

How Could Maternity Referrals Be Supported by an Online CDSS in Practice and Education

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in partial fulfilment of the requirements for the degree of
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I declare that the work described in this dissertation is, except where otherwise stated,
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Summary

Background

The introduction of Clinical Decision Support Systems(CDSS) within healthcare has been proved to significantly improve the quality of care for patients while enhancing quality assurance. These systems provide the healthcare worker with up-to-date information that may improve their decision making capability.

CDSSs have been a mechanism for plugging evidence based medicine into standard practice allowing the patient to benefit from the most up-to-date research. While CDSSs are becoming more common within the healthcare environment it has not been seen to be prevalent in the educational environment.

There are a number of areas within health sciences that a CDSS can be applied. For the sake of this study we will be focusing on its application in improving referrals within maternity services. The identification of risk for complications of pregnancy is paramount to antenatal care. Risk assessment is conducted during a woman's initial visit to a midwife. This visit, called the booking visit is where the woman provides information about various medical and social elements of her life and a risk profile is built up. This profile is then used in assigning an appropriate care plan to the woman.

Aim and Objectives

The objectives of this study were to develop a web based tool to simulate a booking system based on the systems currently used in the hospitals. The tool should integrate principles of CDSS while encapsulating best practice into the booking system. Evidence based guidelines were to be integrated into the system along with midwifery best practice. The tool will be built with ease-of-use in mind in order to gain support from the potential users. The tool will then be evaluated under the perceived functionality, usefulness, overall satisfaction and usability.

Methodology

Maternity booking systems were observed and evidence based guidelines were retrieved from maternity hospitals in Dublin. A midwifery team was set up of academic and practicing midwives to assist with the development of the concept model. Evidence based data retrieved from the guidelines was validated by the midwifery team and elements of best practice were integrated.

The tool was piloted on academic midwifery staff first and after several revisions the tool was trialled on a group of postgraduate midwifery students. The students were given 3 simulated scenarios between a woman and a midwife. The students were asked to use the tool as if using a booking system and to enter relevant information disclosed in the simulations. The students were then asked to assign an appropriate care plan.

An online questionnaire was then presented to the students. This questionnaire contained open and closed questions. The results of this questionnaire were used to gauge the student midwives perception of the tool.

Conclusion and Discussion

The overall findings indicated that the academic and student midwives were very happy with the tools CDSS elements and felt the tool offered appropriate referral guidance and excellent risk assessment. They all felt this tool could be helpful in both academic and practice environments. All participants agreeing that the tool was easy to use and supported decision making.

The study revealed that there is certainly scope for the introduction of clinical decision support systems within the health sciences educational environment. Students perceived the CDSS tool as a helpful and practical learning tool and would also like to see this in place in their current course and in the work place.

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Abbreviations:

Clinical Decision Support System (CDSS)

Midwifery Led Unit (MLU)

Consultant Led Unit (CLU)

Health Service Executive (HSE)

General Practitioner (GP)

Body Mass Index (BMI)

RCOG (Royal College of Obstetricians and Gynaecologists)

NICE (National Institute for health and clinical excellence)

Chapter 1 Introduction

1.1 Background

The introduction of Clinical Decision Support Systems(CDSS) within healthcare has proved to significantly improve the quality of care for patients while enhancing quality assurance(Bates et al, 2003). This provides the healthcare worker with up-to-date information that may improve their decision making capability.

“This field is rapidly evolving because of technological advances and increasing access to computer system in clinical places”(Hunt et al, 1998)

CDSSs have been a mechanism for plugging evidence based medicine into standard practice allowing the patient to benefit from the most up-to-date research. While CDSSs are becoming more common within the healthcare environment it has not been seen to be prevalent in the educational environment.

There are a number of areas within health sciences where a CDSS can be applied. For the sake of this study we will be focusing on its application in maternity services and referrals. There are a number of areas within midwifery where a CDSS could be positioned to provide detailed knowledge to improve the quality of care to the patient. One such area is in risk assessment. The identification of risk for complications of pregnancy is paramount to antenatal care (Knox et al, 1993). Risk assessment is conducted during a woman’s initial visit to a midwife or primary care provider. This visit, called the booking stage, is where the woman provides information about various medical and social elements of her life and a risk profile is built up. This profile is then used in assigning an appropriate care plan to the woman.

With increased use of computer interaction within the health care environment, health science graduates and professionals will need to be more familiar with computer use within the industry. While most health science courses now offer online portals where notes can be downloaded and read there is not a high level of interactive educational material available. With this increased level of computer interaction in health care, health science students will be under more pressure be familiar with interactive technology and the benefits of this in the workplace.

1.2 Motivation

There is now a clear divide opening in maternity care services in Ireland since the establishment of midwifery led units (MLUs) and the ending of the legacy of a dominant consultant led care structure. New policies have been put in place to ensure eligible woman are offered a range of safe and acceptable options for place of birth, giving rise to more involvement of the midwifery led units(Begley, Devane and Clarke, 2009).

Midwifery led units (MLU) are relatively new in Ireland with the first MLU being setup in Drogheda in 2004. A previous legacy of consultant led care prevailed up to this point. Recent studies in the North Eastern area of Ireland administered by the HSE-North East found the benefits of midwifery led care in comparison to consultant led care. This study conducted by Begley et al (2009) concluded that midwifery led care:

- Was as safe as consultant led care.
- Resulted in less intervention.
- Costs significantly less.
- Is viewed with greater satisfaction by women.

In this study women who showed no risk factors were offered the opportunity to join a midwifery Led Unit (MLU) from the start of their care. In order to be added to the MLU the women had to meet certain criteria.

The current methods used in Dublin to gather risk factors offer no guidance to the midwife as to which care-plan to assign the woman to and frequently allow a midwife to assign a woman to an inappropriate care-plan without justification.

Ireland is currently experiencing a baby boom leading to significant population growth. See table 1.-1 for number for births in Ireland in the last 5 years. The need for well trained midwives is evident and so the balance of consultant led care and midwifery led care should be better adjusted leaving consultant care for the women who require specialist care and monitoring and midwifery led care to women with little or no risk factors to be cared for within the community or day care settings.

Table 1-1: BIRTH NUMBER 2005 - 2009(Central-Statistics-Office 2010)

Year	Total Live Births
2005	61,042
2006	64,237
2007	70,620
2008	75,065
2009	74,278

Effective load balancing between consultant led units (CLU) and MLUs should provide significant cost savings to the health care provider and will relieve the hospitals of unnecessary visits. An effective method of load balancing could result from accurate risk assessment and evidence based referral assignment at initial consultation or booking stage.

A means to support maternity referrals is to introduce a CDSS at booking stage that may improve risk assessment and support a midwife in the referral process. A prototype of such a tool has been developed as part of this research. An ideal platform to trial such a tool would be in a hospital or clinical environment. However this study will focus on the use of the tool within midwifery education. The study will simulate real booking stage conversations and try to ascertain the perceptions of student midwives to such a tool being introduced.

A clear divide has been exposed between the required information skills of healthcare professionals and their actual skills when graduating from university(Wilkinson, While and Roberts, 2009). Their study goes on to provide evidence internationally that healthcare professionals, although displaying positive

attitudes to ICT were not confident at the point of qualification. With this in mind an online simulation strategy was considered to support student midwives practice risk assessment and referrals. The use of e-learning has developed significantly in recent years in nursing and midwifery, with most students happy to use this method of learning despite perceived levels of computer literacy(Koch et al, 2009).

The increased reliance of e-learning within the school of nursing and midwifery, Trinity College has provided a platform which could be used to allow students to make use of an online CDSS for training. With the onset of CDSS in the medical arena it was considered as worthwhile to investigate if a CDSS could be perceived to improve midwifery referrals and be seen as useful in the learning environment for midwifery students.

1.3 Research Question and Objectives

The research question was posed as:

How could maternity referrals be supported by an online CDSS in practice and learning.

The objectives of this study were to attempt to simulate a booking system based on the systems currently used in the hospitals. Integrate principles of CDSS into the booking system and evaluate the perceived functionality, usefulness, overall satisfaction and usability of the tool. The tool would have to be built with ease-of-use in mind in order to gain support from the potential users.

For the purpose of this study we would design and develop a web based tool. The tool would be designed to incorporate clinical decision support and encapsulates best practice within a CDSS. The tool would integrate clinical guidelines and midwifery best practice to support practicing and training midwives in their referrals process. The tool would be built with an easy-to-use interface. The tool would then be evaluated based on:

- Functionality
Did the tool function as it was expected to by the user?
- Usefulness
Was the tool perceived by the user as useful in practice and training?
- Satisfaction

Were the users satisfied with the tool?

- Usability

Was the tool easy to use?

1.4 Methodology

A Literature review was conducted in the areas of obstetric risk assessment, clinical decision support systems, simulation strategies and online learning tools.

The tool was developed in close collaboration with a group of academic and practicing midwives. The tool was piloted on academic midwifery staff first and after several revisions the tool was trialled on a group of postgraduate midwifery students.

The participants were given 3 written simulated scenarios between a woman and a midwife. The participants were asked to use the tool as if using a booking system and to enter relevant information disclosed in the simulations. The participants were then asked to assign an appropriate care plan.

An online questionnaire was then presented to the participants. This questionnaire contained open and closed questions. The results of this questionnaire were used to gauge the midwives' perception of the tool.

The questions were divided into 4 sections. Each section contained a set of questions both open and closed, to assess the participants' perception of the tools functionality, usefulness, satisfaction and usability.

1.5 Thesis Outline

Chapter 2 describe the literature reviewed regarding risk assessment and the current state of maternity services in Ireland. The benefits of CDSS are discussed and their continuous introduction into clinical practice. It highlights the benefits of accurate risk assessment and proposes the rationale for producing a CDSS at booking stage. The chapter discusses the adoption of e-learning within nursing and midwifery and highlights current online learning within health sciences in Ireland. This chapter takes a look at the benefits of online learning tools to midwifery students.

Chapter 3 describes the steps taken in the development and implementation of the tool. It describes how the concepts of a CDSS were integrated into the tool. It explains how the knowledge of experienced midwives was harnessed and integrated into the tool along with official guidelines and standard processes expected of a professional midwife. The chapter explains the design of the user interface and the attributes of the CDSS that were incorporated.

Chapter 4 explains the evaluation methodology used. It explains how we went about finding out if the tool would be perceived as useful. It explains the methods of data collection and analysis. It briefly describes how ethics approval was granted, the methods of recruitment used, the procedure for the day of the trial and the production of the questionnaire.

Chapter 5 presents the findings in a clear and concise manner. This chapter gives a detailed analysis of each question posed and the results obtained. The chapter discusses the finding from each of the sections of Functionality, Usefulness, Satisfaction and Usability. Each section is summarised

Chapter 6 presents the conclusions and recommendations as a result of the study.

1.6 Limitations

The tool would ideally be developed for a clinical setup, with the intention of improving actual practice. The scope of the project was limited to academic and student midwives as this was a more achievable and accessible working group to the author.

The tool was developed as a concept model only. The tool does not attempt to cover all aspects of risk assessment during the initial consultation. The tool was built only for use by students and to demonstrate the use and potential benefits of a CDSS within a booking system.

The student population was postgraduate as these students may have experienced or used a booking system in their time on placements.

1.7 Summary

The research question was posed as:

How could maternity referrals be supported by an online CDSS in practice and learning?

This research explored the use of a CDSS in support of maternity referrals and identified areas to improve usage, future adaption and possible developments.

The tool was developed in close collaboration with academic and practicing midwives. The tool was trialled on a number of postgraduate midwifery students and feedback was obtained via an online questionnaire.

The participants were overall satisfied with the tool's ability to assess risk and guide referrals. The participants felt that this tool would improve the referrals process in practice and could enhance learning.

The areas identified for improvement of the CDSS could easily be developed to support the role of the midwife in working practice and education.

Chapter 2 Literature Review / State of the art

2.1 Introduction

This chapter describes some of the literature covering obstetric risk assessment, current referral practices in Ireland and Clinical decision support systems proposed for maternity services. The Chapter discusses current child birth trends developing in Ireland and the use of online learning tools for midwifery students. It also takes a look at the current state of the art of online learning within the midwifery schools in Ireland. The benefits of e-learning to nursing and midwifery students are highlighted and the use of simulation strategies discussed.

2.2 Obstetric Risk Assessment

“Identification of patients at risk for complications of pregnancy is fundamental to antenatal care.”(Knox et al, 1993)

“A high-risk pregnancy is one in which the maternal environment or past reproductive performance presents a significant risk to fetal or maternal well-being”.(James and Stirrat, 1988)

The identification of high and low risk pregnancies is potentially beneficial to both the patient and the health care provider(Knox et al, 1993). There are a variety of antenatal care plans available to low and high risk patients in Ireland.

In Ireland those identified as low risk can be cared for in the community by primary care providers such as general practitioners (GP) or community midwife schemes managed by midwife led units (MLU) associated with the local maternity hospital. Primary care is usually a combination of both MLU and GP.

Those identified as high risk cases are cared for by secondary care providers such as consultants or specialists in the local maternity hospital.

Appropriate distribution of such care could give rise to a reduction of pressure on hospital\secondary care service providers. Referring more women identified as low risk to primary care providers would result in keeping secondary care providers free to care for those who have been identified as higher risk.

Some of the benefits outlined by a recent report on the evaluation of midwifery led care in Ireland are highlighted below.(Begley, Devane and Clarke, 2009)

The benefits of low risk women referred to an MLU are;

- The reduced intervention rates such as caesarean sections, labor induction, epidurals etc.
- The ability to meet a professional in the community rather than queuing in a hospital.
- The opportunity to build rapport with a midwife.
- These women would more likely to have a natural spontaneous labor as opposed to active management of labor.
- Cost savings to the Health Service Provider

This study also found that women entered into these midwifery led programs have proven to have greater satisfaction than in consultant led care units.

Those identified as high risk can benefit from consultant led care units in which they will attend secondary care services where the appropriate technical equipment and expertise will be available to them.(Knox et al, 1993)

The Benefits to being identified as high risk

- Assigned a consultant with expertise in particular area of risk.
- Care plan tailored to woman's requirements.
- Access to appropriate technical equipment.

A recent surge in births in Ireland has given rise to the need to better balance the load of primary and secondary care. See table 1-1 above for recent birth statistics

The Health care system in Ireland administered by the Health Service Executive (HSE) can benefit from appropriate risk categorisation. As reported by Begley et al (2009) in 'An Evaluation of Midwifery-led care' midwifery led care is a more cost effective choice for low risk women. Identifying these women and allocating appropriate care plans at the booking stage could save significant costs.

Begley et al's(2009) conclusion of this evaluation is that the MLU is a cost effective alternative method of delivering maternity services for healthy women without risk factors for labour and delivery.

2.3 Basing this tool on a decision support system

A clinical decision support system can be described as a tool that provides clinicians or patients with clinical knowledge and patient related information, intelligently filtered and presented at appropriate times, to enhance patient care (Osheroff et al, 2005). These systems have been shown to provide decision makers with the possibility of achieving significant improvements in performance, bridge the gap between research and practice and to improve safety for patients. (Bates et al, 2003)

“CDSSs can enhance clinical performance for drug dosing, preventative care and other aspects of medical care.” (Hunt et al, 1998)

They also state that there has been insufficient study on the effect of CDSSs in the outcome of patients.

However Knox et al (1993) support that a CDSS based on an obstetric scoring system can be used to define a risk category at booking stage for women and has been proven to be extremely successful for women who have had more than one pregnancy (multigravida). This study used risk factors to predict bad outcomes and identified 27 significant ante-natal variables that could be included in such a system. Knox et al (1993) applied a weighting to each variable to create a sophisticated level of obstetric risk assessment. This system predicts risk based on a combination of variables rather than on the presence of one particular risk factor. Knox et al (2009) argues that statistical weighting is potentially better than clinical weighting as it excludes experiential bias.

Another study by Gothri et al (2009) proposed the use of an automated ante natal risk assessment tool for assistance in third world countries where expertise in the area was scarce, they also argue the potential use of this tool in education. This study also highlights the benefits the potential reduction in errors and medico legal liability.

Previous studies on the use of hand held clinical decision support systems for medical undergrads have been successful in providing the following encouraging results (Johnston et al, 2004), medical students felt the CDSS

- Helped in identifying learning needs
- Provided information required to care for patients
- Enhanced learning

Johnston et al (2004) study effectively evaluated this CDSS by questioning students on four topics, functionality, usefulness, satisfaction and usability.

CDSSs have also been successfully introduced into nursing environment(O'Cathain et al, 2004; Kearns, 2008). The integrations of such CDSS into nursing Triage systems has been very successful in the diagnosis and prioritisation of patients.(O'Cathain et al, 2004; Kearns, 2008)

2.4 Producing a simulation CDSS tool

Wilkinson et al(2009) reports of a worrying divide between the required information skills of healthcare professionals and their actual skills when graduating from university. They go on to provide evidence internationally that healthcare professionals, although displaying positive attitudes to ICT were 'not confident at the point of qualification'(Wilkinson, While and Roberts, 2009).

A combination of the Wilkinson et al's(2009) study and the evidence collected on current learning tools by the midwifery learning centres in Ireland seen in table 2-1 corroborate a lack of practical supplemental interactive material available to current midwifery students.

"In midwifery practice, clinical decision making involving higher cognitive skills is critical to the safety and outcomes of mothers and infants" (Jane, Nita and Fiona, 2005) A study on the effect of simulations strategies on the clinical decision making of midwifery students (Jane, Nita and Fiona, 2005)has provided a basis that simulation strategies can have the following positive effects on student midwives.

- Students collect more clinical information
- Students revisited collected clinical information less
- Student made fewer formative inferences
- Students reported higher confidence levels

This study took a group of volunteer students and broke them into two groups, a control group was given the traditional lectures and the experimental group were given simulation situations in which they would have to think out loud and justify their steps when presented with a particular labour scenario. This study provided indicators that simulation strategies improved confidence and decision making in the experimental group.

While Wilkinson et al(2009) reports of the lack of confidence in graduating health care professionals, Jane, Nita et al(2005) study provide information that 'simulations can positively affect the decision making process among midwifery students' while also improving confidence and data collection techniques. Jane Nita et al (2005) concludes that "the use of simulation strategies can promote deeper learning for students".

Johnston et al (2004) conducted research into the evaluation of clinical decision support systems for evidence based learning on medical undergraduates and concluded that 'having the CDSS specially designed for undergraduate use is essential to increasing student adoption of such point-of-care tools'(Johnston et al, 2004)

2.5 Designing a CDSS

With the concepts of clinical decision support described earlier in this chapter the best methods of producing such a CDSS can be taken from previous implementations of CDSS and studies where success factors have been identified. Bates et al (2003) put forward ten elements of best practice within a CDSS after studying several instances of CDSS introduction. Bates et al (2003) also supports the addition of referential links in systems to web based evidence.

Usability would be a key factor of any application design in health care. Gould and Lewis (1985) put forward the key principles of usability as early focus on users and tasks, empirical measurement and iterative design. These principles are very much user centered and would require intense end user consultation and interaction to succeed.

