Meeting National Safety and Quality Health Service Standards – The Role of the Point-of-Care (POC) Audit Application

Christopher A. Bain, Tracey Bucknall, Janet Weir-Phyland, Suzanne Metcalf, Pam Ingram, and Lucy Nie

***Abstract*—We designed and deployed a point-of-care (POC) clinical information system on a Motion tablet to allow data collection at the bedside by specialist auditors in support of organizational clinical audit objectives. This initiative has been undertaken in the context of the new National Safety and Quality Health Service (NSQHS) Standards for Australia. Collected data was then warehoused in a Microsoft SQL Server Environment in real time, allowing immediate feedback through corporate level reporting. The reporting framework consists of self-service non-interactive reports and scorecards, and self-service interactive reports (or dashboards) where users can seek detailed information from an organizational level down to a patient level. Information is presented both numerically and graphically, including in a traffic light paradigm, to highlight clinical risks and their relative urgency. This paper examines the implementation of this system, its drivers, and the lessons learned from this unique initiative.**

***Index Terms*—Mobile, clinical audit, information management, implementation.**

I. Introduction

Safety and quality considerations are paramount in the delivery of healthcare services be they on a small scale – at an individual practice level, or on a large scale – for example, across a multisite healthcare organization. The aim of this particular piece of work was to improve the provision of quality of care information to healthcare executives, managers and clinicians, in order to target organizational strategies to achieve clinical improvements and increase patient safety. This initiative has been undertaken in the context of new nationally driven quality and safety standards for healthcare in Australia [1]. This has been achieved through the use of a new mobile data collection platform linked to tailored business intelligence (BI) tools. BI tools are known to have a place in assisting in the management of facilities and systems in range of industries [2], [3] and healthcare is no different [4], [5]. This project is also part of a larger program of development of BI capability in the organization under discussion.

II. Background

As part of recent political reforms in the healthcare industry, the Australian Federal Government, through its healthcare quality agency, the Australian Commission for Quality and Safety in Healthcare, released a series of 10 clinically focused standards ("the standards"). Health services need to meet the standards in order to be accredited as quality health service providers. Failure to meet the standards can have adverse effects on the financial state and reputation of health services. As a result, achieving this objective has become a major focus of activity for many Australian health services.

These 10 standards [1] cover the areas of:

- Governance
- Partnering with consumers
- Infection control
- Medication safety
- Patient identity checking
- Clinical handover
- Blood product usage
- Pressure injury prevention
- Managing deterioration in a patient's condition and
- Falls prevention.

For many years, clinical audits have been a part of clinical practice improvement in healthcare [6]-[9]. Historically, many clinical audit [10], [11] processes- designed to collect information about an organizations or individuals compliance with clinical quality standards (eg - care measures to prevent pressure ulcers)- have been centered around primary data collection on paper-based structured, or unstructured, assessment tools. An example is the Surgical Tool for Auditing records (STAR), used for auditing clinical records in the UK [12].

Typically, data has then been secondarily entered into electronic systems for subsequent analysis, reporting and benchmarking. Obviously such processes are error prone and far from ideal from an information management perspective. They also introduce a potential delay between primary data collection and subsequent feedback to key staff, which can influence practice and improve outcomes for patients.

There are several challenges attached to these processes. One important practical and information management challenge imposed by this approach is the need to randomly audit numerous patients for each different kind of audit - pressure care, falls management, drug interactions and so forth. As a result, such audits often need to be conducted in a rolling fashion through multiple clinical areas so as not to create an implementation burden for frontline staff. However this in turn delays feedback to these staff and reduces the frequency of measurement - effectively creating a series of "photographs" in relation to clinical quality and safety, rather

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than a constantly running "movie". Clearly such a “movie” can provide a constant stream of information on which a continuous cycle of improvement can be based.

Whilst clinical audit is an activity undertaken by many areas across a health service organization, one of the largest groups undertaking such work is typically the nursing area of the service. In this case, the nursing division of a large tertiary - quaternary Australian health service conceived of a modular, electronic audit tool to allow data collection at the bedside. Data collection at the bedside using a range of devices is a topic of interest amongst nursing staff given the nature of their work [13]. In this case, the senior nursing staff had a vision of a system that would dramatically improve the efficiency and validity of the audit process, as well as of resultant intelligence about care that could improve outcomes for patients in a range of dimensions. Technical staff at the health service shared the vision and played a key role in bringing the system to life. The commencement of the standards program acted as a further catalyst for the work.

