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RESEARCH

Tablet computers for recording tuberculosis data at a community health centre in King Sabata Dalindyebo Local Municipality, Eastern Cape: a proof of concept report

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Background: Data at primary healthcare (PHC) clinics are handwritten in registers by nurses for submission to the District Health Information System (DHIS). Compared to pen and paper, data capture, using handheld computers, has fewer errors, is more efficient and is readily accepted by users. This study describes the process of developing a tablet computer programme to capture data, and explores nurses' experiences of using tablets at a community health centre.
Method: OpenDataKit® was used to design XForms for touchscreen entry. Data for tuberculosis screening were captured by nurses on Android® 9.7-inch tablets over a week. Their experience was explored by means of a focus group interview.
Results: Data were recorded for 24 patients and seamlessly transferred for analysis. Nurses thought that the tablets were easy to use and saved time. They would be happy to use tablets in preference to pen and paper. They expressed a desire to extend the use of tablets to other areas of their work.
Conclusion: Tablet computers were readily accepted by the nurses. They are a feasible alternative to pen and paper for recording data at point of care. This tablet-based system could be used to transfer PHC data directly to the DHIS.

Keywords: analysis, clinic data, computers, Eastern Cape, primary health care, tablet, tuberculosis data

Introduction

Primary healthcare (PHC) in South Africa is mainly provided by nurses at community health centres (CHCs) and clinics in the public health sector.[1] Data at CHCs are handwritten in registers by nurses for government monitoring and evaluation purposes, and aggregated for submission to the District Health Information System (DHIS). Identified problems with this type of approach include a high work burden by clinicians and poor data quality.[2-4]

There is evidence that health information technology could improve the quality of healthcare by increasing adherence to guidelines, enhancing disease surveillance and decreasing medication errors.[5] Also, it is believed that electronic health record systems reduce the time spent by nurses on documentation in hospitals.[6] The Department of Health has published plans whereby primary healthcare facilities will migrate from the current predominantly paper-based system to the electronic submission of data for the DHIS, and according to which an electronic health record system will be introduced.[7] In the meanwhile, it is important to explore methods that assist nurses in recording data more efficiently and accurately, and those that may inform the design of an electronic health record.

The aims of this study were:

- *Phase 1:* To describe the process of identifying and developing a tablet computer programme to capture data.
- *Phase 2:* Qualitative evaluation of the use of tablet computers to record data at a rural CHC.

Method

Data collection process at community health centres

There are essentially two data collection systems at CHCs. The first pertains to registers for the DHIS. Essentially, this is the same process as that for field surveys. It is the recording of items of service at the point of contact, e.g. administered immunisations, sputum collected for tuberculosis testing, the number of persons diagnosed with tuberculosis, and laboratory results for human immunodeficiency virus (HIV)-positive patients. The second pertains to patient management. Patient data and information are recorded on paper sheets and cards. Some records are kept at the CHC, but most of them are retained by patients. This study dealt with data that were principally required for the DHIS.

Review of the literature: electronic data entry compared to pen and paper data entry

The advantages of handheld electronic devices for data collection compared to paper, i.e. the reduced cost of data collection, less risk of data loss, early detection of systemic data collection errors, a high user acceptance and reduced time for data entry, have been demonstrated in numerous studies.

In a questionnaire survey on vaccinations conducted in US family practices in 2002, it was found that data entered by practice staff on personal digital assistants (PDAs) were more complete and accurate that those on paper forms.[8] Another US study on an anaesthetic service showed that a PDA was more efficient, in terms of time taken and data completeness, in collecting data, than pen and paper.[9]

