Reducing Nosocomial Infections: A User-centered approach to developing an eHealth system for Sri Lankan ICUs

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Abstract. Nosocomial infections are a health concern in hospitals both in developed and developing countries. Immuno-compromised patients in intensive care units (ICU) have been identified as being particularly vulnerable. However, despite numerous interventions, infection rates remain high and antibiotic resistance is now of global concern. In Sri Lanka, higher than anticipated infection rates appear linked to a range of factors including hierarchical work flow, poor surveillance feedback and health staff attitudes and awareness. By deploying a user-centered approach to understanding these factors this research-in-progress will develop and evaluate the capacity of an eHealth system to contribute to reduction of nosocomial infections in Sri Lankan ICUs.

Keywords. Nosocomial infections, attitudes, eHealth, User-centered approach

Introduction

Nosocomial (hospital acquired) infections are a major public health concern throughout the world that contribute to increased patient mortality, permanent disability and/or increased length of hospital stay. Rates of infections range from one in twenty admissions in developed countries to one in five admissions in some developing countries [1]. Patients in intensive care units (ICUs) have been identified as particularly vulnerable due to the acuity of their conditions, the range of invasive procedures they undergo and that generally they are more immunocompromised than other patients in the hospital.

Hand hygiene and antibiotic use have long been identified as the primary methods for reducing and/or treating nosocomial infections [2]. However, the widespread use of antibiotics for infection treatment has contributed to less emphasis being placed on prevention of infections per se. This has gradually contributed to a rise of infection rates and the global concern about the growth of antibiotic resistant bacteria [3].

More recently efforts have re-focused on prevention of nosocomial infections and this has led to an expansion of research into measures to prevent/reduce infection rates. These measures include the creation of infection control teams, education programs, replacement of infusion pumps at regular intervals, care in catheterization and urinary bag maintenance, universal decolonization, appropriate and targeted use of antibiotics and change in design of ICUs to create single patient rooms [4-8]. However, despite

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awareness of these measures nosocomial infection rates continue to remain high [1].
This is particularly the case in developing countries, although as Sri Lanka indicates,
the association between infection rates and socio-economic status is not simple. Indeed,
some of the highest infection rates are not found in the lowest income countries [9-11].
This research-in-progress deploys a user-centered approach to understand the factors
impacting on the incidence of nosocomial infections and to develop and evaluate the
capacity of an eHealth system to contribute to their reduction in Sri Lankan ICUs

1. Deploying a User-centered approach in Sri Lankan ICUs

Research in Sri Lanka on reducing/preventing nosocomial infections has highlighted
improper hand hygiene, inadequate surveillance and antibiotic misuse as significant
problems [12]. Interestingly, research done outside Sri Lanka has noted that hand
hygiene compliance among “more educated” physicians is significantly lower than
nurses[13]. Alongside these human factors, it appears probable that organizational and
environmental factors also contribute to persistent high nosocomial infection rates
despite clear policy initiatives and guidelines on measures to reduce/prevent infection
being in place[14].

In this context, engaging ICU health professionals at all levels through a user-
centered approach will allow the development of understanding into the factors that
contribute to high nosocomial infections rates and support the development and
evaluation of an eHealth system to contribute to their reduction and prevention. User-
centered approaches have previously been used to successfully change behaviors and to
sustain those behaviors by ensuring a sense of ownership of the new system amongst
end-users [15]. User-centered approaches have also been used to support the
development of health improvement tools including eHealth systems that are practical
and implementable [15] and also improve safety culture and implant positive attitudes
towards health care quality [16].

2. Methodological Approach

This research-in-progress will rely on a detailed understanding of end-user attitudes,
perspectives and priorities in relation to nosocomial infections. Given the range of ICU
stakeholders, the approach adopted has been to involve all stakeholders through use of
a participatory design model complemented by agile software development and rapid
proto-typing of the evolving eHealth system [17]. Importantly, simple pre- and post-
implementation evaluation of the system through quantitative methods is not
considered sufficient to capture the potential sustainability of the system. While this
quantitative evaluation will be conducted, the research is also engaging in qualitative
evaluation with the end-users. The four-phases of the methodology being used in
conducting this research adopt a pre- and post- interventional assessment.

It should also be noted that although research data collection, analysis,
interpretation and system development are discussed as discrete steps, they are iterative
processes with the data collection of each phase dependent on outcome of the
proceeding phase.

The study sample for this research will include nine tertiary care public hospitals in
Sri Lanka. Surgical ICUs have been identified as the primary sites for investigation at
each of the hospitals. Phase one of the project consists of retrospective analysis of nosocomial infection rates data for preceding three years in each of the nine selected ICUs. Based on this data, the ICUs will be categorized into one of three bands – low, medium or high infection rates. Subsequently, one ICU from each of these bands will participate in phase two, where behavioral observations, semi-structured interviews and focus group discussions will be carried out to determine the perceptions, attitudes and work practices of hospital staff towards infection reduction. Further, system development will be conducted during this phase utilizing a user-centered approach based on the principles of agile software development methods.

