Health Information and Libraries Journal

Health Libraries Group | cilip Chartered Institute of Library and Information Professionals

DOI: 10.1111/hir.12076

A mixed-methods analysis of a library-based hand-held intervention with rural clinicians

Richard L. Wallace, Nakia J. Woodward & Travis S. Clamon
Quillen College of Medicine Library, East Tennessee State University, Johnson City, TN, USA

Abstract

Background: The East Tennessee State University Quillen College of Medicine Library has participated for several years in projects to provide rural clinicians with health information resources.
Objectives: To determine whether a strategy of hand-held devices with a best-evidence point-of-care disease tool and a drug database paired with access to a medical library for full-text articles and training to use the tools would be an affordable way to meet the information needs of rural underserved clinicians.
Methods: This study is a mixed-methods methodology. The first project was evaluated using a randomised controlled trial (RCT) methodology. The second was evaluated qualitatively using interviews and focus groups.
Results: The quantitative findings discovered that clinicians equipped with a hand-held device with evidence-based software more frequently found answers to clinical questions, found answers more quickly, were more satisfied with information they found and use expensive resources such as continuing medical education, online databases and textbooks less than the group that did not have access to online technology. Qualitative results supported the quantitative findings.
Conclusion: Librarians can implement a three-pronged strategy of the secondary literature via a hand-held, the primary literature via Loansome Doc and quality training to meet basic information needs of rural clinicians.

Keywords: access to information; education and training; evaluation, evidence-based medicine (EBM); health information needs; qualitative research; quantitative research; United States of America (USA)

Key Messages

- Hand-held devices are a great way to provide basic medical library services to health care professionals underserved with information.
- Librarian involvement and training is a key to any information access project.
- Medical librarians must be proactive in seeking out communities of clinicians that are underserved with information and create ways for them to gain access.

Introduction

Health science librarians feel strongly that what they do is important. The services they provide to patrons change lives. It is imperative that they are motivated and passionate to ensure that all health professionals have access to health information resources at an adequate level. In the United States, access to adequate health science library resources is far from being realised. The hypothesis of this study is that if clinicians were provided with: (i) a hand-held device – personal digital assistant (PDA) or smartphone – with evidence-based disease, drug, screening, immunisation and other appropriate software; (ii) access to the primary literature via the PubMed/Loansome Doc utility (www.pubmed.gov; https://docline.gov/loansome/login.cfm); and (iii) training to use the above resources by a health sciences librarian, then the unmet information needs of underserved clinicians would be largely filled. Over the course of eight years, the authors initiated six projects leading to this overarching

Correspondence: Richard Wallace, Quillen College of Medicine Library, East Tennessee State University, Box 70693, Johnson City, TN, USA. E-mail: wallacer@etsu.edu

© 2014 The authors. Health Information and Libraries Journal © 2014 Health Libraries Journal

hypothesis. This article reviews the mixed-methods analysis of the final two projects.

Literature review

The Appalachian region of the United States is a rural one with many health disparities owing to cultural, economic, geographic and historical reasons. The region is where East Tennessee State University (ETSU), the authors' institution, is located. Almost half of the Appalachian rural counties are federally designated health professions shortage areas. Physicians in rural settings can find themselves in limited information settings which can hinder their impact.[1] Obstacles to retrieving health information are lack of time, lack of access, isolation, cost, lack of training and dislike of technology.[2–5] Barriers in rural areas are exacerbated by practice patterns, geographic area and inequitable access to information resources.[3] Rural physicians because of issues like isolation have to assume more of the costs of information usage individually, because in most US rural hospitals, there are no print libraries and fewer online subscriptions compared to urban counterparts.

Lucas *et al.*[6] found that access to evidence impacts treatment, with physicians reporting they changed treatment plans in eighteen per cent of patients after reviewing the literature. A proposed remedy to the lack of access in rural areas is the uptake of hand-held devices by rural clinicians.[7] These technologies can reduce feelings of isolation, provide the latest information and provide continuing education needs. Rubin *et al.*[8] found that computerised clinical decision support systems have the ability to improve both patient safety and outcomes. Lasserre *et al.*[9] found that students on rural rotations found hand-held devices to be useful when they were in rural communities.

Prgoment *et al.* pointed out that health care is a mobile field and hand-held devices dovetail into this environment. These devices assist with prompt treatment of patients and are also utilised to facilitate interprofessional communication. Hand-helds were found to impact physician work practices through the databases and mobile applications that were available to them for decision-making.[10] Lindquist *et al.*[11] found that hand-held devices were most utilised when they solved practical issues. They facilitate rapid response medication error prevention and data management and are especially useful in situations where desktop computers are in limited numbers. In a 2013 scoping review of systematic reviews, hand-held devices were found to improve decision-making, save time and provide new information at a faster pace.[12] Honeybourne *et al.*[13] stressed the speed at which information can be delivered is one of the key components to the importance of a hand-held device. Hudson *et al.*[14] found hand-held devices to be desirable because they provide a wide array of information in a matter of seconds at the user's fingertips. The best resources for hand-held devices are drug databases, medical calculators, guideline information and administrative tools. Drug information databases are the most commonly utilised hand-held tool.[9,14,15]