Studies undertaken in developing countries showed similar results. In a study in 2002 on malaria in Gabon, there was a low rate of discrepancies (1.7%) between data entry errors on PDAs and those on paper forms.[10] PDAs required less manpower for data entry, and clinicians found the PDAs to be efficient. In a field study in the Gambia, use of a small handheld computer resulted in fewer data errors and faster interview times than pen-and-paper questionnaires.[11] A paper-based system was compared with a PDA system to collect tuberculosis results from remote laboratories in a time motion study in Peru. The PDA system resulted in a 60% reduction in the time taken to collect and process the results.[12] Bernabe-Ortiz et al[13] showed that data entry into PDAs resulted in fewer errors

and inconsistencies than a paper-based system. A review of nine randomised trials indicated that PDAs were faster and were preferred by most users over pen and paper.[14] In South Africa, Seebregts et al[15] showed that the running costs for data collection by PDAs were lower than those of paper, and calculated that the purchase and programming costs of PDAs were recovered once they had been used for eight studies.

In contrast to the above studies, one report showed more errors when nurses entered data on a PDA, than when a paper-based form was used.[16] Most mistakes occurred in fields containing a default value, such as a date. However, the report was a letter to the editor, and lacked sufficient detail to justify a full evaluation of the study.

Handheld computer devices for data entry

Digital data collection with handheld computers for surveys and fieldwork has shown advantages over desktop and laptop devices, e.g. portability and robustness.[15]

Choice of handheld computer device

PDAs have been superseded by smart phones and tablet computers. Rajput et al[17] identified the disadvantages of PDAs when they were used for fieldwork in rural Kenya, i.e. data could not be exported directly into an electronic health record. The Pendragon® Forms Software on PDAs had limited functionality, the device had to be linked to a separate global positioning system unit, and the costs were substantial.

Smartphones

Smartphones using the Android® operating system were used for data collection by community-based health workers.[17] The Android® operating system was chosen as it is open source. It is the most popular system for smart phones. OpenDataKit® is an available tool for writing forms. Data were entered onto forms and transferred as XML files into OpenMRS® (an open-source electronic health record) using a USB cable. Users favoured the smartphone over the PDA device in terms of speed, ease of use and data quality. The cost per individual entry was also estimated to be cheaper than that of a PDA or paper-based system.

Tablet computers

Tablet computers have been in existence for over a decade. Previously, they were laptop computers with a swivel screen, and required a stylus for screen input. The current generation of "post-PC" tablet computers, as exemplified by the Apple® iPad2 and Samsung® Galaxy, can avail the use of cloud-based storage, and include readily available inexpensive software. "Post-PC" tablet computer devices, using Android® and iOS® operating systems, most frequently use capacative touchscreens with multi-touch, which don't require the use of a stylus. They should be considered to be completely new devices.

Tablets have been used for data entry by patients[18] and at point of care by nurses.[19] They are mobile and as portable as paper.[20] Ehrler et al[21] identified Android® as the most appropriate operating system for clinical applications on tablet devices.

Based on the above studies, data for the DHIS entered on Android® tablets should be more complete and accurate than that entered on paper registers, and the tablets are acceptable to nurses. Therefore, Android® tablet computers were identified as the most suitable device for digital data entry at CHCs. Scroll Elite® 9.7-inch tablets were used as they were supplied with Android® version 4 (the latest version available in early 2012), and were obtained at a reasonable cost of R3 013 each.

Phase 1: Identification and development of a tablet computer programme

The authors identified OpenDataKit® as the most appropriate tool for data collection as it supports a total process and environment to help create mobile data collection services.[22] An overview of OpenDataKit® concluded that "the modular, extensible and open-source design allows users to pick and choose the tools best suited to their specific deployment".[22] OpenDataKit® supports the user in building forms, validating them and delivering them from a cloud server to a tablet. It also facilitates data collection on a tablet, the transfer of results to a cloud server, and then storage and analysis of the data using OpenDataKit® Aggregate. Many of the current Android® data collection apps are based on OpenDataKit®, e.g. OpenClinic®, CommCare® and DataWinners®. It is a well supported open-source set of tools. The authors were familiar with XML and could use OpenDataKit® Collect to develop forms for data collection on Android® tablets. The authors set up a Google® app engine that made it easy to install on the server, OpenDataKit® Aggregate.

