The impact of digitisation of the FRAIL assessment in the emergency department setting

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This dissertation is submitted to Trinity College Dublin

in partial fulfilment of the requirements for the degree of

Master of Science in Health Informatics

2017

Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own, and has not been submitted as an exercise for a degree at this or any other university. I further declare that this research has been carried out in full compliance with the ethical research requirements of the School of Computer Science and Statistics.

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Abstract

Introduction: The management of frail older patients requires complex multi-disciplinary management with rigorous communication and handover. The ED-FIT Team is a group of allied health professionals reviewing patients aged over 75 years of age attending the study site Emergency Department. The team works collaboratively utilising traditional tools such as a whiteboard and paper to facilitate communication. This research investigates the ability of healthcare information technology to facilitate collaborative working in a complex multi-disciplinary environment.

Objective: This research seeks to design a digital system for the ED-FITT process and to evaluate the impact of this digitisation on the efficiency of the process, the channels of communication utilised by the team and on the completeness and availability of data from completed assessment forms.

Methodology: An iterative design process was undertaken and combined with a mixed methods research methodology to evaluate the system. The impact of the system on efficiency was evaluated by assessing the time, number of steps required to complete the assessment. Communication was assessed by considering the volume of onward referrals generated. Completeness and availability of data was assessed using the QNote tool. All aspects were discussed with participants utilising a semi-structured approach to elicit opinions regarding the impacts of the system.

Results: In terms of efficiency, the new system took slightly longer (20.30 minutes (pre), 23.81 minutes (post)), required fewer steps on average (9.75 (pre), 9.08 (post)) and was met with generally positive feelings from end users. Regarding communication, there was an increase in the referrals made and a consensus that automation of process was beneficial. The new system provided improved availability of data with 100% of forms compared to 67% available and a marginal improvement in quality using the QNote score (69.39 (pre), 73.81 (post)).

Conclusion: The system was successfully deployed and demonstrated modest improvements in terms of efficiency, communication and data quality.

Acknowledgements

It is hard to know who not to thank as I write this acknowledgements as so many people have contributed in many, many ways to this dissertation.

Firstly I would like to thank my colleagues in the FIT team for their input and participation in this process. My gratitude must also be extended to all of the members of the IT department for their help and patience. Thank you also to Fiona Keogan, Helen Heery, Joanne Finn and Mark Graham for all your advice and support throughout.

To all my physiotherapy colleagues, thank you for your support and advice not just in the last year, but in all the years that preceded it, you are all amazing and I wouldn't be where I am without you. To my IT colleagues, sorry for being so annoying, but it's all over now and I'm glad I was on the list.

To Ciara, thank you for making me do it, you were right as always.

To Kareena, two and pair are the same thing, but thanks for trying to suggest otherwise.

To Dr. Lucy Hederman, thank you for all your guidance, encouragement and for always keeping a check on my grammar! This would not have been possible without your insight and drive and your encouragement to see things in a completely different way.

I would like to thank my classmates for all the support, different viewpoints and the friendships that have developed over the last two years, the future of Health Informatics is looking good.

Lastly but most importantly, my deepest gratitude to my family for all their love and support, always.

To Mam, thank you for always being there for me and supporting me in everything I do.

To Karen, thank you for always giving me the advice I need to hear whether it's what I want to hear or not and for always being there when I need you.

A special note of appreciation to Cassie, Barney, Jessica and Penny for always being there when I needed distracting.

And lastly, to Colm, simply, thank you for being you.

Thank you all for helping me to keep it all together over the last year. I couldn't have done this without you.

Abbreviations

AHP	Allied Health Professional	**ED**	Emergency Department
AMAU	Acute Medical Assessment Unit	**FITT**	Frail Intervention Therapy Team
BRAT	Beaumont Rapid Access Team	**HIT**	Healthcare Information Technology
CGA	Comprehensive Geriatric Assessment	**ICT**	Information Communication Technology
COW	Computer on Wheels	**PAS**	Patient Administration System
CSCW	Computer Support Cooperative Working	**PDA**	Personal Digital Assistant
CST	Common Screening Tool	**PDF**	Portable Document Format
D2A	Discharge to Assess	**PIPE**	Patient Information Profile Explorer
DBA	Database Administrator	**SGW**	Specialist Geriatric Ward
DTA	Discharge to Assess	**SQL**	Structured Query Language

Glossary

Acute Floor: Comprised of the Emergency Department and Acute Medical Assessment Unit
AHPs: Physiotherapists, occupational therapists, speech and language therapists, medical social workers or dietitians
Beaumont Rapid Access Team: Team of physiotherapists and occupational therapists assessing patients in ED with a view to facilitating discharge home without the need to have the patient admitted.
CGA: Comprehensive, multidisciplinary assessment of the older adult
FITT: Team of HSCPs treating patients over 75 years of age
HSCPs: Physiotherapists, occupational therapists, speech and language therapists, medical social workers or dietitians
MDT: Team comprised of medical team and multiple HSCPs providing coordinated care to patients
Patient Flow: Hospital department in charge of bed management and allocation of patients to appropriate ward

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Chapter 1. Introduction

This chapter will outline the motive for completing this study. It will provide the reader with an overview of current practice, along with the research question being investigated and the methods used to investigate it.

1.1. Background

This section outlines what is meant by frailty, the impact it has on patients and service provision, how it is assessed and the response of the study site hospital to the phenomenon. We will also discuss the complex nature of care provision to patients with frailty in the context of complex handovers, multi-disciplinary team working and the need for communication across different team members, services and locations.

1.2. Frailty

Ageing is a natural process that results from the accumulation of molecular and cellular damage over the course of a person's lifetime (Kirkwood 2005), representing a state of increased vulnerability caused by a stress event such as an infection, and is a term often used clinically especially in relation to older patients (Clegg *et al.* 2013). It is a complex phenomenon, generally held to be heavily age related (Rockwood and Mitnitski 2007). Frailty has been shown to impact on patients' outcomes with an increased incidence of adverse outcomes and mortality (Fried *et al.* 2001). It has been reported that incidences of frailty are associated with increased disability, dependency, falls and the need for long term care (Fried *et al.* 2004). Those patients who are identified as frail will commonly present with decreased muscle strength and bulk, weight loss, diminished walking speed, fatigue and decreased functional independence (Hoogendijk *et al.* 2015).

There are two main models of frailty which shall be discussed in the subsequent sections.

1.2.1. The Phenotype Model

The Phenotype Model was proposed by Fried et al. (2001) in their study of 5210 individuals aged over 65. The authors were able to identify five components of frailty as echoed by Hoogendijk et al. (2015) above: decreased grip strength, weight loss, diminished walking

speed, fatigue and decreased functional independence. Table 1.1 outlines the criteria defined as part of the phenotype. Fried et al. suggested that patients who present with three or more should be deemed "frail", one or two deemed "pre-frail" and none deemed "not frail".

Frailty Indictor	**Measure**
Weight loss	Self-reported weight loss of more than 10 pounds or recorded weight loss of ≥ 5% / yr
Self-reported exhaustion	Self-reported exhaustion on CES-D depression score (at least 3-4 days per week)
Low energy expenditure	Energy expenditure <383 KCal/week (males) or <270 KCal/week (females)
Slow gait speed	Standardised cut-off times to walk 15 feet, stratified for sex and height
Weak grip strength	Grip strength, stratified by sex and BMI

Table 1.1: Five frailty phenotype indicators ((Fried et al. 2001) adapted by (Clegg et al. 2013))

1.2.2. The Cumulative Deficit Model

The Cumulative Deficit Model is also known as the Frailty Index. It involves identifying the presence or absence ninety-two variables, also known as deficits, and calculating the proportion present compared to the whole (Rockwood and Mitnitski 2007). In basic terms the authors propose that the greater proportion of deficits the more frail the individual is. Further investigation has reduced the number of variables from ninety-two to thirty-six, making the model more user-friendly in the clinical setting (Song *et al.* 2010).

1.2.3. Prevalence

Frailty has been shown to be more prevalent in women than men and increases with age (Song *et al.* 2010). There is a variation in the reported literature regarding the incidence of frailty associated with are. A systematic review of 21 internationally based studies found that those aged between 65 and 69 years have a 4% incidence, those aged 70-74 have a 7% incidence, 75-79 years present with a 9% incidence. The incidence of frailty continues to rise exponentially in those aged over 80, with those aged 80-84 years with a 16% prevalence and those over 85 years of age have the highest incidence with 26% incidence (Collard *et al.* 2012).

The population of Ireland is continuing to expand and the proportion aged over 65 is estimated to continue to rise over the next ten years almost doubling by 2026 as demonstrated by Figure 1.1 below (CSO 2011). With the increase in frailty prevalence associated with age, this increase in population aged over 65 would infer a representative increase in the incidence of frailty within the population by 2026.

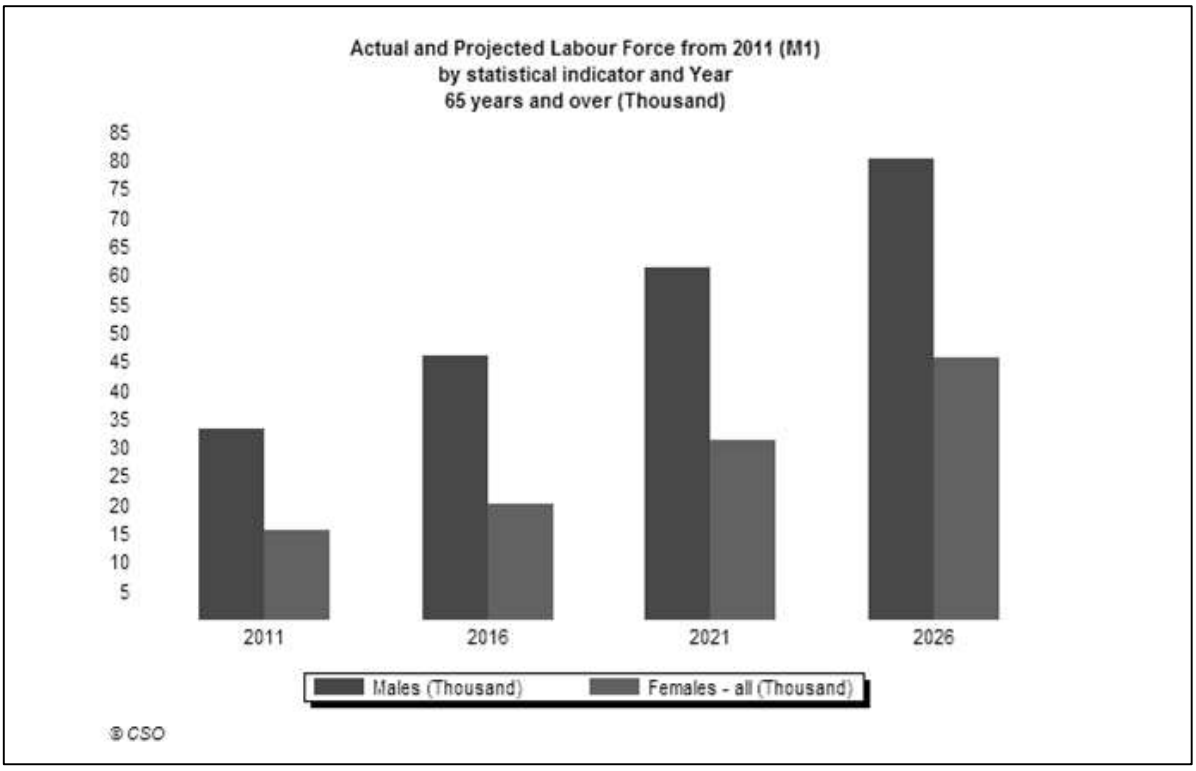

Figure 1.1 Projected growth of over 65 population (CSO 2011)

1.2.4. Management of Frailty

The "gold standard" in the management of frailty is early identification of those at risk and prompt completion of a comprehensive geriatric assessment for patients that need it. Engaging in early targeted comprehensive geriatric assessment (CGA) has also been shown to be linked with a decrease in length of stay and improvements in mortality rates (NHSScotland 2014). Provision of a CGA is dependent on multi-disciplinary engagement and requires excellent communication among the team to allow for the development of a thorough plan of care for the patient and safe handover (Ellis *et al.* 2011). The need for communication across multiple team members as part of the CGA in itself adds a layer of complexity as well as the potential for error.

In the next section we will review how the study site hospital chose to address this issue and explore the motivation for completion of this research.

1.3. The Study Site Hospital

The study site hospital is a large academic teaching hospital located based in North Dublin serving a population of 1,022,184 people. As with the overall trend in the Irish population, the catchment area for the hospital is experiencing an increase in the proportion of those over 65 years of age. In 2011, 24% of the population of over 65s living in Dublin, resided in the catchment area of the study site hospital, a significant increase from the 1997 proportion of 5% (CSO 2011). The proportion of individuals aged over 85 has increased by 20% nationally overall, the study site hospital however has seen an increase of 60%. It is anticipated that there will be a 44% increase in the North Dublin population aged over 65. This ongoing increase in the number of individuals aged over 65 represents an increase in the number of frail elderly who will seek treatment from the study site hospital. This has necessitated a change in the practice of therapists within the organisation and the formation of the Frail Intervention Therapy Team.

1.3.1. Frail Intervention Therapy Team

The Frail Intervention Therapy Team (FITT) is a team of Allied Health Professionals based on the Acute Floor (Emergency Department and Acute Medical Admissions Unit) of the study site hospital.

The team was set up in September 2015 in response to changing service demands and is comprised of a core group of physiotherapists and occupational therapists with access to speech and language therapists, dietetics, pharmacy and social work as required.

The team triages all patients presenting to the ED between 8 and 4 Monday to Friday, that are aged over 75 for frailty using the NHS Scotland “Think Frailty Triage” or FRAIL tool (NHSScotland 2014).

The FRAIL tool is a simple set of “yes/no” questions that identifies frailty in patients and those who may benefit from further dedicated geriatric assessment. Those patients deemed

frail and requiring further assessment are assessed and followed up by the appropriate team members.

1.3.2. FITT Activity

Since the FIT team was created in 2015, the therapists involved have assessed 6,000 patients over 75 who have presented to study site hospital (O'Reilly *et al.* 2016). It has been found by the FIT Team that there was an 11.6% increase in the number of presentations to ED of patients aged 75 or older from Q1 2015 when compared with Q1 2016.

1.4. Purpose of the study

The purpose of this research is to design and evaluate a digital FRAIL assessment process within the Emergency Department (ED) of the study site hospital.

As the study site hospital does not currently have an organisation wide electronic patient record, assessments are paper based. All documentation is completed in accordance with designated HSE standards (HSE 2011). While paper records have been deemed to be "Gold Standard" when it comes to documenting the patient journey (Stausberg *et al.* 2003), they also encourage the "silo-ing" of information with limited ability to transfer pertinent data between professionals and sites to further patient care (eHealthIreland 2015).

This use of paper assessments is of particular concern within the study site hospital ED setting. There is significant duplication of work to ensure handover is completed in a safe and thorough fashion. The use of paper assessments also means that in the event that a patient is re-admitted, the previous assessment form may not be available, resulting in potential delays in access to assessment and further duplication of information being captured. A service profile that was completed in August 2016 identified issues with the availability of completed assessment forms once the patients had left ED. With on-going service developments and engagement with community colleagues, there is an increasing need for information to be transferable seamlessly across sites.

This project will involve the design and development of a digital version of the current ED-FITT workflow and assessment form and an evaluation of the effect of the new

computerised system on the workflow and communication processes, quality and availability of patient information from the ED.

1.5. Research Question

The first component of this research is the design of a digitised process to replace the current paper process in place within the ED-FIT team. The second component investigated as part of this research is to examine:

"What effect does the digitisation of the ED-FITT workflow and assessment form have on the efficiency of the ED-FITT triage process, on the communication process and on the quality and availability of clinical information within the ED?"

1.6. Summary

Frailty is a significant area of concern for healthcare providers generally and for the study site hospital in particular. The structuring of services to meet the demands of service users has required an increase in multi-disciplinary working to meet service needs. The environment inhabited by the FIT team is complex and requires systems to be in place to facilitate and promote communication and sharing of data to aid in the co-ordination of patient care. As part of this research project, the researcher will develop a digitised system to facilitate the assessment process and will investigate how this impacts on clinicians in the provision of care.

The literature surrounding the core domains considered as part of this research, the method of evaluation, system design, results and considerations for future research will be considered in the ensuing chapters.

Chapter 2. Literature Review

This chapter will present and evaluate the current state of the art with regard to the use of computer systems in collaborative working environments and also the quality and completeness of clinical documentation and the potential secondary uses of data contained within clinical documents.

2.1. Introduction

The completion of a thorough literature review is a pre-requisite for completing thorough research, allowing the researcher to fully understand what has gone before and where future research should be directed (Boote and Beile 2005). Creswell (2013) echoes this, suggesting that completing a literature review will identify the need for further research within a topic while providing a benchmark for the results of research currently being undertaken. Cooper (2009) further suggests that a literature review may either assimilate previous opinions, critique existing studies, connect related topics, or categorise the central themes of the area under review.

As outlined in Chapter 1, many areas of concern exist within the multi-disciplinary working environment that the FIT team have created within the ED. Primarily the researcher is interested in the co-ordinated approach to care, methods of facilitating communication and handover and the availability and quality of data. With this in mind, a complete and thorough literature review has been undertaken and will be outlined in the subsequent sections of this chapter.

2.2. Methodology

It has been suggested that a three step approach of firstly searching journals to identify references, followed by reviewing the citations of those articles and finally reviewing the identified articles may be utilised (Webster and Watson 2002). It has also been purported that this process can be expanded into a six step approach commencing with searching in academic databases for relevant articles in ranked journals, taking account of citations

within those articles and combining the results of these searches into the final review (Mathiassen *et al.* 2004).

Noting this, the researcher separated the search into discrete areas; Computer Supported Cooperative Working and Clinical Documentation; and Web of Science, PubMed and ACM Digital Library web based databases were systematically and exhaustively searched. Search criteria was limited to journal articles and conference proceedings published from 2006 – 2016. The references of selected articles were then searched for relevant articles which were subsequently reviewed for suitability and inclusion in this literature review. The following sections will outline the results of these searches and how this information has been used to design and evaluate this study.

2.2.1. Computer Supported Cooperative Working

The keywords searched were “computer supported collaborative working”, “CSCW”, “electr* whiteboard” and “workflow management”. Results were further specified using AND “healthcare”.

2.2.2. Clinical Documentation

The keywords searched were “EHR quality”, “EHR secondary use”, “clinical documentation quality” and “healthcare record”.

2.3. Results

As a result of undertaking the methodology outlined above 75 references were identified in total for inclusion in this review.

Having identified articles using the above keyword searches in the academic databases outlined above, articles were reviewed for suitability based on relevance to the chosen topic and language. Only systematic reviews, or studies of a quantitative, qualitative or mixed methods approach or feedback provided through recognised international conference proceedings were considered eligible to be included. Articles were further excluded if not English language or not peer reviewed. In order that studies utilised were most relevant to

the study site setting, included articles were limited to healthcare settings in countries of similar socio-economic context. Figure 2.1 below demonstrates the process outlined above.

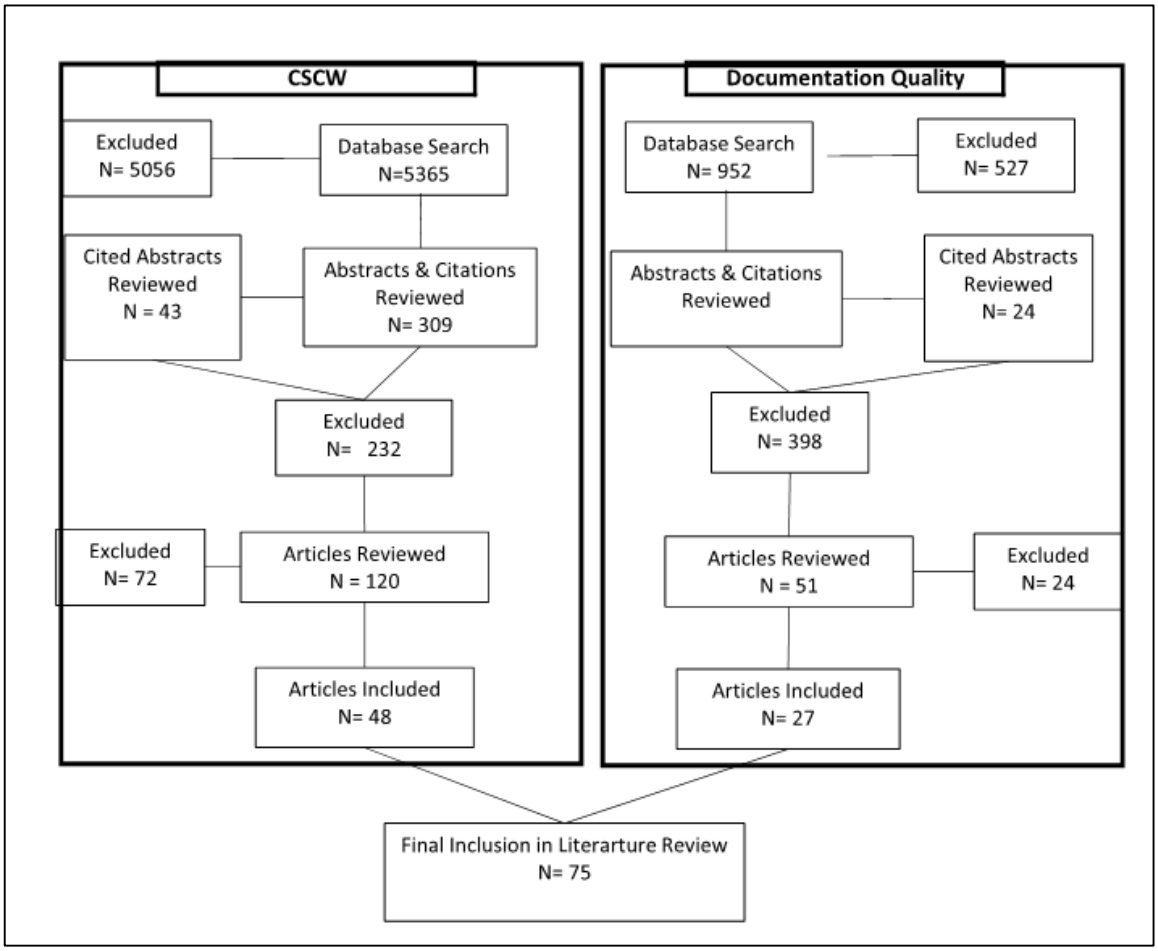

Figure 2.1 Systematic Literature Review Flowchart

The results of this literature review are discussed below.

2.4. Computer Supported Cooperative Working

This section outlines the results of the search concerning computer supported cooperative working and the impact of informatics on workflows and processes within healthcare.

2.4.1. Introduction

The term Computer Supported Cooperative Working or CSCW has been in operation since the late 1980s and refers to the study of groups of individuals and how they and their work processes interact with computer systems (Greif 1988). The ability of computer systems to

support and not impede inter-disciplinary working should be questioned when considering this particular area of informatics (Bannon and Schmidt 1989). The following sections investigate the field of computer supported cooperative working, with special consideration for the issue of affordance, use of artifacts within cooperative working including the use of electronic whiteboards in this field and also how CSCW impacts the process of workflow management.

It has been suggested that healthcare informatics may be used to support the complex dynamic work processes that exist in healthcare (Chiasson *et al.* 2007). In order to develop a system that is truly successful, it is necessary to consider the wider role that such systems play in interpersonal and interdisciplinary communication and the impact that this will have on the usability of a system and the collaborative working environment in which it resides (Reddy *et al.* 2003). One must also consider the affordance of paper tools in a healthcare setting, where they are quick and easy to access, allowing for notes to be quickly documented to be entered into formal systems at a more convenient time and how this translates into practice with computerised systems (Gonzales *et al.* 2015). Gonzales et al., also highlight the need to consider how space constraints within the environment will impact on the ability for the team to utilise the system. These are key aspects to be considered when implementing a computerised system into a collaborative working environment. There is an established need to evaluate systems in healthcare, not in isolation, but, in conjunction with the "human" element (Burkle *et al.* 2001, Winter *et al.* 2001).

In order to evaluate how clinicians use technology in the completion of their day-to-day roles, there is also a need to identify the workflows attached to the day-to-day activities, the communication, the need for handover and the environment in which they work.

2.4.2. Affordance

One aspect to consider is the affordances provided by objects such as the medical charts that are used within the environment and workflow. Houben et al (2015), when investigating the affordances of paper and electronic records in a cooperative working environment, identified 4 potential variants that should be considered; mobility and

portability, co-located access, shared overview and mutual awareness. These are discussed below.

2.4.2.1. Mobility and Portability

One of the most valuable aspects of paper in consideration of the healthcare environment is its ability to be mobile and flexible, to move with clinicians as they complete ward rounds and engage with patients (Harper *et al.* 1997). This is echoed by ∅sterlund (2008) who suggests that not only are paper records portable but also allow for indexed and chronological working across multiple members of the team. This would suggest that any electronic system introduced into this environment needs to allow for information to be portable and shared across team members. There is potential for this to be met by the use of "Computers on Wheels" (COWs), personal digital assistants (PDA) or tablets (Houben *et al.* 2015). There is, however, a need to differentiate the information visible on different displays with electronic whiteboards containing a broad overview but sit-down computer screens being used for more in-depth data (Gjære and Lillebo 2014).

2.4.2.2. Co-located Affordance

Medical records are generally kept within an area that is accessible to all of the team who need to access them. There is a general understanding of all team members of the role played by different communication artifacts such as paper notes and the record itself (Houben *et al.* 2015). To optimise efficiency, the environment is usually tailored to minimise the amount that staff need to manoeuvre themselves and the data they need, including the use of trolleys during ward rounds (Bardram and Bossen 2005b). As opined by Houben et al., there is scope for mobile technology devices to provide this affordance as information is always available at the site that it is needed.