Scott *et al.* found in a study of preceptors that over 60% would take a hand-held device instead of a monetary stipend as compensation from the university. Information access was more important to these clinicians than a cash incentive. Of the people who received the hand-held device, over 93% reported they were currently using it for clinical care. The hand-held device was reported to positively impact patient care.[15]

A large barrier to hand-held device use is the initial set-up of the medical resources and the continual updating of information on the hand-helds.[13,14] This problem is becoming easier to overcome with improving technology. Most barriers are found to be behavioural rather than technical in nature. [15] In a study by Hudson, when students ran into frequent problems, they ceased to use the hand-held devices.[14] This problem underlies the importance of having technical support. Grad *et al.* found that family physicians tend to not take time to manually update their hand-held software. [16] This lack of updating and technical awareness shows the importance of physicians having continual technical support.[15]

Librarians can play an important role in the resolution of this problem by providing guidance on downloading applications and assisting with set-up and technical support, thus saving the physician time. The key is finding a way to make the introduction of the hand-held into the

© 2014 The authors. Health Information and Libraries Journal © 2014 Health Libraries Journal

clinician's lifestyle a seamless one.[13] Research about rural outreach suggests that information use is greater when an information professional is able to provide the service.[3] Results from a survey by D'Alessandro stated, 'While physicians may only need to be trained once, they will need access to ongoing technical assistance. High-quality courteous, readily available technical support is crucial to the continued successful use of a [digital health sciences library] by physicians. Intensive training and long term support of users has been found to be the most effective means for successfully ensuring that practicing physicians adopt new technologies'.[4]

Background

Mobile technology and primary care clinicians

The background section reviews four mobile technology projects that led the authors to develop their hypothesis. In 2004, librarians at the Quillen College of Medicine Library of East Tennessee State University (ETSU) in Johnson City, Tennessee, partnered with family medicine physicians to test the feasibility and effectiveness of providing best evidence at the point of clinical decision-making with hand-held devices in a rural primary care setting. Twelve clinicians received hand-held devices loaded with the database InfoRetriever, now called Essential Evidence Plus (www.essentialevidenceplus.com/). A two-hour training session was provided. The goal of the project was to measure changes in the clinical management of antibiotics for sore throat/pharyngitis, antibiotics for acute sinusitis and X-ray for acute ankle injury. Measurements were taken by analysing the medical records of the patients treated by the twelve clinicians before and after having the mobile device with the point-of-care software. Although the power of the study was too small to detect any significant findings, it had the effect of confirming the value of mobile information technology in the clinic to ETSU medical librarians.

Thus inspired, ETSU librarians sought to cultivate mobile technology use in ETSU faculty, residents and students. The librarians were convinced that health science information had migrated from print to electronic format and that electronic information was moving from desktop to hand-held. The hand-held trend seemed intuitively beneficial to clinicians because the information they now had access to could be used at the point-of-care. If health science librarians were going to continue to be useful, they were going to have to change their practices to match these migrations or risk obsolescence.

Mobile technology and medical residents

East Tennessee State University medical librarians' second hand-held project was with family medicine residents at ETSU. Five grant-funded hand-held devices were given to residents on a hospital service in 2005. The hand-helds were rotated among the residents over the course of a year. The residents' reactions to the hand-held devices were favourable. At the end of the project, the hand-helds were given to the family medicine attending physicians, resulting in the added benefit of hand-helds becoming essential tools to their medical practices. The findings from this project cemented in the minds of the ETSU librarians that, 'It is difficult to escape the feeling that hand-held computers were designed with clinical practice in mind'[17] and that, 'By introducing PDAs to patrons even on a small scale the librarian is seen as technology explorer, expert, and innovator'.[18] The ETSU Medical Library became known as the place to go on campus for hand-held computing help, adding prestige to the library. Since the beginning of the first hand-held project, the library has recorded over 2000 service encounters related to hand-held devices.

Over the course of the projects, the ETSU librarians developed several beliefs related to hand-held devices. 'The best source of information provides highly relevant and valid information and can be obtained with minimal effort', and this retrieval of information is made possible by hand-helds.[19] The best way to teach technology is one-on-one or in small groups with hands-on experience as a major component. Physicians must be exposed to and taught to use clinical tools available on mobile technology such as the drug database Epocrates (www.epocrates.com) and point-of-care tools such as DynaMed (https://dynamed.ebscohost.com/),

© 2014 The authors. Health Information and Libraries Journal © 2014 Health Libraries Journal

UpToDate (www.uptodate.com,) and Essential Evidence Plus (http://www.essentialevidenceplus.com/). Older physicians, who may be resistant to new technologies and lack technology skills, must be brought up to speed in order to effectively teach and model the best clinical behaviour for medical students and residents.

Mobile technology and older faculty physicians

In 2006, ETSU librarians obtained grant funding to purchase seven hand-helds for ETSU faculty physicians. The goal of this project was to train the older, possibly technophobic faculty physicians so that they would see the value of using mobile technology in the clinic. As an incentive for completing the training, the physicians received continuing medical education credits. Training was done one-on-one in the physician's office from 1 to 4 hours. In a post-project survey, the physicians indicated the device was useful in aiding medical decision-making, that they were comfortable retrieving information from the device in front of patients, and that they would recommend other physicians use this device for medical education.

