knowledge: the 2 active CME interventions combined: mean % change (95 CI) from immediate posttest to 12 weeks posttest	5.4% (95% CI 2.6%-8.2%)	
			Skills: patients appropriately screened for dyslipidemia, mean % change (95% CI) from baseline to 12 weeks postintervention	Live Web-based: −3.3 (−5.9 to −0.7) Web-based: −0.1 (−2.9 to 2.6) No intervention: −0.8 (−3.5 to 1.8), *P*=.24	
			Skills: patients appropriately treated for dyslipidemia, mean % change from baseline to 12 weeks postintervention	Live Web-based: −1.1 (−4.9 to 2.7) Web-based: 5.0 (1.0-9.1) No intervention: 1.2 (−2.8 to 5.1), *P*=.04	
			Perceived usefulness: % of participants satisfied with the learning experience	Live Web-based: 100% (49/49) Web-based: 94% (44/47) No intervention: NR	
Computerized decision support system					
	Gill, 2011 [30]	EHR[h]-based clinical decision support (n=53) No intervention (n=66)	*Skills*: % of patients receiving guideline-concordant care, OR (95% CI)	EHR: 25.4% No intervention: 22.4%, OR 1.19 (1.01-1.42)	There was a statistically significant difference favoring the EHR intervention compared with no intervention for the proportion of patients receiving guideline-concordant care.
	Peremans, 2010 [31]	EHR-based clinical decision support (n=15) Empowered patient group (n=15) No intervention (n=13)	*Skills*: consultation and prescribing skills based on a 48-item checklist, mean difference (95% CI) from baseline to 5 months postintervention	EHR: –1.79 (–4.97 to 1.65) Empowered: 4.92 (1.96-7.89) No intervention: –0.91 (–3.37 to 1.92)	The empowered patient group was the only group that had improved consultation and prescribing skills scores after 5 months postintervention and the only intervention that demonstrated a statistically significant difference compared with no intervention.
Electronic educations game					
	Kerfoot, 2009 [21]	Electronic game/survey 2 questions every 2 days (n=735) Electronic game/survey 4 questions every 4 days (n=735)	*Knowledge*: median % (IQR) scores for knowledge test baseline	Electronic game 2 questions every 2 days: 48% (18) Electronic game 4 questions every 4 days: 45% (15)	Both electronic game cohorts demonstrated statistically significant improvements in knowledge compared with baseline.
			Knowledge: median % (IQR) scores for knowledge test postintervention (12 or 24 weeks), *P* value	Electronic game 2 questions every 2 days: 100% (3) Electronic game 4 questions every 4 days: 98% (8), *P*<.001	

ICT intervention	Study	Interventions	Outcome(s)	Effect size	Conclusion
Email					
	Lobach, 1996 [19]	Biweekly emails of computer-based audit/feedback program (n=22) No intervention (n=23)	*Skills*: median % (IQR) participant compliance with guidelines, *P* value	Email: 35.3% (NR[i]) No intervention: 6.1% (NR[i]), *P*=.01	The email intervention demonstrated statistical significance in greater compliance with guidelines compared with no intervention.
	Stewart, 2005 [32]	Email Web-based learning for 2 evidence-based modules (type 2 diabetes, prevention) (n=27) Waiting list (n=31)	*Knowledge*: mean (SD) score (out of 100) at baseline	Email (diabetes): 66.8 (14.1) Email (prevention): 53.8 (12.8) Waiting list (diabetes): 68.6 (10.4) Waiting list (prevention): 51.9 (9.5)	The intervention group (prevention module) demonstrated statistically significant improvements compared with the control group for knowledge at 2 and 6 months, as well as compliance at 6 months. There was no statistically significant difference with the diabetes modules.
			Knowledge: mean (SD) score (out of 100) at 2 months postintervention, *P* value	Email (diabetes): 72.7 (14.1) Email (prevention): 63.8 (17.6) Waiting list (diabetes): 67.7 (16.8), *P*=.57 Waiting list (prevention): 50.5 (13.8), *P*=.002	
			Knowledge: mean (SD) score (out of 100) at 6 months postintervention, *P* value	Email (diabetes): 73.2 (7.7) Email (prevention): 65.7 (15.2) Waiting list (diabetes): 68.6 (11.4), *P*=.14 Waiting list (prevention): 53.3 (10.5), *P*=.004	
			Skills: mean (SD) score for compliance with guidelines (out of 100) at baseline	Email (diabetes): 53.8 (12.5) Email (prevention): 52.2 (11.1) Waiting list (diabetes): 51.2 (11.6) Waiting list (prevention): 51.1 (14.4)	
			Skills: mean (SD) score for compliance with guidelines (out of 100) at 2 months postintervention, *P* value	Email (diabetes): 51.7 (12.9) Email (prevention): 52.2 (11.7) Waiting list (diabetes): 51.6 (9.5), *P*=.90 Waiting list (prevention): 47.7 (13.8), *P*=.11	
			Skills: mean (SD) score for compliance with guidelines (out of 100) at 6 months postintervention, *P* value	Email (diabetes): 47.1 (9.2) Email (prevention): 55.0 (10.0) Waiting list (diabetes): 50.8 (9.1), *P*=.14 Waiting list (prevention): 50.0 (14.4), *P*=.03	

ICT intervention	Study	Interventions	Outcome(s)	Effect size	Conclusion
Multifaceted					
	Bernhardsson, 2014 [33]	Multifaceted: implementation seminar/group discussion, website, and email reminders (n=168) No intervention (n=88)	*Knowledge*: change in % of participants who were aware that guidelines exist from baseline to 1-year follow-up, *P* value	Intervention: 27.9% No intervention: 7.3%, *P*=.02	There was a statistically significant difference favoring the intervention group for change in awareness, knowledge of where to find guidelines, and accessibility of guidelines at 1-year follow-up. There were no significant differences in frequent use of CPGs.
			Knowledge: change in % of participants who knew where to find guidelines from baseline to 1-year follow-up, *P* value	Intervention: 25.2% No intervention: 4.8%, *P*=.007	
			Perceived ease of use: change in % of participants who felt guidelines were easy to access from baseline to 1-year follow-up, *P* value	Intervention: 17.4% No intervention: −4.3%, *P*<.001	
			Skills: change in % compliance with use of CPGs (frequently or almost always)	Intervention: 9.2% No intervention: −0.2%, *P*=.30	
	Chan, 2013 [34]	Multifaceted: in-person education session and Web-based support (n=31) No intervention (n=22)	*Beliefs about capabilities*: change in % (95% CI) of participants who were self-confident in following CPGs at 2 weeks postintervention	Intervention: 25.9% (4.2 to 45.5) No intervention: 6.3% (−2.0 to 32.1)	There were statistically significant improvements in self-confidence to use, satisfaction in following, and willingness to follow CPGs among the intervention group at 2 weeks postintervention. There were no significant improvements among the control group.
			Perceived usefulness: change in % (95% CI) of participants who were satisfied in following CPGs at 2 weeks postintervention	Intervention: 40.7% (16.1-59.6) No intervention: −12.5 (−37.3 to 12.7)	
			Intention: willingness to use new CPGs, mean score change (95% CI) (out of 4, 4=all CPGs) at 2 weeks postintervention	Intervention: 0.74 (0.36-1.1) No intervention: 0.19 (−0.10 to 0.48)	
	Desimone, 2012 [35]	Multifaceted: in-person education, Web-based support, printed materials (n=11) Usual education (n=11)	*Knowledge*: mean % (SD) of correct responses (11 items) at baseline	Multifaceted: 69% (1.7) Usual education: 76% (1.2)	There was a statistically significant improvement in knowledge in both groups at 1 month postintervention. There were no observable differences between groups (between-group statistical analyses not performed).
			Knowledge: mean % (SD) of correct responses (11 items) at 1 month postintervention, *P* value	Multifaceted: 83% (2.1), *P*=.003 Usual education: 84% (1.4), *P*=.02	

ICT intervention	Study	Interventions	Outcome(s)	Effect size	Conclusion
	McDonald, 2005 [36]	Multifaceted: email reminder with provider prompts, patient education material, and clinical nurse specialist outreach (n=97) Email reminder of recommendations (n=121) Usual care (n=118)	*Skills*: adjusted mean difference in probability that participant assessed bowel movement based on CPG compared with usual care, *P* value	Email reminder: –5.7, *P*=.02 Multifaceted: –2.7, *P*=.26	In the email reminder intervention group, there was a decrease in performance, as the probability of nurses completing bowel movement assessments was statistically significantly lower compared with usual care. There was no statistically significant difference compared with the multifaceted group. Other nurse assessment and instruction practices did not reach statistical significance when the email reminder and multifaceted interventions were compared with usual care (results not shown).
	Fretheim, 2006 [18]	Multifaceted: educational outreach visit, audit and feedback at outreach visit, computerized reminders, risk assessment tools, patient information material, telephone follow-up (n=257) Passive guideline dissemination (no additional active promotion or encouragement for use of guidelines) (n=244)	*Skills*: mean change in % participants prescribing in concordance to CPGs from baseline to 12 months, between-group difference RR[j] (95% CI)	Multifaceted: 11.5% Passive dissemination: 2.2%, 1.94 (1.49-2.49)	There was a statistically significant difference in participants prescribing in concordance to CPGs from baseline to 12 months favoring the multifaceted group compared with passive guidelines dissemination. No statistically significant differences were demonstrated for differences in participants performing risk assessments at 12 months.
			Skills: between-group difference in mean % participants performing risk assessments according to CPGs at 12 months, RR (95% CI)	1.04 (0.60-1.71)	
	Shenoy, 2013 [37]	Multifaceted: Web-based education, audit, feedback (n=24) Mailed guidelines (n=21)	*Knowledge*: mean change (95% CI) in total score (18 clinical vignettes) from baseline to 12 weeks postintervention	0.04 (1.22-1.31)	There was no statistically significant change in knowledge between intervention groups from baseline to 12 weeks postintervention. There was no statistically significant difference between intervention groups for the proportion of patients receiving CPG-adherent care at 12 weeks postintervention (results not shown).

[a]OR: odds ratio.

[b]NR: not reported.

[c]CPG: clinical practice guideline.

[d]Crossover design with same participants in both groups.

[e]IQR: interquartile range (25th to 75th percentile).

[f]ADHD: attention-deficit/hyperactivity disorder.

[g]CME: continuing medical education.

[h]EHR: electronic health record.

[i]IQR values illustrated in a diagram; however, values are not explicit.

[j]RR: relative risk.

Usability

Perceived usefulness was assessed in 1 study [17]. There was no statistically significant difference between intervention groups in regard to the proportion of physicians and nurses finding the intervention to be usable for integrating the learning into clinical practice. However, 76.7% (218/284) of physicians and nurses in the interactive Web-based tool plus Web-based didactic material found the intervention to be "very useful/useful." Usability was not measured in the Web-based

didactic material-alone group and no comparative statistical analyses were performed.

Perceived ease of use was assessed in 3 studies [22,23,25]. Balamuth et al [22] found that physicians using the Web-based 1-page summary reported that the supplemental materials were "simpler" to use than did the group using a weblink to guidelines (odds ratio, OR 6.1, 95% CI 2.8-13.6). In 1 of the studies involving only medicine residents and fellows by Bell et al [23], the median (95% CI) learner satisfaction scale score (out of 20) was statistically significantly greater (P<.001) in the self-study Web-based guidelines group (OR 17.0, 95% CI 16.0-18.0) than in the print-based guidelines group (OR 15.0, 95% CI 15.0-16.0). In Wolpin et al [25], the other study involving only medicine residents and fellows, there was no statistically significant difference in overall satisfaction with learning experience between the intervention groups.

Practice Behavior

Knowledge was assessed in 4 studies [17,22,23,25]. In all 4 studies, there was no statistically significant improvement in knowledge when compared with respective comparators.

Intention to use CPGs and reduction in barriers were assessed in 1 study [24]. There was no statistically significant difference between groups for intention to use material to educate patients, and no statistically significant difference in reduced barriers to using the material to educate patients.

Computer Software

The use of computer software for the dissemination of CPGs among health professionals was assessed in 3 studies [26-28] (Table 3). Bullard et al [26] used a crossover design to compare a wirelessly networked mobile computer program with a desktop computer program among physicians (n=10) after 8-hour shifts. Butzlaff et al [27] compared CPGs provided by CD-ROM and Internet (n=53) with no intervention (n=66) among physicians after approximately 70 days. Jousimaa et al [28] compared CD-ROM computer-based guidelines (n=72) with textbook-based guidelines (n=67) among physicians after 1 month.

Usability

Perceived usefulness was assessed in 1 study [26]. Statistically significant mean (95% CI) satisfaction scores (out of 7, with 7 representing excellent) favored the wireless network mobile computer program group compared with the desktop computer program group for several items such as "impact on efficiency" (OR 3.2, 95% CI 2.6-3.8 vs OR 4.3, 95% CI 4.0-4.6, P=.02), "increased use of CPGs" (OR 4.1, 95% CI 3.6-4.6 vs OR 3.5, 95% CI 2.9-4.0, P=.03), and "saving time" (OR 3.1, 95% CI 2.3-3.9 vs OR 4.2, 95% CI 3.6-4.7, P=.05). Other satisfaction items such as "configuration," "availability," "reduced communication with staff and patients," and "accessibility" did not show statistically significant differences between intervention groups. Physicians appeared to be indifferent regarding the usability of the wireless computer with respect to their efficiency, with a mean (95% CI) score (out of 7, with 7 representing strongly agree) of 3.30 (2.33-4.27). Usability of the desktop computer program was not assessed.

Practice Behavior

Knowledge was assessed in 1 study [27]. There was no statistically significant difference in knowledge scores between intervention groups.

Skills were assessed in 1 study [28]. There was no statistically significant difference between intervention groups for compliance skills with CPGs for laboratory, radiological, or physical examinations.

Web-Based Workshops

The use of Web-based workshops for the dissemination of CPGs among health professionals was assessed in 2 studies [20,29] (Table 3). Epstein et al [20] compared a Web-based didactic education session or workshop (n=27) with no intervention (n=22) among pediatricians after 6 months. Participants in the Web-based didactic education workshop group received four 1-hour training sessions with instructions to use an Internet portal to assess attention-deficit/hyperactivity disorder (ADHD), titrate and monitor responses to medications, and communicate with patients and their parents and teachers using a Web-based report card. Fordis et al [29] compared a live Web-based continuing medical education (CME) workshop (n=51) with a Web-based (nonlive) CME workshop (n=52) and with no intervention (n=20) among physicians after 12 weeks.

Usability

Perceived usefulness was assessed in 1 study [29]. The proportion of physicians satisfied with the learning experience was 100% (49/49) for the live CME group and 94% (44/47) for the Web-based CME group. No comparative statistical analyses were performed for the perceived usefulness outcome.

Practice Behavior

Skills were assessed in both studies [20,29]. In Epstein et al [20], the Web-based didactic education workshop group demonstrated statistically significant improvements (mean percentage change from baseline) in ADHD care practices when compared with no intervention for the following CPG recommendations: "use of parent ratings of ADHD during assessment" (23.8% vs 5.7%, P=.03), "use of teacher ratings of ADHD during assessment" (22.6% vs 6.0%, P=.04), "use of DSM-IV [*Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition)] ADHD criteria during assessment" (47.3% vs 17.9%, P=.03), "use of outside provider for ADHD diagnosis" (–60.7% vs –10.7%, P<.001), and "use of teacher ratings of ADHD to monitor treatment responses" (38.7% vs 6.3%, P=.003). In Fordis et al [29], among the 3 intervention groups, there was no change from baseline screening levels following the intervention and no statistically significant differences between interventions groups. There was a statistically significant (P=.04) increase in the mean proportion (95% CI) of patients appropriately treated by the Web-based CME group (5.0%, 1.0%-9.1%) when compared with the live CME (−1.1%, −4.9% to 2.7%) and control groups (1.2%, −2.8% to 5.1%).

Knowledge was assessed in 1 study [29]. There was a statistically significant (P<.001) improvement in knowledge for both Web-based interventions groups combined, with a mean

(95% CI) change of 31.0% (27.0%-35.0%) from baseline to immediate posttest, and 36.4% (32.2%-40.6%) to 12 weeks posttest.

Computer Decision Support System

The use of CDSSs for the dissemination of CPGs among health professionals was assessed in 2 studies [30,31] (Table 3). According to Peremans et al [31], a CDSS is defined as "any software designed to directly aid clinical decision making, whereby individual patient records are matched with a computer database of guidelines" (pg 281). Peremans et al [31] compared an electronic health record (EHR)-based CDSS intervention (n=15) with a group receiving a visit by a simulated "empowered" patient (n=15) and with no intervention (n=13). Gill et al [30] compared an EHR-based CDSS intervention (n=53) with no intervention (n=66) among physicians and clinicians in ambulatory practices after 12 months.

Usability

Usability was not assessed in any of the included studies that used CDSSs for the dissemination of CPGs.

Practice Behavior

Skills were assessed in both studies [30,31]. In Peremans et al [31], the role of the simulated patient was to ask the physician specific clinical questions (a clinical scenario that was agreed upon by a panel of authors and researchers) regarding the prescribed pills she had received. The empowered-patient group was the only group that had statistically significant improved mean scores (out of 48 points) for consultation and prescribing skills after 5 months postintervention when compared with no intervention, with a mean (95% CI) difference of 4.92 (1.96-7.89). In Gill et al [30], there was a statistically significant difference favoring the EHR-based CDSS intervention compared with no intervention for delivering guideline-concordant care (OR 1.19, 95% CI 1.01-1.42).

Electronic Educational Game

The use of an electronic educational game for the dissemination of CPGs among health professionals was assessed in 1 study [21] (Table 3). Kerfoot et al [21] compared an electronic educational game with a survey containing 2 questions distributed every 2 days (n=735) with a group receiving the same game, but with a survey containing 4 questions distributed every 4 days (n=735) among urologists after 34 weeks.

Usability

Usability was not assessed in Kerfoot et al [21].

Practice Behavior

Both game groups demonstrated statistically significant (P<.001) improvements in knowledge compared with baseline, with median scores of 48.0% (interquartile range, IQR 18) versus 100.0% (IQR 3) for the electronic game cohort answering 2 questions every 2 days, and 45.0% (IQR 15) versus 98.0% (IQR 8) for the cohort answering 4 questions every 4 days.

Email

The use of email for the dissemination of CPGs among health professionals was assessed in 2 studies [19,32] (Table 3). Lobach [19] compared biweekly emails of a computer-based audit and feedback program (n=22) with no intervention (n=23) among physicians, general internists, nurses, physician assistants, and family medicine residents after 12 weeks. Stewart et al [32] examined the use of email to disseminate 2 separate evidence-based modules on diabetes and prevention (n=27) compared with a waiting list (n=31) among physicians after 6 months.

Usability

Usability was not assessed in any of the included studies that used email for the dissemination of CPGs.

Practice Behavior

Skills were assessed in both studies [19,32]. In Lobach [19], there was a statistically significant difference favoring the email intervention compared with no intervention for median rate of compliance with CPGs (35.3% vs 6.1%, P=.01). In Stewart et al [32], there was a statistically significant difference (P=.03) in skills favoring the email intervention compared with the waiting list, with mean (SD) compliance scores (out of 100) of 55.0 (10.0) versus 50.0 (14.4) for the prevention modules at 6 months. There was no statistically significant difference in compliance scores between intervention groups for the diabetes modules at 6 months and for both modules at 2 months.

Knowledge was assessed in 1 study [32]. There was a statistically significant difference (P=.002) favoring the email intervention compared with the waiting list, with mean (SD) knowledge scores (out of 100) of 63.8 (17.6) versus 50.5 (13.8), and 65.7 (15.2) versus 53.3 (10.5) for the prevention modules at 2 months and 6 months, respectively. There was no statistically significant difference in knowledge scores between intervention groups for the diabetes modules at 2 and 6 months.

Multifaceted ICT Interventions

The use of a multifaceted intervention including an ICT with more than one CPG dissemination strategy among health professionals was assessed in 6 studies [18,33-37] (Table 3). Bernhardsson et al [33] compared the combination of an implementation seminar with group discussion, a website, and email with no intervention (n=88) among physiotherapists after 12 months. Shenoy [37] compared the combination of Web-based education and audit and feedback (n=24) with mailed CPGs (n=21) among physicians after 5 months. Fretheim et al [18] compared the combination of an educational outreach visit, audit and feedback at the outreach visit, computerized reminders, risk assessment tools, patient information material, and telephone follow-up (n=257) with passive guideline dissemination (no additional active promotion or encouragement for the use of guidelines) (n=244) among physicians and practice nurses after 45 days. Chan et al [34] compared the combination of an in-person education session and Web-based support (n=31) with no intervention (n=22) among nurses after 2 weeks. Desimone et al [35] compared the combination of in-person education, Web-based support, and printed materials (n=11) with usual education (n=11) among internal medicine residents after 4 weeks. McDonald et al [36] compared the combination of email reminders with provider prompts, patient education material, and clinical nurse specialist outreach (n=97) with email

reminders of recommendations only (n=121) and usual care (n=118) among primary care and family medicine residents after 24 months.

Usability

Usability was assessed in 1 study [33]. There was no statistically significant difference between intervention groups for the change in proportion of physiotherapists who felt the CPGs were easy to access and the proportion of those who used the CPGs frequently.

Perceived usefulness was assessed in 1 study [34]. There was a statistically significant improvement in the proportion of nurses who were satisfied in following the CPGs at 2 weeks postintervention compared with baseline among the multifaceted intervention group, with a mean (95% CI) of 40.7% (16.1%-59.6%).

Practice Behavior

Knowledge was assessed in 3 studies [33,35,37]. In Bernhardsson et al [33], there were statistically significant improvements from baseline favoring the intervention group compared with no intervention for the proportion of physiotherapists who were aware that guidelines exist (27.9% vs 7.3%, *P*=.02) and the proportion of physiotherapists who were aware of where to find guidelines (25.2% vs 4.8%, *P*=.007). In Shenoy [37], there was no statistically significant improvement in knowledge among either the multifaceted intervention or the mailed guidelines groups. In the study involving only medicine residents and fellows by Desimone et al [35], there was a statistically significant improvement in correct responses (out of 11 items) from baseline in both intervention groups, with mean (SD) proportions for the multifaceted intervention group (83%, SD 2.1% vs 69%, SD 1.7%, *P*=.003) and the usual education group (84%, SD 1.4% vs 76%, SD 1.2%, *P*=.02).