2.4.2.3. Shared Overview

In order for clinicians to be able to manage care within the complex healthcare environment, there is a need to ensure that they have a complete understanding of the entirety of the information available. With this in mind, clinicians may orientate the available data to give themselves the best overview they can (Houben *et al.* 2015). It is also important to consider

the number of clinicians involved in the management of a single patient and that the information available needs to be shareable and promote the ability for clinicians to engage in conversations and tasks such as the developing of care plans (Bossen and Jensen 2014).

2.4.2.4. Mutual Awareness

As clinicians work within a team and become used to an environment, their awareness of where information is available is also an important part of affordance (Houben *et al.* 2015). Another component of mutual awareness is the availability of "signifiers", although it has been argued that signifiers in the design of systems may be more useful than the concept of "affordance" itself (Norman 2008). This could extend to colours on a whiteboard which are understood by all users. Norman however suggests that signifiers may provide a richer understanding of a system by allowing users to infer their own meaning.

Affordance is an important concept and any system design must consider it, especially when replacing such a familiar system as paper with an electronic system. The following section will discuss the instruments used as part of the collaborative working environment.

2.4.3. Collaborative Artifacts

As outlined above, it is not possible to consider affordance within the healthcare environment without considering the tools that are used to gather and share information.

There are a wide variety of tools employed within the complex healthcare setting to foster a collaborative working environment. The use of visual work schedules, for example, facilitates an awareness of where co-workers are based and what duties they are due to perform, "post-it" notes can be used to document tasks to be completed in order to facilitate handover and whiteboards afford the opportunity for a shared awareness of the plan for patients on the ward among all staff involved in the duty of caring (Bardram and Bossen 2005a).

With the increasing amount of collaborative artifacts within the healthcare environment, Bardram and Bossen (2005a) also suggest that there is a certain amount of redundancy within the artifacts utilised in a healthcare environment with frequent repetition of data across multiple media. This is echoed by Cabtiza et al. (2005), who report significant

duplication of data. They also argue that while the role of this duplication may be contentious, on one side serving a purpose by enhancing the robustness of data being captured. On the other it may lead to asynchronous versions of data being captured. Given the proliferation of artifacts within the healthcare environment, the potential for duplication is noteworthy, however the fact that this duplication may be of benefit in planning for patient care must also be contemplated.

As computers and technological devices have developed they have in some senses become invisible, being designed to be smaller or built in the surrounding environments. This development stops them from being simply articles that are used by actors but allows them to become facilitators of communication and co-operation and to change everyday objects such as a table or a wall into artifacts to facilitate cooperative working (Streitz *et al.* 2007).

While the availability of tools for recording and sharing data and fostering communication is changing with new design, there is potential for clinicians to use new mobile technology to allow them to engage in clinical workflows and share information in a personalised manner. With careful design, it is possible for users to decide how they wish to view information either as a stand-alone view or as a part of a multiple view record (Park *et al.* 2008). This allows for improved fluidity for the clinician, being able to actively decide with which parts of the clinical journey they need to interact and how they chose to do so. This view is endorsed by Pennathur et al., (2011) who suggest that bigger screens may improve the experience of users with a need for significant volumes of clinical information while this may not be as important for clerical staff who are less dependent on large volumes of data.

In order to facilitate a shared view of the relevant patient data that will enable group working and by making that information publically visible the use of collective whiteboards may be of benefit (Hertzum and Simonsen 2015). This will be explored in the next section.

2.4.3.1. The Use of Whiteboards in Healthcare

This section will review the use of whiteboards in healthcare to facilitate the process of cooperative working in the healthcare environment.

2.4.3.1.1. Whiteboards as a form of Collaborative Planning Tool

Whiteboards have traditionally acted as a type of transient artifact, allowing for practical information to be documented, facilitating the collective workflow (Chen 2010). They facilitate the coordination of previously asynchronous and widely distributed information (France *et al.* 2005) and dependent on their position within the working environment, have the potential to facilitate ad-hoc meetings among team members (Scupelli *et al.* 2010). The use of whiteboards also allows for team members to be kept up-to-date "at a glance" (Wong *et al.* 2009).

Having reviewed the use of whiteboards and specific icons in the ED setting, Torkilsheyggi and Hertzum (2015) reported on the implications which should be considered when implementing whiteboards into clinical settings. They suggest that the use of whiteboards, while allowing for sharing of information in the setting of a collaborative workplace, is best aimed for sharing information which is not critical or time sensitive. They further report that by allowing for information to be shared across all members of the team, there is also potential to prevent errors of oversight, however, it is important to remember that the inclusion of items on the whiteboard is not a guarantee of them having been reviewed by the relevant individuals.

With the affordances of whiteboards in the arena of cooperative working, the potential for using an electronic whiteboard in this environment should be considered and this is discussed in the following section.

2.4.3.1.2. Electronic Whiteboards

The sentiment that an understanding of how systems fit within the wider cooperative working environment is echoed by Hertzum and Simonsen (2015) who found that there is a combination of visual data recorded by an electronic whiteboard and the oral communication needed for true coordination of care. They purport that electronic whiteboards serve as instrumental co-ordinators allowing for pertinent details to be available "on-demand".

The ability of electronic whiteboards to support communication within the ED environment is well noted within the available literature. Aronsky et al. (2008) suggest that the ability of an electronic whiteboard to connect with other existing systems, such as an EPR, allow for pertinent data to be accessed promptly when needed. The impact of electronic whiteboards on communication in the healthcare setting is echoed by France et al. (2005) who suggest that the ease with which information can be accessed and its visibility reduced the need for team members to interrupt each other to find information and thus reduced the cognitive load on clinicians.

Despite the findings described above, it has conversely been proposed by some studies that electronic whiteboards may negatively impact on clinical practices. The ability to quickly update information on traditional whiteboards and the ease of recording comments may be lost as data is automatically recorded within electronic systems meaning refinement or update becomes more difficult (Pennathur *et al.* 2007).

Despite the more negative impacts outlined above, one of the prospective benefits of electronic whiteboards is the potential for information to be accessed by multiple users in multiple locations. In order to maximise efficiency there is a need, however, to ensure that the process of using the whiteboard is as streamlined as possible (Rasmussen and Kushniruk 2013).

It is surmised from the researcher's review of the current literature that there is potential for the use of electronic whiteboards to facilitate communication especially during the handover of patients. It has been suggested that this is a particularly complex process and involves much duplication with documentation, phone-calls and face-to-face communication occurring throughout (Benham-Hutchins and Effken 2010).

Hertzum and Simonsen (2013) found that implementing an electronic whiteboard in an ED was associated with an increase in the time spent directly with patients by nursing staff. Although this was not evident for physicians, there was a general consensus among participants that the electronic whiteboards gave an improved overview of patients especially during busy periods.

2.4.3.1.3. Summary

The complexity of both the interpersonal relationships of collaborative clinical teams and the environments in which they operate necessitate the use of systems that facilitate communication and sharing of information. When designing systems to work in this environment, it is necessary to consider the affordances offered by various artifacts and implement those most appropriate. There is potential for the use of whiteboards, electronic in particular, to benefit the communication and coordination of clinical teams in the planning of patient care.

Implementing any artifact into such a complex environment requires consideration of the workflows that pre-exist. The impact of implementing IT systems on workflows as described in the literature is discussed in the next section.

2.4.3.2. Workflow Management

This section identifies the impact of IT on the workflow processes with special consideration for its impact on the management of workflows in healthcare.

2.4.3.2.1. Introduction

It is necessary when considering workflows to appreciate that while they are often considered in isolation, i.e.: that of a single individual, workflow analysis in a clinical setting requires consideration of how individual clinician workflows interact and the attention given to the patient as part of the greater whole (Ozkaynak *et al.* 2013).

It has been proposed that there are multiple methods of implementing an IT system into a collaborative working environment. First one may change the system to match the current work practices, conversely one may implement a system which requires a complete reworking of current workflows but the most successful method may be to create a system that facilitates some aspects of the current workflow while causing a change in others (Pratt *et al.* 2004).

Pratt et al., (2004) further elaborate on the complexities of workflow planning in an environment where exceptions to pre-determined flows need to the expected and suggest

that while this is an area to which humans can adapt, it is more difficult for systems to do so and that the field of CSCW may provide the best methods to assess the implications of this.

In the following sections we will investigate the role of IT systems on workflow management.

2.4.3.2.2. Workflow Management

There is a general assumption that the implementation of IT systems will impact on the workflows existent within the environment into which they are implemented. This sentiment is presented by Vishwanath et al., (2010). In investigating the perceived impact of an EHR on workflows, the authors report that users anticipated that the implementation on the EHR would have the biggest effects on administration, documentation efficiency and efficiency in patient processing.

There is some concern, however, that the implementation of electronic systems can interrupt the "flow" in the clinical environment. Concerns have been expressed that IT systems may "destabilise" the ability of clinicians to utilise their skills to clinically reason and construct a true representation of the "patient's story" (Varpio *et al.* 2015). The authors found that, clinicians, when utilising an EHR, complained of data fragmentation making the process of consolidation of clinical information more difficult. It is necessary to consider the impact of this when considering how IT systems impact on complex clinical situations and the collaborative working needed to navigate it.

Another perceived drawback of the implementation of electronic systems is the time taken to log into multiple systems and the impact that this has on the clinical workflow (Unertl *et al.* 2012). In their study evaluating the impact of health information exchange technology across multiple emergency departments and ambulatory clinics, it was found that role specific workflows presented themselves across multiple organisations. Nurses were found to access the system to gather information about previous patient hospital contacts early in their contact with the patient, while doctors accessed a broader variety of information and used this information to direct clinical decisions. This would suggest that there is potential for the same system to impact differently on clinical workflow depending on the clinician involved.

The implementation of an electronic whiteboard was found to directly impact on the workflow practices of a Danish hospital. The study found that there was a perceived improvement in the ability to prepare for the arrival of new patients possibly due to the fact that unlike traditional whiteboards which can only be accessed in one location, the electronic whiteboard was available on multiple computers, affording access to information without the need to change location. There was also a corresponding increase in the amount of direct patient care by nursing staff (Hertzum and Simonsen 2013).

Similar results were found when the impact of implementing electronic patient journey boards on flows surrounding a patient journey was investigated. Here the researchers found that the use of electronic tools to facilitate communication resulted in a decrease in length of stay and, as a result of improved communication, a time saving of 20 minutes for each staff member per shift and 2.5 hours saving for ward managers (Clark *et al.* 2014).

There is also a need to identify the impact that a new IT system will have on the workflow in regards of the consequences of its use. These may be intended, such as a streamlining of the workflow or conversely they may be unintended such as adhering “post-it” notes to the screen of an IT system (Coiera 2014).

A method suggested to investigate such unintended consequences is Interactive Sociotechnical Analysis (ISTA) (Harrison *et al.* 2007). The authors of this method describe 5 different potential types of unintended consequences that can be associated with healthcare information technology. These are outlined in the Table 2.1 below.

Table 2.1 Unintended Consequences by ISTA Type (Harrison et al. 2007)

ISTA Type	Unintended Consequences
New HIT changes social system	• More / New work for clinicians • Impaired or disrupted communication practices • Changes to workflow
Technical & Physical Infrastructures	• Paper persistence
Social Systems mediate HIT use	• New error Types • Cognitive overload due to overemphasis of structure • Paper persistence • Misrepresentation of workflow resulting in inflexibility and workarounds • Misrepresentation of communication resulting in a loss of communication and feedback • System unsuitable for use in highly interruptive environment
HIT-in-use changes social system	• Changes in power structure • Over-reliance on technology • Changes in communication
HIT-social system interactions engender HIT redesign	• Never-ending system demands

As can be seen in Table 2.1, there are an abundance of ways in which the implementation of healthcare information technologies can impact on clinical workflows from altering the way in which communication occurs to the ongoing use of paper as a transient artifacts within the healthcare environment (Harrison *et al.* 2007).

2.4.3.2.3. Summary

There is potential for the implementation of healthcare information technology to impact on the existent workflows within the clinical environment. Quite often this may improve or streamline these workflows but there may be unintended consequences which also need to be identified and considered. The ability of IT to influence workflow management plays an important part when considering the collaborative working environment that is multidisciplinary healthcare.

The following section will review the information presented as part of this chapter.

2.4.4. Summary

The healthcare environment is complex with a large variety of actors and a large volume of ways in which data becomes available and is utilised within these environments. IT systems must facilitate the collaborative working of multi-disciplinary teams and there is suggested potential for electronic whiteboards in part to do this. Reasonable consideration of the potential for IT systems to impact on the workflows that exist in clinical settings must be made in order to ensure that processes become streamlined as a result of their implementation.

Following from this, the next section of this literature review will consider the role of clinical documentation within the healthcare setting and the impact of digitisation on its completeness and consideration of the potential secondary uses of data captured.

2.5. Clinical Documentation

This section will outline the current state of the art with regards to assessing the quality of medical records and documentation when using newer information technologies in comparison with more traditional paper methods. We will also investigate the potential uses for information kept as part of the medical record and how this information is accessed.

2.5.1. Introduction

Medical records provide a detailed narrative of a patient's journey as well as documenting evidence for clinical decisions, facilitating communication within the MDT and supporting clinical workflow. They should be contemporaneous and meet nationally set standards requiring that notes should be made in black ink, be free from abbreviations and with the clinician clearly identifiable (HSE 2011).

Paper records have been deemed the "Gold Standard" of record keeping (Stausberg *et al.* 2003). Some of the benefits that have been suggested of paper records is that they allow for individual preference, are flexible and familiar (Fitzpatrick 2000). However, despite these advantages, paper records are not perfect. They are generally maintained as large, poorly indexed tomes (Donnelly 1988), that act to "silo" information and segregate patient care

(eHealthIreland 2015). EHealth Ireland has suggested that the implementation of electronic records can be seen as a solution to some of the difficulties associated with paper records, allowing for improved access to patient information across all healthcare settings and also expediting the patient journey through the healthcare system (2015). It is possible to maintain electronic records as structured, unstructured, semi-structured or a combination of these to fit to the needs of the clinicians using them (Batra and Sachdeva 2016).

In order to assess whether the implementation of electronic notes is an improvement on the paper system, it is necessary to consider the quality of the notes being completed. It is also pertinent to review the ability of the notes to be used for secondary purposes. The subsequent sections will review the literature on the quality and completeness of medical documentation and also the potential uses of clinical documentation data.

2.5.2. Documentation Quality

Much research has been completed regarding the quality of the information captured by the use of electronic records.

Quality in healthcare can be said to be comprised of high standards, minimal patient risk, management of resources, patient satisfaction and uninterrupted passage of the patient through the system (Olsen 2013). The use of healthcare documentation facilitates this concept of quality, the components of documentation "quality" being further derived from the AORN "Guideline for Patient Information Management" to include facilitation of data capture while enhancing workflow, secure, compliant with local and national policies, standardised and have the potential to be used for research activities. (Fencl 2016).

One of the key uses of clinical documentation is to facilitate communication between clinicians at the transition of patient care. Poor quality documentation can in such instances impact on patient safety such as the incorrect procedure being documented or a consent form being inaccurately completed. It has been opined that such out-of –date, insufficient or illegible data may be caused due to time constraints and may in turn cause failures in communication (Braaf *et al.* 2015).

One component of quality which should be considered in regard to reviews of clinical documentation is completeness. This has different meanings depending on the intended use of the data. It may purely be regarding the account of a clinical encounter, may be that the required data is available for the purpose of research, that there is a sufficient volume of data available or that the data can be used to predict an outcome (Weiskopf *et al.* 2013). The ability to assess the completeness of a record is pertinent in the development of an electronic system and methods of measuring this must be considered.

A study completed by Edwards et al. (2014) investigating the quality of physician notes using an EHR, utilising a subjective scale for assessing quality, found that the quality of notes was dependent on the speciality of the physician involved. The authors found that primary care practitioners were more likely to use structured notes with some free text, while cardiologists and endocrinologists used more free text. The authors also found that aspects of the patient's care that was of particular relevance to the speciality was more likely to be included by them, for example; endocrinologists were more likely to include details of eye exams in diabetic patients than other disciplines. There were significant gaps found within the notes examined with a final diagnosis for a newly found symptom documented fully in less than half of notes reviewed (49.2%). The authors also found that there was little correlation with subjective assessment of the quality of note-taking with the objective detail included within the EHR itself. This would suggest that there is a need for a more objective assessment of the quality of notes held within the EHR.

A tool devised by Burke et al. (2014) purports to allow for such an objective assessment. "QNote" is a tool that has been derived by 61 clinicians and encompasses an assessment of 12 components deemed necessary for quality health records. These domains are set out in Figure 2.2 below.

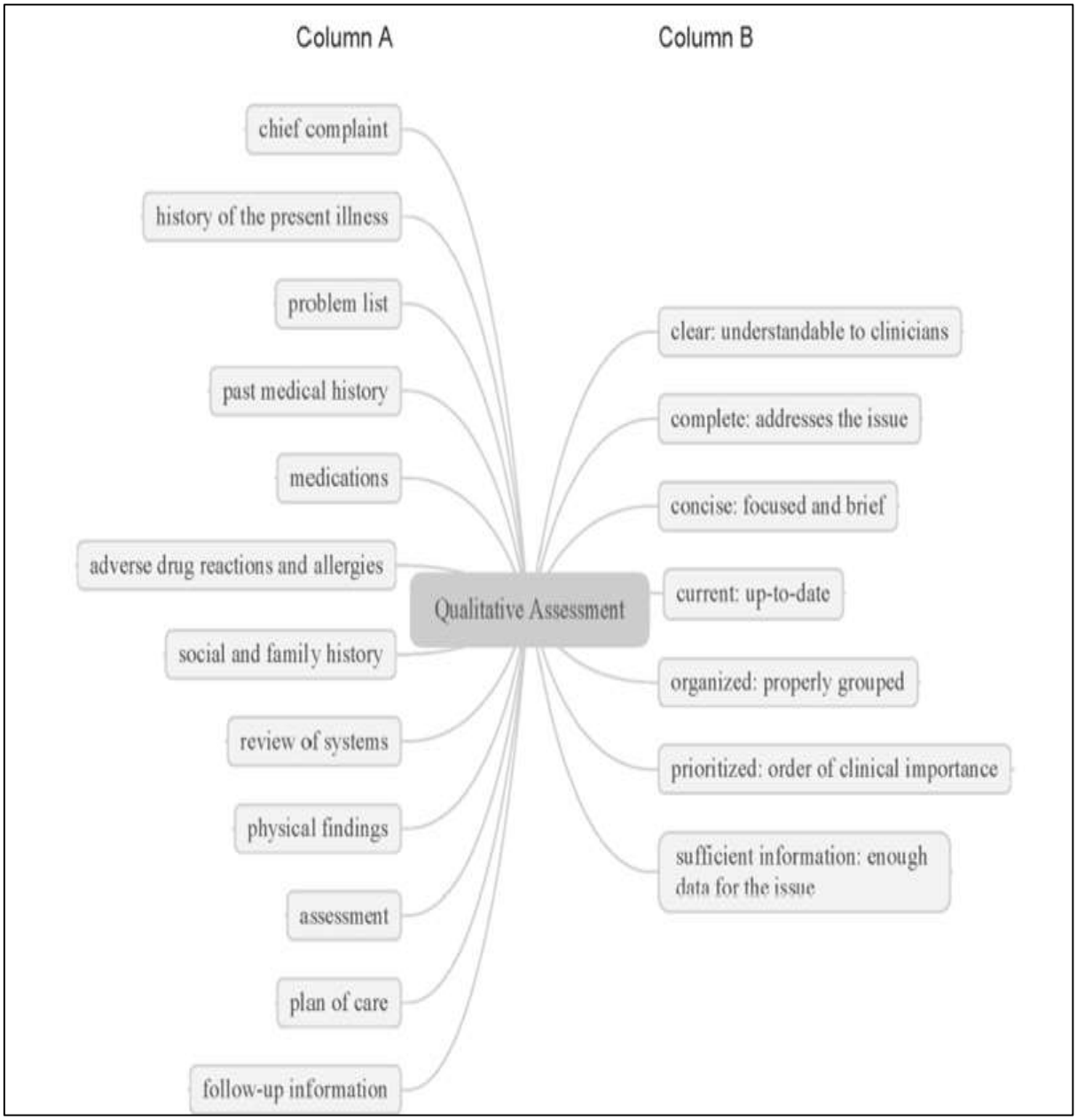

Figure 2.2 QNote domains and components of assessment (Burke et al. 2014)

The tool was found to have high inter-rater reliability and was equally valid when used on paper and electronic notes allowing for assessment not only of the completeness but also the accuracy, clarity and organisation of the data.

Once the validity of the "QNote" tool was established, it was possible to use it to assess the quality of electronic notes when compared to paper records. It has been found that there is a statistically significant improvement in the quality of records, as found by the "QNote"

tool, from assessment pre-implementation of an EHR and that completed 5 years post implementation (Burke *et al.* 2015).

The improved quality of electronic note-taking when compared with paper records was echoed by Jamieson et al. (2016). The authors investigated the quality of admission notes using structured paper documentation and compared this with electronic admission notes. The authors found that the use of electronic notes improved the quality not just of the structured components but also the free text segments. Moreover, a review of systematic reviews previously completed found that the use of handheld devices for the completion of such records resulted in improved efficiency, more complete data being recorded and a decrease in errors of documentation (Mickan *et al.* 2013).

However, the use of electronic notes is not infallible in relation to ensuring that medical records are of the best quality. While the use of structured sections may be deemed a benefit of an EHR in general, it can make it difficult to ensure that complex information regarding the complex patient is accurately documented. Also the use of tick boxes, while improving ease of use for clinicians, may lead to a lack of clinical detail being captured (Burke *et al.* 2015).

In summary, the use of a tool such as "QNote" may allow the quality of the medical records to be ascertained, while also allowing for areas of concern or "gaps" to be identified. This would suggest that "QNote" may be of use in this study of the effect of implementing a digitised assessment process in lieu of a pre-existing paper format. Not only is the quality of records of concern, but also the ability to utilise data that is recorded as part of the chart for secondary purposes needs to be considered. The current literature with regards to secondary use of medical records data is explored in the next section.

2.5.3. Secondary Use of Clinical Data

It has been suggested that the use of medical records may be beneficial in terms of developing clinical decision support systems, allowing for planning of resource allocation, billing and assessment of adherence to clinical guidelines (Vuokko *et al.* 2015). Vuokko et al (2015) reported this having systematically reviewed 85 articles regarding secondary use of

medical records, and also purport that this is most easily achieved through the use of structured records, with the records themselves being more consistent and complete. This would suggest that in order to be truly useful a structured EHR may be better than one which allows greater amounts of free text entry. It is necessary to weigh this against the preferences of clinicians when creating electronic assessments and records.

There is also reference in the literature to the use of data contained within an EHR for further research purposes. It may be possible to structure EHRs in such a way that pertinent clinical "common data elements" while comprising an integral part of the record itself is easily identifiable and accessible by researchers (Bruland *et al.* 2016). As with the findings of Vuokko et al., above this would suggest that there is significant benefit in structuring EHRs in such a way that information is complete and available. As outlined above this may hinder the clinician preference for free text, however, by utilising standardised terminologies such as SNOMED and standardised interoperability protocols such as HL7, there is also potential for the more unstructured elements of clinical EHRs to be communicated in a more structured format to facilitate clinical research and organisational business needs (Rea *et al.* 2012).

As discussed above, there is a need for records to be of good quality in order for them to be useful with regards to enabling secondary use. One must consider more than just the detail of the clinical visit but also the likely secondary uses of data collected during the development to ensure that all of the data is captured with the necessary frequency to allow for research needs to be met (Weiskopf *et al.* 2013).

While the potential benefits of EHRs have been discussed, the components of the record which allow it to comply with the concept of "Meaningful Use" must also be considered. The record should allow for information to be easily transferred between services and locations, provide for summary care record development and for patient and disease specific lists to be compiled (Blumenthal and Tavenner 2010). Considering these aspects allows for the development of a system that is truly useful, and becomes more than a repository of patient interaction, allowing for the information being captured to be utilised to improve the

patient journey and streamline the complex processes that underpin the patient-clinician interaction.

2.5.4. Summary

There is a requirement for all clinical encounters to be documented. In developing systems to replace the "gold standard" of paper, it is necessary to be sure that all necessary data can and is captured accurately. By not only considering the quality of the information being included as part of the record, but also the structure of the record, type of data being recorded and potential secondary uses for this data, allows for a complete system of record keeping, with benefits that extend beyond complying with the legislative needs to maintain a record of true usefulness, with the ability to feed data back into the wider hospital organisation.

2.6. Conclusion

The intention of the researcher in completing this literature review chapter was to consider the available literature in relation to how computerised systems impact on collaborative working environments and what is meant by quality of clinical documentation and how that might be assessed.

From the literature reviewed, it would appear that although paper records offer many of the affordances needed within the complex healthcare setting, there is potential for digitised systems to act similarly as collaborative artifacts. For example, electronic whiteboards have been shown to allow quick and up-to-date access to information and consequently streamlining workflows and increasing direct "time-to-care". It is necessary to consider not just the system being implemented but also the environment into which it will be implemented in order to provide clinicians with a system that is an improvement of existing paper dominant systems.

Another area that must be considered is the quality of data being collected. When implementing a system we need the information collected to be accurate and complete and in the case of healthcare should facilitate communication and allow for secondary use such as research.

Once the quality, completeness and use of clinical documentation is considered, one must also consider the system itself and how it should be evaluated. This will be considered in the upcoming chapter addressing the methodology utilised during this research.