2.6 Benefits of an online learning tool to nursing and midwifery students

"Technical innovations, in parallel with an increased need for fiscal efficiencies, new markets for educational commodities, and consumer demands for accessibility and flexibility, are compelling education providers to increase access to methods of web-based learning."(Patterson, Lorenzetti et al. 2008) cited by (Koch et al, 2009)

Recent studies into web-based intervention to support learning in nursing and midwifery courses have yielded significant indicators that prove students find this method of educational support efficient and effective.(Grant and Brett, 2006; Koch et al, 2009)

Independent studies conducted by Koch et al(2009) and Grant et al(2006) have highlighted that students benefitted from such online support in the following ways:

- Enhanced learning experience, students indicated in both of these independent studies that the opportunity to access additional modules during the term was helpful by reinforcing materials gathered during day-to-day lectures.
- Exam preparation, Students found this method of online access extremely useful during revision for exams.
- Study at my own pace, students highlighted the ability to study at their own pace was of significant benefit. These online tutorials and notes allowed ‘the student’s option of time and place of instruction’(Grant and Brett, 2006) . The additional benefit of allowing students who did not have English as a first language view lectures and additional quizzes or interactive material in their own time was seen as a significant benefit by students in Koch et al’s(2009) study.
- Accessibility for distance learning was also an enabler for distance learning with many modules being accessed by students who have other commitments such as full time carers or part time jobs.

2.7 Learning tools currently being used in Ireland

The author contacted all midwifery learning centres in the Republic of Ireland to ascertain what sort of web-accessible material, if any, was being used to supplement modules being taught in class. The aim was to ascertain if any decision support software was currently being used as a learning aid.

All the midwifery schools in Ireland replied to the initial communication, indicating what they were currently using as a web-based learning supplement, if any. No school was currently using a decision support tool. A clinical decision support tool can be described as a software tool that supports a decision making process based on the patient data supplied, the appropriately filtering of such data and the accurate presentation of such data in a format that support decision making for the user.

Out of the six schools contacted the following web-based learning tools were used.

Three of the schools were using K2 Fetal Monitoring Training System. K2 is a fetal monitoring training system that can be accessed over the internet. It provides training in ‘CTG interpretation and labour management’ (K2-Medical-Systems, 2010)

Two of the schools were using WebCT for publishing documents and quizzes. WebCT is an online learning portal used to distribute course notes online.

Two of the schools were using the 'An Bord Altranais' website. 'An Bora Altranais' is the Irish nursing board, a government organisation which is the regulatory body for the nursing profession in Ireland. This website contains 2 e-learning modules, 'Competence Assessment' and 'Scope of Practice', both modules relate to general nursing and are not specific to midwifery training. There are currently 2 Learning modules available as of 14/05/2010 (An-Bord-Altranais, 2010)

Table 2.1 below summarises the responses from the midwifery schools in Ireland.

Table 2-1: SUPPLEMENTAL LEARNING TOOLS USED IN IRELAND

	Video/DVD	K2	Web CT	ABA
UCC	Y		Y	
UCD				Y
NUIG		Y		
UL		Y		
DKIT		Y		Y
TCD			Y	

2.8 Summary

The chapter discussed obstetric risk assessment and the benefits of a balanced referral system. It also provides the justification for the use of CDSS within practice and some of the design concepts that could be used in development. This chapter also mentions the benefits of simulation strategies and the benefits of online learning to midwifery students. The next chapter will take us through the aims and objectives of the study it will also discuss the design and implementation of the tool.

Chapter 3 Design and Development of the Tool

3.1 Introduction

This chapter will discuss the aims and the objectives set out for the project. This chapter goes into some detail on the types of processes required and the interventions used. The concepts of design and development are discussed and justified. The specific interventions implemented and how the user interface will operate.

3.2 Aims and objectives

The aim of the design and development stage was to design, develop, implement and evaluate a tool based on a clinical decision support system.

The objectives during the design and development stage were as follows

- Develop a tool that would simulate a midwifery booking system
- Incorporate Decision Support within the tool
- Encapsulate best practice within decision support.
- Integrate clinical guidelines into the tool
- Integrate midwifery best practice obtained from practising and academic midwives
- Design a clear and easy-to-use interface

3.3 Integrate midwifery best practice

The Researcher obtained support from several practicing and academic midwives associated with the school of nursing and midwifery, Trinity College, Dublin. A team was formed of 4 academic and 1 independent practicing midwife. Several meetings were arranged in order to extract their working knowledge and integrate this into the tool. This was essential during the development of the concept model and revision of this.

3.4 Develop a tool that would simulate a midwifery booking system

In order to create a web based tool to simulate the booking stages a knowledge base of the current booking systems in place was required. This information was acquired by informal discussions with 2 IT midwives (midwife responsible for overlooking IT use in the midwifery department) based in the Coombe Women's Hospital and The Rotunda Hospital Dublin, both large maternity hospitals in Dublin. Each IT midwife gave a running demonstration of their booking systems using anonymous training simulations.

Both systems mentioned above operate in the following fashion. The system allows the midwife to enter the woman's demographic details, Obstetric history, Medical History, Gynaecological History and Social background. These details are then saved to the woman's record and the midwife then assigns the appropriate care plan with the woman's agreement.

The IT-midwife then overlooks care-plan referrals. If a referral is incorrect then the midwife who was responsible for the referral is questioned on the rationale for her decision. If the rationale is not sufficient for the referral, then the midwife is either cautioned or given training in that particular area.

The current systems offer no guidance on care-plan referral and care plan referrals are overlooked by a senior IT midwife.

Data Sets Collected: Demographic Data, Obstetric History, Medical History, Genealogical History and Social background.

Data Set collection sequence Identified in current systems and illustrated in the process flow chart below in figure 3-1.

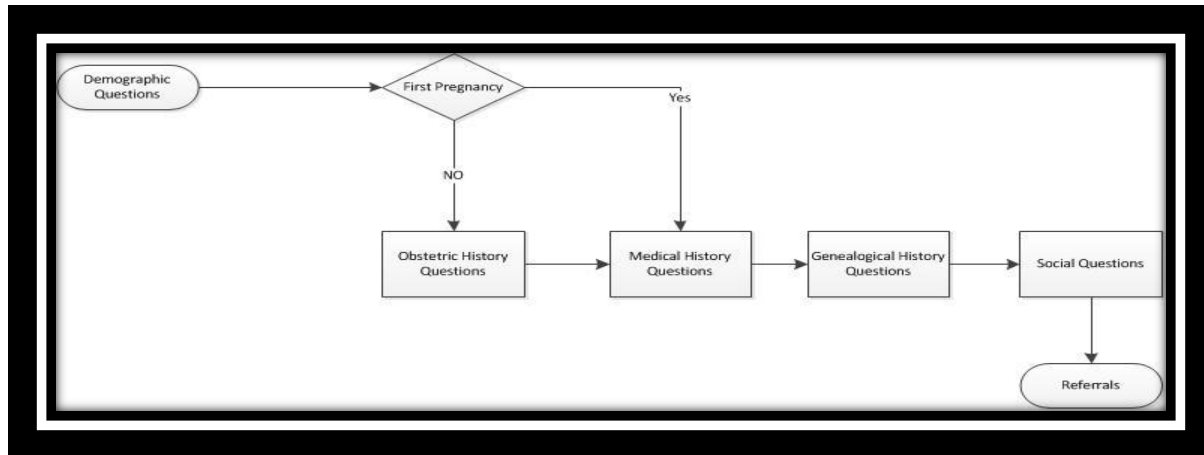


Figure 3-1: CURRENT PROCESS IN DUBLIN HOSPITALS

The Tool was built with the same process flow with an added feature of summary and referrals as below in figure 3-2

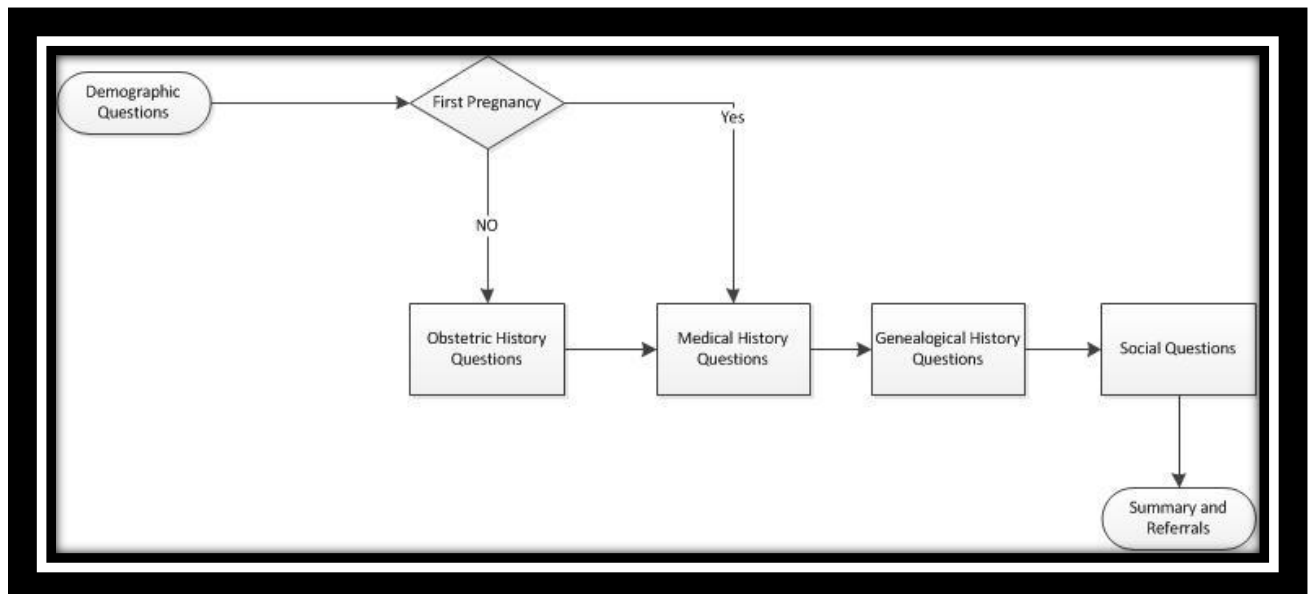


Figure 3-2: PROPOSED PROCESS FLOW OF TOOL

As all midwives will at some stage be using a booking system, the concept model was based around the data sets collected at this point and the current process flow of the systems in place.

3.5 Concept model developed

A concept model was developed on paper and discussed with the midwifery team. This concept model was reviewed several times and agreement was reached on each iteration. The concept model contained process flows and detailed information about data sets required.

3.6 Integrate clinical guidelines into the tool

Initial consultation and Referral guidelines were obtained by contacting the midwives responsible for the Midwife Led Units(MLU) for all maternity hospitals in Dublin. Two midwives responded by email with a list of guidelines in order to qualify for a MLU. The two guidelines received were from the Coombe Women's Hospital Dublin and The Rotunda Hospital Dublin.

These guidelines were originally taken and broken into 4 sections: Obstetric History, Medical History, Genealogical History and Social History. Each section contained relevant questions asked on initial (booking) consultation. There was considerable overlap between the 2 documents and so a single document was created merging both sets of questions. This document was shown to the midwifery team who confirmed the validity of the questions.

This single document was then coded into the relevant sections for clarity and use in programming of the tool. Below are examples of the coding of such questions, see figures 3-1 – 3-4.

Each obstetric questions was coded using the letter 'O' and the number in which it was asked, a sample of the coding of questions can be seen in table 3-1

Table 3-1: SAMPLE OBSTETRIC CODING

O10	Previous 3 rd degree tear or complications associated with perineal trauma	Yes/No/NA
O11	Multiple pregnancy (in current pregnancy).	Yes/No/NA

Each medical question was coded using the letter ‘M’ and the number in which it was asked, a sample of the coding of questions can be seen in table 3-2.

Table 3-2: SAMPLE MEDICAL CODING

M2	Epilepsy	Yes/No/NA
M3	Diabetes	Yes/No/NA

Each gynaecological question was coded using the letter ‘G’ and the number in which it was asked, a sample of the coding of questions can be seen in table 3-3

Table 3-3: SAMPLE GYNAECOLOGICAL CODING

G4	Any significant gynaecological surgery / pelvic fracture	Yes/No/NA
G5	Known gynaecological anomalies (DES exposure or uterine anomaly)	Yes/No/NA

Each Social question was coded using the letter ‘S’ and the number in which it was asked, a sample of the coding of questions can be seen in table 3-4.

Table 3-4: SAMPLE SOCIAL CODING

S6	Current history of drug or alcohol abuse	Yes/No/NA
S7	Lack of home facilities or unsatisfactory environmental conditions	Yes/No/NA

Guidelines were obtained after discussions with the midwife team, several guidelines were referenced during these meetings but agreement was reached that the 2 major sources for guidelines should be as follows.

The first set of guidelines was taken from the published clinical guidelines of the National Institute for Health and Clinical Excellence(NHS, 2010). This organisation hosts hundreds of clinically accepted guidelines. The category of interest here was Gynaecology, Pregnancy and Birth.

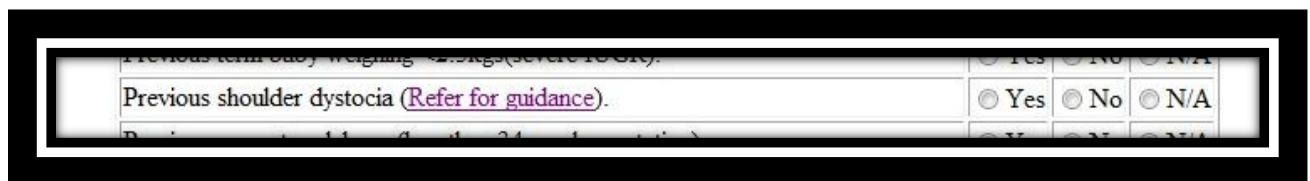
The second set of guidelines was taken from the Royal College of Obstetricians and Gynaecologists (RCOG, 2010). Other Guidelines mentioned were hosted by the International confederation of Midwives(ICM), and the International Federation of Gynaecology and Obstetrics(FIGO).

3.6.1 Positioning of the guidelines

During discussions with the midwifery team it was highlighted that any reference must be directed exactly to the particular article and not a larger more general guideline. This was identified as a possible source of stress and annoyance to the midwife.

To get the right information and display this at the right time we needed to not only find the correct guideline but also the actual paragraph that was relevant to the particular question. During the discussion with the midwifery team it was evident that displaying a full guideline document was not sufficient as the midwife would have to spend time finding the relevant section of the often large document.

During design, where an official guideline was available, the relevant section was identified within the guidelines and a link was customised to point directly to that section of the document. This link was then presented to the user at the time when the question was to be asked or discussed with the woman. See figure 3-3 for sample link presentation.



The image shows a screenshot of a digital form. The form has a white background with a black border. It contains two rows of text input fields and three radio button columns. The first row is partially visible and contains the text 'Previous temporary weighing <2.5kg (severe IUGR)'. The second row contains the text 'Previous shoulder dystocia' followed by a purple hyperlink that says '(Refer for guidance)'. To the right of each text field are three radio buttons labeled 'Yes', 'No', and 'N/A'.

Previous temporary weighing <2.5kg (severe IUGR).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Previous shoulder dystocia (Refer for guidance).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A

Figure 3-3: LINK PRESENTATION

See figure 3-4 for the block of text to which the link refers to, this block of text is the relevant text the midwife would be interested in seeing at this point.

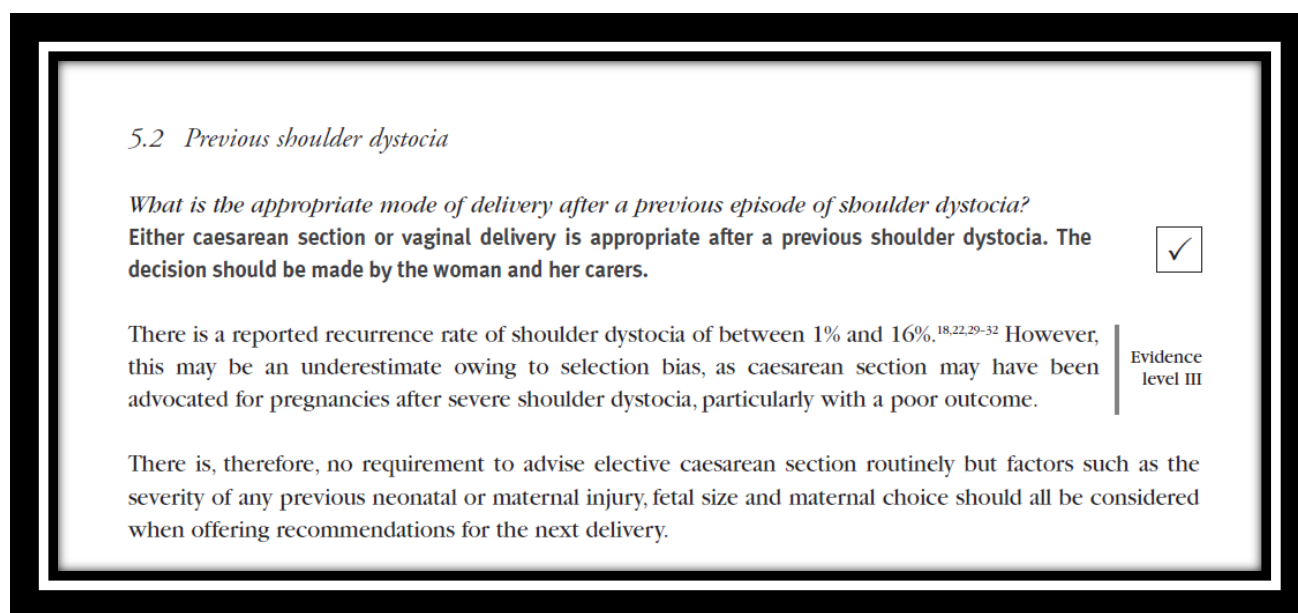


Figure 3-4: BLOCK OF TEXT DESCRIBING GUIDELINE

These guideline links were, where applicable, also displayed in the Referrals and Summary page, allowing the midwife to review the references before making a decision.

3.7 Incorporate Decision Support within the tool

The section describes the types of interventions used by the tool and where they were positioned in the tool. This section also describes the decision support processes used to guide the user in decision making.

3.7.1 Alerts and Alarms Intervention

Designing the interventions

During the midwifery team meetings a number of required interventions were recommended. The following interventions are described using illustrations.

3.7.1.1 Consultant with no issues identified

Location: Summary and Referrals page

Type of Intervention: Alert

Point of Intervention: User attempts to refer a consultant to a woman that has no risk factors identified.

Process Description: The user attempts to assign a consultant to a woman who has had no risk factors identified in the initial consultation. The system advises the user via a prompt that the woman is suitable for the Midwifery Led unit, prompt seen in figure 3-5. The user can now choose to ignore the prompt and continue or cancel and return to the Summary and Referrals page. If the user continues by clicking on the 'OK' button, a justification text box is presented to the user in order to capture the rationale for the decision. This justification text box can be seen in figure 3-6. This text box allows the user to enter free text to describe the rationale for the decision. Once the rationale is entered into the justification text box, the user can click on the 'OK' button to continue. The woman is now assigned to a consultant. See figure 3-7 for process flow.