The forms were designed by replicating the data to be captured for the paper-based tuberculosis screening tool routinely used in PHCs. XForms were developed and a Google® apps server was set up and connected to OpenDataKit® Aggregate. Forms were downloaded to the tablets, together with a copy of OpenDataKit® Collect (Figure 1).

Data collection form

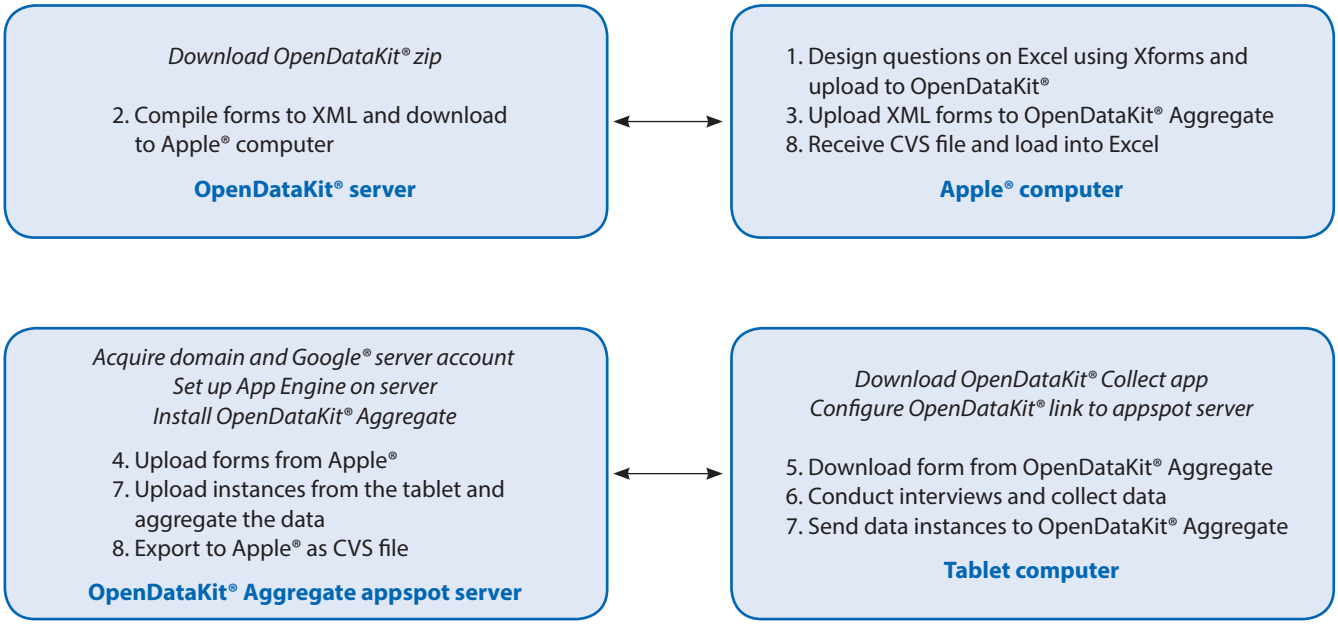
The tuberculosis screening tool is used to screen HIV-positive patients for tuberculosis and consists of 10 questions. If any response is "Yes", then the patient is referred for a tuberculosis investigation. If "No", then the patient is offered isoniazid prophylaxis therapy. These outcomes generate four more questions. The date, time and tablet identifiers were all captured automatically for data entry. To ensure confidentiality, anonymised data were collected without patient identifiers, e.g. names, addresses and telephone numbers.

Phase 2: Qualitative evaluation of tablet computers to record data

One CHC in King Sabata Dalindyebo Local Municipality was chosen as a site for qualitative evaluation as it is part of the teaching platform of Walter Sisulu University. A previous study had shown that nurses in King Sabata Dalindyebo Local Municipality had favourable attitudes to health information technology, and that many used smartphones.[23] Training of the nurses who worked mainly in tuberculosis care took approximately an hour before they were competent enough to use the application. They used two tablets for one week in December 2012 to record the tuberculosis symptoms of patients sent for tuberculosis screening.