III. Method

The POC clinical information system was designed and deployed on a Motion tablet to allow data collection at the bedside by specialist auditors. Deployment on a mobile device that would allow data collection at the bedside was a non negotiable requirement of the project.

Auditors were typically nurse educators or other senior staff. Collected data was then warehoused in a Microsoft SQL Server Environment in real time, allowing immediate feedback through corporate level reporting. The reporting framework consists of self-service non-interactive reports and scorecards (Microsoft Reporting Services), and self-service interactive reports (Qlikview) where users can seek detailed information from an organizational level down to a patient level. Information is presented both numerically and graphically, including in a traffic light paradigm, to highlight clinical risks and areas for action.

A. Development Context and Approach

The application was developed using an iterative prototyping approach with a phased implementation, commencing with a pilot amongst the core nursing staff involved in the development process. This approach allowed for the shifting requirements landscape, and afforded a good risk mitigation strategy given the severe time and resourcing constraints imposed upon the project.

The constraints that characterized this project included the limited time frame- approximately 6 months from the need being raised, to an implemented outcome being expected. In addition, there was little if any, additional funding available to support the work. However, the importance of establishing an electronic tool to support clinical audit data collection and reporting for the purposes of demonstrating compliance with the new national standards, cannot be overstated

B. System Features

The POC system is a Microsoft Excel- VBA application and hence can be run on any platform capable of running Excel with macros enabled. One of the drivers for the use of this platform was the fact that the initially available programming resource had already demonstrated proof of concept in this space with another, smaller audit application, and the responsible managers were impressed with the results. In addition, it could be seen that development on this platform would enable completion of the project under the immense time pressures surrounding the project, and within existing resource allocation. At project initiation it was always accepted that the application may need to be ported to a more stable and long term deployment platform when time allowed.

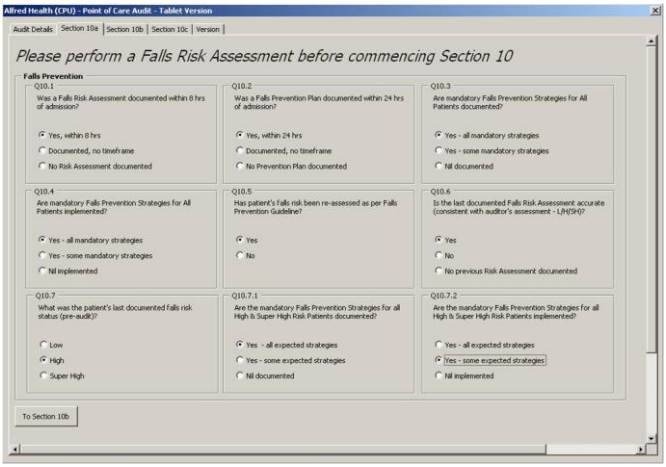

Fig. 1. The POC application–Module 10-Falls.

C. Graphical User Interface (GUI)

In relation to the graphical user interface (GUI), the POC application was specifically designed to be deployed on a Motion tablet, but can be run on a PC, laptop, computer on wheels (COW) or other devices, thru minor GUI adaptions that do not affect the core flow and function of the application.

The mismatch between the functionality and usability of clinical information technology (IT) solutions, and the needs of users, is an often heard anecdotal complaint in healthcare. In this case, the GUI has several specific design features to enhance the usability of the application. These design features include a modular design - at this stage users can select a "full audit" - all 10 modules; or a single audit module from a pick list. In terms of content, these modules align very closely (but not precisely) to the individual standards under the new national framework.

Another key GUI design feature is the progressive exposure of questions to users as they proceed down the relevant logic chain. So, for example, within a given module, if the largest number of questions a user may have to answer is 20, they will not be presented with these all at once. Each question will only be displayed on the screen as the last one is answered. This reduces the cognitive load on the user and allows them to focus on accurately answering the question at hand, rather than mentally skipping ahead to answer the next question, or the one after that.

As is the case with most good surveys, a consistent feature across all POC modules is a highly structured question format with codification of answers, and with minimal need for, or opportunity to enter, free text answers. Data entry is supported by a stylus with rapid system response time.

