Potential benefits of a WiFi Patient Tracking System in a surgical unit.

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Master of Science in Health Informatics

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Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work, and has not been submitted as an exercise for a degree at this or any other university.

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Amanda McKenna

September 10 2008

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- Last but not least, thanks to my family for their endless patience and support.

Summary

Patient safety and quality of care are among the most important issues facing hospitals and healthcare facilities. It is important to continually revise procedures and policies to ensure they maintain pace with current best practice. It is also essential to ensure that the best use is made of available resources. The research for this dissertation is based on a small pilot project, which over the course of a twelve month period, aimed to develop and trial a prototype Wifi patient tracking system in a surgical unit. Tracking technologies have been available and used successfully in a variety of domains for some time. The application of this tracking technology to assist in direct patient care is a relatively new innovation. The purpose of this study was to assess whether the proposed Patient Tracking System would show potential to help enhance patient safety procedures and efficiency of the day surgical process.

The methodology used in this evaluation study was a combination of a number of approaches intended to address the objectives. It involved the collection of both quantitative and qualitative data. The present state of the art was researched through available literature on the use of patient tracking systems both past and present. It was necessary to attain a complete understanding of processes in the clinical areas concerned in order to establish an understanding of present efficiencies and to best predict where and how the pilot system could achieve its objectives. This involved a comparison of data collection both pre and on initial post pilot of the system. The primary methodology used was the survey approach to obtain opinions of both patients and staff. A time and motion study of the present process and research into current data capture was completed pre the pilot, along with the collection and comparison of pre and post telephony data. In summary, the system was positively received by staff and patients. Although time for this research was limited and much has yet to be achieved, it can be concluded that the pilot system has potential for both the enhancement of patient safety procedures and process efficiencies.

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List of Figures & Tables

List of Abbreviations

A&E	Accident and Emergency
AIDS	Acquired Immune Deficiency Syndrome
AOL	America On Line
BMJ	British Medical Journal
e-List	electronic-List
EPE	Ekahau Positioning Engine
HIQA	Health Information and Quality Authority
HSE	Health Service Executive
ICU	Intensive Care Unit
ID	Identification
IT	Information Technology
JCAHCO	Joint Commission On Accreditation of Healthcare Organisations
Max	Maximum
Min	Minimum
MRN	Medical Record Number
NHS	National Health System
OR	Operating Room
PACU	Post Anaesthetic Care Unit
PC	Personal Computer
PIMS	Patient Information Management System
Prep	Preparation
RTLS	Real Time Location System
SPSS	Statistical Package for Social Sciences
TEAMS	Education and Audit Management System
US	United States
WHO	World Health Organisation
WiFi	Wireless Fidelity
WLAN	Wireless Local Area Network

Chapter 1 Introduction:

1.1 Summary

This document outlines the Research which is the subject of this dissertation. It was carried out within a Pilot Patient Tracking Project over a twelve month period. This pilot project was developing a prototype WiFi patient tracking system and researching how it could enhance patient safety and efficiency in the clinical setting. It was also investigating other potential benefits of patient tracking. *"A pilot will normally test the new way of working on a small scale, so that the total benefit can be extrapolated"* (Ward, Daniel, & Peppard, 2007, p.13).

The project is a collaboration between a large urban teaching hospital, Trinity College Dublin, and GariVo Technologies Ltd. It is funded by Enterprise Ireland and GariVo, under the Innovation Partnership program, grant ID IP 2005/0290 [5]. Hospital Research Ethics committee approval was obtained in advance of the project. The author's role of Clinical Research Assistant had a broad scope which was determined by the Primary Investigator/Lead Consultant. It involved working with clinical staff to inform, educate, and obtain feedback on the prototype patient tracking system. It also required direct contact with patients invited to participate in the Research. The Research team was composed of individuals from both a clinical and technical background and an important role of the Clinical research Assistant was to liaise with all members of the team, act as an advocate for staff and patients, and ensure all precautions were taken into account to promote patient well being. Requirements gathering and system testing was carried out with the software engineer and other technical project staff. A key aspect of the role was assessing whether the patient tracking system successfully met the primary and secondary objectives agreed by the project team.

Tracking patients is important for several reasons, in particular safety aspects and process improvements. Patient safety is the most important issue for all hospitals and a key benefit of tracking systems in hospitals is the prevention of medical errors.

Also, in the absence of systems providing reliable quantitative data on clinical processes it is difficult to demonstrate where best practice is being adhered to and where improvements are required. Efficiency begins with data, and such data is provided by tracking systems.

It is well known and has been stated in a number of governmental reports, including the Brennan and Prospectus Reports (2003) that the use of Information technology within the Irish health service remains sub-optimal and varies widely. Some healthcare facilities are run with minimal use of computer technology, while others are using wireless networks and mobile devices. This fact has been recognised by the government and strategic plans have been proposed to remedy the situation, documented in the most recent Statement of Strategy (2008-2010). The success of small projects such as this has potential to provide further incentive for advancement of IT in healthcare.

1.2 Objectives

1.2.1 Primary Objective

The Primary Research Objective was to assess whether the proposed Patient Tracking System would show potential to help enhance patient safety procedures and the efficiency of the Day Surgical process. The initial pilot of the prototype was in the clinical areas of day ward and operating theatres.

1.2.2 Secondary Objectives

Potential benefits of the proposed system which are linked to the primary objective include:

1. Reduction of opportunity for error
2. Time saving for Nursing and Medical staff
3. Clinical user satisfaction
4. Quality improvement of the clinical process
5. Application to other clinical areas

First, it is necessary to describe what is meant by the term efficiency.

1.2.3 Efficiency - A definition

There are several definitions of efficiency dependent on its context. According to the Thesaurus;

1. The quality of being efficient: productivity. Competence, good organization.
2. The power or capacity to produce a desired result: effect, effectiveness...

As defined by Peter. F. Drucker "*Efficiency is doing better what is already being done.*" (Answers.com, 2007)

According to Egan and Sandburg, (2007) 'efficiency' can often be confused with speed, and speed is believed to be dangerous. This is because it compresses the time available for the performance of all the checks essential to the provision of safe patient care. Egan and Sandburg contend that *true 'efficiency'* (as defined by the timely provision of all required data, equipment and material to those on the front line of care delivery) *actually enhances safety*.

1.3 Actions

To achieve the objectives it required:

1. A review of the available literature, on work both past and present in the area.
2. Attaining a complete understanding of the current processes in the clinical areas concerned to establish both efficiencies and delays in the process.
3. Prediction of exactly where and how the pilot system could enhance patient safety and efficiency and an assessment of the potential impact on processes and resources in the area.

1.4 Overview of prototype

A prototype is defined as:

'*A first or original model, of hardware or software'.*

'Prototyping involves the production of functionally useful and trustworthy systems through experimentation with evolving systems. Generally, this experimentation is conducted with much user involvement in the evaluation of the prototype' (Answers.com, 2007).

The development of the prototype Patient Tracking System in this project was an iterative process. Each clinical area had different requirements although basic functionality was the same. Continual feedback from end users aimed to achieve maximum user satisfaction and usability. A goal of the prototype was to reduce reliance on paper based lists, and phone communication as it provided an electronic list in all clinical areas. Staff knew at a glance where the patient was and which stage of the surgical process they were undergoing.

1.5 Application domain

The clinical areas for the pilot study within the hospital were divided into two phases. Phase one, as stated was Day Surgery. "Day surgery is the admission of selected patients to hospital for a planned surgical procedure, returning home on the same day. "True day surgery" patients are day case patients who require full operating theatre facilities and/or a general anaesthetic, and any day cases not included as outpatient or endoscopy" (Department of Health, 2002, p10). Should the patient fail to meet the criteria for discharge prior to midnight on the day of surgery, the patient is classed as an Inpatient.

Phase two extended to Surgical Inpatient wards. Phase two originally planned to include day Endoscopy patients, and was modified in May 2008 to include Surgical Inpatients. The decision was made following further research, and a trial of the tagging process in Endoscopy. The tracking system was deemed unsuitable for day patients in the hospital's Endoscopy unit due to a number of factors, in particular the proximity of the endoscopy suites and patient cubicles.

The pilot project included only patients on one Consultant Surgeon's operating lists. This Consultant's major operating lists were scheduled for Wednesday, usually commencing with day cases.
The aim was to use wireless systems combined with WiFi based Real Time Location Services (RTLS) to help streamline the delivery of care within the areas mentioned above. The RTLS used the existing hospital Wireless Local Area Network (WLAN). Active radio tags were worn on the wrist by patients. The tags were recognised by a wireless network when a patient arrived in a clinical area such as the operating theatre.

In conclusion, this dissertation contains a total of six Chapters. This chapter provides a summary of the pilot, and the primary and secondary research objectives it sets out to achieve. Chapter two reviews the state of the art and how the work proposed in this project is representative of the present situation. Chapter three describes the context and background of the project, while Chapter four presents the Research methodology. Chapter five evaluates the Research and Chapter six concludes the document. It is hoped the importance of tracking patients, and the potential benefits of such an application will become apparent to the reader throughout the document.

Chapter 2 State of the Art:

This chapter aims to provide an understanding of patient tracking, how it is used internationally at the present time, and how this research compares in its approach and objectives. The various technical solutions to patient tracking are described in terms of both positive and negative aspects of each. It concludes with a short description of patient safety and healthcare quality improvements.

2.1 Use of tracking systems in healthcare:

The technology *'has been around for quite a while',* and has many and varied uses (Mullen, D. cited in Anastasi, J. 2007). The majority of health care facilities use tracking technologies to maximise patient safety and quality of care. These include bar codes, passive and active RFID, and active RFID over WiFi (Halamka, 2006).

2.1.1 Bar Code technology

Bar codes have been positively used in Industry over several decades and are available in two basic forms – linear and two dimensional. Linear bar codes are the most basic and can encode up to twelve characters or numbers. A typical example is bar codes on products in supermarkets. They can be used to encode a Medical record number on a patient ID band. Two dimensional bar codes can hold more information, and provide more detail on patients, such as name and date of birth. This type of technology is already widely used in hospitals, as it is reliable and economical. The major limitation to the use of bar codes is line of sight scanning. It is necessary to disturb patients to read the information, and linear bar codes need to be straightened out to read properly. They cannot be read properly when damaged. See figures 2-1 to 2-3. Images obtained via AOL and Google image search.

Figure 2-1 linear bar code

Figure 2-2 linear bar code within a Patient ID band.

Figure 2-3 Two dimensional bar code

2.1.2 RFID technology

According to Nagy et al, (2006) the concept of RFID has been around since the early 1940s. One of the first uses of RFID dates back to World War II, when Britain's aircraft batteries used radio waves to identify friendly airplanes returning from missions. Numerous competing Business groups are involved in development and promotion of this technology for healthcare. It has been used successfully in the US, Japan, and other European countries including the UK. In healthcare, it is still in its infancy, but it has been used for Inventory management and tracking of medical devices and equipment, as a safety system for healthcare personnel, and for pinpointing emergency management resources ahead of disasters

(Ekahau, 2007). New innovations are constantly being introduced around this technology. Nagy et al (2006), agree that because it is so new to health, "*much of the published scholarly and trade literature about RFID is speculative and unsupported by useful data or experiential evidence*" (Nagy et al, 2006, p.61).

Passive RFID technology consists of tags with an antenna and a chip. They vary in shape and size and do not have batteries. Readers provide radio frequency energy which is absorbed by the antenna. This stimulates the chip to display its data. Passive RFID tags may be used to track books in libraries, equipment and medication in the healthcare sector, and track persons and animals. They include implantable chips to positively identify domestic pets. While they are attractive in that they are more resistant to damage and do not require line of sight reading, they are more expensive. They are not fully reliable and can fail in manufacture resulting in non readable wristbands. Many different frequencies are used to read different tags, and standards for the technology are still evolving (Halamka, 2006). See Figures 2-4 and 2-5. Images obtained via AOL and Google image search.

Figure 2-4 Passive RFID tags

Figure 2-5 Passive RFID chip

Currently WiFi tracking or active RFID over WiFi, appears to be the most cost effective solution, as it does not require an active RFID specific network. Tags contain a battery and transmitter which provides information on the physical location of the active tag within the hospital. Tags in use at the present time vary in design according to manufacturer, but are still fairly bulky. For example outside dimensions of tags used in this research study are 45 x 55 x 19(mm). They weigh 1.7 oz/ 48 g with batteries (Ekahau 2007). See Figure 2-6 below. Images are courtesy of Ekahau (2007). They require regular battery replacement and currently cost about €80 each. As the technology progresses tags are expected to have a longer battery life, become smaller and less costly.

Figure 2-6 WiFi tags

Beth Israel Hospital Deaconess Medical Centre, in Boston has trialled several forms of patient tracking. It uses passive RFID to track newborn babies via RFID wristbands and also to track mothers' milk stored in tagged containers. They ensure the right baby receives the right milk by using a software application and an RFID scanner which automatically creates an audit trail (Halamka, 2006).

Beth Israel was also one of the US hospitals to use active tracking technology in its emergency department to track patients and clinicians in 2004. It was piloted in the Emergency Room and the cardiac care unit. In addition to tracking individuals it was intended to help the hospital with workflow analysis (Rosencrance, 2004). In Birmingham Heartlands hospital (UK) a technology trial of a patient location tracking system using

WiFi was piloted in 2005. Known as the Safe Surgical System, it was designed for use in the hospitals ENT operating theatres and Day care ward. The expectations of Birmingham Heartlands hospital included experiencing improved efficiency and safer patient care. The pilot study was successful and the hospital considered expansion of the network to ten additional theatres and surgical wards. (Proxim, 2005)

The Real Time Location System (RTLS) has been deployed in August 2007 in Herentals Hospital, Belgium to track patients through its operating room complex. According to the IT manager at Herentals hospital *"Precision tracking of patients through the operating theatre will enable more efficient throughput and better use of existing resources, which is essential to the running of any modern hospital"* (Nath, N.S, 2007).

Wang et al (2006) conducted a study on RFID Application in hospitals. Reported in 'Proceedings of the 39th Annual Hawaii International Conference on System Sciences', the case study was on a demonstration RFID Project in a Taiwan hospital. This case highlighted that RFID in healthcare may have great potential both to improve hospital services and patient safety, and to reduce costs. Findings from this study indicate that RFID has potential in all these areas. Wang et al state that tagging people is a major challenge because it involves patients, clinicians, medical knowledge, practices, and organisational issues. The study found that data collected from tagged patients helped improve medical processes, decision making, and resource management.

Benefits and value were shown to be derived from the IT infrastructure within the hospital. According to the study the value of RFID is delivered through its business applications. Although RFID has potential, the study cautions that it cannot in itself automatically deliver value to a hospital.
Wang and others advise, if the value of RFID is not immediately clear, '*a launch and learn approach'* may be best (Wang et al, 2006, p.9).
Use of the technology has been shown to require some changes in the organization if the organization is to cope with it; and it also causes changes in the organization and processes. Hospitals must be prepared to accept such change. The study acknowledges its limitations, as being derived from a single hospital, but states that the findings are of significant value for other hospitals. It concludes by stressing that several

important issues remain to be studied in order to improve understanding of the use of RFID in hospitals.

In conclusion, the pilot projects and studies described in this section of the document give a broad outline of how patient identification and tracking technologies are being successfully employed in healthcare facilities internationally. This patient tracking pilot project had similar expectations in relation to the benefits the technology is reported to bring to healthcare. The trial was the first to use WiFi technology to track patients in Ireland and it compared favourably with the approach, objectives and technology used internationally. Although it was a small pilot, it was an important step for the research team, its sponsors and the hospital concerned.

2.2 Improving patient safety and healthcare quality

There are numerous reports relating to quality improvement and enhanced standards of patient care. '*Health care improvements should be patient-led with the fundamental aim being the provision of responsive, consistent, high-quality and safe patient care'* (NHS, 2007). These are the principles of clinical governance.

Clinical governance was defined in the 1998 consultation document "A First Class Service: Quality in the New NHS" (p33) and in the 1998 Scally and Donaldson article in the BMJ as:

'A framework through which NHS organisations are accountable for continuously improving the quality of their services and safeguarding high standards of care by creating an environment in which excellence in clinical care will flourish' (NHS, 2007). This definition is equally applicable to the HSE. The primary goal of clinical governance is to ensure that standards are met for the provision of safe, high quality care. Patients are the main focus and priority.

It is expected that patient tracking has potential to promote patient safety and quality of care within the health care system. Accreditation is a way to define and promote quality standards, to identify and share examples of best practice, and to ensure that services meet minimum safety standards (Butler, 2000, p10). The Joint Commission on Accreditation of Healthcare Organisations (JCAHO) is a US performance measurement organisation. The approach taken by the JCAHO is to provide guidance for organisations to select their own performance measurement systems. The purpose of The Joint Commission's National Patient Safety Goals is to promote specific improvements in patient safety.

See Appendix ten for examples of the Joint Commission's (US) national safety goals. This document outlines how certain safety measures are currently met and how they may be enhanced by patient tracking. At home, the Health Information and Quality Authority (HIQA) were established in May 2007. It is responsible for setting and monitoring standards on safety and quality of healthcare services in the public sector. (Department of Health and Children, 2008) They also provide programs of accreditation for independent healthcare providers. (HIQA, 2008)

More recently (June 2008), the World Health Organisation (WHO) has released a new safety check list for surgical teams to use in operating rooms. This is according to an online report published in the Lancet, June 25, regarding the '*Safe Surgery Saves Lives'* initiative. This is the first edition of the WHO guidelines and checklist, which will be finalised for dissemination by late 2008, following evaluation in eight pilot sites globally. (Barclay, L. 2008) See Appendix ten for further information.

Chapter 3

The Project - Context and background:

This chapter explains in more detail the project background and context. It describes the surgical process as it existed prior to the study. It provides more detail on the prototype and potential benefits deriving from its use and attempts to predict how the pilot system could affect processes and resources in the area.

3.1 Background:

In October 2004, the hospital introduced an Education and Audit Management system, known locally as 'TEAMS' using 'point of care' wireless handheld computers on the wards. Wireless technology simply adds another critical layer to sharing information - mobility (Wachter, 2001).The system links with the PIMS (Patient information management system). It can be used to produce patient reports, discharge letters, and prescriptions, and is a valuable audit tool. This system is an example of successful collaboration between the Department of Surgery and the hospital IT Department. WiFi Patient tracking builds on the experience of using wireless networks gained with TEAMS, and adds an extra dimension of location tracking to the existing wireless network.

As described in chapter 2, the difference between WiFi and RFID tags is that the WiFi tags work with standard Wireless networks. This eliminates the need for specialised reading equipment for the tags, reducing deployment time and costs occurred in building a separate infrastructure (Proxim, 2005). Updated patient details are displayed in a variety of views on mobile and fixed computing devices for clinical staff in each area. As mentioned, the study has been approved by the hospital Research Ethics committee. Patients are fully informed and participation in the pilot is voluntary. There are no known health and safety issues, and tags conform to specified industry standards.

3.2 Summary of System features, Architecture, and Functionality:

3.2.1 System features:

Patient safety features

1. Electronic operating lists integrated with PIMS
2. Allergy and infection status information is flagged
3. Staff checklists for nurse, doctor and anaesthetist checks
4. Time out procedure in theatre, following JCAHO/WHO guidelines
5. Alert if patient is brought to the wrong operating theatre
6. The patient currently present in theatre is flagged

Communication and coordination

1. Patient location is displayed, so staff can see at a glance where their patients are.
2. Patient status is displayed, so staff can see what stage of the process they are in
3. Changes to the list are communicated immediately to all staff
4. Comments can be added to communicate important information to all staff
5. Automatic alerts when a patient has to be moved

Management Information

1. Records key points on the patient's surgical journey automatically
2. Data are accurate and available in electronic format so reports can easily be generated
3. Provides the information needed by theatre nurse managers in real time
4. Provides searchable database of patient records
5. Display audit trail for an individual patient

3.2.2 Architecture and Functionality:

System Architecture

The Ekahau Positioning Engine (EPE) and WiFi tags were chosen to implement the tracking technology, see www.ekahau.com .

WiFi tags are attached to patients and communicate with the EPE via the hospital's Wireless LAN (WLAN). As we required room level accuracy extra access points had to be installed in the day ward, recovery area and theatres to give the required accuracy. WiFi bleepers are used to alert staff when patients need to be moved.

The tracking system consists of a web application and the EPE interface. As patients progress through their surgical journey, their location is tracked as they move into each new clinical area. The location information is recorded and stored in a database where it is retrieved by the web application. See figure 3-1 below.

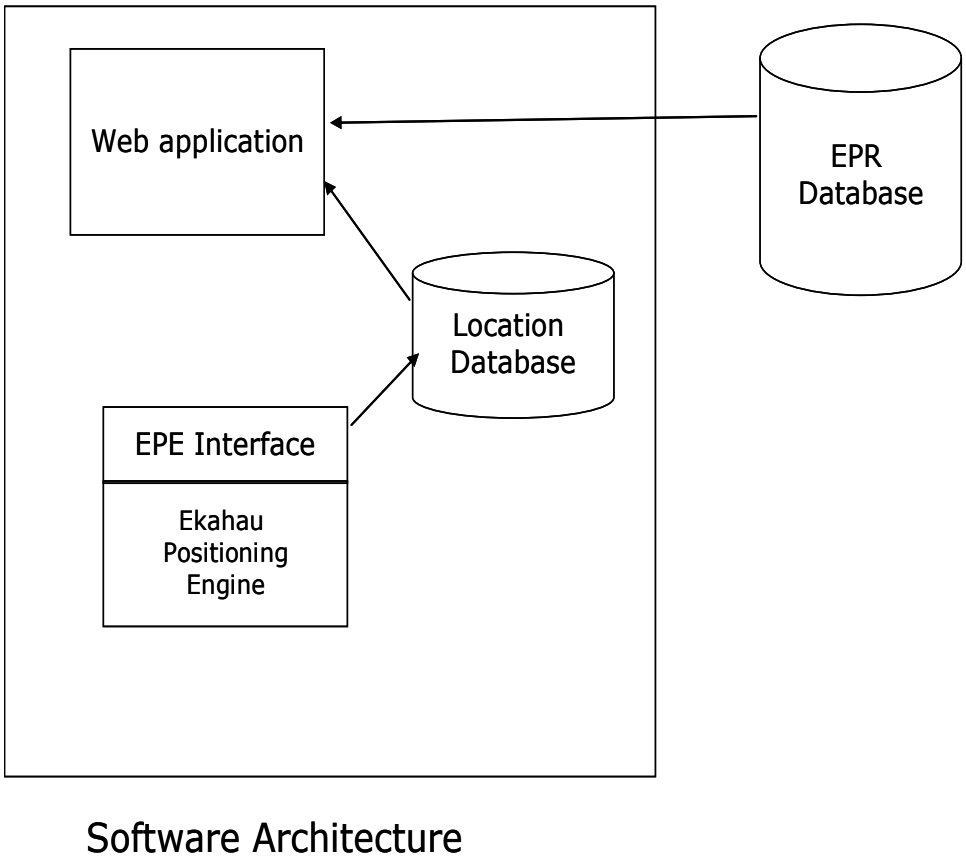


Figure 3.1 System architecture

The web application can be accessed via Internet Explorer from any wireless or fixed PC on the hospital network. Patient demographic details are pulled from the hospital patient records database. Access is read-only, by means of a JDBC database connection to a predefined view.
The software was implemented using Java, JSP, and Java Server Faces. The web server is Apache Tomcat and the database is My SQL. The Quartz scheduler was used to run a periodic job which polls the EPE every 30 seconds to get the location of the tags.

Functionality

Patient Safety

1. Checklists for Nurse, Doctor and Anaesthetist checks
2. Support for timeout checks
3. Wrong theatre indication
4. Extra ID check – patient present in theatre is flagged
5. Allergies and infections can be indicated

Coordination and Communication

1. WiFi bleepers alert staff when patients have to be moved
2. Updates to list are communicated immediately
3. Comments may be added to communicate important information

(O'Shea, M. 2008)

Sample Screenshots (From Dummy/test database)

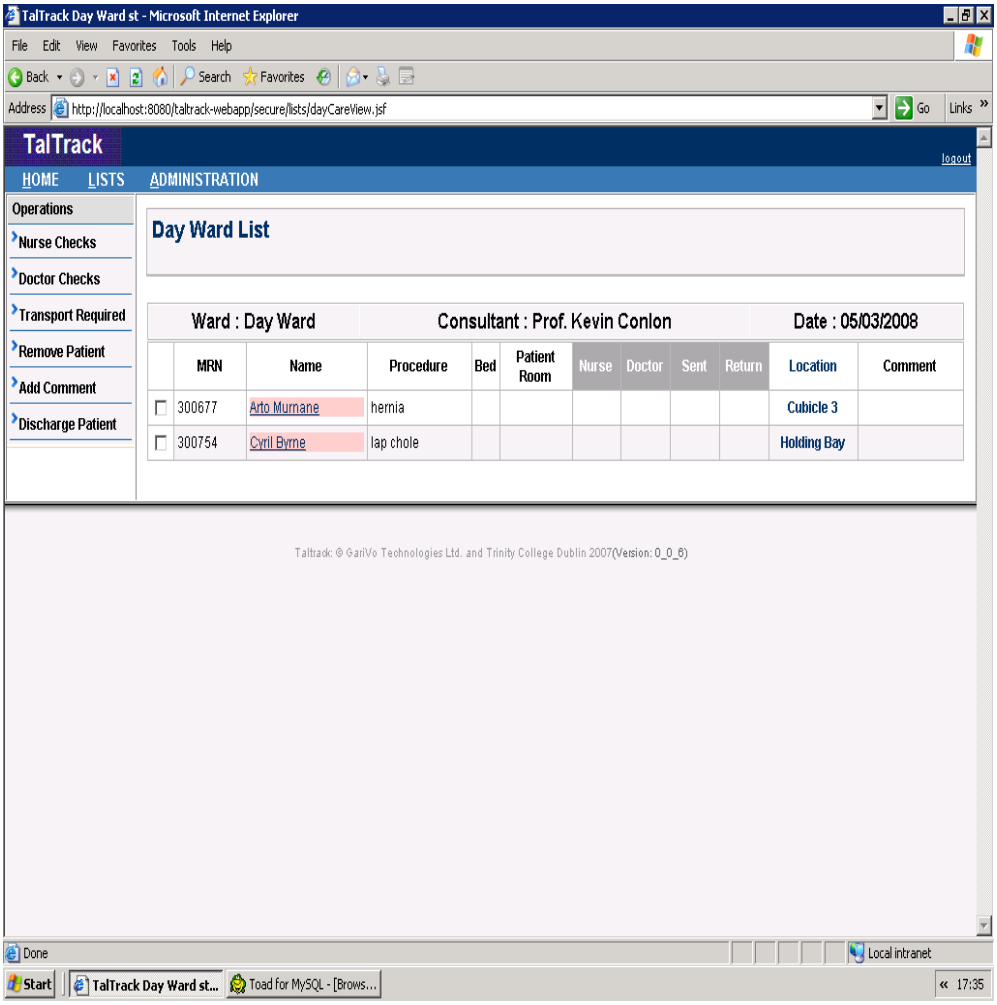


Figure 3-2 Sample Day Ward screen shot

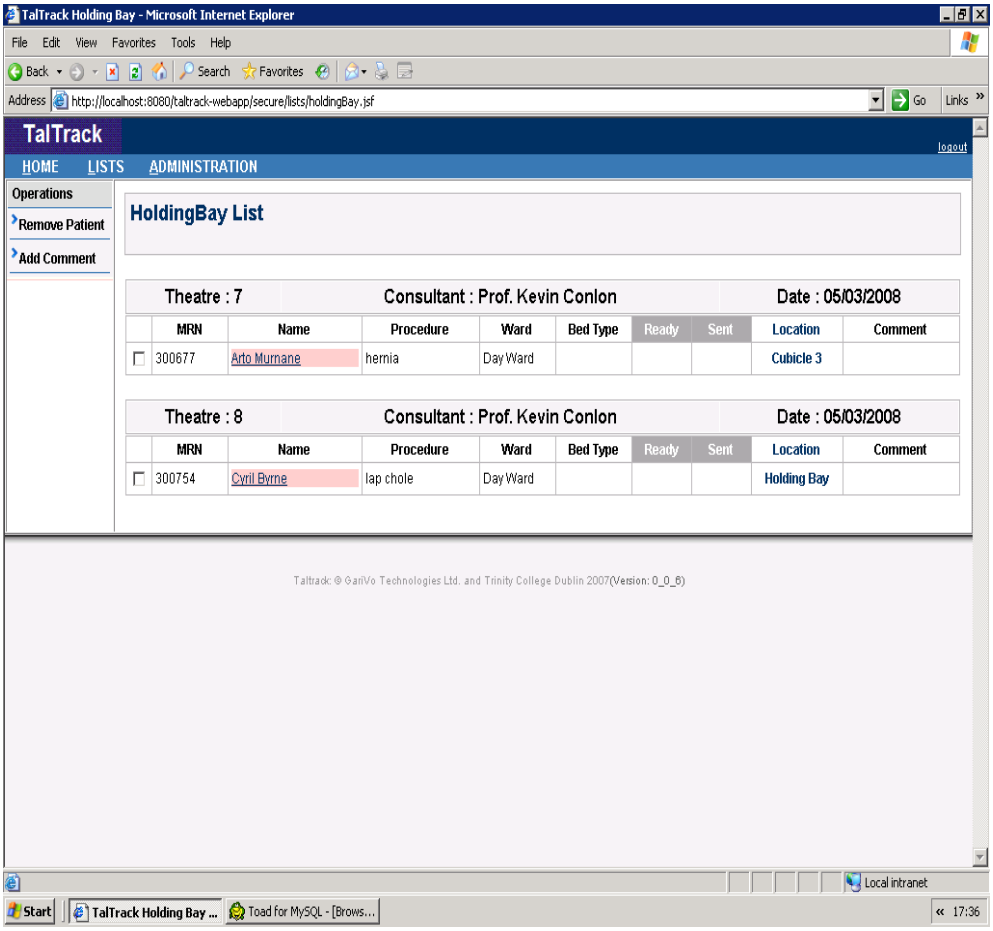


Figure 3-3 Sample Holding Bay screen shot

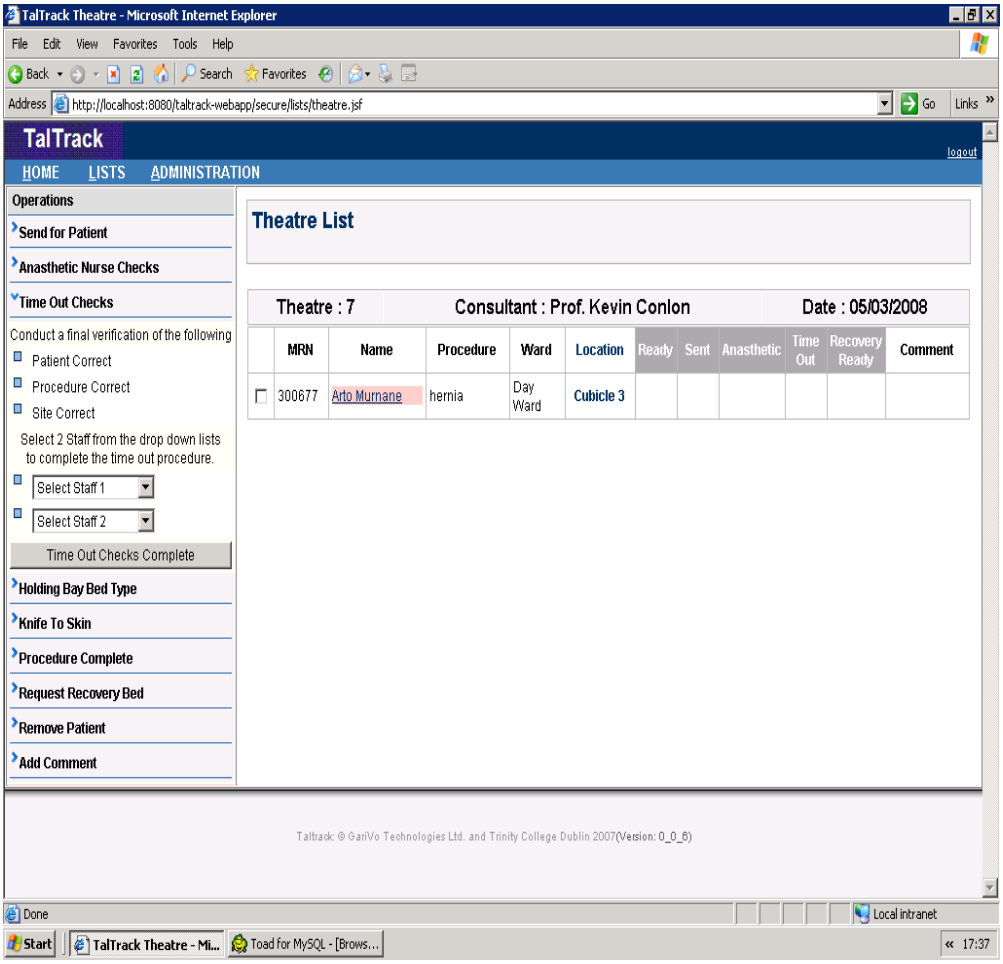


Figure 3-4 Sample Theatre screenshot

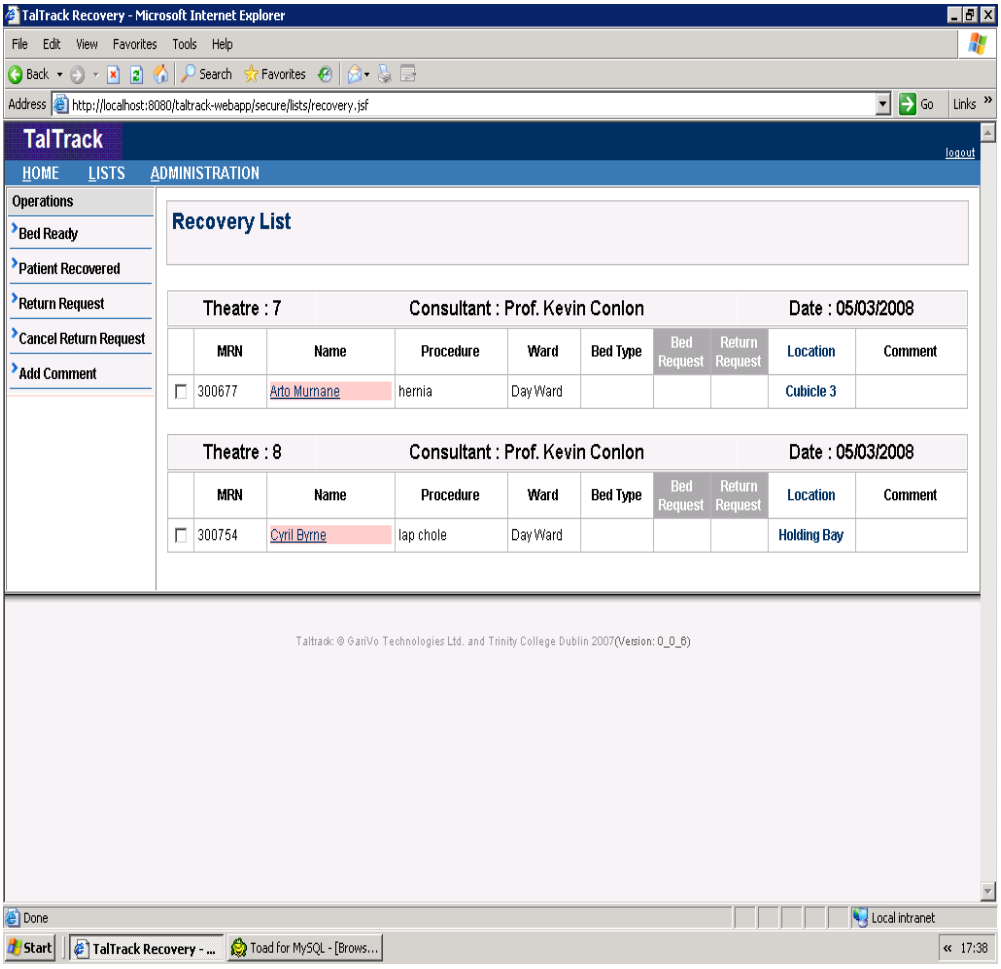


Figure 3-5 Sample Recovery Ward Screenshot

Reports

Reports such as the Audit trail below can be generated online.