Mobile technology and rural clinicians

From 2006–2008, the Tennessee Hospital Association asked the ETSU medical library to partner in a grant-funded project to bring mobile technology to eight rural critical access hospitals in Tennessee. Critical access hospitals are small, remote, rural hospitals that qualify for different compensation rates under the U.S. Medicare program. Outside researchers were hired to analyse the results. A survey was created based on the Rothschild study.[20] One hundred seventeen responses were received. Survey results indicated a number of positive changes that occurred by utilising mobile technology. Ninety-three per cent of the clinicians were better able to inform patients of issues related to their care. Sixty-six per cent of the clinicians indicated that their patients were more satisfied with care. Sixty-five per cent felt that Epocrates prevented at least one adverse drug event per week. Ninety per cent of the clinicians felt that Epocrates answered all their questions at least three-fourths of the time. Eighty-three per cent of the respondents thought the device increased their drug knowledge base. Eighty-nine per cent believed the device contributed to improved drug-related decisions. Seventy-five per cent felt that the device affected clinical decisions at least once per week.

Objectives

These four experiences with hand-held devices motivated the authors to investigate whether hand-held devices with librarian support and the primary literature via LoansomeDoc could both easily and inexpensively meet the information needs of underserved clinicians. The authors hypothesised that if an underserved clinician was provided with: (i) a hand-held device with a best-evidence point-of-care disease tool and a drug database; (ii) access to a medical library for full-text articles through PubMed/Loansome Doc; and (iii) training to use these tools by a medical librarian, that basic information needs could be affordably realised (Fig. 1). The purpose of this paper was to test this hypothesis with two more mobile technology interventions.

Methods

The ETSU Institutional Review Board approved the study methods and instruments for this project. This study is a mixed-methods methodology. Two more hand-held projects were implemented to test the hypothesis. The first project was evaluated using a randomised controlled trial (RCT)

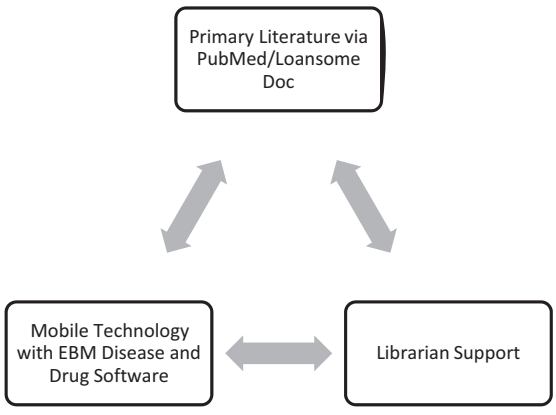

Figure 1 A three pronged approach to meeting the information needs of rural health professionals

© 2014 The authors. Health Information and Libraries Journal © 2014 Health Libraries Journal

methodology. The second was evaluated qualitatively using interviews and focus groups (Table 1).

For the quantitative project, grant funds were obtained from the U.S. National Network of Libraries of Medicine/Southeast/Atlantic region (NN/LMSE/A) (http://nnlm.gov/sea/). From 2008–2010, eighty hand-held devices were purchased and DynaMed was installed as the point-of-care, best-evidence disease database along with the free Epocrates (www.epocrates.com) drug database. Eight rural hospitals were chosen, in which ten clinicians per hospital received a device. Participants received unlimited access to ordering full-text articles through PubMed/Loansome Doc.

The hospitals were divided into two groups of four with forty participants in each group. The hospitals were randomly assigned into one of the two groups. The hospital administration chose who received the devices. Physicians who did not have a mobile device or who needed a new one were given top priority. The two groups of hospitals were matched to have similar demographics. Twenty-one were lost to follow-up, leaving 26 usable responses from the surveyed-after group and 33 from the surveyed-before group (Fig. 2).

The eight hospitals were chosen based on accepted definitions of rurality listed by the U.S. Centers for Medicare & Medicaid Services rural health clinics status and the Office of Rural Health Policy. A survey was developed based on validated instruments (See Appendix 1). It was pilot-tested with a small group of family medicine residents to determine validity. Group one received the survey before using the hand-held device, and group two received the survey after approximately 6 months of using the hand-held. This was the only difference between the two groups.

For the qualitative project in 2010–2012, one hundred iPod Touches were purchased with grant funding from NN/LM SE/A and distributed to ten clinicians in each of ten rural hospitals. As a qualitative study, there was no comparator group or any randomization. Clinicians were chosen by the hospital based on their need for the device. An iPod Touch is an Apple product (www.apple.com). It has all the functionality of an iPhone but will not make telephone calls. The devices were loaded with Epocrates for drug information and clinical evidence (www.clinicalevidence.com) for disease information. As with previous projects, the librarians travelled to each site and provided training on how to use the device and the medical software. The librarians were available for assistance anytime during the one-year time period of the project. Unlimited access to full-text journal articles through PubMed/LoansomeDoc was provided. The project was analysed qualitatively through structured interviews with participants. Interviews were recorded and transcribed, and themes were analysed. The process continued until data saturation was achieved. Eighteen clinicians were interviewed at length. Three coders analysed the data using NVIVO 9 (http://www.qsrinternational.com/products_nvivo.aspx). Comments of the interviewees were organised into logical categories based on their remarks. These categories were training, interlibrary loan, Epocrates, other databases, non-hand-held resources, the iPod Touch device, information barriers, information needs and future projects.