Chapter 3. Methodology

Having considered the fundamentals of computer supported collaborative work and clinical documentation raised as part of the literature review and the need to evaluate the user experience in regard to system design, a research project has been undertaken to identify the impact of replacing a paper based process with a digital version within a busy collaborative healthcare environment. Chapter 4 that follows, will discuss the design process that the researcher undertook in developing this digitised process for use by the ED-FIT team. The current chapter seeks to outline the research methods undertaken largely as part of the evaluation of this system within the ED-FIT team working environment.

3.1. Introduction

In Chapter 4, the researcher will discuss in detail the design process executed with regards to developing the new digitised assessment process. Prior to this, the researcher will discuss the methods used to evaluate the deployed system with consideration given to workflow management as part of collaborative working, clinical documentation quality and user evaluation. The rationale for the methods chosen, participants and collection and analysis of data collected will be discussed in subsequent sections.

3.2. Research Question

This research focussed on designing a digitised assessment process for the ED-FITT service and in doing so sought to answer the following research question as a result of its deployment:

"What effect does the digitisation of the ED-FITT workflow and assessment form have on the efficiency of the ED-FITT triage process, on the communication process and on the quality and availability of clinical information within the ED?"

In order to address this question the research first sought to design an electronic system to replace the current paper based system used by the ED-FIT team and then aimed to evaluate the impact of the implementation of this digitised process into the various aspects of the ED-FITT assessment workflow.

Discussions were held with users to define system requirements, to be considered during the design arm of this research. From this it was determined that the system was required to:

- Streamline the process for the therapists on the ground
- Facilitate communication of assessment once patient has left ED setting to:
    - Appropriate ward therapists if patient is admitted
    - "Discharge to Assess" / Outreach team if patient is discharged to their care
    - Community services (HSE) if patient discharged with referral to same
- Ensure awareness of the patient journey through the triage process
- Ensure that completed forms are available to ED staff without the need to pull medical chart should the patient re-present or if there is need for the information to be accessed
- Ensure completeness of assessment form.

The process then undertaken to design the system surrounding these requirements is discussed in Chapter 4.

The impacts measured by the researcher while endeavouring to answer the research question posed will be discussed later in this chapter. First, the researcher will describe the various methods which may be employed in such an evaluation.

3.3. Research Methods

This section will review research methods that have been discussed within the literature. The researcher will evaluate qualitative, quantitative and mixed methods methodology.

3.3.1. Qualitative Research Methodology

Qualitative research is often considered interpretive research and involves immersion of the researcher within a "natural setting" to develop a holistic understanding of the issue under observation while collecting multiple sources of data (Creswell 2013). There are a variety of qualitative methods which may be employed when considering the design of a study such as case studies, focus groups, interviews or participant observation. However, in order to

implement a truly holistic approach, it is necessary to combine these methods when considering the design of the research (Kumar 2011). Due to the high level of interpretation that occurs as part of qualitative research, it has been suggested that it can be difficult to replicate findings between studies as results will vary from study to study and researcher to researcher (Barnham 2015). Despite this, qualitative research should allow for critical and balanced assessment of the subject being investigated (Almalki 2016). The value of using qualitative methods in evaluating computer systems is outlined below.

3.3.1.1. Qualitative Methods in System Evaluation

As discussed earlier, the healthcare environment is a complex environment requiring clinicians and technology to work collaboratively to provide the best service to the patient. This section outlines qualitative methods employed in evaluating systems.

In considering the evaluation of a system, one of the first complexities that arises is not just considering the equipment and software but also the human interaction and the environment in which it co-exists (Ammenwerth et al. 2003). There is also a need to be cautious of how the system is presented to users at first as there is a risk of influencing their opinions of the system itself (Vishwanath et al. 2010).

It has been suggested that qualitative methods lend themselves very well to the process of system evaluation (Kaplan and Maxwell 2005). Kaplan and Maxwell advocate using qualitative methods to evaluate the system to allow the researcher to understand how users perceive and evaluate the system, including what it means to them. It also provides for an understanding of the influence exerted by the organisation, the casual processes undertaken and obtaining user perceptions of a system in development (2005).

Qualitative methods also allow for investigation of the unintended consequences of implementing a system into a healthcare environment. The instances of unintended consequences have been divided into different categories through a means of interactive sociotechnical assessment (Harrison et al. 2007). Here the authors suggest that unintended consequences may arise from HIT changing the environment into which it is deployed, the impact of the physical environment on the system, social interactions with the system and

how the system affects those interactions and finally how interaction with the system can ultimately lead to redesign of the system itself.

3.3.1.2. Evaluation Methods

When considering how to evaluate the impact of a system, it is first necessary to consider what change one is attempting to measure and also how the organisation perceives this change (Anderson et al. 1994). Kushniruk suggests that methods such as questionnaires, observation and interviews may be used when attempting to evaluate the impact of a newly deployed system into an environment (2002). Subsequent sections will outline the qualitative methods chosen to evaluate this process.

3.3.1.3. User View Elicitation

When studying user views of newly implemented health informatics systems, Lærum and Faxvaag (2004) suggested utilising a questionnaire that evaluates not only user opinion but also user exposure to computers and seeks feedback regarding how the implementation of an EMR has impacted on clinical workflow. When considering user satisfaction, the authors question content, accuracy, format, ease of use and timeliness of information. They also ask whether the EMR has added value and improved the quality of work carried out. The use of a likert scale in this instance, allows for a more quantitative interpretation of user views and although the topics considered provide useful insight, the opinion that face-to-face interviews may be more beneficial is demonstrated in much of the literature (Gerrish and Lacey 2010).

While qualitative methods allow for the researcher to develop a broad understanding of the subject under investigation, they are not the only methods available. Another methodology, quantitative research is discussed below.

3.3.2. Quantitative Research Methodology

Unlike qualitative research, quantitative research pertains to what could be considered an analytical approach to empirical evidence (Kumar 2011). Quantitative methods allow the researcher to utilise samples to generalise to the wider population, to test the impact of an intervention or test a hypotheses using the relationships between variables which are

defined by the experimental design (Creswell 2013). There is a need to consider the validity and reliability of the method used and the data collected (Barnham 2015). Investigations completed as part of quantitative studies will concentrate on the number of contacts within the study population, a defined time period or the nature of the investigation itself (Kumar 2011).

While both methods discussed above can allow the researcher to perform an investigation into a subject with rigour, when blended together, the method can be a stronger tool for assessment. This "mixed methods" approach is discussed in the next section.

3.3.3. Mixed Methods Methodology

By implementing a mixed methods approach, the researcher can blend qualitative and quantitative methods to obtain a better understanding and a stronger assessment of the subject being investigated (Creswell 2013). While a relatively new form of research method, its characteristics are well described and the methodology itself involves the use of both open and closed ended questions, requires rigour and allows for the merging of both forms of data (Johnson et al. 2007). By utilising both quantitative and qualitative methods, the limitations of both methods are somewhat mitigated and can allow for a more comprehensive understanding to be drawn from both forms of data that are generated (Creswell 2013).

Creswell (2013) suggests that when undertaking a mixed method approach, there are several different variations that can be utilised. There is the potential to complete a convergent parallel approach where an attempt is made to relate the results of qualitative and quantitative investigations of the topic that are undertaken in parallel. In certain instances the researcher may choose to employ an exploratory sequential technique where data extrapolated from either qualitative or quantitative methods initially, subsequently informs the design of the alternative method of data collection.

For this study, a convergent parallel mixed methods approach was deemed the most robust investigation technique and therefore the most appropriate method to investigate the impact of the digitisation of the ED-FITT triage assessment.

3.4. Impacts Measured

In order to address the aspects raised by the research question and those elicited from discussion with end users, the researcher has chosen to evaluate the effect of the newly digital system on the efficiency of the process, the handover and communication process undertaken by the ED-FIT Team and the quality and availability of clinical data. From review of the literature, attention was also paid to the occurrence of unintended consequences following the deployment of this system.

3.4.1. Efficiency

In a bid to measure the effect on efficiency, the researcher has chosen to evaluate the time taken, number of steps required and quantity of assessments completed. The interviews and observations completed also provide insight into the impact of the system on efficiency.

3.4.1.1. Time

Due to the busy nature of the environment under investigation, the time taken to complete an assessment has been determined by the researcher to be an important variable in understanding the impact of digitising the ED-FITT assessment process. This is echoed by Hertzum and Simonsen (2013) who investigated the changes in time available to care as a result of implementing an electronic whiteboard into the ED.

Measurement of time taken to complete current triage and assessment forms by observation of process by the researcher and comparison of this with that taken using digital form was undertaken. It was assumed that the commencement of the process is when the ED-FIT team becomes aware of the patient and the patient's name is included on the whiteboard or SharePoint list. The process was deemed to be completed when the assessment has been completed or the patient has left the ED. Only time when the therapists are directly engaged in the assessment process has been deemed eligible to be measured and delays caused by external process such as bed management or home care package approval was not calculated.

3.4.1.2. Number of steps required to complete assessment

The researcher chose to record the number of discrete steps required to complete the assessment process for the ED-FIT Team pre and post digitisation. It has been surmised in the literature that a reduction in steps required may result in a reduction of the time demands involved in the task being undertaken (Rasmussen and Kushniruk 2013).

The researcher calculated the number of discrete steps (for example; moving from PC to PC, accessing specific hospital system or attempting to find patient) required for the members of the ED-FIT Team to complete their triage process through direct observation of the processes being undertaken. Similarly to the method employed to evaluate the time taken, it was assumed that the start point of the process was when the ED-FIT team became aware of the patient and the patient's name was included on the whiteboard or SharePoint list. The process was deemed to be completed when the assessment was completed or the patient had left the ED.

3.4.1.3. User opinion regarding the direct impact of the system on the ED-FITT Triage process.

The researcher sought to ascertain user opinion regarding the impact of the newly deployed system in terms of the ED-FITT process. This formed the first component of the semi-structured interview process, where participants were questioned regarding the impact of the system on the day-to-day workflow of the team and also on whether it was felt that the digital process streamlined or further complicated this workflow.

3.4.2. Impact on Communication, Handover and Referrals Generated

One of the purposes of the system being implemented is to facilitate communication between the ED-FIT team and the wider hospital. In order to identify the impact of the digitisation of the ED-FITT process on communication, the researcher collated details of onward referrals generated by both processes in combination with engaging with clinical staff during the semi-structured interview process to discuss their opinion regarding handover and communication.

The researcher identified the referrals generated both by paper and digital systems over a 2 week period pre and post roll out of the new system. Data relating to the paper process was identified through chart audit and review of written hand-over sheets and photographs of the whiteboard. Results from this chart review were then be compared to information made available through the newly implemented system with regards to referrals generated. The researcher was then able to compare the volume of referrals generated and identify the recipients for each referral in both systems.

Further feedback was then sought from users regarding the impact of the system on the handover and communication processes within the ED-FITT workflow through face-to-face interview and observation of the process within the ED environment and with the wider team.

3.4.3. Quality and availability of clinical data

The impact of electronic notes on clinical data captured has been well described in the literature with many researchers suggesting that implementing electronic records improves the quality and completeness of notes captured by clinicians (Mickan et al. 2013, Jamieson et al. 2016). In order to identify the impact of the newly digitised process on clinical documentation, the quality of the clinical data captured has been investigated pre and post implementation. This allowed the researcher to compare the quality of data collected in paper and digital forms.

The researcher employed the "QNote" assessment as detailed Section 2.5.2, to assess the quality of notes captured using both paper and digital processes. The charts of patients assessed by the ED-FIT team, as part of the observed processes, pre and post roll-out of the digitisation process were scrutinised using the QNote tool. The assessment examines quality by way of assessing the completeness, accuracy, conciseness and currency of data collected for defined components of the clinical documentation (Present Complaint, History of Present Illness, Problem List, Past Medical History, Medications, Allergies, Social and Family History, Review of Systems, Physical Examination, Assessment, Plan of Care, and Follow-up). A score of 100 is assigned if the attribute is deemed to be fully complete, 50 if partially complete and 0 if unacceptable or missing. The scores for each attribute are averaged to give a

component score and these are averaged to give an overall quality score for the document in question.

Participants were also questioned about their opinions regarding the quality of data captured. In order to ascertain their view on the availability of data, they were further questioned regarding their ability to access pertinent clinical data and the ability of the system to facilitate an overall awareness of the patient journey through the ED.

3.4.4. Unintended Consequences

As outlined both in Chapter 2 and earlier in this chapter, unintended consequences frequently occur when HIT systems are implemented. In this instance the researcher sought to evaluate this phenomenon through interview and observation of process.

3.5. Participants

A convenience sample of 7 therapists working within the ED-FIT team was recruited for both the observational and interview components of this study. Prior to commencement of this study, exclusion criteria was also set, with participants to be excluded from engaging in this study if they did not have experience in working as part of the ED-FIT team or of directly completing the assessment process. Participants were also to be excluded if they did not have experience in using both baseline and new systems.

All participants were members of the ED-FIT team, aged between 18 and 65 years of age, are qualified physiotherapists or occupational therapists and had experience of using both baseline and new systems of assessment.

3.6. Data Collection

Multiple variables have been captured in order to assess the impact of the new system on the efficiency of the process, the communication and handover components of the process, and the quality of data including its availability. This section outlines the method employed to elicit user opinions regarding these aspects in conjunction with the observation of processes to develop a holistic understanding of the process itself.

3.6.1. Interview Process

Having thoroughly investigated the literature available with regard to the most suitable methods for evaluating user opinions of the newly digitised process, the researcher completed a semi-structured interview with participants.

By drawing on the work of the Lærum and Faxvaag (2004) discussed above, the following three set questions with associated follow-on questions were chosen.

QUESTION 1: (to evaluate user opinions regarding the efficiency of the process)

What do you feel has been the impact of the new digitised system on your day-to-day work?

Follow-on questions included: How has the new process impacted on the time taken to carry out an assessment? Do you feel the new system has streamlined or complicated the process?

QUESTION 2: (to evaluate unintended consequences and general experience)

How would you describe your experience of using this system?

Follow-on questions included: Are there suggestions you would make to improve the system? Have you had to change how you work to adapt to the system? How? Have you developed any tricks to make to help navigate the system easier?

QUESTION 3: (to evaluate communication and data quality)

What do you think has been the impact of the system on communication and patient hand-over?

Follow-on questions included: Do you feel that you are more or less aware of what is happening with patients?

Interviews were conducted face-to-face and in a private space away from the clinical area with each member of the team. Each interview lasted approximately 20 minutes and all interviews were audio recorded with permission from participants. Recordings were then reviewed and documented verbatim to allow for coding and thematic analysis to be

performed. The detail of this analysis is outlined later in this chapter. The interview protocol is available in Appendix A.

While the use of a semi-structured interview allowed the researcher to gain insight into the user views regarding the new system, it did not allow for a full understanding of the environment into which the process was deployed. For this, the researcher opted to undertake a direct observational study as discussed in the following section.

3.6.2. Observation of Process and Environment

The process of observation is deemed a naturalistic form of assessment and as such forms part of an ethnographic research methodology, evaluating individuals and phenomena within the environment upon which they act (Kushniruk 2002).

The researcher drew on the work of Li (2010) when considering how to evaluate the impact of the newly implemented digitisation of the ED-FITT assessment process. Here the Li describes the need to implement a socio-technical approach that not only considers the software and hardware components but also the environment and clinical interactions. For this reason, the researcher chose to observe the assessment process pre and post implementation in order to garner the maximum amount of information regarding work practice and behaviour that may impact on the user opinion regarding efficiency, data quality, communication and unintended consequences, and ultimately adoption of this new process. This direct observation sought to be ethnographic in nature with the researcher participating as an external observer of the processes undertaken within the ED-FITT workflow and ED environment. As part of this observation, details of selected quantitative variables such as time and number of steps were also captured to allow for subsequent analysis.

Details of the data analysis undertaken is discussed in the following section.

3.7. Data Analysis

When considering collection and analysis of verbally generated qualitative data, such as from interview, Giorgi (1997) outlines five steps which all researchers should undertake:

1) “collection of verbal data,
2) reading of the data,
3) breaking of the data into some kind of parts,
4) organization and expression of the data from a disciplinary perspective, and
5) synthesis or summary of the data for purposes of communication to the scholarly community.”

In this respect, the researcher has obtained verbal data through direct face-to-face interview with the study participants. Questions were defined to assess the user views regarding efficiency, communication, data quality and unintended consequences. However, in order to remain faithful to this method of data collection, questions were kept open-ended and the interviews were audio recorded and transcribed. Once captured, the data was read to allow the researcher to obtain a global understanding of the information available. The researcher then took the data and attempted to compartmentalise to allow for further in-depth analysis regarding the impacts to be assessed. This required re-reading of the acquired data and dividing it into sections to which a descriptive meaning could be assigned. Once completed, the defined units were then re-evaluated and sociological themes were interpreted from them. There is potential for researcher bias to occur at this point in the analysis phase as this step requires the researcher to infer themes from the responses given by participants and to translate everyday language provided by participants into sociologically accepted terminology and themes. This is discussed later in this chapter when limitations of this study are considered.

For the analysis of the data obtained through observation, the researcher has undertaken an inductive approach and ultimately implemented the process described by Pope et al (2000). This required the researcher to firstly become familiar with the raw data, utilising the research question to be answered by this research to identify a thematic framework followed by the grouping of data into linked thematic units. This data was then summarised and further synthesised to allow it to be “charted” along defined thematic units of efficiency, data quality, communication and unintended consequences. The researcher further interrogated the data to identify associations and the range of data within themes.

Appendix B gives an overview of the themes derived from this analysis and their distribution within the raw data.

3.8. Ensuring Rigour

While consideration has been given above to the collection and analysis of data, it is also beholden on the researcher to consider means to ensure rigour as part of this research. When considering rigour as part of the mixed methods research process one must consider how to ensure validity in both the qualitative and quantitative arms of the study. This section outlines the attempts that have been made by the researcher to ensure rigour throughout this research process.

3.8.1. Validity and Reliability

In terms of qualitative research methods, validity relates to accuracy of an account in relation to the phenomena it seeks to describe (Silverman 2011). Quantitative research however, considers the appropriateness of the measures used to capture the intended concepts (measurement validity), the way the study supports causal statements (internal validity) and the ability to generalise the outcomes to other areas (external validity) (Lewis et al. 2014). Table 3.1 below outlines the concepts of validity as part of both quantitative and qualitative methods (Venkatesh et al. 2013).

Reliability refers to the reproducibility of the study findings if the methods were to be employed by other researchers (Lewis et al. 2014) however, this may not always be entirely possible when considering qualitative studies. It is suggested by Lewis et al., that in order to improve reproducibility and thus reliability, the researcher must be confident that the elements and factors identified within the study would recur in a different population. Also the researcher must ensure that the analysis of data has been undertaken in a consistent manner to ensure the integrity of the data.

Table 3.1 Types of Validity for Qualitative and Quantitative Methods (Venkatesh et al. 2013)

Quantitative Methods	
Design Validity	• *Internal validity*: The validity of the inference about whether the observed covariation between independent and dependent variables reflects a causal relationship (e.g., the ability to rule out alternative explanations).
	• *External validity*: The validity of the inference about whether the cause-effect relationship holds over variation in persons, settings, treatment variables, and measurement variables.
Measurement Validity	• *Reliability*: The term reliability means repeatability or consistency. A measure is considered to be reliable if it produces the same result over and over again. There are various types of reliability, such as inter-rater or inter-observer reliability, test-retest reliability, parallel-forms reliability, and internal consistency reliability. • *Construct validity*: The degree to which inferences can legitimately be made from the operationalizations in a study to the theoretical constructs on which those operationalizations are based. There are many different types of construct validity, such as face, content, criterion-related, predictive, concurrent, convergent, discriminant, and factorial.
Inferential Validity	• *Statistical conclusion validity*: The validity of inferences about the correlation (covariation) between independent and dependent variables.
Qualitative Methods	
Design Validity	• *Descriptive validity*: The accuracy of what is reported (e.g., events, objects, behaviors, settings) by researchers. • *Credibility*: Involves establishing that the results of qualitative research are credible or believable from the perspective of the participants in the research to convincingly rule out alternative explanations. • *Transferability*: The degree to which the results of qualitative research can be generalized or transferred to other contexts or settings.
Analytical Validity	• *Theoretical validity*: The extent to which the theoretical explanation developed fits the data and, therefore, is credible and defensible. • *Dependability*: Emphasizes the need for the researcher to describe the changes that occur in the setting and how these changes affected the way the researcher approached the study. • *Consistency*: Emphasizes the process of verifying the steps of qualitative research through examination of such items as raw data, data reduction products, and process notes. • *Plausibility*: Concerned with determining whether the findings of the study, in the form of description, explanation, or theory, fit the data from which they are derived (Sandelowski 1986).
Inferential Validity	• *Interpretive validity*: The accuracy of interpreting what is going on in the minds of the participants and the degree to which the participants' views, thoughts, feelings, intentions, and experiences are accurately understood by the researcher. • *Confirmability*: The degree to which the results could be confirmed or corroborated by others.

In the case of this study, the researcher has endeavoured to implement tests that will capture the desired phenomenon accurately and to present the methodology used to ensure the reproducibility of the study undertaken. By combining the use of quantitative and qualitative methods in a mixed methods methodology, it is hoped that the data generated will allow for triangulation, thus strengthening the results obtained from this research.

The researcher has endeavoured to ensure validity and reliability as part of this research however there still exist limitations within the study methods employed and these are considered in the next section.

3.9. Limitations of Study Methods

While all efforts have been made to conduct this research in a rigorous, reliable and valid way, as with most forms of research, this study is not without its limitations. These limitations are discussed below.

The first limitation of this study is the fact that it is non-randomised and no control was utilised. When considering the hierarchy of scientific evidence, the empirical scientist considers multi-centred trials and systematic reviews as being of the highest quality (Evans 2002). This study combining quantitative measurement with observational data, according to this hierarchy, ranks as fair to good in terms of feasibility, appropriateness and effectiveness. It was not possible in this instance to attempt a blinded or randomised control trial due to the nature of the working environment and the method employed by the ED-FIT team of shared working.

The second limitation relates to the interview process undertaken. It has been suggested that in order for an interviewer to truly understand the topic they are investigating, three interviews should be held with each participant. It is purported that this allows the researcher to first understand the participant's experience, secondly to gain insight into how this experience relates to the context in which it occurs and finally to allow the participants to reflect on what that means to them (Seidman 2006). In this study due to time constraints on clinical staff that needed to leave the ED to partake in the interview process, only one face-to-face interview was completed with each participant.

Another limitation is the potential of the "Hawthorne Effect". This refers to changes in the behaviour of individuals as a direct result of being observed and may introduce bias into a study (Holden 2001). It has, however, also been suggested that while the "Hawthorne Effect" is infamous, changes in behaviour may not always be due to the presence of the observer and in some instances may be due to other factors such as asking participants to consider aspects under examination which they had not considered previously. However, while this effect may be well noted in the literature it would appear that there is no mechanism to assess its impact on the area of study (McCambridge et al. 2014). In this study, due to the environment and work practices, all subjects were aware of the observation in process, which may in turn have impacted on their behaviour.

As this study sought to utilise a convergent parallel mixed methods approach, the sample size was dictated by the number of processes observed in order to reach saturation. As a result quantitative data was only available from the processes observed and it may be

difficult to allow for generalisation of the outcome as no power calculation was employed. It is hoped instead that the results relating to the quantitative test variables will allow for triangulation of data accrued from the qualitative arm of this research to provide a more comprehensive understanding of the phenomenon under investigation.

Another limitation is the time constraints that impacted on the process. A two week period was allowed for "bedding in" of the digitised process prior to completing observation or seeking feedback. There was limited ability to monitor the persistence of findings over a longer time period and this is something that may form the basis of a follow-up study.

3.10. Ethical Considerations

A submission was made to the Research Ethics Committee of the study site hospital who reported that the implementation of this digital system will form part of a service development plan for the ED-FIT team (A copy of the letter received from the Research Ethics Committee can be found in Appendix C).

The researcher applied to the Trinity College Research Ethics Committee to ensure compliance with ethical consideration with regards to the evaluation component of this research. (The proposal submitted to the Research Ethics Committee can be found in Appendix D).

The evaluation of the system was undertaken by the researcher and was comprised mainly of observation of the process as it occurs. No identifiable patient data accessed as part of the study. Semi-structured interviews were conducted with clinical staff using the system. Prior to conducting interviews, permission was sought from therapy managers to engage with staff and informed consent was obtained from all participants. All staff were made aware that there would be no discrimination, penalty or impact on career progression regardless of their decision to participate or not. Data obtained as part of this study was not shared with management nor utilised as part of a performance review. It should be noted that the principal investigator was known to staff; however, as the investigator has no role in managing or overseeing these staff members, no conflict of interest was anticipated.

3.11. Summary

This research has been implemented using a mixed methods approach. Attempts have been made to ensure that good research practices have been employed to ensure validity and limitations of the study have been considered. The initial component of this research, however, was the design of the digital ED-FITT assessment and is discussed in the following chapter.

Chapter 4. Design

This chapter seeks to outline the process of design undertaken by the researcher in the development of this system. A brief overview of design methods utilised in system design will also be considered below.

4.1. Introduction

Many models have been proposed as possible methods for information system design. Most paradigms outline the various steps through which systems must pass from conception to implementation, however aside from a similarity in the beginning and end points of the processes there is often limited overlap between methods (Davis *et al.* 1988). The following section will outline the most common methods utilised within information system development.

4.2. Design methods

A framework for the "life cycle" of software processes is described in Standard 12207 (ISO 2008). This standard lays out the processes that should be applied during the design of software systems such as agreement, project and implementation processes. The standard outlines that no one model of design is preferable, but what all successful design and implementations collectively demonstrate is the need to define a suitable life cycle. Some of these methods are described in more detail below.