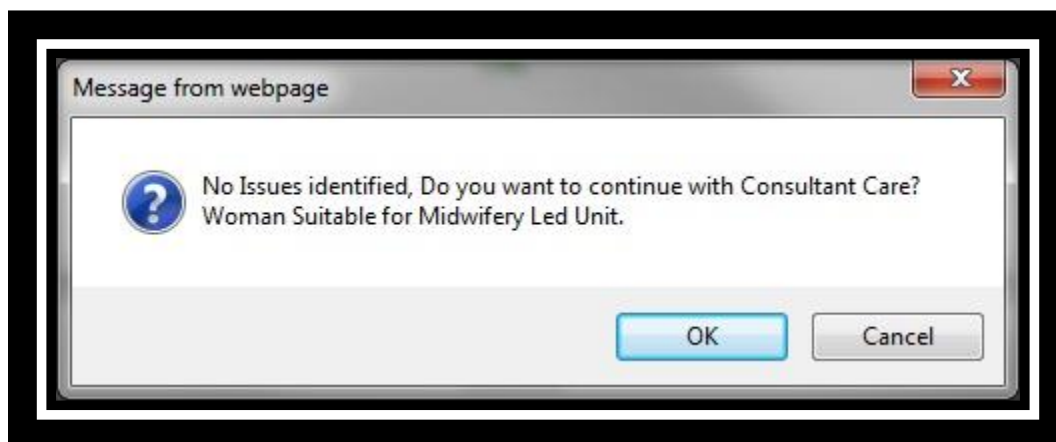


Figure 3-5: WOMAN SUITABLE FOR MLU

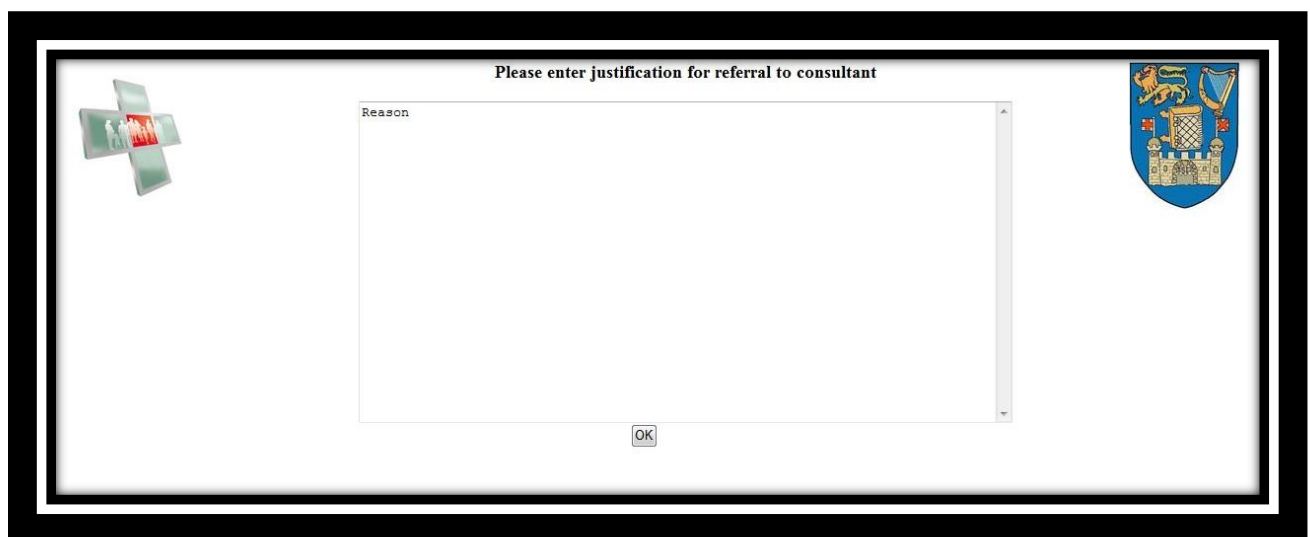


Figure 3-6: JUSTIFICATION BOX FOR ASSINGMENT TO CONSULTANT

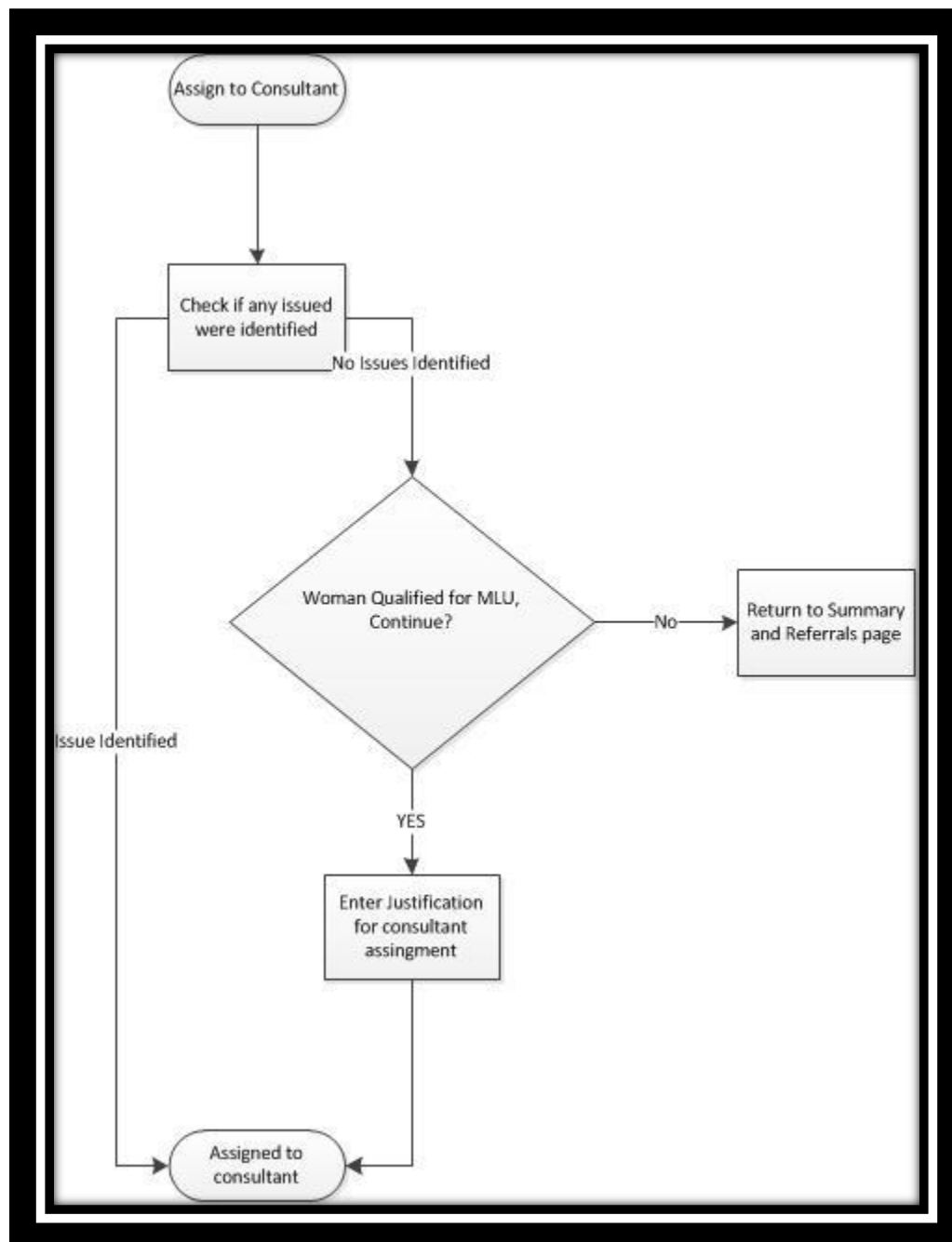


Figure 3-7: CONSULTANT NO ISSUES INTERVENTION PROCESS

Reason for intervention: Women who display no risk factors are better suited to a Midwifery Led Unit as they are less likely to need medical intervention. This will alleviate resources such as consultants and specialist to cater for women who have displayed high risk factors and would require more specialised expertise.

3.7.1.2 Midwifery Led Unit with Issues Identified

Location: Summary and Referrals page

Type of Intervention: Alert

Point of Intervention: User attempts to refer a woman to the midwifery led unit when risk factors have been identified.

Process Description: The user attempts to assign a woman who to the midwifery led unit who has had risk factors identified in the initial consultation. The system advises the user via a prompt that the woman has had an issue identified, prompt seen in figure 3-8. The user can now choose to ignore the prompt and continue or cancel and return to the Summary and Referrals page. If the user continues by clicking on the 'OK' button, a justification text box is presented to the user in order to capture the rationale for the decision. This justification text box can be seen in figure 3-9. This text box allows the user to enter free text to describe the rationale for the decision. Once the rationale is entered into the justification text box, the user can click on the 'OK' button to continue. The woman is now assigned to the midwifery led unit. See figure 3-10 for process flow.

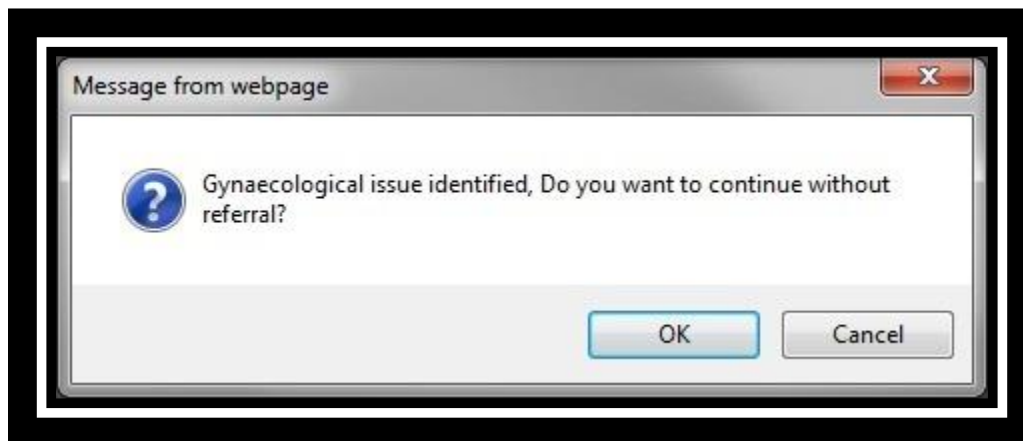


Figure 3-8: GYNAECOLOGICAL ISSUE IDENTIFIED

Please enter justification for referral to MLU

Reason

OK

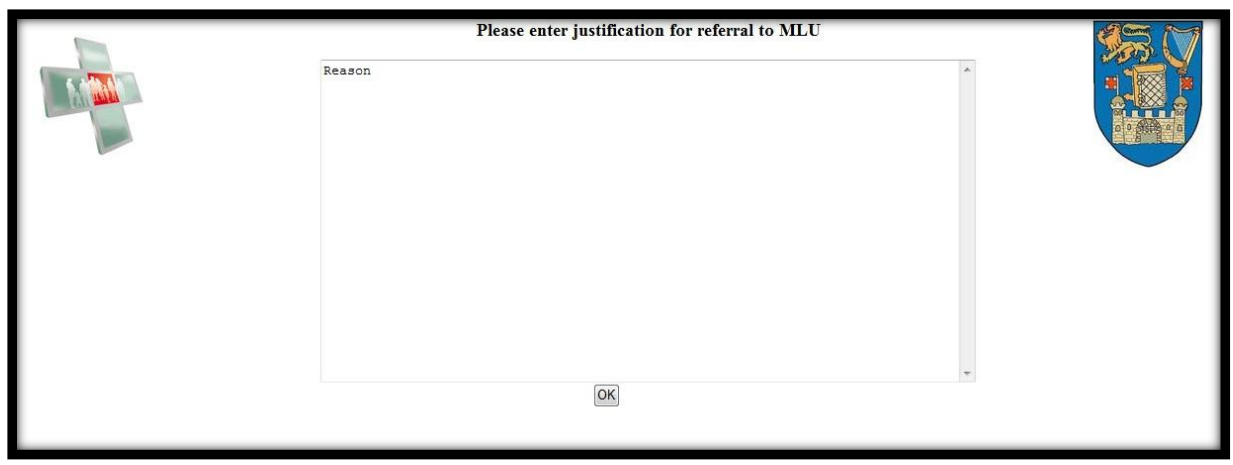


Figure 3-9: JUSTIFICATION BOX FOR ASSIGNMENT TO MIDWIFERY LED UNIT

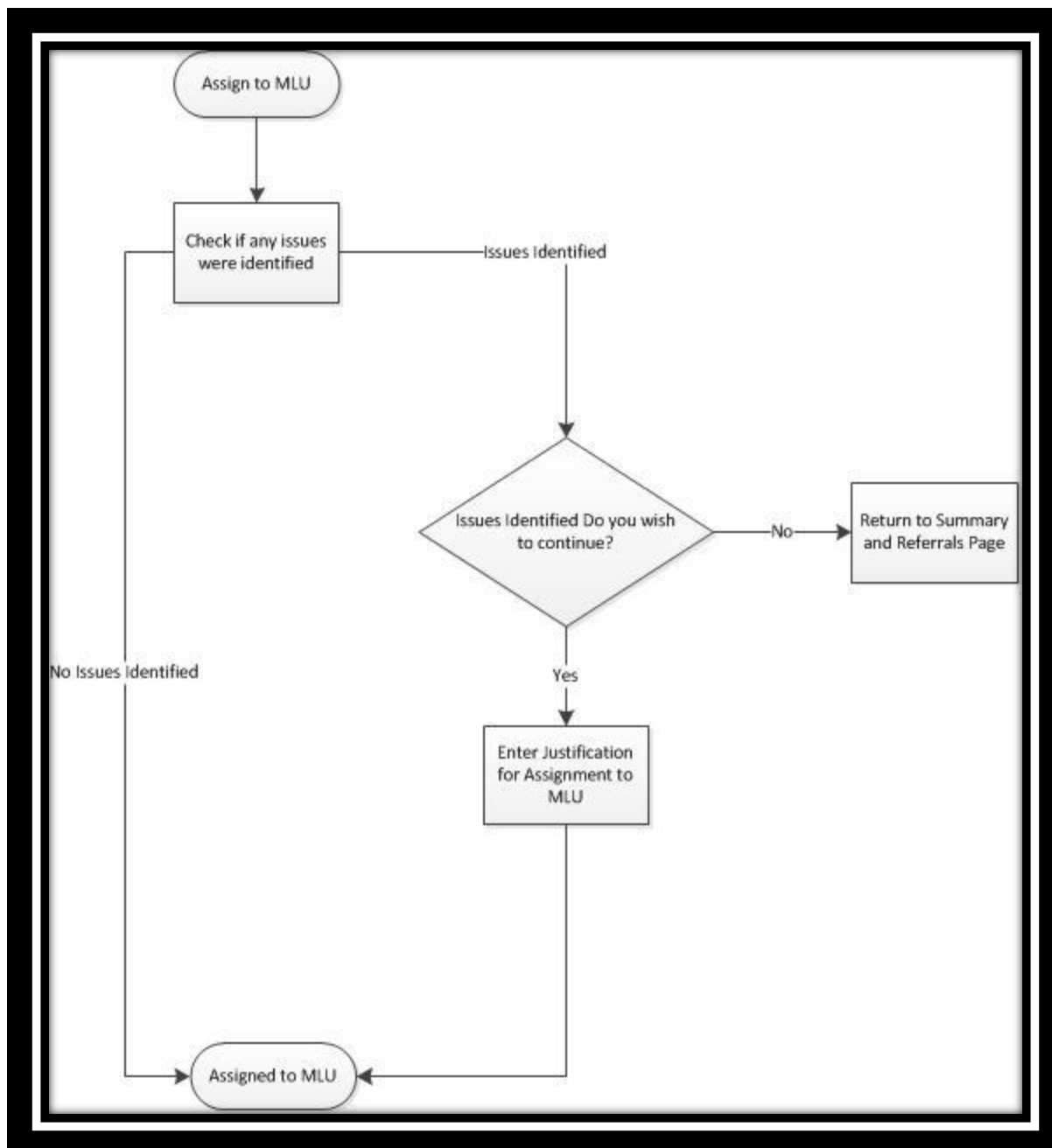


Figure 3-10: MLU ISSUES IDENTIFIED INTERVENTION PROCESS

Reason for intervention: Women who display risk factors may be better suited to a consultant or specialist where they can receive expertise care for specific issues. However in some cases a risk factor identified during initial assessment may be considered much lower once addition rationale is included. For example, if a woman has had a previous caesarean section but has since given birth through natural means, the risk may be identified but is much less significant since she has given birth without intervention since the risk factor was identified.

3.7.1.3 *Social Issues Identified*

Location: Summary and Referrals page

Type of Intervention: Alert

Point of Intervention: User attempts to assign a woman to either a consultant, specialist or midwifery led unit without addressing social issues.

Process Description: The user attempts to assign a woman to care plan without addressing social issues identified in the summary. The system advises the user via a prompt that the woman has had a social issue identified, prompt seen in figure 3-11. The user can now choose to ignore the prompt and continue or cancel and return to the Summary and Referrals page. If the user continues by clicking on the 'OK' button, a justification text box is presented to the user in order to capture the rationale for the decision. This justification text box can be seen in figure 3-12. This text box allows the user to enter free text to describe the rationale for the decision. Once the rationale is entered into the justification text box, the user can click on the 'OK' button to continue. The woman is now assigned to the chosen care plan. See figure 3-13 for process flow.

