Barriers to the inclusion of Wireless Technology in Aged care Applications – A Review

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Abstract
The recent improvements in the wireless technology have prompted aged care organisations to consider wireless devices as a part of their overall information technology solution. This paper reports the barriers to wireless technology identified through a literature survey. The objective of the paper is to draw the attention of aged care organisations to various technical as well as management barriers to wireless technology in order to achieve a successful implementation of wireless technology in aged care.

Keywords: Wireless Technology, Health, Aged care

Introduction
Recent advances in wireless and mobile technology have enabled the aged care[1] to show performance improvements in specific areas of data management. Research into performance problems in aged care settings are now addressed with wireless technology and applications that are emerging in the market solve some of the problems associated with data capturing procedures. Developments in wireless technology have prompted new research into the application of this technology to the aged care settings including prescriptions, pharmacy, billing applications. According to a report released in the Wireless News in 2003, it appears that the 'hospital' systems[2] are the fastest growing market for wireless technology. Wireless technologies for the generic healthcare including the aged care sector are expected to become a $2 billion industry within five years. According to GE Medical, the number of clinicians using wireless tools will increase from 1 in 100 today to 1 in five by 2004 (Phillips, 2003). Therefore, care providers are investing money into technology that will augment the management of hospital operation. However, there is still doubt as to whether wireless mobile technology would save time and money and improve patient care as the introduction of such technology in hospital environment is still in its infant stages. A number of barriers associated with the performance of wireless technology are yet to be answered in the literature as there is a lack of objective research into the justification of wireless technology in the aged care (McConnell, 2000). This paper provides an initial discussion as to the barriers of wireless technology specific to the aged care setting.

Wireless Mobile Technology
Wireless Information Technology is used in various healthcare settings including aged care due to the flexibility and mobility offered by the technology (Wisnicki, 2002). Wireless technology includes the concept of mobile computing, which consists of portable devices that can connect to traditional networks without the utilisation of cables (R.L. Simpson, 1996). In aged care settings, this technology can be used to access data about a patient, to enter certain predefined terms in order

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[1] The term 'aged care' is loosely used in this paper. This term is not distinguished with healthcare in this paper as the wireless technology is equally applicable to both sectors.
[2] The term hospital systems is loosely used and includes comparable systems found in aged care

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to process billing details or to capture patient data at the point of entry. Common to all these activities is the transmission of data from a mobile device at the point of entry to an existing legacy system commonly found in aged care settings (Stevenson, 2001).

Current computing systems in the domain of health, due to the ever-increasing costs and due to the complexities in managing the patient data and associated information such as billing and pharmaceutical information, are not functioning at its expected level (Davis, 2002). This has, in turn, compromised the level of service provided to the customers of aged care systems including patients and doctors. For instance, a patient may have difficulties in accessing pharmacy information and associated benefits provided by the government to different categories, as this information doesn't appear to have been integrated with the current hospital systems. On the other extreme, it may be difficult for a doctor to ascertain whether an operation theatre in a hospital is available to schedule an operation as hospital administrative staff and doctors maintain the current systems. While it is possible to point out that these problems can be sorted out with proper integration and access to systems (Craig & Julta, 2001), it is also possible to argue that the wireless technology will be able to provide better access to data from anywhere at any time (Stuart & Bawany, 2001). This notion has prompted aged care organisations to consider wireless devices in their overall information technology development.

The need for wireless technology in the area of aged care can be justified as a solution to the financial crisis encountered in many aged care systems[3] (Davis, 2002), to address the increasingly complex information challenges (Yacano, 2002), to comply with the rigorous regulatory framework (Wisnicki, 2002), to reduce the medication errors (Turisco, 2000) and to generate affordable computing applications that allow for greater mobility and ease of use in entering, sending and retrieving data (Athey & Stern, 2002).

While this justification appears to be valid, it should be remembered that wireless technology would not solve all problems encountered specific to aged care (Wisnicki, 2002). The wireless devices are still in their infancy stages and slower in speed compared with the desktop computers (Shah, 2001), high costs to initially set up these may be warranted (Shroeder, 1999), lack of real time connectivity due to the mobility of the device (Stevenson, 2001), the size of the screen and hence the problems that may be encountered to display data (Toms, 2000), little or no provision for high quality graphic display (Atwal, 2001), hard-to-see display (Bevan, 2001) and the perceived lack of security in the wireless domain (Kuechler & Grupe, 2003). These barriers appear to be impeding the progress of wireless uptake in hospital settings.