4.2.1. Waterfall

The Waterfall Paradigm is a well-established method of system design and implementation that has been described in the literature since 1970 when it was described by Royce (1970). The method describes a step wise approach beginning with phases to outline the system and software requirements, followed by analysis, design, coding, testing and operation and is displayed below in Figure 4.1. This model requires that each step is completed in sequence and is dependent on it being clear before the process begins exactly what purpose the proposed system is required to fulfil and how components of the system should interact before they are built (Davis *et al.* 1988). While this method may be appropriate for short

well understood projects, it is generally not deemed appropriate for more complex or dynamic projects especially if ambiguity exists around the system requirements (Baseer *et al.* 2015). The method has also been accused of being overly dependent on documentation which may not be applicable in interactive systems involving end-users (Boehm 1988) or in larger scale projects (Petersen *et al.* 2009).

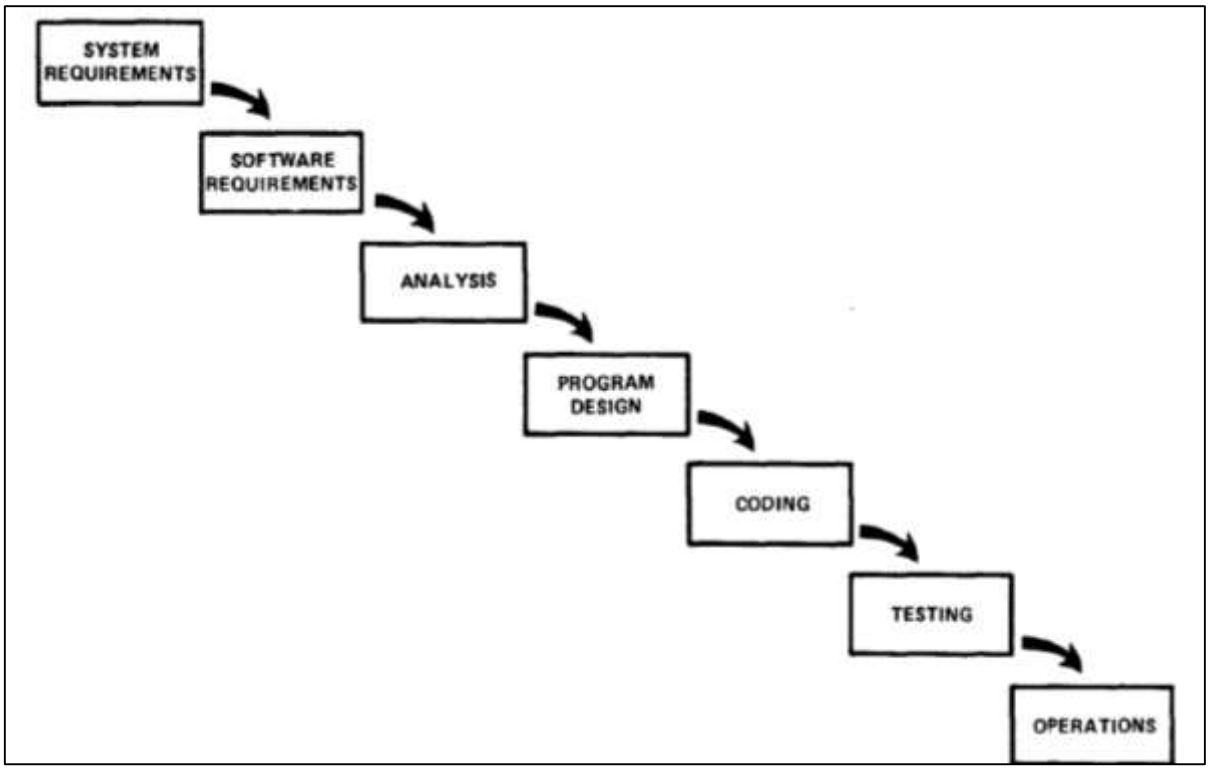

Figure 4.1 Implementation Steps of Waterfall Method (Royce 1970)

Royce, when describing the "Waterfall Paradigm" suggested that the method may work best with iteration between steps allowing for refining of system in response to user feedback (1970).

4.2.2. Spiral Paradigm

The "Spiral Model" of software system design was described by Boehm (1988) somewhat as an evolution of the "Waterfall Model". Boehm suggests proceeding through previously defined steps repeatedly throughout the project with each iteration refining the one preceding it, while maintaining a focus on the risks associated with the development of the system, allows the model to focus on eradicating errors early in the process. This is however

dependent on risk analysis expertise and the ability of the individuals involved to be flexible throughout the cycle (Boehm 1988).

4.2.3. Agile

The "Agile" approach to system design focuses on the principles of continuous innovation, adaptability, improved time-to-market and reliability (Highsmith 2004). Agile developed from the need for a less document driven and more adaptive approach to design when compared with the more traditional "Waterfall" methodology (Palmquist *et al.* 2013). It seeks to uncover better ways of developing software and values individuals and interactions, working software, collaboration and response to change (Beck *et al.* 2001).

Agile and other iterative type models have been shown to result in better quality systems, with an increased requirement for testing but increased productivity for developers (Mitchell and Seaman 2009).

4.2.4. Usability and Human Centre Design

When considering the design of informatics systems, it is also necessary to consider the "usability" of the system. This is especially true when considering the human interaction components of systems (Göransson *et al.* 2003). It has also been suggested that developing a system with evident consideration of user experience may help to foster trust among users and the system (Trauzettel and Minge 2016) and can lead to an improvement in productivity and acceptance combined with a reduction in errors and the training and support needed for the system when deployed (Maguire 2001).

The core principles of Human Centred Design (HCD) dictate that, regardless of the development model being utilised, the user and task requirements should be clear with active end user participation, a clear delineation between functions of the user and functions of the system, iterative design and the inclusion of a variety of team members with different skills in the design process (Maguire 2001). Any development should also create a system that is easy for the user to learn how to use, is efficient, memorable, not prone to error and satisfying for the user (Holzinger 2005).

4.3. International Standards

Multiple international standards may be considered when developing informatics systems. Each standard lends itself to a different aspect of the design and the consideration of "usability" characteristics (Bevan 2001) as have been described above.

For example, according to the IEEE Standard 29148 (IEEE 2011), one must consider the functionality, external interfaces, performance, attributes and design constraints when developing a software requirements specification. Such a document should be correct, clear, complete, consistent, modifiable and traceable. The standard suggests that in order to fully engage the end user with the system, the use of a prototype may be of benefit as it allows for quick feedback, demonstrates any unintended consequences and may ultimately shorten development time.

Similarly, when considering the requirements engineering exercise for system development, this standard outlines, that a similar method be undertaken, with consideration given to the user interfaces and ultimate usability of the system. The two documents should be used in conjunction to ensure that the exact attributes, functional requirements and constraints are clearly understood and can be verified.

Ultimately in generating the requirements for a system, there should be a synergistic approach where requirements description feeds analysis and ultimately design as demonstrated in Figure 4.2.

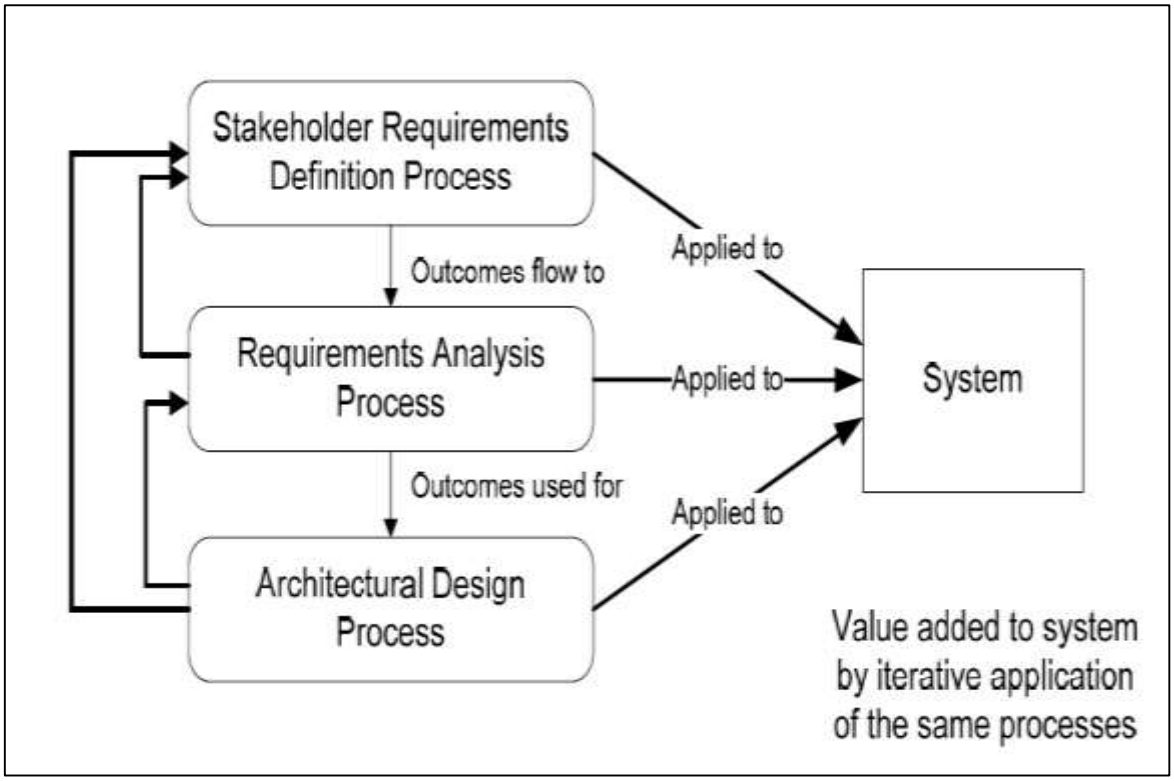

Figure 4.2 Iterative Process of Design (IEEE 29148)

4.4. Design Process

This section outlines the design process that was undertaken to digitise the ED-FITT workflow and how this new digital system was implemented within the collaborative working environment of the ED. An iterative process was used in the design of this system, together with the fluidity espoused as part of the Agile process, although not all of the structure inherent in that method, and the heuristic considerations of Human Centred Design.

In the following sub-section, the researcher outlines the methods by which the requirements for the system were elicited.

4.4.1. Elicitation of requirements:

The first step undertaken within this process was to elicit the requirements for this system.

The researcher drew on personal experience from having worked as a part of the ED-FIT team in identifying and contextualising some of the requirements and functions of any proposed digitised system. The knowledge that the ED-FIT team operates as a

multidisciplinary team within a complex and fluid environment, compelled the researcher to consider the role of computer support collaborative work when engaging in the design component of this system.

The existing proforma in use for patient assessment and communication handover among the team and to outside sources were reviewed. Key data, such as the FRAIL score, was identified from these forms and formed a key component of the system.

The researcher spoke with key stakeholders to establish the perceived workflows and how the system was anticipated to work in the collaborative working environment of ED. Advice was taken from key members of the team regarding fields that should be marked as compulsory and how the assessment should flow.

Aspects of design which may improve the interaction of users with the system, such as integration with existing systems to minimise the need for data entry, was also considered as part of these conversations. It became apparent from this engagement, that any system implemented into this environment must be robust and have the ability to connect with existing systems such as the PAS and ED system.

In order to visualise the system, a simple high level use case diagram was completed (see Figure 4.3) to outline how users may interact with the system and where the system would fit within current systems in use in the ED. By identifying users and those who will interact at some level with the assessment process, such as admin staff, patient flow / bed management, patients and the members of the ED-FIT Team itself, it was also possible for the researcher, with cognisance of the most appropriate human computer interaction considerations, to adapt the system accordingly.

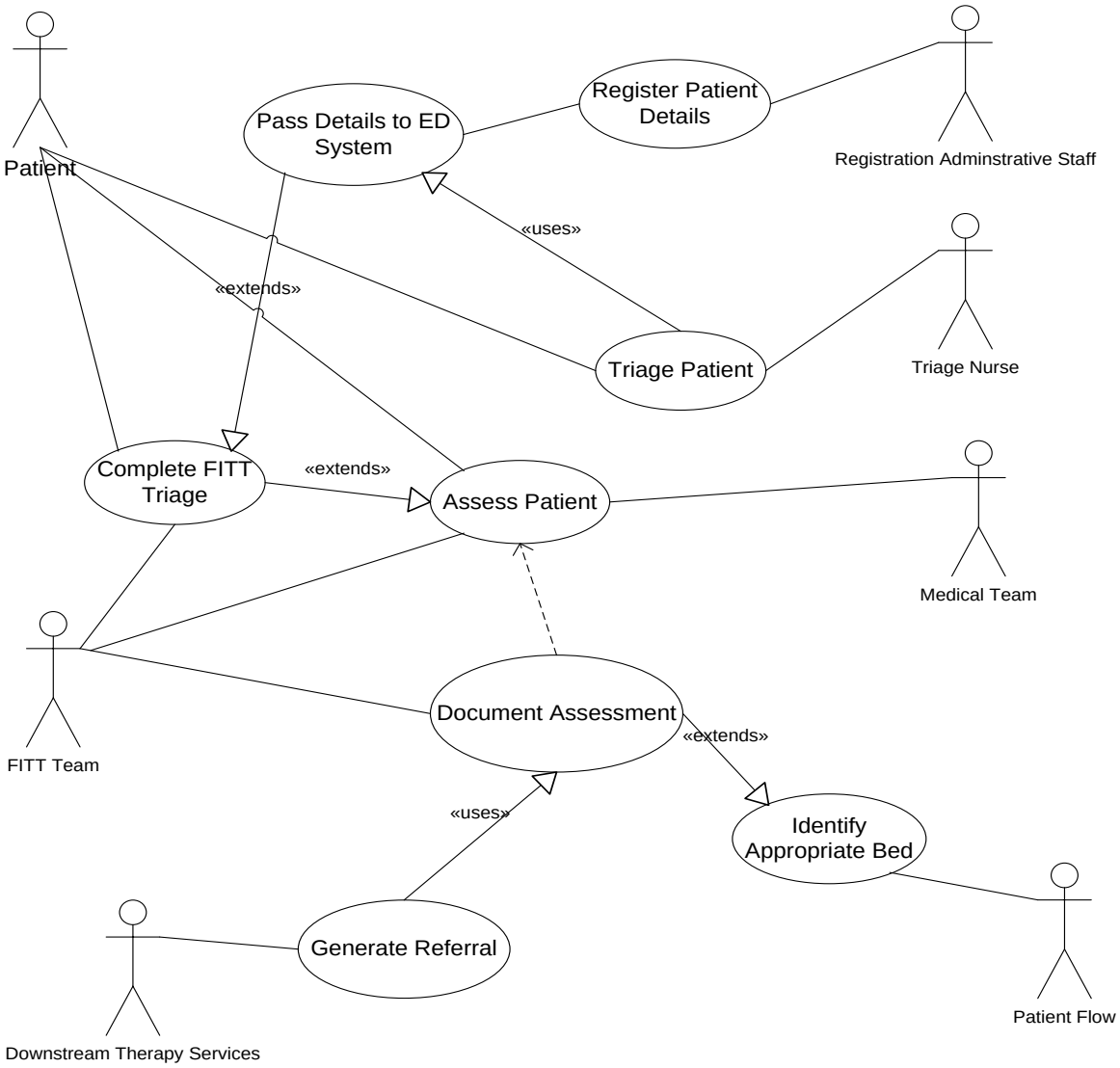

Figure 4.3 ED-FITT System Use Case Diagram

From review of the existing paper assessment forms and processes a prototype test system was created and feedback was sought from users regarding the ability of system to meet previously discussed requirements, further previously undecided requirements were also elicited at this point; such as the ability to utilise secondary data to monitor service activity and compliance with locally set standards and guidelines regarding the treatment of elderly frail patients.

The functions the system would need to fulfil were identified as:

- Secure log-in and audit functionality – In order to maintain confidentiality of patient data, it is necessary to ensure that only authorised personnel can access the system and there must be the ability to audit that access and general interaction with the system
- Documentation of assessment – The system must be able to faithfully record all data inputted and allow for retrieval of same in a timely manner
- Multi-user and device access - The system is required to work within a collaborative environment, meaning that data must be available to all members of the team on demand. Due to the nature of the environment, it is also vital that the system works not only on desktop PCs but also hand held devices.
- Integration with existing legacy systems – The study site hospital uses a specific localised PAS with limited ability to connect to new software. In order for functionality of the system to be maximised the ability for the system to interface with the PAS is deemed necessary
- Generation of documentation and transfer summaries – As the study site hospital remains heavily dependent on paper documentation, it is necessary that all assessments can be made available in paper form for inclusion in the medical chart. Transfer summaries and documentation for onward referral is also a pre-requisite function of the system

The user requirements were determined to be:

- Simple, intuitive, searchable system that allows for accurate collection of patient data and easy retrieval of same – Due to the high volume of patients reviewed by the ED-FIT Team, any system being used in this environment must be easy to use. All data must be accurately recorded to comply with national standards regarding medical documentation and in order to facilitate patient care all data must be available when required and easy to retrieve
- Ability to generate referrals to downstream services automatically – The ED-FIT Team refers patients to a multitude of services as indicated when the patient leaves the ED.

To aid in streamlining the process undertaken by the ED-FIT Team, automatic generation of referrals together with automatic generation of appropriate proforma is necessary to avoid duplication in data collection and provision

- Communication tool among all members of team – As the ED-FIT Team work as a collaborative group, there is a strong dependency on communication channels to ensure that patients are receiving the correct care and to minimise the amount of duplication occurring within the service, while enabling the team members to have an overview of service and patient needs
- Facilitate communication outside of ED – As outlined above, the ED-FIT Team will ultimately engage with other members of the hospital staff as well as outside agencies as indicated to facilitate the best onward care for patients, there is an expectation that the system will be able to facilitate this communication through automatic generation of appropriate electronic correspondence and the sharing of screens with appropriate personnel such as the Patient Flow Department
- Ability to use data recorded for profile of service and clinical audit – There is an onus on all services within the study site hospital to generate profiles of service activity. The system should allow for the necessary data to be collected and reported as needed

With the elicitation of system functions and user requirements, the researcher proceeded with design of a test system utilising FlowForma software as will be discussed in the following section and evaluated during the course of this research.

4.4.2. FlowForma

FlowForma is the software chosen by the researcher to develop the digitised version of the ED-FITT process.

FlowForma was chosen as it is currently in use in the study site hospital within the Occupational Health department to allow referrals to be generated from across the organisation. It is also fully supported by the hospital's IT department.

The FlowForma tool allows for complex processes to be mapped electronically. It allows for paper forms to be assimilated into the process using question banks and business logic rules ensuring completion in a timely manner by the right individual. The process can generate mail merged documents and automatically email appropriately pre-determined individuals based on the responses given to questions within the process. It is also possible to automatically set question values depending on previously given responses and to create automatically calculated responses based on simple formulae.

A high level depiction of the FlowForma architecture is given in Figure 4.4. The data from the ED-FITT system is housed internally on a secured local Sharepoint server with connections to the provider's FlowForma server via HTML5 to access the functionality of the FlowForma system itself (FlowForma 2017).

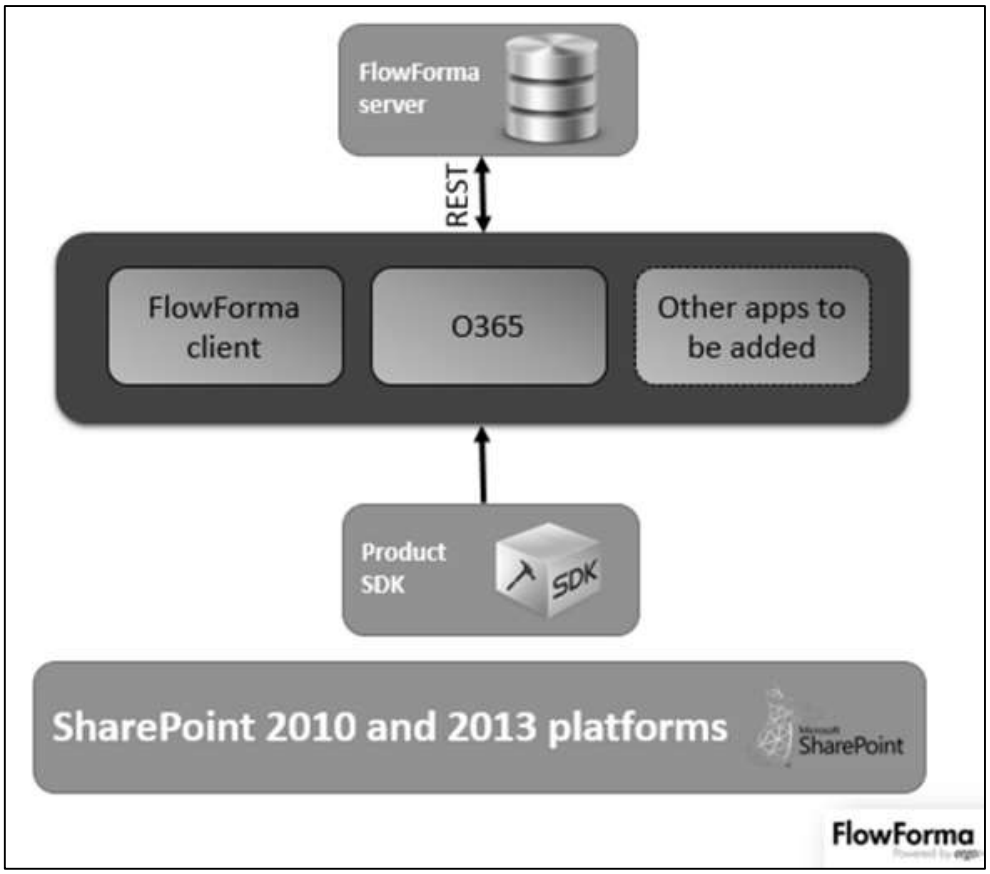

Figure 4.4 FlowForma Architecture (FlowForma, 2017)

FlowForma is a useful tool for digitising workflow processes and allows development of a system matching user requirements and fulfilling the required system functionality. However, to optimise the functionality afforded by the programme requires a certain amount of tenacity on the behalf of the developer. While the ability to utilise business logic to facilitate communication, connectivity or document generation, the programme has a certain inflexibility in terms of how this logic may be applied. There is, as previously described, for example, the capacity to utilise existing fields within the process in a calculation within another question. However all of the requisite fields must be visible within the process, even if not actively being utilised or needing to be seen by end users. In order to facilitate calculation of a cognitive score automatically, the researcher had to create a SharePoint list within the FlowForma environment and implement a "list look up" rule to populate fields automatically to allow for calculation to occur without displaying fields with which the user does not need to interact.

The following section describes the consideration given by the researcher to the views and user interaction with the system during design.

4.4.3. System Views and User Interface

Consideration was given to the direct interaction, for example, the completion of the assessment components, and equally to the collaborative interaction, for example the whiteboard component. In view of the need for shared communication, the researcher has evaluated the information currently available and utilised by the ED-FIT team and has ensured that all pertinent data is available within a "Handover List" view that mimics the whiteboard currently in use (Figure 4.5). The data included is generated automatically by completion of the assessment form, but there is scope for users to "free hand" into certain fields to allow for quick annotation of data to facilitate communication within the team which while pertinent to patient care may not need to form part of the formal patient record, for example; "gone for scan, review post same".

The system has been designed to have initiated and completed forms feeding into a SharePoint list that will be visible to staff on logging into the system. This list will form the basis of the electronic whiteboard that will be the central tool for the collaborative working

environment. The system and list will only be accessible by staff with whom the FlowForma has been shared. This is to maximise patient confidentiality and data security.

Views can be tailored by the individual user and are dependent on the medium being used; mobile versus desktop. One of a choice of lists can be defaulted to the landing page and the format of the flow display has been altered to give the user the most straightforward experience when accessing the system. The colour scheme itself can also be adjusted by the user if desired.

Due to the high patient turnaround within the ED department, the “Handover List” has been filtered to only display patients added within the last 48 hours. However an “All Forms” default within the system allows for all patients added to be searched and accessed.