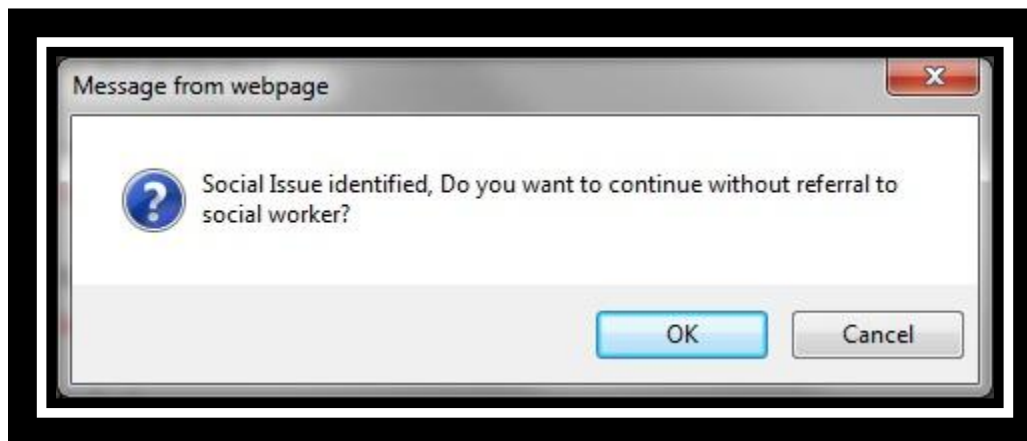


Figure 3-11: SOCIAL ISSUES IDENTIFIED

Please enter justification for referral without social worker

Reason

OK

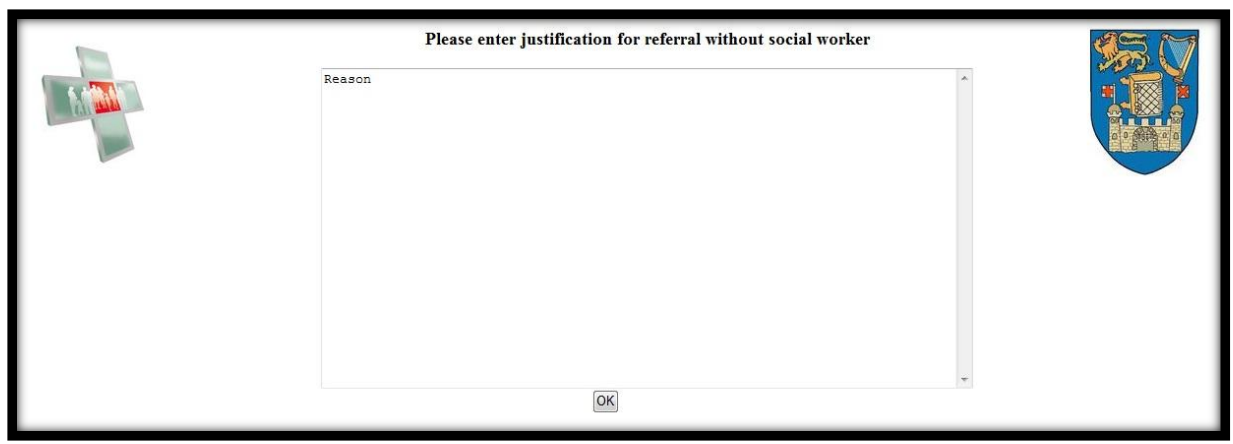


Figure 3-12: JUSTIFICATION FOR REFERRAL WITHOUT SOCIAL WORKER

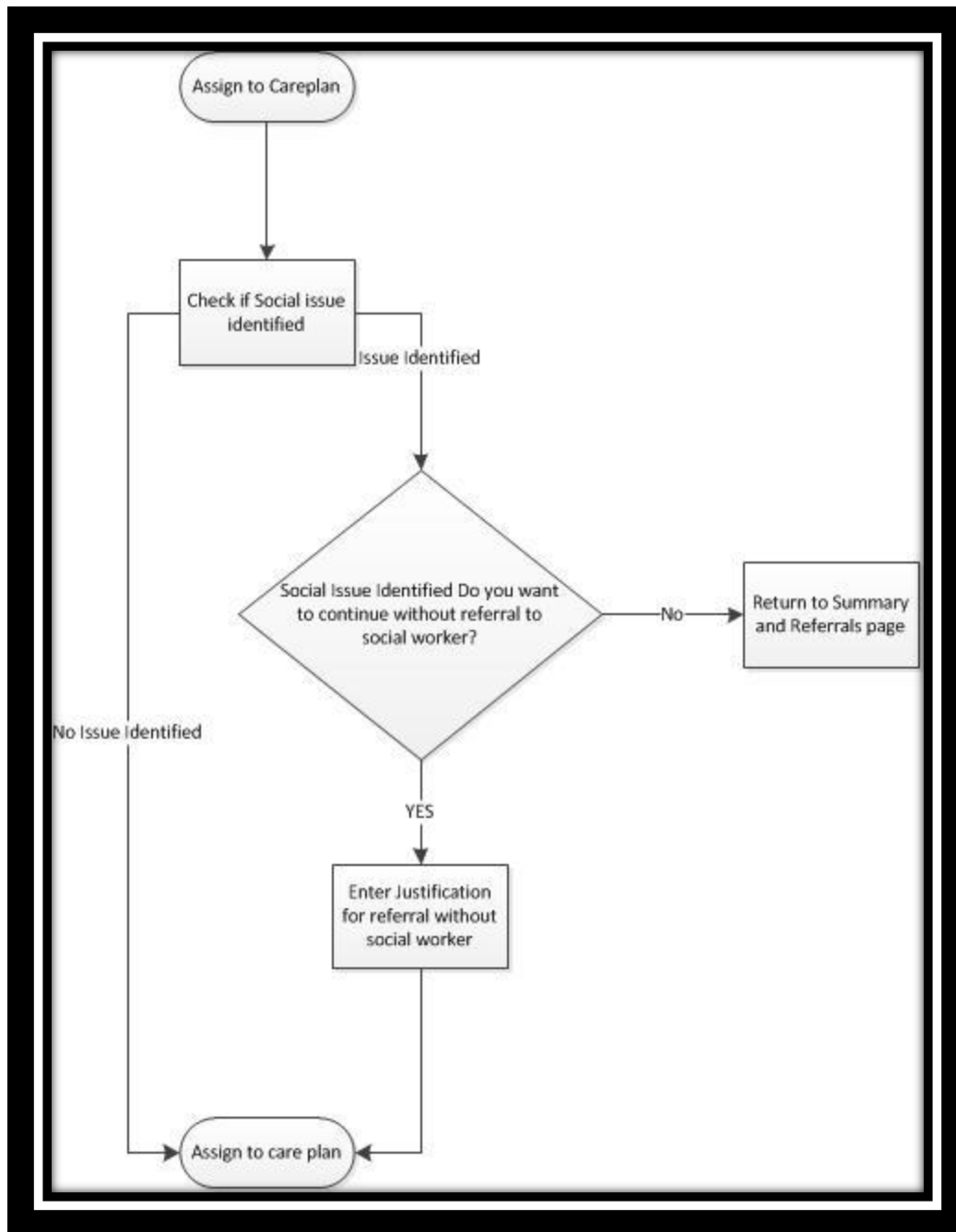


Figure 3-13: SOCIAL ISSUES IDENTIFIED INTERVENTION PROCESS

Reason for intervention: when a social risk has been identified a social worker may be assigned to the woman. It is important to have this option available to the women. The intervention is placed here to remind the user that a social worker should be assigned. It is quite possible that the woman does not want a social worker and this can be explained in the justification box.

3.7.1.4 *Assigning a Social worker*

Location: Summary and Referrals page

Type of Intervention: Alert and Alarm

Point of Intervention: User attempts to assign a social worker to a woman.

Process Description: The user attempts to assign a social worker to a woman. The system asks the user if the woman has given permission to have a social worker assigned, question seen in figure 3-14 the user now has the option to; press the 'Cancel' button which will revert the user back to the summary and referrals page; click the 'No' button which will trigger an alarm seen in figure 3-15 which tells the user that permission to refer is required and will then revert the user back to the summary and referrals page; click on the 'yes' button which will assign the social worker to the woman. See figure 3-16 for process flow



Figure 3-14: PERMISSION FROM CLIENT



Figure 3-15: ALARM PERMISSION REQUIRED

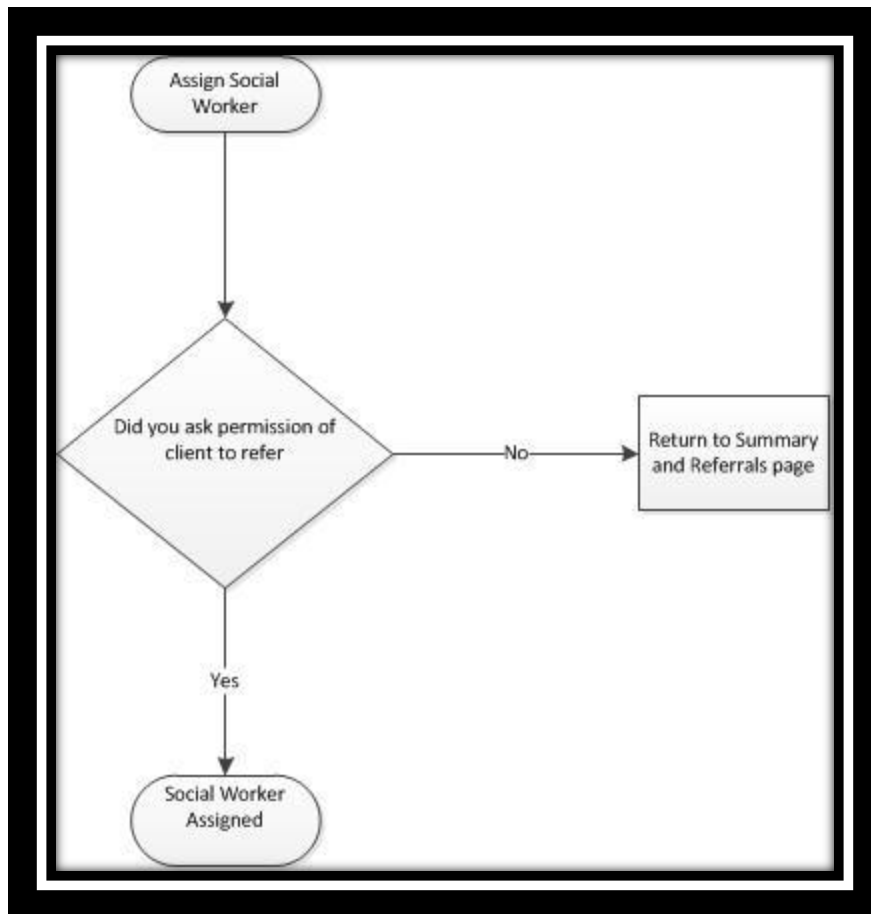


Figure 3-16: ASSIGN SOCIAL WORKER PROCESS

Reason for intervention: this intervention was requested by the midwifery team. This was to enforce best practice identified by the midwifery team that woman must be asked if they would like a social worker assigned to them. The process of assigning a social worker when social issues are identified is not mandatory and the woman must permit the assignment. The midwifery team wanted this alarm to be put in place to avoid accidental assignments.

3.7.1.5 *Care plan not assigned*

Location: Summary and Referrals page

Type of Intervention: Alarm

Point of Intervention: User attempts to finish tool without assigning a care plan.

Process Description: User clicks on the 'Finish' button before assigning a care plan to the woman. When this button is clicked the system checks if a care plan has been assigned. If a care plan is not assigned, an alarm is triggered and the user is prompted to refer the woman to a care plan. This alarm can be seen in figure 3-17

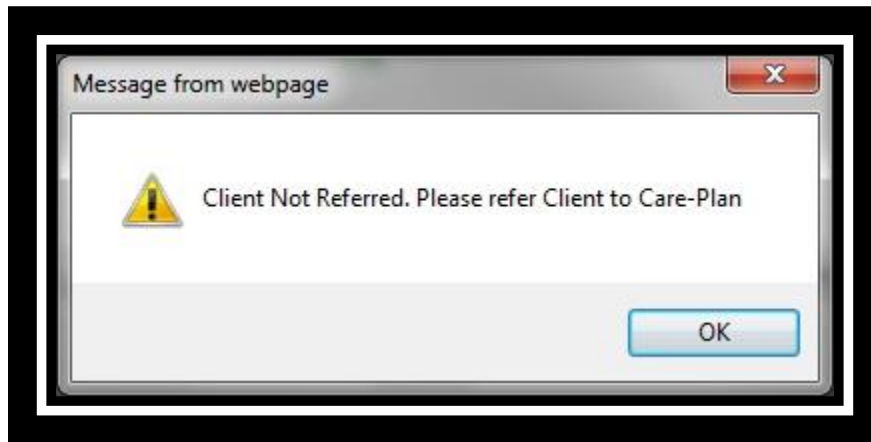


Figure 3-17: ALARM CLIENT NOT REFERRED

Reason for intervention: This intervention was requested by the midwifery team as an essential duty of care. All women must have a care plan assigned.

3.7.2 Passive interventions

Passive intervention for the sake of this document is defined as information displayed to the user that does not require an action from the user. Passive interventions were colour coded to indicate risk status.

The midwifery team identified some information collected regarding age and body mass index ratings that must be highlighted to the user but could not agree on direct action to be taken. In these cases and alert or alarm could not be agreed on so a passive intervention was proposed.

The data identified for passive intervention was BMI Categories and Age categories, described below.

BMI “Body Mass Index (BMI) is a simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity in adults.”(WHO, 2010)

BMI is calculated by dividing the weight in kilograms by height in meters squared.

$$BMI = \frac{\text{Kilograms}}{(\text{Height in Meters}) \times (\text{Height in Meters})}$$

BMI risk is categorised in table 3-5 as follows;

Table 3-5: BMI CATEGORISATIONS

Classification	BMI	Risk
Underweight	<18.5	High
Normal Range	18.50 - 24.99	Low
Overweight	25.00 – 29.99	Medium
Obese	≥30	High

Reason for intervention: BMI categories are important risk factors, women classified as underweight have been shown to have increased risk of preterm delivery, low birth weight and anaemia. Women classified as Obese have an increased risk of gestational diabetes, preeclampsia and are more prone to require a caesarean section(Kabiru and Denise Raynor, 2004)

Age was defined as a risk factor by the midwifery guidelines obtained from the two Dublin hospitals. Age risk was validated by the midwifery team and categorised as in table 3-6 below.

Table 3-6: AGE CATEGORISATIONS

Classification	Age	Risk
Young	<18	High
Normal Age	18 – 35	Low
Medium Risk	35 – 39	Medium
Old	≥40	High

Colour coding was decided as the best method to passively identifying risk associated with this data.

The colour coding assigned as seen in table 3-7 below.

Table 3-7: COLOUR CATEGORISATIONS

Risk	Colour Code
High	Red
Medium	Orange
Low	Green

The colour green indicated Low Risk, the colour orange indicated Medium Risk and the colour red indicated High Risk.

See figure 3-18 to figure 3-21 for illustrations of how there passive interventions were displayed to the user on the summary and referrals page.



Figure 3-18: AGE OK

Fig 3-18 illustrates the passive data presented to the user on the summary and referrals page indicating that this woman's age and BMI ratings falls into a low risk category. As we can see from the above image these details are displayed in the colour green representing low risk. Additional text was added so the user could understand the colour coding and remove any possible ambiguity. In this case the text is "OK" for both Age and BMI.



Figure 3-19: AGE OK BMI OVERWEIGHT

Fig 3-19 illustrates the passive data presented to the user on the summary and referrals page indicating that this woman's age falls into the Low risk category and the BMI ratings falls into the medium risk category. As we can see from the above image these details are displayed in the colour green representing low risk and orange representing medium risk. Additional text was added so the user could understand the colour coding and remove any possible ambiguity. In this case the text is "OK" for Age and "Overweight" for BMI justifying the colour coding.

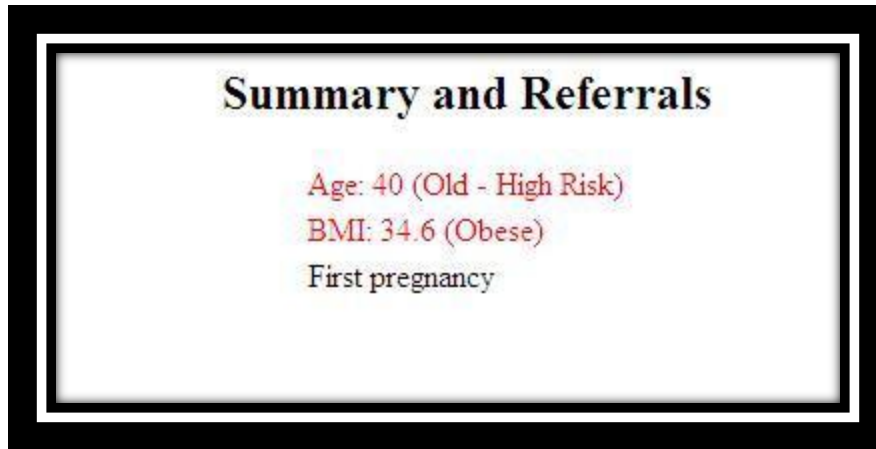


Figure 3-20: OLD AND OBESE

Fig 3-20 illustrates the passive data presented to the user on the summary and referrals page indicating that this woman's age and BMI rating fall into the High risk category. As we can see from the above image these details are displayed in the colour red representing high risk. Additional text was added so the user could understand the colour coding and remove any possible ambiguity. In this case the text is "Old – High Risk" for Age and "Obese" for BMI, justifying the colour coding.

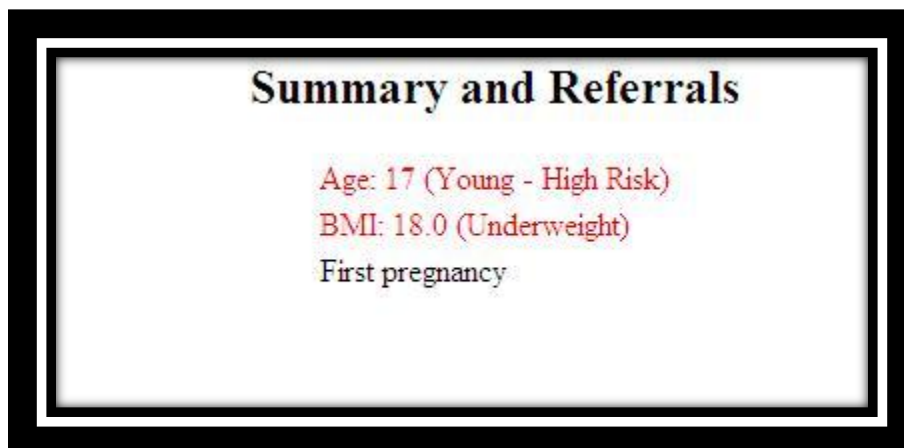


Figure 3-21: YOUNG AND OVERWEIGHT

Fig 3-21 illustrates the passive data presented to the user on the summary and referrals page indicating that this woman's age and BMI rating fall into the High risk category. As we can see from the above image these details are displayed in the colour red representing high risk. Additional text was added so the user could understand the colour coding and remove any possible ambiguity. In this case the text is "Young – High Risk)" for Age and "Underweight" for BMI, justifying the colour coding.

3.8 Encapsulate best practice within decision support.

Clinical decision support is defined as providing clinicians or patients with clinical knowledge, intelligently filtered and presented at appropriate times.(Osheroff et al, 2005)

Basing best practice on the study 'Ten commandments for effective clinical decision support'(Bates et al, 2003) study and cataloguing of success factors associated with successful clinical decisions support systems we take several recommendations from this report and implement them.

3.8.1 Speed

Bates et al (2003) study identifies that if the system is slow then the decision support is useless. The tool is written in java and runs within the user's browser. This maximises the speed of the response to the user. The guideline references, where available, were also hosted on the colleges web server allowing for faster and guaranteed access when they were called upon. Radio buttons were used to increase the speed at which the user could gather data. Information was displayed and reference information was redisplayed on summary for speedy access to information.

3.8.2 Anticipate Needs and Deliver in Real Time

Bates et al (2003) points out that it is not good enough for data to be somewhere in the system, it need to be available to the clinician at the time the clinician requires it.

The tool attempts to meets this need by in the following ways;

Links to related official guidelines are available where the midwife is collecting the information. When the question is posed and the answer anticipated, the tool provides links to guidelines for referencing. Allowing the clinician easy and quick access to the guidelines they will require at the time the information is provided see figure 3-3 for link presentation and figure 3-4 guideline presented.

When assigning a care plan the midwife is also presented with all the risk factors indentified during the assessment. This provides an overall look at the woman's risk status when the decision is to be made on a care plan. Providing all the information required by the user at the correct time.

3.8.3 Fit into the Users workflow

“Success with alerts, guidelines, and algorithms depends substantially on integrating suggestions with practice”(Bates et al, 2003)

The tool attempts to use workflow suggested by the midwifery team during consultation and integrate the workflow into the system. As seen in the process flow chart figure 3-2 the tool represents the sequence of questioning in an operational booking system figure 3-1. The tool guides the process by easily bringing the user from page to page based on the sequence identified in the booking systems. Information is provided when the information is required such as guidelines at the point of questioning and summarising. Processes are in place to allow a midwife to continue assigning a care plan when the evidence obtained may suggest an alternative referral, by entering a line of justification, this was put in place to avoid stopping the user and improve work flow see figure 3-7.

3.8.4 Little things can make a big difference

“Usability matters a lot”(Bates et al, 2003).

The tool attempts to meet this need by using a simple interface to guide the user through the assessment process. The tool was piloted on academic users first to get feedback and modified to improve user experience. The summary and referral page is colour coded to improve the immediate identification of risk factors. Special attention was given to not stopping users making a decision more so to facilitate the decision by requesting justification for decisions made that may contradict the evidence collected.

3.8.5 Recognise that physicians will strongly resist stopping

The tool attempts to accommodate user’s choice by allowing users to choose care plans where evidence may suggest alternative plans. The tool allows users to continue along a chosen path as long as a line of justification is entered. This is put in place to avoid irritation of the user and to facilitate unseen circumstances that may be out of the scope of questioning.