Skills were assessed in 3 studies [18,33,36]. In McDonald et al [36], the probability of nurses completing bowel movement assessments was statistically significantly lower in the email reminder intervention group (*P*=.02) than in the usual care group, with an adjusted mean difference of –5.7% (89.0% vs 94.7%), representing a decrease in performance. There was no statistically significant difference compared with the multifaceted intervention group. Other nurse assessment and instruction practices did not reach statistical significance when the email reminder and multifaceted interventions were compared with usual care. In Fretheim et al [18], there was a statistically significant difference in the proportion of physicians and practice nurses prescribing in concordance to CPGs from baseline to 12 months favoring the multifaceted group (11.5%) compared with the passive guidelines dissemination group (2.2%), with a relative risk (95% CI) of 1.94 (1.49-2.49). There was no statistically significant difference between intervention groups for physicians and practice nurses performing risk assessments at 12 months. In Bernhardsson et al [33], there was no statistically significant difference between intervention groups for change in the proportion of physiotherapists who "frequently or almost always" used the CPGs.

Beliefs about capabilities and intention to use CPGs were assessed in 1 study [34]. There was a statistically significant improvement in the proportion of nurses who were self-confident in following the CPGs at 2 weeks postintervention compared with baseline among the multifaceted intervention group, with a mean (95% CI) of 25.9% (4.2%-45.5%). There was a statistically significant improvement in intention to use the new CPGs when compared with baseline among the multifaceted intervention group, with a mean (95% CI) change in score (out of 4, with 4 representing willingness to use all CPGs) of 0.74 (0.36-1.1). There was no statistically significant improvement among the control group for each of the outcomes listed above.

Discussion

The aim of this review was to identify research on health professionals' perceived usability and practice behavior with ICTs for the dissemination of CPGs. In summary, results varied by the type of ICT used. While rapidly changing technologies may pose challenges for the development, implementation, and evaluation of ICT-based interventions, as they may be associated with greater barriers for adoption by health professionals [38], there were no apparent trends when comparing established and older ICTs (eg, email and computer software) versus newer emerging ICT interventions (eg, electronic educational games, Web-based workshops, and the multifaceted ICT interventions). Studies using websites to disseminate CPGs [17,22-25] demonstrated no improvements in knowledge [17,22,23,25], reduced barriers [25], or intentions to use CPGs [25]. There were positive effects for perceived usefulness [17] and perceived ease of use [22,23] (2 of 3 studies). Studies using computer software [26-28] demonstrated no improvements in knowledge [27] or skills [28], but an effect on perceived usefulness [26]. We found that 2 studies using Web-based workshops [20,29] demonstrated improvements in knowledge [29] and perceived usefulness [29] and skills [20,29]. Studies using CDSSs demonstrated variable results for skills, as 1 study [30] demonstrated a positive effect, while the other did not [31]. While both studies were compared with no intervention, it should be noted that in the latter study [31], the non-ICT intervention (empowered patient group) was the only group that demonstrated a positive effect when compared with no intervention. The 1 study that used an electronic educational game [21] demonstrated an improvement in knowledge. Studies using email [19,32] demonstrated improvements in knowledge [32] and skills [19,32]. Studies using multifaceted ICT interventions [18,33-37] demonstrated improvements in knowledge [33,35] (2 of 3 studies), perceived usefulness [34], perceived ease of use [33], intention to use CPGs [34], beliefs about capabilities [33], and skills [37] (1 of 2 studies). While the multifaceted interventions in this review mostly demonstrated positive findings for improvements in usability and practice behavior, it remains unclear whether they are in fact superior to single interventions. Grimshaw et al [8] revealed that effect sizes in multifaceted interventions do not necessarily increase with increasing number of components, and these types of interventions appear to be more costly than single interventions. Similarly, a review by Squires et al [39] concluded

that there is a lack of compelling evidence to demonstrate that multifaceted interventions are more effective than single interventions.

Outcome selection was guided by both the TAM2 [16] and the TDF [2]. We chose the TAM2 because it was originally designed to predict ICT acceptance and usage in the workplace and has been widely used for diverse sets of ICT users [40]; we chose the TDF because it simplifies and integrates many behavior change theories, including social cognitive theory, learning theory, and diffusion theory [2]. The TAM2 is a validated and robust theoretical framework that has been used for predicting and explaining behavior related to ICTs [16]. In addition to cognitive instrumental processes, the TAM2 encompasses social influence processes, including subjective norms, which have shown to explain the perceived usefulness of ICTs [41]. Developed from a synthesis of psychological theories, the TDF is an integrative framework that has been shown to be useful and flexible for the assessment of behavior change and barriers among a diverse group of health professionals working in various clinical settings [42]. Together, both theoretical frameworks provided a comprehensive list of outcomes to measure health professionals' usability and practice behavior change of ICTs for the dissemination of CPGs.

The variable findings in knowledge improvement are supported by a recent systematic review [7] of educational strategies for teaching medical trainees, which found no difference in learner outcomes when comparing lecture-based versus Web-based strategies. While previous reviews have assessed interventions for promoting ICT adoption [43] and KT dissemination strategies focusing on practice behavior change among health professionals [8] distinctly, this systematic review adds to the body of literature by summarizing current evidence pertaining to health professionals' perceived usability and practice behavior change with ICTs, specifically for the dissemination of CPGs. A systematic review by Gagnon et al [43] concluded that there is very limited evidence on effective interventions promoting the adoption of ICTs by health care professionals, while a systematic review by Grimshaw et al [8] concluded that the evidence to guide the choice of KT strategies targeting health professionals is incomplete. Understanding how health professionals engage with and use ICTs to access CPGs will enable health care provider organizations to create content that is more Web friendly [44]. While the evidence is limited, studies of ICTs included in this review have shown promising findings. ICTs are novel ways of disseminating CPGs, compared with more traditional methods such as printed educational materials [9], educational meetings [10], educational outreach [11], local opinion leaders [12], and audit and feedback [13]. This review highlights which ICTs have been successfully used as a dissemination strategy for CPGs; however, it remains unclear whether one ICT is more effective than another. It is also unclear whether other ICTs not captured in this review, such as social media, can be used as effective dissemination strategies for CPGs. Further research, by conducting well-designed randomized controlled trials, is necessary to determine whether the use of ICTs is an effective strategy to disseminate evidence-based medicine to health professionals. There were differences in study durations and measurements among the included studies. As none of the studies measured sustainability, researchers should consider what is an appropriate time frame to expect meaningful differences in behavior change. Future studies, designed to compare these strategies head-to-head, would provide further guidance. While the scope of the review focused on the dissemination of CPGs to health professionals, future research should also assess how ICT dissemination strategies can be used as a tool to share information between health professionals and patients. As only 1 of the included studies [24] assessed barriers, future research should consider barriers as a crucial outcome of interest.

Strengths and Limitations

The strengths of this systematic review include the broad eligibility criteria that we used, allowing for numerous types of ICTs and various health professional populations (ie, physicians including medical residents, nurses, and physiotherapists) to be included and summarized in this review. Additionally, we used a systematic approach to review the literature and assessed the methodological quality of each included study. This systematic review was conducted following the PRISMA checklist [14].

Nevertheless, there are limitations of this review that should be considered. We did not include information published in languages other than English; thus, we may have excluded some relevant findings. The small number of included studies per ICT and the heterogeneity between studies in regard to the included health professional populations, definitions of outcomes assessed, selected comparators (some compared interventions against no intervention, while others used active comparators), and duration of studies did not allow for comparisons between studies. As a result, we were not able to calculate pooled effect sizes or perform meta-analyses. The terminology of outcomes in the included studies sometimes differed from the identified concepts in the TAM2 and domains of the TDF that we used to define the usability and practice behavior change outcomes, respectively. Several studies measured numerous outcomes, and it remains uncertain whether these studies were adequately powered to detect meaningful differences. Furthermore, the overall findings were limited by the high loss to follow-up in numerous studies [17,21,23,25,30,32,34,36]. While reasons for loss to follow-up remain unclear, one potential cause as suggested by study authors may be professional or organizational barriers related to the use of these ICTs. CPG dissemination and KT strategies should be tailored and driven by barriers to improve adherence in practice [44].

The authors of the included studies did not always assess the quality of information being presented or quality of ICT. The quality of information being presented was previously assessed and deemed appropriate by authors in 4 of 5 (80%) studies using websites [17,23-25], 1 of the 2 (50%) studies using Web-based workshops [29], the study using an electronic educational game [21], 1 of 3 (33%) studies using computer software [26], both studies using email [19,32], both studies using CDSSs [30,31], and 4 of 6 studies (67%) using a multifaceted intervention including an ICT [33,35-37]. It was unclear whether the quality of information was assessed and deemed appropriate in the remaining studies. The quality of the ICT was assessed and deemed appropriate in 2 of 5 studies (40%) using websites

[24,25], 1 of the 2 (50%) studies using Web-based workshops [29], the study using an electronic educational game [21], 1 of 3 (33%) studies using computer software [26], 1 of 2 (50%) studies using email [19], and 1 of 6 studies [35] using a multifaceted intervention including an ICT. In studies using CDSSs, the quality of the ICT was assessed in 1 of 2 studies (50%) [30] but was not generally accepted by users. It was unclear whether the quality of the ICTs was assessed and deemed appropriate in the remaining studies.

The overall methodological quality of included studies was strong for the website studies, while it was uncertain for the electronic education game, email, and multifaceted studies (Multimedia Appendix 4). Studies using computer software, Web-based workshops, and CDSSs were of variable methodological quality, as some studies were predominantly strong, while others were of uncertain quality. Several studies were conducted more than 10 years ago; thus, these ICTs may not reflect current technology and may no longer be relevant. The goal of this systematic review was to transparently present the current state of knowledge about ICT use among health professionals and to allow readers to make informed decisions regarding their relevance.

Conclusion

The findings of this systematic review suggest that health professionals' perceived usability and practice behavior change vary by type of ICT. Website studies demonstrated improvements in perceived usefulness and perceived ease of use, but not for knowledge usability, barriers, and intentions. Computer software studies demonstrated improvements in perceived usefulness, but not in knowledge and skills. Web-based workshop and email studies demonstrated improvements in knowledge, perceived usefulness, and skills. An electronic educational game intervention demonstrated an improvement in knowledge from baseline to 12 or 24 weeks. CDSS studies demonstrated variable findings for improvement in skills. Multifaceted ICT interventions demonstrated improvements in beliefs about capabilities, but not in usability. Most multifaceted ICT studies demonstrated improvements in knowledge, perceived usefulness, perceived ease of use, and beliefs about capabilities. In summary, heterogeneity and the paucity of properly conducted studies did not allow for a clear comparison between studies and a conclusion on the effectiveness of ICTs as a KT strategy for the dissemination of CPGs.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Search strategy.

[PDF File (Adobe PDF File), 40KB - mededu_v2i2e16_app1.pdf]

Multimedia Appendix 2

List of excluded studies.

[PDF File (Adobe PDF File), 84KB - mededu_v2i2e16_app2.pdf]

Multimedia Appendix 3

Included study characteristics.

[PDF File (Adobe PDF File), 78KB - mededu_v2i2e16_app3.pdf]

Multimedia Appendix 4

Methodological assessment of included studies.

[PDF File (Adobe PDF File), 75KB - mededu_v2i2e16_app4.pdf]

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Abbreviations

ADHD: attention-deficit/hyperactivity disorder
CDSS: computerized decision support system
CME: continuing medical education
CPG: clinical practice guideline
EHR: electronic health record
ICT: information and communication technologies
IQR: interquartile range
KT: knowledge translation
PICOS: population, intervention, comparison, outcome, and study design
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
OR: odds ratio
TAM2: technology acceptance model
TDF: theoretical domains framework

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Original Paper

A Virtual Community of Practice for General Practice Training: A Preimplementation Survey

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Abstract

Background: Professional isolation is an important factor in low rural health workforce retention.

Objective: The aim of this study was to gain insights to inform the development of an implementation plan for a virtual community of practice (VCoP) for general practice (GP) training in regional Australia. The study also aimed to assess the applicability of the findings of an existing framework in developing this plan. This included ascertaining the main drivers of usage, or usefulness, of the VCoP for users and establishing the different priorities between user groups.

Methods: A survey study, based on the seven-step health VCoP framework, was conducted with general practice supervisors and registrars—133 usable responses; 40% estimated response rate. Data was analyzed using the t test and the chi-square test for comparisons between groups. Factor analysis and generalized linear regression modeling were used to ascertain factors which may independently predict intention to use the VCoP.

Results: In establishing a VCoP, facilitation was seen as important. Regarding stakeholders, the GP training provider was an important sponsor. Factor analysis showed a single goal of usefulness. Registrars had a higher intention to use the VCoP (P<.001) and to perceive it as useful (P<.001) than supervisors. Usefulness independently predicted intention to actively use the VCoP (P<.001). Regarding engagement of a broad church of users, registrars were more likely than supervisors to want allied health professional and specialist involvement (P<.001). A supportive environment was deemed important, but most important was the quality of the content. Participants wanted regular feedback about site activity. Regarding technology and community, training can be online, but trust is better built face-to-face. Supervisors were significantly more likely than registrars to perceive that registrars needed help with knowledge (P=.01) and implementation of knowledge (P<.001).

Conclusions: Important factors for a GP training VCoP include the following: facilitation covering administration and expertise, the perceived usefulness of the community, focusing usefulness around knowledge sharing, and overcoming professional isolation with high-quality content. Knowledge needs of different users should be acknowledged and help can be provided online, but trust is better built face-to-face. In conclusion, the findings of the health framework for VCoPs are relevant when developing an implementation plan for a VCoP for GP training. The main driver of success for a GP training VCoP is the perception of its usefulness by participants. Overcoming professional isolation for GP registrars using a VCoP has implications for training and retention of health workers in rural areas.

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KEYWORDS

medical informatics; e-learning; virtual communities of practice

Introduction

Professional isolation is an important factor in low rural health workforce retention [1]. Isolation can lead to decreased knowledge sharing [2] and can affect the career choices of doctors, including intending to work reduced hours and moving away from rural areas [3-5]. Training for doctors in general practice in Australia can be particularly isolating [3,4]; trainees, or registrars, can be spread across large geographic areas, moving between different practices in urban and regional placements, and are usually alone in their consulting room with a patient. These factors of geography and structure are barriers to knowledge sharing, impeding the natural communities of practice that form in medical training.

Communities of practice (CoPs) are "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" [6]. CoPs reflect the master and apprentice knowledge sharing that occurs between senior doctors and those in training. In knowledge management terms, there are two types of knowledge being shared in this type of master and apprentice learning. Firstly, explicit knowledge sharing occurs around a topic; for example, the details of which drugs are appropriate for a clinical condition [7]. This can be referred to as the *know-what*. Secondly, and most importantly, CoPs help participants share tacit knowledge [7]. This is the *know-how* of putting that knowledge into practice; for example, how to ensure a clinical condition is identified from a primary care database, that the patient is recalled, that patients are encouraged to take medications, and how to anticipate and treat a range of side effects. Through this knowledge transfer, CoPs can lead to significant quality improvement in patient care, such as the establishment of a nationally lauded stroke service in the United Kingdom [8] or the delivery of care to hepatitis C patients in rural areas to the same standard as an academic medical center [9].

More recently, online technology has been enabling medical information sharing on an unprecedented scale [10-12], with doctors around the world joining and using a wide range of online medical communities [13]. As a result, virtual communities of practice (VCoPs) have developed in a number of industries, including health care, in which online technologies are used to overcome barriers of distance and work structure [14-16]. For example, in Canada, emergency department staff share knowledge between rural and urban centers [14], while in primary health care in Spain, the HOBE network has engaged over 1500 primary care professionals in a VCoP for health care innovation, leading to the development and implementation of a number of important service improvement strategies [17].

In this context, two studies have shown that there is the interest, ability, and Internet access among general practice (GP) registrars and supervisors to establish a VCoP for GP training in a regional area of New South Wales, Australia [18,19]. As part of these studies, a health framework for VCoP implementation was developed, based on a review of the business and health care literature [16,20].

The aim of this study was to gain insights to inform the development of an implementation plan for the Virtual Community of Practice (VCoP) for General Practice Training in regional Australia. The VCoP platform was based on the NING social networking software [21], which can be customized to offer a variety of features for private social networks. Users were asked about features such as forums, live chat, shared document repositories, and videoconferencing (see Multimedia Appendix 1). The study also aimed to assess the applicability of the findings of an existing framework in developing this plan. This included ascertaining the main drivers of usage, or *usefulness*, of the VCoP for users and establishing the different priorities between user groups.

Methods

Ethics approval was obtained from the University of Wollongong's Human Research Ethics Committee.

Participants

The sampling frame comprised all general practice registrars, supervisors, and educators in Coast City Country General Practice Training (CCCGPT). CCCGPT provides general practice training in a 160,000 square kilometer region of Australia, covering urban, regional, and small rural centers in the Australian Capital Territory and New South Wales. After 2 hospital years, GP registrars progress through a minimum of three general practice terms of 6 months.

In October 2011, an email was sent to the GP training provider database by the training provider administration, inviting recipients to fill in an online survey. The GP training provider database keeps an accurate record of registrars and their email addresses, listed by date. The registrar sampling frame was 143. The supervisor database is less accurate as supervisors' details are not updated each term, while registrars' details are. Supervisor emails are not always updated when they change and there is no date range to retrospectively check when they were active as supervisors or having a break from training. Given these limitations, a manual review by the training provider administration of the list of supervisors within the training program, cross-checked against the training program database, gave a supervisor sampling frame of 175, giving a total registrar and supervisor sampling frame of 318. In the invitation email, there was a link to SurveyMonkey, a Web-based survey program (SurveyMonkey, LLC, Palo Alto, CA, USA), with a survey and participant information sheet. A total of 183 out of 318 people responded, yielding a 57.5% response rate; 50 cases were removed for not providing consent or demographics (n=12) or for not completing the majority of the survey (n=38). Some of these noncompletions were due to emails going to practice management staff rather than doctors. The total usable response

rate was 41.8% (133/318): registrar 46.9% (67/143) and supervisor 37.7% (66/175).

Questionnaire

The questionnaire was based on previous studies demonstrating GP registrar and supervisor interest in a VCoP, and a framework that guides the implementation of health VCoPs [18-20].

The seven steps of the health VCoP framework are as follows: (1) organizing facilitation; (2) engaging stakeholders; (3) establishing clear goals; (4) involving a broad church of participants; (5) creating a supportive environment; (6) including measurement, benchmarking, and feedback in the design; and (7) technology and community factors, such as users self-selecting and having a mixture of face-to-face and online engagements. There were 28 questions in the final survey. Questions included categorical and 5-point Likert scale response items. The questions collected information on each of the seven steps, to investigate whether the steps were applicable to a VCoP for GP training. This included questions in which respondents rated the importance of a step, along with questions seeking further detail on that step to help guide the VCoP implementation. In addition, questions were asked to assess the knowledge needs of registrars when implementing guidelines, so that information on the appropriate content for the site could be obtained. Items about the features of the site were included to determine which tools would be most useful. The survey is included as Multimedia Appendix 1, but it is worth noting that, due to the logic within the online survey, the printed version can appear to have repetitions. In the online survey, participants only received each appropriate question once.

The instrument was piloted with 2 GP registrars, 2 supervisors, and 4 researchers. Discussion among this group led to some minor alterations to clarify wording. Results are presented under the seven headings of the health VCoP framework.

Statistical Analysis

Data were analyzed using SPSS version 19 (IBM Corp, Armonk, NY, USA). For comparison between groups, respondents were categorized as either registrar or supervisor; *t* test and chi-square analyses were performed. The paired-samples *t* test was used to compare responses within a group. The independent sample *t* test was used to compare categorical and scale data. All statistical comparisons were two-tailed and statistical significance was set at $P<.05$.

Principal axis factor analysis using varimax rotation was used to determine which Likert scale items grouped naturally in questions with multiple Likert scale items; for example, the question on the practical outcomes, or usefulness, that an online network would have for that user. If eigenvalues were >1.0, factors were included. To test for the agreement between the Likert scale items, such as the five factors perceived as *useful* outcomes for a VCoP, and separately for the two items of *intention to actively use the VCoP*, the Cronbach alpha test for reliability was calculated.

General linear regression modeling was used to test the multivariate associations of independent variables such as age, training stage, and usefulness, and the dependent variable of intention to actively use an online network for GP training.

Results

Overview

There were 133 medical practitioners in the final sample. Of these, 51.9% (69/133) were male, 57.1% (76/133) were from a rural setting, and 50.4% (67/133) were registrars. Registrars were younger (mean 36.70 years, SD 6.85) than supervisors (mean 52.62 years, SD 7.90; *t* test $P<.001$) and more likely to be female (63% [42/67] female registrars compared with 33% [22/66] female supervisors; chi-square $P=.001$).

Factor Analysis

To determine which questions in the survey naturally clustered together, principal axis factor analysis using varimax rotation factor analysis was performed on two groups of questions. Participants were asked these questions to verify applicability of *Step 3: Goals and Objectives*, as seen below, and the results will be fully discussed in that step. The factor analysis is described below. Cronbach alpha was >.80, above the recommended threshold of .70 in both cases.

The first question contained five items. Participants were asked what practical outcome, or *usefulness*, such a network would deliver. The five items included helping registrars pass exams, participants feeling more confident in medical skills, learning from colleagues about putting guidelines into practice, feeling more supported in general practice, and developing a broader network of colleagues. These were analyzed using factor analysis and found to be a single factor (Cronbach alpha=.90, eigenvalue=4.01). The single factor covered a broad range of useful outcomes of a network, including support, broad network, improved confidence, and learning skills, and so the factor was labeled *useful for training*, and afterward referred to as *usefulness*.

Secondly, participants were asked about their intention to use an online network for training by ranking their likelihood of participating through reading, sharing knowledge by answering questions, and uploading new topics. The rating scale ranged from 1 (not likely) through to 5 (highly likely). *Only reading* was passive participation. Sharing knowledge by posting new topics and sharing knowledge by answering questions were both methods of active participation. Factor analysis of these two active participation questions revealed a single factor, *likelihood to use actively* (eg, posting and starting topics). For analysis purposes, the question on passive participation is referred to as *likelihood to use passively* (*only reading*).