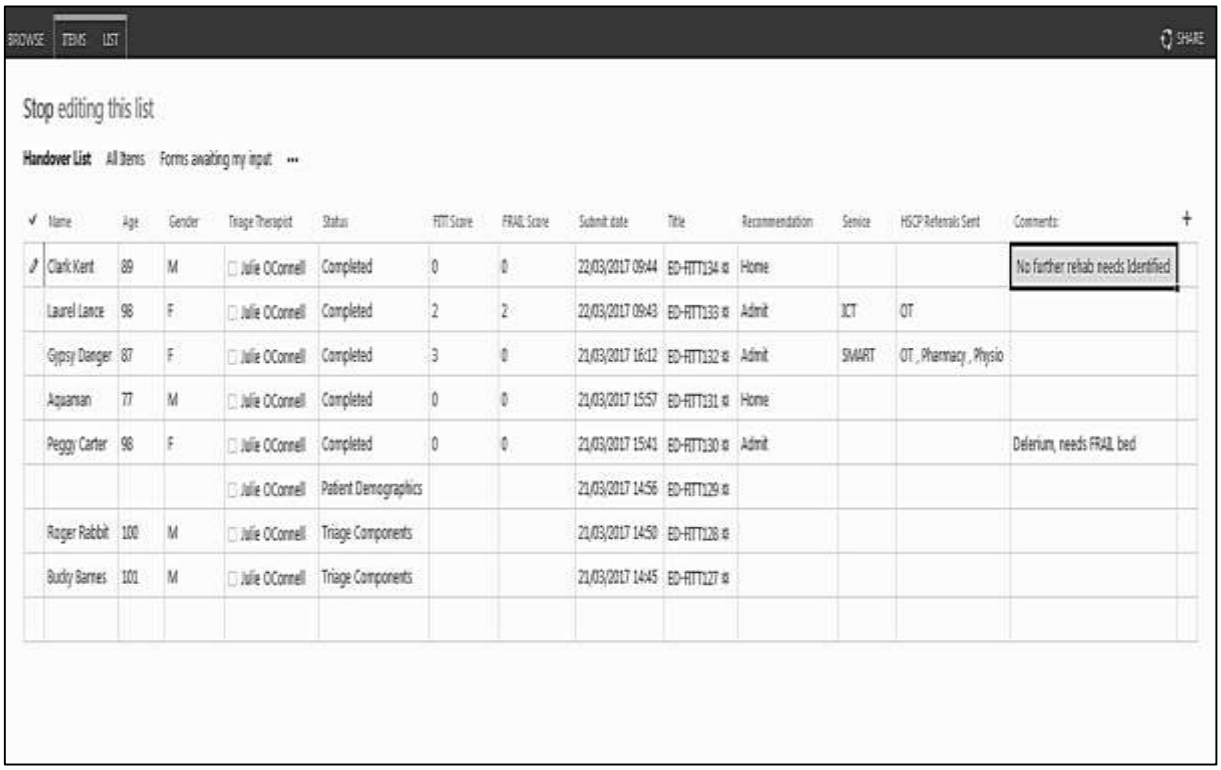

Figure 4.5 "Handover List" Screenshot

Within the FlowForma, logic has been applied to allow certain fields to remain hidden depending on the responses to questions earlier within the flow. This results in a more streamlined interface for users with only relevant options and questions being shown at the relevant time.

Following discussions with senior decision makers within the ED-FIT team, certain questions have been identified as compulsory and must be answered in order to progress through the flow. If the user attempts to progress without completing these required responses, the step marker changes colour and the missing required information is described so the user is clear what information is being sought, as can be seen in Figure 4.6.

Further user feedback was sought at various points within the process, especially when giving consideration to the assessment components included within the flow. Feedback was also sought regarding the best question type to elicit the most useful response, such as a freetext box in the instance of objective assessment or set options in relation to the FRAIL score.

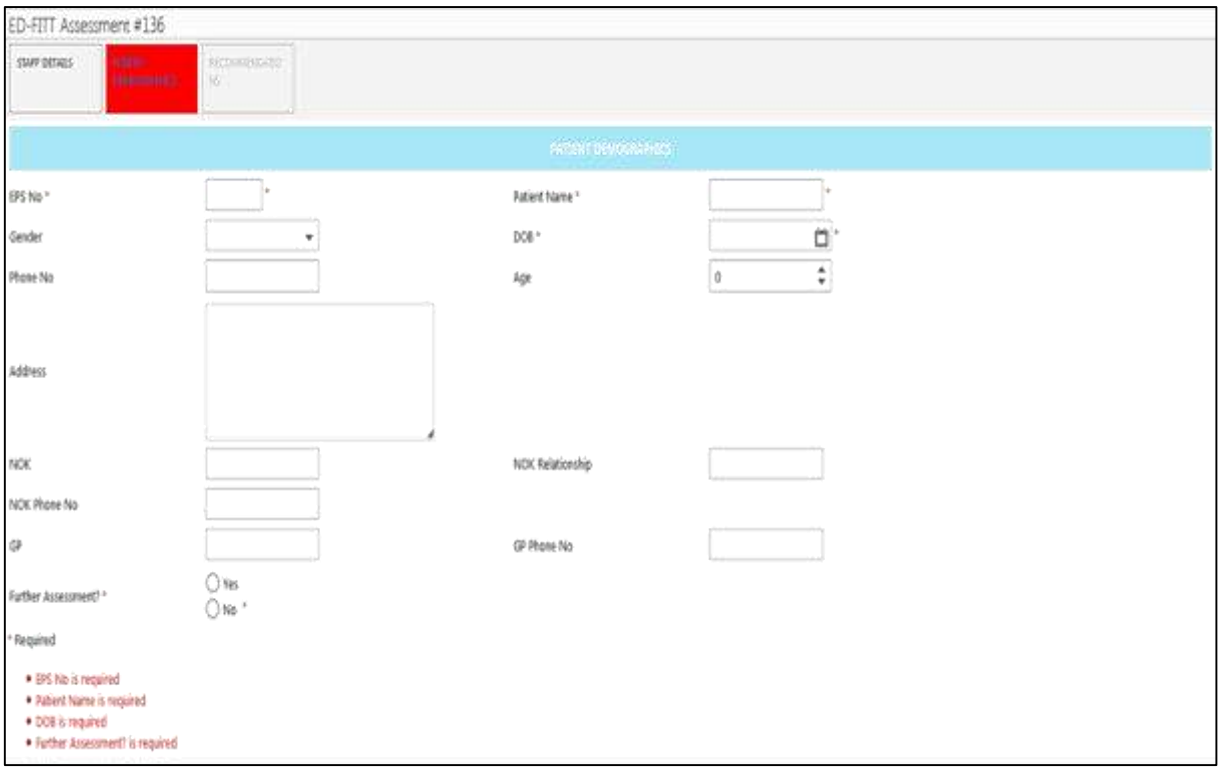

Figure 4.6 Screenshot with Required Data Highlighted

However, conversely, in order to address the need for fluidity during assessment, parallel grouping of certain components of the flow have been created allowing the user to move

back and forward through the flow as information becomes available. The overall flow of the process can be seen in Figure 4.7.

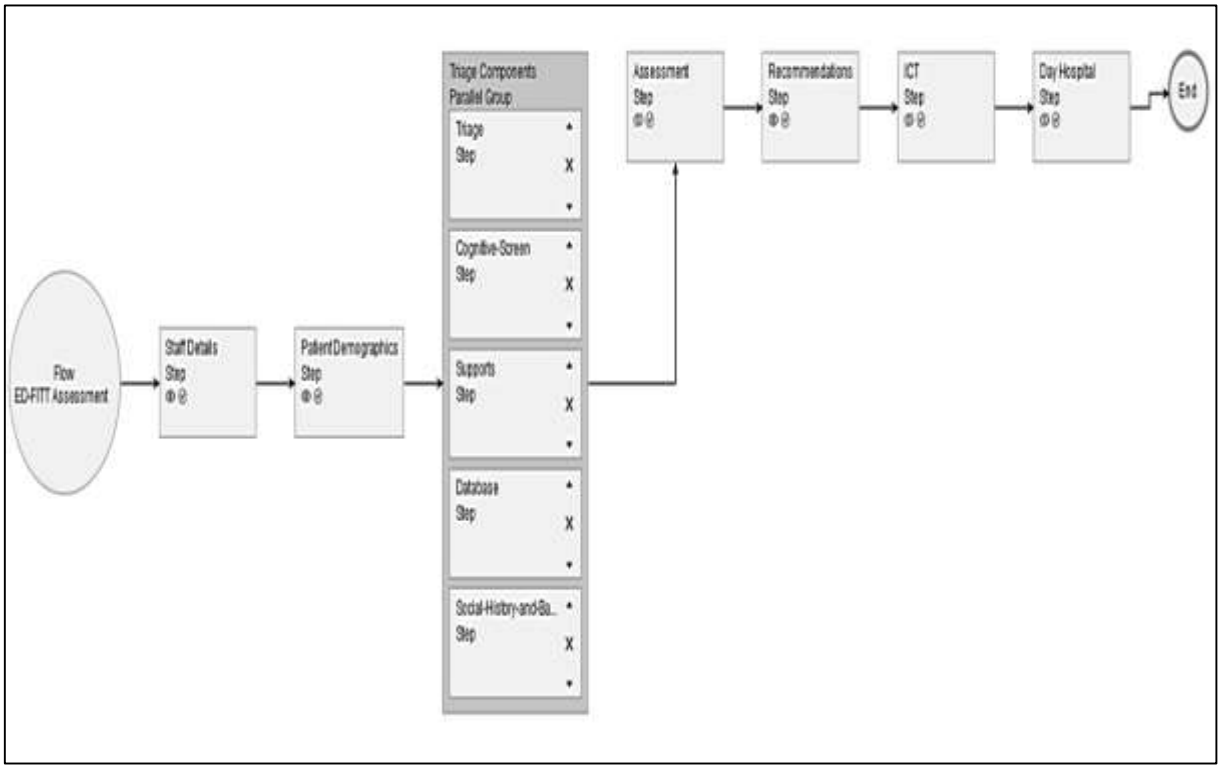

Figure 4.7 ED-FITT Flow

One of the required components as part of the triage process was the completion of a cognitive screen. The screen chosen assigns numeric values to pre-defined responses. By utilising logic to calculate scores, the researcher was able to implement clinical decision support into the system to recommend clinicians consider a diagnosis of delirium dependent on the outcome of cognitive assessments. An element of clinical decision support is also possible by the inclusion of information points accessible by hovering over the questions on the screen (Figure 4.8).

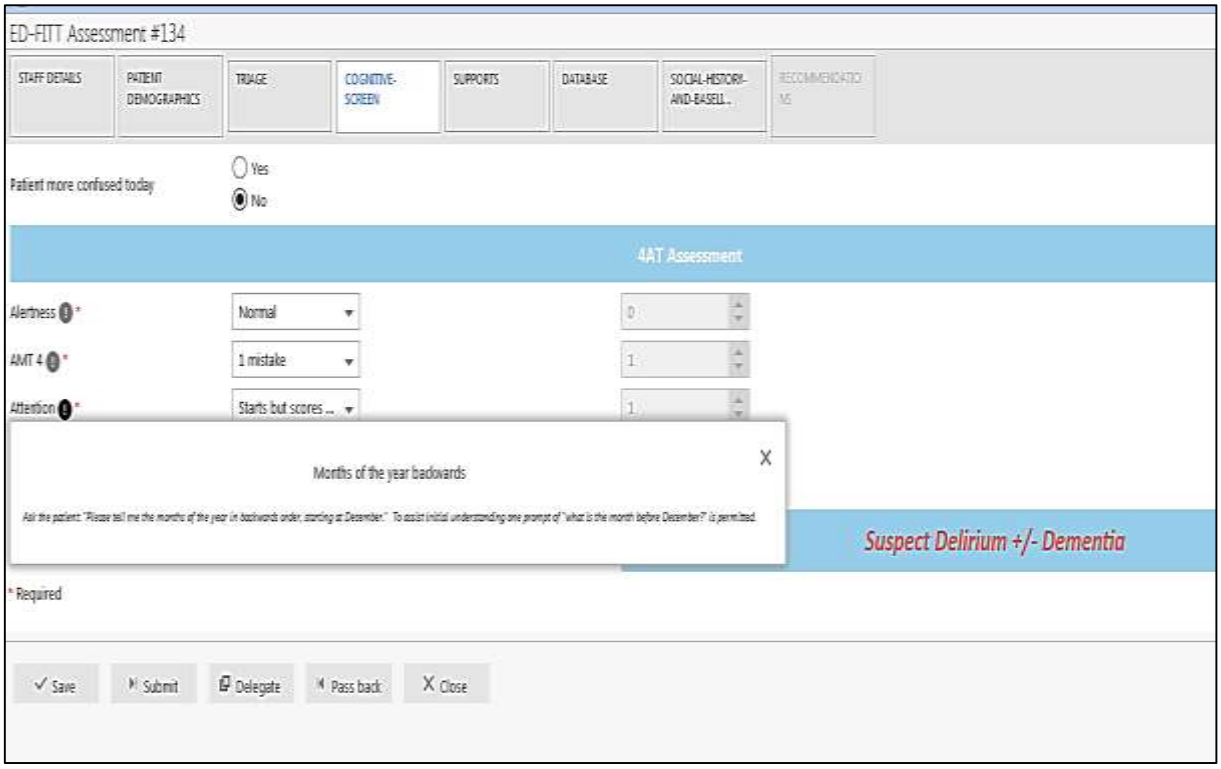

Figure 4.8 Screenshot of Cognitive Assessment with Information Button

In order to facilitate connectivity to existing legacy systems, assistance was sought from the study site DBA and development team to create a SQL procedure that can be executed as part of the business logic included in the patient demographics screen. This procedure allows for patient demographics to be drawn from the PAS, minimising the need for duplication of data entry, streamlining the process and minimising user error. There is a requirement for the user to input an episode number related to the patient into system in order to activate the stored procedure and initiate the PAS interface.

A conscientious effort was made to ensure that the templates for documentation were as close in layout to existing documentation in order to capitalise on user familiarity. Login details were used to identify the staff completing the assessment and this detail together with the time and date stamp of the assessment, thus complying with guidelines regarding the signing and contemporaneousness of notes being kept. The templates for emails forwarded to the relevant services were formatted by the researcher to ensure clear communication of pertinent referral details with inclusion of a PDF version of the assessment (Figure 4.9).

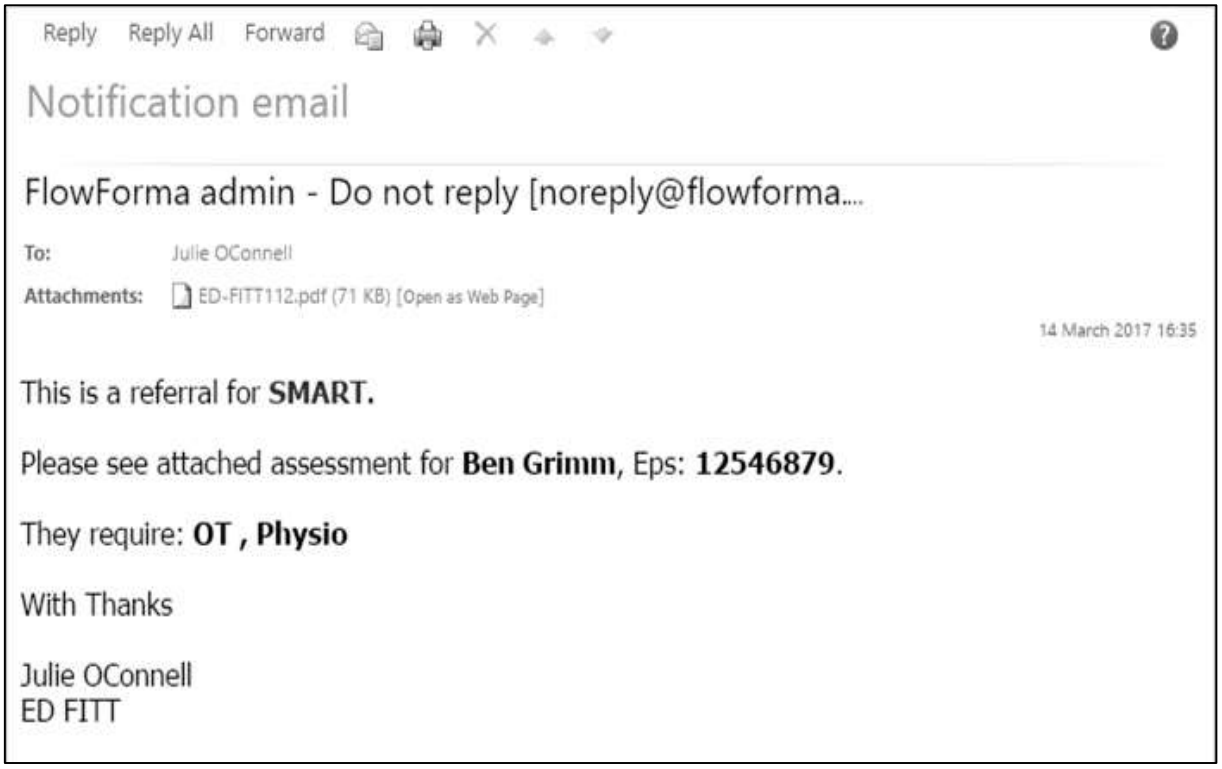

Figure 4.9 Notification Email

Before implementation, robust testing was undertaken to ensure that the system works as anticipated and is stable. The following section, outlines the testing of the system undertaken.

4.4.4. Testing

As outlined above, the flow has been designed with several separate steps that flow into each other. As each component of the system was built, it was tested by the researcher. Firstly the step was tested to ensure that it captured the required information accurately. Secondly, any logic that was included as part of the step was investigated to ensure that it worked as intended. If multiple questions within a step involved logic, this combination was assessed to ensure that there was no conflict and that each portion of the logic was correct.

The automatic creation of a whiteboard view required significant testing in order to ensure that information was accurately populated. Various methods of utilising business logic to generate a SharePoint list was employed before finally utilising a “publish” option. Once this method was adopted, testing of the accuracy of each published component was completed

by populating each component within the flow and checking the effect before completing testing on the next component. The relevant section was completed, the flow was saved and the resultant information was reviewed. The effect of "free typing" was also tested to ensure that while this was possible, it would not overwrite the detail of the data captured within the assessment that would be filed as part of the patient's chart.

While the system was designed utilising a desktop PC, it was the intent of the researcher that ultimately the system should be used on a portable device such as a tablet. To this end, the test system was trialled by users using a touchscreen device before deployment allowing for users to access the system at the patient's bedside thus minimising potential interruptions to the assessment process. The system was rigorously tested on both a desktop PC and also a touchscreen device to ensure that data could be accurately and easily entered in both formats.

The final component of testing that was completed was user acceptance testing. The system was shared with members of the ED-FIT team to ensure that the system met the requirements that have previously been discussed. The usability of the system was also addressed during this portion of testing.

Once the researcher and users were satisfied that the system was robust and met the pre-defined requirements, it was implemented into the ED-FITT workflow. This process is outlined in the following section.

4.4.5. Deployment

One of the aspects that was considered as part of the deployment of this system was the environment into which it would be implemented. The area was assessed for Wi-Fi coverage and touchscreen tablets were procured and registered on the medical device network to ensure the security of the system. The technical services department was engaged to provide electrical and data ports to the shared space that serves as the ED-FIT team base. This ensured that the whiteboard view required to facilitate the collaborative work of the team was visible in a shared area but in order to maintain patient confidentiality was not on display in the general department.

With the system implemented, the next step was to evaluate the effect that it has on the existent workflows. This evaluation is considered as part of the following chapters.

4.5. Conclusion

There are many sources of inspiration to be found when considering the best method for design of a system such as the ED-FITT Assessment.

The design process undertaken as part of this study drew from international standards in usability design combined with iterative feedback and a strong emphasis on human centred design. The task and user requirements were clearly defined before development commenced and further refined it progressed. User feedback was sought to ensure usability of the system and robust testing was completed to ensure reliability of the system once deployed. This allowed the researcher to design this system in a structured and methodical manner with clear identification of roles and requirements prior to its deployment as part of this research study. The evaluation of the impact of this system will be discussed in detail as part of the next chapter.

Chapter 5. Findings

This chapter outlines the findings of the research undertaken to date. An outline the findings of the observations undertaken including details of the participants involved together with a comparison of the ED-FITT process pre and post deployment is presented in section 5.2. Section 5.3 presents findings in relation to efficiency, section 5.4 communication and handover, section 5.5 data quality and availability and finally section 5.6 outlines the findings relating to the occurrence of unintended consequences.

5.1. Introduction

The research undertaken seeks to answer the question of what impact digitising the assessment process of the ED-FIT Team ultimately has on the efficiency of the process and its effect on communication and on the availability and quality of data collected.

A total of 249 patients aged over 75 years presented to the ED in the two week observation period pre-deployment and 289 post-deployment. In the period of assessment prior to the deployment of the digital system, 184 patients (106:77, M:F) presented to the ED during the hours of operation of the ED-FIT team and were referred for assessment by the ED-FITT service. The average age was 80.9 years (SD = ±7.81 years). 223 (96:127, M:F) patients attended during ED-FIT team working hours and were included on the whiteboard post deployment, with a mean age of 82.02 years (SD=±5.51). Figure 5.1 outlines the appropriateness for triage of the patients whose details were captured during the 2 week periods under consideration pre and post-deployment.

Twelve processes were observed pre and 12 post roll out of the newly digitised system. The number of processes observed was determined by the need to reach saturation. Data relating to the efficiency of the process; including time taken, number of steps required and field observations; communication and user experience; including unintended consequences were captured during these observations and in subsequent interviews and the details of these are explored below.

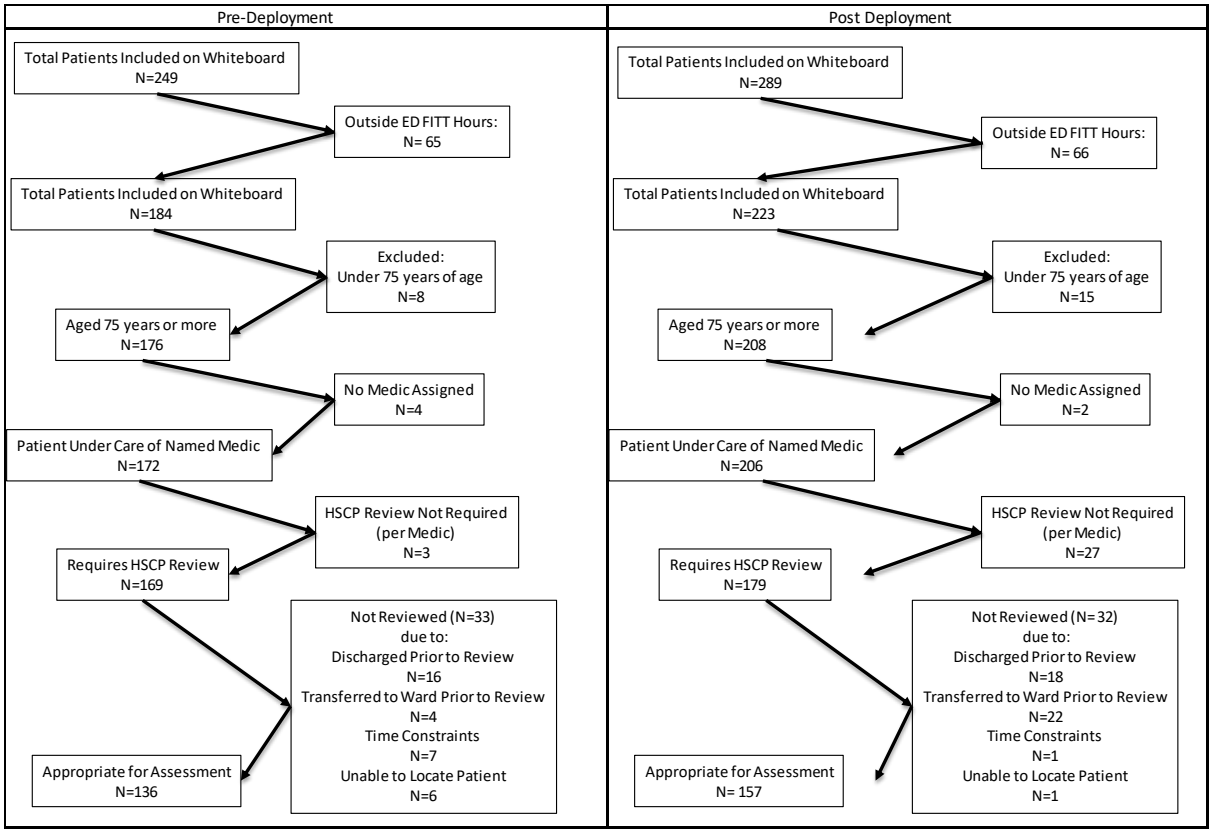

Figure 5.1 Appropriateness for Triage

The following section will outline the process undertaken by the ED-FIT Team before and after deployment of the digitised system.

5.2. Findings of Observations

This section describes the participants observed and interviewed during this research together with an overview of the processes evaluated pre and post deployment of the new system.

5.2.1. Participants

The sample pool (n=7) was drawn from a convenience sample of physiotherapists and occupational therapists who work as part of the ED-FIT Team for inclusion in both observations and the interview process. One therapist was excluded from the process as they did not have experience in using the newly digitised process. Respondents were qualified therapists and representative the full range of clinical grades; clinical specialist, senior grade and staff grade therapists. All respondents had a minimum of 12 months

experience working within the study site hospital and at least 4 months experience working as part of the ED-FIT Team. The breakdown of the participants is depicted in Table 5.1 below.

Table 5.1 Participants

Excluded N=1	Grade		
Discipline	Clinical Specialist	Senior	Staff Grade
Physiotherapy	1	1	1
Occupational Therapy	1	0	2

5.2.2. Overview of the ED-FITT Process

This section seeks to give an overview of the ED-FITT assessment process as observed by the researcher.

5.2.2.1. Introduction

As discussed in Chapter 1, the ED-FIT team consists of specialised AHPs who review patients over 75 years of age attending ED. Occupational therapists and physiotherapists complete the triage and assessment of these patients and forward referrals to other members of the team as clinically indicated. The team operate in a busy ED with a small office space located off the main ED floor. This is the space in which team utilise a whiteboard for communication among themselves regarding the status of patients. Figure 5.2 below shows the layout of the ED at the study site hospital.