3.8.6 Simple interventions work best

The tool attempts to activate only simple interventions throughout the tool, all alerts and alarms attempt to be clear and concise and only presented when necessary. The necessity of these interventions was dictated by the midwifery team. Such an example can be seen in assign to social worker process illustrated in figure 3-16

3.8.7 Ask for additional information only when you really need it

The tool sticks to this concept and as mentioned above only requested a line of justification when a decision is made that is not expected. For example when a woman with no risk factors is assigned to a consultant the alert in figure 3-5 is presented. If the user wishes to continue then a line of justification is required.

3.8.8 Monitor Impact, Get Feedback and respond

The tool was trialled with the midwifery team and feedback was obtained from each individual midwife. Changes were made that were possible and agreed with the group as a whole. The tool was then trialled on the student midwives and feedback on that trial is discussed in chapter 5 Findings.

3.9 Designing the User interface

Simplicity and usability were key elements of the user interface design. Keeping to concepts of Bates et al (2003) the usability and simplicity matter. A significant effort was made in making the tool easy to use and simple to navigate. The interface was designed using Gould and Lewis (1985) design principles of Usability.

3.9.1 Start Page

The first page of the tool seen in figure 3-22 was simple to design. The first page allows the user to enter the woman's weight, height and age. The body mass index (BMI) is calculated automatically and presented to the user. The 'Next' button takes the user to the next page of the tool. The images at the far most right and left were for aesthetic reasons only.

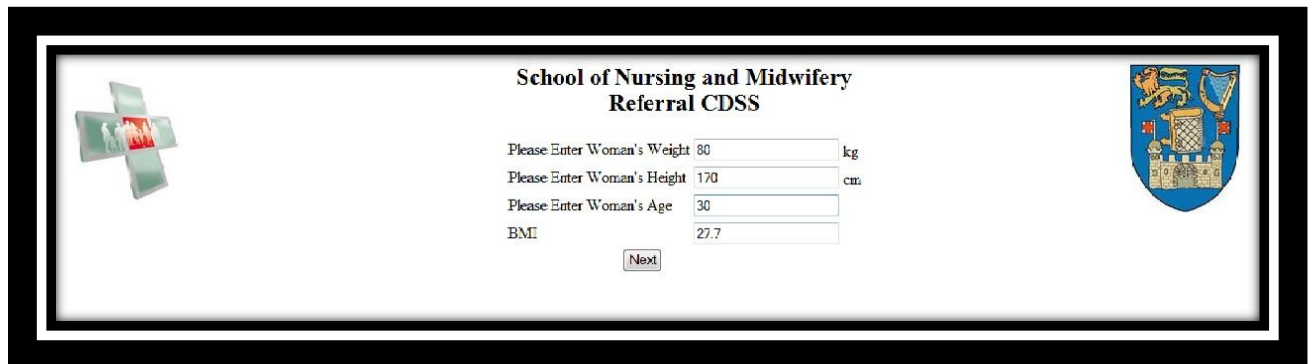


Figure 3-22: START PAGE

3.9.2 First Pregnancy Page

The first pregnancy question required its own page as the answer to this question dictated the next steps of the tool. When answered 'Yes' the user would be taken to the Medical Questions Page, when answered 'No' the user would be taken to the Obstetric history page. This can also be seen in the process flow in figure 3-2

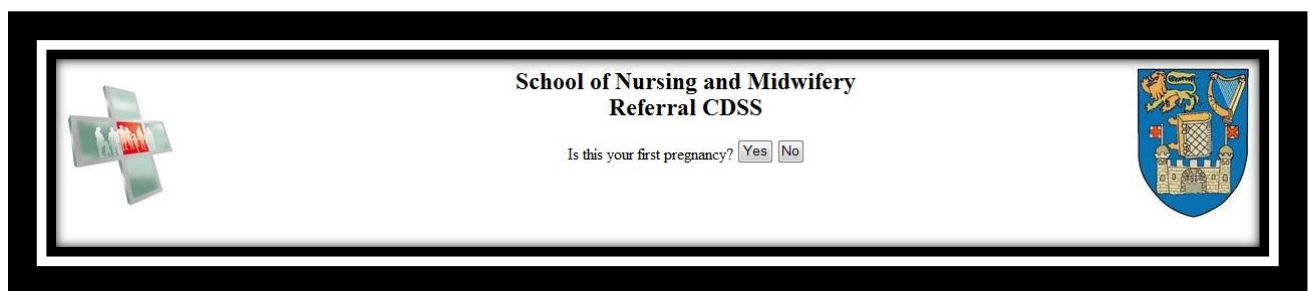


Figure 3-23: FIRST PREGNANCY PAGE

3.9.3 Obstetric History Page

The Obstetric history page seen in figure 3-24 contained all the questions collected from the 2 guidelines received. The questions were in some cases reworded or otherwise modified by the Midwifery team. All

questions had to be answered. The choices of answer were selected using radio buttons. The options were 'Yes', 'No' or 'N/A'. N/A in this case indicated Not Available. Not available was to be used in cases where the information was not available at the time of the consultation.

Purpose of the page:

The purpose of this page was to collect important information related to the woman's obstetric history. All questions represent significant risk factors.

Navigation:

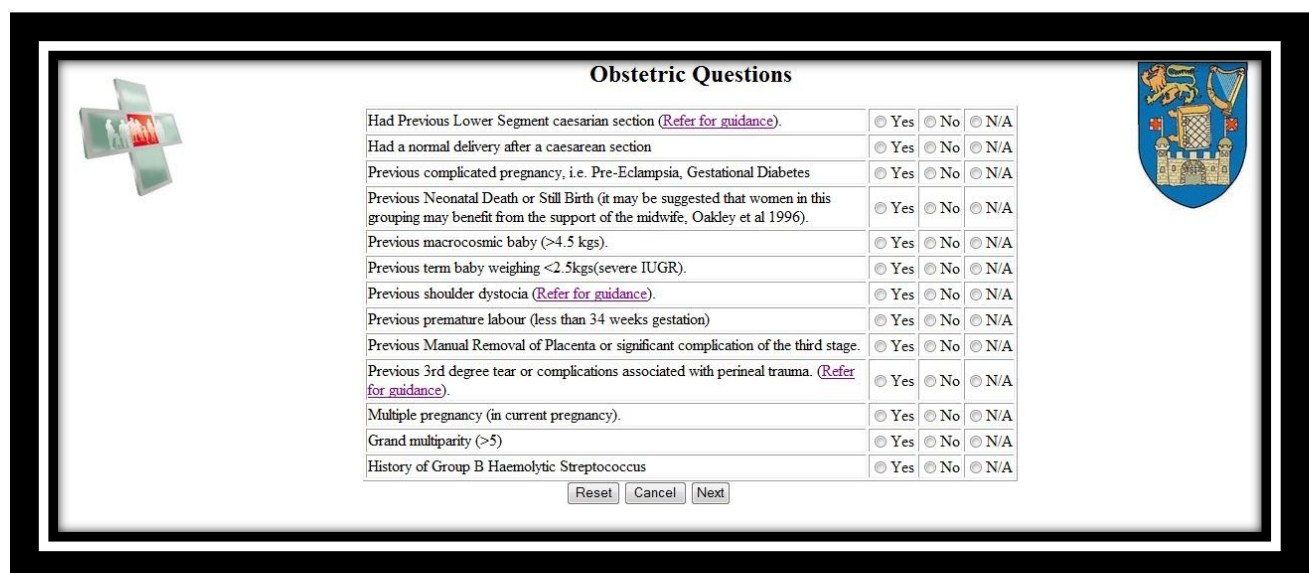
This page is displayed after the user answered the question "Is this your first pregnancy?" by clicking on the 'NO' button.

Any Links labelled 'Refer for guidance' would open a new window containing the relevant section of the particular guideline the user is requesting guidance for. A sample of this can be seen above in figure 3-4. The Obstetric history page remains open and active during this referencing time.

Pressing the 'Reset' button on this page will clear all the selected radio buttons used to indicate answers to questions.

Pressing the 'Cancel' button on this page returned the user to the start page seen in figure 3-22

Pressing the 'Next' button will bring the user to the Medical Questions page seen in figure 3-25



Obstetric Questions			
Had Previous Lower Segment caesarian section (Refer for guidance).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Had a normal delivery after a caesarean section	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Previous complicated pregnancy, i.e. Pre-Eclampsia, Gestational Diabetes	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Previous Neonatal Death or Still Birth (it may be suggested that women in this grouping may benefit from the support of the midwife, Oakley et al 1996).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Previous macrocosmic baby (>4.5 kgs).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Previous term baby weighing <2.5kgs(severe IUGR).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Previous shoulder dystocia (Refer for guidance).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Previous premature labour (less than 34 weeks gestation)	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Previous Manual Removal of Placenta or significant complication of the third stage.	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Previous 3rd degree tear or complications associated with perineal trauma. (Refer for guidance).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Multiple pregnancy (in current pregnancy).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Grand multiparity (>5)	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
History of Group B Haemolytic Streptococcus	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A

Reset Cancel Next

Figure 3-24: OBSTETRIC HISTORY PAGE

3.9.4 Medical History Page

The Medical history page seen in figure 3-25 contained all the questions collected from the 2 guidelines received. The questions were in some cases reworded or otherwise modified by the Midwifery team. All questions had to be answered. The choices of answer were selected using radio buttons. The options were 'Yes', 'No' or 'N/A'. N/A in this case indicated Not Available. Not available was to be used in cases where the information was not available at the time of the consultation.

Purpose of the page:

The purpose of this page was to collect important information related to the woman's medical history. All questions represent significant risk factors.

Navigation:

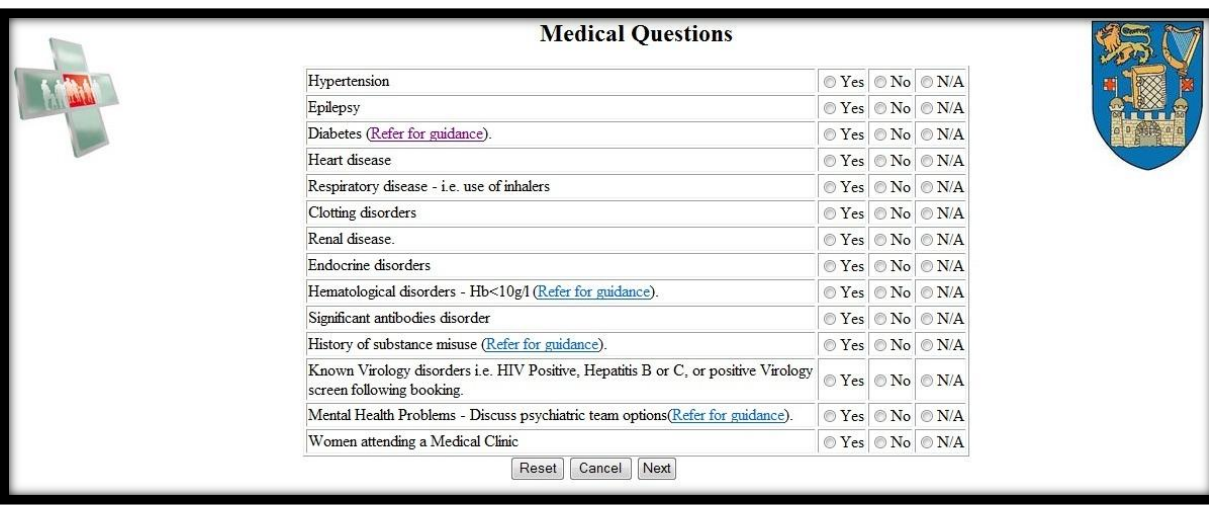
This page is displayed directly after Obstetric history questions have been answered and the user has clicked on the 'Next' button. Alternatively if on the 'first pregnancy page' the user answered the question "Is this your first pregnancy?" by clicking on the 'Yes' button.

Any Links labelled 'Refer for guidance' would open a new window containing the relevant section of the particular guideline the user is requesting guidance for. A sample of this can be seen above in figure 3-4. The Medical history page remains open and active during this referencing time.

Pressing the 'Reset' button on this page will clear all the selected radio buttons used to indicate answers to questions.

Pressing the 'Cancel' button on this page returned the user to the start page seen in figure 3-22

Pressing the 'Next' button will bring the user to the Gynaecological history page seen in figure 3-26



Medical Questions			
Hypertension	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Epilepsy	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Diabetes (Refer for guidance).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Heart disease	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Respiratory disease - i.e. use of inhalers	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Clotting disorders	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Renal disease.	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Endocrine disorders	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Hematological disorders - Hb<10g/l (Refer for guidance).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Significant antibodies disorder	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
History of substance misuse (Refer for guidance).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Known Virology disorders i.e. HIV Positive, Hepatitis B or C, or positive Virology screen following booking.	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Mental Health Problems - Discuss psychiatric team options(Refer for guidance).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Women attending a Medical Clinic	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A

Reset Cancel Next

Figure 3-25: MEDICAL HISTORY PAGE

3.9.5 Gynaecological History Page

The Gynaecological history page seen in figure 3-26 contained all the questions collected from the 2 guidelines received. The questions were in some cases reworded or otherwise modified by the Midwifery team. All questions had to be answered. The choices of answer were selected using radio buttons. The options were 'Yes', 'No' or 'N/A'. N/A in this case indicated Not Available. Not available was to be used in cases where the information was not available at the time of the consultation.

Purpose of the page:

The purpose of this page was to collect important information related to the woman's Gynaecological history. All questions represent significant risk factors.

Navigation:

This page is displayed directly after the Medical History page, the user will navigate to this page by clicking on the 'next' button on the Medical history page.

Any Links labelled 'Refer for guidance' would open a new window containing the relevant section of the particular guideline the user is requesting guidance for. A sample of this can be seen above in figure 3-4. The Gynaecological history page remains open and active during this referencing time.

Pressing the 'Reset' button on this page will clear all the selected radio buttons used to indicate answers to questions.

Pressing the 'Cancel' button on this page returned the user to the start page seen in figure 3-22

Pressing the 'Next' button will bring the user to the Social Questions page seen in fig 3-27

Gynaecological Questions			
History of infertility	<input type="radio"/> Yes	<input checked="" type="radio"/> No	<input type="radio"/> N/A
Cervical incompetence / history of cervical suture.	<input type="radio"/> Yes	<input checked="" type="radio"/> No	<input type="radio"/> N/A
Uterine Fibroid.	<input type="radio"/> Yes	<input checked="" type="radio"/> No	<input type="radio"/> N/A
Any significant gynecological surgery / pelvic fracture	<input type="radio"/> Yes	<input checked="" type="radio"/> No	<input type="radio"/> N/A
Known gynecological anomalies (DES exposure or uterine anomaly)	<input type="radio"/> Yes	<input checked="" type="radio"/> No	<input type="radio"/> N/A
Repeated miscarriages (consult with Obstetrician).	<input type="radio"/> Yes	<input checked="" type="radio"/> No	<input type="radio"/> N/A

Figure 3-26: GYNAECOLOGICAL HISTORY PAGE

3.9.6 Social History Page

The Social history page seen in figure 3-27 contained all the questions collected from the 2 guidelines received. The questions were in some cases reworded or otherwise modified by the Midwifery team. All questions had to be answered. The choices of answer were selected using radio buttons. The options were 'Yes', 'No' or 'N/A'. N/A in this case indicated Not Available. Not available was to be used in cases where the information was not available at the time of the consultation.

Purpose of the page:

The purpose of this page was to collect important information related to the woman's Social background. All questions represent significant risk factors.

Navigation:

This page is displayed directly after the Gynaecological History page, the user will navigate to this page by clicking on the 'next' button on the Gynaecological history page.

Any Links labelled 'Refer for guidance' would open a new window containing the relevant section of the particular guideline the user is requesting guidance for. A sample of this can be seen above in figure 3-4
The Social history page remains open and active during this referencing time.

Pressing the 'Reset' button on this page will clear all the selected radio buttons used to indicate answers to questions.

Pressing the 'Cancel' button on this page returned the user to the start page seen in figure 3-22

Pressing the 'Next' button will bring the user to the Summary and Referral page seen in figure 3-28

Social Questions			
Current history of drug or alcohol abuse.	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
No family support at home	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Outside the geographical area.	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Lack of home facilities or unsatisfactory environmental conditions	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Language assessment - use and understanding of English is not sufficient	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A
Domestic Violence (Refer for guidance).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> N/A

Figure 3-27: SOCIAL HISTORY PAGE

3.9.7 Summary and Referrals Page

The Summary and referrals page seen in figure 3-28 contains a summary of all the data collected on all the pages that are of any significance to the user. In this tool all questions answered with a 'Yes' are summarised and displayed under their relevant section.

The Woman's age, BMI and pregnancy status are presented at the top of the page. The next section, Social Summary is displayed directly below this followed by Obstetric, Medical and Gynaecological summary.

Purpose of the page:

The purpose of this page was to display important information that would contribute towards building a risk profile for the woman. Each section will represent significant risk factors to the user. This page will provide the user with a clear risk profile. This page will allow the user to choose a care plan that they feel is appropriate to the risk profile presented. When a care plan is successfully selected the assignment will be presented to the user under the 'Actions Taken' section. This provides the user with a clear map to what actions have been taken. Once a specific care plan has been selected the page will deactivate buttons that are no longer necessary. For example when a woman has been assigned to the MLU, the button for assign to consultant will be deactivated. This is to prevent a user assigning 2

conflicting care plans in error. This page will also allow the user to unassign a care plan and select another if they feel the selection was not appropriate.

Navigation:

This page is displayed directly after the Social History page, the user will navigate to this page by clicking on the 'Next' button on the social history page.

Any Links labelled 'Refer for guidance' would open a new window containing the relevant section of the particular guideline the user is requesting guidance for. A sample of this can be seen above in figure 3-4. The Summary and Referrals page remains open and active during this referencing time.

Pressing the 'Assign to social worker' button starts the assign-to-social-worker process seen in figure 3-16.

Pressing the 'Assign to MLU' button starts the assign-to-MLU process seen in figure 3-10.

Pressing the 'Assign to consultant' button starts the assign-to-consultant process seen in figure 3-7.

Pressing the 'Assign to specialist' button assigns a specialist to the woman's case.

Pressing the 'Unassign' button will remove the selected care plan and present user with all the care plan selections.

Pressing the 'Finish' button will end the session

Summary and Referrals

Age: 30 (OK)
BMI: 26.9 (Overweight)
Not first pregnancy

Social
OK

Obstetric
Previous shoulder dystocia ([Refer for guidance](#)).

Medical
OK

Gynaecological
OK

Actions taken:
Assigned to consultant

Figure 3-28: SUMMARY AND REFERRALS

3.10 Summary

This chapter presented the concepts of design and development used in the production of this tool. The next chapter will discuss the methods used to evaluate the tool.

Chapter 4 Methodology

4.1 Introduction

With the research question in mind “How Could Maternity Referrals Be Supported by an Online CDSS in Practice and Education” this chapter will take a look at the methodology used to answer this question. In this chapter the study aims, objectives, study design, methods and ethical procedures will be described.

4.2 Aim of the Study

The overall aim of the study was to design, develop, pilot and evaluate a web based tool for use in midwifery referrals. The tool was to be used at booking stage and was to use CDSS best practice in supporting midwifery referrals. The tool would be evaluated for use in practice and education. The tool was to meet requirements at booking and referral stages of initial consultation between a woman and a midwife.

The tool was to encapsulate essential attributes of a Clinical Decision Support System(CDSS) offering influential information at the point where a decision needed to be made.