Health Virtual Community of Practice Framework Step 1: Facilitation

> *Facilitators promote engagement and maintain community standards. [20]*

Respondents (N=132) rated the need for formal facilitation between *important* (62/132, 47.0%) and *very important* (32/132, 24.2%). Mean scores were calculated for each group. Analysis using a *t* test showed there were no differences between the importance of formal facilitation for registrars and supervisors

(t_{130}=-0.79, P=.43). The most popular choice for community facilitator/leader was a topic expert (53/133, 39.8%), with registrars rating a topic expert as highest and supervisors rating a topic expert second behind the training provider administration. Chi-square testing showed that registrars were significantly more likely to want a topic expert than were supervisors (P=.03), with no statistical significance between other results (see Table 1).

Table 1. Preferred leader/facilitator for the online training network (multiple responses allowed).

Facilitator	Registrar (n=67), n (%)	Supervisor (n=66), n (%)	Significance (chi-square test)
Topic expert	33 (49)	20 (30)	Yes: P=.03
GP[a]registrar liaison	14 (21)	8 (12)	No
GP supervisor	14 (21)	12 (18)	No
GP training provider administrator	19 (28)	24 (36)	No
Network developer (IT[b])	5 (7)	5 (8)	No
Network designer (doctor)	18 (27)	17 (26)	No

[a]GP: general practice.

[b]IT: information technology.

There were nine comments in the *other* section. Regarding who would make the best facilitator, two comments showed participants were unsure who would make the best one, four comments were variations of "someone with medical knowledge," one was "someone savvy with online leadership," one was "someone with lots of time," and another suggested that facilitation could be rotated.

Health Virtual Community of Practice Framework Step 2: Champion and Support

> *The network needs to have an initial stakeholder champion, with stakeholder support. [14]*

Respondents (N=130) rated the need for formal support from the main stakeholder, the GP training provider, between *somewhat important* and *important* (mean 3.73, SD 1.09). The *t* test analysis showed no significant differences between registrars and supervisors (t_{128}=-0.44, P=.66).

The importance of the GP training provider's support was also reflected in the previous step (see Table 1), in which supervisors rated the GP training provider as the preferred choice of leader/facilitator, whereas the GP training provider was the second preference for registrars. A comment by one respondent supports stakeholder involvement, suggesting that the GP training provider's medical educator should be the leader/facilitator.

Health Virtual Community of Practice Framework Step 3: Objectives and Goals

> *Clear objectives provide members with responsibilities and motivate them to contribute more actively. [20]*

Participants were asked about a range of goals for the network, and the key goal, as identified by factor analysis discussed above, was *usefulness*. The perceived usefulness varied between user groups, being significantly higher among registrars (mean 4.11, SD 0.73) than among supervisors (mean 3.44, SD 0.82; t_{131}=4.98, P<.001). A thematic analysis by the first author (SB) of the 25 comments about specific goals showed an even split between concepts of knowledge sharing and improving connectedness/overcoming isolation. Knowledge sharing comments focused on sharing information about medicine, employment opportunities, or just being able to exchange information. Examples included "staying up to date with medical knowledge," "easy to communicate and exchange information," and "knowing about local services available." The isolation comments included several participants wanting to "reduce isolation," "keep in contact with other registrars," and "debrief," and noted that such a network would be "particularly important for rural and time-poor colleagues."

From the health VCoP framework, clear goals are supposed to encourage active participation. Registrars (mean 3.00, SD 1.14) were more likely to state that they would participate actively than did supervisors (mean 2.52, SD 0.87; t_{131}=4.08, P<.001), while there was no difference between supervisors and registrars intending to participate passively (t_{131}=0.02, P=.99).

A multivariate generalized linear regression model was developed using *intention to use actively* as the dependent variable, as active use is the most important driver in establishing an online community. Variables of age, training stage, gender, rurality, and usefulness were included. Perceived usefulness was the only factor significantly predictive of intention to use the network actively (F_1= 29.46, P<.001).

Health Virtual Community of Practice Framework Step 4: A Broad Church

> *Consider involving different, overlapping but not competing, professional groups, different organisations and external experts. However make sure the church is not too broad... [20]*

Respondents were supportive of a broad church of participants. The inclusion of all medical clinicians within the training provider, including GP registrars, supervisors, and medical educators, was highly supported (see Figure 1), with much less support for the involvement of administrators.

There was also much less support for participation from groups outside the training provider, including specialists, students, academics, allied health professionals, and external registrars

(see Figure 2). However, registrars (mean 0.63, SD 0.49) were significantly more likely than supervisors (mean 0.30, SD 0.46) to want allied health professionals (t_{131}=3.93, P<.001). Further, registrars (mean 0.57, SD 0.50) were also significantly more likely than supervisors (mean 0.33, SD 0.48) to want specialists in the network (t_{131}=2.77, P=.01).

Figure 1. Percentage of respondents supporting participant involvement within training provider. GP: general practice.

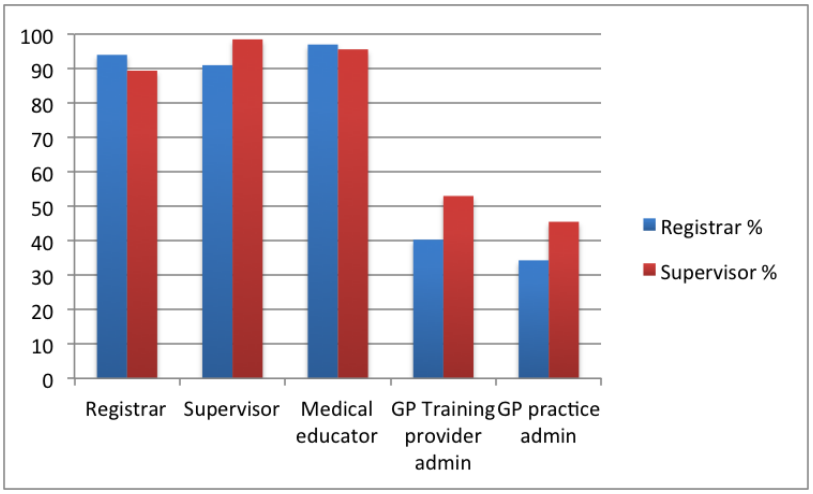
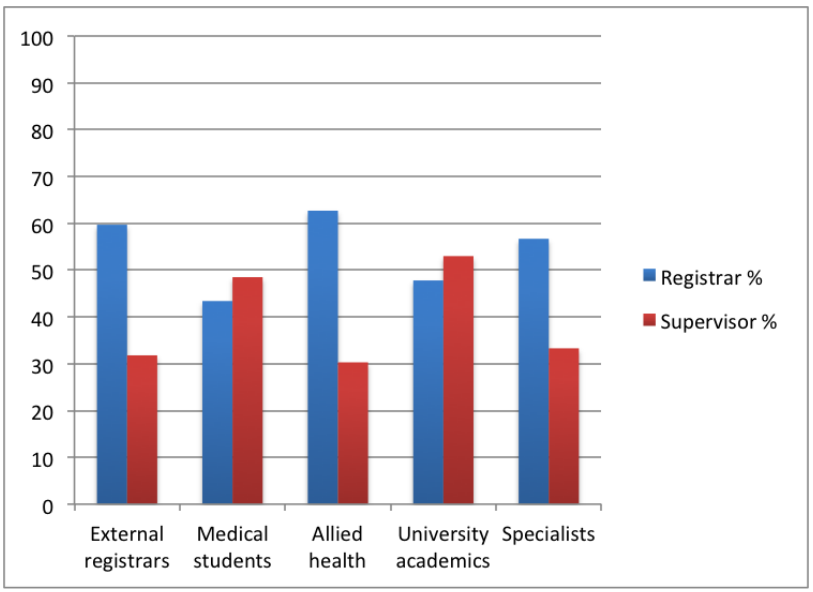


Figure 2. Percentage of respondents supporting participants outside training provider.



Health Virtual Community of Practice Framework Step 5: A Supportive Environment

> *Health VCoPs should promote a supportive and positive culture that is both safe for members, and encouraging of participation. [14]*

Respondents were asked about the aspects that would keep them participating in an online network, including content quality, strength of relationships, financial rewards, continuing education points, and an online points system. Respondents rated the quality of online content as their first preference (mean 4.20, SD 0.63), and their second preference was the strength of the online interaction (mean 3.98, SD 0.73). The preferences in both the registrar and supervisor groups were the same.

Health Virtual Community of Practice Framework Step 6: Measurement Benchmarking and Feedback

> *Health VCoPs should consider measurement as a factor in their design, including benchmarking and feedback.[20]*

Receiving emails from the community, such as comments, updates, and responses to posts, is termed *feedback* in this context. This feedback can be a useful method of users benchmarking their own knowledge against that of other users, by being directed to updates and responses.

When asked how often respondents would like to be notified that another member had added information, registrars wanted notifications more frequently than supervisors. As shown in Table 2, for registrars, the most common frequency periods for notifications were 1-2 times a week, followed by fortnightly, and then 3-4 times a week. The largest group of supervisors

wanted to be notified monthly, followed by 1-2 times a week, and then fortnightly.

Registrars also wanted more frequent notification than supervisors for comments being made on a topic that they had posted. Around half (34/67, 51%) of the registrars wanted to be notified every time a comment was made, compared with only 40% (26/65) of supervisors.

Health Virtual Community of Practice Framework Step 7: Technology and Community

> *Online CoPs should ensure ease of use and access, along with asynchronous communication. Other options including chat and meetings can also be considered, along with the need for training. Communities are more likely to share knowledge when there is a mixture of online and face-to-face meetings, members self-select, and both passive and active users are encouraged. [20]*

Communities of practice rely on experts and novices sharing knowledge. Respondents were asked how comfortable they were sharing their knowledge. Registrars and supervisors were both comfortable sharing knowledge with colleagues in the training program, although *t* test analysis showed that supervisors (mean 4.32, SD 0.50) were significantly more comfortable than registrars (mean 4.06, SD 0.42; t_{131}=-3.2, *P*=.002).

VCoP research states that knowledge sharing is best achieved by a mixture of face-to-face and online interaction [16]. As shown in Table 3, results from this study were consistent with VCoP research, as the most common method was a mixture, followed by face-to-face, and then online only. Similar results were found for receiving professional support, with most preferring a mixture of face-to-face and online, followed by face-to-face, or online only.

Table 2. Comparisons between registrars and supervisors on notifications from the site.

Question	Registrar, n (%)	Supervisor, n (%)
How often would you like to be notified that another member had added information? (registrar n=67; supervisor n=66)		
Every day	3 (5)	10 (15)
3-4 times/week	12 (18)	8 (12)
1-2 times/week	29 (43)	20 (30)
Fortnightly	17 (25)	16 (24)
Monthly	5 (8)	21 (32)
Would you like to be notified every time a comment is made on a topic that you have posted on? (registrar n=67; supervisor n=65)		
Yes	34 (51)	26 (40)
No	12 (18)	24 (37)
Not sure	21 (31)	15 (23)

Table 3. Preference for site-related material, support, and knowledge (N=133).

Question	n (%)
How would you like to share knowledge?	
Purely face-to-face	20 (15.0)
Purely online	9 (6.8)
A mixture of online and face-to-face	104 (78.3)
How would you prefer to receive professional support?	
Purely face-to-face	17 (12.8)
Purely online	6 (4.5)
A mixture of online and face-to-face	110 (82.7)

Building trust is also important for sharing knowledge. Respondents indicated they were significantly more likely to build trust with other members of their knowledge-sharing community through face-to-face interaction (see Table 4), with no significant difference between registrars and supervisors. In contrast, for simple information transfer such as *help topics*, respondents significantly preferred online delivery to formal face-to-face training.

In terms of the technology used, the most popular feature was shared documents and guidelines, followed by general discussion forums, private subdiscussion groups, email mailing list, videoconferencing, and lastly live chat (see Table 5). The preferences were identical between the groups.

Table 4. Preferred methods of building trust and receiving training.

Preferred methods		Mean (SD)[a]
Preferred method for building trust		
	Face-to-face (N=132)	4.19 (0.67)
	Online (N=133)	3.69 (0.80)
Preferred method of training to use the platform (N=132)		
	Formal face-to-face training	2.92 (1.33)
	Online help (text and images)	3.59 (1.09)

[a]Likert scale ranges from 1 (not important) to 5 (very important).

Table 5. Most desirable features for an online training network (N=133).

Preferred features for the technology	Responses, n	Mean (SD)
Shared documents	131	4.01 (0.82)
Discussion forum (all)	132	3.52 (0.97)
Discussions (private)	130	3.22 (1.01)
Email listservs	130	3.10 (1.13)
Videoconferencing	131	2.90 (1.17)
Live chat	131	2.47 (1.19)

When asked for preferences on site usernames, the most popular choice was to use their own name followed by a choice of pseudonym or real name, then using a pseudonym only (see Table 6). Results also show that having a private password-protected site was the clear preference, compared with no password (see Table 6).

Table 6. Preference for usernames and passwords for an online training network (N=133).

Preferences for usernames and passwords		n (%)
Site username preference		
	Own name	65 (48.9)
	Pseudonym	5 (3.8)
	A choice	63 (47.7)
Should the site be password protected?		
	Yes	120 (90.2)

Finally, to further examine the knowledge-sharing needs of registrars and supervisors, participants were asked about the perceived knowledge needs of registrars. The topics covered 14 broad areas of the curriculum for the first 6 months of GP training. Respondents were asked to rate each topic according to how much help GP registrars needed, firstly, in knowing guidelines and, secondly, in implementing guidelines.

Both groups agreed that registrars needed help with their knowledge of topics, but on a combined measure, supervisors felt more strongly that registrars needed help than did the registrars (see Table 7). This pattern was the same with a combined measure for the implementation of knowledge. Supervisors agreed more strongly than registrars that registrars needed assistance. Overall, both groups agreed that the need for support for knowledge acquisition was more important than the need for support regarding the implementation of knowledge, although the absolute difference was small (see Table 8).

Table 7. Knowledge of topic areas covered in the first 6 months of general practice training in Australia.

Support needed for registrar learning	Registrars, mean (SD)	Supervisors, mean (SD)	Mean difference	*P* (*t* test)
Need help with knowledge	3.54 (0.80)	4.37 (0.83)	0.83	.01
Need help with implementation	3.59 (0.81)	4.29 (0.50)	0.70	<.001

Table 8. Difference between perceived help needed by registrars for knowledge support versus support for implementation of knowledge.

Support needed for registrar learning	Mean (SD)	Mean difference (SD)	*P* (*t* test)
Need help with knowledge	4.02 (0.76)	0.10 (0.44)	<.001
Need help with implementation	3.92 (0.80)		

When looking at the scores of the 14 individual topics, supervisors and registrars rated the importance of topics differently. For example, supervisors gave *knowledge of consultation management* the highest score of importance out of the topics, while registrars gave it the lowest importance score. Administration and compensable injury consultations were in the top five importance scores for both groups.

Discussion

Principal Findings

From these results, it is evident that the findings of the health VCoP framework [20] are relevant to the establishment of a VCoP for GP training. However, the results of this study suggest useful additions to some of the steps that will inform the development of an implementation plan for a GP training network using this approach.

The survey results were supportive of a facilitator for the network, in particular a topic expert. The importance of a facilitator is in keeping with previous literature reviews [22,23], and the recent HOBE study in Spain [17]. In the HOBE study, over 5000 primary care providers were invited to participate in a VCoP to encourage innovations in practice. Facilitation was a key factor in the success of the network. The facilitator in the HOBE network was not necessarily a topic expert, yet the desire for a topic expert fits with CoP theory, in which there is a knowledge gradient between experts and novices [6].

However, topic expertise is not the only desirable attribute in facilitators. In *Step 5: A Supportive Environment*, the quality of the relationships with other members and the supportive culture of the network were also seen as important motivators for use. The establishment of this culture is largely the responsibility of a facilitator, who can moderate posts and ensure the tone of interactions is respectful and appropriate [22]. Thus, the role of a facilitator can be demanding because building trust and administering the network are as important as sharing knowledge. The high demands of the role were anticipated by two participants in this study who commented that the facilitator should either be “someone with plenty of time” or “the role should be rotated.” When implementing a GP training network, facilitation needs to account for the demands of administration, maintenance of a supportive culture, and provision of some topic expertise. It may also be desirable to share these roles among different facilitators.

The establishment of clear goals for a VCoP is seen as an important motivator for uptake [16]. In the HOBE study [17], primary care providers in Spain were invited to a VCoP for the Basque region with the agreed-upon goal of developing and implementing innovations in primary care. As a result, a range of innovations were developed and then implemented. In this study, some specific goals such as *helping registrars to pass exams* and *learning how to put guidelines into practice* were deemed important. However, factor analysis showed that this group of goals could be seen as a single factor, which was labeled *usefulness for training*. The generalized linear regression showed that this *usefulness* factor was the key independent predictor of intention to actively use the network. Thus, it appears that the network should be useful for training as its overall goal, rather than focusing only on, for example, passing exams. The review of the comments by users showed that this usefulness largely fell into two categories of training support: support for knowledge transfer and professional support to overcome isolation. These two concepts are likely linked because barriers to knowledge sharing, such as time, geography, and the structure of the workplace, can lead to professional isolation [3].

The importance of perceptions of usefulness as drivers of intention to use is consistent with the technology acceptance model, in which uptake of a technology is driven by its perceived usefulness, and usefulness as a driver is even stronger than ease of use [24]. Perceived usefulness was higher among GP registrars than supervisors, as was their intention to use a VCoP for training purposes. This finding is in keeping with a previous study in which intention to use a VCoP for GP training was shown to be independently linked to the training level of the registrar, with the most junior registrars indicating the highest intention to use the VCoP [18]. However, the finding contrasts in some ways with a US study in which social media usage by doctors was associated with being younger, male, and having teaching hospital privileges [25]. Although the study explored a different set of technology tools, the contrasting findings suggest there is more to learn about the factors affecting adoption of technology tools by doctors. Finally, the quality of the content was seen as an important driver for use of the VCoP. This suggests that the quality of the content may influence the perception of usefulness. Whether the relation between the uptake of social media and an intention to use technologies for training purposes can be explained by training stage, age, quality of content, or other variables requires further investigation. However, understanding what is perceived as useful for the target participants of a VCoP remains a key factor in VCoP design.

Therefore, in the establishment of a VCoP for GP training it will be important to focus on the usefulness for supervisors and registrars. Supervisors may need more convincing about the usefulness of the VCoP than registrars and in fact the VCoP may ultimately be more useful for registrars than supervisors. However, promoting the perception of usefulness to the potential participants may encourage uptake. The perceived usefulness will rest on clear goals of improved support for knowledge sharing and overcoming professional isolation. It may even be that supervisor perception of usefulness could increase if registrars use such a VCoP and find that it achieves these goals.

A broad church of users is acknowledged as an important factor for success from the literature [6,16] because a knowledge gradient is important to effective knowledge transfer. In this study, this breadth was supported by respondents, with both registrars and supervisors clearly favoring the inclusion of all levels of GP registrars and supervisors. However, the inclusion of specialists and allied health professionals was more favored by registrars than supervisors. This disparity may be a reflection of different expectations of supervisors and registrars. Registrars may feel that specialized providers will give them more knowledge; however, supervisors may feel that they, as senior GPs, are the best providers of the types of knowledge that a GP in training will need. This difference in expectation between registrars and supervisors was also evident in the different ranking of levels of support needed and the topics of need. Although there were significant differences between registrars and supervisors for some topics (eg, cardiology), the overall trend was for topics with a large *tacit* knowledge component to be ranked more highly. Topics such as managing a consultation, compensable injury medicine, and certifying someone as fit to drive all involve a high degree of *know-how* (ie, tacit knowledge), as well as *know-what* (ie, explicit knowledge). The transfer of tacit knowledge is seen as a particular strength of VCoPs, in which knowledge is not only imparted, but is discussed and subsequently implemented in a user's practice, rather than simply being passed on [26]. When implementing a VCoP for GP training, important elements will include the exact breadth of the *church*, the alignment of knowledge needs and expectations among participants where possible, an acknowledgement of different needs for different groups where needs do not align, and a focus on the benefits of tacit knowledge transfer.

According to the health VCoP framework, another important aspect of a VCoP for health is *Step 7: Technology and Community*. From this study, the preference for a mix of face-to-face and online interactions was highlighted by the difference between building trust and meeting training needs. Most respondents preferred to build trust face-to-face, but the reverse was true for training, with respondents largely preferring online training. This is supported by the literature in which participants are more likely to build trust online through prior face-to-face contact [26]. Online environments are sometimes seen as more impersonal, as facial cues and body language can be missed, making it more difficult to build trust [27]. It has been suggested that online trust building may be improved by creating trust in the organization through integrity and openness [26]. There may also be a role for improving trust by transmitting body language and facial cues with emerging applications such as video chat. In contrast to this, training online is quite appropriate for information transfer, which can efficiently take place online when required. The need to build trust online perhaps also explains the preference for users to use their own names and have a private, password-protected site, rather than an open, pseudonym-based site. When implementing a VCoP for GP training, help and basic information may be provided online, but trust will ideally be built face-to-face, augmented potentially by video applications and the credibility of the network itself.

Conclusions

The findings of the health framework for VCoPs are relevant when developing an implementation plan for a VCoP for GP training. The implementation plan should involve following the seven steps of facilitation: stakeholder engagement, developing clear goals, engaging a *broad church* of users, creating a supportive environment, using benchmarking and feedback, providing a range of online tools, and establishing online and face-to-face community engagement to transfer knowledge and build trust. Some additional considerations are that the facilitator role may be split between several members to provide administrative as well as expert support, training can be online but trust may be better off initially built face-to-face, and knowledge expectations and needs of supervisors and registrars need to be aligned where possible and addressed separately where needs differ. Most importantly, such a network needs to provide high-quality content and be perceived as useful to drive usage. All of these steps aim to drive uptake of the network and facilitate knowledge sharing, thus improving connectedness and overcoming professional isolation.