Hardware

Besides the ever present drive for more processing power, hardware problems in wireless technology include interference, range issues, materials, bandwidth and energy consumption (Anon, 1989; Martin, 1999; Ogando, 2001). Research into this area includes the combination of electronic and mechanical components to reduce interference (Martin, 1999). An area for current controversy within the literature and the IT industry is the support for wireless protocols (Sullivan, 1997). On one hand the hardware manufacturers are imbedding support for as many wireless protocols as possible, allowing for integration of new and legacy wireless systems, which is crucial to maintain aged care applications developed so far. On the other hand, support for multiple non-standardised wireless protocols increases hardware prices and encourages non-compliance with standards. It is only within the last five years that wireless hardware has become cost effective and has become a cheaper alternative to wired systems (Martin, 1999). The comparative analysis of wired and wireless costs has been extensively covered in the literature (Martin, 1999).

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[3] Davis (2002) was discussing generic health care issues. This paper extends this notion to aged care as the problems encountered in both sectors in terms of IT are similar.

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Software

In terms of software, research into wireless mobile software is currently scattered in terms issues ranging from use of web technology (Ratib et al., 2003) to computing language and protocol support (Tachakra, 2002). An area of common agreement found in the literature is that hospital systems are custom applications that cannot be applied to other hospitals (Abreu, 2001; Microsoft, 2002). Research into this problem includes the design of generic wireless hospital toolsets, which can be applied and customised to any hospital (Pappas et al., 2002), the abstraction of network connection components within the software, which will allow for adaptation to either wireless or wired environments (Segarra & Andre, 2000). There is also a significant rivalry between proprietary languages for dominance over the wireless market (Taft, 2001).

Protocols

While protocols such as bluetooth have the backing of large organisations, there is a general push for the use of non-proprietary protocols such as the IEEE 802.11 series in the literature (Cole, 1995; Sealander, 1999; Tachakra, 2002). This has resulted in the development of measurement of performance of wireless protocols (Sullivan, 1997). While there have been many implementations of wireless mobile technology within the health care system, ranging from the different hospital departments to home care and military hospitals, much of the research done into wireless implementations have been descriptive in nature. Much of this research describes the advantages of using the wireless system and use single qualitative opinions to back up these claims(Larkin, 2001; McConnell, 1999; Mendez-Wilson, 2001). There is an overall lack of quantitative data collection to attempt to prove the claimed wireless advantages.

Cost

In terms of aged care management, budgets are crucial to allocate finance for development of new information systems. There are competing views within the literature as to whether wireless systems are worth the cost of development and implementation (Clark, 1995; Rege, 2002). Few studies have expressed the feeling that wireless technology is not worth the implementation because of the unjustified benefits. However, these feelings might have been expressed because of the fact that most of the research into wireless implementation have invested a lot of money into the area and are unwilling to back out at the risk of looking deficient. These few studies discuss the costs of installation of the new system when a working wired system is already installed and the lack of return on the investment.

For the majority of research into wireless implementations, wireless technology is portrayed as the next revolution in hospital care (GE, 2002; Niekerk, 2002; Sealander, 1999). "Wireless" would seem to dictate that there is no need for wires, but wireless system need to connect to the main wired infrastructure at some point. However, the advantage is that wires are not needed from the mobile computer to the network interface[4]. This aspect can save a lot of money from installing wires in operating theatre walls, especially in old hospitals or where walls are single thickness and difficult to wire (Martin, 1999). Third world countries will also benefit from wireless technology as their lack of wired infrastructure can be overcome through the installation of wireless technology. This may bypass the wired phase of development and get them connected with minimum installation costs(Martin, 1999).

Return on investment is what businesses are aiming for when investing in a system. This area has also been covered extensively within the literature, and most seem to highlight the reduced occurrence and therefore cost of recovery from medical inaccuracies (Niekerk, 2002; B. I. C. Phillips, 1998b). Studies have highlighted the issues of savings from billing errors in order to

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[4] Interface between the wireless network and the wired backbone network of the hospital

reduce cost involved in fixing these errors and any associated legal costs (Niekerk, 2002; B. I. C. Phillips, 1998b) as the costs of billing errors have been estimated for individual businesses and the

health industry at $40,000-$60,000 per year (Phillips, 1998b). Interestingly, hospitals are also looking into setting up their wireless network as an internet service provider (ISP) so that patients may surf the net (Phillips, 2003). This may also bring in further revenue and return on wireless investments.