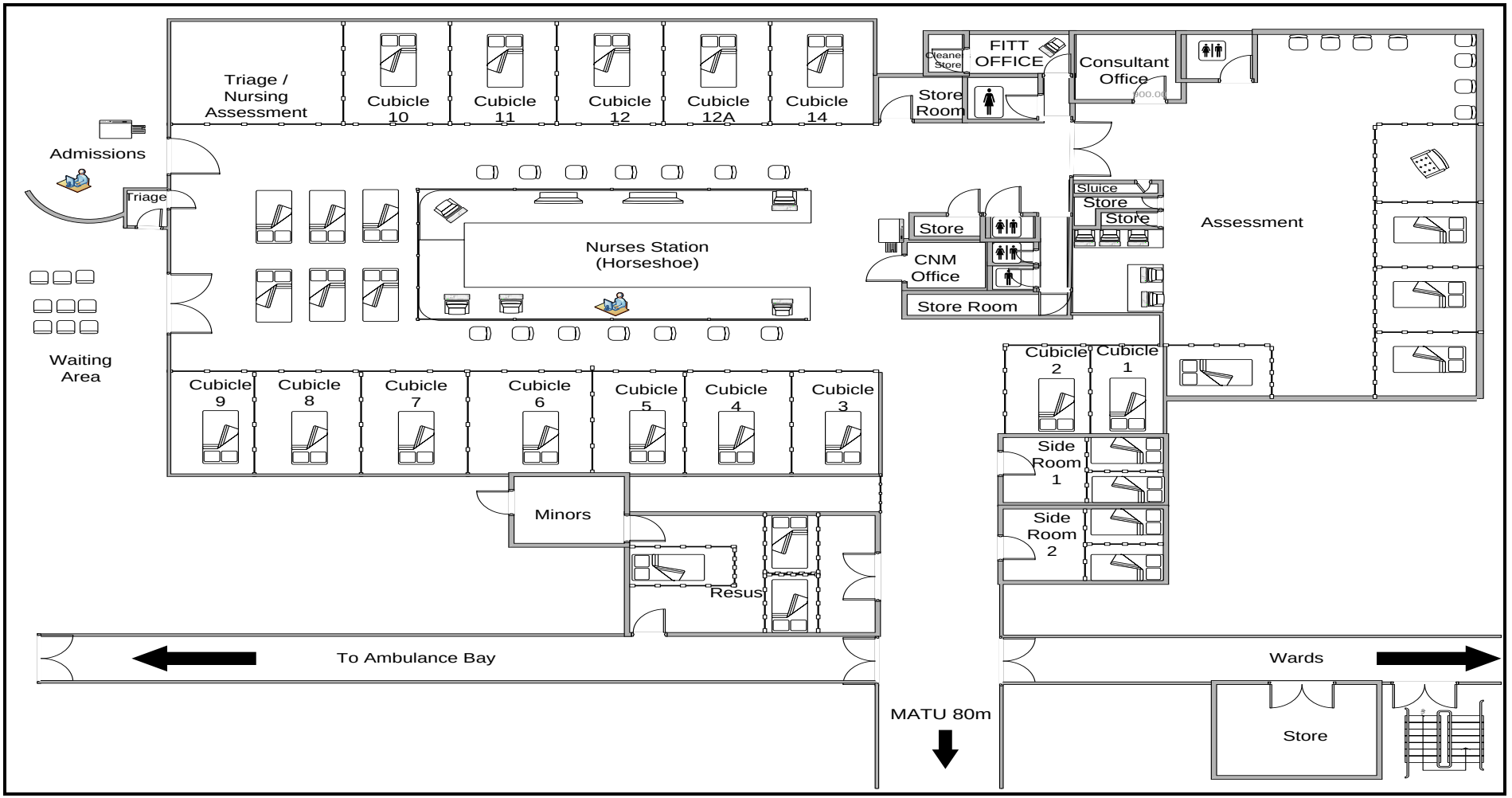

Figure 5.2 Layout of ED at Study Site Hospital

5.2.2.2. Pre-Deployment ED-FITT Process

Patients are admitted through ED and once their details have been inputted into the PAS these details are automatically forwarded to the ED system, they are triaged by nursing staff and then await review by medical and if they are over 75, the ED-FIT team. A member of the ED-FIT team will perform a screen check and note the details of any patients over the age of 75. These details are then transferred to the ED-FIT team whiteboard and the paper record sheet (which is retained by the team to allow for review of the details of patients seen once the whiteboard has been cleared). Patients are assigned to the next available therapist in sequence. The therapist initials are put on the board and the therapist commences the assessment. The first step in the assessment process is for the therapist to obtain basic data on the patient from a variety of hospital systems, the patient's medical chart and the medical team member caring for the patient. Once all pertinent information is documented, the therapist attends the patient and completes the triage process. Once the triage process is completed, the therapist documents the outcome, updates the whiteboard, photocopies the assessment form for handover and files the completed assessment form in the patient's medical chart using pink paper to ensure visibility of the assessment. The services required to see the patient are noted on the whiteboard and these are viewed by the relevant AHPs on attendance to the ED-FITT office. The process may be complicated by the need for the therapist to find multiple computers as the required hospital systems may not be available on all computers. Also the need to photocopy blank assessment forms on pink paper was noted to occur repeatedly and impacted on the efficiency of the process as the therapist was required to leave the ED to find a working photocopier to photocopy spare assessment sheets, prior to commencing the assessment process. This flow is represented in Figure 5.3. Much of this process was noted to require duplication with information being repeatedly documented in multiple places firstly to promote communication across the team and secondly as a form of redundancy in the eventuality of an instance of the data being lost.

As part of this study, the researcher sought to investigate how the implementation of the digitised process design affected the established assessment process for the ED-FIT team. An overview of the process post deployment is discussed in the following section.

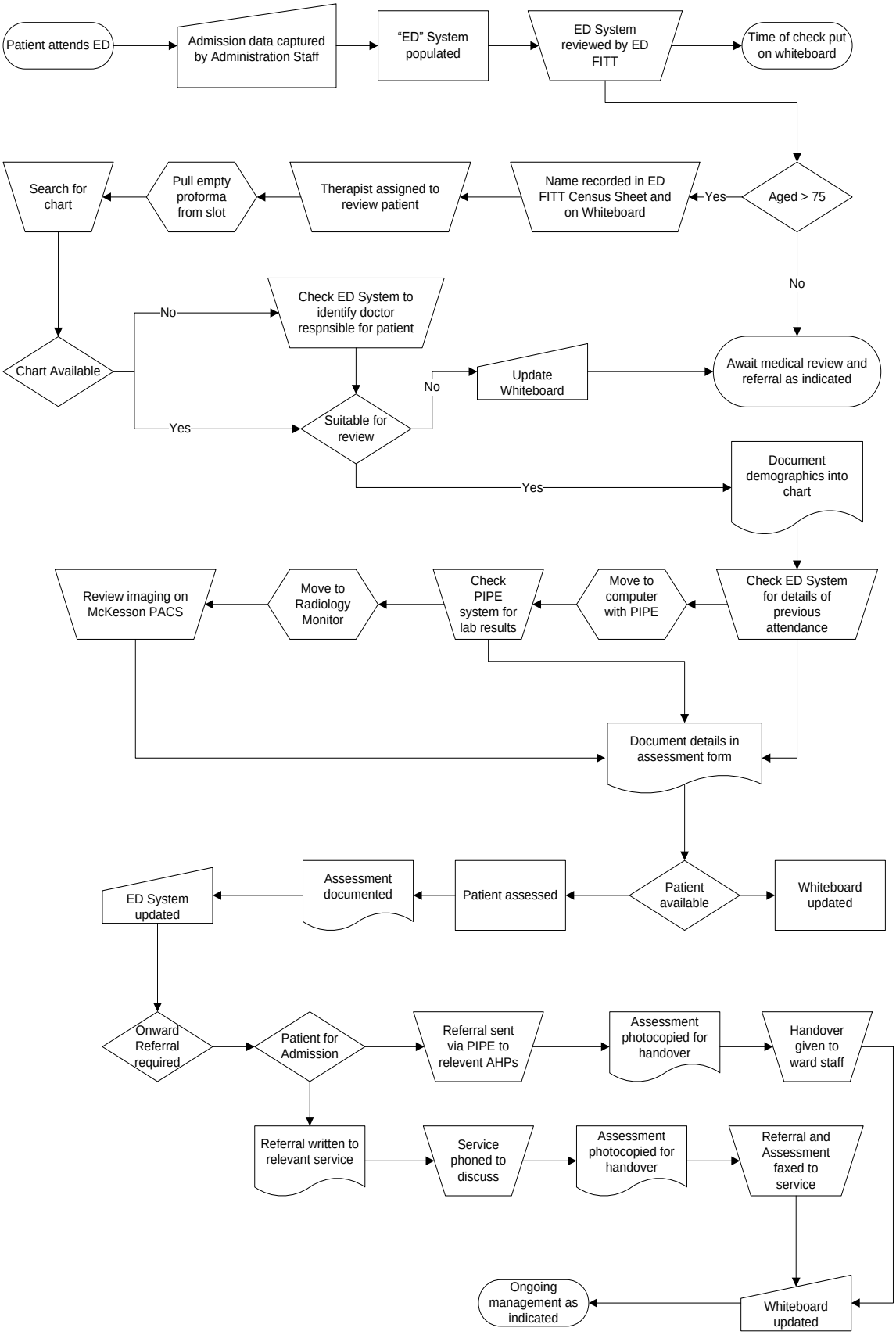

Figure 5.3 Pre-Deployment ED-FITT Process

5.2.2.3. Post-Deployment ED-FITT Process

There are similarities between the ED-FITT process pre and post deployment. In both instances, the patient's details are inputted in existing hospital systems by administrative staff on presentation to the ED. Post roll-out of the new ED-FITT process, the details of patients aged over 75 are automatically passed to the FlowForma system and automatically populate the electronic whiteboard now in use by the ED-FIT Team. As much of the surrounding processes and documentation practices are paper based, there is still a large proportion of time spent by therapists attempting to locate the patient, medical chart or treating physician.

While therapists will update the electronic whiteboard in order to communicate with other team members, any pertinent information that is captured during the assessment process is automatically added to the whiteboard without the therapist needing to take any further action.

Once a decision has been made regarding onward referrals required, these are automatically generated by the system negating the need for the therapist to generate them separately.

As the electronic whiteboard is accessible to all relevant members of the team, and views can be customised to allow for easy retrieval of relevant data in all situations, there is no longer a need to duplicate data across multiple platforms. The current flow is demonstrated in Figure 5.4 below. In comparing this with Figure 5.3 of the original process above, it can be seen that the new process contains more automated processes, fewer steps that result in paper documentation and fewer manual steps required especially with regard to the referral process.

While it would seem that there have been efficiencies gained in regard to the new process especially in relation to automation of facets of the process itself, the impact of the newly digitised process on efficiency, communication and quality of clinical documentation were also investigated. The results of this are discussed in the following sections together with the role of unintended consequences.

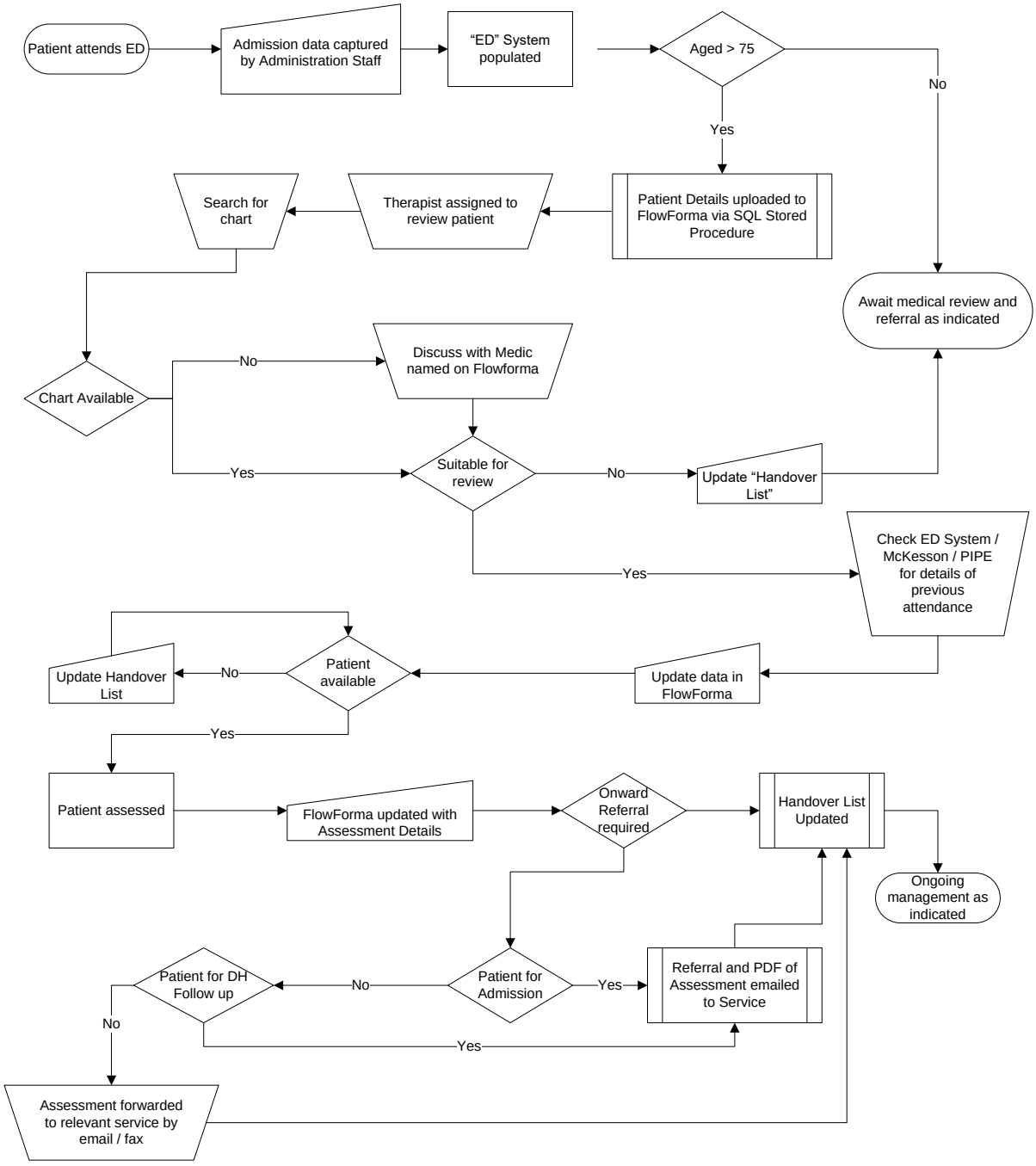

Figure 5.4 Post-Deployment ED-FITT Process

5.3. Efficiency

The effect of the digitised process on the efficiency of the ED-FITT workflow was evaluated through investigation of the time and number of steps required to complete the process, as well as the opinions of users regarding the impact, streamlining or complicating, of the process on the day-to-day workflows. The results are presented below.

5.3.1. Time

The time taken to complete the process of assessment was considered. The process was deemed to have started when the patient's details were included on the whiteboard used by the team as a communication tool and to have concluded when the assessment was completed or the patient had left the ED.

Overall, no significant difference was found between the two groups. The average duration of the assessment process prior to the implementation of the new digitised process was 20.30 minutes (SD = ±14.16). A large part of this time was spent in accessing data prior to the patient being directly contacted by the therapist with 6.75 minutes (SD = ±3.19) spent by therapists accessing data from various computer systems and paper documentation. The amount of time with therapists directly involved in the assessment of a patient was on average 8.44 minutes (SD = ±9.26) with an average of 4.75 minutes (SD = ±5.45) required to document the assessment completed and a further average of 0.36 minutes (SD = ±0.30) utilised to update the whiteboard. The details of the total time taken for the observed processes is shown in the graph depicted in Figure 5.5 below.

Figure 5.5 Total Time Taken per Observed Process Pre-Deployment

After the implementation of the newly digitised process, the average duration of those processes observed was 23.81 minutes (SD = ±10.64). Of this 6.78 minutes (SD = ±4.77) was spent obtaining pertinent clinical information from a variety of sources. Therapists were found to spend an average of 9.29 minutes (SD = ±8.35) in direct contact with the patient and a further 7.47 minutes (SD = ±5.16) documenting the completed assessment. An average of 0.32 minutes (SD = ±0.25) was spent by the therapists in directly updating the whiteboard. The time taken is demonstrated in Figure 5.6 below.

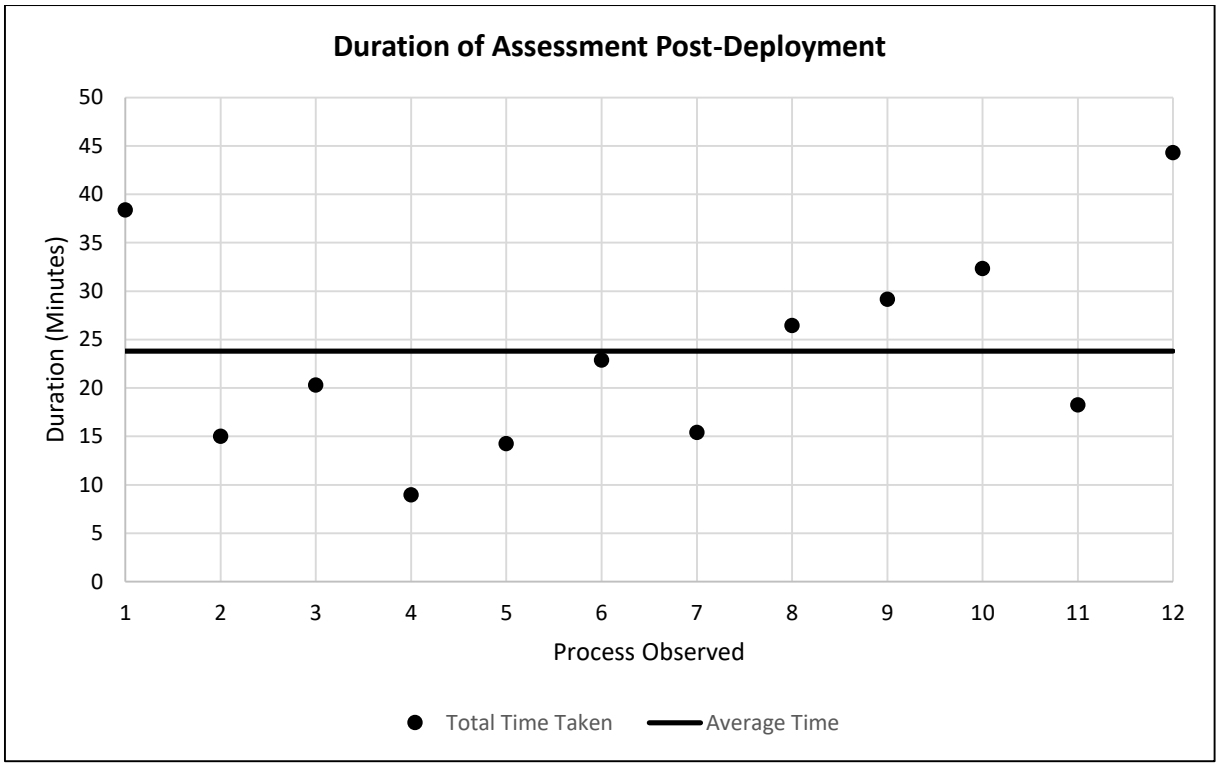

Figure 5.6 Total Time Taken per Observed Process Post Deployment

5.3.2. Number of Steps Required to Complete Assessment Process

The next variable considered was the number of steps required to complete the process pre and post implementation of the newly digitised process. Similarly to the findings regarding time, there was no significant difference found between the number of steps required pre and post-deployment of the new system. As defined above, a step constituted a defined

activity within the process being undertaken, such as updating the whiteboard or locating the medical chart.

Prior to the implementation of the digitised process, the average number of steps required to complete the observed processes was 9.75 (SD = ±4.18). The number of steps required to complete the assessment process in each observed instance prior to the deployment of the digitised system is shown in figure 5.7 below.

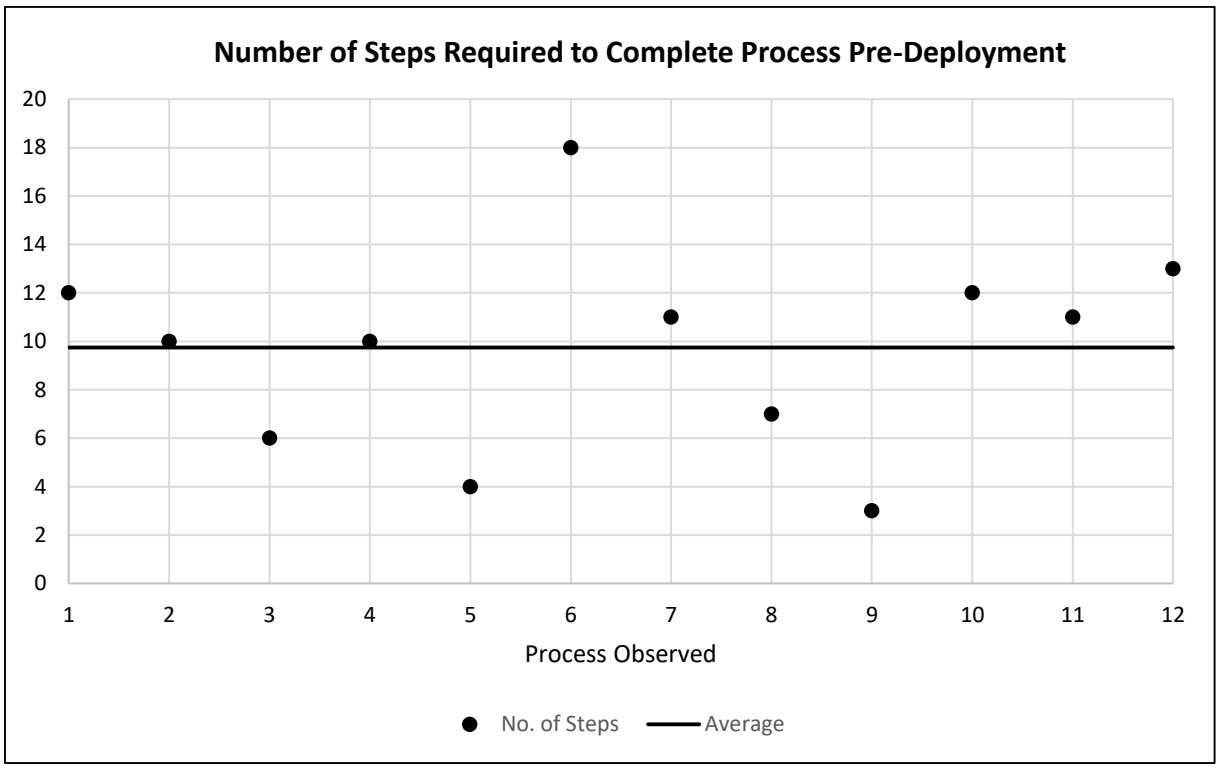

Figure 5.7 Number of Steps Required Pre-deployment

After the deployment of the system, the average number of steps required to complete the FRAIL triage and assessment was 9.08 (SD = ±2.11). As can be seen from Figure 5.8 below, which demonstrates the steps required to complete each process observed utilising the newly digitised system, there has been a minor reduction in the number of steps required and there is less variation across the sample when compared with the findings from the evaluation of the paper based process.

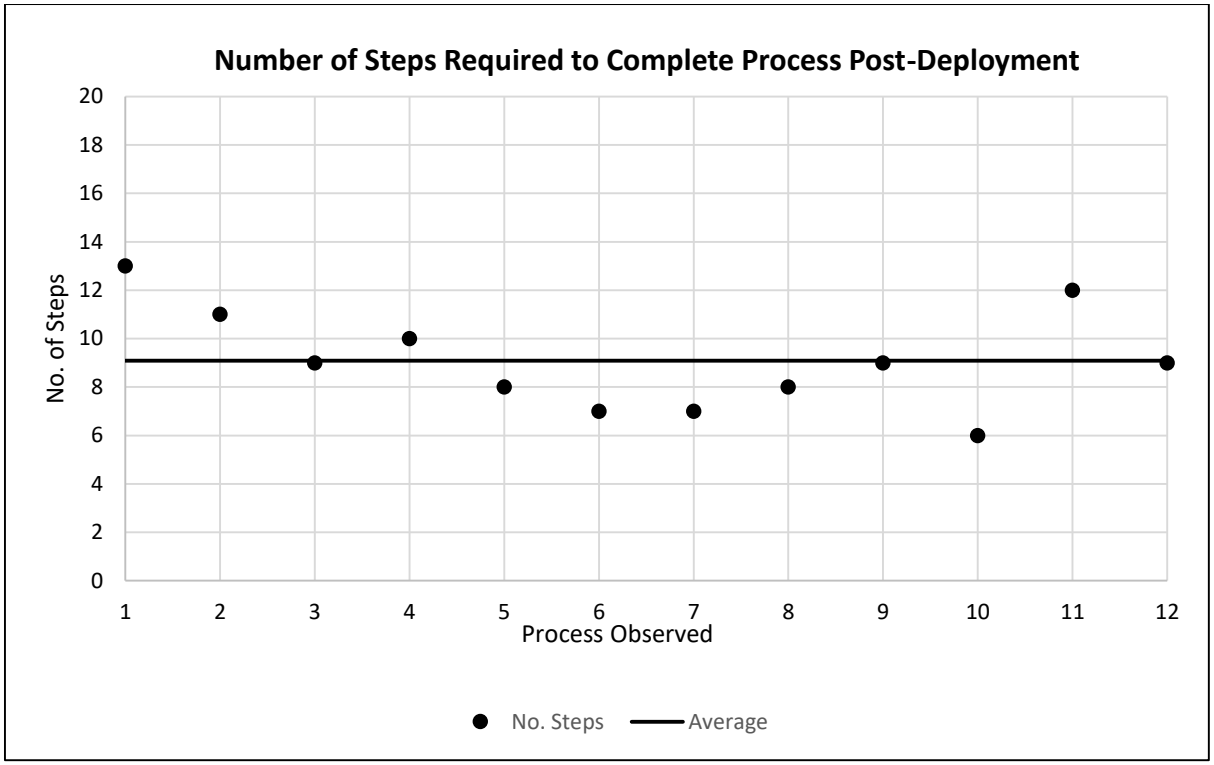

Figure 5.8 Number of steps required post-deployment

5.3.3. User Views on Impact on Efficiency

The first question posed to participants sought to address the perceived impact of the new digital system on the day-to-day workflow for the ED-FIT Team. From these discussions it was noted that:

- The change in practice, while in general perceived as a positive experience, is not without its frustrations. Despite this, there was a consensus among the team members of an overall benefit in adapting to the new process.
- The implementation of the new system has resulted in a beneficial change to the handover process as perceived by the respondents. There is less duplication within the process. It was also opined that there have been improvements in the availability of data.
- The new process was felt to be slower, but it was thought that this may just have been due to it "bedding in".