In phase three the developed system will be implemented in three ICUs directly involved in its development and three other ICUs, one from each identified band (to provide comparison and contingency as discussed below). Post interventional qualitative data will be collected in these ICUs during the first, fourth and seventh month of the implementation. Phase four will occur at the end of the seventh month, when retrospective collection of nosocomial infection data will be completed for all nine ICUs.

Analysis of the first and fourth phases will include infection rates in each ICU, rates of infections according to sites, causative organisms, antibiotic usage and relationship between invasive procedures and infection rates. Data from the second and third phases will be coded and analyzed to identify key ideas and behaviors affecting nosocomial infection rates and actions to reduce/prevent their occurrence.

As mentioned above the development of the eHealth system will be based on participatory design combined with agile software development methodology. Requirements gathering for the system will be done in parallel to the phase two data collection with focus groups convened representing all staff and service categories. Rapid prototyping and usability testing will support the evolving system and support awareness, education and training amongst stakeholders.

It is anticipated that data interpretation will explore several dimensions of the research. Pre-intervention data interpretation will include nosocomial infection status, attitudes, perceptions and behaviors of health staff towards reduction of nosocomial infections and requirements of health staff of an eHealth system. Post interventional interpretation will consist of description of the post intervention nosocomial infection status and comparison of post intervention data with pre intervention data. This comparison will include the effects of the eHealth system on nosocomial infection rates in high, medium and low nosocomial infection environments, hawthorn effect on infection rates, effect of invasive procedures on infection rates and the antibiotic usage patterns. These interpretations will facilitate identifying the impact of the eHealth system in contributing to nosocomial infection reduction.

Preliminary work to date in the early scoping phase involved site visits to three hospitals. Observations of work flow in the ICUs and other organizational and environmental elements were carried out. Preliminary insights have highlighted and confirmed the importance of human factors, including awareness, attitudes and perceptions as well as the key relationship between existing workflows and contemporary nosocomial infection rates.

One challenge that has already been identified is differentiating nosocomial infections from other infections. This challenge will be addressed by using strict nosocomial infection guidelines embedded into a computer algorithm to differentiate nosocomial infections from other infections. It is important to address this challenge as it will have a large impact on the final evaluation of the system to be developed.
3. Discussion

Nosocomial infections can be transmitted in several ways. These include: patient to patient, family member/caregiver to patient, staff to patient, equipment to patient, environment to patient and opportunistic parasites on patient’s body acting during reduced immunity. The possibility of acquiring an infection depends on severity of the disease being treated, health status prior to illness, invasive procedures and virulence of organisms in the environment.

In this context, the development of an eHealth system to contribute to reducing nosocomial infections is a complex task. However, existence of nosocomial infections despite all recent advancements in reduction measures requires a novel approach in dealing with these infections, especially in developing countries. Previous reported success in combining user-centered approaches and eHealth to directly address improvement of workflows, work practices and safety culture strongly supports the aims of this research to test a similar approach to contribute to reducing nosocomial infections. Advantages of computer technology in health data collection and dissemination augment the requirement of using an electronic system in addressing this task [18].

Based on experience of successful similar systems, it is anticipated that this system will help the staff to acknowledge the presence of the problem and contribute to development of “their own” system for confronting and controlling the problem. Further, this approach will contribute to reduce the negative attitudes towards computer systems by developing a sense of ownership to the ‘newly’ developed socio-technical system.

The methodological approach described above aims to support validation of the system in several ways. Placing of ICUs in to three bands according to nosocomial infection rates; high, medium and low and selecting one ICU from each band for two test groups and the control group will allow for assessment of the effectiveness of planned interventions according to differences in infection prevalence. Involving one group directly in the development process of the system and an additional test group from that band only in system implementation will help to assess the influence of user involvement in commitment to reducing nosocomial infection status.

User-centered design will have a pivotal role in system development. It will not only identify the user requirements accurately, but also facilitate development of a system which will integrate seamlessly to current workflows and work practices. Though the final design of the system depends of the users’ requirements, it is anticipated that this system will have a suite of solutions including a health education module, a monitoring module, a surveillance module and a decision support module.

Despite this paper providing a logical argument of the way to develop and implement an eHealth system to contribute to reducing nosocomial infections, the ultimate success depends on how this system can be integrated meaningfully into the social setting and work-flow of Sri Lankan ICUs. It is anticipated that this research will directly contribute to improving awareness of and mechanisms for reducing nosocomial infections.
4. Conclusions

This research-in-progress paper has discussed the global challenge of nosocomial infections and the actions currently being taken to reduce these infections. The paper also discussed why many of these measures have proved ineffective in developing countries like Sri Lanka and proposed an eHealth approach developed using a user-centered approach as a way forward.

It is anticipated that this approach will lead to better awareness among all health workers with regard to the threat of nosocomial infections, and their improved awareness of both the threat and preventative measures that can contribute to a reduction of nosocomial infections in Sri Lankan ICUs.

References