Results

The authors set-up the quantitative analysis as a randomised trial. The first question asked respondents to give responses from '1' to '5' on a Likert-type scale in which a '1' represents 'finding an answer less than 10% of the time when they had an information need' and a '5' 'finding an answer 75–100% of the time when they had an information need'. The group that was surveyed after using the iPod Touches in the project indicated that they found answers at a slightly higher rate than the untrained group (Fig. 3). The second question measured the speed of finding information when needed. Respondents could choose from a Likert-type scale of '1' – '5', with '1' representing less than one minute and '5' greater than 15 minutes. The 'before' group fell close to the 6- to 10-minute point on the scale, whereas the 'after' group fell closest to the 2- to 5-minute response point (Fig. 4).

The respondents were asked whether they were satisfied with the clinical information they retrieved when they had an information need. A Likert-type scale was used with '1' representing

© 2014 The authors. Health Information and Libraries Journal © 2014 Health Libraries Journal

Table 1 Summary of investigators PDA/Smartphone interventions 2004–2012

Project	Partner	Subjects	Purpose	Research Methods	Results
1.	ETSU Family Medicine (PI)	Twelve rural primary care clinicians	To see whether Essentials Evidence Plus (formerly Inforetriever) could change primary care clinicians' practice habits	Evaluation of medical records	Power of study too small to detect significant findings
2.	NN/LM	Twenty-one ETSU Family Medicine residents on hospital service	To test whether a combination of a PDA/smartphone with a clinical librarian at morning report would positively influence residents care given to patients	Survey based on Rochester Study questions[21]	Residents reported significant changes in treatment given, etc.
3.	None	Older technophobic physicians	To investigate whether a free PDA with individual office-based instruction would change negative attitudes of older faculty physicians towards technology	Post-project survey	Physicians felt comfortable with technology, found it useful and would recommend it
4.	Tennessee Hospital Association (PI)	130 rural physicians associated with critical access hospitals. Recipients were trained.	To improve patient safety in rural critical access hospitals	Post-project survey based on Rothschild study [20]	Clinicians better able to inform patients, adverse drug events prevented and knowledge base increased
The interventions listed above are described to indicate investigators background with PDA/Smartphones. The two interventions below are analysed in this paper					
5.	NN/LM	80 rural physicians associated with rural hospitals. Recipients were trained. Free Ill with PubMed/LoansomeDoc provided	To improve information access of rural clinicians	RCT	Clinicians who used smartphone/PDAs found information faster, were more satisfied, etc.
6.	NN/LM	100 rural physicians associated with rural hospitals. Recipients were trained. Free Ill with PubMed/LoansomeDoc provided	To improve information access of rural clinicians	Qualitative analysis	Clinicians pleased with iPod Touch, ePocrates and training. Did not use primary literature through PubMed/LoansomeDoc

© 2014 The authors. Health Information and Libraries Journal © 2014 Health Libraries Journal

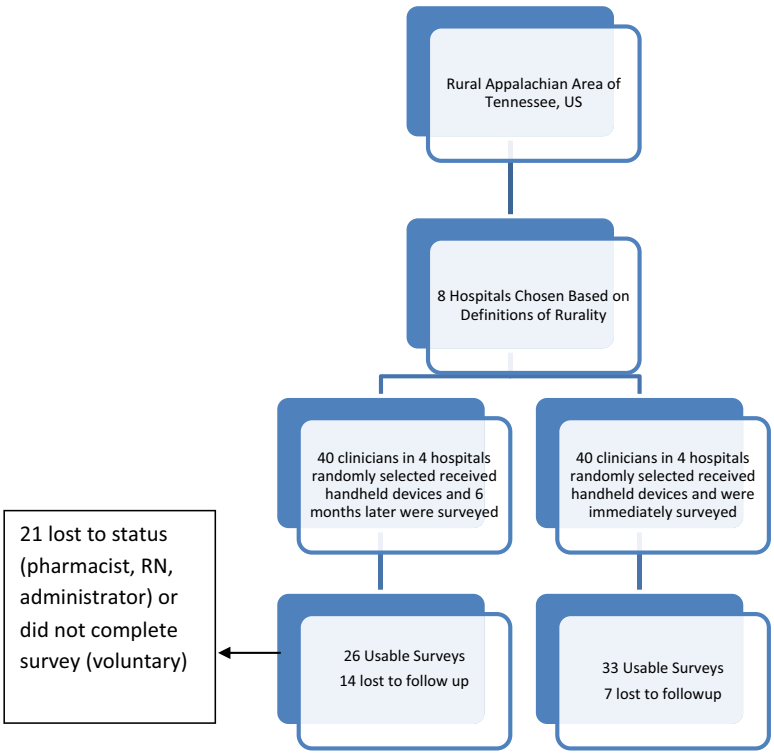

Figure 2 Randomized controlled trial of use of handheld technology by rural clinicians

'very satisfied' and '4' unsatisfied. The group who had used the hand-helds indicated they were more satisfied than the before group who had not used the device (Fig. 5).