The sharing of knowledge to overcome professional isolation and improve connectedness is a useful goal for a VCoP. GP training can be isolating, leading to issues of workforce retention in rural areas. If professional isolation can be overcome, this may assist with the training and ultimately the retention of rural and regional general practitioners. This has broader implications beyond the training of rural general practitioners in Australia; this may inform training of medical specialists and allied health professionals as they rotate through regional placements, both in Australia and in other countries attempting to train and retain health professionals across a wide geography.

Limitations

There are a number of limitations to this study. Firstly, the study was conducted in a single regional training provider. This may introduce bias around demographics and geography which could limit the generalizability of the findings. However, in terms of rural and urban comparisons, the study participants were evenly distributed across rural and urban areas, with no significant differences found based on rurality, so this may improve the confidence in the external validity of the studies.

Secondly, the response rate for the surveys was 40%, but the overall numbers were modest. Response rates to physician surveys are often lower than those for nonphysicians, but the response rate here is still a little lower than the 40-50% quoted in a review of physician response rates [15]. This lower response rate may mean that there is self-selection bias, with users more interested in this area more likely to response to a survey, and thus the generalizability of the results may be affected. Methods to improve response rates were used, including a personal message from the author and a nonmonetary incentive; however, the literature notes that monetary incentives and shorter questionnaires have higher response rates, and the questionnaires in this study were quite lengthy [15].

There may be a self-selection bias in this study, as it was a study regarding online attitudes and the survey was distributed via email with a survey link. This online distribution method may

have encouraged responses from users with higher baseline levels of confidence with online communication. In spite of this potential bias, the overall levels of confidence and usage were at least in keeping with, if not below, the levels found in some comparative studies, such as a recent study on social media usage among physicians in the United States [16], indicating that any bias may not be large.

Finally, it is important to acknowledge the dynamic nature of technology. Since this survey was conducted in October 2011, new versions of technology tools have been developed with increasing functionality. The technology knowledge and skills of medical practitioners has also evolved during this period. The finding should, therefore, be read with this in mind. Despite this, the tools discussed in this study remain the foundation of many online interactions and the conceptual model we discuss can be applied to any set of technologies.

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Authors' Contributions

SB (Stephen Barnett) designed the survey and carried out the majority of the analysis and writing. SJ assisted with survey design, analysis, reviews and amendments to the paper, and final approval. SB (Sue Bennett) assisted with survey design and drafts of the paper. DI assisted with survey design, analysis, and amendments to the paper. LR performed initial data analysis and was involved in drafting the manuscript. All authors reviewed and approved the final manuscript.

Conflicts of Interest

Funding was provided for this study by Coast City Country General Practice Training. The first author (SB) is the Medical Director of e-healthspace, an online community for doctors.

Multimedia Appendix 1

Study survey given to participants.

[PDF File (Adobe PDF File), 169KB - mededu_v2i2e13_app1.pdf]

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Abbreviations

CCCGPT: Coast City Country General Practice Training
CoP: community of practice
GP: general practice
IT: information technology
VCoP: virtual community of practice

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Original Paper

Teaching Shared Decision Making to Family Medicine Residents: A Descriptive Study of a Web-Based Tutorial

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Abstract

Background: DECISION+2, a Web-based tutorial, was designed to train family physicians in shared decision making (SDM) regarding the use of antibiotics for acute respiratory infections (ARIs). It is currently mandatory for second-year family medicine residents at Université Laval, Quebec, Canada. However, little is known about how such tutorials are used, their effect on knowledge scores, or how best to assess resident participation.

Objective: The objective of our study was to describe the usage of this Web-based training platform by family medicine residents over time, evaluate its effect on their knowledge scores, and identify what kinds of data are needed for a more comprehensive analysis of usage and knowledge acquisition.

Methods: We identified, collected, and analyzed all available data about participation in and current usage of the tutorial and its before-and-after 10-item knowledge test. Residents were separated into 3 log-in periods (2012-2013, 2013-2014, and 2014-2015) depending on the day of their first connection. We compared residents' participation rates between entry periods (Cochran-Armitage test), assessed the mean rank of the difference in total scores and category scores between pre- and posttest (Wilcoxon signed-rank test), and compared frequencies of each. Subsequent to analyses, we identified types of data that would have provided a more complete picture of the usage of the program and its effect on knowledge scores.

Results: The tutorial addresses 3 knowledge categories: diagnosing ARIs, treating ARIs, and SDM regarding the use of antibiotics for treating ARIs. From July 2012 to July 2015, all 387 second-year family medicine residents were eligible to take the Web-based tutorial. Out of the 387 eligible residents, 247 (63.8%) logged in at least once. Their participation rates varied between entry periods, most significantly between the 2012-2013 and 2013-2014 cohorts (P=.006). For the 109 out of 387 (28.2%) residents who completed the tutorial and both tests, total and category scores significantly improved between pre- and posttest (all P values <.001). However, the frequencies of those answering correctly on 2 of the 3 SDM questions did not increase significantly (P>.99, P=.25). Distribution of pre- or posttest total and category scores did not increase between entry periods (all P values >.1). Available data were inadequate for evaluating the associations between the tutorial and its impact on the residents' scores and therefore could tell us little about its effect on increasing their knowledge.

Conclusion: Residents' use of this Web-based tutorial appeared to increase between entry periods following the changes to the SDM program, and the tutorial seemed less effective for increasing SDM knowledge scores than for diagnosis or treatment scores.

However, our results also highlight the need to improve data availability before participation in Web-based SDM tutorials can be properly evaluated or knowledge scores improved.

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KEYWORDS

decision making; patient participation; education, medical, graduate; educational measurement; program evaluation; computer-assisted instruction

Introduction

Acute respiratory tract infections (ARIs) are the main cause of consultation in family medicine units in North America [1]. Despite numerous evidence-based guidelines [2-8] demonstrating that antibiotics are ineffective for treating most ARIs [9-12], primary care physicians seem unable to break the habit [13,14]. Widespread overuse of antibiotics for treating ARIs ultimately creates antibiotic resistance [15,16]. In a shared decision making (SDM) approach, health professionals explain the risks and benefits of the available treatment options to patients based on the best available scientific data and take into account patients' values and preferences before making the treatment decision together [17,18]. Over the years, SDM has been recognized as an effective strategy for reducing the overuse of treatment options not clearly associated with benefits for patients [19]. Despite the willingness of policy makers in many industrialized countries to implement SDM in their health care systems, implementation has not been widespread in clinical practice [20], and few medical curricula include SDM training [21,22]. For this situation to change, SDM should be taught as early as possible in medical training and also as part of continuing education programs [23-25].

Web-based learning has become an increasingly popular approach to medical education [26,27] and is now ubiquitous in university education [28]. Although some have raised concerns about its effectiveness [27], Web-based learning modules have proved to be efficient in targeting many types of health professionals [26,29,30] for various purposes, including reducing the overuse of antibiotics. Little et al [30] recently conducted a study to assess the impact of a Web-based training intervention that aims to optimize the prescription of antibiotics for ARIs among general practitioners in 6 European countries. Their training program showed that Web-based training to enhance communication skills significantly contributed to a decrease in the prescription of antibiotics for treating ARIs. Although they did not focus specifically on SDM, there is widespread consensus that risk communication skills are one of its most important components [31]. Web-based programs have also been shown to be popular among residents. In 2005, Cook et al led a randomized controlled trial to find out whether there was a difference in internal medicine residents' preferences between a Web-based module and printed materials and the level of knowledge achieved [26]. They found that the participants preferred the Web-based module because it saved time and concluded that Web-based learning was effective, well-accepted, and efficient [26].

In 2010, our team developed a multicomponent intervention (DECISION+2) for family medicine residents at Université Laval and for all health care professionals in the university's family practice training units (FPTUs) [25,32]. Its final version contained a Web-based tutorial entitled "Shared decision making to treat ARI," a 2-hour workshop in the form of a classroom course, and a decision aid. The impact of the full DECISION+2 was assessed as part of a cluster randomized trial that included 9 FPTUs and first- and second-year residents [33]. The results of this study showed that DECISION+2 contributed to reducing the number of patients deciding to use antibiotics for ARIs by facilitating their involvement in the treatment decision (to take antibiotics or not). The Web-based tutorial is currently mandatory for second-year family medicine residents at Université Laval, Quebec, Canada.

The potential of Web-based learning as an instructional tool for medical education has been recognized for many years [34,35]. However, little is known about how effective Web-based learning is for increasing SDM knowledge among physicians [36], how to evaluate usage and participation, and what kind of data are needed for these purposes. The objectives of this study were, therefore, to (1) describe the use of this Web-based training platform by the family medicine residents over time and its effect on knowledge scores (primary outcomes) and (2) note any gaps in data available for these purposes (secondary outcome).

Methods

The Web-Based Tutorial

The SDM training program has changed twice over 3 years. It was introduced in the family medicine residency program in 2011 as a multicomponent program: a Web-based tutorial entitled "Shared decision making to treat ARI," a 2-hour workshop in the form of a classroom course, and a decision aid. However, the 2-hour workshop was withdrawn after the 2012-2013 residency period, leaving only the Web-based tutorial and the decision aid. The rationale for this removal was the time constraints in the residents' schedule. Before July 2014, the Web-based tutorial contained 5 modules including information about diagnosis, treatment, and key components of the SDM process in the treatment of ARIs in primary care. After the 2013-2014 residency period, a sixth module on integrating the knowledge acquired in the first 5 modules was added. This addition also integrated parts of the workshop that had been removed 1 year earlier. Figure 1 shows a timeline of the major modifications made over the 3 residency periods.

The SDM tutorial was offered to all second-year residents in the entire network of 12 FPTUs of the Department of Family Medicine and Emergency Medicine at Université Laval, Quebec, Canada. This tutorial is one of the several tutorials available

via the intranet on the department's Web platform. At the beginning of their second year of residency, residents were given the link and invited to complete the tutorial and the pre-posttests over the course of the year. On the Department home page, residents entered their student identification number and password to access the tutorial. Then, they encountered a brief description of the tutorial before starting it (Textbox 1) [33]. The tutorial included videos, exercises, a link to access the decision aid, and a pre-post knowledge test. This tutorial was designed to be completed in 2-3 hours. It was required as part of the family medicine curriculum but not specifically evaluated. However, at the end of their residency, residents were examined on all the subjects they learned via the intranet.

Textbox 1. DECISION+2, a Web-based self-tutorial in shared decision making.

Module 1: Introduction

- Introduce the shared decision-making process and acute respiratory infections

Module 2: Diagnostic probabilities

- Know the most useful signs and symptoms for the diagnosis of acute respiratory infections
- Integrate notions of diagnostic probabilities
- Know how to use diagnostic tools

Module 3: Treatment

- Know evidence on the effects of antibiotics in treating acute respiratory infections
- Integrate the concepts of probability associated with the effects of antibiotics in treating acute respiratory infections
- If the option for antibiotics is selected, choose which one

Module 4: Effective communication of risk and benefits

- Understand the essential elements of effective communication of treatment options and their benefits and risks
- Use the communication tool on the benefits and risks associated with using antibiotics or not to treat acute respiratory infections

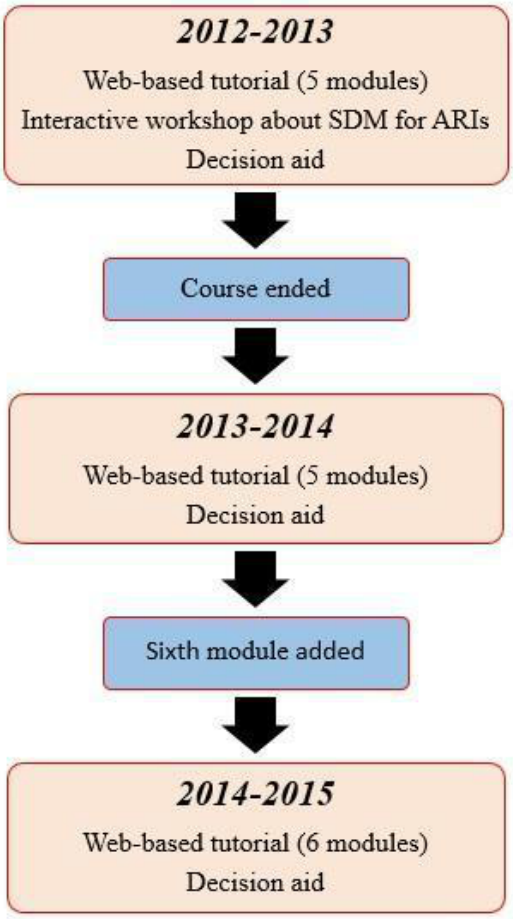
Module 5: Promoting active patient participation

- Ask questions related to patient preferences and values, such as questions regarding their concerns about the benefits and risks associated with taking antibiotics or not
- Use a visual tool to help patients clarify their values and preferences about the benefits and risks associated with taking an antibiotic or not
- Verify patient comfort with the decision made

Module 6 (added after July 2014): Integrate all acquired knowledge

- Estimate diagnostic probabilities
- Effectively communicate the benefits and risks
- Identify the values and the preferences of the patient
- Promote an informed choice based on the best evidence available and that reflects what is important for the patient

Figure 1. History of Université Laval SDM training program between July 2012 and July 2015. SDM: shared decision making; ARIs: acute respiratory tract infections.



Participants

We included all second-year family medicine residents in the Department of Family Medicine and Emergency Medicine at Université Laval from July 2012 to July 2015 who logged in on the department's Web platform to register for the tutorial, whether they completed it or not. Residency begins on July 15 of each year.

Data Collection

To describe the participation in and usage of the DECISION+2 Web-based tutorial used to teach SDM at Université Laval and its effect on knowledge scores, we collected all available data about (1) its content and scoring system; (2) its history and the incentives offered for undertaking it; (3) residents' participation in and usage of the tutorial; and (4) changes in their pre-post test scores. In observing the history of the SDM program, we noted any changes made to it and the reasons for change. Data for tutorial registrations between July 2012 and July 2015 were extracted from department's Web platform. Data included identification number of each registrant, date of the first and last connection, frequency of connection, total time spent on the tutorial, and answers to each of the pretest and posttest questions. With the connection frequencies we were able to determine how many registered residents started the tutorial. Residents who logged in were separated into 3 entry periods (2012-2013, 2013-2014, and 2014-2015) depending on the day of their first connection to the tutorial. For example, a resident who logged in to the tutorial on March 23, 2013, was classified in the 2012-2013 cohort because he or she began between July 15, 2012, and July 14, 2013. We considered the tutorial as completed if the residents answered all the pretest and posttest questions.

The knowledge test used for the pretest and the posttest contained 10 multiple-choice questions and was only available in French (Université Laval is a French-language university). It was based on information in the tutorial and contained key elements considered by the authors as essential knowledge for the practice of SDM regarding the use of antibiotics for treating ARIs. Some questions were multiple response while others were single response, and participants did not know which kind they were answering. Four questions were concerned with diagnosis (all single response), 3 were concerned with treatment (2 single response and 1 multiple response), and 3 were concerned with SDM (1 single response and 2 multiple response; Multimedia Appendix 1). The knowledge scores were displayed as follows: for single response items, 1 point for a correct answer and 0 points for any incorrect answer; for multiple response items, 1 point if all answers were correct and 0 if any answer was missing or incorrect. The maximum score was 10 points. Residents could only see their scores at the end of the posttest questions.

Statistical Analysis

We performed simple descriptive statistics including frequencies, median, and interquartile range (minimum and maximum) to summarize characteristics and modalities of use among all family medicine residents who logged in to the Web-based tutorial, and to understand how residents used the tutorial. Also, we estimated proportions of family medicine residents, per period, who logged in to the tutorial, did the pretest only, did the posttest only, or did both. The Cochran-Armitage test for trend was performed to test the change in proportions of family medicine residents who logged in over time. Because the knowledge score was an ordinal variable and did not respect the normality assumption, we used nonparametric tests. To describe the change in the level of knowledge among those who completed the tutorial, we used Wilcoxon signed-rank test to identify significant pre- or posttest differences between the total scores and scores on each of the 3 knowledge categories (diagnosis, treatment, SDM). This kind of test is used especially for paired samples. We used McNemar test to measure if residents answered the questions correctly after doing the tutorial. Finally, the distribution of knowledge total scores and category scores between periods were compared using Mann-Whitney U test. We considered a difference statistically significant when the *P* value was <.05. We performed statistical analysis using the SAS version 9.4 (SAS Institute Inc).

Ethics

As the study was supported by the institution where it was performed, no ethical approval was requested because the Web-based tutorial was part of an academic program and data were provided anonymously.

Results

Participants' Use of the Tutorial

All 387 second-year family medicine residents were eligible to take the Web-based tutorial. Out of the 387 residents, 247 (63.8%) logged in to the Web-based tutorial. Among the 247 who logged in, 109 (44.1%) completed both the pre- and posttest, 95 (38.5%) completed the pretest only, 2 (0.8%) completed the posttest only, and 41 (16.6%) logged in but did not complete either test. In total, only 28.2% (109/387) of all eligible family medicine residents completed the tutorial (Figure 2).

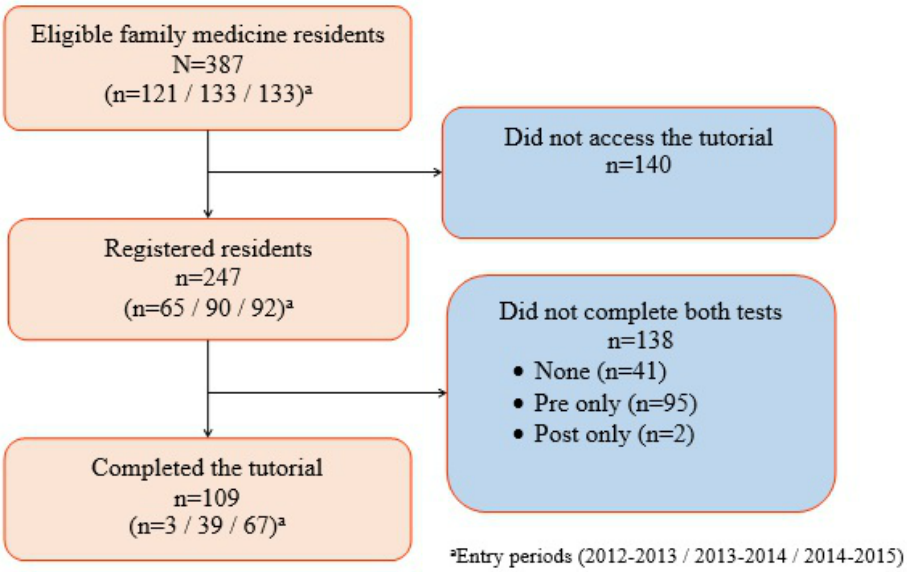
Table 1 shows simple descriptive statistics of participants for the different entry periods. Proportions of women and the median number of connections were similar between cohorts. However, a relative increase in the median of time spent in the tutorial was observed between the 2013-2014 and 2014-2015 cohorts. Also, the proportion of registered residents who logged in to the tutorial per entry period was 53.7% (65/121) in 2012-2013, 67.7% (90/133) in 2013-2014, and 69.2% (92/133) in 2014-2015 (Cochran-Armitage test; *P*=.006). Participation rates increased between each succeeding entry period and seemed more pronounced between the 2012-2013 and 2013-2014 cohorts.

Table 1. Description of the characteristics and modalities of use of family medicine residents who entered the tutorial.

Characteristics	2012-2013 n=65	2013-2014 n=90	2014-2015 n=92	Total N=247
Gender, n (%)				
Female	54 (83)	69 (77)	70 (76)	193 (78)
Male	11 (17)	21 (23)	22 (24)	54 (22)
Number of connections				
Median	2	3	3	2
IQR[a]	(1, 4)	(1, 5)	(2, 4)	(1, 4)
Range	1-7	1-14	1-10	1-14
Total time passed (hours)				
Median	1.54	1.87	2.77	2.22
IQR[a]	(0.09, 2.71)	(0.49, 3.10)	(1.24, 3.87)	(0.38, 3.32)
Range	0.00-10.13	0.00-9.29	0.00-19.98	0.00-19.98
Tests done, n (%)				
None	18 (28)	15 (17)	8 (9)	41 (17)
Pretest only	44 (68)	34 (38)	17 (18)	95 (38)
Posttest only	0 (0)	2 (2)	0 (0)	2 (1)
Pre- and posttest	3 (4)	39 (43)	67 (73)	109 (44)

[a]IR: Interquartile range (Q_1, Q_3).

Figure 2. Flowchart of the participants.



Family Medicine Residents' Knowledge Scores

Twelve out of 109 residents who completed both tests had a posttest score equal to or lower than their pretest score, that is, the percentage of participants whose total knowledge score did not improve was 11%. Table 2 shows the medians and the interquartile ranges in the total knowledge scores and in each category among those who completed the tutorial. The median total knowledge score and each of the 3 category scores improved significantly between the pre- and posttest (Wilcoxon signed-rank test; all *P* values <.001). Table 3 shows the frequencies of those who answered each question correctly pre- and posttest. More participants answered the posttest questions correctly (McNemar test; all *P* values <.01) except for questions 7, 8, and 9 (the SDM category). In addition, low frequencies of those who answered correctly were observed for both pre- and posttest on questions 8 and 9.

Table 2. Medians and interquartile ranges in the knowledge total scores and for each category of those who completed the tutorial.

Category	Pretest, median (IQR[a])	Posttest, median (IQR)	*P* value[b]
All (out of 10)	4 (3-5)	7 (6-8)	<.001
Diagnosis (out of 4)	2 (1-2)	3 (2-4)	<.001
Treatment (out of 3)	2 (1-2)	3 (2-3)	<.001
Shared decision making (out of 3)	1 (0-1)	1 (1-1)	<.001

[a]IQR: interquartile range.

[b]Difference assessed with Wilcoxon signed-rank test. *P* values do not represent the median difference but represent improvement in the mean rank of the difference in scores between the pre- and posttests.

Table 3. Frequencies of those who correctly answered each question.