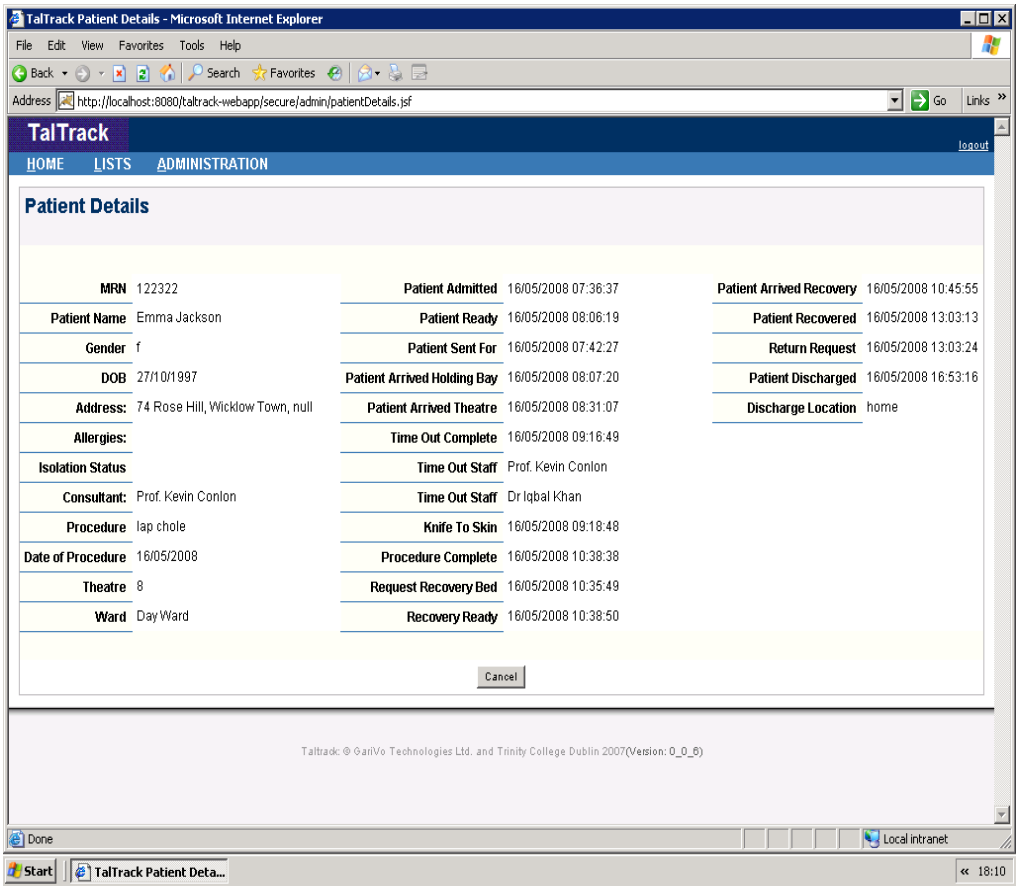
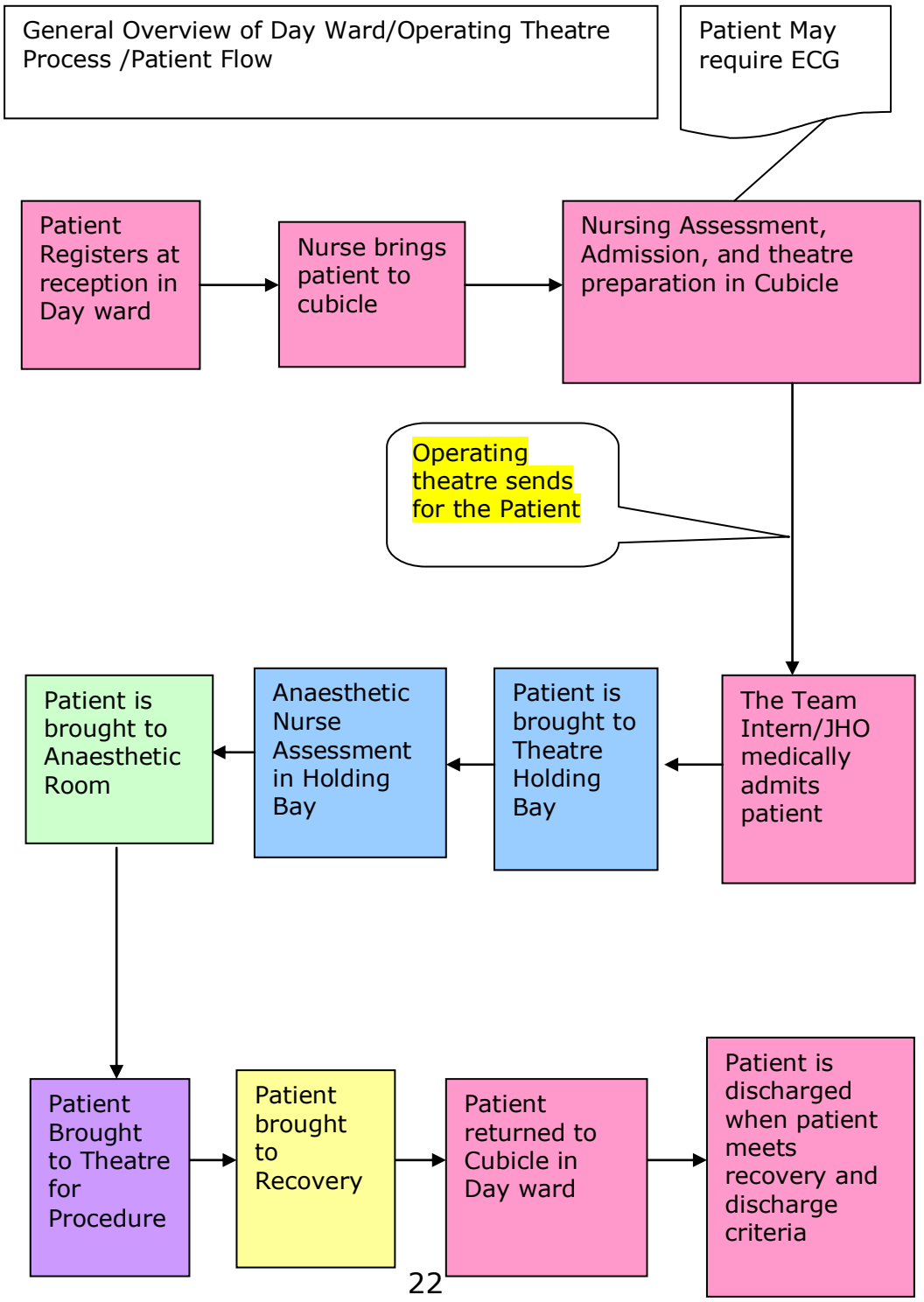


Figure 3-6 Sample Audit trail screenshot

3.3 Assessment of the current process:

This strand of the research provides an overview and description of the hospital's present surgical process. Both Surgical Day Care and surgical inpatients go through a similar journey. (See figure 3-7 below)

Figure 3-7 Day patient process



As observed in this project, it was clear that the dedicated staff involved provided safe and efficient care for each patient. There is however, no room for complacency when dealing with important issues such as patient safety. Medical errors have become a leading cause of death, killing more people annually than AIDS or aeroplane crashes.
(Chao et al, 2007).

A breakdown of these errors by Chao et al are categorised as;
1. Poor decision making.
2. Poor Communication.
3. Inadequate patient monitoring.
4. Patient misidentification.
5. An inability to respond rapidly and poor patient tracking.

The patient journey has critical steps or stages where patient information is passed between clinicians involved in patient care. Research has shown that '*inadequate access to timely information and ineffective communication among patient care team members are frequent events that are proximal causes of medical errors*' (Chen and Cimino, 2002, S.54). Staff communicated with other clinical areas mainly by phone, and also face to face handovers of patient care. There were staff coordinators in each area responsible for overseeing effective communication and organisation of patient care.

A Prospective study of patient safety in the operating room, illustrated that communication breakdown and information loss, when combined with increased workload and competing tasks, had an adverse effect on patient safety in the operating room. This study by Christian et al, (2006) identified two qualitative system features that were shown to significantly influence patient safety and case progression in all cases.

These are:

1. Communication and Information flow:

Information flow is '*the successful transfer of information'* from one provider to another including across physical locations. The study found that problematic communications often began as an asynchronous communication between staff through a third party.

2. Coordination of workload and competing auxiliary tasks:

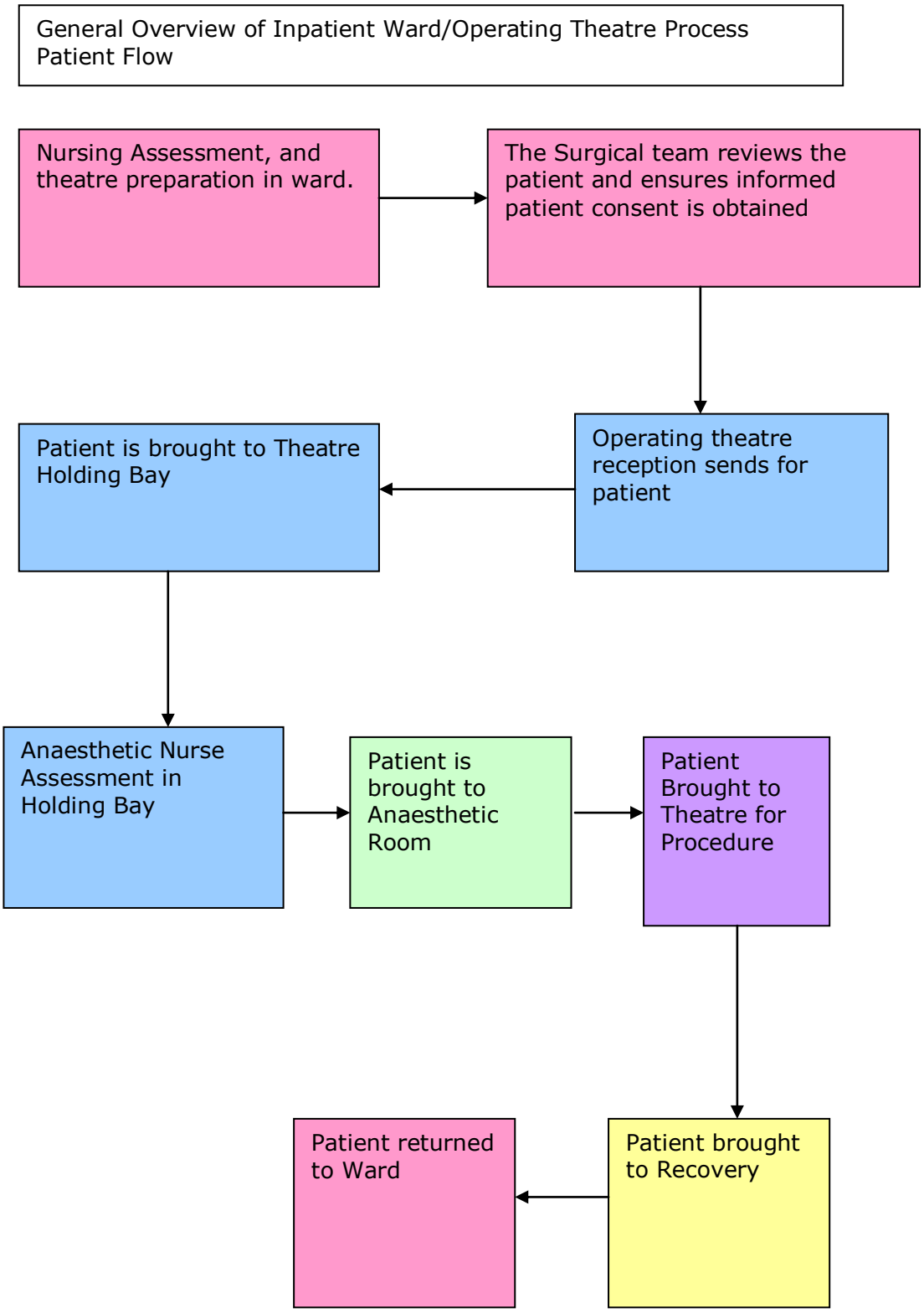
The study defined auxiliary tasks as any task that is not directly patient-centered, an example of which is answering telephones.

"*Like other complex systems, the OR is information-intensive, with performance and safety relying heavily on how well information flows between phases, physical locations, and providers. We observed wide variation in the type and format of the information that was lost or degraded and the phase at which this occurred, suggesting a generalized vulnerability of the OR system to information loss.*
Information loss led to delays, overuse of staff and resources, uncertainty in clinical decision making and planning, and oversights in patient preparation" (Christian et al, 2006, p.169).

Efficient flow of accurate information is vital to ensure quality and safety of patient care. Information specific to patient safety includes positive patient ID verification, allergy and infection awareness and alerts, and completion of pre-operative checks. All patients in the study had an ID band checked by staff with patient chart, patient, and/or family/carer. There was no ID band for allergies in use at prior to the study. Allergies were recorded in the patient's medical and nursing notes. Nurse and Doctor Checks were signed off in the documentation as they were carried out. Patient safety checks were performed routinely at several separate stages of the process by staff in each clinical area.

The ward inpatient flow (Figure 3-8) was very similar to that of day ward. It must be noted the main differences were that the workload was heavier and more intense on inpatient wards and was inclusive of at least two shift changes daily. The patient had pre-operative checks and operating theatre preparation (as for day patients) on the ward.
There were no actual theatre lists on the ward. In-patients were scheduled for surgery and staff were informed in advance during the ward rounds.

Figure 3-8 Inpatient Process



Surgery schedule:

Surgical Inpatient wards

The Surgical Consultant's patients were generally admitted to four particular in patient wards. Occasionally patients may have been admitted to other wards which were not included in the pilot study. Up to eight inpatients were scheduled for major surgical procedures on Wednesdays from these four wards. One of these cases generally required PACU/ICU management for recovery and was not included in the pilot.

Day ward

The Consultant had up to three patients for **day** surgery each Wednesday. Patients were cared for in one particular 6-bedded cubicle. One nurse assumed responsibility for the six patients admitted to this cubicle. An additional nurse provided assistance as required. The Coordinator oversaw all procedures in day ward. Nursing staff commenced their shift at 0730. Paper lists for the Consultant's patients were compiled by junior medical staff the day before from the General Surgery booking diary. These lists were distributed to theatre and relevant staff. Day ward lists were produced by ward clerical staff a day prior to surgery. Surgery was generally carried out in two specific theatres located next to each other.

Steps in the Day Surgical Patient journey

Step one:

Patient Registers at Reception in Day Ward

Day Surgery patients arrive to the hospital for 0730 and are checked in by clerical staff in Day Ward reception.

Step two:

Nurse brings patient to cubicle

The Nurse collects each patient and escorts them to the cubicle where they are prepared for theatre. The Nurse may need to bleep the Doctor to admit the patient.

Step three:

Nursing Assessment, Admission, and theatre preparation in cubicle

The Nurse assesses the patient and their care plan is completed. Each cubicle has a theatre list and the patient's name is highlighted on arrival and a bed number written in beside their name. At some point, usually in the early stages of the Nursing admission or a short time after, the Operating theatre Coordinator will send for the patient. Sometimes the first patients for both theatres are sent for simultaneously as an efficiency measure. The Day ward Coordinator receives this message and passes it on to the Nurse in charge of the patient's care. The Day ward Coordinator carries a master list and amends this paper list during the course of the day.

Step four:

The Team Intern (Junior House Officer) medically admits patient

The next stage in the process is the Medical admission. A Doctor from the Surgical team (usually a Junior Doctor), comes to the cubicle and medically admits the patient. Occasionally a senior Doctor may oversee or review this admission. Patient Informed consent is obtained. Medication is administered as prescribed.

Step five:

Patient is brought to Theatre Holding Bay

At this stage the patient is fully prepared and ready to be taken to the Operating theatre. The admitting Nurse accompanies the patient who generally walks to theatre holding bay. On arrival in the holding bay the ward Nurse hands over the care of the patient to the holding bay Nurse, who takes the patient details and medical chart. The holding bay Nurse then highlights the patient name on holding bay list (which is on a large clipboard with all theatre lists for the day) and also adds the patient to her own list. Holding bay coordinates lists with Theatre reception.

Step six:

Anaesthetic Nurse Assessment in Holding Bay

The Anaesthetic Nurse comes to holding bay to admit the patient and verifies correct patient, procedure, (site, and side of surgery if applicable).

Step seven:

Patient is brought to Anaesthetic Room

The Patient is brought to the Anaesthetic room on a bed/trolley by the Anaesthetic Nurse. The patient's name is fully highlighted on holding bay list and the patient is crossed off the Nurses list. At this stage further patient checks are carried out by the Nurse and Anaesthetist. The patient may speak with the surgeon at this point.

Step eight:

Patient Brought to Theatre for Procedure

When checks are complete the patient is anaesthetised and brought into theatre. On completion of surgery, theatre phone recovery to request a bed. The bed is most often assigned immediately and the patient brought straight into recovery. If recovery is busy they take a note of the bed request and call each theatre in order of their telephone requests as beds become available.

Step nine:

Patient brought to Recovery

Patient is brought to recovery ward and care is handed over to the recovery Nurse. Recovery also has a large clipboard with all lists for the day. They update these lists from the reception lists. This involves the Nurse walking to reception with the clipboard at intervals throughout the day. Recovery also keeps a log book of the patient's admission and discharge times. When patient is recovered the Nurse puts the patient's name on a separate recovery log sheet. This also records the time transport is requested to take the patient back to day ward and the time the patient is discharged from recovery. At times there is a delay in transporting a recovered patient back to day ward.

The recovery Nurse Coordinator must phone the ward for a nurse escort to transport the patient back to day ward and coordinate this with location of an available porter.

Step ten:

Patient returned to Cubicle in Day ward

The patient recovers in day ward.

Step eleven:

Patient is discharged when patient meets recovery and discharge criteria

The patient is often reviewed on day ward by Surgeons prior to discharge.

3.4 Preliminary/Pre- Pilot Assessment of safety and efficiency deriving from prototype:

The surgical day care process required much coordination between staff in each clinical area; wards and operating theatres. The patient journey needed to be highly organized and exact from admission to discharge. Most of this communication was carried out by phone. One problem seemed to be that telephone communication between clinical areas could be slow if lines are busy and could delay the movement of patients from one area to another. Constant telephone calls could be a disturbance and distraction to staff, as they had to leave what they were doing to answer the phone. Also as mentioned, paper lists were used to monitor and log the arrival and completion of patient procedures. This process was potentially error prone and time consuming for Staff, impacting on both patient safety and efficiency.' *Errors associated with the preparation of operating lists have been identified as an important patient safety issue for acute trusts'* (National Patient Safety Agency, 2007).

The process began with the booking of patients in the day surgical diary. Operating theatre lists were created from information in this paper diary allowing potential for errors to be carried into the theatre list.

There was also potential for additional errors to occur, during transcription of patient information. In the case of day surgical lists, two lists were produced, one by ward clerical staff and another by Junior Medical staff the day before surgery. This further increased the margin for error. During the course of this Research, errors were observed involving incorrect Patient MRN's on lists and MRN's missing from lists. This had potential at best for confusion of staff and at worst an error in patient care. By using the patient tracking system, potential for such errors could be greatly reduced.

It has been demonstrated in previous studies that timely use of technology for prompts and reminders reduces the potential for human error. In his study on patient safety, Schimpff (2007) refers to the US Institute of Medicine 1999 report 'To Err Is Human' and states that humans that double-check will still make mistakes. Schimpff concludes that there is a need for systems to be in place to prevent an error from being made, or to detect it early and correct it, to minimise the harm that may result. Electronic lists are less error prone than paper lists. As with TEAMS, the tracking system is functionally integrated with the Patient Information Management System. In order to create the surgical list the correct patient MRN must be input to retrieve the data from the PIMS database. This greatly minimises the potential for error with patient operating lists.

As detailed, the tracking system provided an extra safety check for positive patient ID and location. Allergies and infection risks were highlighted on screens in all clinical areas. In addition, prior to the clinical staff signing off on pre-operative checks, an informative remainder of each check was present on a drop down menu. This was a double reminder that all necessary checks are complete. There was also a '*Time out'* check to verify correct patient, site and side of surgery with two clinicians, for example the Surgeon and Anaesthetist, or Anaesthetic Nurse. '*Time out*' is a safety pause period and a critical step in every procedure. Version 3.1 of the software has been modified as requested by clinical staff (July, 2008) to include a third clinician as per WHO, guidelines.

The time it took for the process at each stage provided a measurement of the current surgical process efficiencies. Time stamping enables the hospital to gather statistical data regarding patient throughput for multiple purposes including audit, process improvement efficiency analyses, and quality improvement of the clinical process. The time it took for an entire patient journey highlighted the areas where both efficiency and delays were experienced. A few approximate times stamps were available in the patient's medical and nursing records but these times had limited usefulness in isolation. In their current format these records were difficult to navigate, and did not provide seamless information. Data quality is a potential issue that use of the system could help improve by the provision of timely information at the point of care to all relevant staff. For example, the '*add comment'* function can communicate important patient information to all staff at the click of a button. Transport type and bed type is also communicated to staff requiring this information, via the electronic list.

The system's audit trail could potentially provide more exact and detailed times. (See figure 1-6). An important potential feature of the system is in its ability to provide reliable data on the process that was previously unavailable. Data can be used to quantify previously unknown information relating to patient flow and resource utilization. This has the effect of increasing transparency and accountability in patient care. This is a well documented advantage of the value of time stamping data and a major benefit emerging from this study. This data provides important information on operating theatre utilization which has potential for clinical managers to maximise efficient use of existing resources. A report on making better use of NHS day surgery in Wales indicates that day surgery rates remain low. This is in part due to inadequate and inefficient use of operating theatres in dedicated units. (Wales Audit Office, 2006)

The process of capturing patient data in paper records also consumed staff time. Junior Doctors obtained the patient names from day ward, typed the information onto a template, print copies for each area, and distributed to theatres and relevant staff. In comparison, the electronic list could be created by the Doctor logging on to any PC in the hospital and simply adding the patient MRN and procedure details. Lists could then be instantly accessed by all relevant staff from wards and theatres.

Nursing staff in day ward and theatres maintained and updated the paper lists. Changes had to be written into each individual list. This also had potential for miscommunication of patient information should the theatre lists show conflicting information. Maintenance of lists involved additional work for staff, in all areas, particularly holding bay and recovery. Both areas had a large clipboard containing all theatre lists for the day. Changes to these lists must be coordinated with lists in theatre reception. Staff had to make phone calls and walk to reception at intervals to ensure all lists were accurate during the course of the day. In comparison, staff using the tracking system could view the process and keep updated on any changes in real time on the electronic list. Taking the current process into account, it was predicted that the WiFi patient tracking system in this pilot had the potential both to avoid errors and save time. It was hoped that once staff became accustomed to the tracking system, they would adopt it positively. A negative aspect of the pilot was that Nurses were using the tracking system alongside the traditional system. It must be acknowledged that this was a direct intensification of nursing staffs' workload because the task of keeping both systems operational ultimately depended on the co-operation of nursing staff.

To summarise, it was expected that using the Patient tracking system had potential to enhance patient safety and efficiency helping to ensure the right patient was in the right place at the right time for the right procedure. It could be reassuring to staff, patients, families/friends to know exactly where each patient is at all times. The system included automatic alerts to staff when patients were ready to be transferred from one clinical area to another. Effective system use enabled enhancement of patient care coordination with the minimum of phone calls between clinical areas. This had the added advantage of minimising environmental noise for patients. With the pressures of the day surgery process as detailed, not being entirely reliant on paper lists and schedules could also enhance the process by saving time, which could be spent caring for the patient. This should potentially increase patient and staff satisfaction.

Chapter 4 Methodology:

This chapter provides a discussion of the research design, an overview of the research process and describes the methods of investigation employed in the study.

4.1 Research design

A Research design should do the best possible job of providing trustworthy answers to the Research questions (Polit & Hungler, 1999).
The Research design in this study is multidimensional. It is an evaluation study which is descriptive, comparative, and non-experimental. It employs a number of methodologies using both quantitative and qualitative methods to collect data. Evaluation research is an applied form of Research. It involves finding out how well a programme, practice, procedure, or policy is working. The outcome or objective is to assess or evaluate the success of a programme (Polit and Hungler, 1999). In this case the 'programme' includes the development of the prototype patient tracking system and research into whether it has potential to enhance patient safety procedures and process efficiencies. Evaluative studies assume great importance in the era of evidence based practice and client-centered care (Parahoo, 1997).

According to Polit and Hungler (1999) the research objective in evaluations is utilitarian – the purpose is to answer the practical questions of people who make decisions, i.e. – Will the system show potential to enhance patient safety and efficiency of the Day Surgical process? In an evaluation study "*the Researcher often confronts a set of problems that are organisational, interpersonal, or political in nature*". "*Evaluation researchers need to have more than methodologic skills – they need to be diplomats, adept in interpersonal dealings with people. If the people operating a program are defensive and noncooperative the evaluation could be unproductive*" (Polit and Hungler, 1999, p201-202)

The traditional strategy for the conduct of evaluation research as advised by Polit and Hungler consists of four broad phases detailed as follows:

1. Determining the objectives of the program.
2. Developing a means of measuring the attainment of these objectives.
3. Collecting the data.
4. Interpreting the data in terms of the objectives.

Analysis in an evaluation study is most often achieved by various evaluation activities such as 'process' and 'outcome' analysis. A process analysis involves the in-depth examination of a programme, which often necessitates the collection of both quantitative and qualitative data. An outcome analysis tends to be descriptive and does not use a rigorous design. It documents the extent to which positive outcomes occur and the level of attainment of the research objectives.

4.2 Research process:

4.2.1 Introduction

The Research aims and objectives within the Patient tracking project were pre-determined following initial Research by the then project team. Upon the author's commencement, the primary and secondary research objectives were already established and documented. The aims and objectives provided the benchmark against which the success of the programme could be measured (Parahoo, 1997).

Developing a means of measuring the attainment of the objectives for this innovative study was somewhat difficult. It was necessary to become familiar with the day surgical process. A workflow document was produced (See figure 3-2) and initial observations documented. Advice was sought from the project team and Trinity College Health Informatics staff on the compilation of the most appropriate measurements to meet the pre-defined research objectives.

It was decided to create a 'research protocol' to summarise and document the key measurements. (See table 4-1). The initial focus of the research protocol was on the collection of quite structured, mainly quantitative data. It became clear as the pilot progressed that it was impossible to rigidly measure and quantify all aspects of the study. Some data collection methods were failing to adequately measure what mattered. Design decisions evolved as new data was gathered and interpreted.

The quantitative data was subsequently categorised into two main parts Time stamping data and Telephony data. The primary purpose of quantitative research is to measure, although this is not always possible. "*Most studies attempt to 'describe', 'assess', or 'evaluate' the level, extent, or degree to which certain phenomena occur. The aim, however is to quantify*." (Parahoo, 1997, p.53) The research protocol established the study would compare the same variables both before and after the piloting of the prototype.

It was decided that staff opinion would be obtained from participating staff by means of the survey approach both before and following introduction of the prototype. Capturing the opinions and attitudes of clinical end users provides valuable information for evaluation of processes and procedures. "*A survey is designed to obtain information from populations regarding the prevalence, distribution, and interrelations of variables, within those populations*" (Polit & Hungler, 1999, p.200). Surveys produce data that are primarily quantitative. Data can be collected in a number of ways including by questionnaires, structured and semi-structured interviews. Some of this data is by its nature qualitative, as it aims to capture the experiences, perceptions and attitudes of respondents. (Parahoo, 1997) It was decided responses would be coded as far as possible and analysed using SPSS 14.

Table 4-1 Research protocol summary table

What can be measured	How can this be measured	Methods
A. Efficiency of current Day Surgical Process: 1. Patient flow/Coordination and Communication of information between clinical areas.	1.1 Measure time taken for present patient journey – patient flow and coordination. 1.2 Observe Communication between clinical areas. Compare and contrast with use of the Tracking pilot system. **Limited times outlining the patient's progress in the medical chart.	1.1.1 With the process map observe and document time-stamps for entire 'patient surgical journey' in Excel. 1.1.2 Collect historical** times from patient medical records and document in Excel to provide an outline comparison. 1.1.3 Collect automatic times from Tracking system database and compare with 1.1.1 &1.1.2 1.2.1 Count number of phone calls between relevant DW and Theatre extensions (Before & during the pilot study) 1.3 Compare and contrast work involved in administration and maintenance of paper patient lists with the generation and updating of the electronic lists. 1.4 Staff opinion on the efficiency of pt flow/ Coordination/communication *****StaffQuestionnaire/Interviews. (Pre and post pilot)

B. Improvements to patient safety/ quality of Patient care: 1.Patient safety checks NOTE 'Live' and In Historical** data: Approx % of patients with Allergies/ Infection risks	1.1.Joint Commission recommendations for patient safety: 2008 National Patient safety Goals & *WHO Safety checklist Look at applicable Joint commission goals/requirements and how present patient safety procedures and the Tracking system patient safety features meet the Joint commission goals/requirements *Also WHO June, 2008 Appendix ten. e-lists are less error prone and more reliable than paper lists Double reminders admission checks are complete is also a potential time-saving measure.	1.1.1 Patient ID verified with patient ID band, checked by staff and patient with patient's medical chart at several stages in the process. 1.1.2 The tracking system has Provision of additional check for ID & location with patient tracking tag on computer. 1.2 No ID band for allergies. Allergies and infection risks noted in patient admission are recorded in patient's medical chart. 1.2.1 Allergies and Infection alerts will be highlighted on the electronic patient lists. 1.3 The electronic list includes an Informative drop down reminder beside Nurse, Dr and Anaesthetic check boxes. This is a Double reminder that all admission checks are complete. 1.4 '*Time out'* checks with two members of staff to verify patient, site and side of surgery included in electronic list. Changed to 3 staff –July '08 1.5 Observe effects of double reminders & safety features in new system. *****StaffQuestionnaire/Interviews. (Pre and post pilot) As for A
2. Increase time for direct patient care.	2.1 Time at bedside/with patient is being taken up on auxiliary tasks – phone calls and administrative tasks.	2.1.1 New system: aims to reduce phone calls. See A. 1.2 2.1.2 Paper lists Vs electronic lists. See A. 1.3 2.1.3 *****StaffQuestionnaire/Interviews. (Pre and post pilot) As for A

4.2.2 Data collection methods

4.2.1.1 Time stamping data:

Initial quantitative methods focused on the time stamping of the day surgical process and practices. Existing 'historical' data within the patient nursing and medical notes was researched to provide an indication of date and timestamps that were most frequently captured.

Manual timestamp data was obtained in the initial phase of the study by observation of the process and recording of times for each step using an Excel chart. This was to assess both the current efficiencies and delays in the process and as a baseline comparison for the pilot system's worth i.e. - to establish whether the prototype could save time. It was decided that the best method of becoming familiar with the day surgical process was to track patients as they went through the process. It was decided that a time and motion study be commenced pre-pilot to track a random number of patients through the process from admission to discharge and manually note the times they arrived into each clinical area. A data collection tool was created in Excel based on observations of the steps in the process and piloted.

4.2.1.2 Telephony data:

The objective of this data analysis was to count the number of calls received by ward extensions involved in the pilot study to observe if there was any effect using the system. It was agreed to source Telephony data to establish the quantity of calls to relevant extensions for several weeks both before the pilot launch and then a few weeks after the launch to determine if there were any early effects on calls using the pilot system.
Nine weeks of telephony data have been randomly gathered for surgery dates pre the pilot, and also during the use of the pilot system (Post-pilot).

4.2.1.3 Survey data:

Survey data was the primary measurement tool and means of data collection for this study. As described in the document, data gathered consists of participating patient and clinical staff opinion on the pilot system.

4.2.2.3.1 Nursing staff:

Data on nursing staff opinion comprises the majority of data gathered. This is appropriate as this group of staff are both the key end users and the single biggest population in the pilot. In this case Nursing staff questionnaires were developed based on the research objectives. The aim was to capture both pre and post pilot opinion of nursing staff in Day ward and Operating theatres on a variety of issues including their opinion of the present systems efficiencies, computer systems in the workplace, and the potential of the tracking system.

Questionnaires were reviewed by the research team and Trinity College staff before being piloted and released. This process was carried out in November (pre- the pilot) and again in June (post launch of the pilot) Nursing staff were invited to complete questionnaires by a personal letter distributed to all staff working in Day ward, Anaesthetics, Theatres 7&8, and Recovery ward/PACU. They were assured of anonymity and confidentiality of their responses. See Appendices two, three and four for staff questionnaires and a sample cover letter. Clinical Nurse Managers were contacted and emailed about the questionnaires. The Nurse Managers in all areas were extremely helpful in provision of staff names and distribution of letters and questionnaires. Completed questionnaires were returned anonymously by leaving return boxes for staff in each clinical area. Nurse Managers were advised to inform their staff and reminder posters were displayed in prominent areas in day ward and operating theatres. Staff were given two months to return questionnaires pre the pilot and a month for the post pilot returns as time was limited.

4.2.2.3.2 Patients:

Participating patient opinion was obtained from a short survey of day patients post-operatively. Patients were given letters and written information leaflets on the study, which as far as possible was posted to their homes prior to admission. A contact phone number was supplied should they wish to ask questions prior to admission. They were spoken with on arrival to the day ward to request their consent and to give them another opportunity to ask questions on the study. Patients were assured of confidentiality. Medical staff obtained informed patient consent as per the ethical committee guidelines. Again, the vast majority of patients were happy to voluntarily participate in the study and feedback to date is pre-dominantly positive. "*Patient/Client satisfaction is a cost-effective, non-invasive indicator of quality of care*" (Health Strategy 2003, p.10) See Appendix eleven for patient survey questions.

4.2.2.3.3 Medical staff:

Medical staff opinion was obtained using the method of structured interview questions, as nursing staff questionnaires did not take the Doctors specific duties into account. Similar questions were asked but were adapted to suit this small group of six staff. Junior and middle grade medical staff respondents willingly gave a few moments of their time to volunteer their opinion on the process both pre and post the tracking system. Medical staff were also advised of anonymity and confidentiality of their responses. Staff were spoken to individually, and the interview process took five to ten minutes on average.

Polit and Hungler state that the greatest advantage of survey research is its flexibility and broadness of scope. Usually undertaken as part of a non-experimental study, it is better suited to extensive rather than intensive analysis as the information it delivers tends to be superficial. (Polit & Hungler, 1999) Personal interviews are deemed the most respected method of securing good quality survey information. To complete the survey evaluation it was decided to carry out additional semi- structured interviews with a cross section of hospital staff. See Appendix seven for sample questions.

All proposed measurements were approved by the Tracking system research team. The phases of collecting the data and interpreting it in terms of the objectives, is described more fully in chapter five: Evaluation.

Chapter 5 Evaluation

This chapter evaluates potential changes, and benefits that the tracking system could bring to the clinical areas under study. Research from experts in the area of realizing benefit from IT has been incorporated and used as a means of describing and summarizing both potential benefits and changes. The evaluation describes results obtained from data analysis both before and following the launch of the prototype. It attempts to reflect the diverse opinions of participating patients and clinical staff involved in the pilot.

5.1 Overview of potential changes and benefits

Both the manual tracking of patients and the requirements gathering phases allowed a greater insight into the day surgical processes and resources within the area. Staff (end user) input (qualitative data) enabled prediction of potential benefit that could be derived from the prototype. Manual patient tracking also indicated potential operational benefits and generated ideas for future application. Potential value and benefits emerging from the study have been evaluated as a measure to determine the extent to which they allow the realisation of the Research objectives.

Within the scope and timeframe of this stage of the research it is not possible to immediately demonstrate 'concrete' quantifiable benefits.
The pilot went live on March 19 2008 and time is required for the system to show its worth and also to implement and trial any required changes.
Lessons learned over the course of the study and data gathered from the research of surgical processes will need to be evaluated by experts in the field and hospital management. '*Benefits only come about through change*' (Peppard and Ward, 2007), and actual process change is outside the scope of this pilot study. Advice has been sought from the hospital's process improvement team as part of the secondary research objectives. As such, benefits emerging over the course of the pilot have been assessed as potential, not actual benefits.

As mentioned in chapter four, having a greater insight into the process, both pre and post introduction of the pilot, enables potential benefits to emerge. Peppard and Ward, (2006) advise that the nature of benefits available will vary over the life of the project. '*Realising benefit and value is a journey, not a destination*' (Peppard, & Ward, 2005 P.67).

According to Professors Ward, Daniel and Peppard (2007, p.3) "*studies continue to show that investments in information technology are failing to deliver expected benefits*". This led the experts to conduct a study of over 100 European Organisations to identify why some organizations were able to realize the expected benefits of their IT investments and others were not. The conclusion was that in order to be successful the organization must develop a structured and rigorous business case, demonstrating all the benefits the investment could deliver – not only financial ones. In any case, financial benefits within innovative based projects such as this one are less certain. "*Innovation is dependent on the combination of the technology, the organisation's technical expertise, and the ability of the organization to change in order to make effective use of the new capabilities*", (Peppard and Ward, 2005, p.58). Peppard (2007) showed we can measure desired benefits by linking them to desired outcomes. For the purposes of this study desired outcomes include the primary Research Objectives.

Desired outcome (A): Enhancing patient safety processes.