A set of several information sources were listed which are not readily available in rural areas and are expensive. The respondents who had used the hand-held device utilised continuing medical

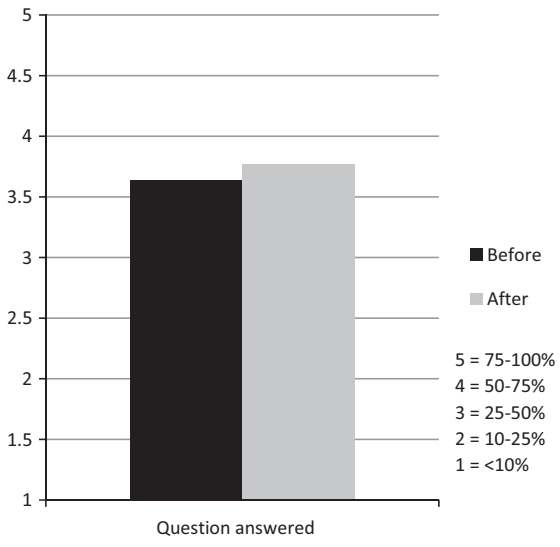

Figure 3 Frequency which clinicians were able to find an answer to their information need

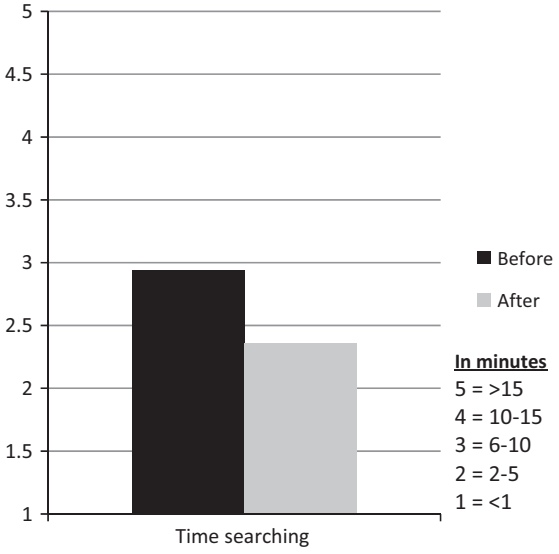

Figure 4 Average time spent searching for an answer in the clinical setting

© 2014 The authors. Health Information and Libraries Journal © 2014 Health Libraries Journal

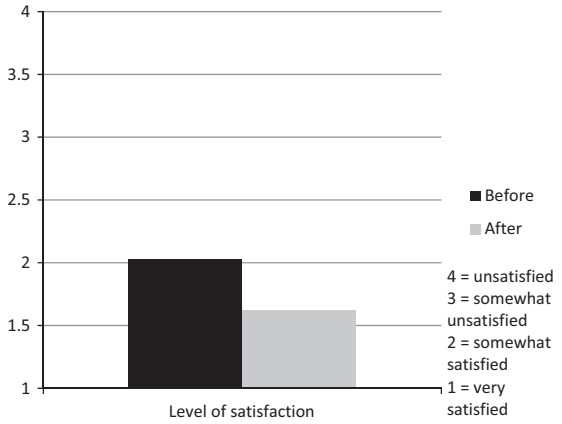

Figure 5 Satisfaction with clinical information found

education classes, colleague consultations, medical journals, online databases and textbooks less than the group who had not used the hand-held. The hand-held group used hand-helds, of course, more frequently than the non-hand-held group (Fig. 6).

Both groups indicated that, by far, time was the major barrier to finding information. Cost was a significant barrier and was nearly identical in the two groups. Difficulty using online resources was a significant barrier for both the groups. Time was less of a barrier in the hand-held group, and technology issues were more of a barrier in the hand-held group. Both of these findings seem logical, as hand-helds should speed up information retrieval, yet introduce new issues with technology (Fig. 7).

The qualitative analysis added depth to the quantitative analysis. When asked about the training the participants received, they stated that it was adequate and the trainers' technical expertise was impressive. They supported the ETSU librarians' belief that one learns from doing. An additional benefit was that the participating clinicians indicated they passed on the skills they learned from the librarians to their colleagues who were not part of the project.

Unfortunately, the clinicians did not fully utilise the PubMed/Loansome Doc aspect of this project. Comments were made that there was no great need for the primary literature. Some indicated they were unaware of the document delivery service aspect of the project, which pointed to an inadequate job of marketing. However, others said they did use PubMed/Loansome Doc and found it helpful. The overall response to Epocrates was very positive. Specific attributes of Epocrates that were noted as valuable were the patient information, pill identifier and BMI calculator. Indications were that Epocrates was used frequently and changed treatment and diagnostic decisions. Other mobile apps which they found useful were Shots! (an immunisation app) (http://www.immunizationed.org/AnyPage.aspx?pgid=2), AHRQ epss (a screening app) (http://epss.ahrq.gov/PDA/index.jsp) and Diagnasaurus (a differential diagnosis program) (http://accessmedicine.com/diag.aspx). The ETSU team