D. Mobile Deployment Issues

There is a growing awareness of the utility of mobile devices, and applications deployed on them, across all of healthcare [14]. There are already a range of clinical areas in which mobile device usage has established a stronghold such as in Nutrition [15], Radiology [16] and Emergency care [17]. This is in no small part due to the mobile nature of many healthcare workers' daily activities.

There are, however, a number of potential issues in relation to deploying and using healthcare applications on mobile devices, be they smart phones, handheld tablets or larger and heavier tablets like the Motion tablet. These include the need for a medical grade tablet device choice at the bedside versus more popular choices such as the iPad. In a bedside setting it is critical that end user devices are physically robust, and that they can also withstand trauma and are able to be wiped down to prevent the spread of infection. Some pieces of computing equipment are certainly known to harbor infectious organisms [18]. The Motion tablet was the device of choice in our facilities based on criteria such as these. In addition, this device was also suitable as a platform on which to deploy other core applications, including the Cerner Millennium clinical system which the health service uses.

E. Information Management Issues

It is critical in this context, where information is being collected against an individual patient – versus for example, collected at a ward level – that the patient in front of the auditor is correctly identified. Patient identity validation is undertaken automatically by the application, by checking the entered patient identification number against the organizational data warehouse. The patient's gender and date of birth are then retrieved so the user can ensure they are auditing the correct patient. As well as ensuring that the collected data will be linkable with other data about the patient, this reduces the risk of incorrect patient details being collected, as can be the case with traditional primary data collection on paper.

Importantly, the POC application was designed from the outset to be connected to what is known as the organizational "information grid". This grid- analogous to the electricity grid, where data is equivalent to electricity- is designed to allow the reliable and predictable flow of data and information to users irrespective of how or where it is generated. The grid concept is at the core of the organizational strategy in relation to data and information usage. The services available to the business from "the grid" include data extraction and distribution, non –interactive (static) reporting through Microsoft Reporting Services, and interactive (dynamic) reporting through Qlikview. It is these latter 2 services that the POC application leverages off to provide feedback to stakeholders regarding collected data.

IV. Results

The POC system has had a strong history of use since its release in April 2013. Let us now consider the results of the project in relation to usage and impact of the system, reporting, and stakeholder acceptance.

A. Usage Statistics and Impact

The extent of use of the POC solution since its deployment has been very pleasing. Since the commencement of the POC audit program earlier this year, in excess of 560 unique patients have been randomly audited in a 3 month period across 3 campuses of the health service. This number will grow substantially over time. This has been across 20, 12 and 4 wards respectively at the 3 main campuses of the health service- these being the main acute campus, the aged and sub-acute care campus, and the community based hospital campus. The POC application and its use were the focus of a presentation to the NSQHS assessors as part of the health service's accreditation process. The system, and the way it had been embedded in the service's quality processes, was commended by the lead assessor. Notably, the health service achieved accreditation and was the first major metropolitan service in the country to achieve this result. One of the developers, who had a smaller part in the project towards its conclusion, even went so far as to say: "with the number (of requirements), resources and time that we had for the project, I believe the team has done remarkable work."

B. Reporting

The interactive report to which the data contributes has had 584 views in 2 months – equating to about 40 views per week.

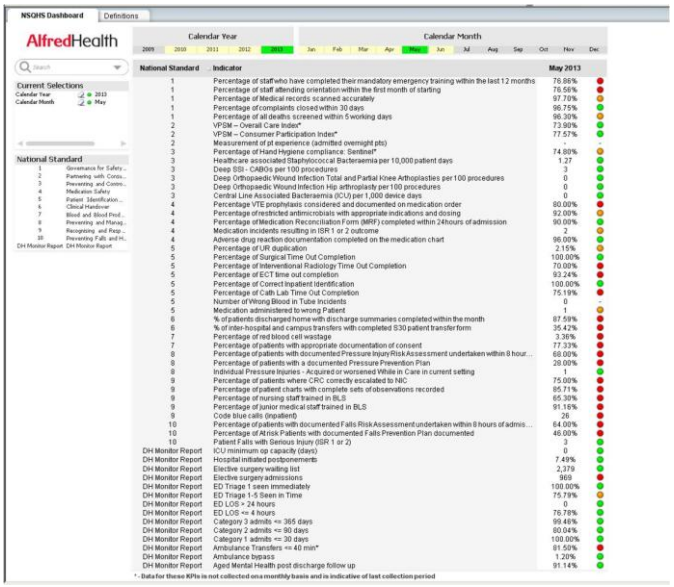

Fig. 2. NSQHS interactive report (or Dashboard) – Development version (Qlikview).