The specific objectives were to ascertain if this web based Clinical Decision Support System (CDSS) could in general

- Support Practicing Midwives in their referrals
- Support Student Midwives in study of referrals

By assessing the tool in the following ways

- Assess tool for functional support
- Assess tool for usefulness
- Assess tool for user satisfaction
- Assess tool for usability

4.3 Literature review

An extensive literature review covered the areas of clinical decision support systems(CDSS), obstetric risk assessment, Irish care plan models, CDSS design concepts, midwifery learning tools, current educational aids being used in the area and the attitudes of Nursing and Midwifery students to online learning. The literature review also focused on assessing CDSS in medical education. The literature review also highlighted design principles and methods of evaluation.

The online search was focused on the following directories, Science Direct, Pubmed and Medline using the keywords “obstetric management systems”, “midwifery learning tool”, “computerised midwife tool”, “computer assisted learning”, “computer assisted decision making”, “computer assisted diagnosis”, “hospital information systems”, “computerised decision support”, “Obstetric risk assessment”, “risk assessment pregnancy”, “decision support systems”, “CDSS”.

The literature is comprehensively reviewed in chapter 1.

4.4 Designing the tool

The Design of the tool was based on several factors. These factors subsequently enhance the validity of the Decision support tool. The design goals are described in more details in chapter 3. Below is a brief description of the design steps taken.

4.4.1 Midwifery team Setup

A panel of experts was setup at the onset of the design phase. This panel consisted of 4 academic midwives and one independent practicing midwife. The panel were used in consultation throughout the design phase and offered expert advice and suggestions on the integration of best practice into the design.

4.4.2 Current systems review

In order to create a web based tool to simulate the booking stages, knowledge of the current booking systems in place was required. This information was acquired by informal discussions with 2 IT midwives based in the Coombe Women’s Hospital and The Rotunda Hospital Dublin, both large maternity hospitals in Dublin. Each IT midwife gave a running demonstration of their booking systems using

anonymous training simulations. The tool was based on the general processes currently in use by these systems

4.4.3 Midwifery guidelines were obtained from 2 hospitals in the Dublin area.

Initial consultation and Referral guidelines were obtained by contacting the midwives responsible for the community midwife scheme for all maternity hospitals in Dublin. Two midwives responded by email with a list of guidelines in order to qualify for a Midwifery Led Unit(MLU). The two guidelines received were from the Coombe Women's Hospital Dublin and The Rotunda Hospital Dublin.

These guidelines were originally taken and broken into 4 sections. Obstetric History, Medical History, Genealogical History and Social History. Each section contained relevant questions asked on initial consultation.

4.4.4 Consultation with Academic and Training Midwives.

After combining and merging the information from the two guidelines, meetings were organised with the midwifery team. These meetings set out the midwifery requirements and the process flows. The evidence based clinical guidelines obtained from the hospitals which constituted best practice in midwifery, were shown to this panel of experts who confirmed the validity of the questions.

4.4.5 Principles used in the design

The tool was developed using the key principles of design for usability(Gould and Lewis, 1985).

4.4.5.1 Early focus on users and tasks

The concept model was originally designed on paper with the midwifery team. Process flows were agreed and requirements set out. Each member of the midwifery team was an experienced expert in the area of midwifery. All data presented in the tool was validated by the midwifery team and all processes were designed in direct consultation with the team. The design was user-centred

4.4.5.2 Empirical Measurement

Simulations were used in the design of the concept model. Each revision of the tool was tested by the midwifery team and suggestions were made at each revision. The tool was built in collaboration with the target users and so early use of the tool by the midwives was essential in the developmental life cycle. All issues and suggestions were recorded and modifications were made where necessary.

4.4.5.3 Iterative design

The process of design, test and measure, and fix were used during the development of the tool. On each cycle a prototype was given to the midwifery team who tested this and made suggestions. The suggestions were then validated by the midwifery team and the fixes applied where agreement was reached. This process was revised several times till all parties were satisfied.

4.5 Evaluating the tool

4.5.1 Simulations Used

Participants were given 3 fictional conversations between a woman and a midwife that would simulate a booking stage visit. These simulations were in the form of a written document. Three different conversations were simulated. Each situation revealed a different set of variables in order to test the full functionality of the tool. The simulated conversations, seen in appendix 3, contained data which the participant would have to extract from the text and enter into the tool. Each simulation should result in a different referral.

4.5.2 Data Collection

Data on the opinions and attitudes towards the tool were collected using a post simulation questionnaire. Questionnaires were completed by participants immediately after the completion of the simulation exercises. The information gathered in these questionnaires revolved around opinions on the functionality, usefulness, usability and overall satisfaction of the tool and its use during the simulations.

A web based questionnaire was used for the collection of data. Students were directed to this by the researcher when they indicated that they were satisfied they had used the tool sufficiently. The data collected was stored using an online survey tool called 'SurveyMonkey' (www.surveymonkey.com).

A questionnaire was used to obtain a centralised account of all responses. The questionnaire was designed in consultation with the midwifery team in order to achieve the best possible data from the responses. An online questionnaire was used for its speed of access to results and its ability to run concurrently as all participants on the day used the tool in the same session.

4.5.3 Data Analysis

The web based survey tool described above allowed the collection of data in a centralised format for further analysis. This tool allows for the simple descriptive statistics indicating the percentage selecting a

particular response. The Data collected for closed questions was categorised into the 4 themes, Functionality, Usefulness, Satisfaction and Usability.

The data collected for these questions are displayed in simple bar charts representing the percentage selection for each question. The answers to each question are then commented on with regards to the relevance to the study.

Responses to the open questions were analysed and categorised based on a coding system. Each qualitative comment was coded based on one of the themes, Functionality, Usefulness, Satisfaction and Usability. For ease of reading these comments were then integrated into the analysis of their respective section in the findings chapter (Chapter 5). Comments that were seen to be outside of these themes were coded as 'Other'.

4.5.4 Questionnaire Design

A questionnaire was composed by the researcher, see appendix 1, and was examined by 2 academic midwives in the School of Nursing and Midwifery, Trinity College, Dublin. The original draft was revised and modified several times following consultations with the academic midwives. Major changes involved the addition of reaction comments from the students. When a question was answered in the negative an opportunity would arise to learn something from this by collecting information from the participant at this time. Comment fields were added to specific questions where further information could possibly be obtained from the participant. This can be seen in questions 3 and 7 of section A and question 7 of section C.

A similar design had previously been used in a study on the evaluation of handheld clinical decision support systems by Johnson et al (2004). The categories of evaluation were based on those found in the methodology Johnston used in the aforementioned study. These categories were functionality, usefulness, satisfaction and utilisation. The questionnaire was designed using these headings as a guideline but used specifically designed questions for this study.

The majority of questions contained 5-point likert scales where participants rated their agreement with statements about the tool. Possible answers ranged from the negative (Strongly disagree) indicating strong disagreement with the statement to the positive (Strongly Agree) indicating total satisfaction with the statement.

4.5.4.1 Section A - Functionality

Section A focused on functionality, with questions designed to assess the overall functionality of the tool. Statements such as “At the time that a decision is to be made about a woman's care plan, the risk factors are clearly identified” and “Links were provided for appropriate guidelines where possible” were used to establish that the tool was functioning as designed.

Some statements prompted comment fields such as “Links were provided for appropriate guidelines where possible” followed by “If you disagree please give us the referral options you would like to see”

This comment field was added following recommendations put forward after discussion with Academic midwives in the School of Nursing and Midwifery. The purpose of this comment was to capture data from the participant when the opportunity arose.

“The tool accurately covered initial risk assessment” “If you disagree with the above statement, please mention risk factors you would add or risk factors you would remove from the assessment.”

These comment fields were added in an attempt to capture important elements the participants may have found missing from the Tool.

4.5.4.2 Section B - Usefulness

Section B focused on usefulness, with questions designed to assess the overall usefulness of the tool. Statements such as “The summarising of risk factors was useful for decision making”, “The appropriate information was available to me at the time a decision was to be made.”, “The links to official guidelines were useful” were used to ascertain the usefulness of the tool as a decision support system within midwifery practice.

Statements such as “I found this tool could enhance my learning in this area”, “I would like to see similar interactive learning available in my course.” were used to ascertain the usefulness of the tool as an educational tool.

4.5.4.3 Section C - Satisfaction

Section C focused on Satisfaction, with questions designed to assess the participant’s overall satisfaction with the tool. Statements such as “I found the tool easy to use” were used to assess the effectiveness of the usability principles applied during design phase. Ease of use was considered a satisfaction indicator.

The following question was asked to assess if the participant saw this tool as having a realistic value in supporting their work “I feel this tool could meet the needs of a midwife during risk assessment”.

The following statement was used to assess if the participant was satisfied with the guidance nature of the tool “Appropriate alerts (warning messages) were used in the right place at the right time.”

This following open question was used to try and harness any information missed during design phase that could be useful in further development “If you feel there is anything else that may improve your overall satisfaction with this tool please mention it below”.

4.5.4.4 Section D - Usability

Section D focused on the usability of the tool, statements such as “The application was easy to navigate (easy to step through)” were used to probe the participant’s satisfaction with the flow of the application.

The following statement was used to probe the perception of clarity with the use of the tool “I found the tool easy to understand and complete”

Open ended questions were used to gather further information from the participants that might not have been covered by the previous statements such as “Please comment on any difficulties you found with the application.”

The following open ended question was used to try and extract ideas and innovation from the student that the application may have inspired. “What recommendations would you make to improve this application”

4.6 Ethical approval and informed consent

Ethical approval to conduct the study was granted from the Research Ethics committee of the Department of Computer Science in Trinity College, Dublin. The study was also endorsed by the head of the School of Nursing and Midwifery in Trinity College Dublin.

An Information brochure was provided to the participant in advance of the study outlining the aims and objectives of the study, see appendix 2. Aligned with best practice the information brochure also described the process, potential benefits and harms, voluntary participation, the right to withdraw without prejudice, assurance of confidentiality, researchers contact details and an offer to answer any questions that may arise. The information brochure also indicated that there was no conflict of interest by the author.

All students and staff who agreed to take part in the study were presented with an information brochure and were requested to sign a consent form, seen in appendix 3, before taking part in the study.

4.7 Recruitment

The Director of Midwifery in the School of Nursing and Midwifery, Trinity college was petitioned to help recruit students for this study. The Director announced the study at the start of a lecture and requested all voluntary participants to meet with the researcher the following day in the School of Nursing and Midwifery lobby.

Students were provided with an information brochure, seen in appendix 2, at this lecture and given details of where to meet the researcher the next day.

4.8 Population

The students aimed for by the researcher were postgraduate students. Students had to be in their second year of the 2 year course. This would ensure that the students had already experienced booking and referral systems within the hospitals. The amount of participants the researcher wanted to get was 20 students. Unfortunately due to the time of the year (May/June) and the off-site nature of the course(split between various practicing hospitals) it was difficult to obtain this many participants. 10 students volunteered to take the trial out of a class of 43 postgraduate midwifery students.

4.9 Running test

Students were met in the reception area of the school of Nursing and Midwifery, Trinity College, Dublin. The Students confirmed at this point that they had read the information brochure. On successful signing of the consent forms, Students were given 3 predefined sample simulations in written text. The researcher explained the process to the students and brought them to a computer lab where they would be given access to the tool. Each student took a workstation each and the researcher navigated the student to the web page containing the tool. The students were then allowed to enter the information extracted from the text simulations. It was explained to the students that it was not extremely important to follow the simulations but they were supplied as a guide.

All students except one followed the simulations. Very few questions were asked during the study. The researcher was present during the processing of the simulations. When the students indicated that they were satisfied with the use of the tool or finished the simulations they were directed by the researcher to an online survey. Students who volunteered information during the simulations were advised that this information could now be entered during the survey where open ended questions or comment fields were present.

Students finished the study within the estimated timeframe of 20 minutes. All students expressed interest in the results of the study and volunteered their email addresses for further updates. The researcher thanked all students for their participation in the study.

4.10 Summary and introduction to next chapter

This chapter described the methodology used to answer the research question. It describes the literature reviewed, the design of the tool and the methods of evaluating the tool. The next chapter will present the findings from the questionnaire.

Chapter 5 Findings

5.1 Introduction

This chapter discusses the findings for all of the questions asked in the questionnaire. The chapter summarises each section under functionality, usefulness, satisfaction and Usability. Each section analyses the questions posed and the answers received.

5.2 Analysis of answers to questions on the Functionality of the tool

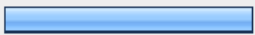
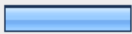
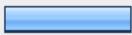

Introduction to functionality, does the tool do what it set out to do. In this sections an attempt is made to probe the students perception of how functionally sufficient or acceptable the tool was. The focus of section one was on functionality. In this section 7 Questions were asked about the functionality for the tool.

Table 5-1: RISK FACTORS CLEARLY IDENTIFIED

1. At the time that a decision is to be made about a woman's care plan, the risk factors are clearly identified		
	Response Percent	Response Count
Strongly agree 	44.4%	4
Agree 	33.3%	3
Neither agree nor disagree 	11.1%	1
Disagree 	11.1%	1
Strongly disagree	0.0%	0
answered question		9
skipped question		1

The results displayed in Table 5-1 indicate the majority of participants either strongly agreed(44%) or agreed(33%) with the statement. This suggests that the tool did indeed identify risks when a decision was to be made on the care plan assignment for the woman.

Table 5-2: LINKS WERE PROVIDED FOR APPROPRIATE GUIDELINES

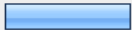

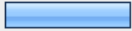

2. Links were provided for appropriate guidelines where possible		
	Response Percent	Response Count
Strongly agree 	44.4%	4
Agree 	22.2%	2
Neither agree nor disagree 	22.2%	2
Disagree 	11.1%	1
Strongly disagree	0.0%	0
answered question		9
skipped question		1

The results displayed in Table 5-2 indicate that the majority of participants either strongly agreed(44%) or agreed(22%) with the statement. The results in this table clarify that the majority of participants were satisfied that appropriate links were displayed.

Qualitative Results were available from the comments that may justify the “neither agree nor disagree” and “disagree” selections.

One participant commented “the links to the NICE guidelines which did not always provide the relevant information to help in the decision making” Indicating a possible requirement for fine tuning of the guideline alignment with the point of reference (hyperlink).

Table 5-3: NECESSARY REFERRAL OPTIONS

3. All the necessary referral options were available		
	Response Percent	Response Count
Strongly agree 	22.2%	2
Agree 	33.3%	3
Neither agree nor disagree 	22.2%	2
Disagree 	22.2%	2
Strongly disagree	0.0%	0
If you disagree please give us the referral options you would like to see		3
answered question		9
skipped question		1

The results displayed in Table 5-3 indicate that just over half of the participants either strongly agreed (22%) or agreed(33%) with the statement. The results in this table indicate that not all participants were satisfied with the referral options available in the tool.

Students were prompted with an open question immediately after question 3 seen in figure 5-1 below, this open comment field was used to capture students' remarks if they did not agree with the statement in question 3.

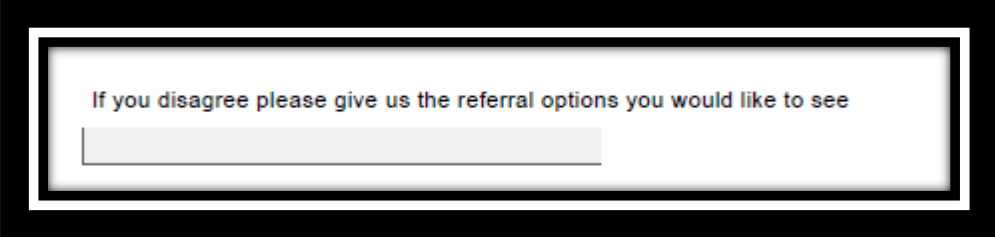


Figure 5-1: MISSING REFERRALS COMMENT FIELD

Qualitative results were consistent with these quantitative findings and yielded additional information on participants' feelings for further referral options and would explain the results in table 5.3.

One participant commented on the need for "specialist drop down list, and the ability for multiple referral"

Participants also commented on the requirement for “dietician referral for diabetes, physio referral for multigravidas” and “dietician, teenage pregnancy, mental health physio”

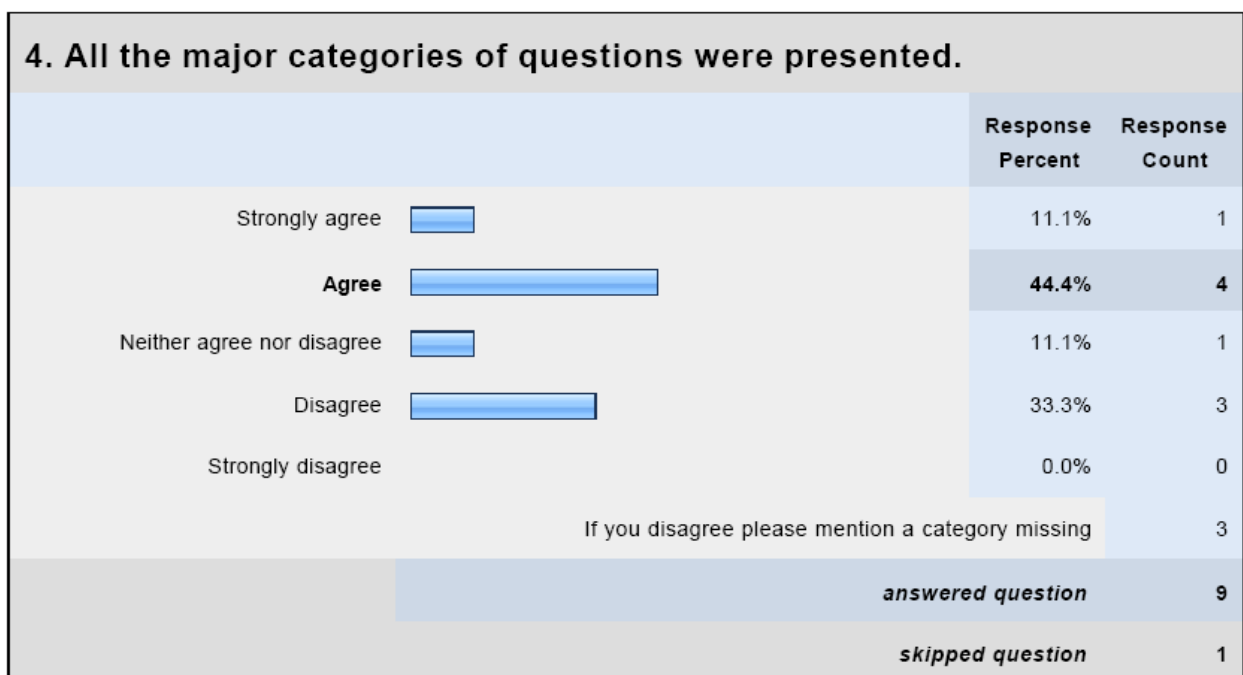
The above comments indicate that there was a strong desire for more granular referral options which would justify the negative response in table 5-3.

Participants commented consistently on the categories that they thought were omitted in the tool, the frequency of new referrals mentioned in the comments field can be summarised in table 5-4 below.

Table 5-4: MISSING REFERRAL OPTIONS

Dietician	Physiotherapist	Multiple Referral
X	X	X
X	X	X
		X

Table 5-5: MAJOR CATEGORIES OF QUESTIONS PRESENTED



The results displayed in Table 5-5 indicate that just over half of the participants either strongly agreed(11%) or agreed(44%) with the statement. The results in this table indicate that not all participants were satisfied with the categories of questions presented by the tool.