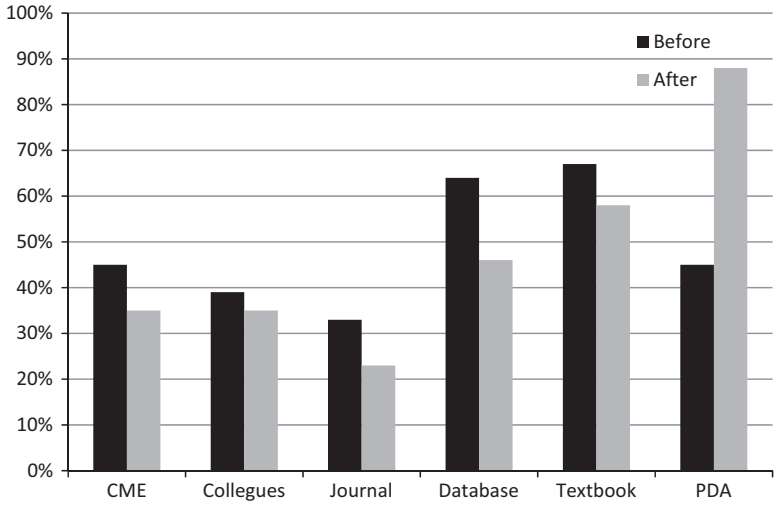

Figure 6 Percent of respondents who indicated that they used the above clinical resources

© 2014 The authors. Health Information and Libraries Journal © 2014 Health Libraries Journal

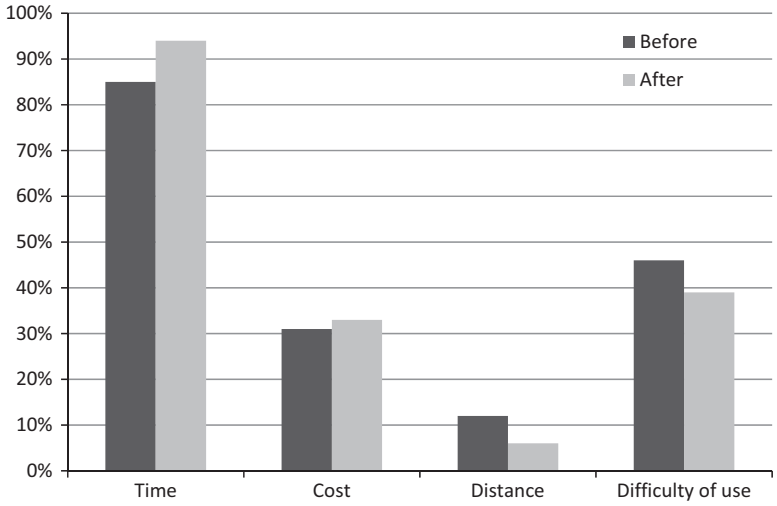

Figure 7 Barriers to use

installed these free apps on all the devices. Other mobile applications or websites mentioned favourably were the *Prescriber's Letter* (http://prescribersletter.therapeuticresearch.com) and viewing podcasts. The ETSU team did not load these resources.

Comments about the iPod Touch were that it helped make better decisions, was easy to use, was used frequently, was very intuitive, was user friendly, replaced text books, saved time, was a good size, was 'a second brain' and was invaluable. One clinician said he needed more iPod Touches to give to his nurse practitioners and nurses. Several said they used them for non-medical reasons as well as medical, and one respondent purchased an iPad as a result of the iPod Touch experience.

Information barriers mentioned were lack of wireless access, time, lack of a medical library onsite, no medical specialists to consult, rural location, cost, lack of technical expertise and drug representatives not as available because of American Medical Association restrictions. One interviewee stated that, 'Information is a huge need in rural practice'. Specific information needs expressed were evidence based medicine resources for family medicine, stroke and other protocols for the emergency room, information about professional conferences, paediatric emergency room information, immunisation information for parents, patient education information, updates on the latest trends in technology, access to grand rounds, continuing medical education access and an anatomy programme for a hand-held device.

One rural physician summed up the difficulty of accessing information in rural practice. He said, 'In prior practice in Philadelphia, I could go down the hall and ask the author of a textbook a question. Now, when I need to consult a specialist, there is only me'.

Discussion

Hand-held devices are extremely valuable to the clinician as is evidenced by their widespread use and studies in the medical literature that illustrate the value of mobile technology to clinical practice. The development of the 'secondary literature' market of evidence-based disease summaries covering most medical topics concurrent with the development of hand-held devices allows high-quality, point-of-care information to be accessible to all clinicians. This study's findings agree with the literature that both mobile computing and point-of-care databases are valuable and help to eradicate barriers to information use among rural clinicians.

A motivation to do this research was the authors' experiences with populations who obtained hand-held devices, yet who never received training on how to use the device, how to download software or how to use medical programmes once they were loaded. Librarians, however, know that patrons must be given appropriate instruction in the use of any

© 2014 The authors. Health Information and Libraries Journal © 2014 Health Libraries Journal

information resource. The researchers' findings were similar to the literature in regard to training. The training provided to the rural clinicians was highly valued. The literature indicates that uptake of mobile technology has a behavioural component. The investigators experienced this in their training particularly with older clinicians. Because of the training, several older clinicians became the most passionate users in the project. Along with mobile technology and librarian support, another factor in this strategy was the inclusion of PubMed/Loansome Doc for the participants, so they could order full-text primary literature. The ETSU team believed that the full range of clinical questions could only be answered with a combination of both primary and secondary resources. A study of information resources used to answer clinical questions on medical rounds at Vanderbilt University demonstrated that secondary resources could only answer a part of clinicians' questions.[22] The findings from this study did not agree with the literature that PubMed/Loansome Doc would be a valuable resource. The reason for this could be the study at Vanderbilt was conducted in an urban hospital setting and the authors' research was mostly done in rural primary care ambulatory clinics. A reason the PubMed/Loansome Doc component may not have been successful is poor promotion on the authors' part to the rural clinicians.