Category	Pretest, n (%)	Posttest, n (%)	*P* value[a]
Diagnosis			
Question 1	96 (88.1)	106 (97.2)	.008
Question 2	14 (12.8)	64 (58.7)	<.001
Question 3	27 (24.8)	68 (62.4)	<.001
Question 4	41 (37.6)	90 (82.6)	<.001
Treatment			
Question 5	40 (36.7)	101 (92.7)	<.001
Question 6	36 (33.0)	90 (82.6)	<.001
Question 7	100 (91.7)	103 (94.5)	.41
Shared decision making			
Question 8	6 (5.5)	6 (5.5)	>.99
Question 9	9 (8.3)	13 (11.9)	.25
Question 10	66 (60.6)	92 (84.4)	<.001

[a]Tutorial effect assessed with McNemar test.

Table 4. Medians and interquartile ranges in the knowledge total scores and for each category between the 2013-2014 and 2014-2015 cohorts.

Knowledge test	2013-2014, median (IQR[a])	2014-2015, median (IQR)	*P* value[b]
Pretest			
All categories	4 (3, 5)	4 (3, 5)	.17
Diagnosis	2 (1, 2)	1 (1, 2)	.96
Treatment	1 (1, 2)	2 (1, 2)	.11
SDM[c]	1 (0, 1)	1 (0, 1)	.69
Posttest			
All categories	7 (6, 8)	7 (6, 8)	.95
Diagnosis	3 (2, 4)	3 (3, 4)	.45
Treatment	3 (3, 3)	3 (2, 3)	.36
SDM	1 (1, 1)	1 (1, 1)	.98

[a]IQR: interquartile range.

[b]Distribution difference assessed with Mann-Whitney U test. *P* values do not represent the median difference but represent a distribution difference between the 2 entry periods.

[c]SDM: shared decision making.

Table 4 shows the medians and the interquartile ranges, and the *P* values of the 2-sided Wilcoxon rank-sum test performed to verify whether the distribution of total scores and the category scores pre- and posttest were the same between entry periods. The 2012-2013 period was not assessed because only 3 family medicine residents completed the tutorial during that period. All *P* values were greater than 5%, that is, there was no significant difference in the distribution of the total score or in any of the category scores for the pre- and posttests between the 2013-2014 and 2014-2015 cohorts.

Overall, we observed that the data available regarding residents' participation in, use of, and effects of the Web-based tutorial on knowledge scores were limited. For example, sex was the only demographic data available, and data on time spent on the tutorial by residents per connection period, which pages they visited per connection period, and their participation in the classroom workshop were not available.

Discussion

Principal Findings

This study described the residents' use of a Web-based training platform over time and attempted to assess whether the residents' knowledge scores about the diagnosis and treatment of ARIs and SDM regarding the use of antibiotics for ARIs were improved by this Web-based training. It also provided an

opportunity to identify what kinds of data are appropriate for evaluating the usage of the training platform and its impact on knowledge. The main results were that residents' use of the Web-based tutorial increased over time, but not their knowledge scores; residents appeared to perform better on knowledge scores about diagnosing ARIs and treatment options than on SDM; just over a quarter completed the tutorial and one-third did not even start it; and little data appropriate for evaluating the course's effectiveness were available. Our results led us to make 4 main observations.

First, we reported an increase in the participation rate between the 2012-2013 and 2013-2014 cohorts. This improvement could be explained by the removal of the workshop component of the course because 2012-2013 was the last year in which it was offered in addition to the Web-based tutorial. Perhaps family medicine residents saw the Web-based tutorial as an unnecessary addition to the classroom workshop on SDM in their curriculum and saw it as too much time spent on the topic. Some studies suggest that such Web-based tutorials should be brief and not too complex or intensive for medical students [24,37]. Furthermore, the average increase of about 1 hour in the median of the time spent in the tutorial observed between the 2013-2014 and 2014-2015 cohorts could have been caused by the addition of the sixth module. However, the added module was supposed to integrate all the knowledge acquired in the first 5 modules and compensate for the removal of the classroom workshop. We expected to see an increase in the distribution of the knowledge scores (total and per category) between these 2 periods, but this was not the case. Perhaps the inclusion of an additional review module was not relevant and may even have unnecessarily extended the duration of the training. More data would be needed to confirm this.

Second, our results suggested that the Web-based tutorial had a significantly positive effect on knowledge scores about the diagnosis and treatment of ARIs. However, the questions that the most residents failed were in the SDM category. This could be because the questions were poorly written, or it could be due to the nature of SDM. Unlike diagnosis or treatment, SDM is a subject that is inherently antithetical to unidirectional learning—it is about person-to-person communication and sharing information [17,18]. Perhaps Web-based tutorials performed in solitude are not an appropriate platform for teaching some of the essentials components of SDM to family medicine residents, namely presenting options, communicating risks and benefits, and clarifying values of patients. Moreover, knowledge scores may be an inadequate form of evaluation for SDM. However, in a 2013 randomized controlled trial on physician communication regarding prostate cancer screening, Feng et al assessed a 30-minute Web-based module and found, at 3-month follow-up, that the family physicians who used the Web-based tutorial had more shared decision-making behaviors and were more likely to encourage patients to consider different screening options compared with usual education [38]. Together, these results suggested that Web-based learning about SDM needs to be reassessed in further studies. They might also reflect the significant heterogeneity among SDM training programs [39], not only in their content but in their modes of delivery and evaluation of knowledge acquired. In this era of rapidly growing numbers of SDM training programs [40] and national efforts to offer them on the Web platform, the most effective methods of delivery and evaluation urgently need to be standardized.

Third, a difficulty we encountered was inadequacy of data organization or availability at the university level, which made it hard to evaluate the usage of the SDM training and its effects on knowledge. Indeed, the data available were not adequate for evaluating associations between participation in the tutorial and its impact on the residents' knowledge scores. Moreover, no data were available that could inform us about whether the loss of the workshop component of the SDM program caused the increase in residents' use of the tutorial. In addition, although all participants were second-year family medicine residents, we were unable to collect any demographic data on participants except for gender. If we had been able to analyze data extracted from log-in dates, visited pages, and time passed on each page per connection, our interpretation would have been more meaningful. To improve a Web-based training such as this, more information is needed about how the residents use the tutorial, and data collection needs to be adapted to reflect modifications in the program when they take place [41]. With the increase in Web-based interventions, the potential for data extraction is growing exponentially [42]. Moreover, sophisticated data analysis methods already exist that take account of the structure of more complex data such as this [43]. Our findings highlight the need to strengthen partnerships with residency programs so that data are made available in an appropriate form to be useful for evaluation purposes, both by faculties and by researchers.

Limitations

The limitations of this study included contamination by residents who spent more than 1 year completing their second-year residency, and potential confounding variables. Lack of available demographic data compounded these problems. In terms of the tutorial's effectiveness, participants were not classified by FPTU. Therefore, we cannot be sure that belonging to the same FPTU did not influence their answers. Also, participants might have logged in to the tutorial and then, rather than doing the tutorial, left the connection open and done something else for several hours (offline) before disconnecting. This might have distorted the time shown as spent on the tutorial. Finally, the psychometric properties of the pre- and post-knowledge tests had not been validated, and therefore scores might not have been valid, consistent, or reliable.

Conclusions

Residents' use of this Web-based tutorial appeared to increase between entry periods following the changes to the SDM program, and the tutorial seemed less effective in the SDM categories than in the diagnosis and treatment categories. However, to evaluate the use of a Web-based tutorial properly and its impact on knowledge, data collection needs to include the different log-in dates, visited pages, time passed on each page per connection, and more complete sociodemographic characteristics. There is still work to be done to improve data sharing, quality, and availability for evaluation purposes, so that implementation of SDM in the context of antibiotics use for treating ARIs becomes a feature of everyday family practice.

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Conflicts of Interest

None declared.

Authors' Contributions

FL, ML, and MC participated in the concept and design of the study. MD, NTD, HR, and RA participated in data acquisition. MD and ST performed the statistical analysis. All authors were involved in interpretation of the data and critical revision for important intellectual content of the manuscript. MD and FL drafted the manuscript. MD and HR coordinated the study. All authors read and approved the final manuscript.

Multimedia Appendix 1

Knowledge test.

[PDF File (Adobe PDF File), 33KB - mededu_v2i2e17_app1.pdf]

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Abbreviations

ARI: acute respiratory tract infection
FPTU: family practice training unit
SDM: shared decision making

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Original Paper

Considerations for the Telehealth Systems of Tomorrow: An Analysis of Student Perceptions of Telehealth Technologies

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Abstract

Background: While much is known about factors that facilitate telehealth adoption, less is known about why adoption does or does not occur in specific populations, such as students.

Objective: This study aims to examine the perceptions of telehealth systems within a large student sample.

Methods: Undergraduate students (N=315) participated in a survey of the perceived advantages and disadvantages of telehealth technologies. The responses to the survey were analyzed using thematic analysis.

Results: We found that students were likely to adopt telehealth systems for the following reasons: (1) the system worked efficiently, (2) the convenience of telehealth, and (3) to gain access to health services. Students also perceived several disadvantages to telehealth systems, such as issues of trust (ie, security, privacy), the impersonal nature of telehealth systems, and they were concerned about the potential for major system errors.

Conclusion: By understanding the current barriers to telehealth adoption in a cohort of students, we can not only better anticipate the future needs of this group, but also incorporate such needs into the design of future telehealth systems.

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KEYWORDS

telehealth systems; younger adults; telehealth advantages; telehealth disadvantages; thematic analysis

Introduction

Telehealth systems are integral to the exchange of electronic health care information between patients and providers. These systems have also vastly improved access to care, as well as the quality of care received [1-6]. Moreover, telehealth has significantly reduced the cost of health care in many countries [1,7-10]. In one meta-analysis, the impact of telemedicine on the management of chronic diseases (eg, diabetes, hypertension) was overwhelmingly positive [11]. Only two studies in this analysis of randomized control trials (RCTs) (N=148) reported negative effects of telehealth. Because of the success of telehealth technologies, the American Telemedicine Association projects that the usage of these systems is expected to double or triple within the next five years [1,12].

Several theories have aimed to explain the widespread adoption of telehealth technologies. One such theory includes the Health Belief Model (HBM), which suggests that perceived disease threat (PDT) and behavioral evaluation (PB) are key factors in telehealth acceptance [13]. PDT is an individual's perception of the severity of an ailment and the perceived risk associated with that health condition, whereas PB encompasses the steps an individual takes to reduce the likelihood of a particular disease or illness. One drawback of the HBM is that it may only

apply to home-based telehealth systems. In addition, there has been limited replication of this model within the telehealth literature and it is not widely used.

One theory that overcomes some of the issues with the HBM is the Technology Acceptance Model (TAM). The TAM suggests that the adoption of a telehealth system is broadly determined by its perceived usefulness (PU) and perceived ease of use (PEOU). PU and PEOU each consist of several subconstructs related to telehealth technology adoption, including motivation and behavioral intentions [14-16]. Many researchers have extended the TAM by incorporating user trust [17], technology readiness [18], or perceived threat (ie, technology will replace a job) [19]. Since the TAM was first introduced, it has been very successful in predicting telehealth acceptance and adoption (variance accounted for ranges from 50% to 70% in most studies) across many populations (eg, veterans, older adults, etc.) [14-16]. However, the TAM is not without its flaws. For example, more nuanced research on system trust needs to be conducted before this factor can be fully integrated into the TAM, as this literature has yielded mixed results [20,21]. Furthermore, the TAM does not address or incorporate the severity of illnesses or the impact of disease burden into its framework like the HBM. Rather, the TAM suggests that, regardless of disease, most individuals will adopt telehealth systems for reasons of perceived usefulness and usability.

Perceptions of Telehealth Systems in Student Populations

To date and to the best of our knowledge, only one study has previously attempted to measure student readiness to adopt telehealth technologies. In this study, 308 undergraduate nursing students participated in an online survey about their anticipation of interacting with telehealth devices, such as telenursing tablets, telerobots, and teleconferencing [22]. In this survey, they found that 66% of respondents would definitely use a telehealth device in their future careers as nurses, and another 70% believed that telenursing should be incorporated into the educational curriculum. Many students indicated that they viewed telehealth technologies positively and saw these devices as having many advantages. However, specific advantages were not reported within this study.

The Present Study

The goal of the present study is to examine student perceptions of the advantages and disadvantages associated with telehealth systems. By understanding the current barriers to telehealth adoption in a cohort of students, we can not only better anticipate the future needs of this group, but also incorporate such needs into the design of future telehealth systems. One approach to studying the perceived advantages and disadvantages of this cohort is to conduct a thematic analysis.

Methods

Thematic Analyses

A thematic analysis studies the themes, or subthemes, that emerge through open-ended survey items. This technique is used to detect trends in open-ended survey responses and results in a deeper, richer sense of the data. As best stated by Braun and Clarke, “thematic analysis is a useful and flexible method for qualitative research in and beyond psychology” (p2) [23]. With regard to the present study, we elected to use grounded theory, a technique that develops themes based on the pattern and frequency of particular responses [24,25].

First, 2 researchers independently identified themes in a randomized subset of the open-ended responses collected from our sample. The researchers then compared the themes they identified independently and collapsed them into 2 lists: 1 for perceived advantages and 1 for perceived disadvantages. The data was then rated by 2 researchers based on these lists of themes. A particular response could be rated as multiple themes if it contained elements from each of these types of themes (ie, the open-ended comment discussed themes about both usability and trust). The researchers were instructed to rate each individual’s response as containing as many themes as were relevant. If a particular comment did not fall into a theme on either list, it was not rated. The researchers were provided with definitions corresponding to each theme (Table 1).

After all of the responses were rated, Cohen’s Kappa (κ) was calculated as a measure of interrater reliability. Kappa statistics were calculated for perceived advantages (κ= .838) and perceived disadvantages (κ= .896). The agreement between the 2 raters was strong [26,27]. The raters agreed on the classification of the themes approximately 84% to 90% of the time.

Procedures

The survey was administered online via an anonymous link using Qualtrics survey software. After electronically signing the informed consent, participants were asked to read our operationalization of telehealth technology [6]. This ensured that all participants were familiar with telehealth systems and that they could respond to all survey items bearing the entire definition in mind. The definition read as follows:

> *Telehealth is the exchange of medical information from one party to another via electronic communication. It is used to improve a patient’s clinical health and mental health status. Telehealth includes using two-way streaming video, email, smart phones, smart watches, wireless tools, or other forms of electronic telecommunications to interact with a medical professional.* [6]

The entire survey took approximately 30 minutes to complete. Data was collected from January 2015 until June 2015.

Table 1. Definitions of each theme.

Theme or subtheme		Definitions and examples
Advantages		
	Accessibility	Improved access to health services; access to health professionals
	Convenience	Data is stored on the device; readily access data; avoid excess travel
	Efficiency	Quick communication; rapid connection to services
	Affordability	Cost of telehealth is within price range; cost effective
	Anonymity	More disclosure of embarrassing or sensitive health information
	Communication	Better communication with provider; written record of conversation
	Connectedness	Improved relationship with health provider; closeness with provider
	Usability	System is designed well; intuitive; organized; modern interface
Disadvantages		
	Trust	Issues involving privacy and security of health information or data
	Impersonality	Fear of machines replacing health care professionals; less connectedness
	System errors	Fear of misdiagnosis; test results are not credible; loss of health information
	Communication	Greater chance of miscommunication; asynchronous response/feedback
	Affordability	Cost of telehealth is out of price range; not cost effective

Measures

Demographics

Items related to student health status included items about mental health, chronic disease, and any other medical complications participants could be experiencing at the time of the survey. Since this information is very sensitive, participants were reminded that they did not have to respond to these questions if they felt uncomfortable. Additional demographic information (eg, age, gender, nationality, etc.) was collected at the end of the survey. Demographic items were administered at the end of the survey to reduce any possible cognitive bias (ie, mental health conditions are still perceived negatively and this could in turn effect how students with a mental illness respond to health-related items).

Open-Ended Survey Items

Two open-ended survey questions were asked during a larger replication study on health and technology. The first open-ended survey item was related to advantages. It read as follows: “Why would you use the telehealth device again in the future?” The second open-ended survey item was related to the perceived disadvantages of telehealth systems. It read as follows:

Why would you not use the telehealth device again in the future? Do you have any concerns about interacting with a telehealth device again in the future?

Participants

To be eligible to participate in the survey, participants had to have interacted with a telehealth device within the past year and specify the name of said device. Participants were awarded course extra credit for completing the survey, which could be applied to a psychology course in which they were enrolled. All participation was voluntary. The University of Central Florida Institutional Review Board approved all procedures and materials used in this study.

In total, 315 undergraduate students (108 male; 206 female; 1 transgender) between the ages of 18 to 49, with a mean (SD) of 20.69 (4.03) years and a median of 19.00 years, met the above study criteria and were recruited from the psychology research participation system at the University of Central Florida. Of these 315 students, 295 (96.7%, 295/315) responded to the advantages open-ended item and 303 (96.2%, 303/315) responded to the disadvantages open-ended item, which were part of a larger study replication on health and anticipated technology usage (the results of this study are published elsewhere) [28]. The larger study consisted of 2 measures (40 items on health technology engagement; 26 items on the psychological impact of assistive devices), open-ended response questions, and participant demographics.

Results

Descriptive Statistics

Generally, our sample was healthy and reported exercising at least once per week for 30 to 60 minutes (on average). Most participants reported that they did not have a mental health concern arise within the past year. Few participants reported a chronic or acute medical condition. All demographic information is reported in Table 2.

Table 2. Participant demographics (N=315).

Item		Students, n (%)
Gender		
	Female	206 (65.3)
	Male	108 (34.3)
	Transgender	1 (0.3)
Age, years		
	18-25	288 (91.4)
	26-35	21 (6.6)
	36-45	5 (1.5)
	46-55	1 (0.5)
Nationality		
	African/African American	20 (6.3)
	Asian/Asian American	25 (7.9)
	Anglo/Caucasian	201 (63.8)
	Hispanic/Latina(o)/Chicana(o)	49 (15.6)
	Alaskan native/native American	2 (0.6)
	Biracial/multiracial	14 (4.4)
	Other	4 (1.3)
Major[a]		
	Health-related[b]	132 (42.9)
	Non health-related[c]	176 (57.1)
Year in college[d]		
	First year	120 (38.1)
	Second year	72 (22.9)
	Third year	65 (20.6)
	Fourth year	56 (17.8)
Exercise		
	Not at all	65 (20.6)
	1-2 times per week	115 (36.5)
	3-4 times per week	70 (22.1)
	5+ times per week	65 (20.6)
Mental health problems		
	Yes	56 (17.5)
	No	259 (82.5)
Health problems		
	Chronic	93 (29.5)
	Acute	5 (1.6)
	None	217 (68.9)

[a]Seven participants did not respond to the item related to their degree.

[b]Health-related majors include degrees related to biomedical sciences, pre-medicine, nursing, etc.

[c]Non health-related majors include engineering, drama, communication, etc.

[d]Two participants did not indicate their year in school.

Perceived Advantages of Telehealth Systems

Of the students, 295 responded to the advantages item. Thematic analysis of the advantages open-ended item resulted in the generation of 3 overarching themes, as well as several subthemes. The themes that emerged from these responses included accessibility (26.5%, 78/295), convenience (24.4%, 72/295), and efficiency (21.4%, 63/295). Other subthemes from the advantages open-ended item included communication (8.8%, 26/295), connectedness (4.8%, 14/295), affordability (2.4%, 7/295), anonymity (2.4%, 7/295), and usability (2.4%, 7/295). The proportion of themes perceived as advantageous are reported in Table 3.

Table 3. Themes related to perceived advantages (N=295) and disadvantages (N=303) of telehealth systems.

Theme		Students, n (%)
Advantages		
	Accessibility	78 (26.5)
	Convenience	72 (24.4)
	Efficiency	63 (21.4)
Advantages subthemes		
	Communication	26 (8.8)
	Connectedness	14 (4.8)
	Affordability	7 (2.4)
	Anonymity	7 (2.4)
	Usability	7 (2.4)
Disadvantages		
	Trust	105 (34.5)
	Impersonality	85 (28.1)
	System errors	59 (19.5)
Disadvantages subthemes		
	Affordability	18 (5.9)
	Communication	7 (2.3)

Perceived Disadvantages of Telehealth Systems

In total, 303 responses were rated for disadvantages and concerns. Similar themes emerged for responses related to perceived disadvantages, which goes to show that what is perceived as an advantage to some is perceived as a disadvantage to others. That said, the following themes emerged from the disadvantages open-ended item: trust (34.5%, 105/303), impersonality (28.1%, 85/303), and system errors (19.5%, 59/395). Several other subthemes emerged from the disadvantages item including affordability (5.9%, 18/303) and communication (2.3%, 7/303). The proportion of themes perceived as disadvantages are reported in Table 3.

Discussion

Principal Findings

It has been well-established in the literature that advantages and disadvantages predict technology adoption, wherein the more advantages a telehealth system has, the more likely individuals are to use the system [11]. The present study utilized a sample of students enrolled in college to support this claim. The thematic analyses indicated that students generally felt as though there were more advantages than disadvantages associated with telehealth systems.

Based on themes derived from this study, students indicated that one major advantage of telehealth systems is that these technologies eliminate many barriers in receiving health care. Many students specifically noted that they would use a telehealth device again in the future if it improved the “availability of services” and “access to these services”. In other words, students could begin to schedule appointments with medical professionals that they perhaps could not normally visit. As well, some students noted that well-designed telehealth systems allow for the “better storage” and “better organization” of health information further facilitating the perceived usability (2.4%, 7/295 of responses) of telehealth technologies.

According to the themes in this study, telehealth devices can “quickly connect” a student to a care provider or practitioner, report health data in “record time”, and “eliminate the need for excessive travel”, all of which are characteristics that exemplify the convenience of telehealth technologies. Many students reported that they would use a telehealth system if it allowed them to conveniently “meet with a doctor at home” and “rapidly connect” to their health information. In a similar vein, many students stated that if a system was efficient, it would allow them to connect to health care services without “wasting time” and “saving money” (ie, these systems can make receiving care more affordable). But, a smaller percentage of students (5.9%, 18/303 of responses) reported the potential cost of telehealth

devices to be a disadvantage, particularly if these devices or services were overpriced. Several students specifically stated that if the cost was "too high" they would not use a telehealth device in the future. This is an important factor for engineers and programmers to bear in mind when designing telehealth systems and applications: telehealth systems should be affordable and accessible to all.