The longest standing non –interactive report to which the data contributes has had 1135 views in just under 2 months – equating to about 110 views per week. Below is an example of the non –interactive report showing the summary traffic lights across the entire organization for all measures captured in the POC application.

Both kinds of reports can be viewed on a variety of devices - as they are intranet based – including on the Motion tablets themselves. In the case of the non- interactive reports, these are updated as soon as the data is submitted from the POC application. This will be particularly important if the POC application itself is ported to another platform, or deployed on

another type of device – so that the application, and the attendant results of its usage, can be interacted with on the one device.

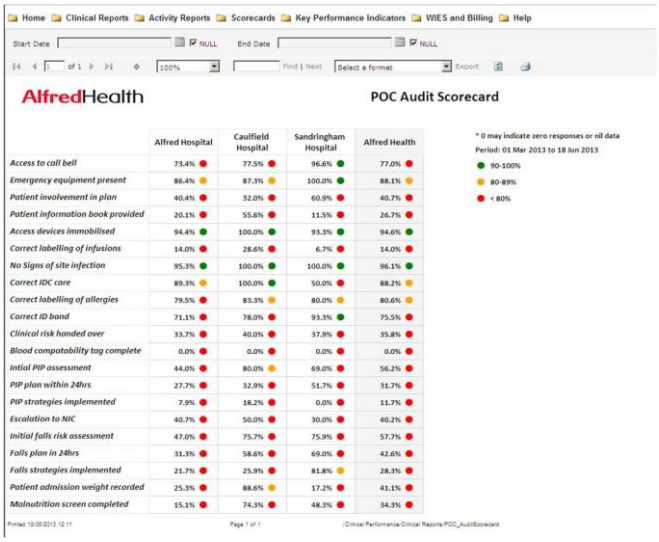

Fig. 3. The POC scorecard – Development version (MS reporting services report).

C. Stakeholder Acceptance

Stakeholder acceptance of the solution- the POC application, the Motion tablets and the reporting options - has on the whole been excellent. There were a number of reasons for this, but one of the key reasons, on the management front at least, is that the solution replaces a mixture of manually executed processes, with a large administrative burden, that resulted in incomplete and insufficiently detailed data stored in disparate Excel spreadsheets.

The difference now is that the management staff responsible for running the clinical audit program, and those charged with driving towards improved outcomes off the back of it, have more complete and robust data that can be fed back almost instantaneously to relevant staff in reports. In addition, that data is stored in a centrally supported, robust technical environment and can be kept for as long as needed and re-used, along with other relevant data from "the grid", for a range of research and evaluation activities in addition to its core and immediate purpose.

Much of the direct feedback obtained from stakeholders has been very encouraging. For example one of the nurse managers stated "It is great that we can see the data instantaneously and can use it to inform our practice". The POC auditors, who were nurse educators, made positive statements such as "(the) ward appreciate receiving the feedback as we complete the audit and can address issues at the time at a local level". Another auditor saw the solution and its use as "A great educational opportunity. We are getting to know what the wards learning needs are by having the ability to look at the data as it is entered".

In relation to the Motion tablets themselves, some comments included that they were "user friendly" and "easy to use". Others felt that it was "great not to have to double handle data!" when compared to the old method of primary data recording on paper then transcribing into an electronic source.

In summary, stakeholder acceptance was high and feedback very positive.

V. Discussion

A. Lessons from the Project to Date

Increased information provision to end users via the intranet scorecard and dashboard systems was able to efficiently and effectively close the audit and feedback loop within the organization. Previous variability and inconsistency that was dependent on individual dissemination was systematically improved to push information to the appropriate decision makers in a timely and efficient manner.

Since this health service is one of the first across the country to undergo accreditation under the new national standards, the system as described is a novel approach to meeting this compliance challenge.

There were a number of specific lessons learned from the development and implementation activities in this project.

B. Requirements Elicitation

One of the key lessons in relation to the project and its relative success was the nature of the requirements elicitation process. Even though the software development approach could be best described as iterative prototyping, the many dozens of questions across all audit modules and their complex conditional logic, were captured and kept up to date in a semi-formal requirements document. This document became critical in maintaining good communication and clarity between the development team and nursing subject matter experts (SME's).