Students were prompted with an open question immediately after question 4, seen in figure 5-2 below. This open comment field was used to capture students' remarks if they did not agree with the statement in question 4.



Figure 5-2: MISSING CATEGORIES COMMENT FIELD

Qualitative results were consistent with these quantitative findings and yielded additional information on students feelings for further categories and would explain the results in table 5-5.

One participant commented on the need for “family history, menstrual history” categories.

Other Participants also commented on the requirement for “family history, surgical hx, menstrual hx, previous details of complicated pregnancies need a dialogue box for typing in details” and “surgical history and menstrual history risk factors”

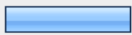
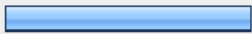
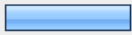

Participants commented consistently on the categories that they thought were omitted in the tool, the frequency of new categories mentioned in the comments field can be summarised in table 5-6 below.

Table 5-6: MISSING CATEGORIES

Family History	Menstrual History	Surgical History
X	X	
X	X	X
	X	X


Using the online survey tool called ‘SurveyMonkey’ (www.surveymonkey.com) we were able to track and link the Participant ID (a unique ID given to each participant) with the comments and establish that all participants who disagreed with the statement in questions 4 also gave comments to justify their disagreement.

Table 5-7: MAKING A FINAL DECISION ON CARE PLAN OR REFERRAL

5. The tool assisted in making a final decision on care plan or referral.		
	Response Percent	Response Count
Strongly agree 	22.2%	2
Agree 	44.4%	4
Neither agree nor disagree 	22.2%	2
Disagree 	11.1%	1
Strongly disagree	0.0%	0
answered question		9
skipped question		1

The results displayed in Table 5-7 indicate that the majority of participants either strongly agreed (22%) or agreed(44%) with the statement. The results in this table clarify that the majority of participants were satisfied that the tool assisted in decision making when it came to referring the women to a care plan or referral.

Table 5-8: ACCURATELY COVERED INITIAL RISK ASSESSMENT

6. The tool accurately covered initial risk assessment.		
	Response Percent	Response Count
Strongly agree	0.0%	0
Agree 	77.8%	7
Neither agree nor disagree 	11.1%	1
Disagree 	11.1%	1
Strongly disagree	0.0%	0
answered question		9
skipped question		1

The results displayed in Table 5-8 indicate that the majority of participants Agreed(78%) with the statement. The results in this table clarify that the majority of participants were satisfied that the tool accurately covered risk assessment.

This question also prompted a comment from the participants in the form of Question 7 which posed the proposition below in figure 5-3.

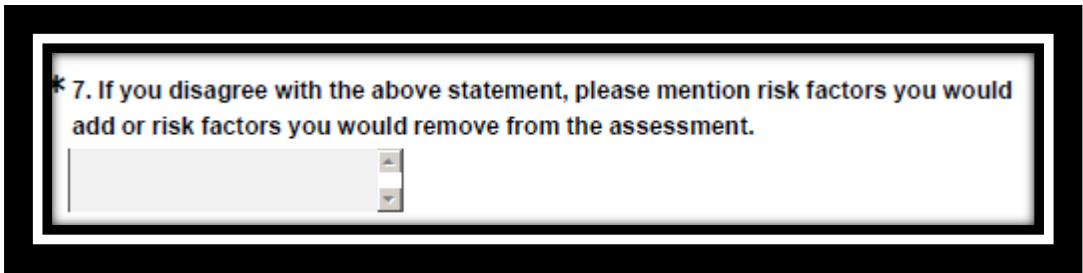


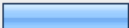


Figure 5-3: MISSING RISK FACTORS

“If you disagree with the above statement, please mention risk factors you would add or risk factors you would remove from the assessment.”

All participants skipped this question or entered invalid data. A possible reason for this may be found in the open questions results, participants were already given the opportunity in this section to declare what they felt was missing in the risk assessment and possibly felt there was not requirement to mention this again at this point. This would partially explain the absence of any “Strongly Agree” selections and the lack of any explanation at this point.

Table 5-9: GUIDANCE ON CARE PLAN ASSIGNMENT

8. The tool offered some guidance on care plan assignment		
	Response Percent	Response Count
Strongly agree 	11.1%	1
Agree 	66.7%	6
Neither agree nor disagree 	22.2%	2
Disagree	0.0%	0
Strongly disagree	0.0%	0
answered question		9
skipped question		1

The results displayed in Table 5-9 indicate the majority of participants either strongly agreed (11%) or agreed(67%) with the statement. This indicated that there was a general strong feeling that the tool offered some guidance on care plan assignment.

5.2.1 Summary of Functionality

Each of the seven statements posed above was attempting to measure the participants attitudes or feelings towards the different functional requirements of the system.

The participants were generally satisfied with the tool's ability to identify risk and provide appropriate guidelines.

Participants also expressed agreement with the tool's ability to assist in making a final decision on a women's care plan or referral and on the tool's ability to accurately cover risk assessment

Feedback was successfully obtained on the possible addition of more granular referral options with three referral suggestions dominating. Further category suggestions were captured during the functional assessment which again provided three dominant category suggestions.

An overall positive result from the functionality questions was obtained, in cases where some participants disagreed with statements, a valid explanation was captured.

5.3 Analysis of answers to questions on the Usefulness of the tool

The focus of sections 2 was on Usefulness. In this section seven questions were asked about the usefulness of the tool.


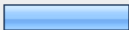
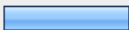
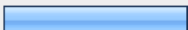
Table 5-10: SUMMARISING OF RISK FACTORS WAS USEFUL FOR DECISION MAKING

9. The summarising of risk factors was useful for decision making.		
	Response Percent	Response Count
Strongly agree 	33.3%	3
Agree 	55.6%	5
Neither agree nor disagree 	11.1%	1
Disagree	0.0%	0
Strongly disagree	0.0%	0
answered question		9
skipped question		1

The results displayed in Table 5-10 indicate the majority of participants either strongly agreed (33%) or agreed(56%) with the statement. No participants disagreed with the above statement, clarifying that the summarising of risks was useful for decision making.

A possible reason for this may be found in the open question results, which revealed comments regarding usage such as “very innovative and a contemporary way of improving data collection and usage”

Table 5-11: APPROPRIATE INFORMATION WAS AVAILABLE AT THE TIME OF DECISION




10. The appropriate information was available to me at the time a decision was to be made.		
	Response Percent	Response Count
Strongly agree 	22.2%	2
Agree 	22.2%	2
Neither agree nor disagree 	22.2%	2
Disagree 	33.3%	3
Strongly disagree	0.0%	0
answered question		9
skipped question		1

The results displayed in Table 5-11 were more evenly spread which made this difficult to analyse. 33% of participants disagreed with the statement, however 44% either strongly agreed or agreed with the statement, with 22% neither agreeing or disagreeing.

Some comments collected at question 26 where the open question “What recommendations would you make to improve this application” was posed may indicate some dissatisfaction here. The comment “I had some difficulty with some of the questions and also the links to the NICE (National Institute for Health and Clinical Excellence) guidelines which did not always provide the relevant information to help in the decision making” indicated that some of the guidelines may need to be reviewed for relevance.

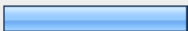



The results identified in Table 5.11 above highlight a possible weakness in the study, a larger population would possibly have produced a clearer picture of the results.

Table 5-12: JUSTIFICATION DIALOG BOX COULD BE USEFUL IN EXPLAINING RATIONALE

11. The justification dialog box could be useful in explaining rationale for decisions		
	Response Percent	Response Count
Strongly agree 	22.2%	2
Agree 	66.7%	6
Neither agree nor disagree 	11.1%	1
Disagree	0.0%	0
Strongly disagree	0.0%	0
<i>answered question</i>		9
<i>skipped question</i>		1

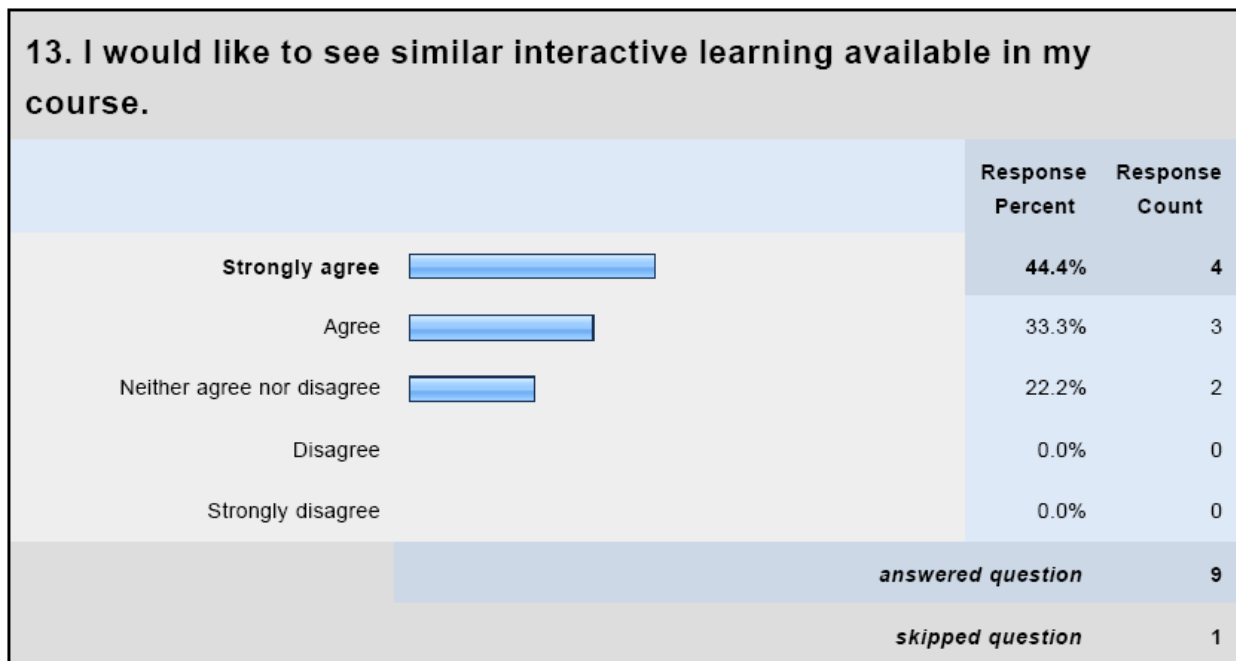
The results displayed in Table 5.12 indicate the majority of participants either strongly agreed (22%) or agreed (67%) with the statement. No participants disagreed with the above statement, signifying that the justification dialog box was found to be useful in explaining rationale for decisions.

Table 5-13: ENHANCE MY LEARNING IN THIS AREA

12. I found this tool could enhance my learning in this area.		
	Response Percent	Response Count
Strongly agree 	33.3%	3
Agree 	44.4%	4
Neither agree nor disagree 	11.1%	1
Disagree 	11.1%	1
Strongly disagree	0.0%	0
<i>answered question</i>		9
<i>skipped question</i>		1

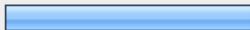
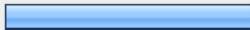

The results displayed in Table 5-13 indicate the majority of participants either strongly agreed (33%) or agreed (44%) with the statement. The results in Table 5-13 signify a possible opportunity to investigate further into how CDSS could enhance learning in this area

Table 5-14: SIMILAR INTERACTIVE LEARNING AVAILABLE IN MY COURSE



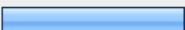
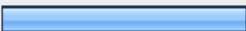
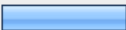
The results displayed in Table 5-14 indicate the majority of participants either strongly agreed (44%) or agreed (33%) with the statement. No participants disagreed with the above statement indicating further development of similar interactive applications could be successful in this learning environment.

Table 5-15: LINKS TO OFFICAL GUIDELINES WERE USEFUL

14. The links to official guidelines were useful		
	Response Percent	Response Count
Strongly agree 	44.4%	4
Agree 	44.4%	4
Neither agree nor disagree 	11.1%	1
Disagree	0.0%	0
Strongly disagree	0.0%	0
answered question		9
skipped question		1

The results displayed in Table 5-15 indicate the majority of participants either strongly agreed (44%) or agreed (44%) with the statement. No participants disagreed with the above statement signifying the perceived usefulness of the links to official guidelines.

Table 5-16: SATISFIED WITH THE OVERALL USEFULNESS OF THIS APPLICATION

15. I was satisfied with the overall usefulness of this application		
	Response Percent	Response Count
Strongly agree 	33.3%	3
Agree 	44.4%	4
Neither agree nor disagree 	22.2%	2
Disagree	0.0%	0
Strongly disagree	0.0%	0
answered question		9
skipped question		1

The results displayed in Table 5-16 indicate the majority of participants either strongly agreed (33%) or agreed (44%) with the statement. No participants disagreed with the above statement indicating a general satisfaction with the usefulness of this tool.

5.3.1 Summary of usefulness

Each of the seven statements posed above was attempting to measure the participants attitudes or feelings towards the usefulness of the system. The objective here was to ascertain that this tool could be either beneficial or of practical use to the participant.

The findings in this section show that participants found the tools features such as the summarising of risk factors, the justification dialogue box and the links to the official guidelines particularly useful.

With regards to learning objectives, participants found this tool to be a practical learning resource and would like to see a similar tool used in their current course.

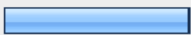



Comments extracted from the open questions results revealed some dissatisfaction with the usefulness of the tool among participants; one participant commented “I felt the tool was very clinical and while I recognise the aim is to safe guard the woman and to provide appropriate care I would be concerned that the women and the importance of midwifery skills could be lost behind a box ticking exercise”

The comment above highlights the complexity of the relationship between the midwife and the woman and that not all situations can be categorised or are tangible. The situation could be improved by working more closely with midwives to achieve a system that would cater also for their specific relationship with their clients.

5.4 Analysis of answers to questions on Satisfaction with the tool

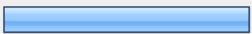
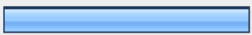

The focus of sections 3 was on Satisfaction. In this section, six questions were asked about the participants' satisfaction with the tool.

Table 5-17: INFORMATION WAS DISPLAYED IN A CLEAR AND CONCISE MANNER

16. The information was displayed in a clear and concise manner		
	Response Percent	Response Count
Strongly agree 	33.3%	3
Agree 	44.4%	4
Neither agree nor disagree 	11.1%	1
Disagree 	11.1%	1
Strongly disagree	0.0%	0
<i>answered question</i>		9
<i>skipped question</i>		1

The results displayed in Table 5-17 indicate the majority of participants either strongly agreed (33%) or agreed (44%) with the statement. Table 5-17 signifies a general satisfaction with the display of information within the tool.

Table 5-18: TOOL EASY TO USE

17. I found the tool easy to use		
	Response Percent	Response Count
Strongly agree 	44.4%	4
Agree 	44.4%	4
Neither agree nor disagree 	11.1%	1
Disagree	0.0%	0
Strongly disagree	0.0%	0
<i>answered question</i>		9
<i>skipped question</i>		1

The results displayed in Table 5.18 indicate the majority of participants either strongly agreed (44%) or agreed (44%) with the statement. No participants disagreed with the above statement indicating a general satisfaction with the tool's ease of use.

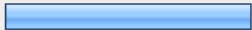

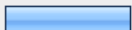
Comments extracted from the open question results revealed satisfaction with the tool's ease of use among participants. One participant commented; "I appreciate how simple it is to use"

Table 5-19: APPROPRIATE ALERTS WERE USED IN THE RIGHT PLACES AT THE RIGHT TIME

18. Appropriate alerts (warning messages) were used in the right place at the right time.		
	Response Percent	Response Count
Strongly agree 	33.3%	3
Agree 	44.4%	4
Neither agree nor disagree 	11.1%	1
Disagree 	11.1%	1
Strongly disagree	0.0%	0
answered question		9
skipped question		1


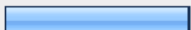

The results displayed in Table 5-19 indicate the majority of participants either strongly agreed (33%) or agreed (44%) with the statement. This question was posed to ensure the alerts were not a nuisance and more of an aid or safeguard to decision making. The results in table 5-19 signify satisfaction with the positioning of alerts.

Table 5-20: SIMILAR DECISION SUPPORT TOOL WOULD BE HELPFUL IN MY STUDIES

19. This tool or similar Decision Support tool would be helpful in my studies.		
	Response Percent	Response Count
Strongly agree 	44.4%	4
Agree 	33.3%	3
Neither agree nor disagree 	22.2%	2
Disagree	0.0%	0
Strongly disagree	0.0%	0
<i>answered question</i>		9
<i>skipped question</i>		1

The results displayed in Table 5-20 indicate the majority of participants either strongly agreed (44%) or agreed (33%) with the statement. No participants disagreed with the above statement indicating a general satisfaction with this type of tool being used as a learning aid.

Table 5-21: SIMILAR DECISION SUPPORT TOOL WOULD BE HELPFUL IN THE WORKPLACE

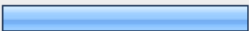
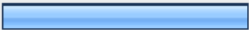

20. This tool or similar Decision Support tool would be helpful in the workplace.		
	Response Percent	Response Count
Strongly agree 	44.4%	4
Agree 	33.3%	3
Neither agree nor disagree 	22.2%	2
Disagree	0.0%	0
Strongly disagree	0.0%	0
<i>answered question</i>		9
<i>skipped question</i>		1

The results displayed in Table 5-21 indicate the majority of participants either strongly agreed (44%) or agreed (33%) with the statement. No participants disagreed with the above statement indicating a general satisfaction with this type of tool being used in the work place.

The results in table 5-21 are comparably similar to the results in table 5-20 showing a high satisfaction level with the use of decision support tools in learning and the workplace.

Comments extracted from the open questions results, revealed satisfaction with the tool's possible use in the work place among participants. One participant commented; "Subject to refinements, as this is currently structured it would be useful at entry level to a midwifery programme"

Table 5-22: THIS TOOL COULD MEET THE NEEDS OF A MIDWIFE DURING RISK ASSESSMENT

21. I feel this tool could meet the needs of a midwife during risk assessment		
	Response Percent	Response Count
Strongly agree 	44.4%	4
Agree 	44.4%	4
Neither agree nor disagree 	11.1%	1
Disagree	0.0%	0
Strongly disagree	0.0%	0
answered question		9
skipped question		1

The results displayed in Table 5.22 indicate the majority of participants either strongly agreed (44%) or agreed (44%) with the statement. No participants disagreed with the above statement indicating a general satisfaction that this tool could be used to aid midwives during risk assessment.

Comments extracted from the open question results revealed satisfaction with the tools possible use in the work place among participants. Participants commented;

"Subject to refinements, as this is currently structured it would be useful at entry level to a midwifery programme."

“I would suggest that it(the tool)could be rolled out to the public to fill in with a view that the midwife would review at the first appointment and allow more discussion about options rather than a strict criteria of needs”

Table 5-23: IMPROVE YOUR OVERALL SATISFACTION WITH THIS TOOL

22. If you feel there is anything else that may improve your overall satisfaction with this tool please mention it below	
	Response Count
	5
answered question	5
skipped question	5

The question seen in table 5.23 was an open question and allowed the participant to enter free text. Five participants submitted suggestions which were categorized and integrated back into the findings. These suggestions were broken into the various sections of Functionality, Usefulness, Satisfaction and Usability and coded accordingly. These comments can be seen in the sections that were most relevant to the nature of the suggested improvement.

5.4.1 Summary of Satisfaction

Each of the seven statements posed above was attempting to measure the participants’ attitudes and perception of satisfaction with the system.

The majority of participants were very satisfied with the tool’s display being clear and concise and the tool’s ‘ease of use’.