Both the literature and the authors' studies indicate that cost is a barrier to accessing information. Rural hospitals (and increasingly urban hospitals as well) do not have medical libraries because of cost. They also do not have site licences to online journal collections and databases for the same reason. The fact that this intervention was grant-funded may seem as an advantage that is not available to those who do not have grant funding. However, hand-held devices have widespread adoption with the advent of smartphones. Many databases such as Epocrates are free. Academic medical libraries with a service attitude can provide initial hand-held device training for rural clinicians in their geographic area and provide Lonesome Doc/PubMed or other document delivery services at low cost. The whole project described in this paper is sustainable at a low cost. ETSU has provided this type service to dozens of health care facilities in rural and underserved areas.

Future

The ETSU Medical library developed a PDF handout with instructions on how to download and use the most valuable clinical apps. It is widely distributed to ETSU medical students and residents. ETSU medical librarians have obtained a regular assignment to teach a 1-h smartphone class as part of a family medicine clinical rotation. External funds to provide mobile devices or software for more clinicians in rural Tennessee communities was applied for, but not funded. ETSU medical librarians always encourage information product vendors to make their products work on mobile platforms. Health information professionals can provide mobile technology services to their users and can reach out to surrounding underserved clinicians and offer support in the use of clinical mobile technology. ETSU medical librarians would like to further investigate the role of the primary literature with rural primary care clinicians. Funding agencies could develop programs that would enable outreach librarians to equip underserved clinicians with smartphones and access to Loansome Doc. Medical Librarians could become more involved in global health and distribute ruggedised mobile devices and Loansome Doc access to clinicians in rural Third World practices.

Limitations

The sample size of the RCT was underpowered. This could be overcome by replicating the study in other sites and combining the results. The RCT non-hand-held group was contaminated by some of the members having previous hand-held experience. However, if this had not been true, the differences found between the two groups would have probably been stronger. The results from the qualitative interviews are not necessarily transferrable to other populations.

Conclusion

The authors feel that combining mobile technology with librarian support and access to the primary literature is a good way to provide the minimum information needs affordably to clinicians who are underserved with information. Subjects in this

© 2014 The authors. Health Information and Libraries Journal © 2014 Health Libraries Journal

study who used health information on hand-held devices found more answers to their clinical questions, found them faster, were more satisfied with the results and were less dependent on consultations and personal subscriptions than those who had not. They expressed high praise for point-of-care databases and mobile computing, were pleased with the training they received and passed on skills they learned to fellow clinicians. Many areas of the United States have large populations of clinicians who do not have access to medical libraries or online collections. These projects illustrate the value of interventions in rural and underserved areas where there is inadequate clinical information resources. Librarians can implement a three-pronged strategy of the secondary literature via a hand-held, the primary literature via Loansome Doc and quality training by a librarian to meet basic information needs. The project was best summed up by an older physician who stated that for him this intervention was a 'gateway to the information age'.

Source of funding

This project has been funded in whole or in part with Federal funds from the National Library of Medicine, National Institutes of Health, Department of Health and Human Services, under Contract No. N01-LM-6-3502 with the University of Maryland Baltimore.

Conflicts to interest

The authors have no conflicts to report.

References

1 Merrell, R. C., Merriam, N. & Doarn, C. Information support for the ambulant health worker. *Telemedicine Journal & e-Health* 2004, **10**, 432–436.

2 Dee, C. & Blazek, R. Information needs of the rural physician: a descriptive study. *Bulletin of the Medical Library Association* 1993, **81**, 259–264.

3 Dorsch, J. L. Information needs of rural health professionals: a review of the literature. *Bulletin of the Medical Library Association* 2000, **88**, 346–354.

4 D'Alessandro, D. M., D'Alessandro, M. P., Galvin, J. R., Kash, J. B., Wakefield, D. S. & Erkonen, W. E. Barriers to rural physician use of a digital health sciences library. *Bulletin of the Medical Library Association* 1998, **86**, 583–593.

5 McGowan, J. J. & Richwine, M. Electronic information access in support of clinical decision making: a comparative study of the impact on rural health care outcomes. *Proceedings/AMIA . . . Annual Symposium*, 2000: 565–569.

6 Lucas, B. P., Evans, A. T., Reilly, B. M., Khodakov, Y. V., Perumal, K., Rohr, L. G., Akamah, J. A., Alausa, T. M., Smith, C. A. & Smith, J. P. The impact of evidence on physicians' inpatient treatment decisions. *Journal of General Internal Medicine* 2004, **19**(5 Pt 1), 402–409.

7 Coggan, J. M. & Crandall, L. A. Expanding rural primary care training by employing information technologies: the need for participation by medical reference librarians. *Medical Reference Services Quarterly* 1995, **14**, 9–16.

8 Rubin, M. A., Bateman, K., Donnelly, S., Stoddard, G. J., Stevenson, K., Gardner, R. M., *et al.* Use of a personal digital assistant for managing antibiotic prescribing for outpatient respiratory tract infections in rural communities. *Journal of the American Medical Informatics Association* 2006, **13**, 627–634.