- Participants reported some difficulty regarding the availability of hardware and reliability of Wi-Fi impacting on the triage process. User preference for hardware was also discussed.
- One of the main factors raised regarding the impact of the newly digitised process was the fact that it was embedded within a paper based system with notes still needing to be printed and "try and find the notes somewhere" (P1) in order to file them.

Having considered the impact on the efficiency of the process, the researcher next sought to evaluate the effect of the system on the communication process and the generation of referrals. The results of this analysis are outlined below.

5.4. Impact on Communication, Handover and Referrals Generated

The researcher reviewed the volume of referrals generated by the ED-FITT process during the 2 week periods of observation undertaken pre and post deployment. The impact of the system on the team's ability to communicate and generate handover was also discussed with team members during face-to-face interviews.

5.4.1. Details of Onward Communication Generated

The requests generated by the ED-FIT Team for follow up by various therapy services over a two week period during the period of observation was captured pre and post deployment. The results of this can be seen in Table 5.2 below. The change in process was associated with an increase in the rate of referral to services outside of the ED-FIT team. This was generally localised to patients who were admitted, with an increase in referral rate to all disciplines of between 11.75 and 44.35%. The change in referral pattern was not as evident for those patients discharged with referrals to dietetics, speech therapy and social work increasing and those to physiotherapy, occupational therapy and pharmacy decreasing.

Further to this, user opinions regarding communication and handover were also reviewed. The following section outlines the main points raised from these discussions.

Table 5.2 Onward Referrals Made by ED-FIT Team

	Admitted				Discharged			
	Pre		Post		Pre		Post	
	% Referred	N=	% Referred	N=	% Referred	N=	% Referred	N=
Total	-	82	-	91	-	54	-	66
Dietetics	19.51	16	32.97	30	7.41	4	7.58	5
MSW	21.95	18	35.16	32	5.56	3	12.12	8
OT	29.27	24	73.63	67	35.19	19	22.73	15
Pharmacy	35.37	29	61.54	56	33.33	18	21.21	14
Physio	48.78	40	72.53	66	59.26	32	46.97	31
SLT	25.61	21	37.36	34	18.52	10	22.73	15
BRAT	-	-	-	-	51.85	28	6.06	4

5.4.2. User Views on Communication

The researcher assesed the impact of the newly implemented system on the handover and communication processes within the ED-FITT triage. When investigating this topic during interviews with the ED-FIT Team members the following points of note were recorded.

- One of the perceived benefits of the system is the ability to share information with the wider hospital and not just the ED-FIT Team itself.
- Standardisation of the data captured by the digitised process and the automation of the handover process were reported by the participants as having a positive impact on patient safety. Referrals are no longer delayed and are not prone to "human error" (P2). The process is less "person dependent" (P5) and as a result, team members no longer "have to worry about the notes, (I) know they're there." (P1).

In considering the impact of the ED-FITT system on communication, it is also necessary to consider the clinical data available for such a handover to occur. The results of the evaluation of the effect the system has on the quality of data available are outlined below.

5.5. Quality and availability of clinical data

The completeness of the data captured as part of the ED-FITT process was considered in the researcher's endeavour to answer the defined research question. Data regarding this impact

was obtained using the QNote tool to assess clinical data quality and completeness and by engaging with participants through observation of processes and face-to-face interviews. The results of this are outlined below.

5.5.1. QNote

The QNote tool was utilised to assess clinical data captured during the observed processes. Of the documentation associated with the 12 processes observed prior to the implementation of the newly digitised processes, the researcher was only able to locate 8 documented assessments having reviewed medical charts, ED notes and scanned documentation. This represented a 33.3% instance of missing documentation and unavailable data. Of the remaining 8 assessment forms reviewed none included any mention of allergies and a problem list was not included. The average quality score attributed to available assessments was 69.39 (SD ± 18.61). It should, however, be noted that while the missing assessments were excluded from the calculation of the QNote score, a case could be made to include them and to score all fields as missing. This would result in the average quality score for the paper process being reduced from 69.39 to 46.26 (SD=±37.25). Table 5.3 below outlines the average scores of each attribute assessed by the QNote tool both pre and post deployment of the new system for all retrieved assessments.

Table 5.3 Average Scores Attributed to Each Quality Domain Pre and Post Roll Out

	Pre Roll Out		Post Roll Out	
	Mean Score	SD	Mean Score	SD
Present Complaint	75	±26.73	75	±33.71
History of Present Complaint	75	±33.41	86.46	±28.43
Past Medical History	87.5	±35.36	66.67	±49.24
Medications	35.42	±49.15	47.22	±44.85
Allergies	0	0	0	0
Social History	86.25	±35.03	91.67	±28.87
Review of Systems	81.25	±37.2	79.17	±39.65
Findings	79.17	±36.46	91.67	±28.87
Assessment	79.69	±36.56	95.83	±14.43
Plan of Care	81.25	±33.41	83.33	±32.57
Follow Up	82.81	±34.03	94.79	±9.91
Overall	69.39	±18.61	73.81	±21.1

All documentation pertaining to the assessments observed post deployment of the newly digitised process was available for analysis to the researcher. The average quality score assigned to the clinical documentation created using this newly digitised process was 73.81 (SD = ±21.1). Similarly to those assessments completed using the paper process, none of the assessments completed using the digital form contained details regarding allergies and problem lists were not deemed appropriate. Examples of completed QNote assessments for both a paper and digital forms are included in Appendix E and F.

5.5.2. User Views on Data Availability and Quality

Participants were questioned regarding how they felt the process had impacted on the availability and completeness of data. The main points of note are outlined below.

- It was felt that more information was available due to the perception that the system required individuals to fully complete all relevant aspects of the assessment, unlike the previous paper process. The information was also felt to be clearer.
- There was also a consensus that the possibility of information being available after a patient has been discharged was a positive outcome.

5.6. Unintended Consequences

When observing processes and investigating user opinions regarding unintended consequences researcher found the following areas of note:

- Participants reported a need for additional fields or modified assessments based on patient cohort such as BRAT patients (P6) and those with cognitive impairment (P4).
- There was a need for members of the FIT Team to “troubleshoot” around issues.
- There is a persistent use of paper within the ED-FITT triage process.
- The process itself continues to evolve as participants become more familiar with the system itself.
- The ability to copy and paste from other systems was also deemed to be of benefit to team members.

5.7. Conclusion

The researcher has found that the newly digitised process has resulted in a marginal increase in the time required to complete the process, a result that is echoed by the results of the interviews undertaken with members of the ED-FIT Team. The output of the team in terms of the volume of assessments completed, is similar both pre and post roll-out of the new process. The newly digitised process required fewer steps overall for completion when compared with the original paper based process. The ability of the system to streamline this process, has been reported by participants who suggest that the automation of various aspects including the handover process has been of great benefit to the team and helped in standardising the process and ensuring communication among team members and the wider organisation. Chapter 6 that follows, will discuss the findings of this research in detail.

Chapter 6. Discussion

This chapter seeks to discuss the results outlined in Chapter 5 in detail.

6.1. Introduction

This research sought to design a system to replace the current paper based ED-FITT triage process and to evaluate its impact on the data collected by and available to the team, efficiency of the triage process undertaken and the ability of the team to communicate with all relevant individuals. The following sections will outline this evaluation together with consideration of the impact of unintended consequences that arose due to deployment of the system.

6.2. Efficiency

The effect of the digital assessment on the efficiency of the overall ED-FITT workflow is considered below.

6.2.1. Time

This study did not find a significant difference in the time required to complete the triage process pre and post roll out of the digital system. This would appear to contradict the findings of Hertzum and Simonsen (2013), who found that employing an electronic whiteboard in ED resulted in increased time being available for direct patient care. A potential reason for this difference, is the fact that the digital system in the study site hospital is only newly introduced. Although a period of adaptation was undertaken, this was short due to the time constraints imposed by the process of this study. Another potential reason for this difference is that the digital process exists within a paper dominated environment. Additional time is required for the team to convert the output of the digital process into a paper format, which is compatible with the persistent paper-based practices in place within the study organisation at large. However, the automation of various aspects of the process has ensured that the time taken is not overly onerous when the processes are compared.

6.2.2. Number of Steps Required to Complete Process

There was no significant difference found between the number of steps required to complete the triage process pre and post deployment of the new system. However, there was a marginal decrease in the steps needed with the newly digitised process. This is in part due to the automation of aspects of the process, such as updating of the whiteboard and referral generation. Many of the steps required to complete the process were due to the nature of the ED environment, where difficulties were experienced in finding notes, finding medical staff and finding patients added to the number of steps required to complete the process. The ability of a well-constructed system to decrease the number of steps required and thus decrease the amount of time required and streamline a process has been suggested in the literature (Rasmussen and Kushniruk 2013). It is possible that with a decreased dependency on paper within the wider hospital environment, the number of steps required to complete the ED-FITT triage process may be further reduced. As part of the observation of processes, the use of copy and paste was also noted to occur demonstrating that the members of the team were attempting to further maximise efficiency and decrease the number of steps required to complete the process.

6.2.3. User Views on Efficiency

A part of the interview process sought to elicit participant opinions regarding the impact of the system on the day-to-day workings of the ED-FIT Team. The data is presented under the various sub-themes that arose from the raw data. These are outlined in Table 6.1 below. They are discussed in detail in the following subsections.

Table 6.1 Sub-themes of Workload Impact Theme

	Theme	Subtheme
Impact on Workflow	Response to change	Emotional response
		Time Requirements
		Dichotomous process
	Technology	Occurrence of “glitches”
		Technology skills
		Hardware

6.2.3.1. Response to change

In addressing the response to change raised during discussion with participants, three main sub-themes were identified, emotional response to change, time requirements and finally the dichotomous process in existence.

6.2.3.1.1. Emotional Response

The emotional response to change proved a recurrent theme echoed by many of the participants. Interviewees reported feelings of frustration with the process, "*I suppose everyone was a little…frustrated because it takes, it takes, well that week it just takes more work*" (P4). This frustration is something which has been mentioned in the literature. Dagroso et al. (2007) similarly found frustration among clinicians during the initial implementation phase, in that instance requiring the developers to re-evaluate the system itself. Similarly, when assessing the impact of an electronic whiteboard on the workflow of ED practitioners, frustration was noted by physicians with the inability to use the system at the patient bedside (Hertzum and Simonsen 2013). This sentiment was further echoed in a study by Unertl (2012) where clinicians expressed their frustration at difficulty accessing information and the multitude of systems in which data was stored. Despite the feelings of frustration, it would appear that these are also intermingled with more positive feelings of "*it's been very exciting to be going electronic*" (P6), and also a general acceptance of this "*as we get used to it, …, it's not too bad*" (P1).

6.2.3.1.2. Time Requirements

Alongside the emotional response to change discussed above, another theme noted was the impact of the new process on time. As echoed by the results of the assessment of time taken to complete the observed processes as part of this study, the participants report that the implementation of the new process has resulted in "*At the minute, it's still a little more….timely…I would say*" (P3) and "*initially we were probably slower in terms of our documentation*" (P5). The sentiment does appear to mimic the reports of frustration being transient with "*people (can) see beyond the initial stages and can see to where, to a time where it will speed up things, reduce waste, increase efficiency and be beneficial, like, hugely*

beneficial to the team, and the service." (P6). The potential for a digital process to decrease the time required for completing assessments is described by Clark et al. (2014). The authors found that utilising an electronic patient journey board increased available clinical time by 20 minutes per shift per staff member. A potential barrier to the ED-FIT Team realising this benefit, may be the fact that this process exists within an organisation that remains significantly paper based. This dichotomy was also raised by the team members and is discussed in the following section.

6.2.3.1.3. Dichotomous Process

Much was mentioned by participants of the ED environment and the existing dual process in situ. There was a general consensus of *"(If) the whole hospital went electronic eventually that would be brilliant, that would be the plan, cause then we wouldn't have to photocopy anything, you just do your note and then it's done, it's up to everyone else to read it*" (P1). Much of the duplication and inefficiency within the process was noted to be due to the need to photocopy or printing. As mentioned above, this adds additional steps and time when processes are completed, thus complicating the process itself. The need to access multiple systems and information being unavailable is an issue that is raised by Unertl et al. (2012). It is suggested by the authors that the use of multiple systems, including paper based ones, results in difficulties for clinicians in finding all the necessary information, a sentiment that is echoed by the users in this study who report "*it's such a challenging environment generally, in terms of finding the patient, finding the notes, finding the doctor, whatever, you're always kind of coming up with your own systems. So say I would often just get a quick verbal handover on them and not have the notes and go directly to the patient and get all the social stuff from them so that I'm not waiting for notes. Those kind of things to try and reduce as much as we can from a time point of view*" (P5). Conversely, however, maintaining a paper record in conjunction to an electronic one may be beneficial at least in terms of a central store of data which can be easily accessed (Varpio *et al.* 2015). The impact of paper persistence will be discussed later in section 6.5.1.

6.2.3.2. Technology

When participants considered the impact of the new process on the assessment workflow, one of the aspects mentioned was the impact of technology on this. Three main aspects were raised; the impact of "glitches", IT skills and the choice and availability of hardware. These are discussed below.

6.2.3.2.1. The Impact of "Glitches"

Glitches were defined by participants as aspects that need "ironing out" (P5) and mainly concerned difficulties regarding Wi-Fi in ED. The main impact on the process caused by Wi-Fi was inconsistent availability. Users described that *"if you're in a place with no Wi-Fi, you lose your page and that's really annoying so it's just that sometimes that little bit of slowness, takes up your time and that's frustrating*" (P3). Other members of the team described similar frustration and impacts on the process when there is "*some sort of a glitch and the form gets wiped on you*." (P4). This has been discussed in the literature as being a factor that influences the adoption of HIT. Concerns have been described regarding data being lost in the event of a "glitch" occurring (Gururajan *et al.* 2013). In this Australian study, technology, along with people and process were identified as the key variables in the acceptance of electronic patient journey boards. The authors suggest that potentially a blackout or a "glitch" could impact on the functionality of the ward, possibly indicating a reliance on the system to drive workflow once it becomes embedded.

Another aspect raised by Gururajan et al. (2013), is the availability of technological support. This is another element raised by users as part of this research study who reported that the need for IT support also impacted on the workflow as "*we're not used to it and we don't know, ….we can't fix the glitches*" (P3) and there is a need for someone "*to troubleshoot for us*" (P4), especially "*when the iPads haven't connected*" (P4).

6.2.3.2.2. User Skills

When the ability of the electronic system to streamline the ED-FITT process was discussed with users, the technological skills of the individuals themselves were raised. It was felt by members of the team that their "*fat fingers*" (P6) and "*my technology skills, (…) it wouldn't*

have helped" (P2) impacted negatively on the workflow and slowed the process down. For those who felt that their technology skills were better, there was a consensus that the process ultimately was more streamlined and more enjoyable for those who were "*more electronic based*" (P1). This aspect was also raised by Gururajan et al. (2013) who suggested that less skilled individuals may find adaptation to an electronic process more difficult.

The impact of training was also raised by one participant who suggested that the introduction of less skilled or familiar staff into the ED would result in a need for training about the "*nuances*" (P6) of the system in order to minimise disruption to the workflow and maximise efficiency. The need to consider the skills of end users in ensuring efficiency with newly deployed systems and the complexity of training requirements findings is also reported by Kelay et al. (2013), whose systematic review pointed to user skills as having a direct impact on clinician workload as they endeavour to adapt to the new system. They also recommend training on systems prior to implementing them. However in the instance of this study, most training was provided in the live environment due to the clinical time commitments of users and thus may have impacted on the efficiency of system use.

6.2.3.2.3. Choice and Availability of Hardware

As discussed in Chapter 4, the system was designed to be accessible using both a desktop PC and also a tablet. The choice of hardware employed by the ED-FIT Team was determined both by availability and personal choice. Users report difficulties with access to iPads as "*6 of us are operating off 3 iPads at the moment so sometimes there's no iPad available*" (P4), "*I suppose at the moment, there is a shortage of iPads, when all of us are on the floor together*" (P2). This has a direct impact on the efficiency of the process, as clinicians need to either employ paper or "*do it from memory*" (P4) and complete the electronic form later, adding time and steps to the process. The issue of availability of equipment also impacts the efficiency of the process as the sharing of printers among all users within the ED can result in a delay in the team's ability to access them to print completed assessments to file within the paper based medical charts and it is hoped that "*going forward, we will hopefully have more direct access to a printer, you know and an easier way of kind of printing"* (P5). This echoes

findings in the literature that hardware availability has a direct impact on system use (Unertl *et al.* 2012).

The use of handheld devices has been shown to improve clinical efficiency and the potential for ongoing gains to be made as technology itself advances (Mickan *et al.* 2013). Despite this, the use of hardware was not only mitigated by availability but also by user choice. Some users expressed the opinion that "*I'm much more quicker, using the computer I think than just maybe using the iPads*" (P2). There is potential that familiarity with technology could be a factor with reports of "*the first couple of days using the iPads, maybe slowed me down*" (P2) and some users indicating that "*I'm trying to input stuff onto the computer rather than the iPad, that'll be the next stage, then*" (P6). The decision to use a PC instead of a portable device denies the therapist the ability to interact with the system at the bedside. However, it affords the users some of the benefits of using a handheld device but requires either duplication in the form of paper documentation or transcription from memory further complicating the process.

6.2.3.3. Summary

With regards to the impact of the system on the efficiency of the process, no statistically significant difference was noted in terms of time or steps required to complete the process. Users reported some frustrations with the process of change, however they expressed feelings of the system ultimately being able to improve on the process once a "bedding in" period had elapsed.

The impact of the system on the ability of the team to communicate is explored in the following section.

6.3. Impact on Communication, Handover and Referrals Generated

In considering the impact of the system on communication, the effect of the automation of the process, together with the clarity of the data being communicated were the sub-themes elicited from the interview process.

6.3.1. Referrals Generated

It is posited that automatic notifications may be of benefit in communicating patient care information (Dalal *et al.* 2014). Increases in the generation of automatic communication is noted in the literature with caveats regarding the need to implement procedures to minimise alert fatigue and ensure the accuracy of the communication generated (Dalal *et al.* 2012). In the current study, the implementation of the digital process saw an increase in referral generation to services outside the ED. The reasons for these increases are not clear. Potentially the increase is due to the ease with which referrals can now be generated. As the process of referral is built into the digital workflow, it does not require the user to access a separate system to generate the referral. It is also possible that the increase is not actually as large as it would seem. Due to the dependency of the process pre-deployment on verbal handover, it is possible that referrals were communicated verbally but not recorded within the system.

6.3.2. User Views on Communication

When discussing the impact of the new system on communication, participant responses demonstrated two main sub-themes, automation of process and clarity. These are discussed below.

6.3.2.1. Automation of process

One of the benefits perceived by the team members is the automation of the handover and communication process. It is seen that "*there was a real time consuming part of our work to get that handover part right, em, so that's been a huge time saver*" (P4). The elimination of the potential for "*human error, …., people have went upstairs and forgotten to bring the handovers*" (P2) has positive impacts on patient safety. This automation has resulted in the team somewhat moving away from the need to communicate with their colleagues outside of the ED verbally and depending on the system to provide that communication. This willingness to accept the automation partially contradicts the findings of Bernham-Hutchins and Effken (2010) who report that 84% of their respondents preferred to communicate

verbally with their colleagues for handover. It could be suggested in this study that the "*time saver*" (P4) perspective has outweighed this desire for verbal communication.

6.3.2.2. Clarity

From discussions with the participants, the use of the new electronic whiteboard has had a mixed impact on the communication within the ED-FIT Team. Opinions ranged from the process providing improved overview with information "*in front of you in black and white so it is much more accessible*" (P3) to team members being less aware of the patient journey. It was opined that "*computer screen is not as visible as a whiteboard*" (P6). This was further emphasised by reports that "*you'd start inputting your data but the list in the main office wouldn't update, so the person HAS to go in and refresh that screen*" (P4). Conversely participants also reported that "*now we have a simple screen and we can see what's happening*" (P3). It has also been suggested that the change in medium has improved face-to-face communication within the team itself as team members "*are definitely talking more and we're better at coming up with, I think, plans as such now*" (P3). This need to ensure what has been termed "communicative co-ordination" is seen in the work of other authors in this field, who found that in order to ensure patient safety and to promote an overview required by the team, verbal communication can be necessary (Hertzum and Simonsen 2015).

Participants also identified the ability of the new system to improve the ability of the team to transfer information outside of the ED itself. There is potential to use the system to "*hopefully help with our FITT pathway system as well and some of the issues we're having getting patients up to the beds that are available*" (P5). This would suggest that the system allows for collaborative working without a dependence on location. This in essence allows for communication without interruption to workflow and in part supports the findings of Hertzum and Simonsen (2015).

6.3.3. Summary

The newly implemented system has had an effect on the communication process undertaken by the FIT Team. There has been a proportionate increase in the referrals generated by the team, however it is not clear if this increase is directly due to the

deployment of the system. User opinion regarding the effect of the system on communication suggests that the automation of the referral generation is seen as a significant benefit of the system. The implementation of the electronic whiteboard would appear to have improved communication with the wider organisation, but has been met with mixed opinions regarding the clarity with which it affords this communication.

6.4. Quality and Availability of Clinical Data

Clinical documentation is critical to allow clinicians to narrate the story of the patient's journey. The impact of the new ED-FITT process on the quality and availability of this critical data is explored below.

6.4.1. QNote

Documentation captured using the digital process scored higher using the QNote tool, although, no significant difference in the completeness of clinical data from assessed forms was found. It should be noted that 33% of the forms completed with the original paper process, where not locatable for evaluation. In terms of the availability of data for the ED-FIT Team, the new digital system has proved 100% reliable with all forms retrievable. The higher quality scores found with those assessments generated using a computer system echoes the findings of Burke et al (2015), who found that the quality of clinical notes improved within 6 months of the implementation of an EHR. The trend continued after 5 years. It is possible that re-evaluation of the ED-FITT system 6 months post implementation may demonstrate a similar significant improvement. A similar trend in improvement in quality was also noted by Jamieson et al (2016). Similarly to Jamieson et al, this study found a greater improvement in the quality of the history of present illness between groups. Overall it would appear that consistent with similar studies available in the literature, the use of the electronic system has improved the quality of clinical notes captured as part of the ED-FITT process.

6.4.2. User Views on Data Availability and Quality

When discussing the quality and availability of data with participants the main subthemes noted were standardisation and availability. These are discussed below.

6.4.2.1. Standardisation

The structure applied to the clinical notes collected by the new system was felt by users, generally, to be beneficial. The process is now less "*person dependent*" (P5) and as a result the "*CST might not have been completed but now, you're completing everything*" (P1). The presentation of the generated document was also welcomed by some users as "*reading back is clearer, 'cause the writing, you know. 'Cause if I'm reading someone else's or even my own at times, it's not very good for reading*." (P2). This is supported by claims in the literature that clinicians prefer to use structured reports (Noumeir 2006).

Concerns were however raised regarding the standardisation within the system as it does not apply to all patients and users report a "*need another option that might say not applicable*" (P4). Compulsory fields may actually lead to inaccuracies in the data collected with, for example, cognitive screens being completed even if not deemed clinically appropriate or actually "*insensitive to a patient, to put them through four questions, when they can't answer it*" (P4). This supports the findings of Jamieson et al., (2016) who report that there are potential benefits in affording clinicians freedom over structure and content in terms of data accuracy.

6.4.2.2. Availability

Clinical data being available for secondary use was seen as a positive outcome of the system, particularly the ease of collection. The team report "*the fact that all this data will be collected is very very important (….) a huge issue (….) to enforce, (….)now, (….) therapists will do their notes and automatically the data will be collected*" (P1). The use of standardisation to allow for such data mining echoes findings in the literature (Batra and Sachdeva 2016). A second key benefit highlighted by the team was that "*it's actually easier now*" (P2) to access data on patients after discharge which is supported by the fact that 100% of assessments completed using the new system were available compared to 67% of the paper based assessments reviewed as part of this study.

6.4.3. Summary

The newly deployed system has impacted positively on the quality of clinical data captured with improved objective quality measures and subjective feedback. 100% of assessments were available for analysis compared with 33% missing assessments using a paper process further demonstrating the benefit of this system regarding the ability to capture and retrieve data as needed.

6.5. Unintended Consequences

The final component of the system evaluation undertaken was consideration of the unintended consequences that occur with its deployment. The main consequences, paper persistence and workarounds, are discussed below.

6.5.1. Paper Persistence

There has been a persistence in the use of paper within this process. In part this is due to the dichotomous process outlined above. There is also a reliance on paper "*to jot things down*" (P6), possibly due to "*not trusting it as much*" (P3). This persistence is documented in current literature where it is suggested that it occurs due to social systems or technical infrastructure (Harrison *et al.* 2007). Another potential reason for the persistence of paper, is in relation to access to the system as highlighted earlier in this chapter, such as access to iPads or PCs or Wi-Fi issues. Another unintended consequence noted here, is the need for the assessment once completed to be printed. This adds another element to the workflow that echoes studies that investigate the occurrence of such consequences (Ash *et al.* 2004).