The desired benefits are;

1. Patient lists are accurate and less prone to error.
2. The tag assigned to the patient acts as an additional positive ID verification for correct patient and location.
3. Allergy notification on the electronic list by means of an allergy icon beside the patient name can alert all staff to potentially dangerous allergies. (E.g. In the case of a latex allergy plans can be made to change the theatre schedule).
4. Infection alert on the electronic list by means of highlighting the patient name. This notifies all staff of potential infectious illness and may also be useful to the hospital infection control team.
5. Staff communication features:

a Current patient location.

b Transport and bed type

c Comment feature.

(E.g. Staff can add a short comment beside the names of individual patients, thus facilitating rapid communication across clinical areas. As previously detailed, it has been well documented that improved staff communication can improve patient safety)

6. Admission and Pre-operative reminders for staff in day ward and anaesthetics.

7. The list incorporates a Safety standard of the Joint Commission and WHO -'*Time out*' checks just prior to surgery, to verify correct patient, procedure, (site/side of surgery, if applicable) See Appendix ten.

Measure of benefit:

The patient is the most important and valuable asset in the hospital and avoiding potential risks or averting any harm to the patient is invaluable.

Desired outcome (B): Enhancing efficiency of the clinical process;

Desired benefits;

A potentially major benefit and efficiency measure of the system is its primary function, the automatic and manual time stamping data recorded in the system database. This is important information for ward and department Nurse Managers. It is statistically sound, reliable evidence of the process from which the system has the ability to efficiently generate all manner of reports. These reports enable the process to be investigated and could potentially help managers utilise resources more effectively.

1, 2, 3 and 4 above:
Electronic lists are more accurate and reliable, avoiding time spent correcting miscommunication of patient information.
By rapidly notifying all staff on patient, allergy, and infection status (Without the need for time-consuming, distracting phone communication)

5 above:
Improving staff communication methods by enhancing the seamless transfer of relevant patient information is also a potential time-saving efficiency measure.
6 above:
Reminders for staff are a potential time-saving efficiency as staff will not have to return to finish aspects of patient care that could be overlooked in the pressure of time pre-operatively.

Measure of benefit:
In the current HSE economy driven situation this has a potentially high value.

Desired Outcome (C) End user feedback

"*Value from IT emerges only through how it is used by the organization*."
This statement from Tiernan and Peppard (2004) p.610 highlights the importance of having a user-friendly system so it is used to its full potential by staff. Research has shown if end users are not satisfied, systems will not be used and therefore value and benefits will fail to emerge. As described, staff and patient opinion on the system and its potential benefit on the processes involved are being researched using survey methodologies. During the requirements gathering phases of our Research, and over the course of the pilot project, clinical end users have been informed and consulted. Lists have been created and adapted to suit the specific individual requirements and workflow of each clinical area.

Desired benefit:
End user input and opinion.

Measure of benefit: An indication of how the system is likely to be accepted by a subset of potential stakeholders. It will predict how it could be used and its potential value to the healthcare organization.

Chapter 2 State of the art, gives an overview of how the technology is being positively applied in similar circumstances.

This is useful to a lesser extent as cautioned by Ward, Daniel and Peppard (2007, p.12) "*Where organizations believe they are achieving an advantage from an innovation, it is unlikely that they will be willing to share all the secrets of their success, so the information gained from reference sites has to be treated with a degree of caution*" They strongly recommend use of a benefit–dependency network to fully evaluate benefits for a business case. An initial step involves using a framework for benefits. See Appendix nine.

5.2 Data analysis and results:

5.2.1 Time stamping data;

5.2.1.1 Existing data

The research of existing 'historical' data found that time stamps within these records are minimal, recorded mainly for the purposes of documenting the patients' clinical observations. Admission times and times patients arrived into theatre are generally not recorded. The paper records document the patient allergy and infection status within various admission documents, and also the patient discharge times. Times within the paper records, if pieced together is a time consuming task and only provides an approximate outline of the patient journey. The most interesting information obtained from the research of existing 'historical' data was: Out of forty-three random day patients, nine had documented allergies, no infections, and four were admitted as inpatients. Whether this is a trend or not is inconclusive.

5.2.1.2 Manual time stamping

An analysis of this data indicates an efficient process prior to the pilot study. A total of twenty-seven patient times were manually recorded prior to the launch of the pilot. The average time for each patient's nursing admission was eight minutes, and ten minutes for the medical admission. On average it took twenty-five minutes for patients called to theatre to arrive in holding bay. From the request for a recovery bed to arrival into

recovery was just four minutes on average. Similarly duration between request for nurse escort and transport until its arrival was just eight minutes. Average arrival to discharge time was found to be eight hours and fifteen minutes. The only delay noted within this sample was due to a patient requiring admission from theatres. Credit for the already efficient process is due to the hardworking and dedicated staff of Day ward and Theatres.

5.2.1.3 Tracking system data

Following the introduction of the tracking system, time stamping data was temporarily resumed owing to technical accuracy issues and it was concluded that manual data matched well with the automatic time stamps obtained via the system. A direct comparative analysis of the time stamps obtained via the system with the pre-pilot manual time stamps collected was not possible due to the ad hoc nature of data collection prior to the tracking system. (See tables 5-1 to 5-5). Total times for nursing and medical admissions were not at all comparable. From patient recovered to bed request were not directly comparable. The most comparable times were from the request to allocation of recovery bed, and from time to cubicle to time of discharge. (Please Note: The max time post-pilot was a WARD time. The max without this time is 10:34) However, times obtained via the system indicate that it has great potential to work efficiently when used as it is intended.

Total Time with nurse		
	Pre	Post
Average	00:08:13	01:01:13
Min	00:02:00	00:00:00
max	00:15:00	14:10:10

Table 5-1 Total time with Nurse

Total time with Doctor		
	Pre	Post
Average	00:10:56	00:32:34
Min	00:05:00	00:00:05
max	00:30:00	03:41:41

Table 5-2 Total time with Doctor

From patient recovered to bed request		
	Pre	Post
Average	00:08:22	09:28:07
Min	00:01:00	00:00:00
max	00:50:00	12:26:34

Table 5-3 Patient recovered

From request for recovery Bay bed to recovery Bay bed allocated		
	Pre	Post
Average	00:04:44	00:04:22
Min	00:01:00	00:00:00
max	00:23:00	00:16:18

Table 5-4 Request for Recovery bed

From time to cubicle to time to discharge		
	Pre	Post
Average	08:15:00	08:41:38
Min	04:35:00	01:28:44
max	10:30:00	22:59:37

Table 5-5 Admission to Discharge

5.2.2 Telephony data;

This data shows the *quantity of calls received* from relevant extensions to extensions involved in the pilot study. These are; Day ward Nurses' station, Day ward Cubicle 3, Theatre main reception, Holding bay, Theatre prep room 7&8, and Recovery. At first glance, early indications showed a small reduction in calls, in particular those received via the recovery ward extension. Numbers of pre and post pilot calls have been compared week by week. See Appendix one. When the computer in recovery was out of order (July 2), a small increase in calls was noted to the recovery extension, supporting the indication that using the tracking system helped reduce calls. See Figures 5-1 and 5-2.

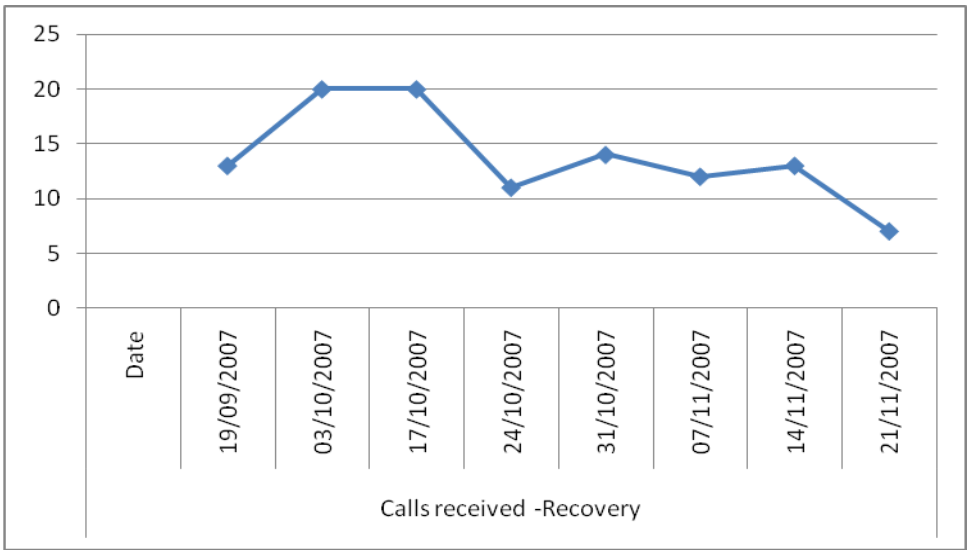


Figure 5-1 Calls received by Recovery Pre-Tracking system

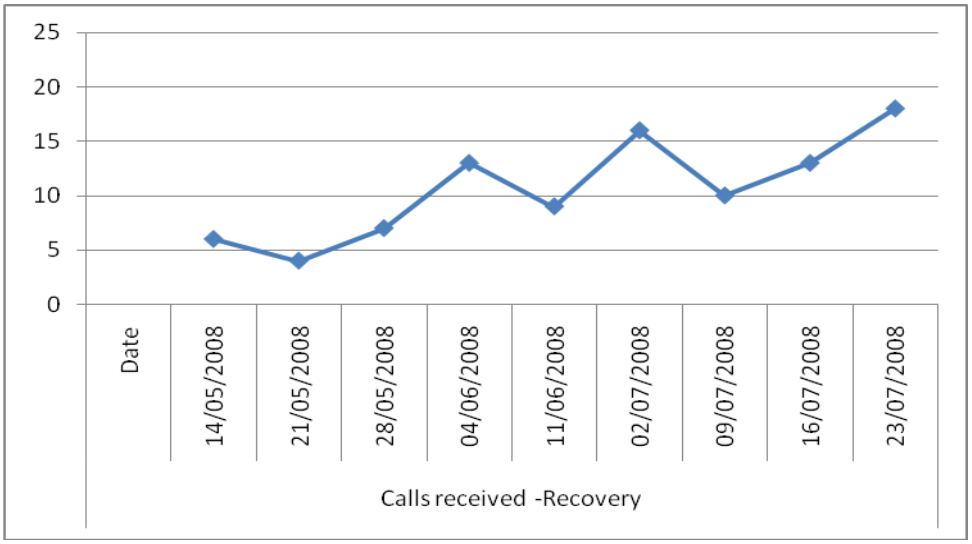


Figure 5-2 Calls received by Recovery Post-Tracking system

However, when the overall picture is examined using trend diagrams, the case is not so simple. It is probable the time of year phone data was gathered had an effect on amount of calls. Pre-pilot data was collected in Autumn/Winter and during the pilot was gathered in Spring/Summer. Other factors such as staff on duty/skill mix/patient issues could influence the number of calls. Calls received during the pilot while on average were noted to be slightly reduced were in themselves prone to undetermined rises and falls. This is quite marked in data on calls received by day ward nurses station. Holding bay appears to be the most stable extension post pilot.

Trend diagrams for calls received to all extensions;

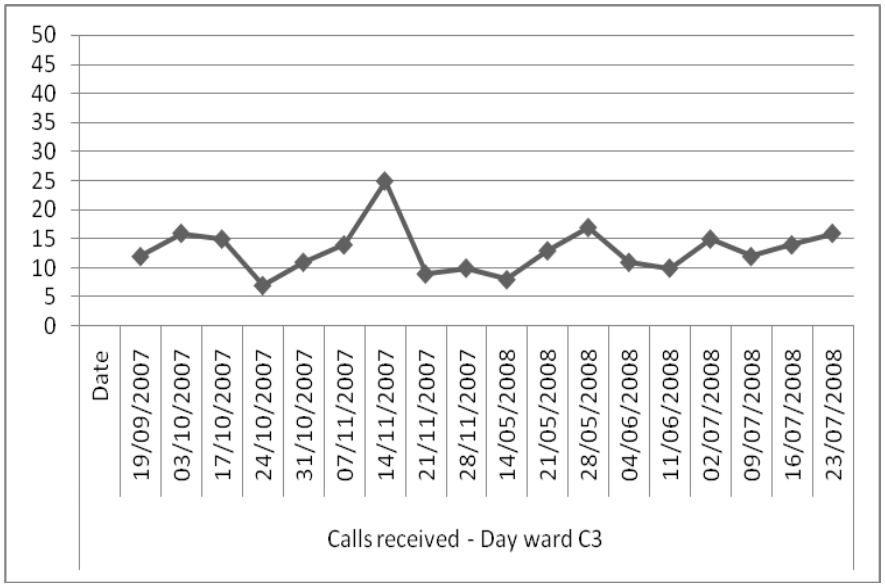


Figure 5-3 Calls received –Day ward, cubicle 3

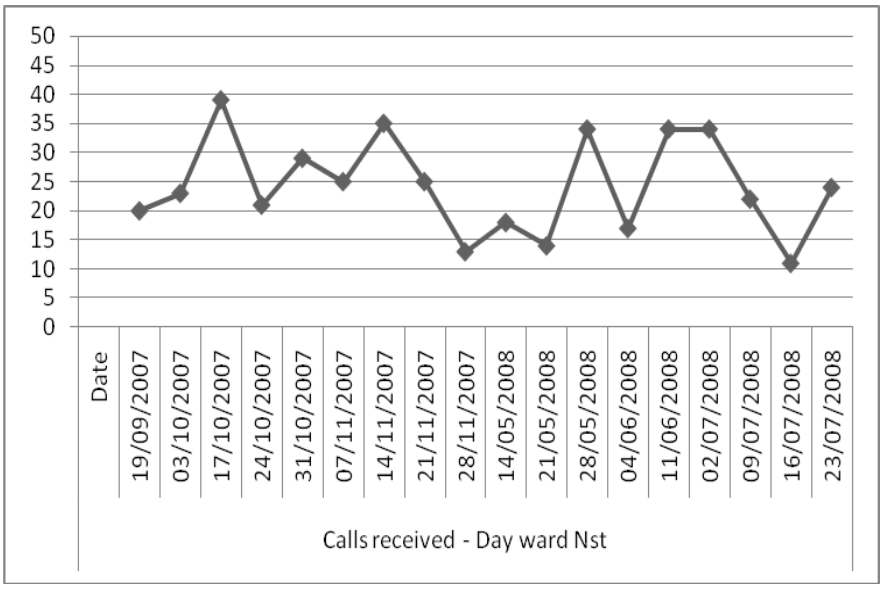


Figure 5-4 Calls received – Day Ward, Nurses station

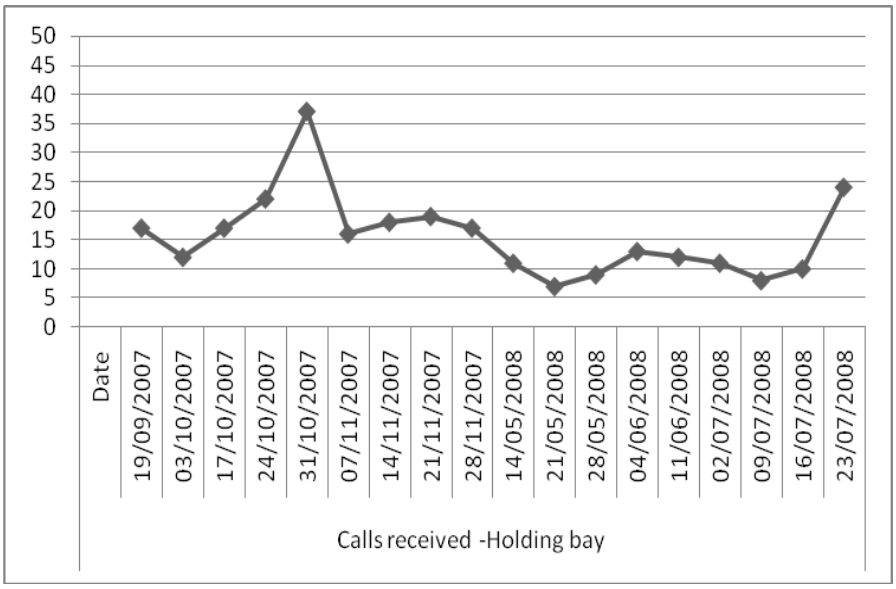


Figure 5-5 Calls received – Holding bay

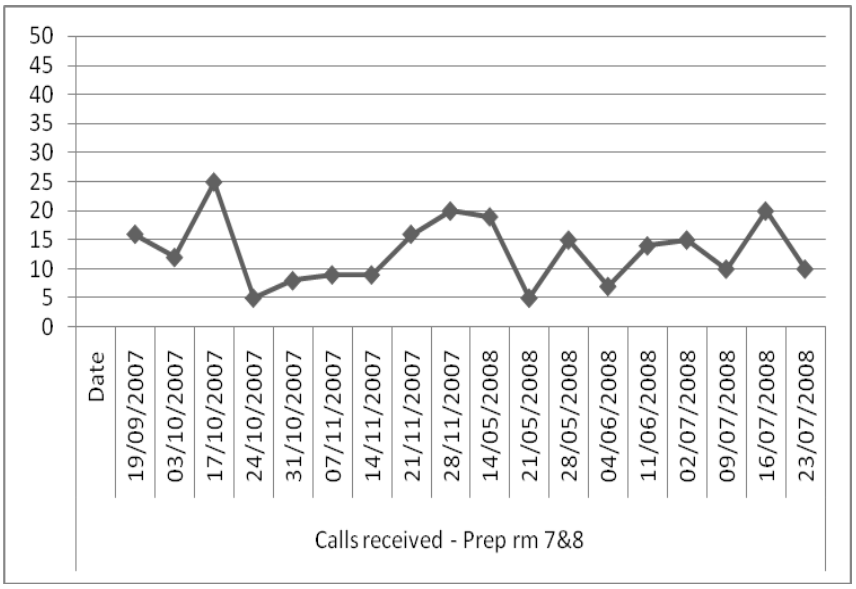


Figure 5-6 Calls received – Prep room 7&8

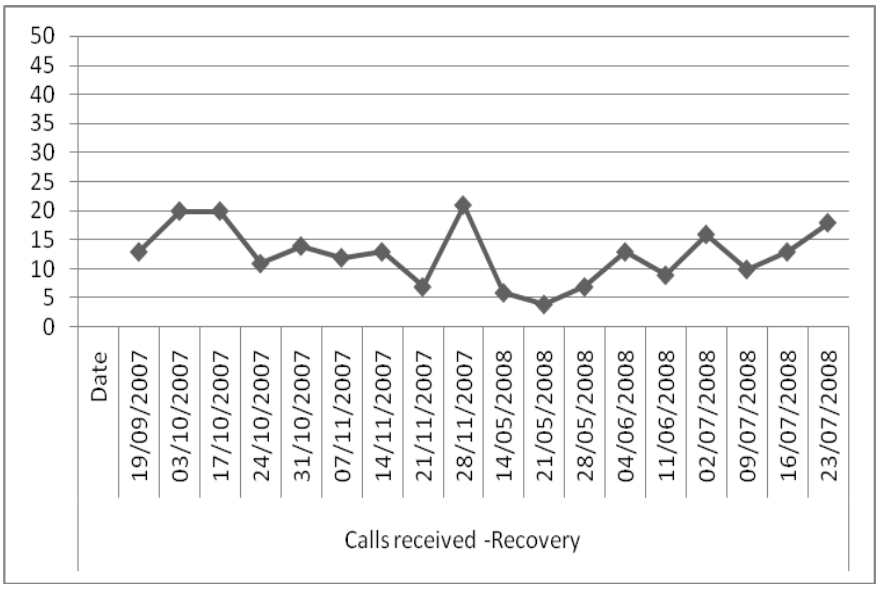


Figure 5-7 Calls received -Recovery

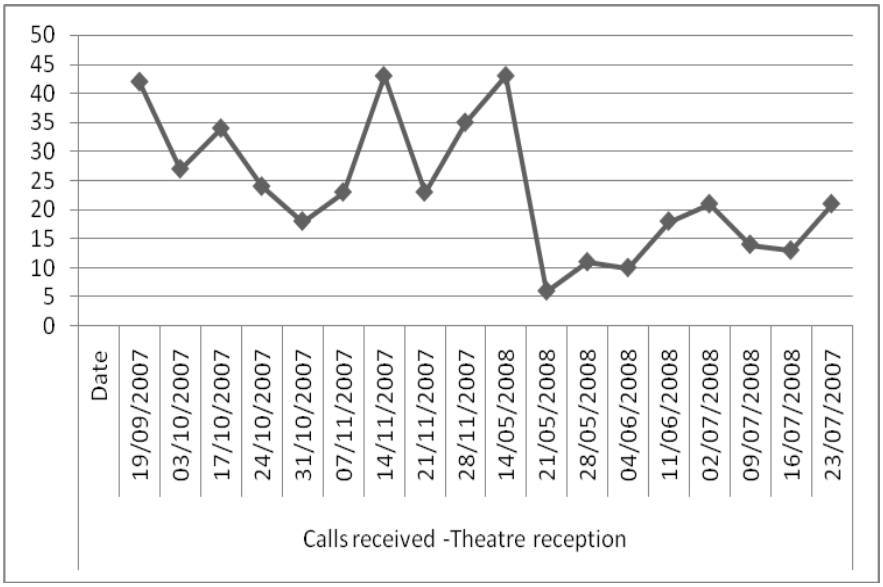


Figure 5-8 Calls received – Theatre reception

Staff feedback has also indicated that whilst the system in theory, has potential to reduce phone calls, in practice this does not appear to be the case. This could be due to a number of factors including pressures of time and staff workload. Also the pilot system has not been in place long enough for staff to become used to and trust in it. It is natural that staff occasionally revert to tried and trusted procedures and means of communication. It must be concluded that analysis of telephony data while showing incidences of lower calls during the pilot, is inconclusive overall as to whether these are as a result of the system. Only time and further extension of the study could reliably tell this.

5.2.3 Survey data;

Responses have been analysed and results will be described separately for each category of respondent.

5.2.3.1 Nursing questionnaire data:

Owing to the large numbers of nursing staff deemed eligible to participate in the study, data gathered was input to SPSS 14 for frequency analysis. Please see Appendix five for bar graphs and detailed frequency tables.

Pre- pilot:

Out of a potential population of 25 from Day ward and 68 from Theatres, invited to participate in the pre-pilot questionnaires, a total of 55 responses were analysed pre-pilot. Some staff were on maternity and long-term sick leave and did not receive their letters. One reply was not applicable for analysis, leaving 54 responses. The main findings of interest were in relation to methods of staff communication, staff opinion on current processes, and staff thoughts on computers in the workplace.

Theatre staff returns totalled 35 (64.8%) and Day ward 19 (35.2%)

Regarding most favoured methods of communication:
Staff rated face to face communication as the most effective method with a total of 81%. Phone communication was rated as the second most effective method by 55% of staff, with 44% disagreeing. Just 11% thought the paging system was an effective communication method. Email was rated by just 7% of staff as an effective form of communication.

Phone calls:
On phone calls, 59% of staff estimated the quantity of incoming calls to be greater than twenty with 42% of peak times for calls being between 1000 and 1300.

Direct patient care:
94% of staff surveyed worked directly with patients and of these 66% spent greater than four hours per shift directly with patients. Most staff thought they had sufficient time with patients, more so in theatres than day ward.

The current system:
66% of staff rated the current system of patient flow as fairly efficient. 14% thought it was efficient and 9% as extremely efficient. 9% did not answer. In relation to confidence in processes within the present system, staff are confident overall. Processes rated were; confidence in identification of allergies and infection risks, (infection risk was rated

slightly lower) positive patient identification verification and verification of site of surgery.

Computer systems in the workplace:
Finally, with regard to introduction of new computer systems in the workplace, staff gave mixed opinion. Just 13% thought positively on new computer systems in general. This went up to 74% if the computer system was thought to improve patient care. If the system was to simplify work processes just 44% were in agreement. Staff were not unsure of new computer systems, with just 37% needing to see the system in action before deciding. They did not rate a new computer system as a negative event either with 94% rejecting the notion of negativity. Training and support for the introduction of new computer systems at work was given a mixed rating. 20% thought it was poor, 25% satisfactory and 38% good. Just 3% thought training and support was excellent. Staff confidence levels in use of computers were also mixed. 25% rated themselves as not confident, 33% as fairly confident, and 35% as confident. 87% of staff used the Internet at home and work, mainly for information searches. This was important to note for training purposes, as the system is a web based application. Staff confidence with computers and the Internet was reflected in the ease with which the majority of staff adopted the use of the tracking system.

Post- pilot:

The potential population invited to participate in the post-pilot questionnaire were 21 from day ward and 66 from Theatres. Nursing auxiliary staff did not use the system and were not formally invited to take part in the survey, although one responded. Also, some staff were on Maternity and sick leave. The response rate post-pilot is much less, with a total of 32 responses. The main findings of interest were how staff viewed the introduction of the new system, and their opinions regarding its potential benefit. The results include short direct quotes from staff, both positive and negative on the pilot system. All comments received have been included. (Appendix eight).

Theatre staff returns totalled 17 (53.1%) and Day ward 15 (46.9%)

Training and support:
Most staff rated training and support for the tracking system as good (43%), 40% thought it was satisfactory, with 15% rating it as excellent. When asked how user friendly staff found the system 46% thought it was satisfactory, 40% thought it was good. 9% found it to be poor, and 3% did not give a rating.

Potential benefits of the patient tracking system:
Results were interesting with regard to the potential benefits of the tracking system. When asked if staff thought the system had potential to enhance staff communication, 40% replied yes, 18% said no, and 37% were unsure. 3% did not reply. When compared to the current methods of staff communication the tracking system was rated as less effective than face to face communication, equally effective to phone communication and more effective than pager communication. The majority of staff were unsure if the tracking system had the potential to enhance efficiency (43%). 40% of staff thought the system had potential in this regard, while 12% thought it did not. 3% did not give an answer.

The tracking system and efficiency:
When asked to rate aspects of the tracking system's potential efficiency functions identified during the course of the study, opinions were mixed.
The system's efficiency in awareness of patient location was given an efficient rating by 43% of staff. 28% of staff gave it an extremely efficient rating. 9% thought it was fairly efficient, and 18% did not answer. The system's efficiency in reduction of need for phone calls was given a fairly efficient rating by 28%, efficient by 25%, extremely efficient by 15%, inefficient by 12% and not answered by 18%. The system's efficiency in the creation and updating of patient lists was rated as efficient by 40% of staff. 25% rated it as fairly efficient, 21% did not answer, 9% thought it as extremely efficient and 3% as inefficient. Finally, the system's efficiency in creation of statistical data for audit was given an extremely efficient rating by 31% of staff. It was deemed efficient by 28%, fairly efficient by 18%, not answered by 18% and inefficient by 3%.

The tracking system and patient safety:

Regarding the potential of the tracking system to enhance patient safety, 53% were in agreement that the system has potential. 25% remained unsure, while 21% said no. A breakdown of staff confidence in the tracking system's potential safety features identified during the study is as follows; 37% of staff were fairly confident in the system's potential to enhance identification and communication of allergies. 28% were confident in this feature, 21% did not answer, 6% were extremely confident and 6% were not confident. 43% were fairly confident in the system's potential to enhance identification and communication of infectious illness. 31% were confident in this feature, 18% did not answer and 6% were not confident. 37% of staff were fairly confident that the system had potential to enhance verification of patient identification and 34% were confident, 18% did not answer, 6% were extremely confident, and 3% were not confident. Finally, 37% were fairly confident in the system's potential to enhance verification of site of surgery. 21% were confident in the system's ability to enhance this aspect of patient safety. 28% did not give an answer, and 12% were not confident. Overall, there were no significant differences noted in staff responses between clinical areas.

In conclusion, the same questions were asked to obtain staffs' general opinion on computer systems as before the pilot. This was to ascertain if opinion had altered following the pilot study. Results were more or less the same. The pilot did not change staff opinion on the introduction of new computer systems at work. On a positive note, it was concluded that 65% of staff are more confident about using computer systems at work following the tracking system pilot study.

5.2.3.2 Patient survey data:

Day patients were the primary population of surgical patients within the study and opinions were not obtained prior to the study. Provided patients were feeling well enough they were asked a few brief questions post-operatively. The aim of the patient survey was to establish if patients had any issues with wearing the tags and to assess how comfortable they were. Prior to the study commencement the Infection control team were consulted regarding the cleaning of tags and later in the trial regarding the wristbands used to secure the tags. A random sample of twenty-four patient surveys indicate that twenty-three patients thought they were given sufficient information on the pilot study. One was unsure as this person did not have time to read the leaflet prior to admission owing to stress.

Comfort of the tag was assessed using a simple rating scale. A score of one was rated as uncomfortable and a score of five as most comfortable. The Average patient score from twenty-two patients surveyed (two did not give a score) was 4.3 out of 5. Patients were asked to comment on what the tag was like to wear and responses varied from the most common; '*didn't notice*' or '*didn't know it was there'* to three patients commenting on the size being '*bulky*' and '*cumbersome*'. Four of the population experienced issues with IV cannulation. This was initially due to the type of wristband being unsuitable for resiting and later to some Anaesthetic staff being unaware the new Velcro strap allowed for ease of removal and reapplication. Early in the study one of the population expressed concerns regarding other people's perceptions of the tag stating it could be perceived negatively as a '*curfew thing'*. Tags were secured by a light Tubifast dressing which improved comfort and obscured the tag from view. This comment was not expressed again to date. The overall perception of participating patients was a positive one. The majority of patients thought the concept of the tracking system was good.

5.2.3.3 Medical structured interview data:

Pre-pilot:

There were a total of six medical staff interviewed. Responses were analysed in Excel and bar chart diagrams produced to illustrate results. See Appendix six.

The current system:

Five out of the six participants rated the current system of patient flow in day surgery as efficient, with one fairly efficient rating. Potential delay to Doctors daily tasks/duties was assessed and issues noted were expressed as rare or occasional occurrences. This was to establish how the system could potentially be of use to medical staff. Miscommunication of patient information, delays with cancellations, and distracting phone calls were assessed as potential issues. Patient ID confused, awareness of allergies and infections, and operating lists not up to date, were not rated as potential issues by the majority of staff. Staff confidence levels in processes within the present system were generally fairly confident to confident.

Post-pilot.

The Patient tracking system:

The same population were asked their opinion on the tracking system post commencement of the pilot. Generally staff feedback was positive in relation to the system and evaluation of its potential to enhance patient safety and process efficiencies. Training and support in the use of the system was rated as excellent by two staff, good by two staff, and satisfactory by two staff. Four staff rated the system's user friendliness as satisfactory, while two rated it as good. All staff thought the tracking system had potential to avoid delays. Five staff thought the system had potential to enhance staff communication, and one was unsure. Six staff were of the opinion that the system had potential to enhance efficiency. The average rating medical staff gave each of the system's potential efficiency functions was efficient. All staff thought the system had

potential to enhance patient safety. Again the staff generally rated the system's potential safety features as efficient with staff being split on verification of site of surgery. Two staff were extremely confident and two were confident on the system's ability to enhance this aspect of patient safety. One staff was fairly confident and one was not confident. One staff was not confident in the system's ability to enhance verification of patient ID.

Chapter 6 Conclusions

Chapter six concludes the document with a discussion of results as detailed in Chapter five. It describes the extent to which the objectives were met successfully, acknowledges limitations of the Research, and includes future recommendations. This concluding chapter attempts to bring all strands of the Research together in a coherent concise manner.

Time stamp data indicates that pre-pilot day surgical processes are efficient overall. The main benefits the system can bring to these clinical processes are enhancement of patient safety checks and collection of previously unavailable process data. As stated, initial pilot data from phone logs were inconclusive. This appears to be due to lack of time post deployment. Staff did not have the required time to become familiar with and fully appreciate the benefits of a tracking system. Survey data gave an overview of staff and patient attitudes and opinions. Both pre-pilot and initial post-pilot data indicate that most staff and patient attitudes and opinions were positive, even at this early stage of the pilot.

The data gathered through survey methods is superficial and while useful and easily quantifiable, does not allow for intensive analysis. To complete this aspect of data collection, it was decided to speak with a cross section of hospital staff, using a semi-structured interview method. This was to obtain more detailed information on their opinion of the system. See Appendix seven for sample questions asked. Not all questions were applicable to all staff, as staff interviewed included both end users and non users. Clinicians included Nursing and Medical staff. The opinions of senior hospital management, Process improvement, and Informatics staff were also obtained during the course of the Research. In summary, the majority of staff view the pilot system overall as a positive initiative.

Managerial staff in particular, view the tracking system's potential very positively. According to a senior manager, capturing data on the patient journey is extremely beneficial. It is not surprising that staff within managerial roles find a system that gathers quantifiable data on the patient journey, including patient throughput and theatre utilisation to be an asset. As theatre currently have no IT system, reports on late starts and overruns have to be carried out manually, which is time consuming.

It is predicted that the search function within the system will be particularly useful in the generation of specific data sets. Process improvement is particularly interested in data on patient outcomes. The system captures data on the discharge location of day ward patients. Managerial staff opinion is that the tracking system has potential to organise the process better and as a result, for quality improvement of the clinical process. The ability of the system to print off reports such as the audit trail is important. Managerial staff realise the system has potential to reduce phone calls. It is also realised this function has a negative aspect. Phone calls allow staff more control, as they can obtain an instant response. (Currently the bleeper system in use with the system does not give an acknowledgement that the message was received). This is an aspect of the system that has been noted as requiring review. Also, using the system to reduce calls involves an element of handing over control.

On the positive side it is recognised that using the tracking system should improve patient safety by its ability to reduce human error. The mechanism for additional checks which were not time consuming, was noted as an important benefit. Other benefits noted were the potential to increase efficiency running the theatre list and the potential to save time on administrative tasks. It is accepted that instant updates obtained using the system have potential to make work more efficient.

Frontline staff find the tracking of the patient to be helpful, in that they know where the patient is at all times, and can inform patient relatives/friends of their progress. It is viewed as a learning experience by staff. Staff can see the potential of the system to reduce phone calls as a positive benefit. Staff report that this is not as yet happening in reality. The general feeling in this initial stage, is that staff on the ground see the phone as a more effective and trustworthy form of communication. Staff see the system's potential in aiding patient safety but practically the pilot is time consuming and causes delays. Staff have voiced concerns about the time it takes to use the system when getting patients ready for theatre, especially if staffing levels are low. The portable tough books in particular appear to consume the most time as they timeout after fifteen minutes and login is not straightforward. The fixed PC's are much easier to use, although staff have commented it is not always feasible to be near

a computer. This places additional pressure on staff nurses. For the present the system's time saving benefit remains attractive in theory, yet inconclusive in practice. Practical suggestions have been made that specified staff should be allocated to run the system while it is being piloted to solve this issue. This would only work if the allocated staff were directly admitting and caring for the patients concerned. Other suggestions include if the system was under trial for all patients, it may be easier. See Appendix eight for a list of staff comments as taken directly from post-pilot questionnaires.

An overview of application to other areas was researched briefly towards the close of this aspect of the study. It was found that Managerial and Informatics staff in particular, acknowledged the system's potential for application to other clinical areas. The tracking of equipment and charts was suggested. High volume areas such as Accident and Emergency, Outpatient department, and X-ray were discussed briefly as possible areas for application. It is realised that application to these areas would require a lot of time and work. A&E currently tracks patient location manually, using a whiteboard. This manual tracking has been reported as problematic, because during busy times it may not be fully completed. It is important for efficient management of A&E to know both the location of patients and how long they are waiting in each area. Patients undergoing Angiographies were suggested as a potential group suitable for tagging. Endoscopy could prove to be a potential clinical area in a hospital where location of the endoscopy suite is physically different from the patient location. Overall, it is clear that the system has multiple applications to other areas. A thorough assessment and investigation into this secondary research objective is required.

Limitations of the study included the fact that it was an innovative pilot project. It was difficult to research, for example, there were no local or national benchmarking reports found relating to the research. The fact it was a prototype system being researched created its own particular issues. As stated, the main limitation was time. The system had to be designed, developed and tested. In addition, it proved difficult to arrange and complete end user information and training days. This was carried out during normal staff duties and staff had to arrange cover with each other to attend. Staff must be given credit for their efforts in this regard.

Overall, the project needs greater end user involvement. Also, a greater lead in time would have been beneficial, to help staff become more familiar with the system. The concept of super users was explored briefly with ward staff at the outset of phase two. These super users should ideally be supervisors on shift and be able to train other staff.

The system was finally implemented on March 19 2008 and the author's work in the trial has concluded on July 23. This time span provided a total of fourteen days trial during which a total of 37 patients were tracked. It was a very limited time to fully evaluate the pilot system. A further limitation and unfortunate use of time resulted from the failure of phase two to run in its original clinical area of Endoscopy. Inpatient wards were included instead in May 2008. With time constraints it has proved impossible to fully research this area, and the system was deployed within just a month of ward staff being made aware of the pilot study. A proper trial and evaluation involving inpatients was not possible based on just two days of the wards piloting the system. On a positive note, the surgical inpatient wards are an area with obvious potential for future research. A lot of valuable lessons have been learned over the course of the research and it is hoped they can be put to good use in the future.