In terms of the theme of communication, many students felt that an electronic means of communication would "improve" their relationship with their medical provider because they "could connect with them quickly" and "communicate their concerns in real-time". Students tended to report that telehealth devices would result in "quicker feedback" from health care providers. Many students felt this would result in "more connectedness" with their health care provider. Only 2.3% (7/303) of student responses indicated that electronic communication via telehealth technology was a perceived disadvantage. On the other hand, almost 3% of the students in our sample noted that one advantage of telehealth systems is that they allow the individual to discuss health issues "more comfortably" or "without feeling embarrassed". A telehealth device may give more sensitive patients "a protective shield" allowing them to be "more honest" and descriptive about their health concerns. In addition, a few students noted that electronic communication through the use of a telehealth device "can serve as a written record". For these reasons, students reported that they would likely use a telehealth system in the future to communicate with their health care professional.

While many themes related to the perceived advantages of telehealth systems emerged, many students also pointed out the disadvantages of telehealth systems and indicated that these pitfalls would prevent them from using a telehealth system in the future. One major disadvantage of telehealth systems was user trust. Nearly 35% of students described reservations about using telehealth devices in the future because of issues released to "privacy and security" of personal health information. More specifically, students stated that they would not want their health information to be "given to the wrong person". Many students suggested that they would not use telehealth systems in the future if there were a "breach of the system" and "personal information was left unprotected". Almost 2% of students claimed that they would "only trust some systems", but not all devices, which shows that trust does not always translate from system to system.

Another notable disadvantage was that telehealth devices seem to be "impersonal" and this would result in students being less likely to use telehealth technologies in the future. Importantly, this theme highlights the fact that individuals still want to have "person-to-person interaction", despite some tradeoffs such as "increased travel time" to the doctor's office or longer wait times. Many students indicated that "in some cases you just have to see a doctor". Almost 7% of students stated that they did not want to see "impersonal" telehealth systems fully "replace medical professionals". As stated by one student, "telehealth might not be as thorough as in-person (visits)".

Many students voiced concerns about the accuracy or "reliability" of test results that may result due to "system errors", which is a disadvantage not only for telehealth systems, but for human-computer interaction in general. The theme of system errors tended to overlap with concerns about the potential for "technological malfunctions" and whether or not data would be "saved during a glitch". To summarize, these perceived disadvantages must be addressed before the adoption of telehealth technologies is widespread within student populations.

Our results also demonstrate partial support for the TAM. For example, one of the most frequently reported disadvantages was trust, which will need to be overcome in order to engage student users with the telehealth device. One way to do this is to convey a clear sense of security over personal health information. Similarly, telehealth devices will have to be well-designed and user friendly, otherwise students may perceive the system as being likely to have system errors or mishandle private health data. Issues with usability, privacy, and security can all effect student perceptions of trust. Perhaps the findings here can be used to conduct more nuanced research on the mechanisms underpinning system trust. In addition, many students touched upon perceived threats, which are defined within the TAM as a fear of technology replacing an occupation. For example, a handful of students explicitly stated that they did not want machines to replace doctors. Many felt that there are serious conditions for which individuals must visit a medical professional.

While our results tended to align with aspects of the TAM framework, the TAM could benefit from the integration of several novel constructs that emerged from the thematic analysis. For example, the TAM does not incorporate factors such as relatedness or connectedness with a medical professional, nor does it address issues of impersonality. At present, the TAM does not incorporate barriers in access to care such as the cost of the device or disease type, which is the strength of the HBM. Given that relatively few students in our sample reported a chronic or acute illness, it is difficult to establish support for the HBM using our student sample.

Limitations and Future Directions

It could be argued that student populations, typically composed of younger, make less use of health care services because they have a lower incidence of chronic or acute illness. However, with regard to technology adoption and usability, younger adult students may have the fewest barriers in terms of accessing care. Nonetheless student opinions are still important in the assessment of telehealth adoption, especially given that little research exists on student perceptions of telehealth systems. Future studies should aim to better understand how and why students interact with telehealth systems since relatively few studies exist in this domain.

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Conflicts of Interest

None declared.

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Abbreviations

HBM: Health Belief Model
PB: behavioral evaluation
PDT: perceived disease threat
PEOU: perceived ease of use
PU: perceived usefulness
TAM: Technology Acceptance Model

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Original Paper

Spaced Education and the Importance of Raising Awareness of the Personal Data Protection Act: A Medical Student Population-Based Study

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Abstract

Background: The Personal Data Protection Act (PDPA) of Singapore was first passed in 2012, with subsequent enforcement regulations effective in 2014. Although medical education via digital platforms is not often used in medical schools in Singapore as of yet, many current means of communication at all levels in the medical community from medical schools to clinics to hospitals are unsecure and noncompliant with the PDPA.

Objective: This pilot study will assess the effectiveness of MyDoc, a secure, mobile telehealth application and messaging platform, as an educational tool, secure communications tool, and a tool to raise awareness of the PDPA.

Methods: By replacing current methods of communication with MyDoc and using weekly clinical case discussions in the form of unidentifiable clinical photos and questions and answers, we raised awareness the PDPA among medical students and gained feedback and determined user satisfaction with this innovative system via questionnaires handed to 240 medical students who experienced using MyDoc over a 6-week period.

Results: All 240 questionnaires were answered with very positive and promising results, including all 100 students who were not familiar with the PDPA prior to the study attributing their awareness of it to MyDoc.

Conclusions: Potential uses of MyDoc in a medical school setting include PDPA-compliant student-to-student and student-to-doctor communication and clinical group case discussions with the sharing of patient-sensitive data, including clinical images and/or videos of hospital patients that students may benefit from viewing from an educational perspective. With our pilot study having excellent results in terms of acceptance and satisfaction from medical students and raising awareness of the PDPA, the integration of a secure, mobile digital health application and messaging platform is something all medical schools should consider, because our students of today are our doctors of tomorrow.

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KEYWORDS

medical education; MyDoc; Personal Data Protection Act; secure messaging; spaced education; telehealth; telemedicine

Introduction

Medical education via digital platforms is not often used in medical schools in Singapore as of yet. Rather, traditional rote or "binge and purge" learning often dominates. Examples of more recent and nontraditional methods of teaching include problem-based learning and the flipped classroom model, both of which our local medical school has attempted to adopt. With spaced education having been shown to increase knowledge by up to 50% and strengthen retention by up to two years [1], its potential impact in education and more specifically medical education is significant. This impact could be maximized through increased use of technology in medical schools, providing greater opportunities and avenues from which medical students may benefit, a point reiterated by two studies published just two years ago [2,3]. In the first, it was strongly suggested that medical students learn from real patients by participating in patient care within an educational practice and that their learning is affected by clinicians' willingness to engage in supportive dialogue; this approach should take place alongside and perhaps ahead of the currently dominant discourse of clinical teaching [2]. The second emphasized the advantages of a sociomaterial approach to practice and learning, stating its specific importance with regard to insights for medical education [3].

The Personal Data Protection Act (PDPA) of Singapore was first passed on October 15, 2012, with subsequent enforcement regulations effective only two years later on July 2, 2014. However, many current means of communication such as social media tools, text messages and hospital messaging system texts are unsecure and do not comply with the PDPA. While at first there may not seem to be any correlation between medical education via a digital health platform and the PDPA, their relationship becomes apparent with the fact that the art and study of medicine inevitably require the sharing of patient information. Although ensuring the use of only nonidentifiable data eliminates the issue of the need for data protection, in medicine this is often not feasible as doctors and students need to be able to identify their patients for various reasons. The primary objective of this study was to deliver medical education in orthopedics through clinical case discussions via the personal digitial platform, MyDoc, and assess the effectiveness of this secure communication and PDPA-compliant platform as an educational tool. The secondary objective was to raise awareness of the PDPA to medical students by determining their reactions to this telehealth platform. We predict that using MyDoc to educate medical students through the use of clinical case discussions will result in improved learning outcomes and raise student awareness of secure messaging and the PDPA in a clinical setting.

Methods

This was a prospective study that included third-year medical students at the National University of Singapore who agreed to participate. Institutional review board approval was sought; the study was deemed exempt from full review. All students were able to understand, speak, and read English. An oral presentation on MyDoc with mention of the PDPA was given to all students with a subsequent email sent to all participants and a second one to all class representatives. Of 300 third-year medical students, 240 (80.0%) participated in the study, including 116 males and 124 females, all between the ages of 20 and 23 years.

Participants were asked to use MyDoc to replace or add to the current methods of communication through mobile applications, text messaging services, or social media. During the 6-week study period, students used MyDoc to communicate in the form of personal messages (Figure 1), case discussions (Figure 2), and providing patient details that peers might find interesting (Figure 3). At the end of 6 weeks, a constructed and validated questionnaire [4] was distributed to all study participants to gain feedback and determine student satisfaction with this innovative system.

Figure 1. Secure communications interface showing personal messages.

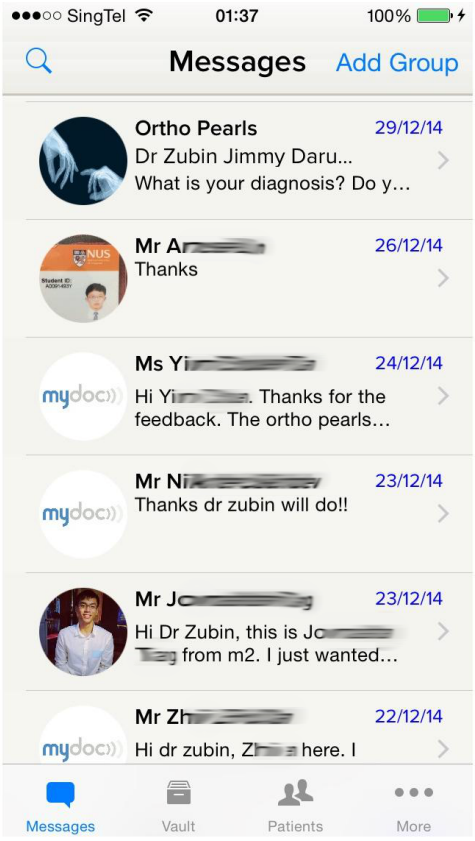


Figure 2. Screenshot depicting format of images used and questions asked as part of clinical case discussions.

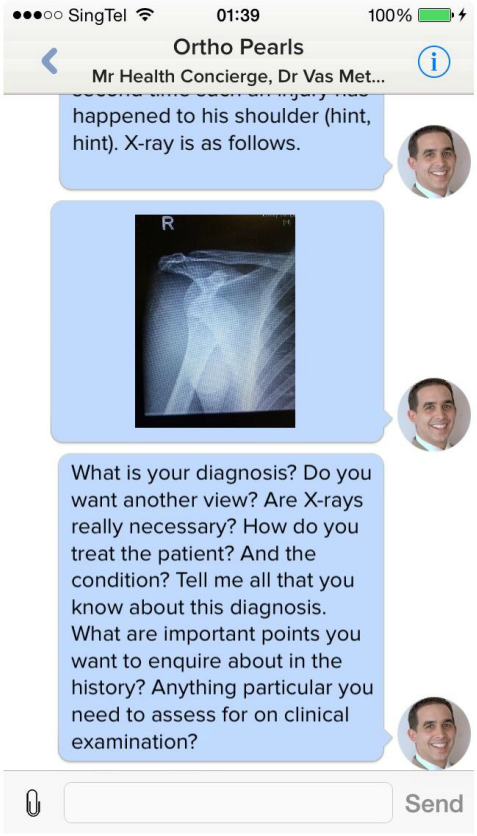
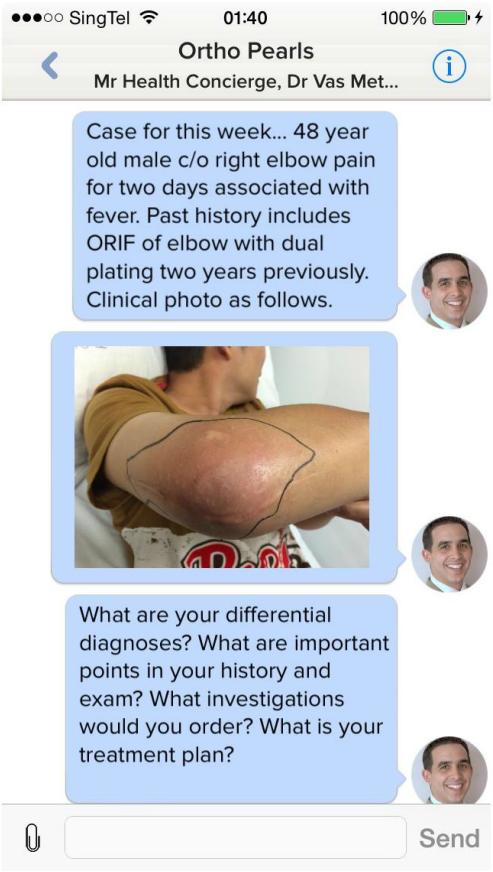


Figure 3. Sharing of a clinical photo of a patient with a common diagnosis all medical students rotating through orthopaedics are expected to know about as part of their syllabus.



Results

All 240 students who participated in the study responded to the questionnaire. Two-thirds (159, 66.3%) considered MyDoc a secure communication platform among medical professionals; 15 (6.3%) disagreed and 66 (27.5%) stated they were unsure. The majority of students (154, 64.2%) felt that using MyDoc as a secure messaging platform is better than using current messaging systems and should be implemented school-wide in order to ensure the highest security standards and comply with the PDPA; 14 (5.8%) disagreed and 72 (30.0%) neither agreeing nor disagreeing. None of the students strongly disagreed. On being asked if they could easily communicate with their peers and senior doctors using the MyDoc secure messaging platform, 137 (57.1%) agreed or strongly agreed, 55 (22.9%) neither agreed nor disagreed, 40 (16.7%) disagreed, and 8 (3.3%) strongly disagreed. While the majority of students (140, 58.3%) were aware of and familiar with the PDPA of Singapore and its medicolegal implications prior to the study, all remaining students (100, 41.6%) attributed their subsequent awareness to this study. More than one-third of the students (91, 37.9%) did not feel MyDoc facilitated their learning in orthopedics while 149 (62.1%) said they felt it did or perhaps it did. In terms of the usefulness of clinical case discussions, the majority of students (122, 50.8%) found them to be useful or very useful while 24 (10.0%) did not. The remaining 94 students (39.2%) answered neutrally. The quality of the images was found to be poor by one student (0.004%), fair by 41 students (17.1%), good by 100 students (41.7%), very good by 63 students (26.3%), and excellent by 35 students (14.6%). In asking what role the clinical case discussions played in comparison to the students' current modes of education, 208 (86.7%) felt it should complement current modes while 32 (13.3%) felt there was no role. Half (121) agreed or strongly agreed that MyDoc was user-friendly while 77 (32.1%) were unsure, 33 (13.8%) disagreed, and 9 (3.8%) strongly disagreed. On being asked if they felt using MyDoc to communicate with faculty would help build a stronger mentor-mentee relationship, 155 (64.6%) felt it would, 61 (25.4%) stated possibly, and 24 (10.0%) felt it would not. In addition, 96 students (40.0%) responded that they would recommend MyDoc to others, 37 (15.4%) said they would not, and 107 (44.6%) said they might. Over a 6-week period, 27,467 individual messages were sent between the students, equating to 654 per day. For group messages, a total of 19,751 were sent, equating to 470 per day.

Qualitative analysis showed 27 students (11.3%) considered *MyDoc* a secure platform due to it being only for doctors, stored on a secure data server, and described as a secure platform with emphasis on trustworthiness, confidentiality, and privacy. While 9 students (3.8%) questioned its reliability due to its nature of being a virtual platform on a mobile device, 6 (2.5%) considered it similar to the cross-platform smartphone messenger, WhatsApp. A total of 10 students (4.2%) were concerned with the technology glitches such as the intermittent system crashing, lack of message tracking, and intermittent malfunctioning on Android devices. From a spaced education point of view, the majority of students considered the telehealth platform secure, easy to use, and an educational tool that facilitated a deeper

communication on clinical cases among peers and senior doctors. They commented that the clinical case discussions in the spaced format helped them apply knowledge to real clinical scenarios, provided extra sources of clinical information, built a platform for students to ask questions, and offered opportunities to learn from seniors and peers. The 41.6% (100) of students who were not aware of the PDPA all reported attributing their new-found awareness to this study. Among those who were already aware of the PDPA, they had learned about it through various channels, including talks given by the medical school or medical societies, parents or elders, newspapers, ethics classes, and research projects that required them to use secure platforms.

Discussion

Our pilot study received positive feedback from most students with regard to using MyDoc's secure application and platform. While the transmission of personal data in the healthcare sector is inevitable, not all methods in the marketplace are secure. This point is reiterated by the American Academy of Orthopaedic Surgeons, which clearly states that while texting speeds communication, it puts doctors at risk and increases liability because it is inherently nonsecure and noncompliant with safety and privacy regulations [5]. It should be noted that any service that simply sends text messages that are readily accessible to anyone who gains access to the phone the messages were sent to is not secure. Considering that the data sent within the medical community is often of a sensitive nature, it would be unacceptable to use any of these services. Although none of the authors of this manuscript condone the words or actions of the medical student who mocked a patient on Twitter some years ago [6], this example clearly illustrates the dangers of using a social media tool as a platform for transmitting any form of personal data.

The objectives of our pilot study were to assess the effectiveness of MyDoc as a secure communications tool and educational tool to further clinical case discussions and to raise awareness of the PDPA and its medicolegal implications to medical students by determining their reactions to this telehealth platform.

While the introduction and integration of MyDoc may prove to be advantageous in a number of ways, there are various disadvantages and key issues that need to be addressed. For example, the integrity of a secure wireless network used for the transmission of sensitive and confidential information is paramount. From a practical point of view, possible loss of the Internet connection or network may make the use of the system both impractical and frustrating. Lastly, the speed of message transmission was an issue a number of study participants raised, stating that it is not as fast as other applications. However, it must be understood that unlike other systems in the marketplace where messages can be read by anyone, forwarded to anyone, remain unencrypted on telecommunication provider servers, and most importantly stay forever on the phones of senders and receivers [5], messages on MyDoc are not stored on the phone. That together with the various levels of security account for the slightly slower transmission speed.

There are many potential uses of MyDoc in medical schools, including the following:

- Enhance and complement current student interactive sessions
- Mentorship for student houses and groups
- Specialty-specific groups for clinical years
- Clinical case-based discussions for clinical as well as preclinical years, (including a focus on basic sciences to allow constant refreshing of memory as students progress from the preclinical to clinical years)
- Access to faculty or teaching staff to answer subject and/or specialty-based questions, including in real time during lectures with the option of anonymity
- Provision of and sharing patient details of interesting patients with clinical signs
- Secure messaging and compliance with the PDPA and medical privacy laws of other countries
- Dissemination of class or faculty announcements
- Observation of outpatient clinics through the use of telemedicine in the form of live video feeds

While some may argue and raise the question as to whether the sharing of identifiable data is even necessary in the context of medical education, we agree but only to a limited extent. Often what one may consider nonidentifiable (a tattoo, for example) may in fact and on the contrary be very identifiable should there be a particular uniqueness to it. In the case of taking a photo of an x-ray or lab result, a name or serial number may invariably but unknowingly be captured in the corner of the image. Ensuring this data is transferred via a secure and PDPA-compliant platform is advantageous to all parties concerned. And for these same reasons, the need for compliance with privacy laws becomes clear.

A few years ago, an article stated that telehealth is expected to grow 6-fold by 2017 [7]. Subsequently, it has been explained how it may even act as a remedy for chronic hospital readmissions [8] and why virtual doctor visits are better than in-person ones [9]. With our pilot study having excellent results in terms of acceptance and satisfaction from all medical students with regard to using MyDoc, the integration of the application in a medical school setting to provide a variety of functions has exciting and limitless potential and is something all medical schools should consider, because our students of today are our doctors of tomorrow. More so with the recently introduced PDPA, this secure application and platform's versatility in terms of its potential applications is something medical schools may find worth promoting, the latter clearly evident by the lead author's recent success in being awarded a Learning Innovation Fund–Technology (LIFT) grant by the National University of Singapore to use technology in medical education to seek feedback from medical students.

Conflicts of Interest

None declared.

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Abbreviations

PDPA: Personal Data Protection Act

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Original Paper

A Critical Analysis of Anesthesiology Podcasts: Identifying Determinants of Success

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Abstract

Background: Audio and video podcasts have gained popularity in recent years. Increasingly, podcasts are being used in the field of medicine as a tool to disseminate information. This format has multiple advantages including highly accessible creation tools, low distribution costs, and portability for the user. However, despite its ongoing use in medical education, there are no data describing factors associated with the success or quality of podcasts.

Objective: The goal of the study was to assess the landscape of anesthesia podcasts in Canada and develop a methodology for evaluating the quality of the podcast. To achieve our objective, we identified the scope of podcasts in anesthesia specifically, constructed an algorithmic model for measuring success, and identified factors linked to both successful podcasts and a peer-review process.

Methods: Independent reviewers performed a systematic search of anesthesia-related podcasts on iTunes Canada. Data and metrics recorded for each podcast included podcast's authorship, number posted, podcast series duration, target audience, topics, and social media presence. Descriptive statistics summarized mined data, and univariate analysis was used to identify factors associated with podcast success and a peer-review process.

Results: Twenty-two podcasts related to anesthesia were included in the final analysis. Less than a third (6/22=27%) were still active. The median longevity of the podcasts' series was just 13 months (interquartile range: 1-39 months). Anesthesiologists were the target audience for 77% of podcast series with clinical topics being most commonly addressed. We defined a novel algorithm for measuring success: Podcast Success Index. Factors associated with a high Podcast Success Index included podcasts targeting fellows (Spearman R=0.434; *P*=.04), inclusion of professional topics (Spearman R=0.456-0.603; *P*=.01-.03), and the use of Twitter as a means of social media (Spearman R=0.453;*P*=.03). In addition, more than two-thirds (16/22=73%) of podcasts demonstrated evidence of peer review with podcasts targeting anesthesiologists most strongly associated with peer-reviewed podcasts (Spearman R=0.886; *P*=.004)

Conclusions: We present the first report on the scope of anesthesia podcasts in Canada. We have developed a novel tool for assessing the success of an anesthesiology podcast series and identified factors linked to this success measure as well as evidence of a peer-review process for a given podcast. To enable advancement in this area of anesthesia e-resources, podcast creators and users should consider factors associated with success when creating podcasts. The lack of these aspects may be associated with the early demise of a podcast series.