9 Lasserre, K., Eley, D., Baker, P. & Kruesi, L. Medical students out of town but not out of touch: use of personal digital assistants to improve access to clinical information and enhance learning at the point of care in rural and remote Australia. *Australian Journal of Rural Health* 2010, **18**, 87–88.

10 Prgomet, M., Georgiou, A. & Westbrook, J. I. The impact of mobile handheld technology on hospital physicians' work practices and patient care: a systematic review. *Journal of the American Medical Informatics Association* 2009, **16**, 792–801.

11 Lindquist, A. M., Johansson, P. E., Petersson, G. I., Saveman, B. I. & Nilsson, G. C. The use of the Personal Digital Assistant (PDA) among personnel and students in health care: a review. *Journal of Medical Internet Research* 2008, **10**, e31.

12 Mickan, S., Tilson, J. K., Atherton, H., Roberts, N. W. & Heneghan, C. Evidence of effectiveness of health care professionals using handheld computers: a scoping review of systematic reviews. *Journal of Medical Internet Research* 2013, **15**, e212.

13 Honeybourne, C., Sutton, S. & Ward, L. Knowledge in the Palm of your hands: PDAs in the clinical setting. *Health Information & Libraries Journal* 2006, **23**, 51–59.

14 Hudson, K. & Buell, V. Empowering a safer practice: PDAs are integral tools for nursing and health care. *Journal of Nursing Management* 2011, **19**, 400–406.

15 Scott, I., Wilson, C. & Gowans, M. Are personal digital assistants an acceptable incentive for rural community-based preceptors? *Family Medicine* 2005, **37**, 727–733.

16 Grad, R., Pluye, P., Granikov, V. & Johnson-Lafleur, J. Many family physicians will not manually update PDA software: an observational study. *Informatics in Primary Care* 2009, **17**, 225–230.

17 Al-Ubaydli, M. Handheld computers. *BMJ* 2004, **328**, 1181–1184.

18 Galganski, C., Peters, T. & Bell, L. Exploring Planet PDA. *Computers in Libraries* 2002, **22**, 32.

19 Shaughnessy, A. F., Slawson, D. C. & Bennett, J. H. Becoming an information master: a guidebook to the medi-

© 2014 The authors. Health Information and Libraries Journal © 2014 Health Libraries Journal

cal information jungle. *Journal of Family Practice* 1994, **39**, 489–499.

20 Rothschild, J. M., Lee, T. H., Bae, T. & Bates, D. W. Clinician use of a palmtop drug reference guide. *Journal of the American Medical Informatics Association* 2002, **9**, 223–229.

21 Marshall, J. G. The impact of the hospital library on clinical decision making: the Rochester study. *Bulletin of the Medical Library Association* 1992, **80**, 169–178.

22 Koonce, T., Giuse, N. & Todd, P. Evidence-based databases versus primary medical literature: an in-house investigation on their optimal use. *Journal of the Medical Library Association*, 2004, **92**(4), 407–411.

Received *22 July 2013*; Accepted *4 July 2014*

Appendix 1

Clinical Information Survey

1 On average, how many patient visits do you have per week?
- □ <25
- □ 25–50
- □ 50–75
- □ 75–100
- □ >100

2 Of those, how many do you have a **clinical information** need for?
- □ <25
- □ 25–50
- □ 50–75
- □ 75–100
- □ >100

3 Of those, how frequently do you look up **clinical information** for patient care?
- □ <10%
- □ 10–25%
- □ 25–50%
- □ 50–75%
- □ 75–100%

4 When looking up **clinical information** for patient care, how often do you find an answer to your clinical information need?
- □ <10%
- □ 10–25%
- □ 25–50%
- □ 50–75%
- □ 75–100%

5 In general, how satisfied are you with the medical information you find? (Circle One)

Very Satisfied Somewhat Satisfied Somewhat Unsatisfied Unsatisfied

6 What sources do you use? Check all that apply
- □ PDA
- □ Textbook, specify name_____
- □ Online Database, specify name_____
- □ Journal, specify name_____
- □ Colleagues
- □ CME/Conferences
- □ Other, specify_____

7 When you seek **clinical information** for patient care, how long do you spend on average loolring/searching for an answer?
- □ <1 minute
- □ 1–5 minutes
- □ 6–10 minutes
- □ 10–15 minutes
- □ >15 minutes

8 What are the two greatest barriers to getting the **clinical information** you need? (Please check two.)
- □ Time
- □ Cost
- □ Distance
- □ Difficulty Using Online Resources
- □ Other, Specify_____

Demographic Questions

HOSPITAL:_____

PRACTICE (CIRCLE ONE): INPATIENT OUTPATIENT BOTH

SPECIALITY: _____

YEARS OF PRACTICE: _____

AGE:_____

GENDER (CIRCLE ONE): F M

EXPERIENCE WITH GENERAL TECHNOLOGY:

INTERNET ACCESS (CIRCLE ALL THAT APPLY): HOME WORK

EMAIL COMMUNICATION WITH PATIENTS (CIRCLE ONE): YES NO

PREVIOUS PDA EXPERIENCE (LIST # OF YEARS):_____

© 2014 The authors. Health Information and Libraries Journal © 2014 Health Libraries Journal

Copyright of Health Information & Libraries Journal is the property of Wiley-Blackwell and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.