In terms of the Research objectives, and data analysis up to this point of the study it can be concluded that the prototype patient tracking system has demonstrated potential to enhance patient safety. It has great potential to reduce the opportunity for error through the electronic list and by the provision of double reminders for staff throughout the surgical process. Checklists and Time out checks have great potential to enhance the current patient safety checks and they fully comply with the World Health Organisation and Joint commission safety recommendations. Please refer to Appendix ten.

The system also has potential to enhance the efficiency of the surgical process for staff and patients. As described, the primary efficiency potential of this system is to be found in its provision of reliable time stamping data. As stated throughout this report this information is a vital tool for measuring the patient journey, and processes within the system. Utilised properly and for a defined period of time the system may have

the chance to fully demonstrate this potential. As stated, the post-deployment phase was too short to complete a full evaluation.

Although great potential exists, there remains much work to be done with the system. It requires further development, refinement, and rigorous evaluation. It is recommended that both clinical and managerial staff become involved in the evaluation of the system, and the time stamp data the system is producing. The system data should accurately reflect *all* the milestones within the process. For example; a timestamp when a patient is actually *ready* for theatre, and when a patient is *ready* for discharge could be useful. Staff input is vital to ensure what matters is actually being measured. Staff should also be given feedback on data being produced by the system. It may help to compare this data with international data or international benchmarks for day care to know if the data is relevant. Further information may need to be gathered on the process. To refine the product, it needs much more end user input. Currently the pilot system is accessed by staff using generic logins. As the system evolves, Individual logins will be required for security, identification and time stamp purposes. Ongoing evaluation of the system is essential. There is also a need for staff using the tracking system to attend regular training updates on the use of the system. As staff become more proficient in using the system they should begin to appreciate more fully all its potential benefits.

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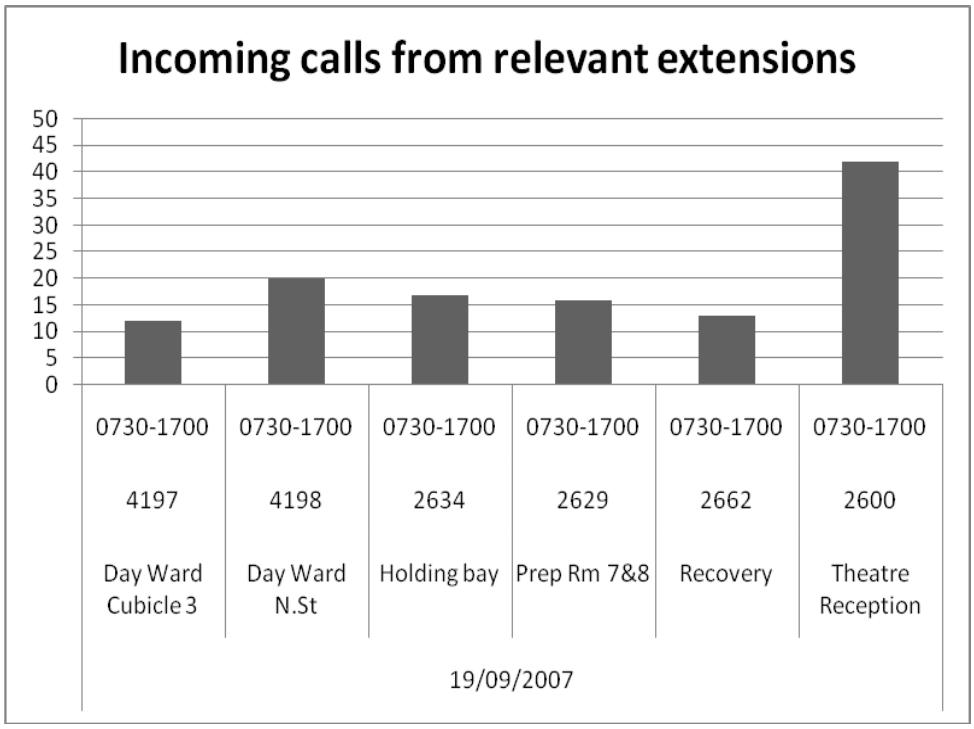
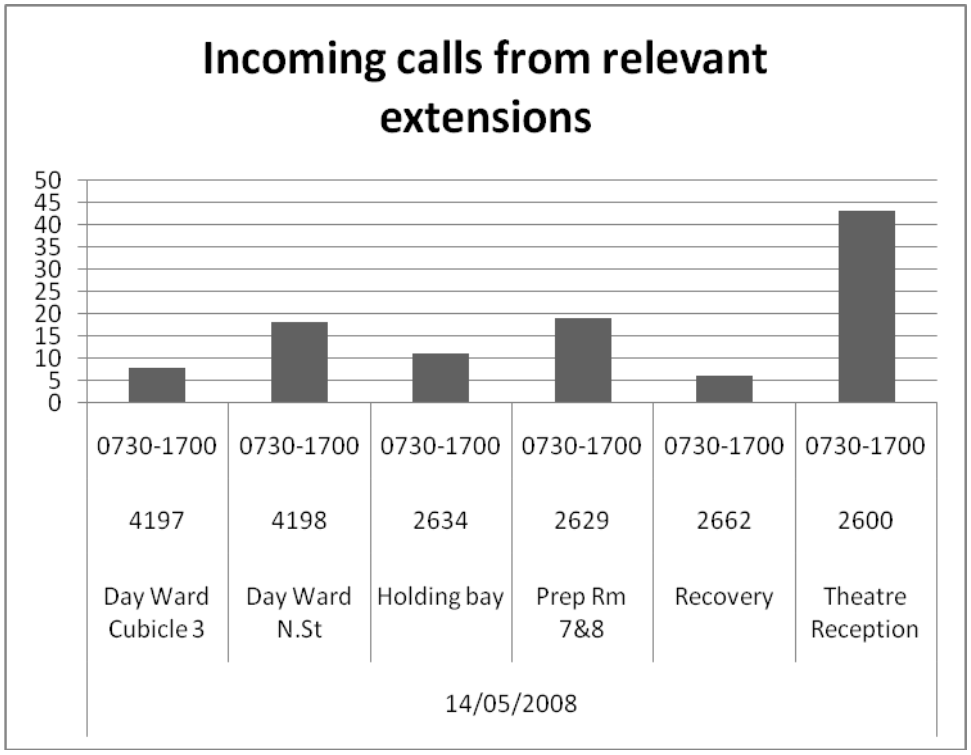
Appendix one

Telephony bar charts pre and post introduction of the Tracking system

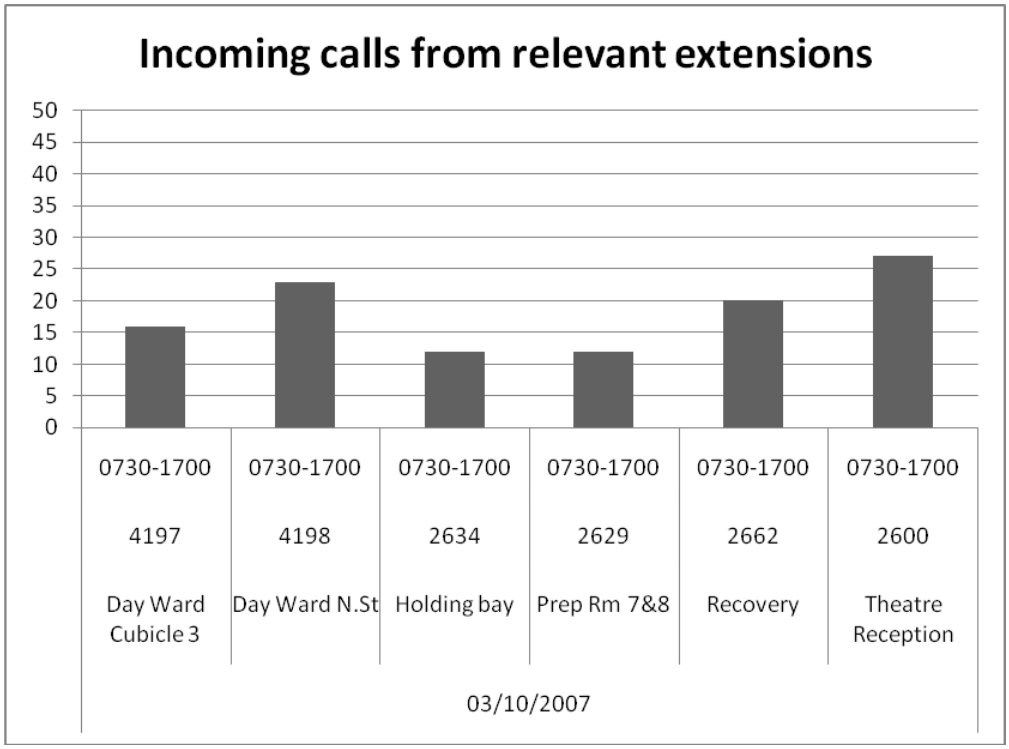
Pre- Tracking system week 1



Post – Tracking system week 1



Pre – Tracking system week 2



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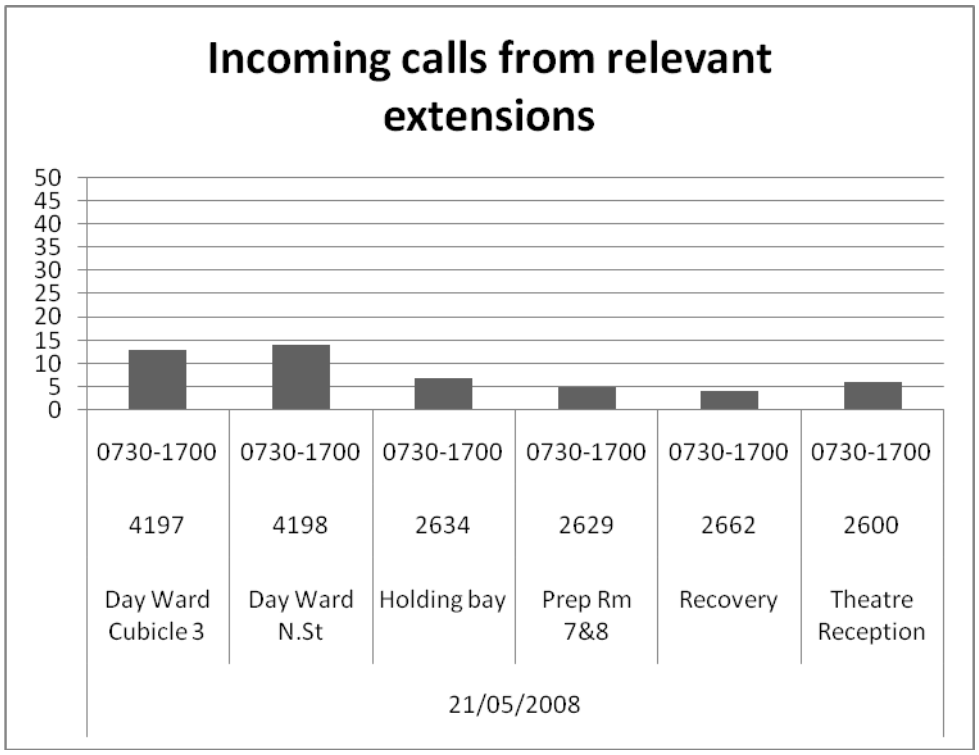

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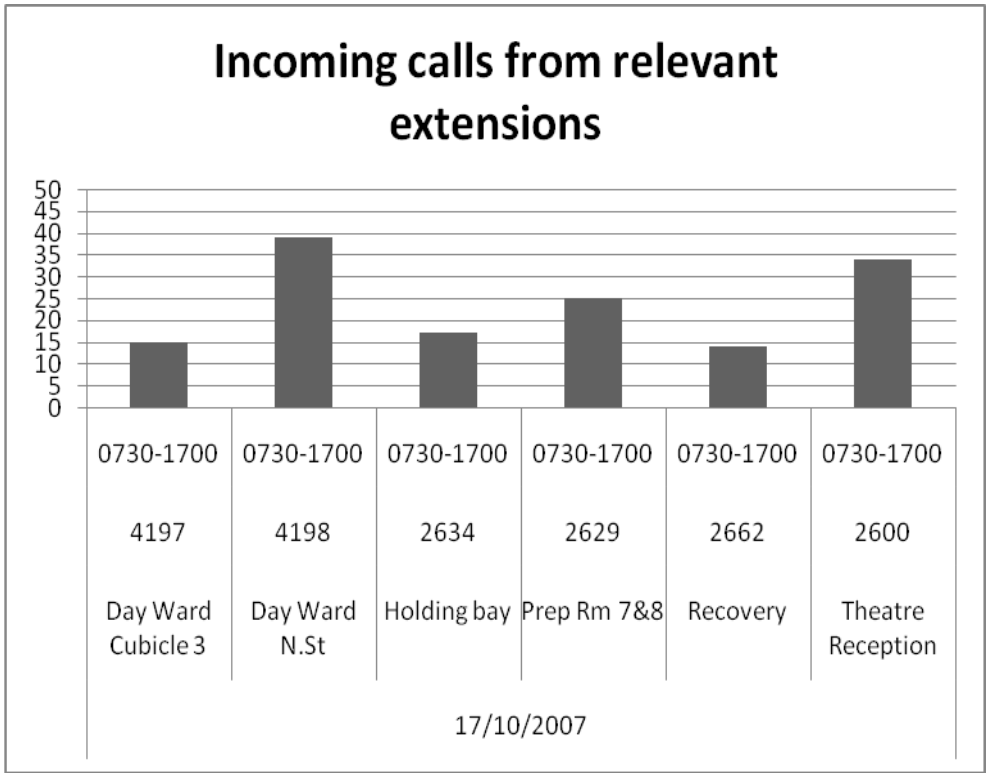
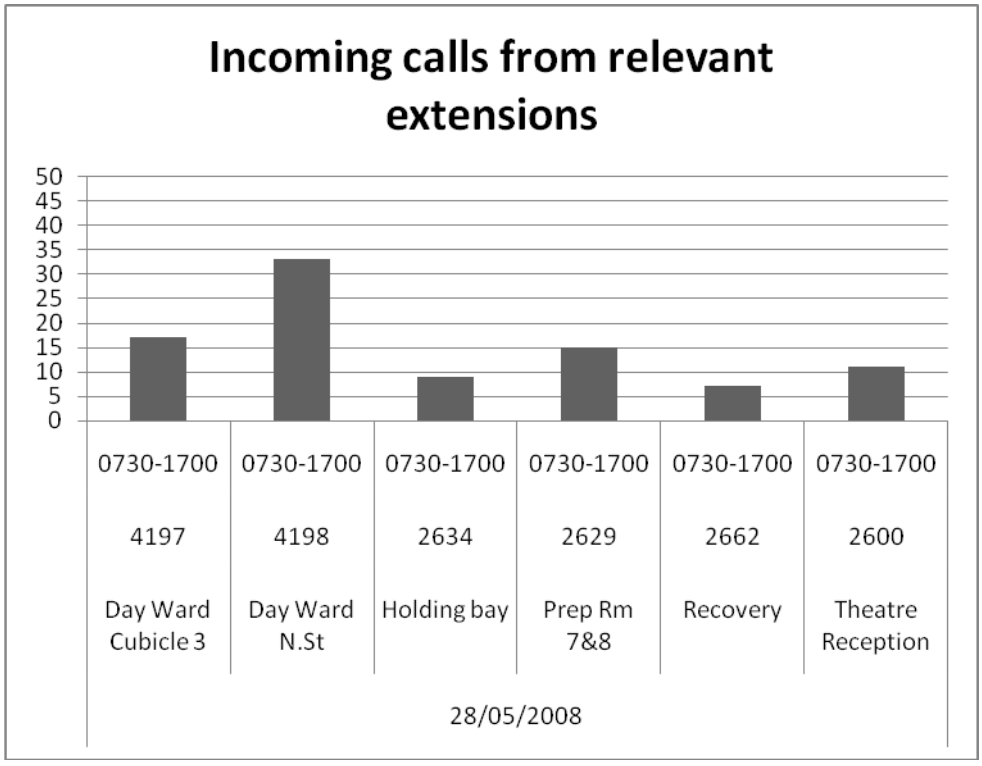
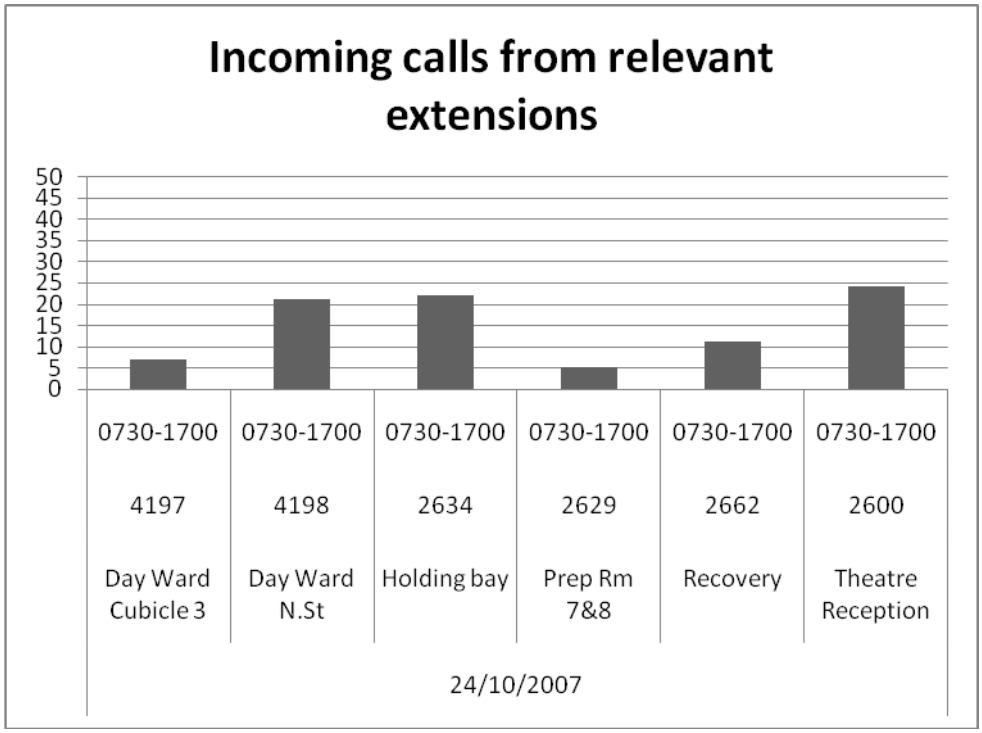