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KEYWORDS

anesthesia; podcasts; peer review; success; e-learning; e-resources

Introduction

Podcasting refers to the distribution of audio or video files in a digital format. These podcasts are viewed on either a user's personal computer or mobile device, such as a mobile phone. In addition, the use of "really simple syndication" communication protocol to push these audio or video files directly to subscribers is what truly separates podcasts from other means of electronically disseminating information. Podcasting has seen significant growth as a tool in medical education [1-7]. Several studies have concluded that podcasts can be used to enhance a user's learning experience by providing small, succinct summaries of complex concepts, revision aids, or simply by providing the user with the ability to absorb at their own pace by exploiting the ability to pause the content [8-12]. Furthermore, podcasts can serve as a practical and valuable resource for providing a more digestible means of information such as journal articles [13-15]. Podcasts also allow the clinical community to share ideas globally and with the addition of video, they can be used for teaching procedural tasks [16-19]. As such, within the realm of anesthesia, podcasts are becoming increasingly popular as an educational tool [20].

Anesthesia podcast users report the need for a wide range of topics available as debates, journal article summaries, and mostly of short duration and multiple media [20]. The development and success of a podcast series may be influenced by the availability of content that meets the target user's needs and inclusion of various evidence-based models for knowledge transfer and retention [21-27]. There is currently no published data on the scope of podcasts in anesthesia. Furthermore, in this growing area of e-resources for anesthesia, it is worthwhile defining and determining the factors that make for a successful podcast series. The importance of peer review and reliability of sources creating podcasts have been reported to influence their use and adoption [20,27]. There is also currently no published literature on the peer-review process for anesthesia podcasts. As such, the goals of our study were to (1) evaluate the scope of anesthesia podcasts, (2) find metrics to define success, and (3) determine factors that were associated with podcast success and podcast peer-review.

Methods

Ethics and Study Design

This study was exempt from ethics approval. We used a validated scoping review and content analysis approach to guide the review and characterization of available anesthesia podcasts [28]. The review was carried out on the Canadian iTunes Store. Between September 1 and September 16, 2014, we entered the keywords "anesthesia," "anesthesia," "anesthesiology," "anesthesiology," "anesthetic," and "anesthetics" into the search field on the iTunes podcasts directory. Two reviewers (DS and CM) recorded the titles, number of episodes, and other variables (Table 1). For the eligibility assessment of the podcasts, the reviewers assessed the entire series during 2 meetings.

Table 1. Recorded metrics of interest for each relevant anesthesia podcast.

Category	Possible values
Authorship	Author, association of author
Country of origin	
Review process present	Yes, no
Frequency of podcast	Weekly, biweekly, monthly, and so forth
Podcast longevity	First and last episode, number of episodes
Duration	Longest and shortest episode (min)
Topic	Basic science, clinical, procedural, professional
Podcast type	Recorded didactic lecture, debate or discussion, journal summary, case presentation, practice oral exams, ground rounds, procedures
Target audience	Medical students, residents, fellows, anesthesiologists, nurse or paramedic, anesthesia assistant or nurse practitioner anesthetist
Supplemental information	Yes, no
Format	Audio, audio with PowerPoint style video, audio with real video
Availability to download	Yes, no
Presence of user feedback	Format, comments
Social media presence	Facebook, Twitter, LinkedIn, Google+

Selection Criteria

Podcasts were initially organized as either "potentially relevant" or "not relevant" based on the title, description, and a review of the audio files. Podcasts were categorized as "potentially relevant" and included in the final analysis if they met 3 criteria: (1) One of the search terms was in the podcast description available on the store, (2) the podcast had at least one episode posted on iTunes, and (3) the podcast was in English.

Podcasts were excluded from the study if they did not have at least one episode posted on iTunes (ie, dead links) and were focused on anesthesia for veterinary services. After independent screening for relevance, the 2 reviewers met to review each podcast that had been marked as "potentially relevant" or "not relevant." Following a literature review, we defined evidence of peer review as podcasts that were created in the context of a publication, presence of 3 or more speakers, grand rounds, and association with a journal or university [29]. For this definition, agreement was sought on each podcast title and a decision was made to include or exclude based on aforementioned criteria. Disagreements found in the review were resolved by consensus.

Data Extraction and Coding

Information was extracted from the store descriptions of the apps for the variables given in Table 1. Where available, weblinks to home pages were followed to extract information verifying authorship, ability to download outside of iTunes, and the presence of supplementary resources such as notes or social media.

Measure of Success

Although acknowledging that the success of a given podcast series should be informed in part by the ratings from the users, after pilot searches of the available anesthesia podcasts found on Canadian iTunes, it was apparent that very few of the podcasts' series (2/22) had any user ratings or feedback. As such, we attempted to devise a mathematical model that could be used in the evaluation of podcast success based on metrics such as the length of the time the podcast series has existed, number of available episodes, and frequency of podcast publishing (further detailed later in the Results section of this paper under "Podcast Success Measure"). We proposed the use of such a model as a means of providing a measurable score of podcast success.

Data Analysis

Descriptive analysis was used to summarize the data. Correlation coefficients with the Podcast Success Index (PSI) were determined by Pearson product-moment correlation if independent variables were continuous or by Spearman rank-order correlation if they were categorical or ordinal. Univariate generalized linear model with an identity link and normal distribution was used to identify factors associated with PSI and the evidence of a review process. Statistical significance was set at $P<.05$.

Results

General Podcast Characteristics, Authorship, and Affiliation

A total of 85 podcasts were found using the search terms; 63 were excluded resulting in 22 podcasts being evaluated. Most podcasts' series 18/22 (73%) were inactive, 6/22 (27%) had not published new content in the preceding 3 months of the study (Figure 1). Most podcasts originated in the United States (15/22 = 68%) with the remainder originating in Canada, the United Kingdom, and Australia (Table 2). Less than half, 9/22 (41%), of the podcasts were produced by individuals and almost a third, 7/22 (32%), by industry. However, only a small minority, (3/22 = 14%), of the podcasts on the Canadian iTunes Store were created by anesthesia journals (Table 2).

Figure 1. Timelines of activity for all relevant anesthesia podcasts found on iTunes Canada.

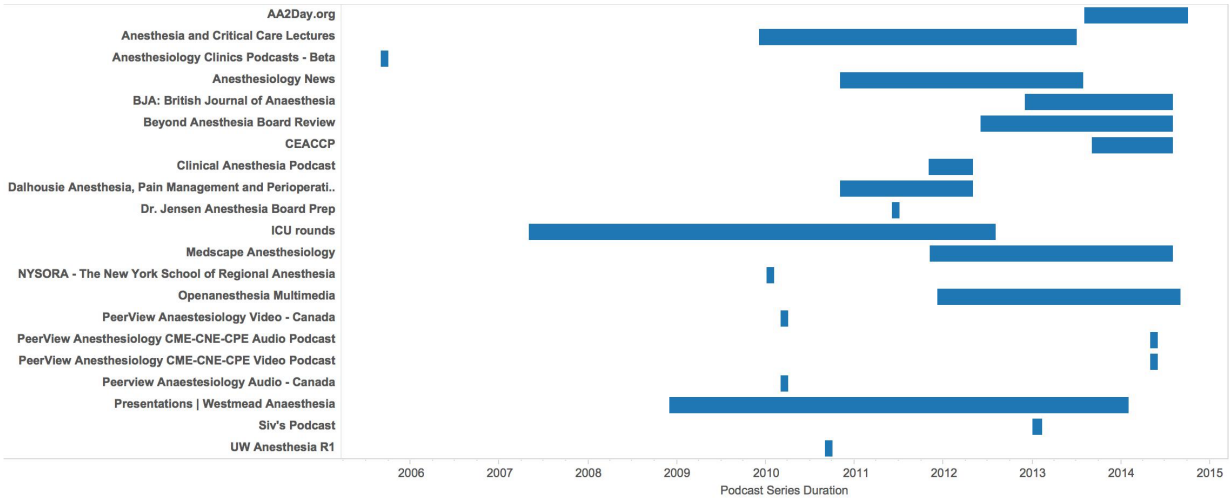


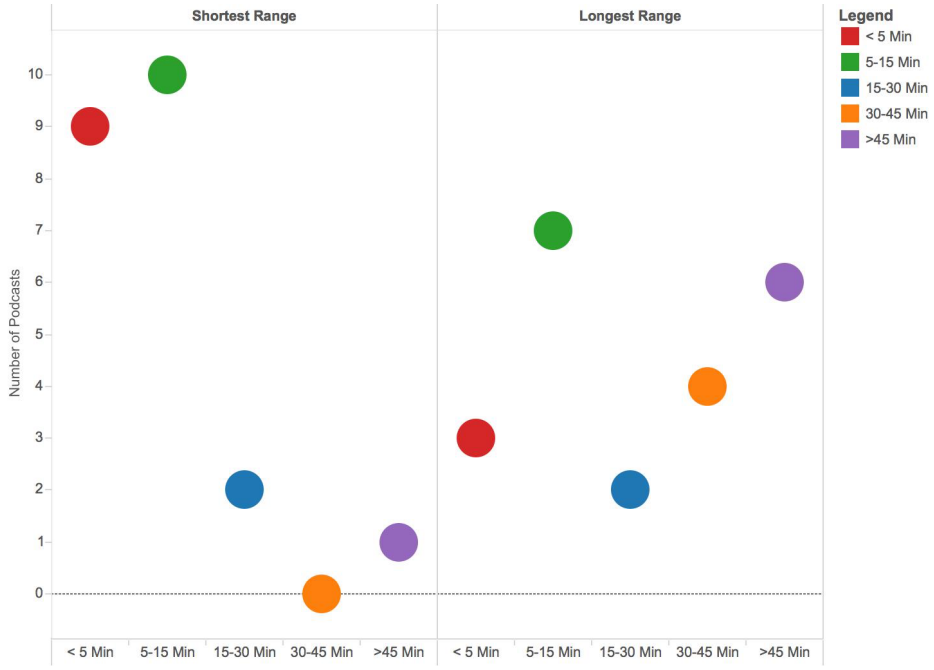
Table 2. Relevant anesthesia podcast series features.

	Included podcasts, N=22 (%)
Country of origin	
United States	15 (68)
Canada	4 (18)
United Kingdom	2 (9)
Australia	1 (5)
Podcast author	
Individual	9 (41)
Industry	7 (32)
Journal	3 (14)
University	2 (9)
Journal	1 (5)
Podcast format	
Audio only	14 (63)
Audio with PowerPoint style video	5 (23)
Audio with real video	3 (14)
Topics covered	
Clinical topics	18 (82)
Basic science	13 (59)
Professional	12 (54)
Procedural	9 (41)
Podcast types	
Debate	15 (68)
Recorded didactic	6 (27)
Journal	4 (18)
Case presentations	3 (14)
Grand rounds	2 (9)
Practice oral exams	1 (5)
Procedures	1 (5)

Podcast Types and Length of Podcast Episodes and Podcast Series Existence Duration

Podcasts ranged widely in length from less than 5 minutes to as long as 65 minutes. Eighty-six percent (19/22) of podcast series included episodes that were less than 15 minutes. Almost half of the series 10/22 (46%) also included episodes that were longer than 30 minutes (Figure 2). Over a third, 8/22 (37%), of podcasts included either video or PowerPoint slides with narration. Overall, 55% (12/22) of anesthesia podcasts were found to be downloadable outside of iTunes on dedicated websites, whereas the remainder were only available through iTunes Canada. Furthermore, 50% (11/22) of podcasts provided supplemental information in downloadable notes on dedicated websites. The median duration of existence of the podcast series was just 13 months (interquartile range, 1-39 months).

Figure 2. Minimum and maximum lengths of relevant anesthesia podcasts (N=22).



Target Audience, Topics, Podcast Style, Peer Review

Anesthesia podcasts targeted all levels of anesthesia providers from trainees to faculty and adjunct services. Almost 80% (17/22 = 77%) of podcast series provided content directly applicable to anesthesiologists, whereas 27% (6/22) were aimed at other services such as nurses, paramedics, and anesthesia assistants.

The anesthesia podcasts covered topics that can broadly be categorized as basic science, clinical, procedural, or professionalism. Clinical topics were the most comprehensively addressed with 82% (18/22) of series covering these. Procedural topics were covered by only 41% (9/22) of podcast series (Table 2). Seventy-three percent (16/22) of podcast series demonstrated evidence of peer review. Podcasts' series describing anesthesiologists as a target audience; that included clinical topics; and podcasts that were still actively producing content were associated with evidence of a peer-review process (Spearman R=0.89, P<.01; Spearman R=0.505, P=.02; and Spearman R=0.52, P=.01, respectively). Podcast reviews were least likely to be reviewed when created by individuals (Table 3).

Table 3. Univariate analysis of factors associated with a peer-review process.

Correlation	Variable	Spearman R	P value
Positive correlation			
	Podcasts targeting anesthesiologists	0.886	<.004[a]
	Podcasting with clinical topics	0.505	.02[a]
	Podcasts currently active[b]	0.516	.02[a]
Negative correlation			
	Podcasts authored by individuals	−0.505	.02[a]

[a]P<.05 (2-tailed).

[b]Episode in the 3 months preceding data collection.

Podcast Style and Evaluation of Podcasts and Use of Social Media

Discussions including journal summaries were the most common podcast style (15/22 = 68%). The least used formats were practice oral exams and procedural instruction, each of which only appears in 1/22 (5%) anesthesia-related podcasts (Table 2). Most podcasts, more than three-quarters, (17/22 = 77%), were not linked to social media, whereas the remaining 5 provided links to Facebook, Twitter, Google+, and LinkedIn. The use of Twitter was associated with podcasts focusing on journal article summaries and procedural topics (Spearman R=0.5, P=.02; Spearman R=0.48, P=.03, respectively).

Only 9% (2/22) of anesthesia-related podcasts located on the Canadian iTunes store had any user feedback or rating.

Podcast Success Measure

Ideally, to measure podcast quality and hence success, each podcast would have been assessed by descriptive and numerical user reviews. Unfortunately, this was not completed in most of the podcasts in this study. As such, in the absence of user ratings

or clear peer review, we created a novel success measure, termed PSI. To address validity of the PSI, we conducted a literature search for factors that could be indicative of quality and success of podcasts. These were compiled and then distributed to podcast developers and users in both medical and nonmedical realms for review. Through an iterative fashion, a consensus was formed determining the following factors to be important in determining a successful podcast series: length of podcast existence, number of monthly episodes, ratings by users, and number of downloads/number of plays. As stated earlier, due to the lack of data on podcast user ratings, number of downloads/number of plays, we eliminated these from our equation resulting in a PSI defined by length of podcast existence and monthly frequency of publication (Equation 1 and Table 4). This PSI equation was then piloted on a random sample of nonanesthesia-related podcasts that did have user ratings and reviews to ensure correlation with PSI scores.

Podcast Success Index = log [(episodes/month) $\sqrt{}$months active] (Equation 1)

Table 4. Podcast success scores.

Podcast title	Date of first episode	Months active	Episodes/month	Success score
AA2day.org[a]	08/2013	14	10.29	1.59
Anesthesia and Critical Care Lectures	12/2009	44	0.27	0.26
Anesthesiology Clinics Podcasts—Beta	09/2005	1	11.00	1.04
Anesthesiology News	11/2010	38	0.92	0.75
Beyond Anesthesia Board Review[a]	06/2012	27	0.85	0.65
BJA: British Journal of Anesthesia[a]	12/2012	21	1.62	0.87
CEACCP[a]	09/2013	12	0.42	0.16
Clinical Anesthesia Podcast	11/2011	6	2.33	0.76
Dalhousie Podcast Grand Rounds—Audio	11/2010	19	0.84	0.56
Dr. Jensen Anesthesia Board Prep	06/2011	1	2.00	0.30
ICU rounds	05/2007	63	1.48	1.07
Medscape Anesthesiology Podcast[a]	01/2011	43	1.16	0.88
NYSORA—The New York School of Regional Anesthesia	01/2010	1	1.00	0
Openanesthesia Multimedia[a]	06/2009	64	3.33	1.43
PeerView Anesthesiology Audio—Canada	03/2010	1	1.00	0
PeerView Anesthesiology Video—Canada	03/2010	1	1.00	0
PeerView Anesthesiology CME/CNE/CPE Audio Podcast	05/2014	1	1.00	0
PeerView Anesthesiology CME/CNE/CPE Video Podcast	05/2014	1	1.00	0
Siv's Podcast	01/2013	1	1.00	0
The World of Anesthesiology Podcast	07/2010	34	0.88	0.71
UW Anesthesia R1	09/2010	1	3.00	0.48
Presentations|Westmead Anesthesia	12/2008	62	1.00	0.90

[a]Podcast active within 3 months of data collection (September 14).

Factors Associated With a High Podcast Success Index

Podcasts that included fellows as the target audience demonstrated positive correlation with a high PSI (Spearman R=0.434; P=.04) (Table 5). Other podcasts targeting residents and anesthesia assistants tended toward significance. The inclusion of a wide array of topics from basic science and professional topics also demonstrated positive correlation with a high PSI. The use of Twitter was positively associated with a high PSI (Spearman R=0.453; P=.03). Interestingly, short podcasts demonstrated negative correlation with PSI (Spearman R = −0.506; P=.02).

Table 5. Factors associated with a high Podcast Success Index.

Characteristic	Variable	Spearman *R*	*P*
	Podcast author	0.011	.96
	Association of podcast author	0.248	.27
	Country	−0.216	.33
	Peer-reviewed	0.138	.54
	Number of ratings	0.386	.08
Target population			
	Med Student	0.104	.65
	Residents	0.399	.07
	Fellows	0.434	.04[a]
	Anesthesiologists	0.138	.54
	Anesthesia assistants/nurse practitioners	0.406	.06
Podcast topics included in the series			
	Basic science	0.456	.03[a]
	Clinical topics	0.375	.09
	Procedural topics	0.603	.003[a]
	Professional topics	0.552	.01[a]
Podcast style			
	Recorded didactic lectures	0.341	.12
	Debate discussion	−0.031	.89
	Journal summary	0.375	.09
	Case presentation	0.432	.04[a]
	Practice oral exams	0.017	0.94
	Grand rounds	0.227	0.31
Other podcast factors			
	Short podcasts (min)	−0.506	.02[a]
	Long podcasts (min)	0.388	.07
	Use of adjuncts (summary documents)	−0.036	.87
	Podcast is downloadable	0.458	.03[a]
	mp3	0.414	.06
	mp4	0.432	.04[a]
	m4v	0.201	.37
Use of social media			
	Twitter	0.453	.03[a]
	Facebook	0.253	.26

[a]*P*<.05 (2-tailed).

Discussion

Principal Findings

Our study demonstrates that anesthesia-related podcasts that have been in existence for a decade include a wide range of topics but have a high attrition rate. Using a novel podcast success tool, PSI, we have identified factors associated with podcast success: target population of podcast, type of topics covered, and the use of social media.

Our results show that podcasts in anesthesiology have been created by a wide range of authors including individuals, universities, journals, and industry. Most podcast creators have

been individuals, responsible for just under half of the podcast series. Surprisingly, universities, professional organizations, and journals contribute just a small proportion of the podcasts' series. Reasons for this may include budgetary or scope of work restrictions. Nevertheless, the journals are all recently new players in this field and more may follow suit. Although industry contributed to about a third of podcast series, industry appears to have largely exited this area as there were no active podcasts from industry during the study period. Reasons for this exit remain undetermined but may be linked to budgetary constraints and the potential presence of conflict of interest. The motivation for the creation of podcasts by individuals may include factors such as academic productivity related to education and research opportunities. Of the podcasts created by individuals, only a small minority are still active. Although studies have suggested podcasts are cheap to create and distribute, the perceived lack of quality content is a known major factor limiting wider adoption [20,27]. Our study does demonstrate that the podcast series duration for many podcasts was just a median of 13 months (interquartile range, 1-39 months). This is akin to a television show that lasts only one season and does not get renewed for subsequent seasons. Other reasons for this rather short existence of podcast series may be explained by the challenges of producing high-quality podcasts. These have been reported to be good quality content and cost related to the state of the art audio production equipment, associated personnel, time, and the presence of submatter experts [20]. These factors may contribute to the low number of individuals creating anesthesia-related podcasts. Current and new podcasts creators will need to consider these issues and challenges to ensure their podcasts' series run as long as "Sesame Street."

A major goal of this work was to develop a mathematical model that could assess the success of the podcasts using data that are currently available. After reviewing the collected data and metrics available for podcast series in anesthesia, it became apparent that a key element was missing to assess quality and impact: user feedback. Only 9% of podcasts had any review on iTunes. This may be explained in part by the structure and function of iTunes, which does not make it easy to evaluate podcasts. Nevertheless, using available data and metric, we developed the "PSI" formula weighted toward podcast productivity and longevity. A podcast author who provided frequent episodes over an extended period could be said to be more successful than a less productive or less long-lasting counterpart; much the way one could evaluate the popularity of a periodical. The use of such an index may assist users with filtering the quality of podcasts and assessing for relevance. It must also be stated that this is a quantitative rating. Recently, podcast assessment rubrics have been proposed consisting of qualitative evaluation criteria that could be used in conjunction with the PSI to enhance assessment of podcast quality and success [30].

It is important to point out that user feedback may improve the utility of our PSI by a user informed dimension of quality. In our data, there was minimal social media presence among the included anesthesia podcasts limiting the inclusion of social media user generated reviews. In contrast, Thoma et al looked at a Social Media Index, proposing the incorporation of social media "likes" and "follows" as well as page ranks of the resource as a quality assessment model of websites and e-resources in emergency medicine [29]. The use of e-resources in emergency medicine is more widespread allowing the existence of many users who provide numerous reviews and feedback on various platforms including social media. Anesthesiology may still be in infancy with regard to the use of e-resources and not have as highly interactive user body.

Nevertheless, the association of factors such as including a wide range of topics in a podcast series with a high PSI suggests that the podcasts may be meeting needs in a broad target population. Creators of podcasts should continue to develop series that provide relevant and pertinent information from broad topics. Short podcasts and case discussions were associated with a higher PSI and were consistent with those from previous work surveying podcast preferences of Canadian anesthesia residents [20].