The other critical aspect of this part of the project was the very direct and regular access that the developers had to the SME's, both in terms of explanations about requirements and feedback on released development versions of the software.

As one of the developers noted: "working on the audit, I've had the opportunity to work closely with (Nurse A), (Nurse B) and (Nurse C), all of whom were exceptional in their part of the audit. Especially with providing clear reporting requirements and auditing of the figures by cross check(ing) of reports".

Another developer described well how the process worked on the ground: "The nursing managers were provided with updated versions of the various reports, thus enabling a feedback loop while in the process of development. This process also presented situations where the nursing department requested changes as they realized that the calculation of certain KPI's was not as they expected. The feedback from the nursing department was critical and extremely productive for the delivery of the project".

These 2 things combined to ensure a stable, well tested application at release that needed little post release work.

C. Software Bugs

Despite the application and its implementation being an overall success, released software can still have bugs, even when developed with an abundance of resources applied to the process. The key software issue discovered in the case of the POC application was to do with the identity checking function.

In short the function appeared to work well when checking against test databases and in small scale production use. However when greater production use began, there were cases where known inpatients could not have their details checked and hence could not have their care audited as the application was designed with this check as a "gatekeeping" step.

An investigation identified the problem which was remedied by having the check look at more than one underlying database for auditable patients. Once this was done the bug was resolved. Ironically this was not due to a fault with the application itself but with an inherited architectural decision in the underlying verification databases.

D. Wireless Coverage

Unfortunately, another unforeseen issue was that of wireless coverage in ward areas. This was especially a problem in the main (acute) campus of the health service. In short, multiple staff using the application in a range of locations highlighted the fact that wireless coverage was somewhat patchy. Users soon found ways around this, but the problem expedited an investigation by the IT department of wireless coverage across the main building of the main campus.

E. Future POC Application Development and Research

There are a range of issues for consideration in relation to the future of the POC application and its use. These include porting the application to a more robust software platform, and potentially expanding the range of devices on which the application is deployed (eg - Windows based phones or smaller, handheld tablets) and increasing the range of usage of the collected data. It is also highly likely that the business will drive changes in the core application - for instance an 11th module relating to audit of timely patient access to care is already under development.

As previously noted, the application has a modular design. This design was a critical feature of the application, and will allow extensibility going forwards. As the technical lead for the project noted "It was imperative that a robust and flexible data structure was adopted. We knew it (the application) needed to support multiple audits (audit modules), and with each one quite different from the last, we developed a modular structure that broke down the question and answer paradigm to fit a relational data model. This approach has proven itself with the success of clinical audits and the reporting of this data back to the clinicians."

What will be critical, in terms of assessing the long term impact of the POC application, is to see the effect of the tool and the feedback loop to clinicians and managers, in terms of reducing bad practice and maximizing good practice. So for example in performing falls risk assessments, or in reducing harder end points like hospital acquired pressure ulcers. An example of such an evaluation is the previously quoted work by Tuffaha *et al*. [12].

There are great opportunities to leverage off, and cross-reference the data collected by the POC application, with data in "the grid". The best example, although there are several, is in the area of pressure ulcers and pressure ulcer prevention. Specifically, data about the completeness of implementation of strategies regarding pressure ulcer prevention, and data about the incidence of pressure ulcers – collected from the POC application; will be able to be compared with data from International Classification of Disease (ICD) codes of admitted patients, and data on adverse events in patients (including pressure ulcers), each from their own separate sources. As the grid matures also, it may be possible to also compare such data with data coded using other descriptors such as SNOMED. These comparisons will not only enable a complete picture of pressure care at the hospital to be built, but also will have the effect of driving up overall data quality in this area of measurement right across our health service.

VI. Conclusions

In this paper we have examined how a novel POC software application deployed on a mobile device (Motion tablet) has been able to successfully supplant much paper based auditing practice, resulting in strong uptake and positive feedback from users and other key stakeholders. The coupling of this application – albeit that it is likely to be a temporary deployment vehicle - with a robust corporate approach to information management, has paved the way for greater amounts of data collection, and greater data quality in this space. These improvements in turn set the scene for improved outcomes for patients. Another essential benefit has been an increase in the ability of the health service to demonstrate its compliance with new national healthcare standards. More than any other reason, this last one is justification for the time and effort invested in the project, given the importance to the health service of achieving accreditation.

Acknowledgment

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