6.5.2. Workarounds

One workaround the team have implemented is the use of "copy and paste". It has afforded them the opportunity to access data from other hospital systems, such as "*the Day Hospital*" (P4) and include it within the assessment, where appropriate. This reduces duplication of data, improves the consistency of data regarding the patient held within a variety of hospital systems and further improves the efficiency of the process. It has, however, been noted that this can lead to data overload especially if care is not exercised regarding the amount and type of data copied (Ash *et al.* 2004).

6.5.3. Summary

Unintended consequences occur frequently with the deployment of a new HIT system. As part of this study, the researcher has identified the persistence of paper and the developments of shortcuts and workarounds as consequences of the implementation of this system which have potential to impact the efficiency of the process, the availability of information and completeness of data.

6.6. Summary

The system has been successfully deployed within ED. On evaluation of the impact of the system on the efficiency of the process, communication and completeness of data, this study has not demonstrated significant differences between the paper and digital process in terms of time or number of steps. The system has demonstrated improvements with regards to the ability to retrieve data as well as its completeness. The system itself has been well received by end users who identify benefits particularly relating to communication and handover and their impact on patient safety. Despite this, paper continues to pervade the process as an unintended consequence and as a direct result of the dichotomous paper reliant process in place within the ED.

Chapter 7 that follows will outline the learnings, future developments and recommendations that follow from this research.

Chapter 7. Conclusion

This chapter seeks to draw conclusions from the research completed as outlined above. It will outline the limitations of the study and the recommendations for future investigation and development.

7.1. Introduction

This study sought to design a digital version of the ED-FITT assessment process and evaluate its effect on efficiency of process, communication, and quality of data. The researcher employed a mixed methods approach to complete the evaluation. The limitations, recommendations and main findings are summarised below.

7.2. Limitations

While every attempt was made to complete this study in a rigorous fashion, this study is not without its limitations. These are outlined below.

- Participants were identified by convenience sampling meaning there was no way conduct a randomised control trial.
- Due to time constraints it was not possible allow more time for the system to become embedded in the workflow prior to completing the evaluation process.
- Participants were aware of the presence of researcher during the observation phase of the study.
- A small number of processes were observed and although this was dictated by the need to reach saturation, it resulted in a small sample being available for evaluation of aspects such as time taken, steps required and quality score.

7.3. Recommendations

This section seeks to outline areas where future research may be directed.

7.3.1. Areas for Future Research

- In order to overcome the limitation of time constraints imposed by this study design, the impact of the digital system re-evaluate after a further period of adaptation.
- Results were limited as the system was implemented in a single ED, evaluating the effect of an electronic system across more sites or more wards within the study site may give wider reaching results.
- Further investigation of the reasons for increased referral to inpatient services.

7.3.2. Areas for Future Development

The ED-FITT digital project continues to grow and develop further impacting the organisation at large. The following demonstrates areas were effort is being directed to maximise the potential of this project largely in response to user feedback:

- More tablets are to be procured for the team to minimise the impact of unavailability of hardware on the process.
- Wi-Fi within the organisation is scheduled for upgrade. It is hoped that this will minimise the issues of dropped connection and "glitches" as described by end users.
- Due to the development within the organisation of a digital document repository and agreement from the Medical Records Steering Committee, digital copies of the completed assessment will be automatically uploaded under the relevant patient, negating the need for printing.
- Review of the compulsory components of the system will be undertaken in response to user feedback regarding their appropriateness in certain cohorts of patients.
- The use of FlowForma to generate referrals for all therapy services from the wider organisation is under review.

7.4. Summary of findings

The purpose of any research project is to attempt to add to the collective knowledge on the subject under investigation. This section will outline the key aspects known from the literature and what this study has added to that knowledge base.

Aspects from literature

- Healthcare informatics has the potential to improve collaborative working in complex healthcare environments
- The implementation of electronic whiteboards directly impacts on clinical workflows
- Electronic systems have the potential to improve note quality.

Lessons learnt from this study

- A digital assessment process can be deployed successfully in an Irish healthcare setting.
- Implementation of a digital system in ED resulted in small improvements in clinical note quality.
- The digital system is generally felt to be beneficial, especially in terms of communication and handover.
- Implementation of a digital system improves the availability of clinical data.

7.5. Conclusion

This research sought to design and implement a digital version of the ED-FITT assessment process and to evaluate its impact on the communication generated, the completeness of the data collected and the efficiency of the process. The study required the researcher to engage in an iterative design process followed by a mixed methods approach to evaluate. It has been recommended by the researcher that to further evaluate the effects of this system, a repeat evaluation be undertaken once a substantial period of adaptation has elapsed. Areas of potential development for the system are also noted. Finally, this study has demonstrated that it is possible to embed a digital system, within a predominately paper environment, with acceptance from end users.

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Appendices

Appendix A – Interview Protocol

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Study title: The impact of digitisation of the FRAIL assessment in the emergency department setting

SAMPLE SEMI-STRUCTURED INTERVIEW PROTOCOL

The investigator intends to use a semi-structured interview approach with 3 set questions with follow-on questions as indicated as outlined below

GREETING:

Thank you for agreeing to sit down with me today. The purpose of this interview is to discuss your thoughts and opinions regarding the new electronic version of the ED-FITT assessment. There are no right or wrong answers; I am purely interested in your honest assessment of this new system and how it impacts on your workflow and assessments. I hope to tape-record this conversation so that I am able to give my fullest attention to this conversation and will not miss details while trying to write notes. Anything you say is completely confidential and no-one other than myself will have access to this recording without your express permission.

Before we start, can you please confirm that you have received the participant information sheet and consent form and are happy to continue with this process.

QUESTION 1:

What do you feel has been the impact of the new digitised system on your day-to-day work?Follow – on questions may include: How has the new process impacted on the time taken to carry out an assessment? Do you feel the new system has streamlined or complicated the process? **QUESTION 2:**

How would you describe your experience of using this system?Follow-on questions may include: Are there suggestions you would make to improve the system? Have you had to change how you work to adapt to the system? How? Have you developed any tricks to make to help navigate the system easier?

QUESTION 3:

What do you think has been the impact of the system on communication and patient hand-over?Follow-on questions may include: Do you feel that you are more or less aware of what is happening with patients?

WRAP UP:

Thank you again for agreeing to participate in this interview. It has been exceptionally helpful to hear your opinions regarding this new system. If you have any questions, I would be happy to answer them.

Interview Protocol Version 1 December 2016

Appendix B – Overview of themes and distribution within raw data

	Theme	Subtheme	Participant					
			P1	P2	P3	P4	P5	P6
Efficiency	Response to change	Emotional response			Y	Y		Y
		Time Requirements	Y	Y			Y	Y
		Dichotomous process	Y	Y		Y		Y
	Technology	Occurrence of “glitches”	Y	Y	Y	Y		Y
		Technology skills	Y	Y	Y	Y		Y
		Hardware		Y		Y		Y
Communication	Communication	Automation of process	Y	Y	Y	Y	Y	Y
		Clarity	Y	Y	Y		Y	
Data	Awareness	Availability of information	Y	Y	Y	Y	Y	Y
		Quality of Data	Y	Y	Y		Y	Y
	Unintended Consequences	Persistence of paper	Y		Y	Y		Y
		Workarounds	Y	Y	Y	Y	Y	Y

Appendix C – Response from Study Site Research Ethics Committee

Beaumont Hospital
Ethics (Medical Research) Committee

Chairperson: Professor Gerry McElvaney
Convenor: Dr. Peter Branagan

Administrator: Phil Oglesby

19th December 2016

TO WHOM IT MAY CONCERN

It is the policy of the Beaumont Hospital Ethics (Medical Research) Committee that service evaluation exercises notified to the Beaumont Hospital Quality and Standards Department do not require research ethics committee approval.

I confirm that the following project has been categorised as service evaluation:
Ms. Julie O'Connell
MSc Healthcare Informatics, Trinity College Dublin
The Impact of Digitisation of the FRAIL Assessment in the Emergency Department Setting

Kind Regards

Yours sincerely

Gillian Vale MSc
IRB Specialist
Ethics (Medical Research) Committee

Ethics (Medical Research) Committee Beaumont Hospital Dublin 9 Ireland
Tel: 353 1 809 2680 Email: beaumontethics.ie www.beaumontethics.ie

Appendix D – Research Proposal Submitted to the TCD Research Ethics Committee

Title of Project

The impact of digitisation of the FRAIL assessment in the emergency department setting

Purpose

This project is being undertaken in part fulfilment of an MSc in Healthcare Informatics.

This research aims to evaluate the extent to which a new electronic system being implemented as part of a service development initiative will meet the following objectives:

1. To streamline the process for the therapists on the ground
2. To facilitate communication of assessment once patient has left ED setting
    a. To Appropriate Ward Therapists if patient is admitted
    b. To Discharge to Assess / Outreach team if patient is discharged to their care
    c. To Community Services (HSE) if patient discharged with referral to same
3. To ensure that there is visibility to all users across the entire process
4. To ensure that completed forms are available to ED staff without the need to pull medical chart should the patient re-present or if there is need for the information to be accessed
5. To ensure completeness of assessment forms
6. To create a user friendly system

Methods and Measurements

The researcher will observe the current practice and map the current workflow and processes. Following implementation of the new system, this process will be repeated. The evaluation of the system will be completed as follows:

System Evaluation:

Streamlining of process

Two methods of evaluation will be completed through observation of the current and proposed processes (see Appendix 4 for protocol and assessment sheet):

1. Measurement of time taken to complete current triage and assessment forms by observation of process by researcher and comparison of this with that taken using digital form. It will be assumed that the start point of the process is when the ED-FIT team becomes aware of the patient and the patient's name is included on the whiteboard or digital list. The process will be deemed to be completed when the assessment has been completed or the patient has left the ED. Only time when the therapists are directly utilising the system will be deemed eligible to be measured and delays caused by external process such as bed management or home care package approval will not be calculated.

2. Calculation of discrete steps required to complete triage and assessment forms pre and post implementation of digital format.

It is proposed that 30 examples of process be evaluated for both the pre and post intervention group.

Facilitate communication of information on transfer from ED

The new digital system will have the ability to generate structured documents of captured information.

The researcher will use information within the system to identify the number of documents generated and to where they have been sent.

Ensure visibility of process

The researcher will observe the whiteboard currently in use by the ED-FIT Team. There will be a comparison of the nature of information being captured using the traditional whiteboard and a list completed automatically as part of the proposed digital process. Special consideration will be given to how this information aids the collaborative working of the team.

Evaluate the availability of information

A profile of the service will evaluate the throughput of patients and the number of forms completed using the digital system in a one month timeframe. Basic non-individually identifiable aggregated data will be captured regarding patient profile. This information will be compared with baseline service evaluation that has already been completed.

Assessment of completeness of data

The researcher will complete chart audit of both the current paper system and proposed digital system. It is proposed to use a structured assessment tool such as QNote (Burke et al. 2014) (See Appendix 5) to evaluate the standard of note keeping in both forms. A sample of 30 charts pre and post intervention will be reviewed

Assessment of user opinions with regard to new digital process

The researcher will evaluate user opinions of the newly implemented process through discussion with therapy staff using the system. Feedback will be sought regarding staff perception of the system to evaluate both intended outcomes and unintended consequences using a semi structured interview (See Appendix 3). Permission will be sought from therapy managers prior to engaging staff in feedback sessions.

Participants

A convenience sample of approximately 8 therapists working within the ED-FIT team will be utilised for both the observational and interview components of this study.

All participants will be over 18 years of age and working as part of the ED-FIT team as either physiotherapists, occupational therapists, dieticians or speech and language therapists.

Participants will be excluded if they do not have experience in working as part of the ED-FIT team. Participants will also be excluded if they do not have experience in using both baseline and new systems.

Debriefing Arrangements

It is intended that the results of this study will be presented to staff and participants as part of "Lunch and Learn", "Grand Rounds" and local staff training events.

Ethical Considerations

This project is being undertaken in part fulfilment of MSc Healthcare Informatics that is being completed by the researcher. A submission was made to the Research Ethics Committee of Beaumont Hospital to clarify that the implementation of this digital system will form part of a service development plan for the ED-FIT team (A copy of the letter received from the Research Ethics Committee can be found in Appendix 6). The evaluation of the system will be undertaken by the researcher and will be comprised mainly of observation of the process as it occurs. There will be no identifiable patient data accessed as part of the study. Semi-structured interviews will be conducted with staff using the system. Prior to conducting interviews, permission will be sought from therapy managers to engage with staff. There will be no discrimination, penalty or impact on career progression regardless of decision made by staff members to participate or not. Data obtained as part of this study will not be shared with management and will not be utilised as part of a performance review. It should be noted that the principal investigator is known to staff, however, as the investigator has no role in managing or overseeing these staff members, no conflict of interest is anticipated.

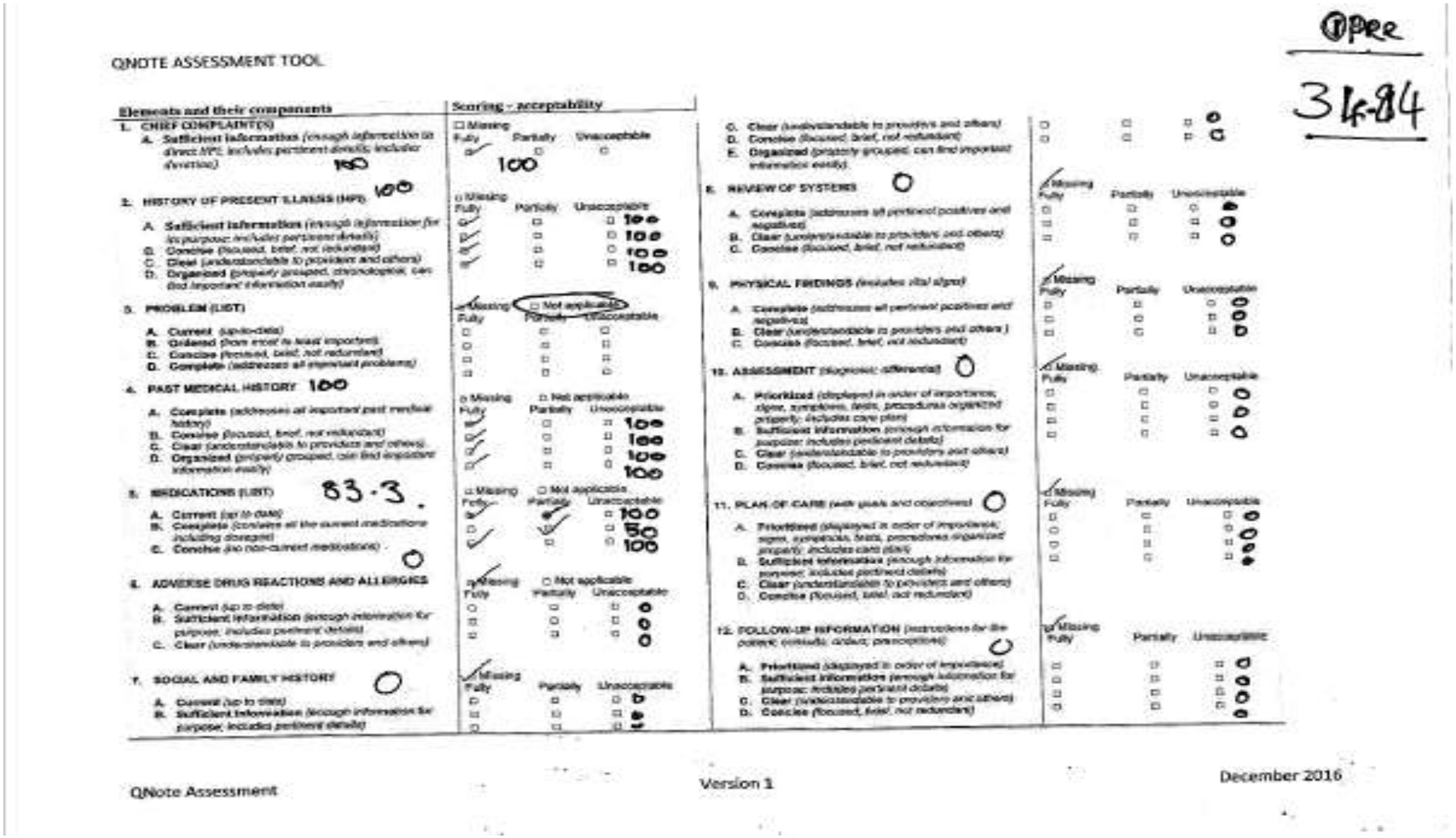
Legislation

All data held will be maintained in accordance with the Data Protection Act. Respondents' identities will be anonymised and all information will be maintained on a secure server and suitably protected.

References

Burke, H. B., Hoang, A., Becher, D., Fontelo, P., Liu, F., Stephens, M., Pangaro, L. N., Sessums, L. L., O'Malley, P., Baxi, N. S., Bunt, C. W., Capaldi, V. F., Chen, J. M., Cooper, B. A., Djuric, D. A., Hodge, J. A., Kane, S., Magee, C., Makary, Z. R., Mallory, R. M., Miller, T., Saperstein, A., Servey, J. and Gimbel, R. W. (2014) 'QNOTE: an instrument for measuring the quality of EHR clinical notes', *Journal of American Medical Informatics Association*, 21(5), 910-916.

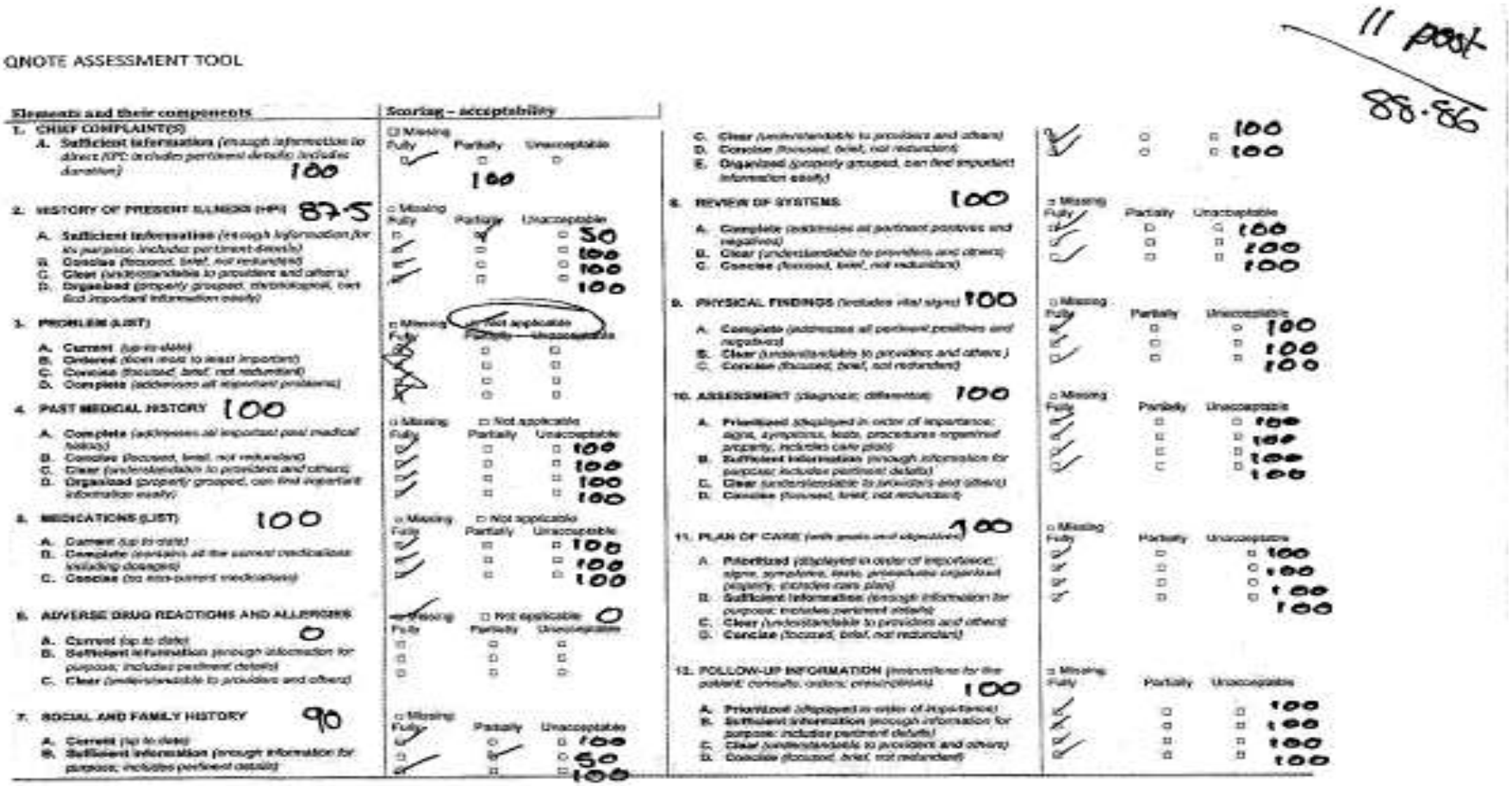
Appendix E – QNote Score sheet for paper assessment



QNOTE ASSESSMENT TOOL

QNote Assessment Version 1 December 2016

Appendix F - QNote Score Sheet for Digital Assessment Form



QNOTE ASSESSMENT TOOL

11 post

88.86

Elements and their components	Scoring – acceptability			
1. CHIEF COMPLAINT(S)	☐ Missing			
A. Sufficient information (enough information to direct IPT; includes pertinent details; includes duration) 100	Fully ✓	Partially ☐	Unacceptable ☐	100
2. HISTORY OF PRESENT ILLNESS (HPI) 87.5	☐ Missing			
A. Sufficient information (enough information for its purpose; includes pertinent details)	Fully ☐	Partially ✓	Unacceptable ☐	50
B. Concise (focused, brief, not redundant)	☐	☐	☐	100
C. Clear (understandable to providers and others)	☐	☐	☐	100
D. Organized (properly grouped, chronological, can find important information easily)	☐	☐	☐	100
3. PROBLEM (LIST)	☐ Missing	☐ Not applicable		
A. Current (up-to-date)	Fully	Partially	Unacceptable	
B. Ordered (does most to least important)	☐	☐	☐	
C. Concise (focused, brief, not redundant)	☐	☐	☐	
D. Complete (addresses all important problems)	☐	☐	☐	
4. PAST MEDICAL HISTORY 100	☐ Missing	☐ Not applicable		
A. Complete (addresses all important past medical history)	Fully ✓	Partially ☐	Unacceptable ☐	100
B. Concise (focused, brief, not redundant)	✓	☐	☐	100
C. Clear (understandable to providers and others)	✓	☐	☐	100
D. Organized (properly grouped, can find important information easily)	✓	☐	☐	100
5. MEDICATIONS (LIST) 100	☐ Missing	☐ Not applicable		
A. Current (up to date)	Fully ✓	Partially ☐	Unacceptable ☐	100
B. Complete (contains all the current medications including dosages)	✓	☐	☐	100
C. Concise (no non-current medications)				
6. ADVERSE DRUG REACTIONS AND ALLERGIES 0	✓ Missing	☐ Not applicable		0
A. Current (up to date)	Fully ☐	Partially ☐	Unacceptable ☐	
B. Sufficient information (enough information for purpose; includes pertinent details)	☐	☐	☐	
C. Clear (understandable to providers and others)	☐	☐	☐	
7. SOCIAL AND FAMILY HISTORY 90	☐ Missing			
A. Current (up to date)	Fully ✓	Partially ☐	Unacceptable ☐	100
B. Sufficient information (enough information for purpose; includes pertinent details)	☐	✓	☐	50
	✓	☐	☐	100
C. Clear (understandable to providers and others)				
D. Concise (focused, brief, not redundant)				
E. Organized (properly grouped, can find important information easily)				
8. REVIEW OF SYSTEMS 100	✓	☐	☐	100
A. Complete (addresses all pertinent positives and negatives)	✓	☐	☐	100
B. Clear (understandable to providers and others)	☐	☐	☐	100
C. Concise (focused, brief, not redundant)				
9. PHYSICAL FINDINGS (includes vital signs) 100	☐ Missing			
A. Complete (addresses all pertinent positives and negatives)	Fully ✓	Partially ☐	Unacceptable ☐	100
B. Clear (understandable to providers and others)	✓	☐	☐	100
C. Concise (focused, brief, not redundant)	☐	☐	☐	100
10. ASSESSMENT (diagnosis; differential) 100	☐ Missing			
A. Prioritized (displayed in order of importance; signs, symptoms, tests, procedures organized properly; includes care plan)	Fully ✓	Partially ☐	Unacceptable ☐	100
B. Sufficient information (enough information for purpose; includes pertinent details)	✓	☐	☐	100
C. Clear (understandable to providers and others)	✓	☐	☐	100
D. Concise (focused, brief, not redundant)	✓	☐	☐	100
11. PLAN OF CARE (with goals and objectives) 100	☐ Missing			
A. Prioritized (displayed in order of importance; signs, symptoms, tests, procedures organized properly; includes care plan)	Fully ✓	Partially ☐	Unacceptable ☐	100
B. Sufficient information (enough information for purpose; includes pertinent details)	✓	☐	☐	100
C. Clear (understandable to providers and others)	✓	☐	☐	100
D. Concise (focused, brief, not redundant)	✓	☐	☐	100
12. FOLLOW-UP INFORMATION (instructions for the patient; consults; orders; prescriptions) 100	☐ Missing			
A. Prioritized (displayed in order of importance)	Fully ✓	Partially ☐	Unacceptable ☐	100
B. Sufficient information (enough information for purpose; includes pertinent details)	✓	☐	☐	100
C. Clear (understandable to providers and others)	✓	☐	☐	100
D. Concise (focused, brief, not redundant)	✓	☐	☐	100