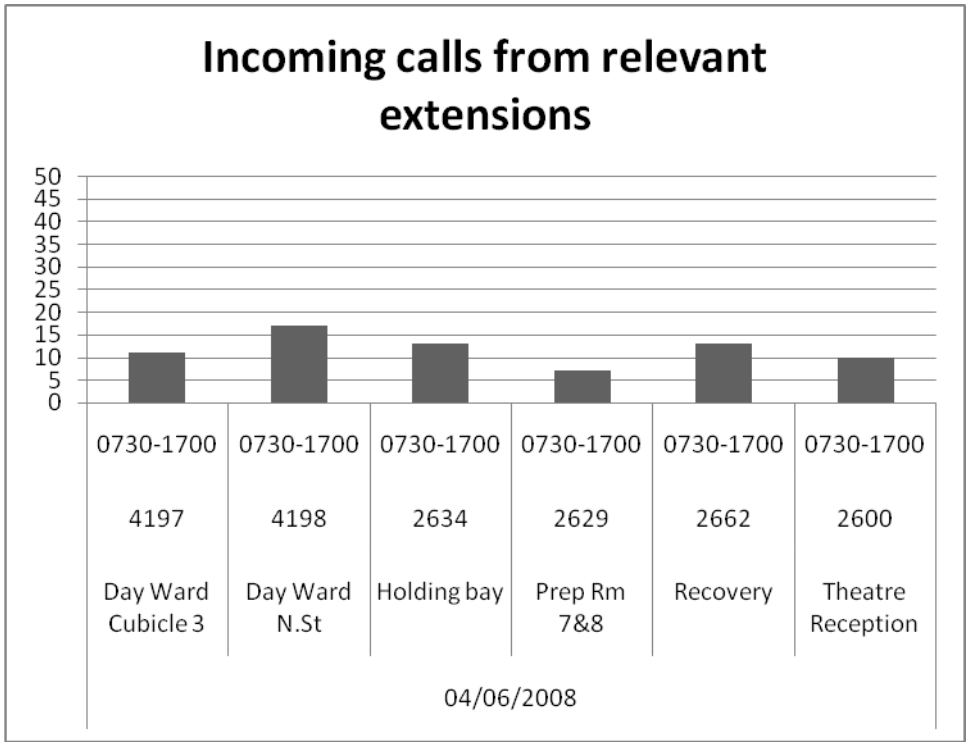
Post-Tracking system week 3



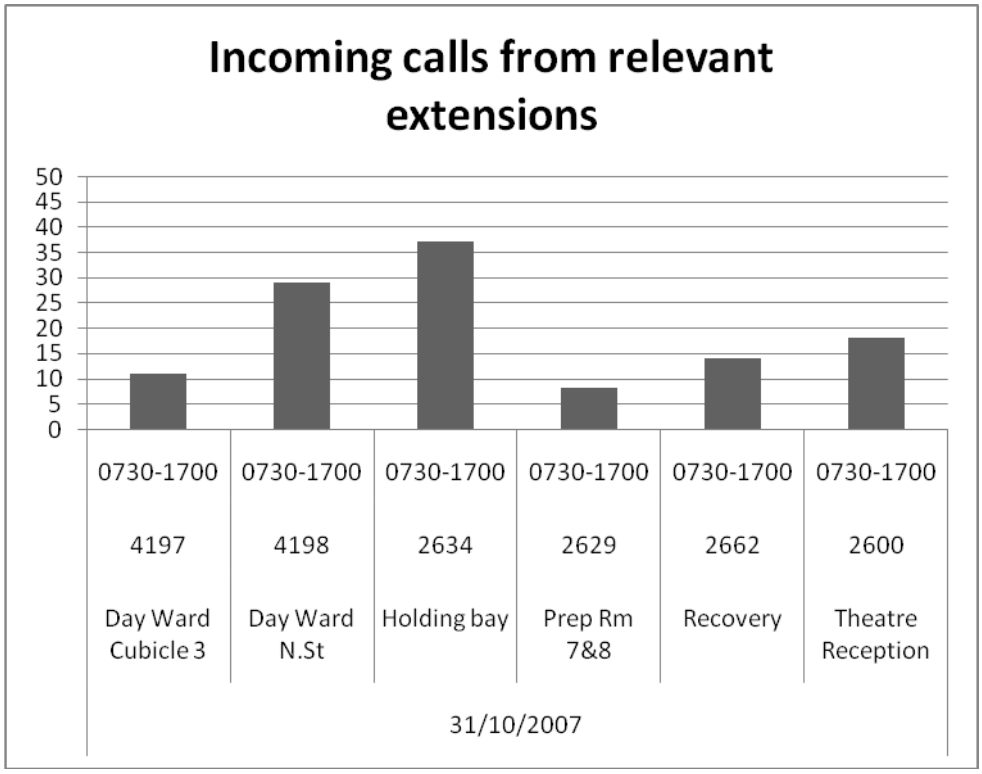
Pre-Tracking system week 4



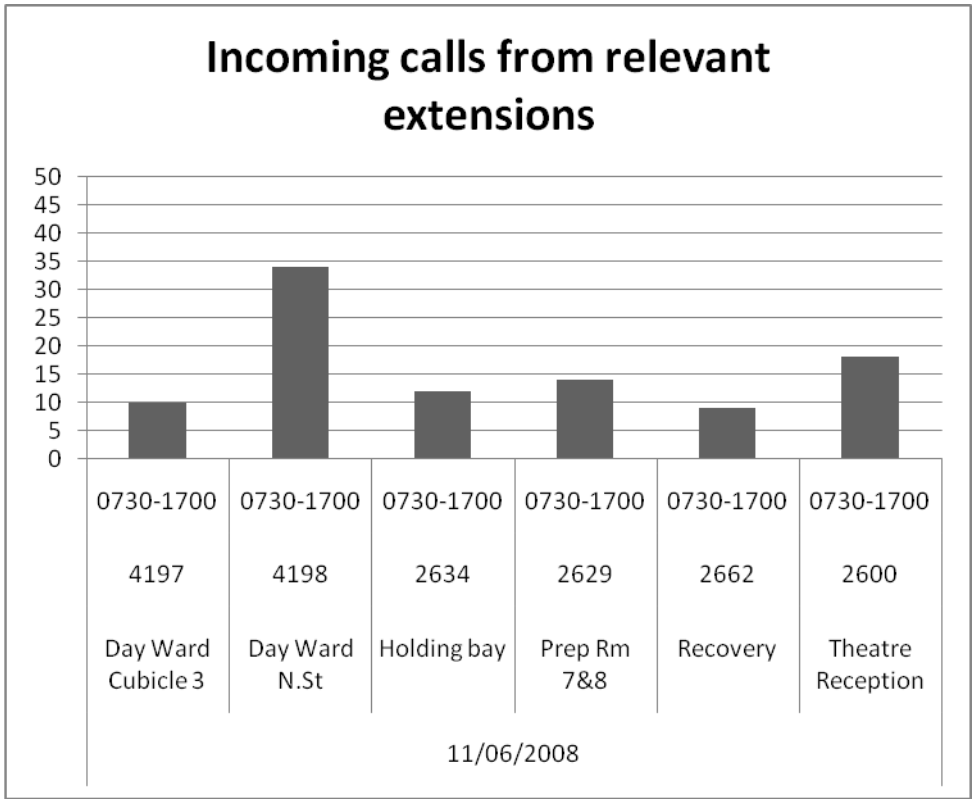
Post-Tracking system week 4



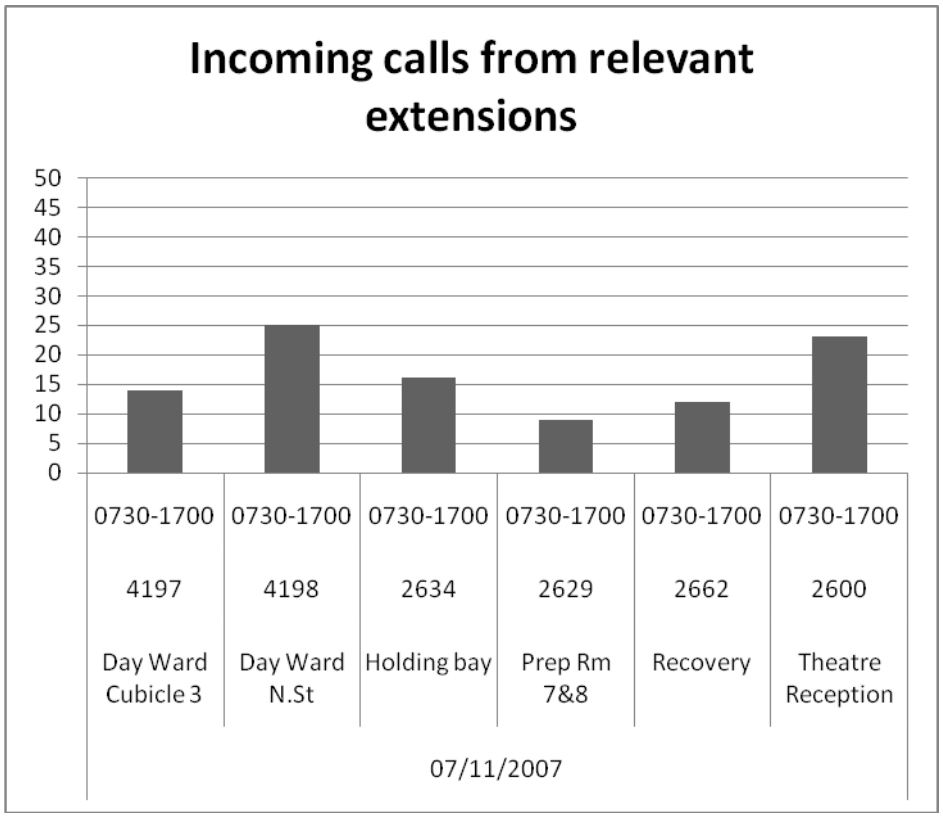
Pre-Tracking system week 5



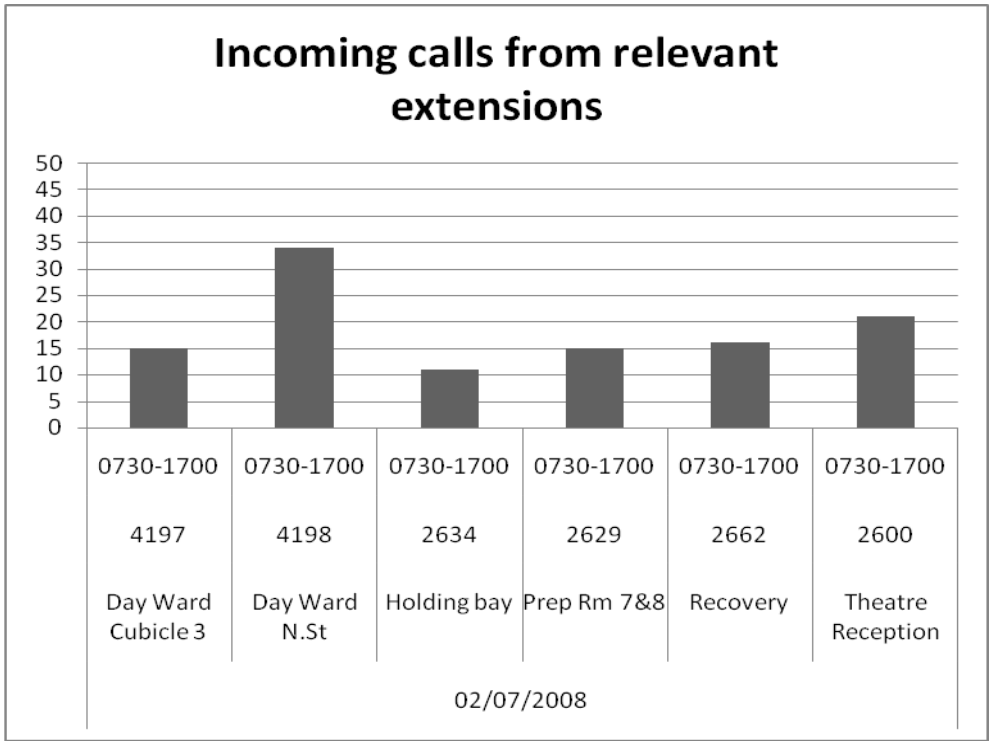
Post- Tracking system week 5



Pre-Tracking system week 6

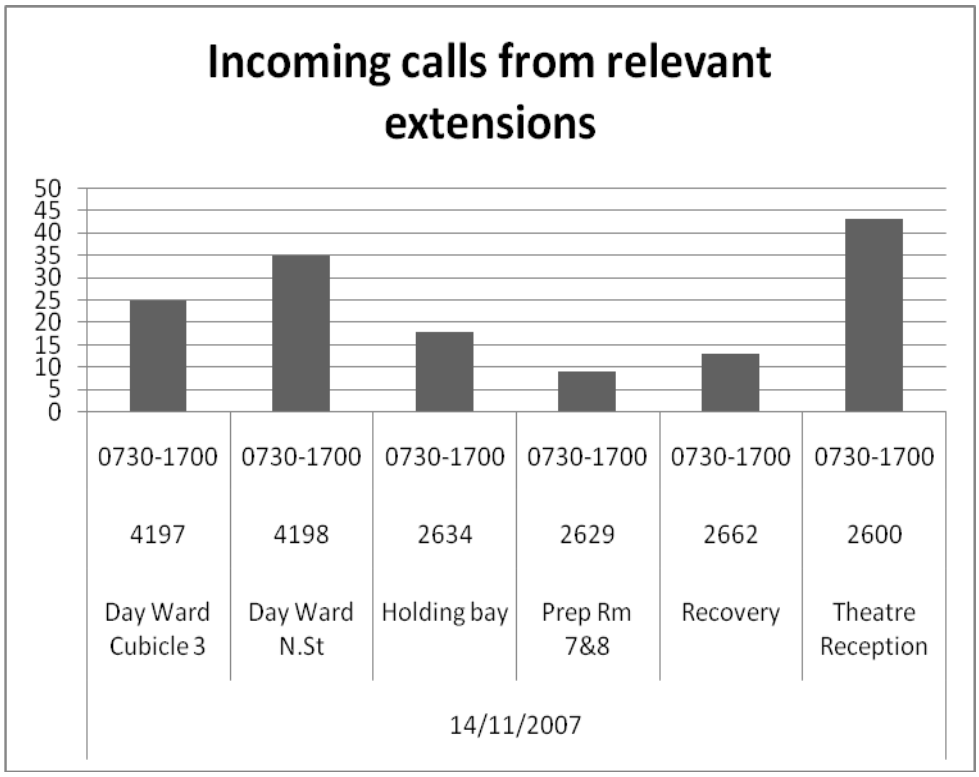


Post-Tracking system week 6

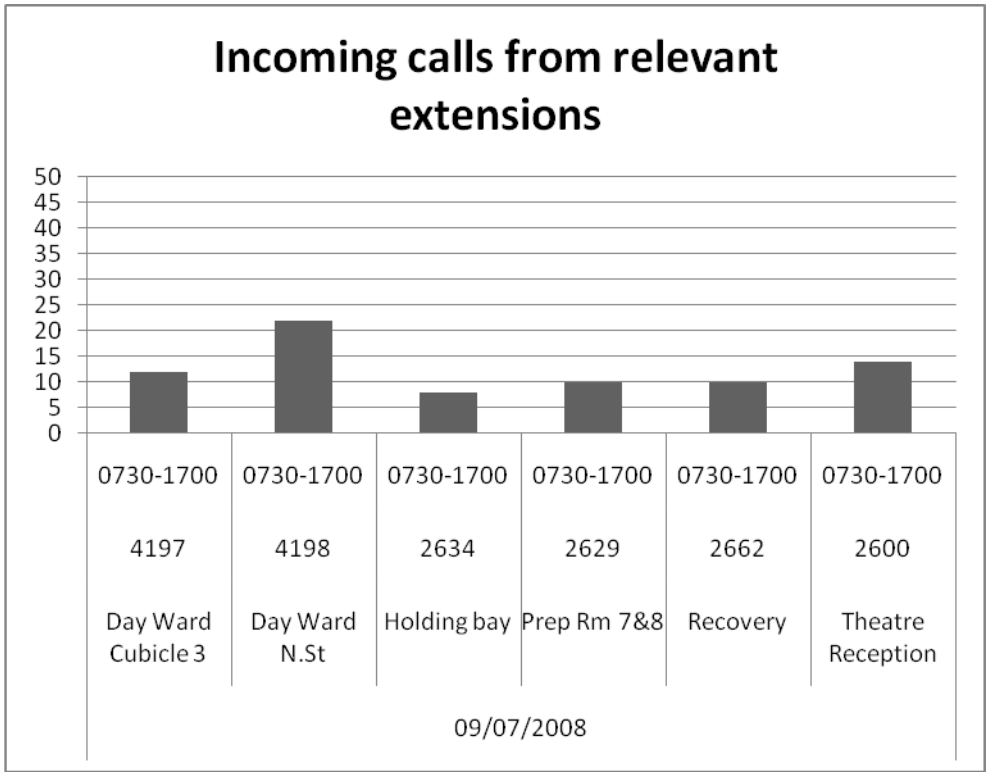


Note: Recovery PC out of order on July 2

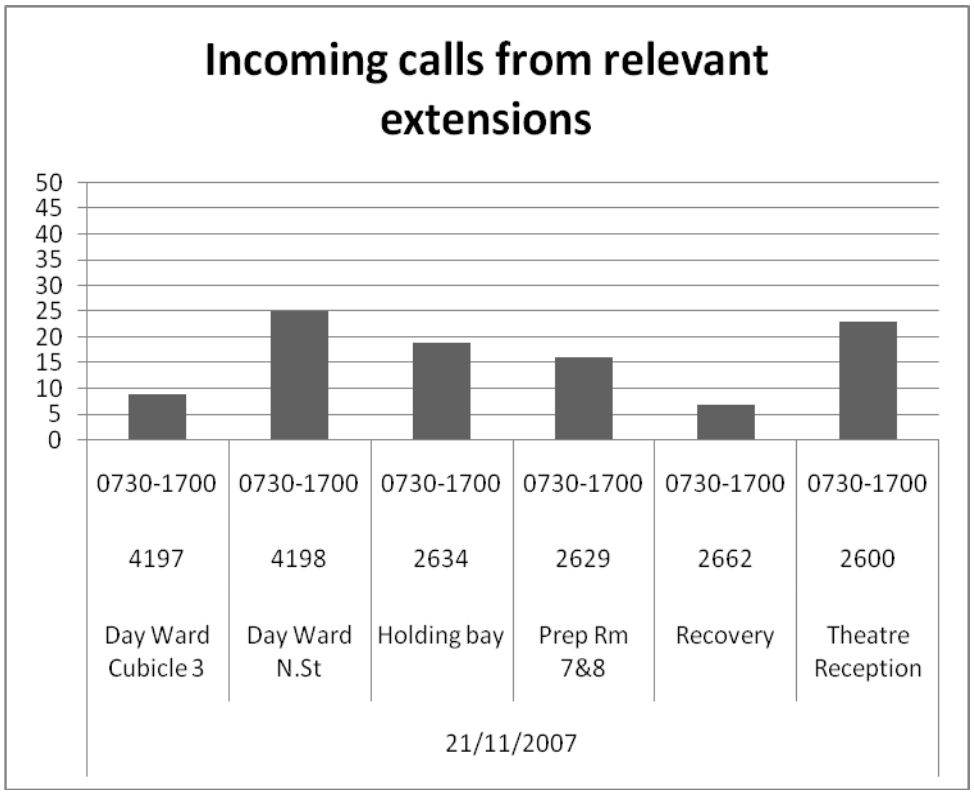
Pre-Tracking system week 7



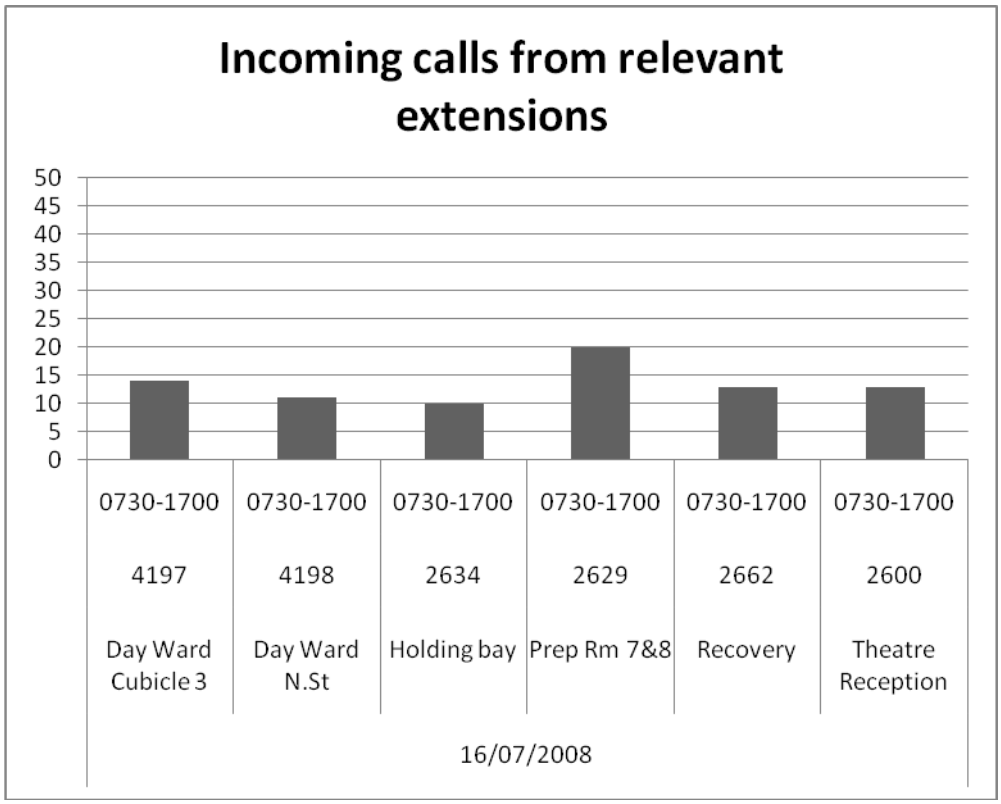
Post-Tracking system week 7



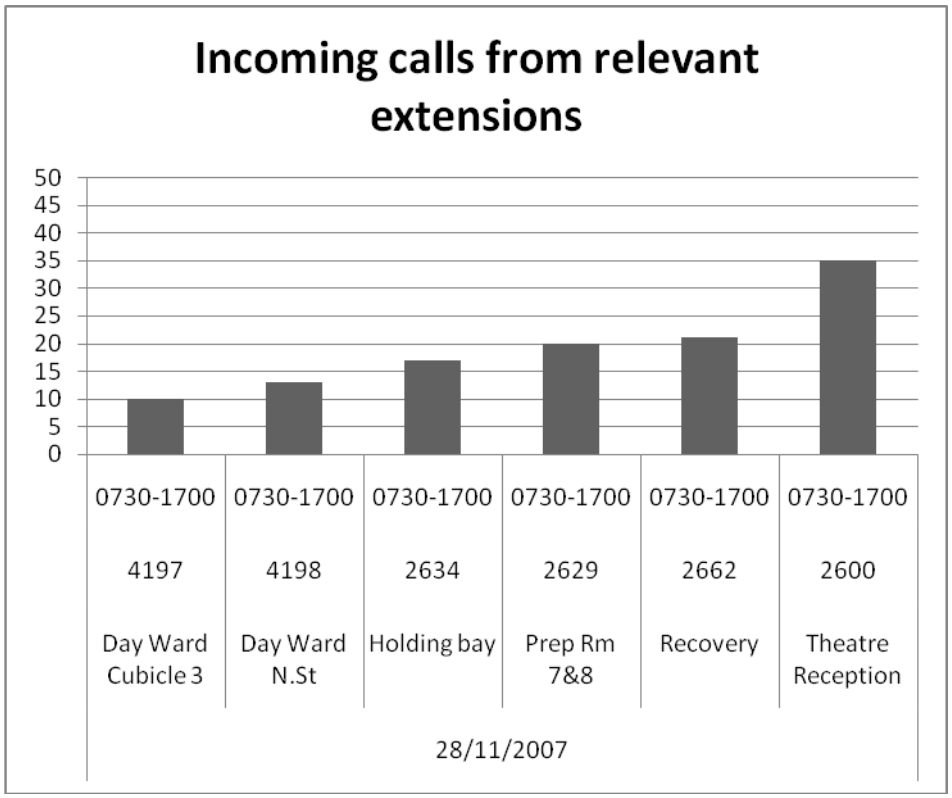
Pre-Tracking system week 8



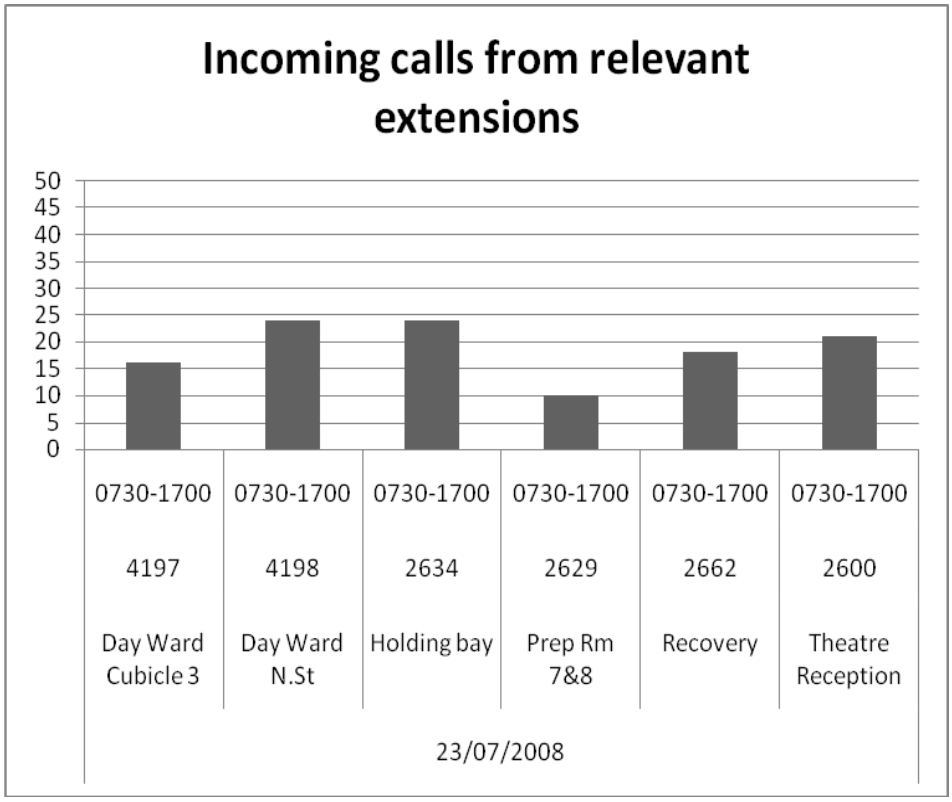
Post-Tracking system week 8



Pre-Tracking system week 9



Post-Tracking system week 9



Appendix two

Pre- pilot Nursing Staff Questionnaire:

1. About you:

Are you?
Nursing ☐ Auxiliary ☐

How long have you worked in your present post?
< 1 yr ☐ 1-5 yrs ☐ >5yrs ☐

Do you work in?
Day Ward ☐ Operating Theatres ☐ Endoscopy ☐

Do you work?
Part time ☐ Full time ☐

2. About your work environment:

What methods of communication do you use most often at work to communicate with staff in other clinical areas?

Face to face conversation ☐ Phone ☐ Pager ☐ Email ☐ Txt/SMS ☐ Other (Please specify) ☐

_____

Which method(s) do you rate as most effective?

Face to face conversation ☐ Phone ☐ Pager ☐ Email ☐ Txt/SMS ☐ Other (Please specify) ☐

_____

In your area would the amount of incoming phone calls regarding patients per day be:

<10 ☐ 10 -20 ☐ >20 ☐

Would the number of phone calls be greater from?

0730-1000 ☐ 1000-1300 ☐ 1300-1700 ☐

How do you rate the overall efficiency of patient flow within surgical day care and Endoscopy?

Inefficient ☐

Fairly efficient, yet with potential for improvement ☐

Efficient ☐

Extremely efficient, with no obvious potential for improvement ☐

3. About your work:

Do you work directly with Patients?

Yes ☐ No ☐

If yes; how much of your time would you spend in a typical day directly with patients? (A Rough estimate)

<2hours ☐ 2-4hours ☐ >4hours ☐

In your opinion, do you have enough time with patients?

Yes ☐ No ☐

If no, why do you think this is? (<15 words

_____

_____

4. About the new system:

How confident are you with patient safety checks within the current patient admission system?	**Confidence Level** NC = Not Confident FC = Fairly Confident C = Confident EC = Extremely Confident

	NC	FC	C	EC
1. Identification and communication between relevant staff of allergies	☐	☐	☐	☐
2. Identification and communication between relevant staff of Infection risks	☐	☐	☐	☐
3.Verification of Patient ID	☐	☐	☐	☐
4.Verification of site of surgery	☐	☐	☐	☐

What do you think about the introduction of new computer systems into your work environment? (Please tick all that apply)

Always a good thing	☐	Good if it improves patient care	☐	Good if it simplifies work processes	☐
I am not interested in computers	☐	Have to see it in action first	☐	Not sure	☐

How do you rate training and support provided to you for the introduction of new computer systems at work?

Poor	☐	Satisfactory	☐
Good	☐	Excellent	☐

How confident are you with using computers?

Not confident	☐	Fairly confident	☐	Confident	☐	Extremely confident	☐

Do you use the Internet?

Yes	☐	No	☐

If yes; (Please tick all that apply

At home	☐	At work	☐
To search for information	☐	To make a purchase/book a holiday	☐

Thank you for your time in completing this questionnaire ☺

Appendix three

Sample letter to Nursing staff

28 May 2008

Dear .....

At the beginning of the patient tracking project, I distributed Questionnaires to obtain staff opinion prior to the pilot study. The response was very good. It is almost time for evaluation of the study and I need to ask your opinion for the final time.

I will be leaving questionnaires in the staff break room (Theatres) and the Nurses station (Day Ward) beside boxes in which they may be returned anonymously. All replies are confidential.

The deadline for returns is strictly June 25, to allow time to collect and interpret the findings.
Your help is greatly appreciated,
Thank you,
Amanda
(Research Assistant).

Appendix four

Post- pilot Nursing Staff Questionnaire:

Staff Questionnaire (post-pilot)

1. **About you:**
Are you?
Nursing ☐ Auxiliary ☐ Clerical ☐

How long have you worked in your present post?
< 1 yr ☐ 1-5 yrs ☐ >5yrs ☐

Do you work in?
Day ward ☐ Theatres ☐ Wards ☐

Do you work?
Part time ☐ Full time ☐

2. About the patient tracking system: (Pilot system)
How do you rate training and support provided to you for the introduction of the system?
Poor ☐ Satisfactory ☐
Good ☐ Excellent ☐

Having used the pilot system, how user friendly did you find it?
Poor ☐ Satisfactory ☐
Good ☐ Excellent ☐

What do you like most about the system? <15 words

What do you like least about the system? <15 words

3. **About your work and the tracking system:**
1. Staff Communication methods.
Do you think the system has potential to enhance staff communication between clinical areas?

Yes ☐ No ☐ Unsure ☐

Pre-pilot questionnaires indicate that Staff mainly use three methods of communication with other staff and rated these in order of preference as:
1.Face to face 2.Phone 3.Pager

In your opinion has the tracking system the potential to be?
1=Less effective,
2=Equally effective
3=More effective
Than the three most commonly used and preferred methods
(Please give each method of communication a number from the rating scale above)
Face to face communication: =
Phone communication: =
Pager communication: =

2.Efficiency.
Do you think the system has potential to enhance efficiency in your area?

Yes ☐ No ☐ Unsure ☐

Potential efficiency features have been identified below:
Please rate these as
1= Inefficient
2= Fairly efficient
3= Efficient
4= Extremely efficient
(Please give each efficiency feature a number from the rating scale above)
Awareness of patient location: =
Reduction of need for phone calls: =
Ease of use to create and update patient lists: =
Creation of statistical data for audit purposes: =

3.Patient safety.
Do you think the system has potential to enhance patient safety?
Yes ☐ No ☐ Unsure ☐

Potential safety features have been identified below:
Please rate your confidence in these features
1= Not confident
2= Fairly confident
3= Confident
4= Extremely confident
(Please give each safety feature a number from the rating scale above)
Identification and communication between relevant staff of **allergies** (Allergy icon on system):
=
Identification and communication between relevant staff of **Infection risks**
(Infection risks highlighted on system):
=
Verification of **Patient ID** (Tracking tag as additional Patient ID):
=
Verification of **site of surgery** (Time out feature):
=

4.Computers at work.
In the pre-pilot survey you were asked your thoughts on the introduction of new computer systems into your work environment.
What are your thoughts on this now?
(As previously, please tick all that apply below)

Always a good thing ☐	Good if improves patient care ☐
Good if simplifies work processes ☐	I am not interested in computers ☐
Have to see it in action first ☐	Not sure ☐

After the pilot, do you think any differently about the introduction of new computer systems into your work environment?
Yes ☐ No ☐ Unsure ☐
Are you any more confident about using computer systems at work?
Yes ☐ No ☐ Unsure ☐

Thank you for your time in completing this Survey/Questionnaire!
☺

Appendix five

Staff Questionnaire Results

Frequency Tables/ Bar Charts

Pre- Pilot Frequency Tables: Nursing questionnaire data

Job title

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nursing	51	94.4	94.4	94.4
	Auxillary	2	3.7	3.7	98.1
	Not answered	1	1.9	1.9	100.0
	Total	54	100.0	100.0	

Duration of present post

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<1year	5	9.3	9.3	9.3
	1-5years	23	42.6	42.6	51.9
	>5years	26	48.1	48.1	100.0
	Total	54	100.0	100.0	

Area of work

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Day Ward	19	35.2	35.2	35.2
	Operating Theatres	35	64.8	64.8	100.0
	Total	54	100.0	100.0	

Do you work full-time or part-time?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	PT	10	18.5	18.5	18.5
	FT	41	75.9	75.9	94.4
	Not answered	3	5.6	5.6	100.0
	Total	54	100.0	100.0	

Face to Face comunication is used most often to communicate with staff in other clinical areas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	40	74.1	74.1	74.1
	No	14	25.9	25.9	100.0
	Total	54	100.0	100.0	

Phone communication is used most often to communicate with staff in other clinical areas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	45	83.3	83.3	83.3
	No	9	16.7	16.7	100.0
	Total	54	100.0	100.0	

Paging System is used most often to communicate with staff in other clinical areas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	17	31.5	31.5	31.5
	No	37	68.5	68.5	100.0
	Total	54	100.0	100.0	

Email communication is used most often to communicate with staff in other clinical areas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	25.9	25.9	25.9
	No	40	74.1	74.1	100.0
	Total	54	100.0	100.0	

Most effective method of communication is Face to face

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	44	81.5	81.5	81.5
	No	10	18.5	18.5	100.0
	Total	54	100.0	100.0	

Most effective method of communication is phone

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	30	55.6	55.6	55.6
	No	24	44.4	44.4	100.0
	Total	54	100.0	100.0	

Most effective method of communication is paging system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	11.1	11.1	11.1
	No	48	88.9	88.9	100.0
	Total	54	100.0	100.0	

Most effective method of communication is email

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	7.4	7.4	7.4
	No	50	92.6	92.6	100.0
	Total	54	100.0	100.0	

Amount of Incoming calls per day

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<10	3	5.6	5.6	5.6
	10-20	18	33.3	33.3	38.9
	>20	32	59.3	59.3	98.1
	Not answered	1	1.9	1.9	100.0
	Total	54	100.0	100.0	

Peak times for incoming calls

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0730-1000	11	20.4	20.4	20.4
	1000-1300	23	42.6	42.6	63.0
	1300-1700	6	11.1	11.1	74.1
	Vary	10	18.5	18.5	92.6
	Not answered	4	7.4	7.4	100.0
	Total	54	100.0	100.0	

Direct patient contact

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	51	94.4	94.4	94.4
	No	3	5.6	5.6	100.0
	Total	54	100.0	100.0	

Time spent directly with patients

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<2hrs	7	13.0	13.0	13.0
	2-4hours	9	16.7	16.7	29.6
	>4hours	36	66.7	66.7	96.3
	Not answered	2	3.7	3.7	100.0
	Total	54	100.0	100.0	

Sufficient time with patients

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	34	63.0	63.0	63.0
	No	17	31.5	31.5	94.4
	Not answered	3	5.6	5.6	100.0
	Total	54	100.0	100.0	

Rating efficiency of patient flow

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fairly efficient	36	66.7	66.7	66.7
	Efficient	8	14.8	14.8	81.5
	Extremely efficient	5	9.3	9.3	90.7
	Not answered	5	9.3	9.3	100.0
	Total	54	100.0	100.0	

onfidence in identification and communication of patient allergies between relevan staff?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident	2	3.7	3.7	3.7
	Fairly Confident	11	20.4	20.4	24.1
	Confident	31	57.4	57.4	81.5
	Extremely Confident	9	16.7	16.7	98.1
	Not answered	1	1.9	1.9	100.0
	Total	54	100.0	100.0	

Confidence in identification and communication of infection risks between relevant staff?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident	8	14.8	14.8	14.8
	Fairly confident	14	25.9	25.9	40.7
	Confident	24	44.4	44.4	85.2
	Extremely confident	7	13.0	13.0	98.1
	Not answered	1	1.9	1.9	100.0
	Total	54	100.0	100.0	

Confidence in verification of patient ID?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident	1	1.9	1.9	1.9
	Fairly confident	3	5.6	5.6	7.4
	Confident	31	57.4	57.4	64.8
	Extremely confident	18	33.3	33.3	98.1
	Not answered	1	1.9	1.9	100.0
	Total	54	100.0	100.0	

Confidence in verification of site of surgery?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident	1	1.9	1.9	1.9
	Fairly confident	6	11.1	11.1	13.0
	Confident	29	53.7	53.7	66.7
	Extremely confident	16	29.6	29.6	96.3
	Not answered	2	3.7	3.7	100.0
	Total	54	100.0	100.0	

Positive response to introduction of new computer systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	13.0	13.0	13.0
	No	47	87.0	87.0	100.0
	Total	54	100.0	100.0	

Positive if improves patient care

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	40	74.1	74.1	74.1
	No	14	25.9	25.9	100.0
	Total	54	100.0	100.0	

Positive if simplifies work processes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	44.4	44.4	44.4
	No	30	55.6	55.6	100.0
	Total	54	100.0	100.0	

Unsure of the introduction of new computer systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	1.9	1.9	1.9
	No	53	98.1	98.1	100.0
	Total	54	100.0	100.0	

Have to see system in action before deciding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	20	37.0	37.0	37.0
	No	34	63.0	63.0	100.0
	Total	54	100.0	100.0	

Negative response to introduction of new computer systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	5.6	5.6	5.6
	No	51	94.4	94.4	100.0
	Total	54	100.0	100.0	

w do you rate training and support provided to you for the introduction of n computer systems at work?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Poor	11	20.4	20.4	20.4
	Satisfactory	14	25.9	25.9	46.3
	Good	21	38.9	38.9	85.2
	Excellent	2	3.7	3.7	88.9
	Not answered	6	11.1	11.1	100.0
	Total	54	100.0	100.0	

How confident are you with using computers?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident	14	25.9	25.9	25.9
	Fairly Confident	18	33.3	33.3	59.3
	Confident	19	35.2	35.2	94.4
	Extremely Confident	1	1.9	1.9	96.3
	Not answered	2	3.7	3.7	100.0
	Total	54	100.0	100.0	

Do you use the Internet?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	47	87.0	87.0	87.0
	No	5	9.3	9.3	96.3
	Not answered	2	3.7	3.7	100.0
	Total	54	100.0	100.0	

Do you use the Internet at home or work?

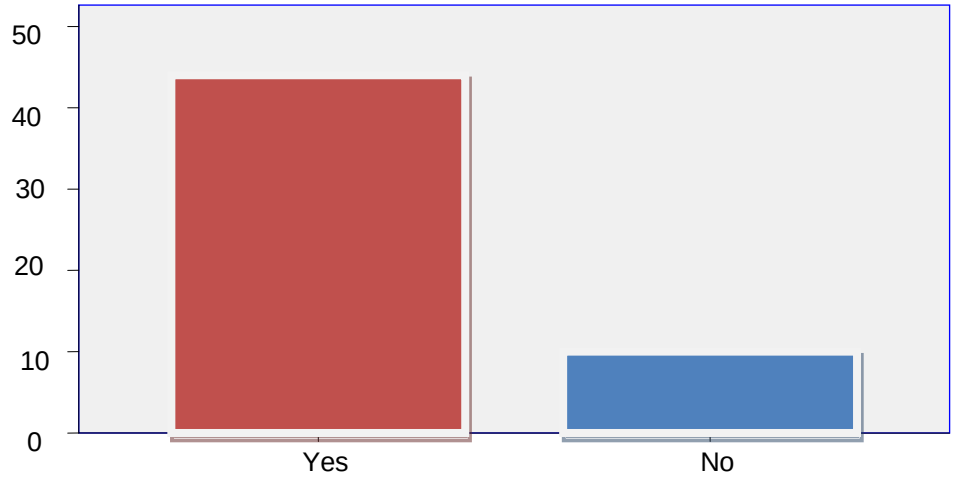
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Home	13	24.1	24.1	24.1
	Work	4	7.4	7.4	31.5
	Both home and work	30	55.6	55.6	87.0
	Not answered	7	13.0	13.0	100.0
	Total	54	100.0	100.0	

Examples of internet use

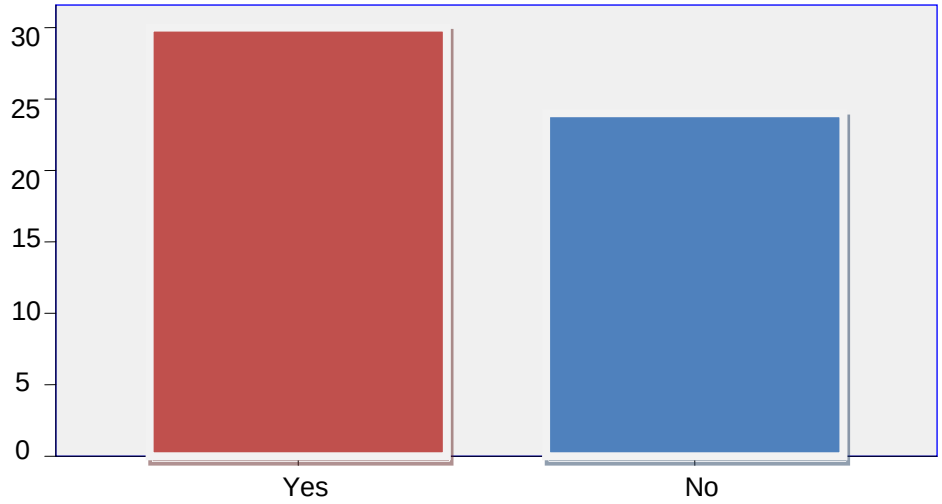
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Information Searches	20	37.0	37.0	37.0
	Purchases/Bookings	2	3.7	3.7	40.7
	Multiple uses	23	42.6	42.6	83.3
	Not answered	9	16.7	16.7	100.0
	Total	54	100.0	100.0	

Pre- Pilot questionnaire bar chart diagrams

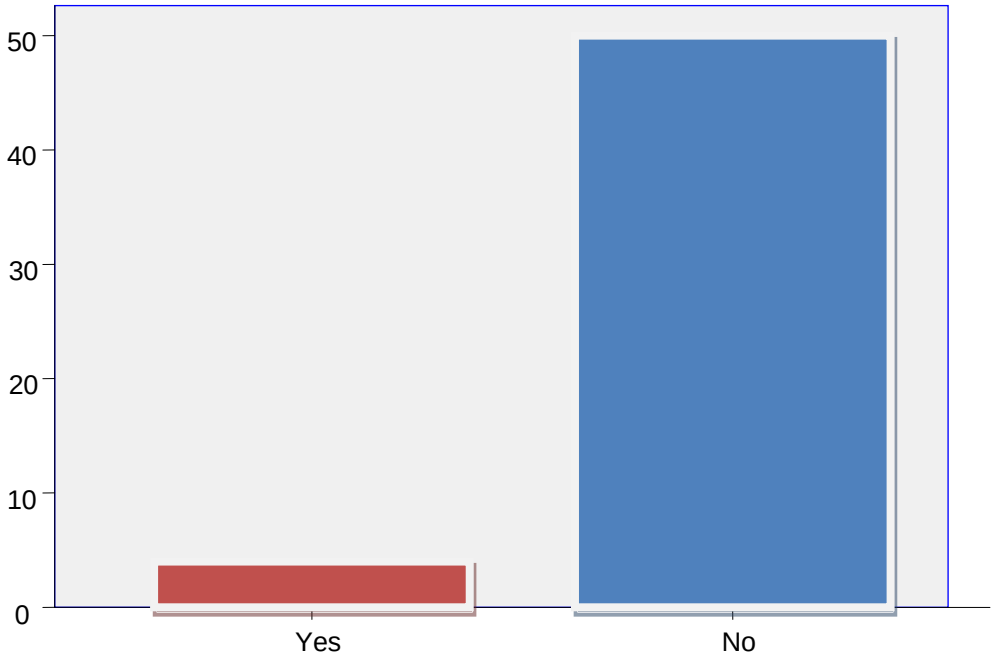
Most effective method of communication is Face to face



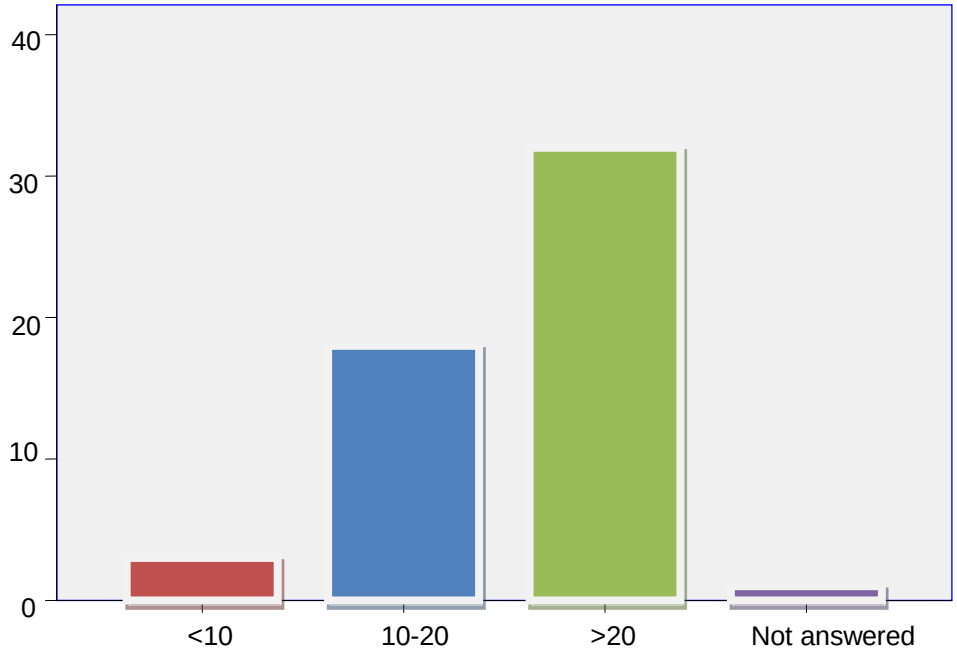
Most effective method of communication is phone



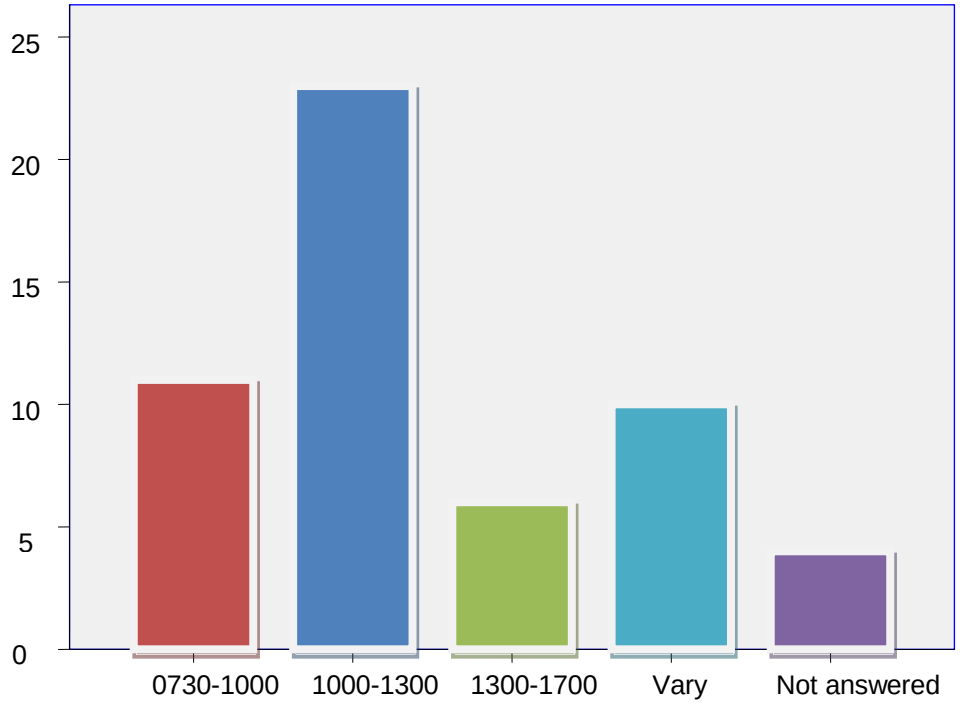
Most effective method of communication is email