Method

A focus group interview, comprising 12 nurses, was undertaken at the end of the trial period. Nurses who used the tablets or worked mainly in tuberculosis care were invited to attend. Consent was then verbally obtained before the group interview commenced. It was explained that attendance was voluntary. Anyone could leave at any time, without explanation, and without the decision impacting on work relationships. It was emphasised that everything that was said at the focus group interview was confidential, and that the information would only be used by the researchers. No-one would be identified by name or rank in any report published on the study. The discussion would be in English, and would be audiotaped. The



OpenDataKit® data capture process: The items in italics can be processed in any order

Figure 1: OpenDataKit® data capture process

audiotape and transcripts would be kept in a locked cupboard in the author's office at Walter Sisulu University.

A series of questions on the use and impact of tablet computers were suggested for discussion. The group was facilitated according to a recognised process[24] by the authors. The discussion was later transcribed, and then analysed and interpreted by the researchers using content analysis. Patton[25] details six generic steps in this process, i.e. the organisation and the preparation of data, reading through the data to obtain a general sense of the meaning, coding, the generation of themes, the representation of themes and interpretation.

Ethical approval was obtained from the Health Research Ethics and Biosafety Committee of Walter Sisulu University (Protocol No. 020/011).

Results

Data recording

The nurses recorded data on 24 patients. Data were complete for each patient. Twenty-four completed files were seamlessly transferred to OpenDataKit® Aggregrate on the Google® server and then exported to an Excel® worksheet. Data quality issues were not identified.

Experience using the tablet computers

The nurses unanimously thought that the tablets were easy to use and saved time: "It saves time. It takes just a few minutes to scan the patient".

They reported that they would be happier using tablets than pen and paper. The nurses thought that gesture entries were easier than typing. They indicated that they did not encounter any technical challenges when using the tablets. The screen size was convenient too. When asked to choose between the Scroll® Elite Tablet (9.7-inch) and a Samsung® S3 cellphone (4-inch), the nurses selected the tablet: "This one (tablet)! This is the working one. That's the fashion one (Samsung® S3)".

The nurses said that patients did not make any comments on their use of the tablets. However, they explained to the patients that they were recording tuberculosis data. The nurses believed that patients thought that they were using cellphones. They expressed a wish to extend the use of tablets to other areas of their work, e.g. to access Tier.net (an information system for recording HIV and tuberculosis data by data capturers), and to use other data-capture devices, such as barcodes. Their only concern was that the devices were easy to steal.

Discussion

This study highlighted acceptance by nurses in a rural CHC of tablet computers for data recording. They also wanted to extend the use of tablet computers to other areas of their work; consistent with their use of mobile technologies as part of everyday life.[23]

The results were consistent with previous studies, in which point-of-care technology with portable computing devices was associated with ease of use and faster recording.[14] Data should be captured once at the point of care so that monitoring and evaluation processes are linked to clinical care.[26] Data capture at the point of care is also part of the eHealth Strategy for South Africa 2012.[7] This study demonstrated that nurses responded positively to using tablet computers to record data within consultations.

Anonymised data were used in this study. Personally identifiable patient data could not be transferred onto a cloud server using public cellular networks without installing secure systems, such as encryption or a virtual private network. This tablet-based system could be used to transfer CHC data directly to the DHIS as DHIS-provided encryption could be implemented.

In summary, this study was a proof of concept. It showed that tablet computers are a feasible alternative to paper-based information systems for nurses at CHCs. Ehrler and Lovis recently stated that "the use of a mobile platform merges the advantages of a computerised information system with the mobility offered by paper".[19] The authors of this paper intend to test this by using tablet technology to input patient data into a clinical record system.

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