The high rate of evidence of peer review (73% of podcast series) was an unexpected finding. This may be due to our definition for evidence of peer review, which may have been liberal. The association of a peer-review process with podcasts targeting anesthesiologists suggests that users may regard podcasts as providing some level of reliable and valid information. However, it will be important for podcast creators to publish their review processes to better inform end users on the reliability and relevance of these resources. More importantly, podcast series created by individuals were least likely to be reviewed. The inclusion of a review process may be a logistic challenge for such individual publishers of podcasts. It is important users of these podcasts take time to familiarize themselves with the producers and the content.

Our study provides new data on the scope of and success of podcasting in anesthesia albeit with some limitations. The first is that our podcasts were limited to the Canadian iTunes Store, which will not show the results of content exclusively available in other countries or regions. This may have contributed to our limited sample size. However, iTunes works as a geofence and so our study sample is relevant to all those who access podcasts in geographical Canada. Furthermore, the majority of the podcasts were from the United States. However, further work could extend the survey to a global level with the inclusion of both international iTunes stores and other pod catcher platforms such as soundcloud, archive.org, and Podomatic. In addition, in terms of individual podcast topics, we assessed broad topic categories such as clinical, procedural, professional, and basic science. The previous work by Matava et al surveyed current residents regarding desired topics was more robust, delving into subcategories of the broader classifications [20]. This analysis could be addressed in future works but would require closer analysis of each and every podcast episode that was not deemed appropriate for our study.

Conclusion

This study is the first to provide a scoping review, critical analysis of the success of the anesthesiology e-resource—podcasts. We demonstrate that podcasts' series for anesthesiology cover a broad area of topics but are relatively short-lived. Anesthesia podcasts demonstrate high-level

peer-review processes in podcasts. Factors such as including particular target populations, type of topics covered, and the use of social media correlate with podcast series success, as defined by a novel PSI. The continued growth in this area may depend on further work involving social media integration and continued inclusion of wide range of topics.

Conflicts of Interest

None declared.

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Abbreviations

PSI: podcast success index

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Original Paper

Use of Social Media for Professional Development by Health Care Professionals: A Cross-Sectional Web-Based Survey

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Abstract

Background: Social media can be used in health care settings to enhance professional networking and education; patient communication, care, and education; public health programs; organizational promotion; and research.

Objective: The aim of this study was to explore the use of social media networks for the purpose of professional development among health care professionals in Saudi Arabia using a purpose-designed Web-based survey.

Methods: A cross-sectional web-based survey was undertaken. A link to the survey was posted on the investigator's personal social media accounts including Twitter, LinkedIn, and WhatsApp.

Results: A total of 231 health care professionals, who are generally social media users, participated in the study. Of these professionals, 70.6% (163/231) use social media for their professional development. The social media applications most frequently used, in the descending order, for professional development were Twitter, YouTube, Instagram, Facebook, Snapchat, and LinkedIn. The majority of respondents used social media for professional development irrespective of their age group, with the highest proportion seen in those aged 20-30 years. Social media were perceived as being most beneficial for professional development in terms of their impact on the domains of knowledge and problem solving and least helpful for enhancing clinical skills. Twitter was perceived as the most helpful type of social media for all domains listed. Respondents most frequently reported that social media were useful for professional development for the reasons of knowledge exchange and networking.

Conclusions: Social media are frequently used by health care professionals in Saudi Arabia for the purposes of professional development, with Twitter most frequently used for this purpose. These findings suggest that social media networks can be powerful tools for engaging health care professionals in their professional development.

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KEYWORDS

social media; education, professional; health education; professional competence

Introduction

Social media are Internet-mediated tools that enable people to create, share, and exchange information, ideas, pictures, and videos in virtual communities and networks. Social media takes on various forms including blogs, business networks, social networks, forums, microblogs, photo and video sharing, products and services reviews, social bookmarking, social gaming, and virtual worlds. There has been a rapid growth in social media networks, with sites including Facebook, Twitter, Blogger, MySpace, YouTube, Flicker, and LinkedIn. The number of social media users worldwide has been estimated at 1.96 billion [1]. In contrast to traditional media, which are based on transmission from one source to many receivers, social media are based on transmission from many sources to many receivers.

From a health care perspective, social media can be used for a variety of reasons including enhancing professional networking and education; patient communication, care, and education; public health programs; organizational promotion; and research [2-4]. There are many benefits associated with the use of social media in health care, including increased accessibility to health information, increased peer support, and public health surveillance [4-7]. However, there are serious concerns about its use, including its governance; the accuracy, quality, and reliability of the information circulated; patient privacy and confidentiality; blurring of the personal–professional boundary; increased risk of liability; and lack of methodological rigor for social media–based research [2-8].

Health care professionals can use social media to undertake web-based professional development, connect with colleagues in their own or other professions, and keep up to date with the latest medical literature [6]. An enhanced connection with professional colleagues has been highlighted as one of the major benefits associated with the use of social media in the health care setting [6].

From an Arabic perspective, there has been an exponential growth of social media into the daily life of people, businesses, and the interaction between governments and their people [9,10]. A recent report estimated that there were more than 135 million individuals using the Internet in 22 Arab countries and more than 71 million active users of social networking technologies, with many in the health care industry in the Arab region using social media to engage with consumers and other influencers [11]. As an example, the United Arab Emirates Ministry of Health is reported as having 16,000 followers on Facebook and 9700 followers on Twitter and uses these to share its e-services, community events, health news, and health tips [11]. Similar initiatives have been commenced in other Arab countries including Saudi Arabia, Kuwait, Oman, and Qatar [11]. A study investigating the perceptions of social media users in the Arab world revealed that while social media were perceived as having many positive benefits (eg, the ability to connect with people and bring people closer together), they can also have negative effects on local culture and tradition [10].

In a recent pilot study that investigated the use of social media among health care professionals, predominantly physicians, in Saudi Arabia, Almaiman et al [12] found, in a Web-based survey of Twitter users, that 79% used Twitter to seek online health information, with users reporting that it increased their medical knowledge and improved their clinical practice. Further research investigating the use of all types of social media for professional development by health care professionals in Saudi Arabia would be useful to assess the impact of social media on supporting professional development and its perceived benefits. Therefore, the aim of this study was to examine the use of social media for professional development among health care professionals in Saudi Arabia and assess their perceptions of its benefit and impact.

Methods

Study Design

A cross-sectional Web-based survey was undertaken in July and August 2015. A link to the survey was posted on the investigator's personal social media accounts including Twitter, LinkedIn, and WhatsApp. This is a pilot study that is considered an "explanatory research" [13] to investigate how health care professionals use the social media network for their professional development and what are the benefits of using social media networks for professional development as perceived by health care professionals.

Participants

The study included a convenience sample from health care professionals in Saudi Arabia who are already using social media networks in general. Health care professionals in this study are defined as all workers holding a qualification of a health discipline working in any health care setting whether clinical (ie, health care provider) or academic (ie, education or research facilities).

Survey

An open web-based survey was purpose-designed by the investigator to explore the use of social media for professional development among health care professionals in Saudi Arabia and assess their perceptions of its benefit and impact.

The survey comprised 3 main sections that are as follows: (1) which social media were used (options included Twitter, Instagram, YouTube, Facebook, Snapchat, and LinkedIn); (2) which social media were used, and how frequently, for professional development; and (3) the participant's perceptions of the benefits and impacts of social media in his or her professional development. For this latter section, questions were asked about the helpfulness (categorized as "not at all helpful," "somewhat helpful," "very helpful," and "extremely helpful") of social media for professional development in terms of its benefits and impacts on 8 domains. These 8 domains were knowledge, clinical reasoning, critical thinking, clinical skills, problem solving, creativity, decision making, and patient outcome. These domains were designed based on Bloom's Taxonomy that is a framework for classifying educational goals, objectives, and standards. The framework consists of 2 dimensions: Knowledge and Cognitive processes [14]. This section of the survey was based on the cognitive processes dimension of Bloom's framework that consists of the following 6 categories of cognitive skills: remember, create, apply, analyze, and evaluate [14]. The survey questions explored which of these cognitive skills in relation to professional skills was improved by social media (Multimedia Appendix 1). Bloom's framework has been used previously in studies investigating the use of social media among health specialists [15]. An additional question with set responses asked respondents to indicate their reasons for using social media for professional development. Demographic data were also collected from participants including gender, age, level of qualification, type of work (categorized as "academic only," "clinical only," "academic and clinical," or "other"), country of residence, and

country of origin. The first draft of this survey was reviewed by 3 health professionals similar to the target group to ensure clarity of the questions and rating scale. No major changes were suggested. A cover letter was attached to the survey explaining its purpose, the investigator's information, the anonymity of participants, and the confidentiality of the information. No personal identification was requested or stored. The survey was distributed via URL link through Google forms.

Statistical Analysis

Analyses were conducted using SPSS version 20.0 (SPSS Inc, Chicago, IL, USA). As well as basic descriptive data for all outcomes, results were compared between participants according to their demographic data. For the purpose of these analyses, data concerning the frequency of use were dichotomized into "yes" ("most of the time" and "all the time") or "no" ("never" and "rarely"). Similarly, categorical data regarding the perceptions of the helpfulness of social media for professional development were dichotomized into "yes" ("somewhat helpful," "very helpful," or "extremely helpful") or "no" ("not at all helpful"). Summary statistics are reported as frequency and percentages.

Results

Participants

The survey was sent to a total of 2500 people, which is the total number of followers of the author's social media accounts, and 231 people responded to the survey. Among the 231 respondents, most were aged 20-40 years and the majority were female (Table 1). Level of education was evenly divided between those with, at highest, a Bachelor's degree and those with a postgraduate degree. Most participants were involved in clinical work only or a combination of clinical and academic work. Saudi Arabia was the country of origin and residence for the majority of respondents.

Table 1. Demographic data for the 231 respondents.

Characteristics	Number (%)
Age (years)	
20-30	111 (48.1)
31-40	67 (29.0)
41-50	45 (19.5)
> 50	8 (3.5)
Gender	
Female	149 (64.5)
Male	82 (35.5)
Highest level of qualification	
Bachelor's degree or below	113 (49.0)
Master's degree or higher	118 (51.0)
Type of work	
Academic only	51 (22.2)
Clinical only	109 (47.4)
Academic and clinical	52 (22.6)
Other	19 (8.2)
Country of residence	
Saudi Arabia	203 (87.9)
United Arab Emirates	10 (4.3)
Other	14 (6.1)
Not specified	4 (1.7)
Country of origin	
Saudi Arabia	204 (88.3)
United Arab Emirates	9 (3.9)
Other	11 (4.8)
Not specified	7 (3.0)

Use of Social Media

All the 231 respondents reported that they used social media, with 163 (70.6%) reporting they used social media for professional development. The most frequently used social media platforms were similar for general usage and for professional development (Figure 1). For professional development, respondents indicated that Twitter was most frequently used (n=137; 84.1%), followed by YouTube (n=119; 73.0%), Instagram (n=116; 71.2%), Facebook (n=99; 61%), Snapchat (n=96; 60%), and LinkedIn (n=79; 49%) (Figure 1).

Among all the age groups, more than 60% reported using social media for professional development, reaching a high of 75.7% for those aged 20-30 years (Table 2). Male respondents reported using social media for professional development significantly more than females (79.3% vs 65.8%; *P*=.03). No significant association of social media usage for professional development was found with educational level or type of work.

The majority of the 163 respondents who used social media for professional development perceived social media networks to be somewhat, very, or extremely helpful in terms of their benefits and impacts across all the 8 domains listed (Table 3). Domains where social media were most frequently rated as somewhat, very, or extremely helpful were knowledge (n=161; 98.8%) followed by problem solving (n=147; 90.2%), with clinical skills least frequently rated as helpful (n=127; 77.9%). When the various types of social media were compared for their helpfulness across the 8 domains, Twitter was perceived as being most helpful across all domains (Table 4). Respondents were also asked to select their reasons for using social media networks for professional development, and as summarized in Table 5, the most frequent reasons for using social media for professional development were for knowledge exchange and networking.

Table 2. Use of social media for professional development according to demographic variables for the 231 respondents.

Variables	N	Used social media for professional development n (%)[a]		*P*-value
		Yes (n=163)	No (n=68)	
Age				
20-30 years	111	84 (75.7)	27 (24.3)	.35
31-40 years	67	46 (68.7)	21 (31)	
41-50 years	45	28 (62.2)	17 (38)	
> 50 years	8	5 (62.5)	3 (38)	
Gender				
Female	149	98 (65.8)	51 (34.2)	.03[b]
Male	82	65 (79.3)	17 (21)	
Highest level of education				
Bachelor's degree or below	111	79 (70.3)	34 (29.7)	.83
Master's degree or higher	120	84 (70.8)	34 (29.2)	
Type of work				
Academic only	51	33 (64.7)	18 (35)	.58
Clinical only	109	76 (69.7)	33 (31.2)	
Academic and clinical	52	40 (76.9)	12 (23)	
Other	19	14 (68.4)	5 (21)	

[a]Percentages are calculated relative to the total number within each row of data.

[b]Statistically significant.

Table 3. Perceptions about the benefits and impacts of using social media for professional development for the 163 respondents who used social media for this purpose.

Variables	Degree of helpfulness n (%)				
	Not at all helpful	Somewhat helpful	Very helpful	Extremely helpful	Helpful[a]
Knowledge	2 (1.2)	69 (42.3)	77 (47.2)	15 (9.2)	161 (98.8)
Clinical reasoning	23 (14.1)	83 (50.9)	47 (28.8)	10 (6.1)	140 (85.9)
Critical thinking	22 (13.5)	74 (45.4)	53 (32.5)	14 (8.6)	141 (86.5)
Clinical skills	36 (22.1)	71 (43.6)	48 (29.4)	8 (4.9)	127 (77.9)
Problem solving	16 (9.8)	72 (44.2)	62 (38.0)	13 (8.0)	147 (90.2)
Creativity	18 (11.0)	54 (33.1)	70 (42.9)	21 (12.9)	145 (89.0)
Decision making	24 (14.7)	75 (46.0)	55 (33.7)	9 (5.5)	139 (85.3)
Patient outcome	20 (12.2)	72 (44.2)	56 (34.4)	15 (9.2)	143 (87.7)

[a]Represents the frequency of merged responses (ie, “somewhat helpful,” “very helpful,” plus “extremely helpful”).

Table 4. The frequency with which the social media networks were perceived as helpful to improve professional development domains.

Variables	N[a]	Twitter n (%)	YouTube n (%)	Instagram n (%)	Snap chat n (%)	LinkedIn n (%)	Facebook n (%)
Knowledge	161	136 (84.5)	118 (73.3)	115 (71.4)	81 (50.3)	75 (46.6)	39 (24.2)
Clinical reasoning	140	123 (87.9)	105 (75.0)	107 (76.4)	73 (52.1)	64 (45.7)	22 (15.7)
Critical thinking	141	124 (87.9)	105 (74.5)	105 (74.5)	72 (51.1)	64 (45.4)	27 (19.1)
Clinical skills	127	111 (87.4)	95 (74.8)	105 (82.7)	69 (54,3)	54 (42.5)	28 (22.0)
Problem solving	147	127 (86.4)	109 (74.1)	108 (73.5)	77 (52.4)	69 (46.9)	28 (19.1)
Creativity	145	125 (86.2)	107 (73.8)	107 (73.8)	75 (51.7)	69 (47.6)	40 (27.6)
Decision making	139	120 (86.3)	101 (72.7)	102 (73.4)	74 (53.2)	67 (48.2)	30 (21.6)
Patient outcome	143	122 (85.3)	106 (74.1)	107 (74.8)	77 (53.8)	65 (45.5)	31 (21.7)

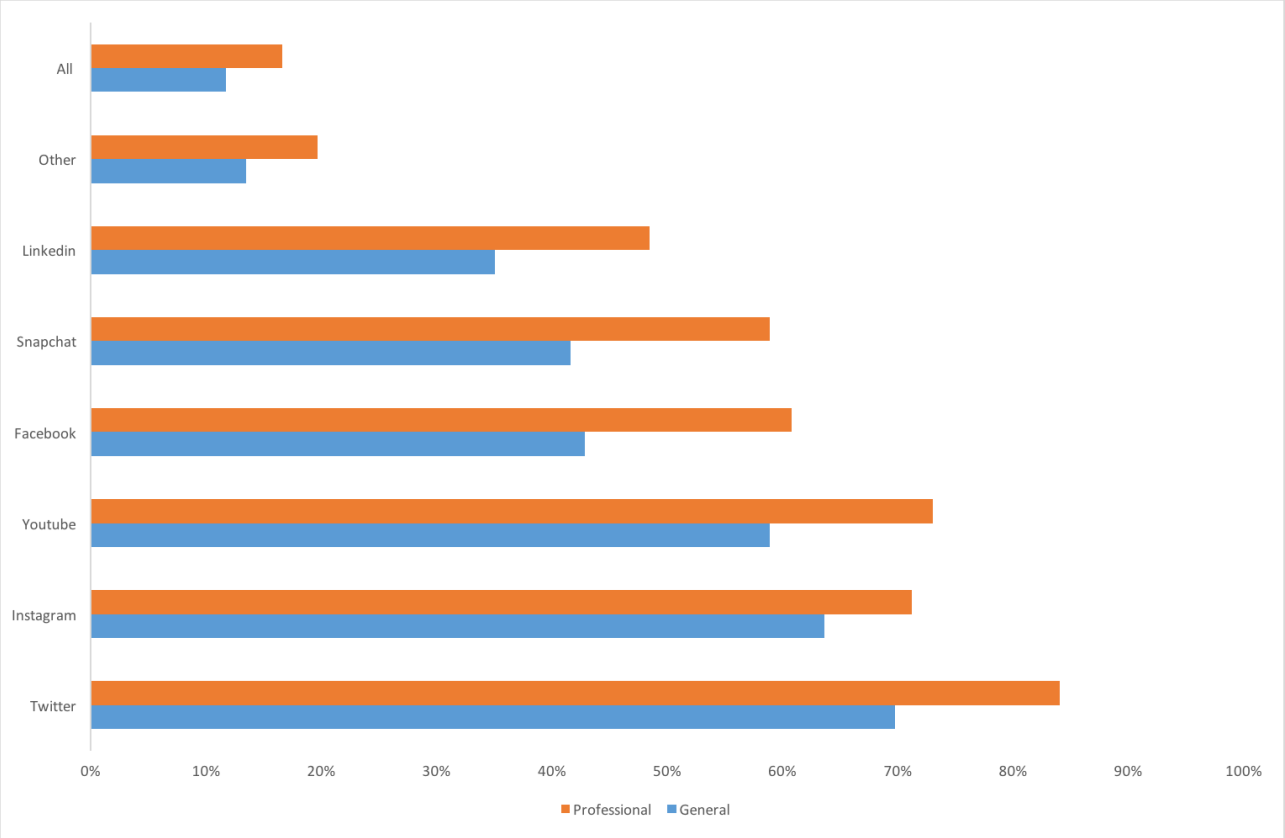
[a]Represents the frequency of merged responses (ie, “somewhat helpful,” “very helpful,” plus “extremely helpful”).

Table 5. Reasons given by the 163 respondents[a] for using social media networks professionally.

Reason	N (%)
Knowledge exchange	114 (69.9)
Networking	86 (52.8)
Professional development	81 (49.7)
Health promotion	70 (42.9)
New updates	66 (40.5)
Self-promotion	59 (36.2)
Employment or research opportunities	43 (26.4)
Other	2 (1.2)
All the above	43 (26.4)

[a]Respondents were able to choose more than one reason.

Figure 1. Frequency of the types of social media used generally (n=231) and for professional development (n=163).



Discussion

Principal Findings

This exploratory study investigated the use of social media networks by health care professionals in Saudi Arabia for the purpose of professional development. All 231 respondents indicated that they used one or more social media networks, with 163 (70.6%) of those reporting that they used social media for their professional development. The social media platforms most often used for professional development were Twitter, YouTube, Instagram, Facebook, Snapchat, and LinkedIn. Social media were perceived as being most beneficial for professional development in terms of their impact on the domains of knowledge and problem solving and least helpful for enhancing clinical skills. Respondents most frequently reported that social media were useful for professional development for the reasons of knowledge exchange and networking.

Comparison With Previous Work

In our sample of health care professionals in Saudi Arabia, we found that Twitter, Instagram, YouTube, and Facebook were the most frequently used social media platforms for general usage, with Twitter, YouTube, and Instagram most often used for professional development. These findings are similar to data compiled by Reyaee and Ahmed [16] who reported that Facebook, Twitter, and YouTube dominated the social media market among the general population in Saudi Arabia.

Among our sample, a higher proportion of younger age groups used social media networks for professional development purposes compared with the older age groups, although this did not achieve statistical significance. This trend may reflect that, in general, younger age groups have been reported to use the social media networks more than older age groups [17].

Using social media for professional development was perceived by the participants in this study as helpful in a number of domains, including most frequently, improving knowledge, and problem solving. These findings support those of Almaiman et al [12] who found, among physicians in Saudi Arabia using Twitter for professional development, that it was reported as being beneficial for increasing medical knowledge and in improving clinical practice.

Limitations

One of the limitations of this study was that it was a pilot study involving only a relatively small number of health care professionals in Saudi Arabia, thus limiting the generalizability of the results. Another limitation was that as the sample was drawn from health care professionals already active online and further utilized a Web-based survey, it is likely that the sample was biased toward those who were more likely to use social media for professional development. Nevertheless, the results provide new data concerning social media usage for professional development among health care professionals in Saudi Arabia who are already engaged in online social media. Further research using offline methods of recruiting participants will be essential to confirm and extend the results of this study.

Conclusions

We found that the majority of health care professionals in Saudi Arabia participating in this study used social media for the purposes of professional development. Twitter, YouTube,

Instagram, Facebook, Snapchat, and LinkedIn were the media platforms most often used for professional development. In terms of their benefits, social media were perceived as being most helpful for professional development for improving knowledge and problem solving. These findings suggest that social media networks can be powerful tools to engage health care professionals in their professional development.

Conflicts of Interest

None declared.

Multimedia Appendix 1

The survey questions.

[PDF File (Adobe PDF File), 204KB - mededu_v2i2e15_app1.pdf]

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