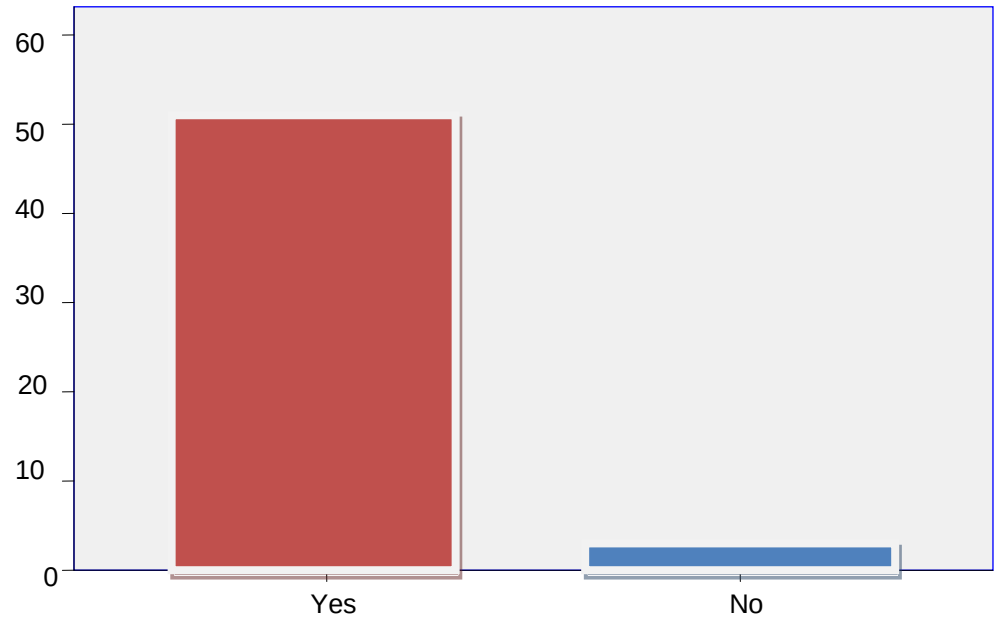
Amount of Incoming calls per day



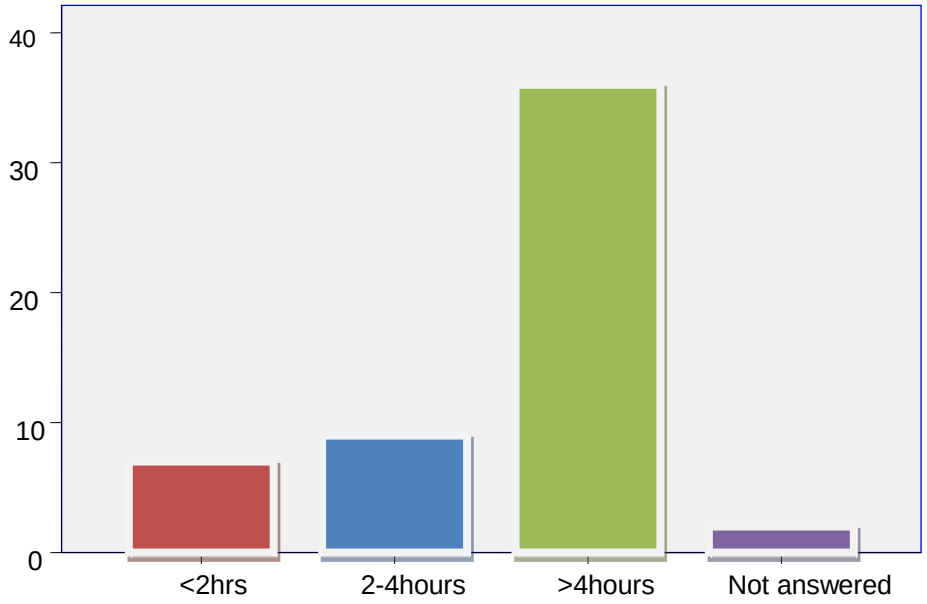
Peak times for incoming calls



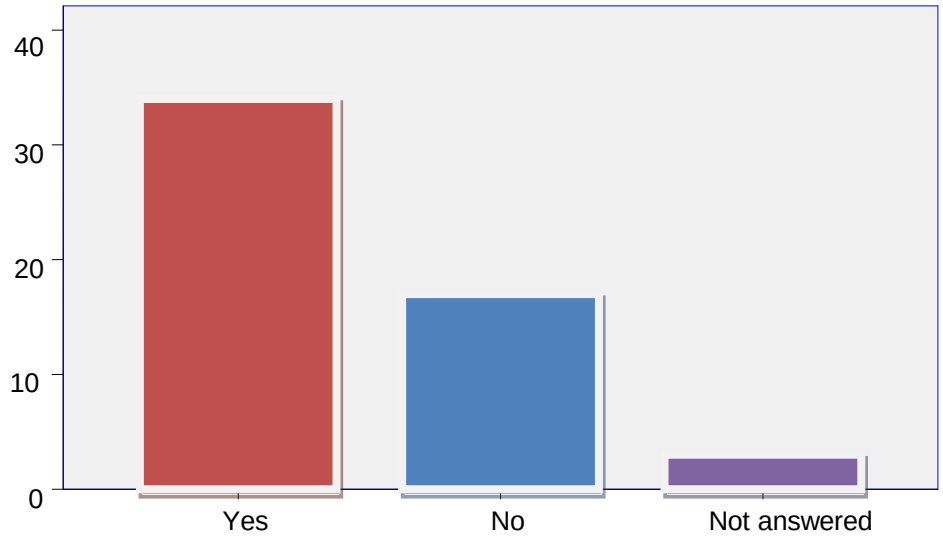
Direct patient contact

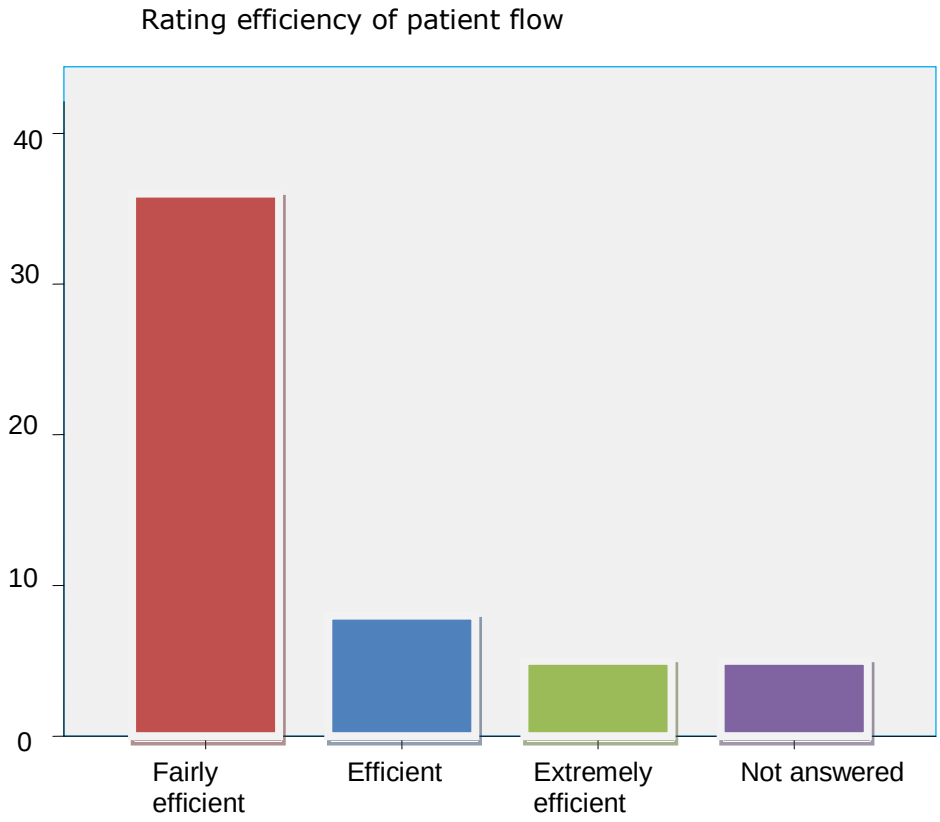


Time spent directly with patients

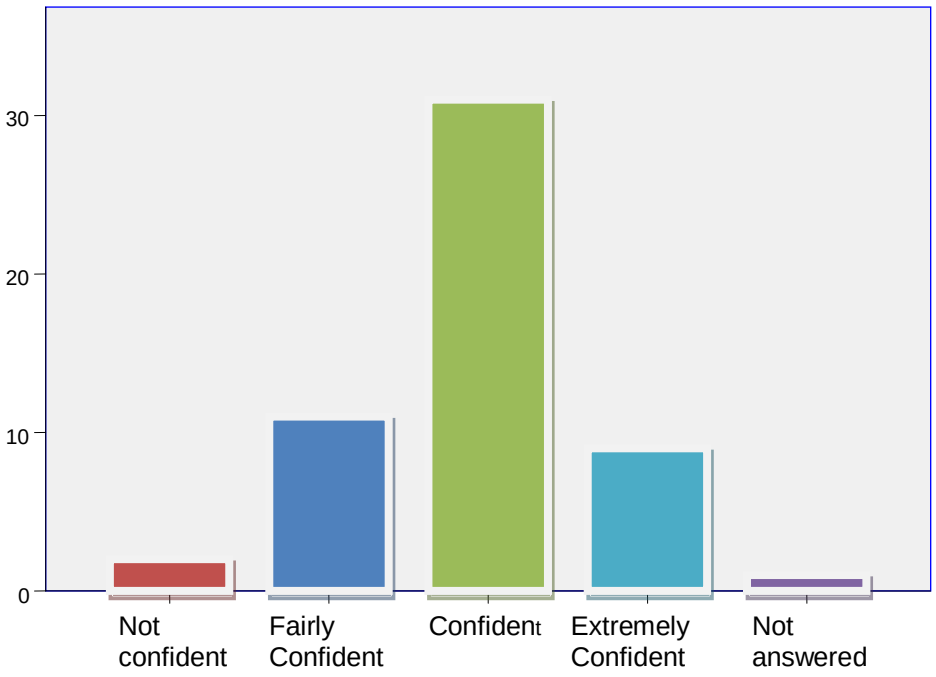


Sufficient time with patients

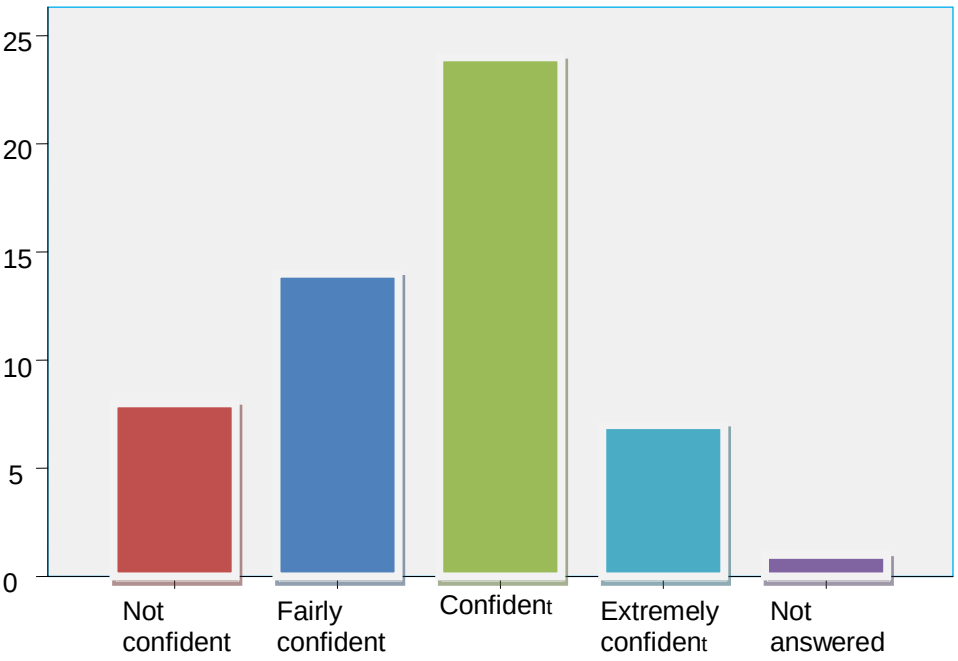



Rating efficiency of patient flow
40
30
20
10
0
Fairly efficient
Efficient
Extremely efficient
Not answered

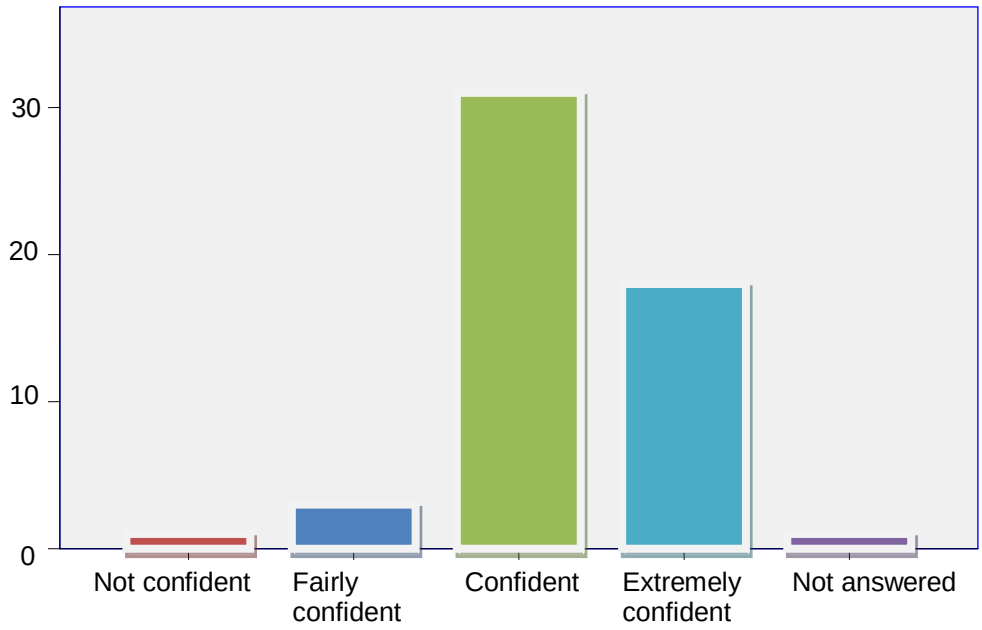
Confidence in identification and communication of patient allergies between relevant staff?



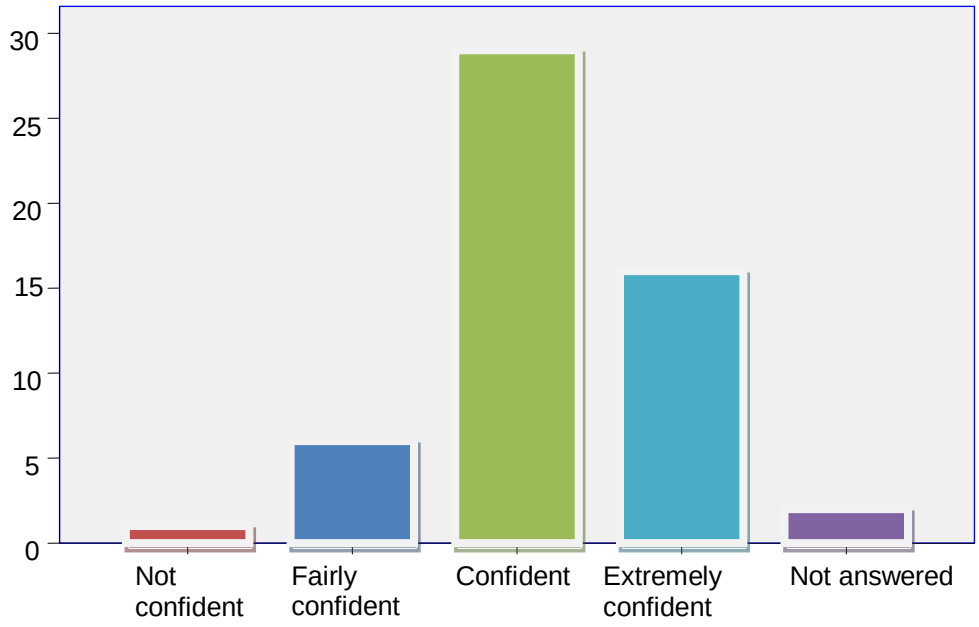
Confidence in identification and communication of infection risks between relevant staff?



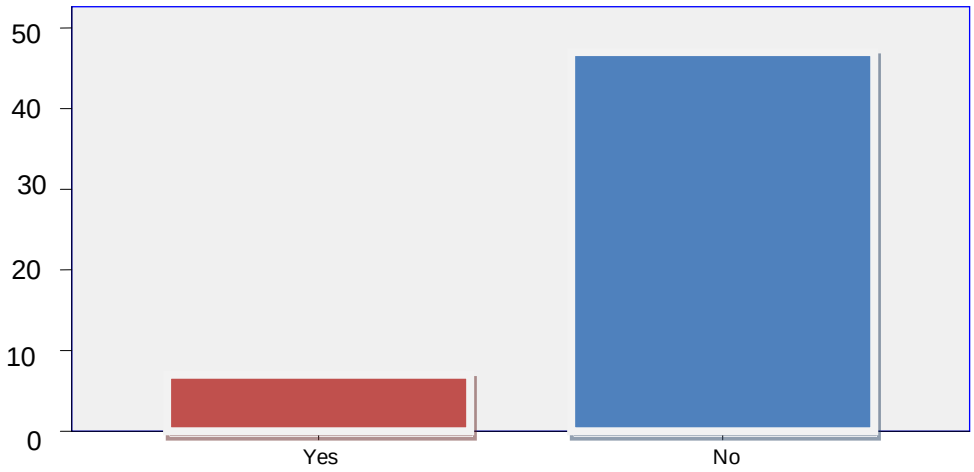
Confidence in verification of patient ID?



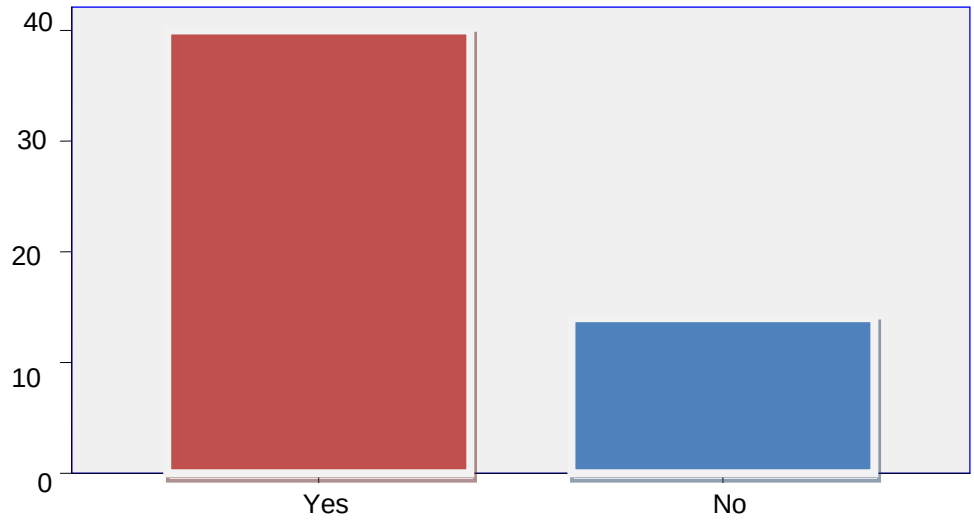
Confidence in verification of site of surgery?



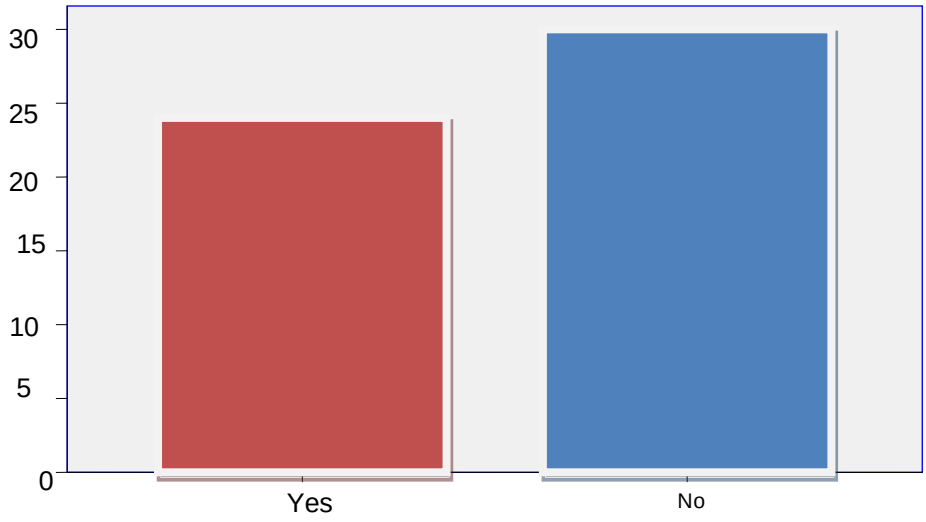
Positive response to introduction of new computer systems



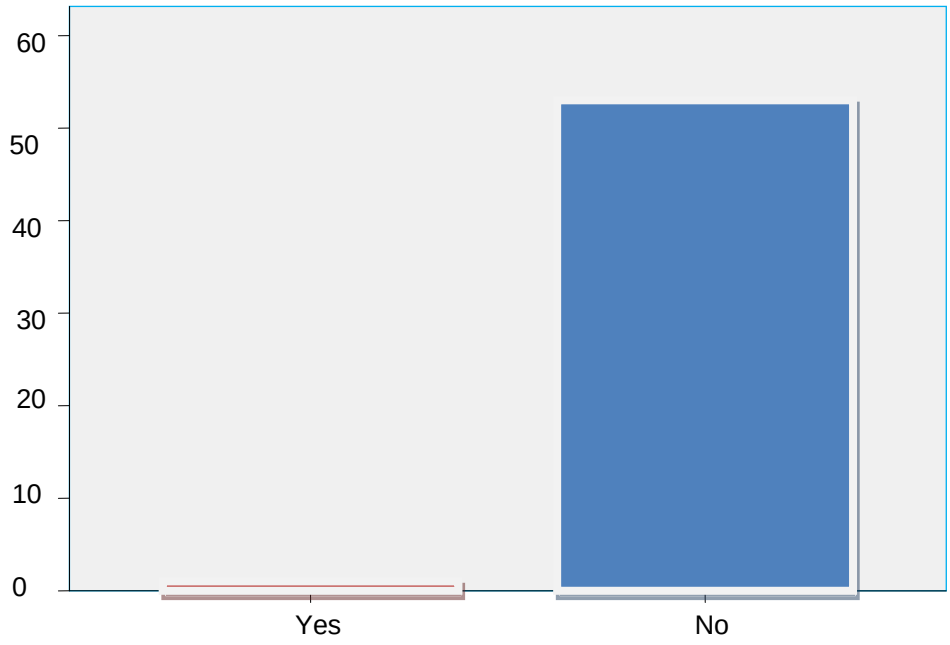
Positive if improves patient care



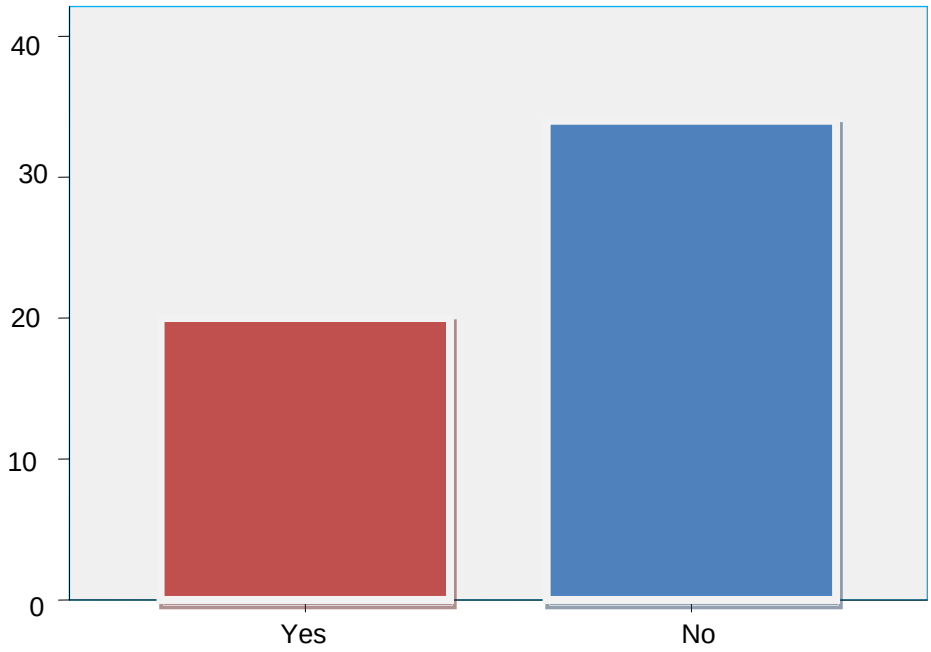
Positive if simplifies work processes



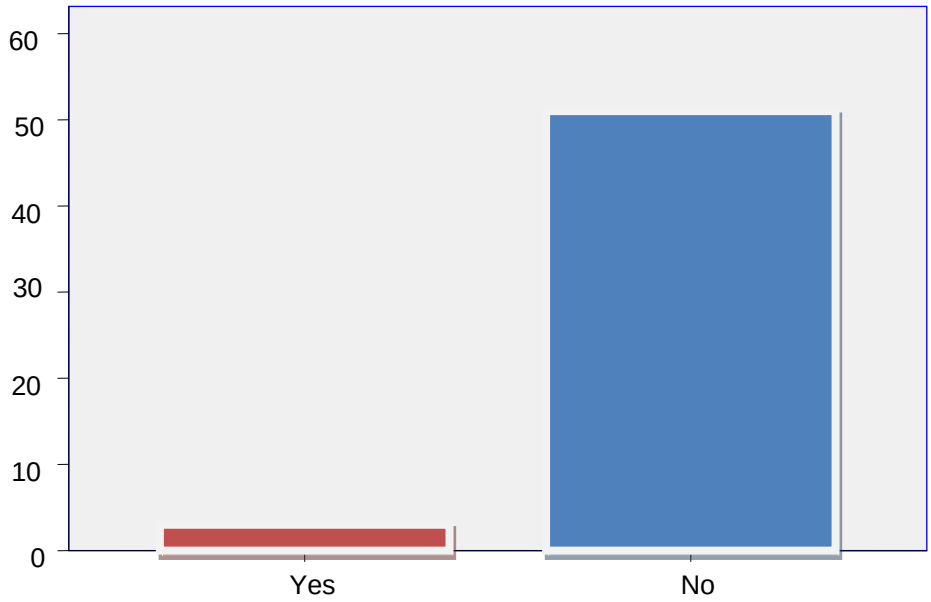
Unsure of the introduction of new computer systems



Have to see system in action before deciding

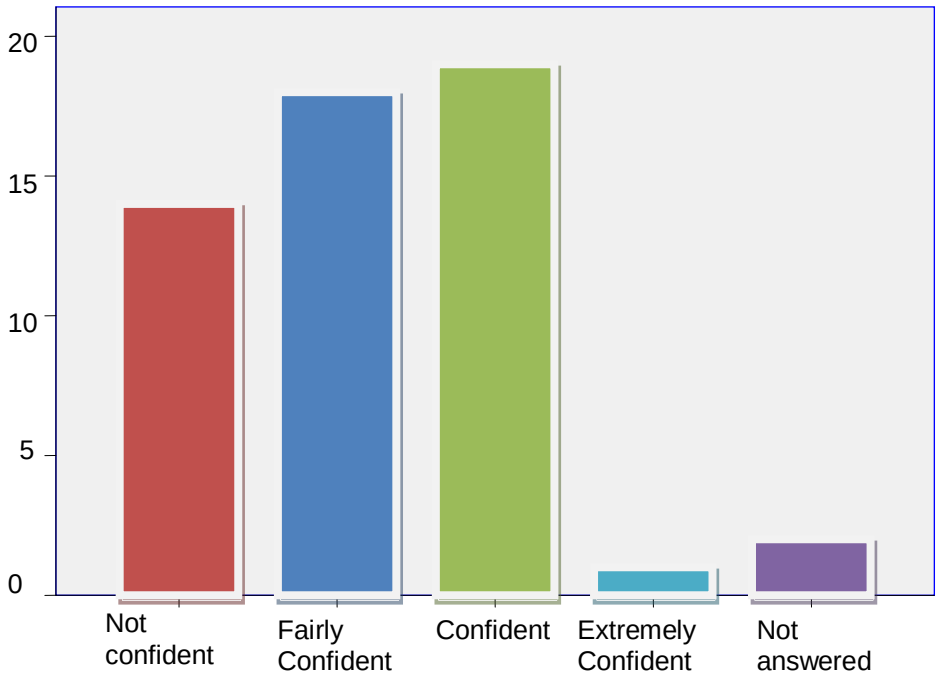


Negative response to introduction of new computer systems

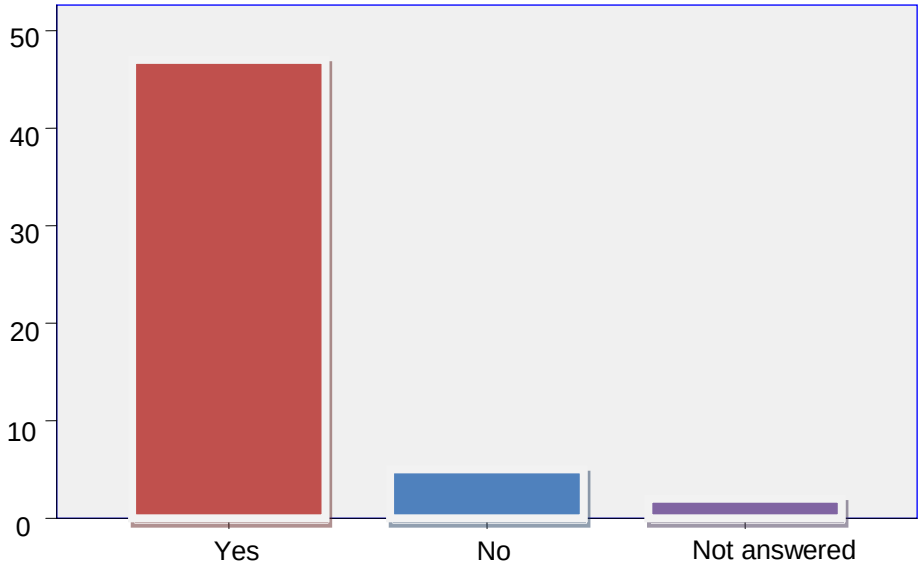


How do you rate training and support provided to you for the introduction of new computer systems at work?

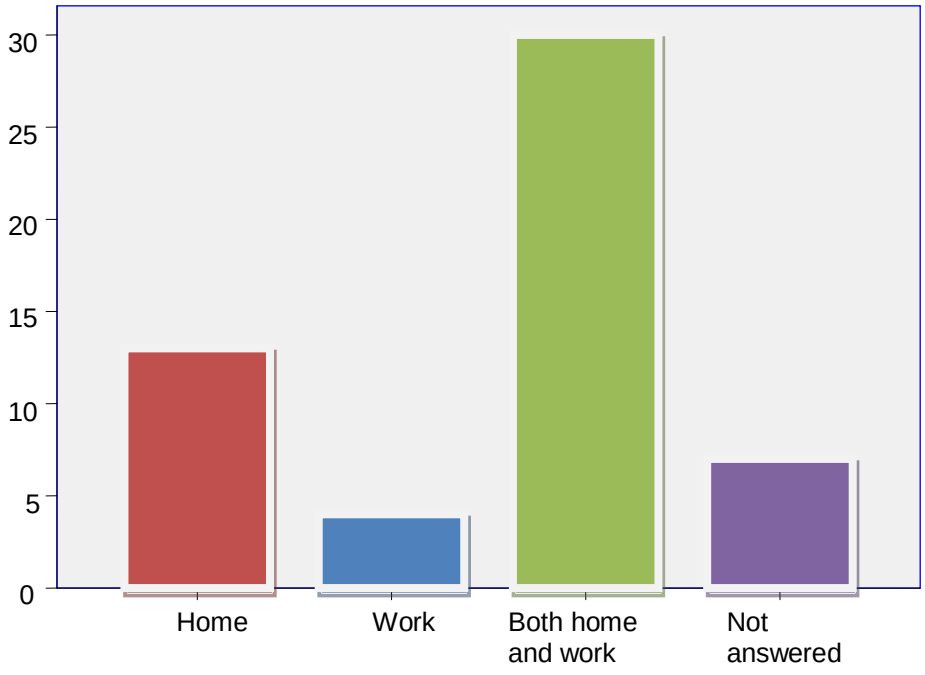
How confident are you with using computers?

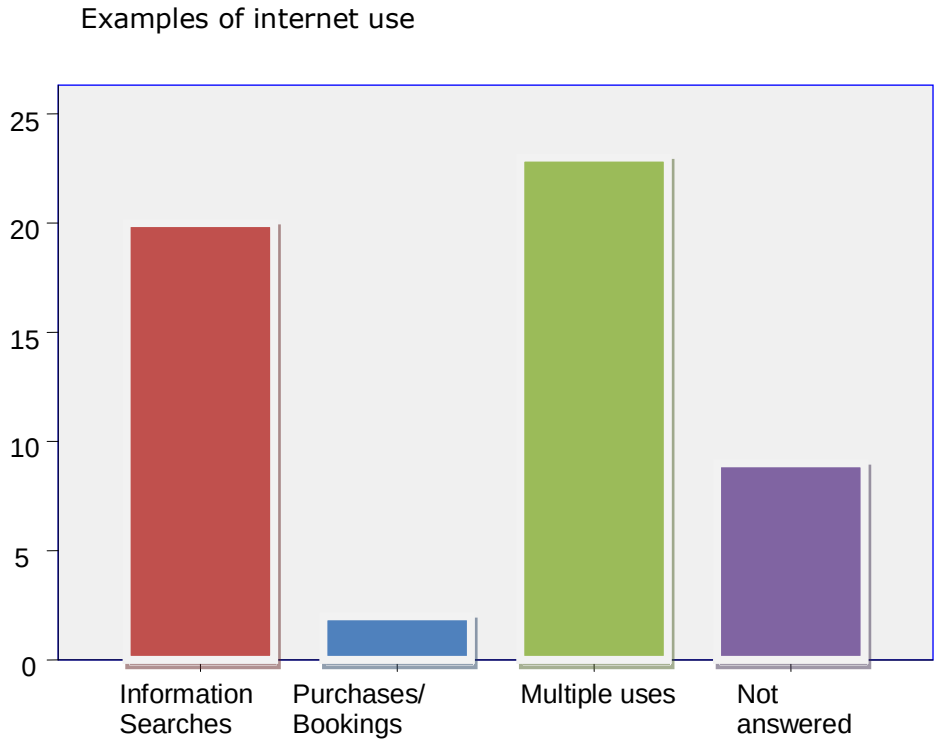


Do you use the Internet?



Do you use the Internet at home or work?




Examples of internet use
25
20
15
10
5
0
Information Searches
Purchases/ Bookings
Multiple uses
Not answered

Post-Pilot Frequency Tables: Nursing questionnaire data

Frequency Table

Job title

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nursing	31	96.9	96.9	96.9
	Auxillary	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

Duration of present post

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<1 year	3	9.4	9.4	9.4
	1-5 years	18	56.3	56.3	65.6
	>5 years	11	34.4	34.4	100.0
	Total	32	100.0	100.0	

Area of work

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Day Ward	15	46.9	46.9	46.9
	Theatres	17	53.1	53.1	100.0
	Total	32	100.0	100.0	

Do you work full-time or part-time?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	PartTime	4	12.5	12.5	12.5
	Full Time	27	84.4	84.4	96.9
	Not answered	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

How do you rate training and support?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Satisfactory	13	40.6	40.6	40.6
	Good	14	43.8	43.8	84.4
	Excellent	5	15.6	15.6	100.0
	Total	32	100.0	100.0	

How User friendly did you find the system?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Poor	3	9.4	9.4	9.4
	Satisfactory	15	46.9	46.9	56.3
	Good	13	40.6	40.6	96.9
	Not answered	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

Has the system potential to enhance staff communication?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	13	40.6	40.6	40.6
	No	6	18.8	18.8	59.4
	Unsure	12	37.5	37.5	96.9
	Not answered	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

Effectiveness compared to Face to Face communication

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less effective	13	40.6	40.6	40.6
	Equally effective	9	28.1	28.1	68.8
	More effective	7	21.9	21.9	90.6
	Not answered	3	9.4	9.4	100.0
	Total	32	100.0	100.0	

Effectiveness compared to Phone communication

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less effective	7	21.9	21.9	21.9
	Equally effective	20	62.5	62.5	84.4
	More effective	2	6.3	6.3	90.6
	Not answered	3	9.4	9.4	100.0
	Total	32	100.0	100.0	

Effectiveness compared to Pager communication

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less effective	8	25.0	25.0	25.0
	Equally effective	6	18.8	18.8	43.8
	More effective	15	46.9	46.9	90.6
	Not answered	3	9.4	9.4	100.0
	Total	32	100.0	100.0	

Has the system potential to enhance efficiency?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	13	40.6	40.6	40.6
	No	4	12.5	12.5	53.1
	Unsure	14	43.8	43.8	96.9
	Not answered	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

Rating system's efficiency in awareness of patient location

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fairly efficient	3	9.4	9.4	9.4
	Efficient	14	43.8	43.8	53.1
	Extremely efficient	9	28.1	28.1	81.3
	Not answered	6	18.8	18.8	100.0
	Total	32	100.0	100.0	

Rating system's efficiency in reduction of need for phone calls

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Inefficient	4	12.5	12.5	12.5
	Fairly efficient	9	28.1	28.1	40.6
	Efficient	8	25.0	25.0	65.6
	Extremely efficient	5	15.6	15.6	81.3
	Not answered	6	18.8	18.8	100.0
	Total	32	100.0	100.0	

Rating system's efficiency in creation and updating of patient lists

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Inefficient	1	3.1	3.1	3.1
	Fairly efficient	8	25.0	25.0	28.1
	Efficient	13	40.6	40.6	68.8
	Extremely efficient	3	9.4	9.4	78.1
	Not answered	7	21.9	21.9	100.0
	Total	32	100.0	100.0	

Rating system's efficiency in creation of statistical data for audit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Inefficient	1	3.1	3.1	3.1
	Fairly efficient	6	18.8	18.8	21.9
	Efficient	9	28.1	28.1	50.0
	Extremely efficient	10	31.3	31.3	81.3
	Not answered	6	18.8	18.8	100.0
	Total	32	100.0	100.0	

Has the system potential to enhance patient safety?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	17	53.1	53.1	53.1
	No	7	21.9	21.9	75.0
	Unsure	8	25.0	25.0	100.0
	Total	32	100.0	100.0	

Confidence in the system's potential to enhance Identification and communication of allergies?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident	2	6.3	6.3	6.3
	Fairly confident	12	37.5	37.5	43.8
	Confident	9	28.1	28.1	71.9
	Extremely confident	2	6.3	6.3	78.1
	Not answered	7	21.9	21.9	100.0
	Total	32	100.0	100.0	

Confidence in the system's potential to enhance Identification and communication of infections?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident	2	6.3	6.3	6.3
	Fairly confident	14	43.8	43.8	50.0
	Confident	10	31.3	31.3	81.3
	Not answered	6	18.8	18.8	100.0
	Total	32	100.0	100.0	

Confidence in the system's potential to enhance verification of patient ID?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident	1	3.1	3.1	3.1
	Fairly confident	12	37.5	37.5	40.6
	Confident	11	34.4	34.4	75.0
	Extremely confident	2	6.3	6.3	81.3
	Not answered	6	18.8	18.8	100.0
	Total	32	100.0	100.0	

Confidence in the system's potential to enhance verification of site of surgery?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not confident	4	12.5	12.5	12.5
	Fairly confident	12	37.5	37.5	50.0
	Confident	7	21.9	21.9	71.9
	Not answered	9	28.1	28.1	100.0
	Total	32	100.0	100.0	

Positive response to introduction of new computer systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	25.0	25.0	25.0
	No	24	75.0	75.0	100.0
	Total	32	100.0	100.0	

Positive if improves patient care

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	50.0	50.0	50.0
	No	16	50.0	50.0	100.0
	Total	32	100.0	100.0	

Positive if simplifies work processes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	37.5	37.5	37.5
	No	20	62.5	62.5	100.0
	Total	32	100.0	100.0	

Unsure of the introduction of new computer systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	6.3	6.3	6.3
	No	30	93.8	93.8	100.0
	Total	32	100.0	100.0	

Have to see system in action before deciding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	21.9	21.9	21.9
	No	25	78.1	78.1	100.0
	Total	32	100.0	100.0	

Negative response to introduction of new computer systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	6.3	6.3	6.3
	No	30	93.8	93.8	100.0
	Total	32	100.0	100.0	

Do you think differently on introduction of new computer systems at work

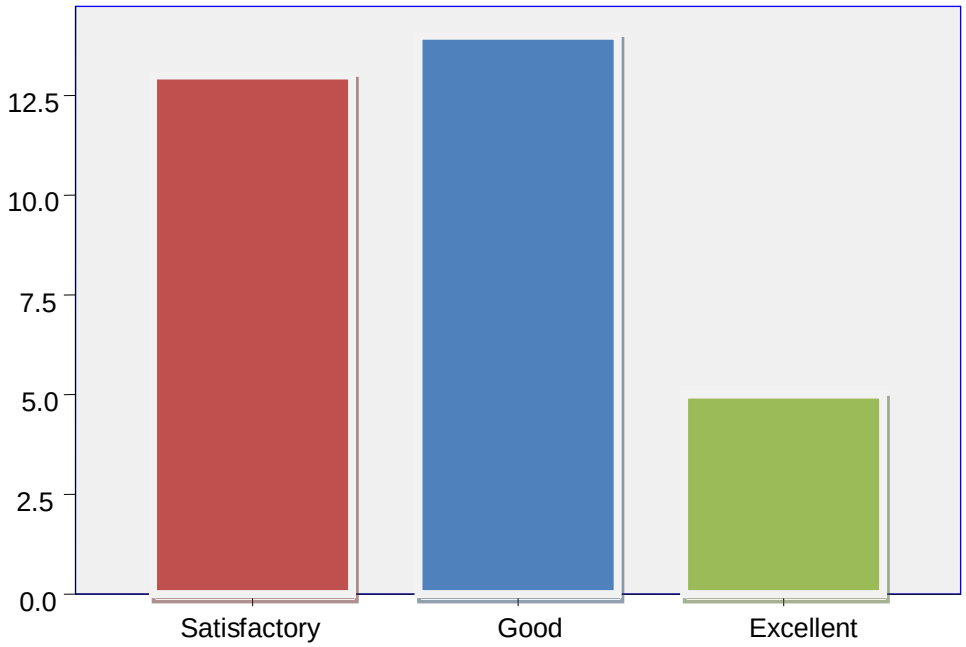
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	25.0	25.0	25.0
	No	18	56.3	56.3	81.3
	Unsure	5	15.6	15.6	96.9
	Not answered	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

Are you more confident about using computer systems at work?