User Interface

While the above problems are associated with physical resources and technology, the issue of user interfaces is emerging in the literature due to the significance associated with the cognitive ability of users in understanding various interaction techniques using these interfaces. User interface design is an established research area for wired systems. Mobile systems interface design have also been researched extensively (see wireless technology section), but surprisingly hospital wireless systems research is at the forefront of mobile interface design (Ancona et al., 2002; Holzman, 1999). This may be due to the special conditions under which the wireless systems are being utilised. In particular is the research into voice recognition for medical command transcription (Ancona et al., 2002). This will allow data entry operators to speak commands into the mobile computer for data entry. A problem that is being investigated is background voices and unauthorised command entries. Research into speaker recognition is hoped to eliminate commands from unauthorised personnel and background voices, by authenticating the users voice, and determining the users authority (Ancona et al., 2002). Prior studies have been conducted at an exploratory level and are yet to be quantitatively established. While the choice of mobile device is an important consideration for wireless implementation, these devices should be chosen in order to augment ease of use within the OT, hospital and external settings (Mills, 2003; Niekerk, 2002).

Coverage

Coverage is not only a technical wireless issue, but is also an issue within the hospital setting. By nature, mobile devices may be used to roam around and it is important that connection to the network is retained so that collected data is not lost and information is accessible when and where it is needed. Many of these issues have been covered within technical wireless research, however research has also been conducted dealing with coverage within the hospital environment (Bissell, 2001; Niekerk, 2002).

Of particular interest to aged care setting is the range of the Wireless Local Area Network (WLAN), due to the scale and dispersion of their buildings (Cole, 1995; Cornell, 2002). This has lead to research into how range can be maximised through optimising bandwidth and signal strength in the hospital setting (Cox, 2003). Research has also been conducted that suggests that wireless range should be limited for security reasons (Baylor, 2002). By having a wider range for wireless devices, the geographical area for network hacking is increased, making these attempts more difficult to monitor and prohibit. Both the views presented would be difficult to collect quantitative data on. None the less, these theories are purely opinion based. Objective research has been conducted which compares the wireless range of available wireless technologies (Blum et al., 2001). The issues of unexpected problems in connection have been studied in prior research (Bissell, 2001). These connection losses are not only inconvenient, but may also risk patient well being and care by not having important patient data available when it is required for medication administration. Prior studies attribute these problems to network range, lead walls and wireless interference (Cole, 1995). Furthermore, it appears that fundamental problems in coverage may result in denial of service when patient information is most needed. Current research studies focus particularly on the load-testing of WLAN's (Milsom, 2000) and whether implementations are capable of handling the wireless needs of the hospital environment. Prior studies into interference

has covered aspects of technical issues and is of particular concern to hospitals due to the importance of medical data integrity (Phillips, 2003) and disruption of sensitive medical equipment, which could put patient's lives at risk.

Due to the importance of medical data for health, billing and medical reasons, data integrity needs to be ensured. Interference from walls (Blum et al., 2001), other RF equipment and coverage holes may diminish or corrupt data integrity leading to losses in patient health, billing revenue, and legal recovery costs (Bissell, 2001).

There exist two dominant competing views within wireless technology literature; one suggests that interference with medical equipment is non-existent (Phillips, 2003), and the other portray interference as life threatening (Hemeon, 1998; Lin, 2000; Niekerk, 2002). According to the first group of literature "Wi-Fi-enabled handhelds or laptops generate about 5 percent of the radiofrequency power that cellular or PCS phones emit". Medical treatment and diagnostic equipment manufacturers have even gone as far as embedding wireless systems into their equipment (Phillips, 2003). However studies have investigated the issues of interference with sensitive equipment and have deployed measures such as frequency modulation to attempt to remove this interference. Interference has been noted ranging from pace maker disruption which, are possibly life threatening to wheel chair malfunctions (Bassen, 1998). These equipment malfunctions have been put down to the lack of medical device immunity to Radiofrequencies (RF) and the increased number of RF emitting devices such as mobile phones and mobile computers. Standards for medical equipment immunity were established in 1993, and these standards must be tightened to allow for increased number and power of RF and their close proximity to sensitive equipment. These conflicting outcomes from prior studies demonstrate that there exists competing views on the issues of interference in the hospital setting, ranging from total acceptance to the banning of wireless technology neither of which seems appropriate (Roy L Simpson, 2002).