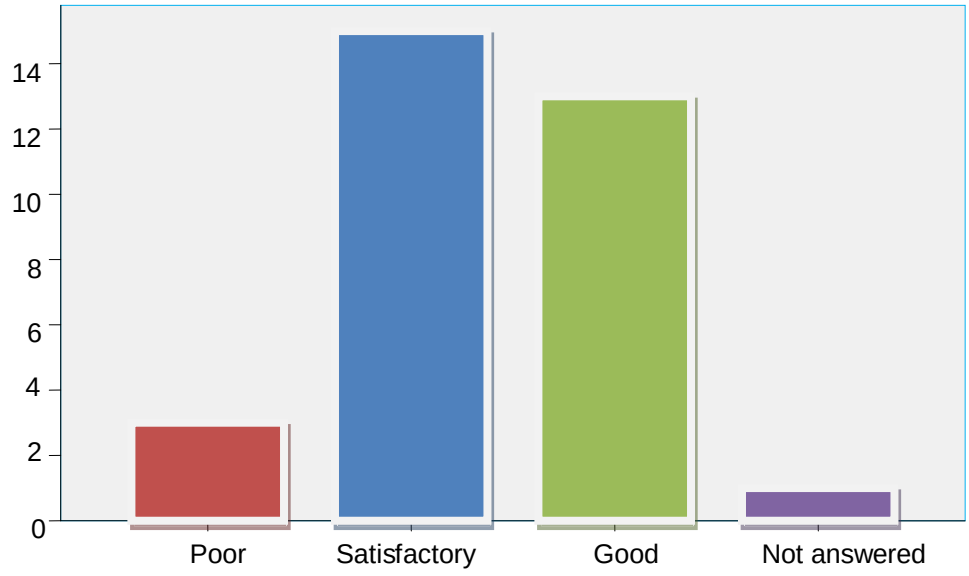
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	21	65.6	65.6	65.6
	No	9	28.1	28.1	93.8
	Unsure	2	6.3	6.3	100.0
	Total	32	100.0	100.0	

Post Pilot questionnaire bar chart diagrams

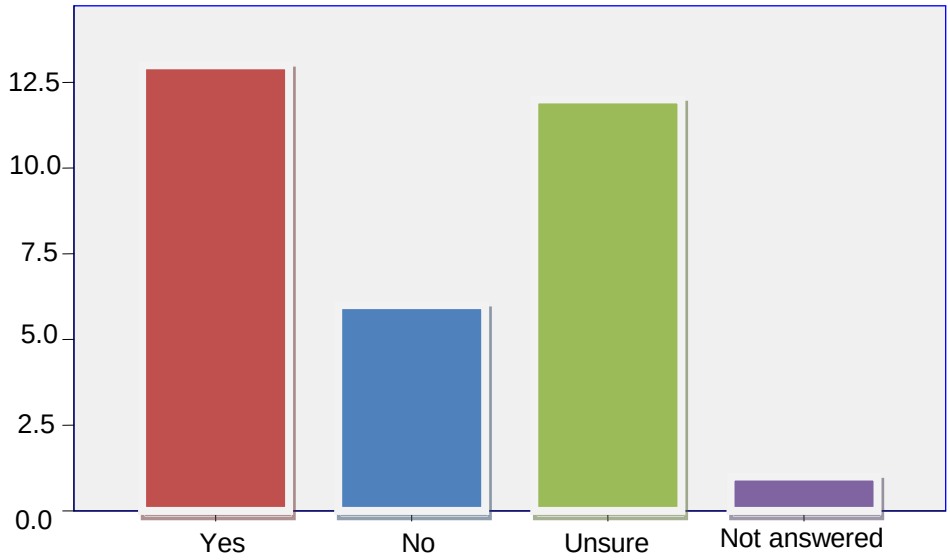
How do you rate training and support?



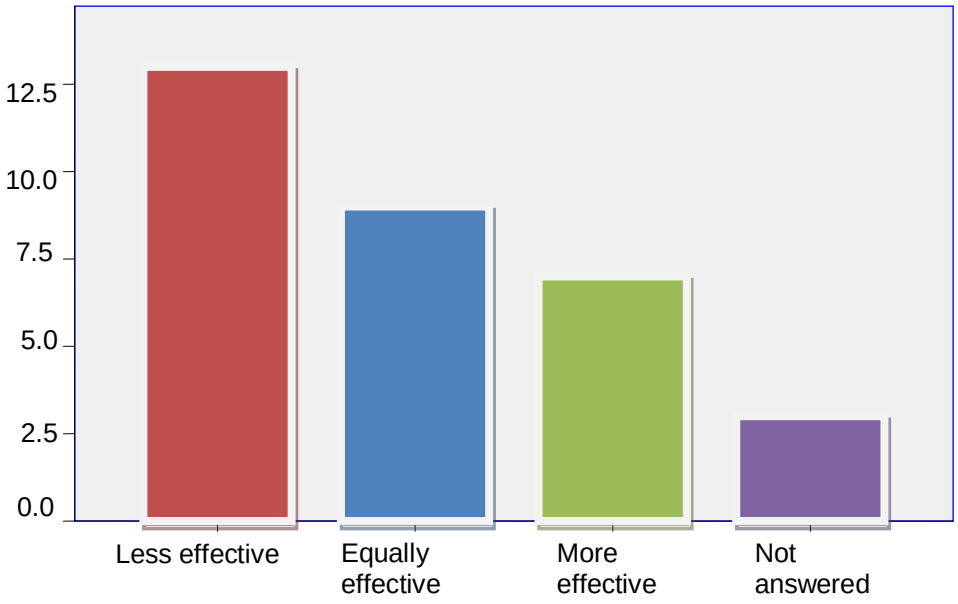
How User friendly did you find the system?



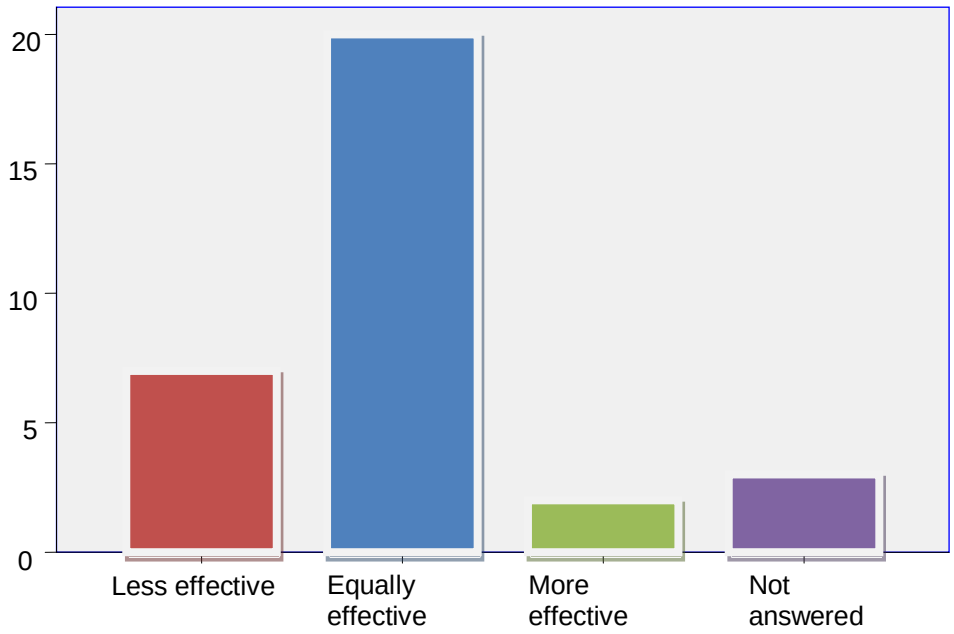
Has the system potential to enhance staff communication?



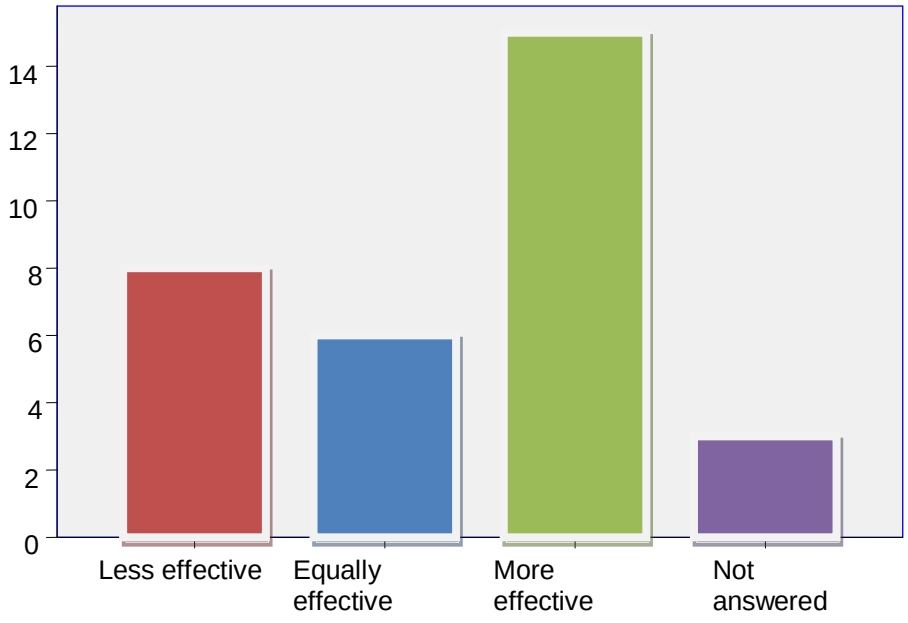
Effectiveness compared to Face to Face communication



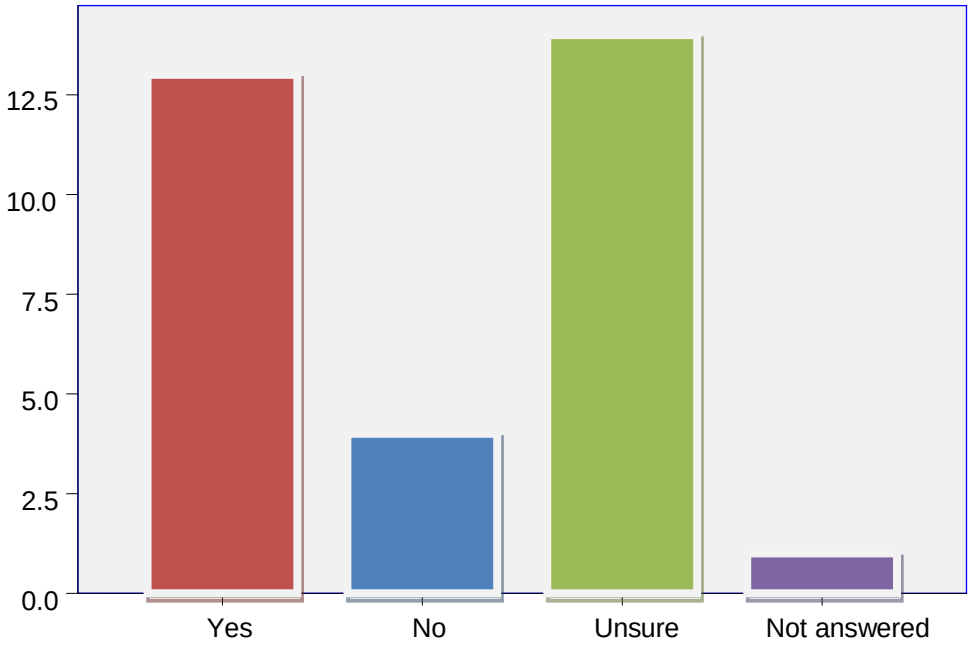
Effectiveness compared to Phone communication



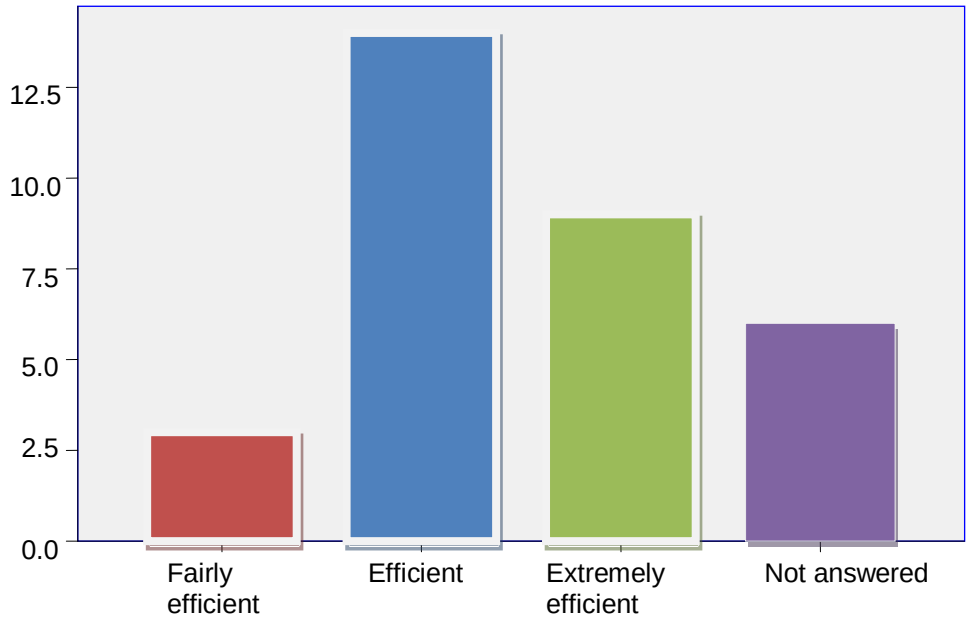
Effectiveness compared to Pager communication



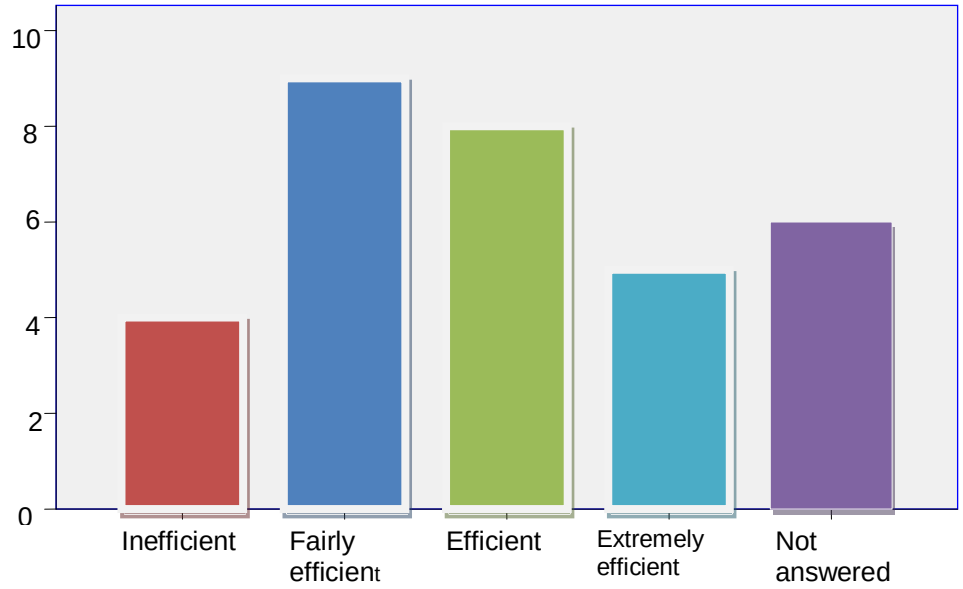
Has the system potential to enhance efficiency?



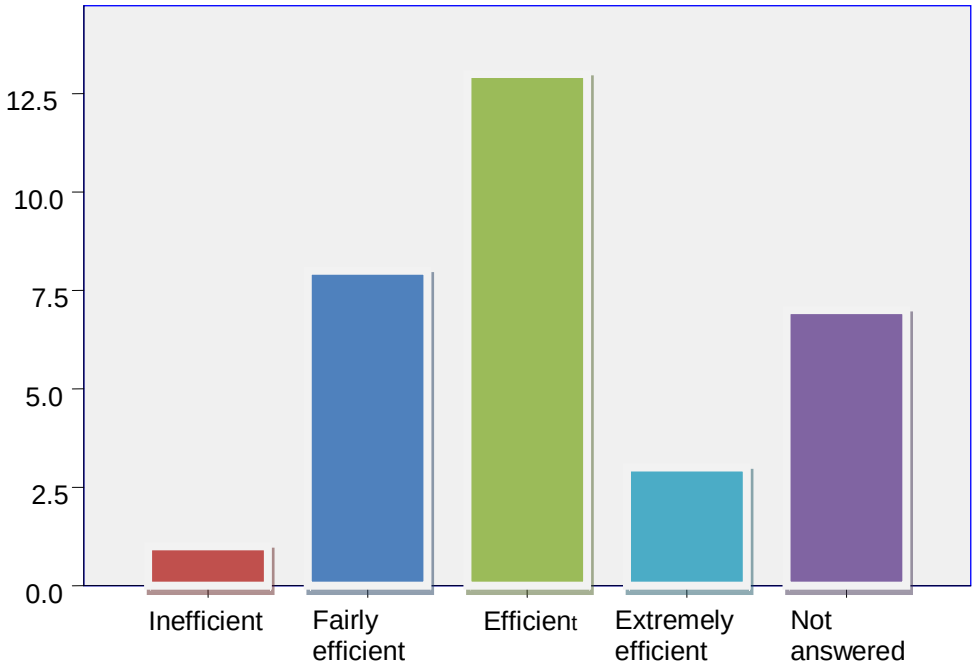
Rating Efficiency in awareness of patient location



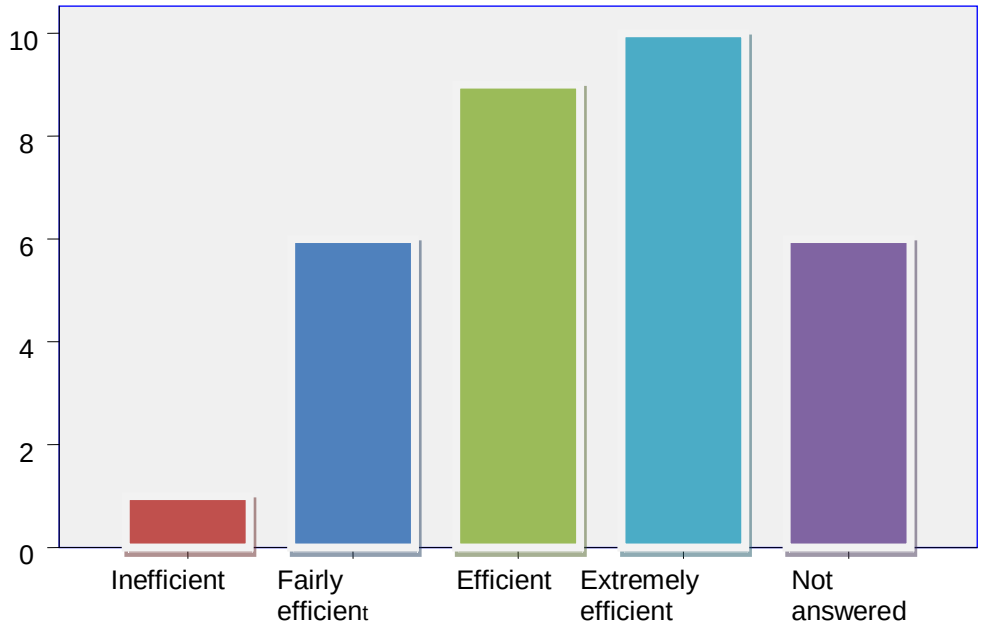
Rating Efficiency in reduction of need for phone calls



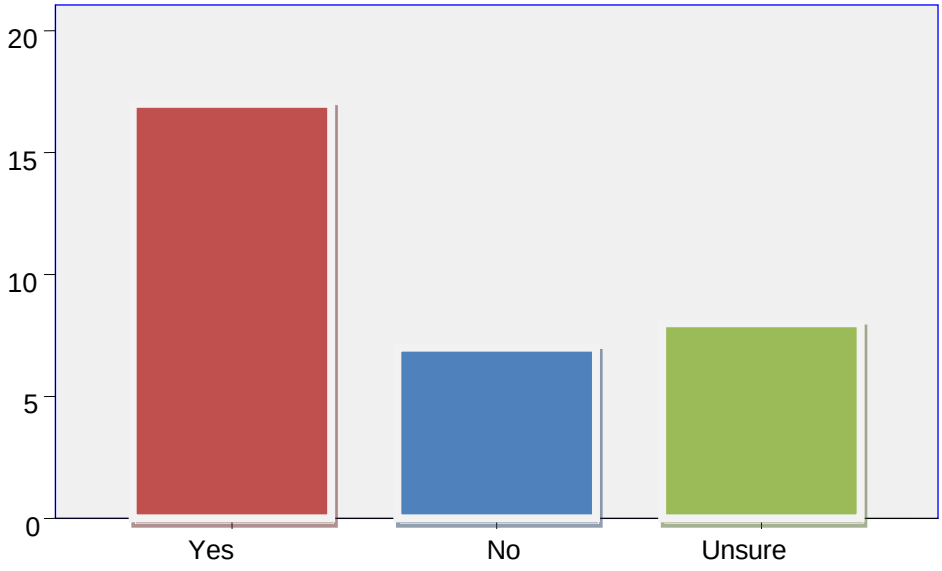
Rating Efficiency in creation and updating of patient lists



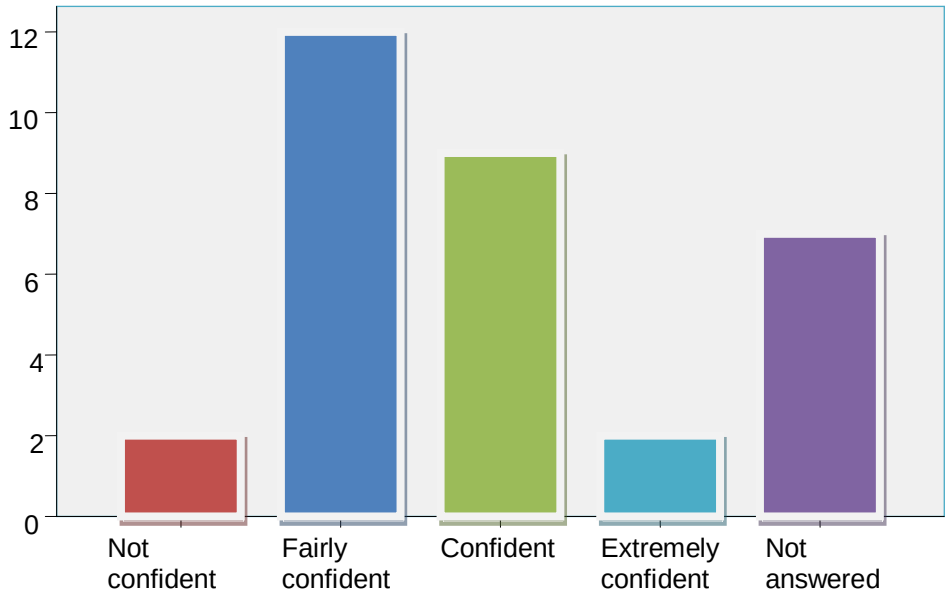
Rating Efficiency in creation of statistical data for audit



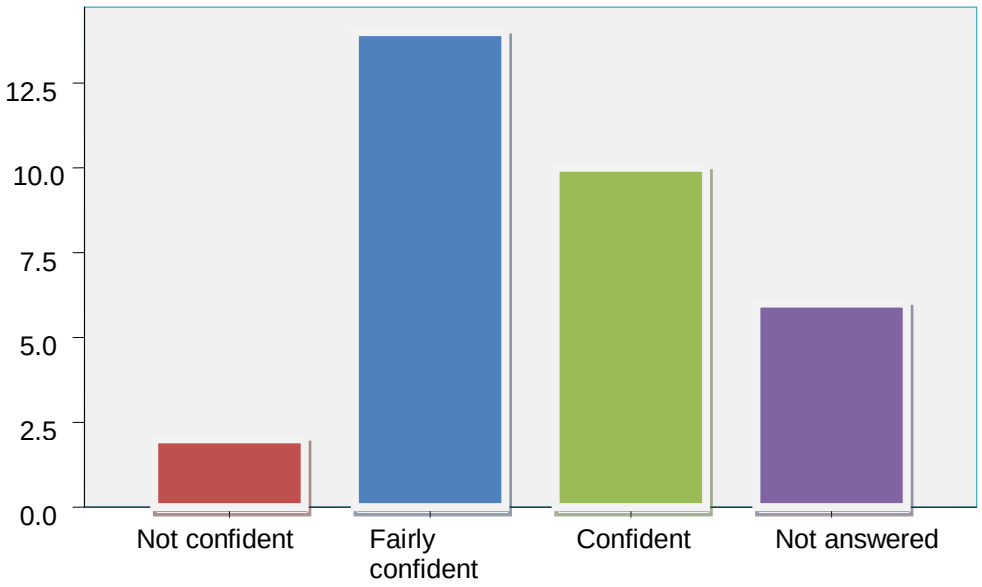
Has the system potential to enhance patient safety?



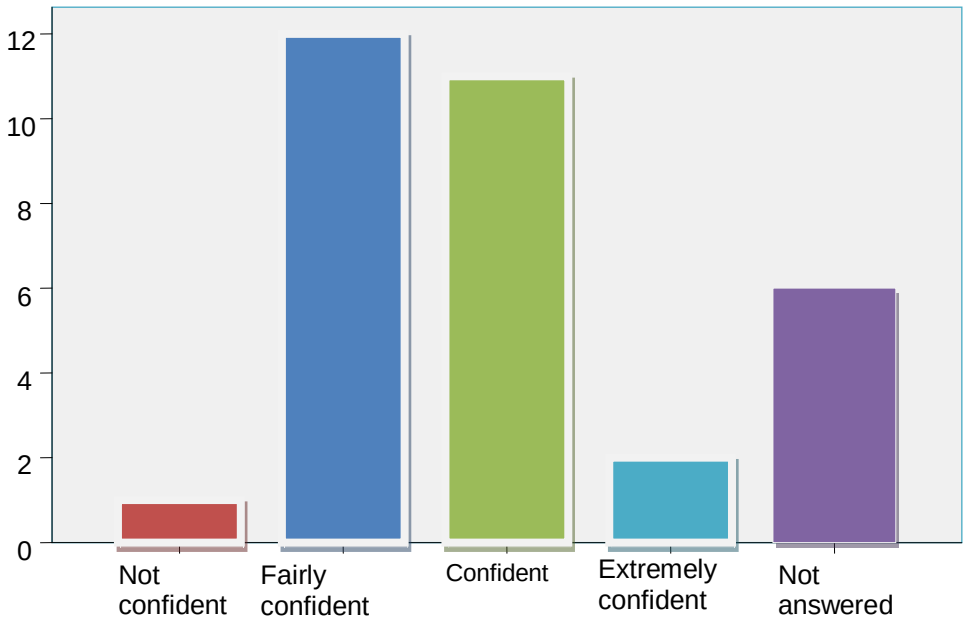
Confidence in the system's potential to enhance Identification and communication of allergies



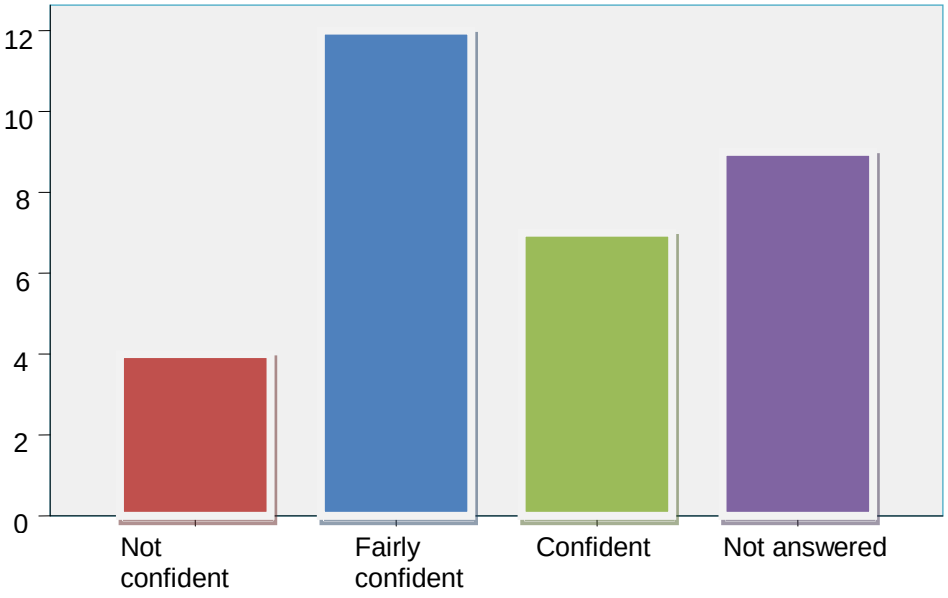
Confidence in the system's potential to enhance Identification and communication of infections



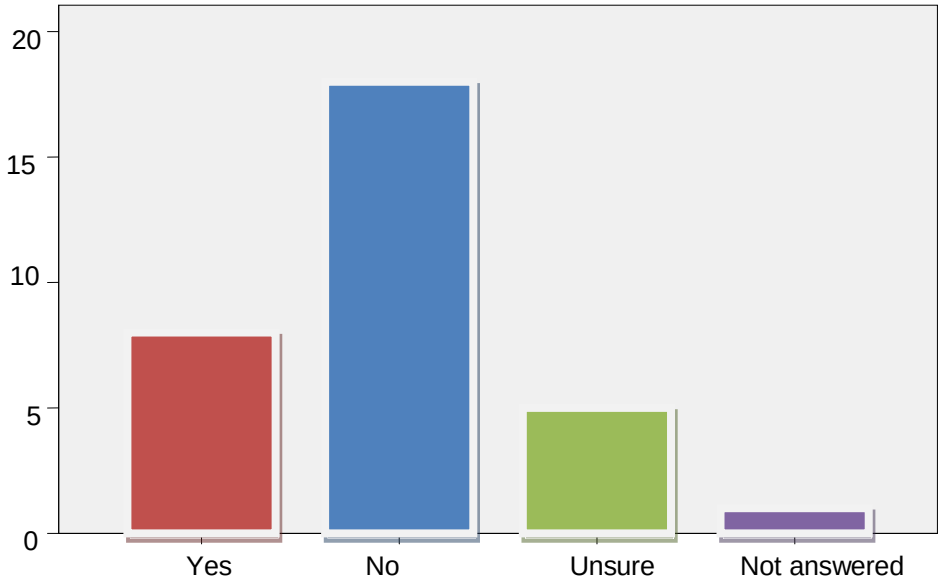
Confidence in the system's potential to enhance verification of patient ID



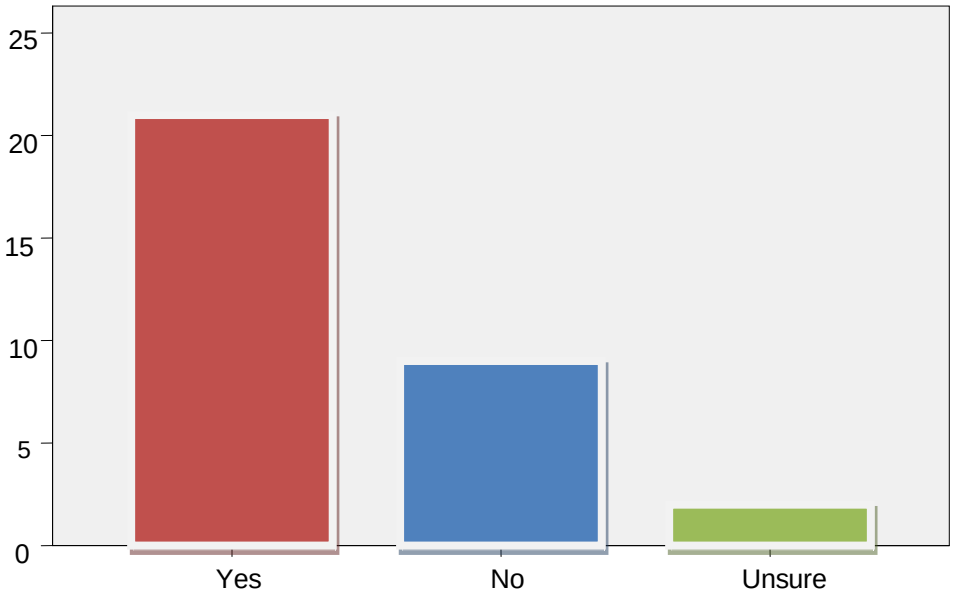
Confidence in the system's potential to enhance verification of site of surgery



Do you think differently on introduction of new computer systems at work?



Are you more confident about using computer systems at work?



Appendix six

Medical Structured Interview Questions and bar chart diagrams

Structured Interview Questions

For Medical staff (Pre-Pilot)

1.
What is your job title?
JHO ☐ SHO ☐ Registrar ☐ Consultant ☐
How long have you been in your present post?
<1yr ☐ 1-5yrs ☐ >5yrs☐

2.
How many days per week do you?
Admit Patients
Review patients
Operate on patients

3.

How often do issues with patient (mis)/ identification delay your daily tasks/duties (per week)?

Patient ID confused,
Miscommunication of patient information,
Awareness of patient allergies/infections,
Delays with pt transfers/cancellations,
Distracting phone calls
Operating lists not up to date
Other.....