Security
Interference risking data integrity is also a security issue. The management of security issues in a hospital is an established area, but is challenged through the introduction of wireless technology. Research has been undertaken to specifically lay down foundations for wireless security management(Baylor, 2002). The main concerns for security management within a hospital setting are confidentiality of billing and medical information (Abreu, 2001; Bissell, 2001; Roy L Simpson, 2002) and specifically privacy of patient information (Abreu, 2001; Bissell, 2001). Of particular concern to the protection of private and confidential is the monitoring of network accesses (Cox, 2003) and the tracking of mobile devices(Phillips, 1998a). Interestingly, the tracking of mobile devices has been utilised to improve care for Alzheimer and mentally ill patients (McConnell, 2000).

Research has also been conducted to restrict information access to where, when and by whom it is being used (Cox, 2003; Phillips, 2003). This is achieved by determining access permissions by the user's authority, the location within the hospital and the stage of patient care. Authentication methods range from speaker recognition to passwords and smart cards (Tieman, 2001). This will therefore limit the amount of data that can be viewed by intruders, and restricts staff access to what is required for treatment.

Efficiency
The improvements in patient care may be put down to the efficiencies of running a wireless mobile system. Improved efficiency allows patients to be quickly and accurately treated. These efficiencies are dependant on the systems performance to improve productivity(Mills, 2003; Phillips, 2003).

Improvements in productivity are an indicator of efficiency improvements, and this concept has been discussed within the literature (Phillips, 2003). Productivity is measured through the improved utilisation of available resources such as personnel, space in the aged care environment and technology. Research has been conducted to ascertain the efficiency of staff utilisation due to the high costs of employees in the aged care industry (Phillips, 2003; Phillips, 1998b). The efficiency and productivity of wireless mobile technology is also important for business reasons. For the introduction of wireless mobile technologies to be justified, there must be a large improvement in efficiency. This is because the introduced technology does not achieve new medical objectives, but rather improves old objectives. Funds for updating non-diagnostic equipment technologies are hard to come by in the aged care sector (Bissell, 2001).

Performance

Wireless mobile technology performance establishes the foundation from which efficiency, productivity and patient care can be derived. It is only through the measurement of performance that wireless and mobile technologies can be justified for use within the aged care setting (Mills, 2003). Without proving the performance of the technology within the given setting it is not possible to determine, without alternative plausible explanations, improved efficiencies.

Due to the time and accuracy critical nature of aged care environment, performance measures should include time and accuracy of the system implementation (Altimier et al., 2002; Rege, 2002). In other words it is the aged care provider's job to get patients in and out with as few mistakes as possible (Phillips, 1998b). The time critical nature also makes wireless mobile technology ideal due its capacity to collect and transmit from the information source compared to the time wasted walking to and from a computer workstation. As discussed previously, accuracy is important for both patient safety and collection of billing information. Wireless and particularly mobile technology provides the capability to improve accuracy by allowing data collection at the information source. In the aged care setting this means that medical and billing information can be collected at the bed side, therefore reducing redundant data transcription errors through the use of paper forms (Bissell, 2001; McConnell, 2000; Phillips, 2003). The application of these accuracy improvements augments correct drug dosages (Phillips, 2003), doctor-pharmacy transcription (Fee, 2002; Phillips, 2003), medical and billing information (Phillips, 1998b).

Conclusion

The objective of this article is to provide an initial review of the existing literature and draw out some of the barriers that are still found in the wireless implementation. While the technology associated with wireless is improving considerably, it is hoped that this review helps practitioners to focus on these issues when wireless implementation is carried out in the aged care sector. Our experience with wireless development specific to healthcare demonstrates that practical issues of healthcare systems such as working conditions impede the uptake of this technology than technical issues. Therefore, any wireless implementation should take into account the applicability of this technology to the specific context such as aged care in order to be successful.

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