4. How do you rate the overall efficiency of patient flow within surgical day care and Endoscopy?

Inefficient	☐
Fairly efficient, yet with potential for improvement	☐
Efficient	☐
Extremely efficient, with no obvious potential for improvement	☐

5. How confident are you with patient safety checks within the current patient admission system?

Confidence Level

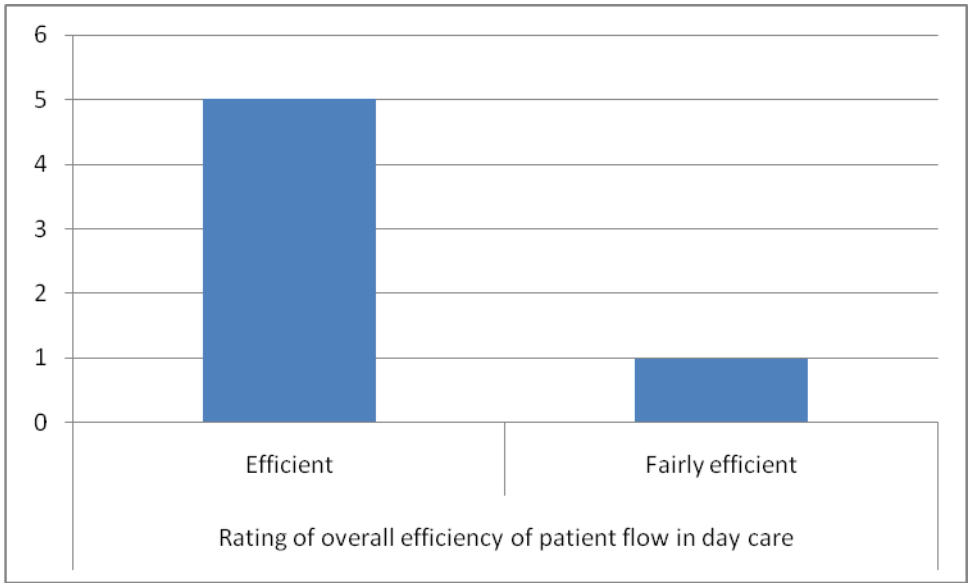
NC = Not Confident
FC = Fairly Confident
C = Confident
EC = Extremely Confident

	NC	FC	C	EC
1. Identification and communication between relevant staff of allergies	☐	☐	☐	☐
2. Identification and communication between relevant staff of Infection risks	☐	☐	☐	☐
3.Verification of Patient ID	☐	☐	☐	☐
4.Verification of site of surgery	☐	☐	☐	☐

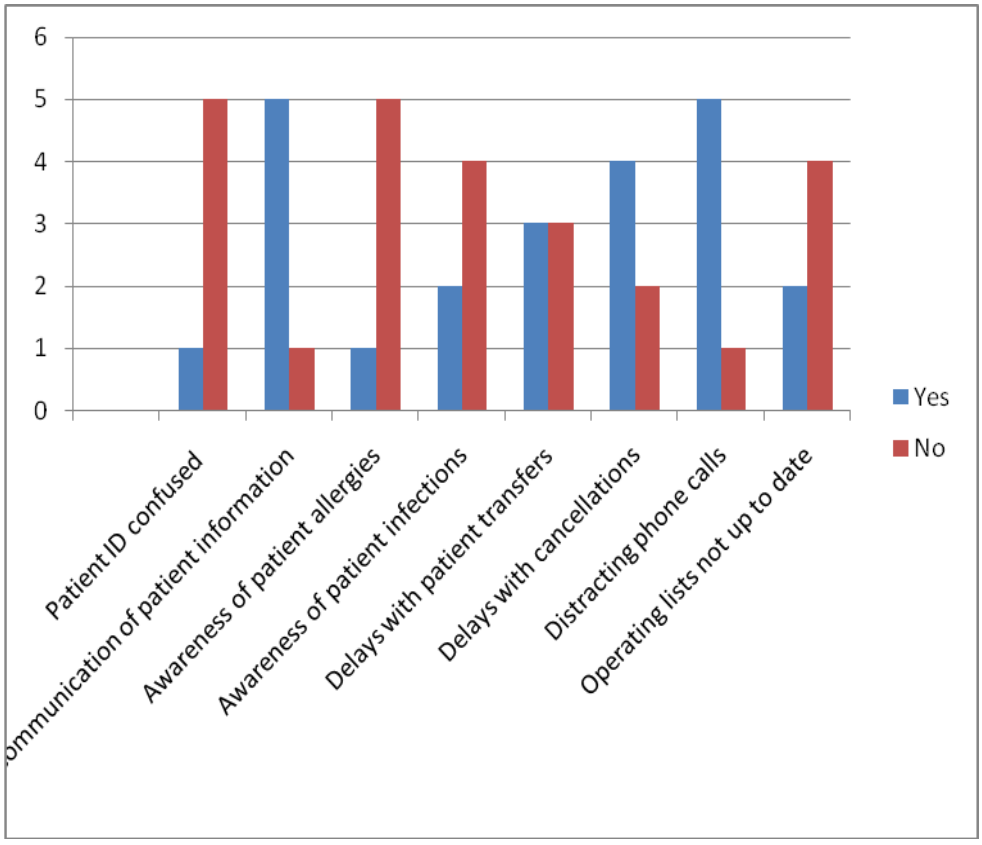
Medical structured interview structured bar charts

Pre-pilot

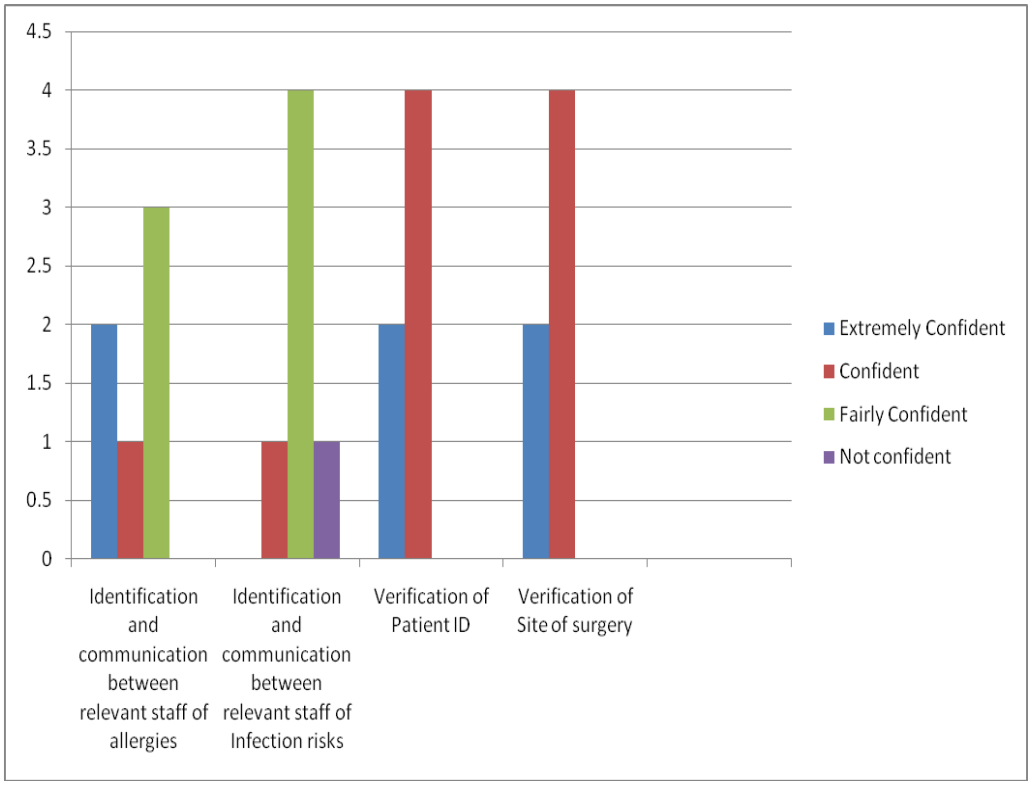
Rating overall efficiency of Patient flow in day care



Potential delay to daily tasks/duties



Confidence levels in aspects of patient care:



Structured Interview Questions

For Doctors (Post-Pilot)

1. What is your job title?		
JHO ☐	SHO ☐	
Registrar ☐	Consultant ☐	
How long have you been in your present post?		
<1yr ☐	1-5yrs ☐	>5yrs ☐

2. Patient tracking (Pilot System)	
How do you rate training and support provided to you for the introduction of the patient tracking system?	
Poor ☐	Satisfactory ☐
Good ☐	Excellent ☐
Having used the pilot system, how user friendly did you find it?	
Poor ☐	Satisfactory ☐
Good ☐	Excellent ☐
What do you like most about the system? <15 words	
What do you like least about the system? <15 words	

3. Pre the pilot a question was asked to ascertain whether any issues within the present system caused delay in your daily tasks. These were:

- Pt ID confused
- Miscommunication of patient information
- Awareness of patient allergies/infections
- Distracting phone calls
- Operating lists not up to date
- Other...i.e.---admin tasks-----

Having used the pilot system, do you find it has potential to help with your daily tasks in relation to avoidance of the issues above?

Yes ☐	No ☐	Unsure ☐
If yes, which issues do you think it could help with?...		
4. Finally, do you think the system has potential to enhance… **1. Staff communication?**		
Yes ☐	No ☐	Unsure ☐
2. Efficiency?		
Yes ☐	No ☐	Unsure ☐
Potential efficiency features have been identified below: Please rate these as **1= Inefficient** **2= Fairly efficient** **3= Efficient** **4= Extremely efficient** (Please give each efficiency feature a number from the rating scale above)		
Awareness of patient location: =		
Reduction of need for phone calls: =		
Ease of use to create and update patient lists: =		
Creation of statistical data for audit purposes: =		

3.Patient Safety?		
Do you think the system has potential to enhance patient safety?		
Yes ☐	No ☐	Unsure ☐
Potential safety features have been identified below: Please rate your confidence in these features **1= Not confident** **2= Fairly confident** **3= Confident** **4= Extremely confident** (Please give each safety feature a number from the rating scale above)		
Identification and communication between relevant staff of **allergies** (Allergy icon on system): =		
Identification and communication between relevant staff of **Infection risks** (Infection risks highlighted on system): =		
Verification of **Patient ID** (Tracking tag as additional Patient ID): =		
Verification of **site of surgery** (Time out feature): =		

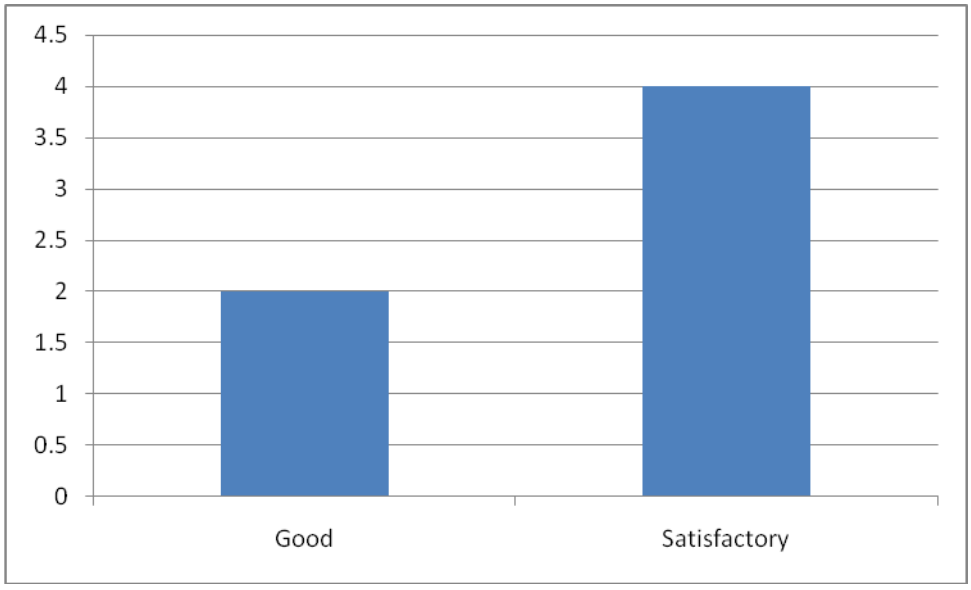
Thank you!

Medical structured interview structured bar charts

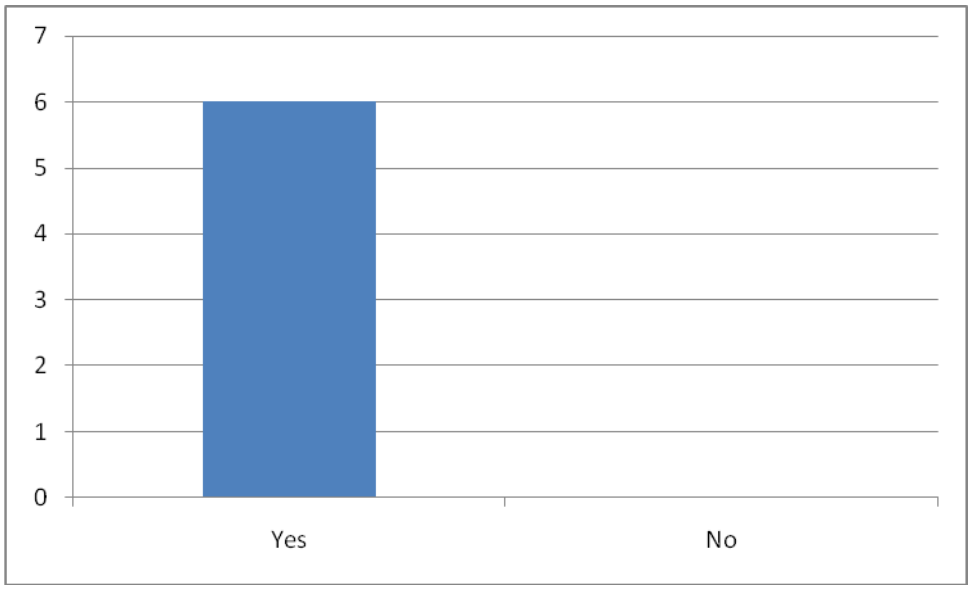
Post pilot

Rating Tracking system training and support

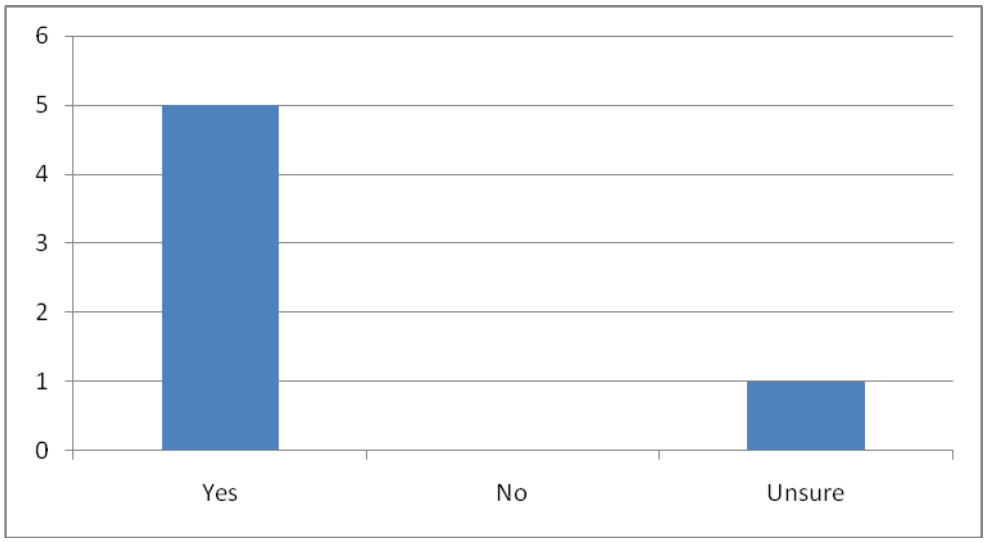
Rating Tracking system user friendliness



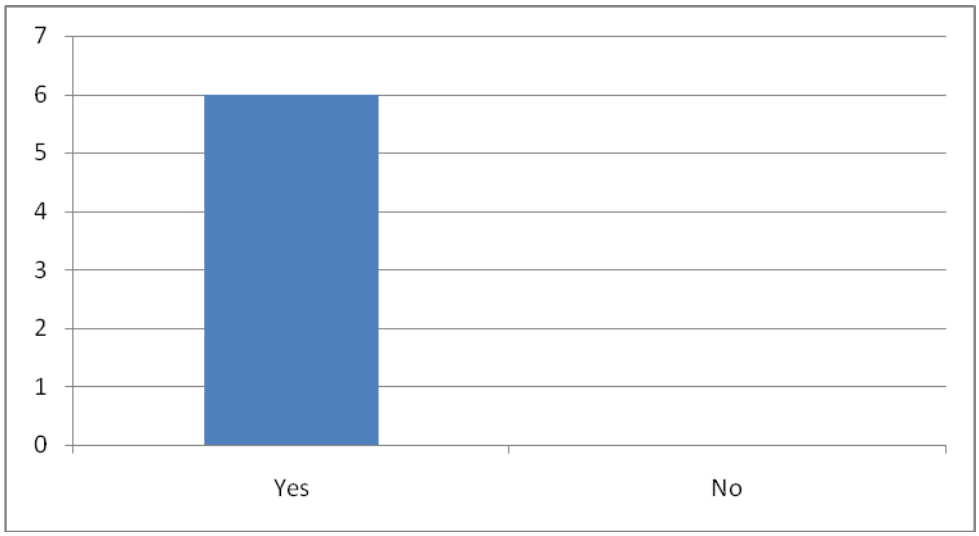
Has the system potential to avoid delays?



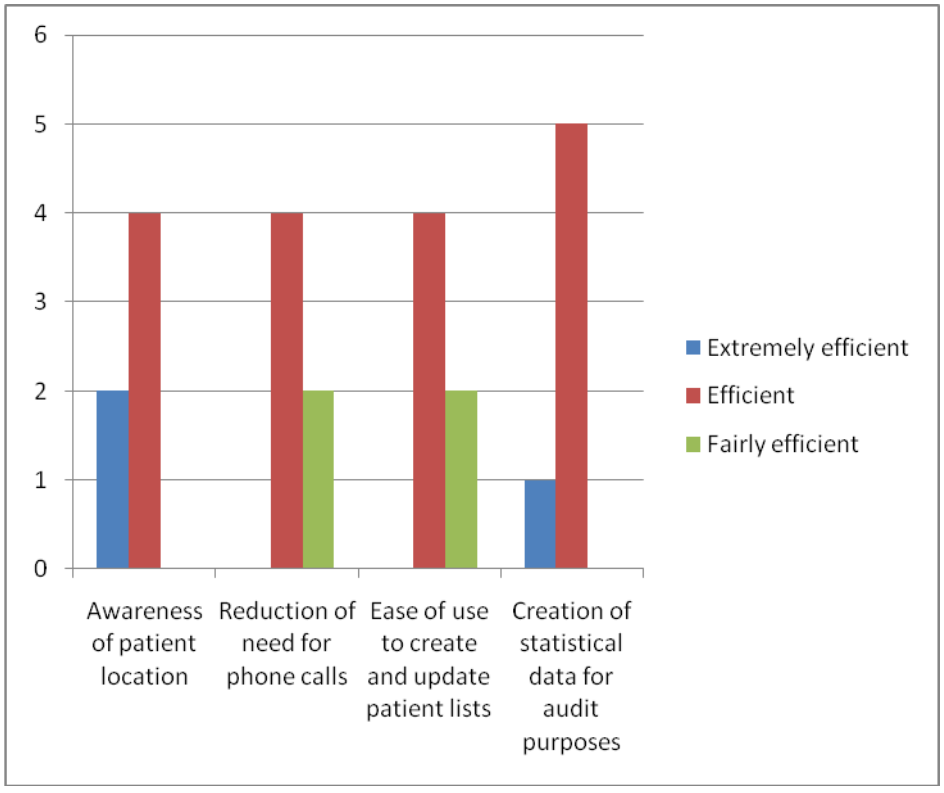
Has the system potential to enhance Staff communication?



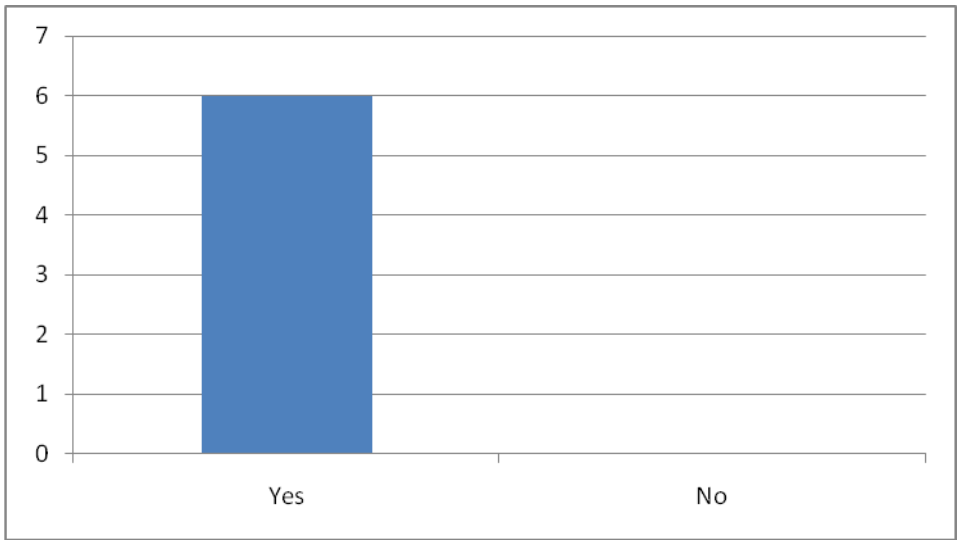
Has the system potential to enhance efficiency?



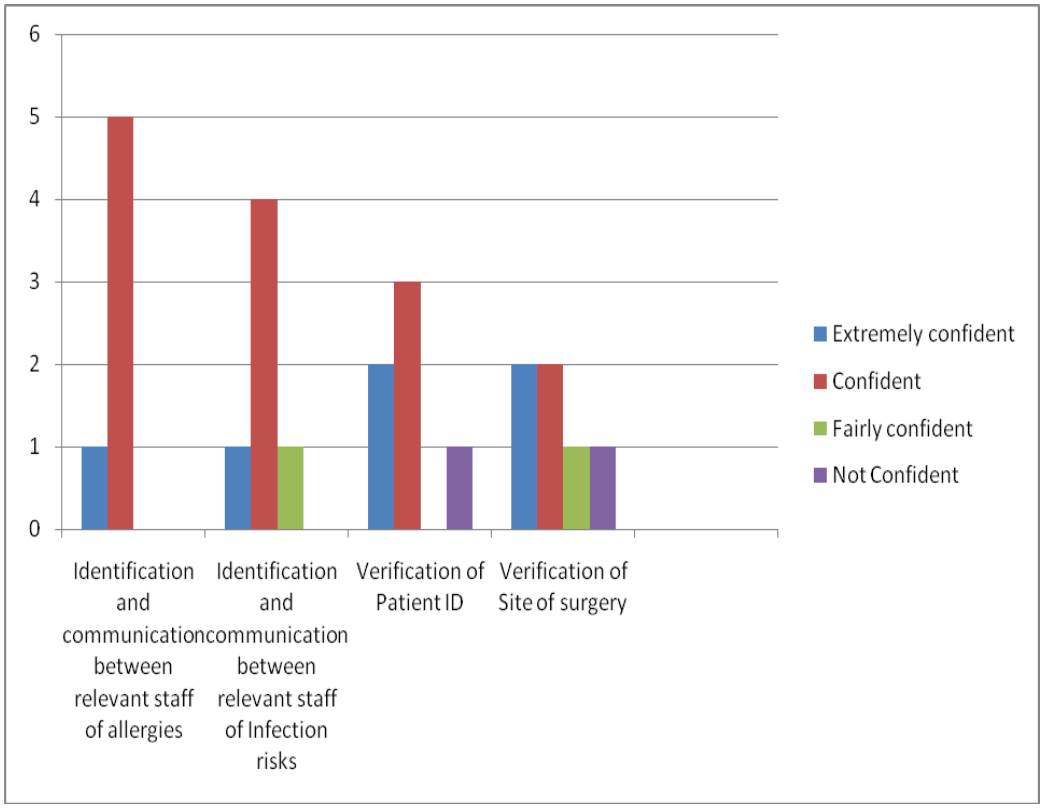
Rating the system's potential efficiency features



Has the system potential to enhance patient safety?



Rating the system's potential safety features



Appendix seven

Sample questions for staff on evaluation of the tracking system

1. What do you think of the pilot study? How has it been in your area of work? Any suggestions for improvement?

2. What would you say is the systems greatest potential benefit & why?

3. What would you say is the systems least beneficial attribute & why?

4. Post pilot Survey data indicates that some staff are unsure of the tracking system's potential in some areas under study; In particular, it's potential to enhance staff communication How do you think the communication system is working?

5. Are the buzzers useful or not. Why/why not?

6. In your opinion is the add comment communication feature useful? Why/why not?

7. Phone calls or Tracking system to communicate? In your opinion which is more effective and why?

8. By reduction of phone calls and administrative tasks associated with paper lists; it is anticipated that a system such as the tracking system has potential to save time for staff. What is your opinion on this?

9. Could the data generated by Tracking system help improve workflow? Is it useful to you? If so, how would you use it?

10. Could a system such as the tracking system help with quality improvement of the clinical process? How? Is it flexible and responsive to the needs of each clinical area? Why/why not?

11. Finally; Patient safety features of the Tracking system system:

- Electronic lists – Accuracy greater- linked to PIMS database. Less error prone.
- Additional positive patient ID and location
- Allergy awareness
- Infection alert

- Staff communication features
- Staff reminders and checklists
- Time out checks

What are your thoughts on these features/functions? Do you think they could enhance patient safety?

12. Which is the most useful and why?

13. Do you have any ideas as to how this system could be developed further to make the process safer and easier?

14. Any other thoughts/comments??? Thank you!

Appendix eight

Staff comments

Nursing Staff Comments on the tracking system;

Positive:

- Seems to be working well, patients seem comfortable with it
- Able to know the location of patient after going to theatre
- It will work well if it was more widespread but would take time as staff become more proficient in its use
- No need to use phone
- You don't need to use phone in calling recovery
- Easy to know where the patient is at any time during the day
- Cuts out unnecessary phone calls. Everyone aware of where the patients are at all times
- Patient can be located in just a click of a button
- No need for phone calls
- No need to make phone calls
- Tracking patient
- It will reduce the usage of phone
- No need of telephone calls
- Easy to track down patient without using phone and paper
- Requesting the recovery bed
- Reduction in noise. Available to everyone
- Efficient. Less phone calls
- We can find out where the patient is at all times
- It helps to track the patient
- Going forward. New and exciting

Negative:

- Mechanical malfunctions
- I found it time consuming having to enter details on computer during busy time getting patients ready for surgery
- It hasn't worked out in regards to the phone calls, are still happening
- The notebook kept charging off, when you didn't use it for a while and you kept having to re-log into it. Time consuming.
- When only using it once a week you needed constant refreshers on use

- When the system have some blitz that needs technical fixing
- There should be somebody specifically allocated for the tracking system
- Specified person allocated to do
- Time consuming
- Might put an extra job
- You have to log in
- Having to be near a computer, it's not very feasible
- Bleeps were very hard to hear
- Delay time in response. Needs indicator box so that we know info is received
- Sometimes it's just quicker to use phone when busy
- Reliant on information the patient discloses. Sometimes they omit details that are very relevant to staff
- Having to wear the buzzer
- More work to do on the computer
- Toughbook too awkward to carry around if busy admitting patients on ward, be better if was smaller, pocket-size.
- Sometimes the bleep doesn't work and we will be phoned
- Time it takes first thing in the morning
- Don't like it. Time consuming.
- Slows process of admitting patients down. Takes up room at work desk

Doctors' comments on the tracking system;

Positive:

- User friendly. Facilitates our work.
- Documents clearly allergies/infections
- Information available to +++ people
- Capacity to generate computerised theatre lists
- Up to date info which is readily available from all over AMNCH site
- Way it is organised. Know where patients are
- Saves paperwork
- Electronic database is statistically more sound

Negative:

- Double input currently –manual OT list, input into Tracking system also
- Palm held computers can be difficult to use in day ward
- Learning process
- Learning curve

Appendix nine

Framework for benefits

This framework demonstrates that benefits result from change, which originates from three basic causes.
These are categorized as:

1. Doing new things
2. Doing things better
3. Stop doing things

When applying this framework to the patient tracking system provisional predictions in each category are:

1. Doing new things:

As this is an innovative project, by piloting the system the hospital are doing something new and different.
An advantage of IT projects can be enabling new functions and ways of working.

It is difficult to accurately predict the value of new functions the system can enable. As previously mentioned, realizing the extent of the value depends on the organization (in this case the hospital staff and managers) evaluating and deciding how the technology might help.
Decisions may involve process and practice changes.
(Wang et al, 2006).

2. Doing things better:

The Research plan gives a comprehensive outline of how Tracking system can enable the enhancement of current processes. The focus is on the primary research objectives which have been covered extensively within the document.

3. Stop doing things:

This is a sensitive category, as it could be interpreted as a criticism of current processes. It should be clarified that as with other categories this one in particular consists of potential suggestions for change which can only be decided by the hospital staff and management.

These points are summarised on the tables on the following pages

Framework for evaluation: Summary prediction of potential benefits

1. Doing new things

Predicted potential benefit	Rationale for benefit/value
Improved service for patients: 1. Using the system to enhance patient safety procedures and procedural efficiencies.	1. Enhanced coordination and Integration of the patient's episode of care leading to improved quality of care.
2.Development of **new services** (**not within the current project**) for the patient such as: Enabling relatives/friends track the progress of the patient by 2.1 A secure & confidential login to the tracking system via the hospital website. 2.2 An electronic whiteboard for parents of paediatric patients. 2.3 Automatic SMS notifying relatives/friends of patient status.	2. Services are more patient orientated, responsive to individual needs and preferences, enabling more seamless continuity of care. For example; 2.2 enables parents to be in recovery when their young child is waking up. 2.3 can reduce waiting on lifts home for patients by automatic notification they are ready for discharge.
Improved workflow for the hospital 1.Use of electronic theatre lists 2. Generation of specific Process reports.	1. Enhanced safety, efficiency and timesaving. 2. Accurate reports on the process, in real time or retrospectively. Reports can be tailored for individual clinical and managerial staff. Reports can provide data for audit, performance management, increase transparency for clinical governance, and assist process improvement and efficiencies. Efficiency begins with data.

2. Doing things better.

Predicted potential benefit	Rationale for benefit/value
Enhancing patient safety processes 1. Electronic lists. 2. Additional positive patient ID and location. 3. Allergy notification. 4. Infection alert. 5. Staff communication. 6. Staff reminders. 7. Time out.	Enhancing safety processes improves quality of care and ensures documented standards and best practice are met. Reducing the potential for error, avoidance of potential risks and inadvertent harm.
Enhancing efficiency of the clinical process 1. Provision of data to improve clinical processes. 2. Electronic lists. 3. Effective staff communication.	Enhancing efficiency of the clinical process helps improve decision making, communication, safety aspects, allows timesaving, and increases user satisfaction.
Enhance communication practices between clinical and portering staff (**Not within the current project**) 1. Porters will have access to their own electronic screen. 2. Porters will be alerted automatically when required.	Time is consumed by clinical staff alerting porters and notifying them of patient location and destination. The tracking system has potential to assist portering staff manage their workload while saving time for both porters and clinical staff.

3. Stop doing things.

Predicted potential benefit	Rationale for benefit/value
Reduction of auxiliary tasks 1. Preparation and word processing of paper lists. 2. Distribution of paper lists 3. Manual updating of changes to individual paper lists 4. Phone calls	1,2,3 Clinical staff (Junior Doctors and Nursing staff) are spending time preparing, distributing and updating paper operating theatre lists. By stopping the necessity for these auxiliary tasks it saves time for staff to spend on direct patient care. 4. Using the tracking system has potential to reduce distracting, time consuming phone calls.

Appendix ten

National Patient Safety Goals: Hospital & World Health Organisation 2008 safety checklist

Goal 1: Improve the accuracy of patient identification. 1A Use at least two patient identifiers when providing care, treatment or services.	
Present Hospital system	Pilot Patient tracking system
The present system meets this goal. Each patient has a unique medical record number (MRN) and chart. Patient identity is verified by name, address, date of birth (DOB) and MRN. Staff check (at each stage in the process) details are correct with patients (and families/carers if patient is unable). Patients are given ID wristbands on admission for procedures with Name, DOB, MRN & Ward.	The tracking system meets this goal. It supports the present patient identification system as the Tag provides an additional patient identifier. The e- lists will show the patient MRN, Name, Procedure and location. e- lists are more accurate drawing patient information directly from the PIMS database. As the system verifies which Theatre the patient is to be brought to, it will flag wrong location should the patient be brought to another location in error.
Goal 2:Improve the effectiveness of communication among caregivers 2A For verbal or telephone orders or for telephonic reporting of critical test results, verify the complete order or test result by having the person receiving the information record and "read-back" the complete order or test result.	
In the present system staff use several effective methods of communication, mainly face to face and telephone communication. All care given is recorded in the patient notes. Patients are sent for by a phone call request. When patients are transferred from day ward to the operating theatres they are accompanied by a Nurse who gives a face to face handover of the patient to the receiving Nurse. Both staff checks the patient ID and patient notes in the presence of patients/patient families/carers.	The tracking system can enhance the effectiveness of staff communication. One of the goals of the system is to reduce phone communication because it can be time consuming and distracting to staff. The system can be accessed on handheld computers at the bedside. There is no need for a phone call to send for the patient. The add comment feature can also help reduce phone communication as any urgent messages regarding patient care can be communicated to all areas simultaneously. Text is clear and unambiguous and can be re-read if necessary. Also the patient location is communicated to all staff.

<table>
<tr><td colspan="2">Goal 7:
Reduce the risk of healthcare-associated infections</td></tr>
<tr><td>The present hospital system records known infectious illness in the patient medical record. There are hospital protocols for infection control detailing policy and procedures to be followed in the event of a patient having a transmissible infection.</td><td>Using the tracking system it is possible for Medical staff to input whether a patient has an infection risk. This is highlighted in red on the electronic list. Details are not displayed but may be accessed by Nursing and Medical staff for the purposes of Infection control.
This function has the potential to enhance awareness and reduce the risks of healthcare associated infections. Statistics can be more easily obtained for audit purposes.</td></tr>
<tr><td colspan="2">2004
Goal 1: Improve the accuracy of patient identification.

1B Prior to the start of any surgical or invasive procedure, conduct a final verification process, such as a "Time out," to confirm the correct patient, procedure and site, using active—not passive—communication techniques.</td></tr>
<tr><td>Currently the patient has safety checks at several stages in the process. These include verification and recording of procedure at clinic, on admission to hospital, and on arrival into the operating theatre/procedure room.
Patient ID and consent are checked off the patient ID wristband, in the patient chart, with the patient and/or family/carers.
When applicable, side checks are carried out, several times, including just before the surgery/procedure.</td><td>The system includes a specific ‘Time out’ check as an additional safety feature within its Operating theatre list.
This function allows staff record a timestamp for Time out checks. It includes a reminder to staff to conduct a final verification of Patient, procedure, and site.
There is a drop down list of staff names which require the selection of *two staff names before clicking the Time Out checks complete button.
*3 staff, (July’08)</td></tr>
<tr><td colspan="2">Goal 4: Eliminate wrong-site wrong-patient wrong-procedure surgery</td></tr>
<tr><td colspan="2">This goal is an extension of Goal 1B above.</td></tr>
</table>

Also mentioned within the document, the World Health Organization (WHO) has released a new safety checklist for surgical teams to use in operating rooms. (June, 2008) See reference below for details.

***Lancet*. Published online June 25, 2008.**

World Health Organization. *Implementation Manual WHO Surgical Safety Checklist (First Edition)*.

Available at: http://www.who.int/patientsafety.

Summary:

"*The 'Safe Surgery Saves Lives' initiative, is a collaboration of more than 200 national and international medical societies and ministries of health led by the Harvard School of Public Health. It aims to reduce avoidable surgical mortality and morbidity.*

The newly developed WHO Surgical Safety Checklist provides a set of surgical safety standards applicable to all countries and health settings.

At 8 pilot sites worldwide, preliminary findings from 1000 patients suggest that using the checklist has nearly doubled the likelihood that patients will receive a higher standard of surgical care, with adherence to these standards improving from 36% to 68%, and to nearly 100% in some hospitals. Better adherence has been linked to significant reductions in surgical morbidity and mortality, although final results are not yet available.

The checklist covers 3 phases of a surgical procedure: before anaesthesia is induced, before skin incision, and before the patient leaves the operating room. For each phase, a checklist coordinator confirms that the team has completed the designated tasks before the next phase of the operation occurs.

Before induction of anaesthesia, key components of the checklist, using the mnemonic "Sign In," are as follows:

- *Check that the patient has confirmed their identity, the surgical site, and the procedure to be done and that the patient has given informed consent.*
- *The surgical site should be marked, if applicable.*
- *The anaesthesia safety check should be completed.*

- *The pulse dosimeter should be placed on the patient and functioning.*
- *Check to see if the patient has (1) A known allergy. If so, these should be documented. (2) An anatomically difficult airway to incubate or aspiration risk. If so, additional equipment and assistance should be available. (3) Risk of more than 500-mL blood loss in adults or 7 mL/kg in children. If so, provision should be made for adequate intravenous access and fluids.*

*Before skin incision, the checklist uses the mnemonic **"Time Out"** for the following components:*

- *Confirm that all team members have introduced themselves both by name and by their role on the surgical team.*
- *The surgeon, anaesthesia professional, and nurse should verbally confirm the patient's identity, surgical site, and procedure to be performed.*
- *Anticipated critical events to be reviewed by the surgeon are any critical or unexpected steps, estimated operative duration, and anticipated blood loss.*
- *Anticipated critical events to be reviewed by the anaesthesia team are whether there are any patient-specific concerns.*
- *Anticipated critical events to be reviewed by the nursing team are confirmation of sterility of the tools, supplies, and field (including indicator results); documentation and discussion of any equipment issues or concerns; whether antibiotic prophylaxis has been given within the last 60 minutes, if applicable; and whether essential imaging is displayed, if applicable.*

Before the patient leaves the operating room, the checklist uses the mnemonic "Sign Out" for the following components:

- *The nurse verbally confirms with the team the name of the procedure to be recorded and verifies instrument, sponge, and needle counts, if applicable; labelling for the surgical specimen, including patient name; and whether there are any equipment problems to be addressed.*

- *The surgeon, anaesthesia professional, and nurse review the key concerns regarding recovery and management of the specific patient.*

The WHO notes that the checklist is not intended to be comprehensive but encourages specific modifications and additions appropriate for each local practice. ”

"Surgical care has been an essential component of health systems worldwide for more than a century," says checklist co-author Atul Gawande, MD, MPH, a surgeon and professor at Harvard Medical School in Boston, Massachusetts. "Although there have been major improvements over the last few decades, the quality and safety of surgical care has been dismayingly variable in every part of the world. The Safe Surgery Saves Lives initiative aims to change this by raising the standards that patients anywhere can expect."

Appendix eleven

Patient survey questions

Sample Patient survey questions

Thank you for participating in the study.

1. Were you well enough informed about the tag?
2. What was the Tag like to wear?
3. Comfort rating scale (1 not comfortable to 5 most comfortable)
4. Have you any comment on this?
5. Were there any other issues about wearing the tag that you would like to comment on?