Participants in general expressed satisfaction with the tool’s ability to provide appropriate alerts in the right place at the right time.

Positive feedback was obtained on the use of Decision Support Systems for learning and in the workplace. Neither statement about DSS was disagreed with by any of the participants. The same majority of participants showed a comparably high satisfaction level with the concept of DSS in both the learning and working environment.

There were positive comments regarding the use of this tool in practice for risk assessment by Midwives, showing a practical appreciation for the tool.

“Subject to refinements, as this is currently structured it would be useful at entry level to a midwifery programme.”

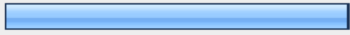
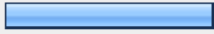
“I would suggest that it (the tool) could be rolled out to the public to fill in with a view that the midwife would review at the first appointment and allow more discussion about options rather than a strict criteria of needs.”

An overall very positive result from the satisfaction questions was obtained. Comments captured that would improve satisfaction were coded and integrated into the relevant section of the findings.

5.5 Analysis of answers to questions on the Usability of the tool

The focus of sections 4 was on Usability. In this section, 4 questions were asked about how participants felt about the usability of the tool. The questions were made up of 2 closed questions and 2 open questions.

Table 5-24: THE APPLICATION WAS EASY TO NAVIGATE

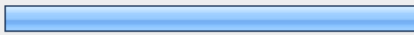
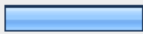
23. The application was easy to navigate (easy to step through)		
	Response Percent	Response Count
Strongly agree 	62.5%	5
Agree 	37.5%	3
Neither agree nor disagree	0.0%	0
Disagree	0.0%	0
Strongly disagree	0.0%	0
answered question		8
skipped question		2

The results displayed in Table 5-24 indicate that all of the participants either strongly agreed (63%) or agreed (37%) with the statement. No participants disagreed with the above statement indicating a collective agreement that this tool was easy to navigate.

Comments extracted from the open questions revealed some dissatisfaction with the tool's ease of navigation. Participants commented "If one made a mistake you cannot go back to the page before" and "Not being able to go back to previous page" as being difficulties that they experienced while using the tool.

These comments suggest some dissatisfaction with the ease of navigation; however the general navigation appears to be satisfactory based on the results in table 5-24.

Table 5-25: EASY TO UNDERSTAND AND COMPLETE

24. I found the tool easy to understand and complete		
	Response Percent	Response Count
Strongly agree 	75.0%	6
Agree 	25.0%	2
Neither agree nor disagree	0.0%	0
Disagree	0.0%	0
Strongly disagree	0.0%	0
<i>answered question</i>		8
<i>skipped question</i>		2

The results displayed in Table 5-25 indicate that all of the participants either strongly agreed (75%) or agreed (25%) with the statement. No participants disagreed with the above statement indicating a collective agreement that this tool was easy to understand and complete.

Table 5-26: COMMENT ON ANY DIFFICULTIES YOU FOUND WITH THE APPLICATION

25. Please comment on any difficulties you found with the application.	
	Response Count
	6
<i>answered question</i>	6
<i>skipped question</i>	4

The question seen in table 5-26 was an open question and allowed the participant to enter free text. Six participants submitted difficulties they experienced which were categorized and integrated back into the findings. These comments were broken into the various sections of Functionality, Usefulness, Satisfaction and Usability and coded accordingly. These comments can be seen throughout this chapter under the relevant category in which the difficulty was experienced.

Table 5-27: WHAT RECOMMENDATIONS WOULD YOU MAKE TO IMPROVE THIS APPLICATION

26. What recommendations would you make to improve this application	
	Response Count
	7
answered question	7
skipped question	3

The question seen in table 5-27 was an open question and allowed the participant to enter free text. Seven participants submitted recommendations to improve the tool which were categorized and integrated back into these findings. These comments were broken into the various sections of Functionality, Usefulness, Satisfaction and Usability and coded accordingly. These comments can be seen throughout this chapter under the relevant category in which the recommendation for improvement belonged.

5.5.1 Summary of Usability

The two statements posed above were attempting to measure the participants' attitudes and perception of Usability of the system. All of the participants were very satisfied with the tool's ease of navigation and the ease at which one could understand and complete the exercise. No participants disagreed with the above statements indicating a collective agreement among all participants that this tool was easy to use and understand. This result is significantly positive for the study as it indicates that the usability of the tool was very good.

5.6 General Summary

This chapter presents the results of the questionnaire. It details the results under the four headings Functionality, Usefulness, Satisfaction and Usability. The closed questions fall under their respective headings. The open questions within each section were broken up, coded as to their relevant section and then integrated into each section to get a more overall view of the attitudes and perceptions of the participants.

The results and recommendations will be further discussed in chapter 6, the Conclusion and Recommendations chapter.

Chapter 6 Conclusion and Recommendations

6.1 Introduction

With the increased use of computer interaction within the healthcare setting and the further adoption of CDSS technologies the question was asked, how could maternity referrals be supported by an online CDSS in practice and education?

The research set out to evaluate the perceptions of use of a CDSS for midwifery referrals at booking stage. The participants were asked to assess the CDSS tool under the following categories;

- Functionality, did the tool achieve what it set out to do
 - Accurately cover risk assessment
 - Supply and guide referrals
 - Assist in Decision making
- Usefulness, was the tool perceived as a practical resource for both education and work place
 - Were the risk summaries useful in decision making
 - Was the info displayed appropriate
 - Links to official guidelines useful
 - Useful in education
- Satisfaction, were the participants satisfied with the tool
 - Was the info clear and concise
 - Was the tool easy to use
 - Would this CDSS be helpful in workplace and education
 - Could it meet the needs of a midwife in practice
- Usability, was the tool straight forward and easy to use.
 - Was the tool easy of navigate
 - Was the tool easy to understand and complete

The conclusions and results are discussed in this chapter.

6.2 Conclusions

The study revealed that there is certainly scope for the introduction of a clinical decision support system to support maternity referrals in practice and in education. Participants perceived the CDSS tool as a helpful and practical referrals tool and would like to see such a tool in place in their current course and work place. The implementation of CDSS principles into the current obstetric management systems was received with encouraging results and provides evidence of the potential success of such a tool in practice and learning.

The Key Findings from the evaluation are as follows

6.2.1.1 *Functionality*

- The participants were satisfied with the tool's ability to identify risk and provide appropriate guidelines
- Participants expressed agreement with the tool's ability to assist in making a final decision on a women's care plan or referral and on the tool's ability to accurately cover risk assessment
- Participants would like to see more granular referral options on the summary and referrals page.
- Participants would like to see further question categories

Overall participants were satisfied with the functionality of the tool. The tool provided the core functions of risk assessment and referral guidance required to support a midwife in referrals. Comments captured during this analysis indicated the requirement for more questions and referral options

6.2.1.2 *Usefulness*

- Participants found the tools features such as the summarising of risk factors, the justification dialogue box and the links to the official guidelines particularly useful
- Participants found this tool to be a practical interactive learning resource and would like to see a similar tool available in their current course.

Participants found the tool useful in summarising risk and particularly useful in supplying official guidelines. The users also expressed satisfaction with the tools use in education and would like to see this tool or similar used in midwifery courses as an educational aid.

6.2.1.3 Satisfaction

- Participants were very satisfied with the tool's display being clear and concise and the tool's ease-of-use.
- Participants were satisfied with the tool's ability to provide appropriate alerts in the right place at the right time
- Participants would like to see the use of this tool or similar CDSS in practice for risk assessment by Midwives.

Participants were satisfied with the ease-of-use of the application. All participants were in favour of this tool being used in practice and education.

6.2.1.4 Usability

- All of the participants were very satisfied with the tool's ease of navigation and the ease at which one could understand and complete the exercise.

All users indicated that they were happy with the tools overall usability, users all agreed that the navigation of the system was simple. All users also agreed that the tool was easy to understand and complete.

6.3 Discussion

Comments extracted from the open questions results revealed some dissatisfaction with the usefulness of the tool among participants; one participant commented "I felt the tool was very clinical and while I recognise the aim is to safe guard the woman and to provide appropriate care I would be concerned that the women and the importance of midwifery skills could be lost behind a box ticking exercise"

The comment above highlights the complexity of the relationship between the midwife and the woman and that not all situations can be categorised or are tangible. The situation could be improved by working more closely with midwives to achieve a system that would cater also for their specific relationship with their clients. This is obviously a sensitive topic among some midwives it may be an area that warrants further investigation.

Positive feedback was obtained on the use of Clinical Decision Support Systems(CDSS) for learning and in the workplace. Both of the statements in the questionnaire numbered 19 and 20 regarding the use of the CDSS with student studies and in the work place were agreed with by all of the participants. The same majority of participants showed a comparably high satisfaction level with the

concept of CDSS in both the learning and working environment. This showed a clear desire to see more interactive tools available in both the course and the work place

6.3.1 Comments on the day

One of the foreign students for whom English is not their first language approached the author after the exercise and wanted to comment on how easy it was to use the tool. In particular the wording of the tool was excellent and made the decision making process easy and clear.

Another student mentioned that the hyperlink access to guidelines would take a lot of the work out of the current systems where one must research and find these guidelines themselves.

All students on the day expressed genuine interest in the results of this study and requested a link to the updated tool and volunteered their email addresses to the author.

6.4 Recommended improvements

6.4.1 Referrals

Reaction comments were successfully captured following questions that may potentially provoke useful comments, for example

Statement: all the necessary referral options were available

Reactions Capture: if you disagree please give us the referral options you would like to see.

These captured comments revealed some improvements that could be made to improve the tool.

Some missing referral options were highlighted by a number of participants, indicating the requirement for a more granular referral range. There was some consistency in the missing referral options that were highlighted. The valid comments indicating three new referral options are summarised in table 6-1 below. This table indicates the frequency that particular referrals were mentioned

This improvement or modification could be made quite easily to the tool by adding extra referrals options. The tool intentionally limited referral options as to keep the tool simple.

Table 6-1: MISSING REFERRAL OPTIONS

Dietician	Physiotherapist	Multiple Referral
X	X	X

X	X	X
		X

6.4.2 Categories of Questions

Participants also suggested that they would like to have seen more categories of questions such as those highlighted in table 6-2. Surgical history can be ruled out in this case as the questions related to surgical history were balanced across Obstetric, Medical and Gynaecological History questions. Again some consistency was seen across the student's suggestions. This table indicates the frequency that particular missing categories were mentioned

Table 6-2: MISSING CATEGORIES

Family History	Menstrual History	Surgical History
X	X	
X	X	X
	X	X

6.4.3 Navigation

The option to go back to a previous page was highlighted as an issue by a number of users. This flaw in the tool was recognised as a bug. This fix can be quickly implemented to resolve this issue.

6.5 Limitations of Research

6.5.1 Population

To improve the study, a larger population would be preferred, unfortunately the timing of the study was not ideal as the trial took place in May and most of the students were already preparing for exams or had left the school resulting in a low volunteer rate. A larger population group would have been preferred in order to get more defined results. A possible reach out to other schools of Midwifery may have helped in this case.

6.5.2 Scope

The tool only covers initial consultation and does not cover all possible questions within this area. As we can see from some of the responses in the findings chapter further categories of questions were

desired and further referrals desired. The range of categories and referral options was intentionally limited to keep development of the tool within an achievable timeframe.

6.6 Future Work

The positive responses obtained from the participants to the concept model of a decision support system were encouraging. The tool works as a basic CDSS for maternity referrals but could be used to enhance learning by reinforcing practice and procedures for students.

6.6.1 A Retrospective study to ascertain improved decision making

A future study opportunity was highlighted during this study by a senior midwife in the school of nursing and midwifery, Trinity College. The proposal was that this tool could be used to go through a significant number of anonymous records where bad outcomes were experienced. A bad outcome can be defined by infant morbidity or where significant interventions such as caesarean section may have kept the woman in hospital for several days after the birth.

The study would take a number of these records, extract the information relevant to this tool and see if the tool could guide the midwife or clinician to a more appropriate care-plan than the one originally selected by the original clinician.

The study may prove that the tool could be used to improve decision making in care-plan assignment within the health care setting and may prompt recognition from health care providers. This could ultimately lead to an improvement in the quality of care for women.

6.6.2 Improved Decision making for students

Further study should be taken to explore the development of decision making skills learned by the students during the trial of this tool. Similar simulation studies have shown students have shown improved confidence levels, fewer inferences and revisited collected data less often. To achieve this, the author proposes a control group would have to be setup. The control group would take the traditional methods of learning through lectures and the test group would be exposed to the tool for certain simulations. For example, what care to provide a woman who has had a previous caesarean section?

An examination of some sort would then be held to verify if the student exposed to the tool could reach the appropriate decision faster and more confidently than the students who were exposed

only to the lectures. This could ultimately prove that interaction with the tool did indeed improve decision making.

6.6.3 Improved Referrals study

A prospective study suggested by the author would be to attempt to demonstrate improved referrals based on the tool developed for this study. A large group of participants would be required. A control group would need to be set up. The test group would use the CDSS tool to support referrals and the control group could use the current obstetric management system for referrals. Comparisons could then be made between the test group and the control group based on the number of expected out-comes relative to their particular care plan assignment. The appropriate referrals could then be analysed against the particular information that was available. This study could measure the impact of the introduction of a CDSS

6.6.4 Potential for Risk updates

During research the author discovered the implication of BMI category changes during pregnancy. A concept suggested by the author may be to introduce an ongoing risk status that can change throughout the term of a pregnancy.

During research into risk factors affecting outcomes, information regarding the change in BMI status and the significant effect it may have on outcomes came to light. A possible feature that could be integrated into this system or alternative obstetric management system is a risk status monitor. Obviously there are many areas that affect risk, and the change thereof, but in this case we can look at the change in BMI status to keep it simple.

For example when a woman's BMI category changes during pregnancy, from overweight to obese, this could be captured and an alarm triggered which could invoke a midwife to assign a dietician or transfer the woman to a consultant as the risk status has now changed to high risk. This would involve the integration of the tool into an electronic health record (EHR). The system could flag a change in risk status and require an action from the midwife. Updates in BMI could be updated from the community or by the woman herself via text message. This only requires weight to be taken at particular intervals during the pregnancy as height would be a constant taken at initial consultation.

6.6.5 Possible liability check list for independent midwives

It was suggested during the midwifery team meetings that this tool, subject to some modifications could be used as a digital audit tool for independent midwives as a way of recording all data collected at the initial consultation. The ability to use the tool from any location as it is web based made this particularly appealing to the independent midwife on the midwifery team. This may be used for medico-legal reasons as a point of reference. The tool could be used as a portable checklist while assessing if a women could qualify for an independent midwife or home birth.

6.6.6 Integration into EHR

As mentioned above with BMI status changes it would be interesting for this tool to be integrated into an EHR. Information collected at this point would either be answered dynamically via the EHR such as medical history questions etc. An updated record via and obstetric management system would also be helpful in corroborating a woman's medical, gynaecological or obstetric history for future births based in the most up-to-date record.

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Appendix 1 Questionnaire

Midwifery CDSS

1. Functionality Questions

The purpose of these questions is to try and assess the overall functionality of the web tool

- * 1. At the time that a decision is to be made about a woman's care plan, the risk factors are clearly identified

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

- * 2. Links were provided for appropriate guidelines where possible

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

- * 3. All the necessary referral options were available

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

If you disagree please give us the referral options you would like to see

- * 4. All the major categories of questions were presented.

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

If you disagree please mention a category missing

- * 5. The tool assisted in making a final decision on care plan or referral.

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

- * 6. The tool accurately covered initial risk assessment.

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

- * 7. If you disagree with the above statement, please mention risk factors you would add or risk factors you would remove from the assessment.

- * 8. The tool offered some guidance on care plan assignment

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

Midwifery CDSS

2. Usefulness

The purpose of these questions is to assess the overall usefulness of the web tool

*** 1. The summarising of risk factors was useful for decision making.**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

*** 2. The appropriate information was available to me at the time a decision was to be made.**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

*** 3. The justification dialog box could be useful in explaining rationale for decisions**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

*** 4. I found this tool could enhance my learning in this area.**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

*** 5. I would like to see similar interactive learning available in my course.**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

*** 6. The links to official guidelines were useful**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

*** 7. I was satisfied with the overall usefulness of this application**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

3. Satisfaction Questions

The purpose of these questions is to assess the satisfaction with the web tool

*** 1. The information was displayed in a clear and concise manner**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

*** 2. I found the tool easy to use**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

*** 3. Appropriate alerts (warning messages) were used in the right place at the right time.**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

*** 4. This tool or similar Decision Support tool would be helpful in my studies.**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

*** 5. This tool or similar Decision Support tool would be helpful in the workplace.**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

*** 6. I feel this tool could meet the needs of a midwife during risk assessment**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

7. If you feel there is anything else that may improve your overall satisfaction with this tool please mention it below

4. Useability Questions

The purpose of these questions is to assess the usability of the web tool

*** 1. The application was easy to navigate (easy to step through)**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

*** 2. I found the tool easy to understand and complete**

☐ Strongly agree ☐ Agree ☐ Neither agree nor disagree ☐ Disagree ☐ Strongly disagree

3. Please comment on any difficulties you found with the application.

4. What recommendations would you make to improve this application

Appendix 2 Information Sheet

Midwifery Decision Support Study

Background

This is a web application developed by a post graduate student in Trinity College. The application is based on midwifery guidelines obtained from 2 maternity hospitals in Dublin. The application attempts to use the data contained in these guideline as well as information obtained from academic midwives to assist training midwives assess risk on initial consultation or booking. The application will summarise risk factors and present care plan options to the user. The user will then be able to assign a care plan based on the information available. The student will be asked for some rationale if the choice of care plan is not that expected of the guideline.

Objectives

The aim of the exercise is to assess whether this tool could be seen as a useful learning resource. We will also be assessing the usefulness of a clinical decision support system at booking stage/initial consultation.

How the experiment will be conducted:

The student will be presented with 3 short simulated conversations, the conversations will represent a booking meeting between a midwife and a women, where the student will be asked to enter details obtained in these conversations by way of filling in on online form. The application will receive a limited amount of information based on obstetric history, Medical, gynaecological and social information all provided in the scenarios. The application will summarise risk factors after obtaining all relevant information and should provide relevant information at the time of decision making on what particular care plan is to be assigned.

On completion you will be asked to fill in an online survey, this will be roughly 20 multiple choice questions related to your experience of the tool. Data received during the survey will be dealt with in a confidential manner. Survey responses are anonymous and if published will not be identified as yours. Questions may be omitted if you wish to skip over them. Data received during the survey will be dealt with in a confidential manner.

Total Estimated Time: 20 minutes

Where and when is this to be conducted

This can be conducted in the computer room in the School of Nursing and Midwifery, 24 D'Olier Street. It is also possible to conduct this outside the college but a consent form will need to be signed before partaking in the study. The study will commence this week on the ____ of ____

Those wishing to partake please contact me at mike.keenan@tcd.ie or 086-4085802 to arrange a setup. Every effort will be made to accommodate volunteer's specific time constraints.

Voluntary Participation

Volunteers must be at least 18 years old in order to partake in this study.

This study will involve using a computer and will require the student to use a computer for up to 20 minutes. If you or anyone in your family has a history of epilepsy then proceeding with this study will be done at your own risk.

Please note that participation in the project is voluntary, there are no rewards for taking part. Students may withdraw from the study at any time for any reason without penalty.

Information entered during the exercise is not saved or stored anywhere. Once webpage is closed all data entered is erased.

Conflict of Interest

The author (Mike Keenan) declares no conflicts of interest, real or perceived, financial or nonfinancial.

Illicit activity

In the extremely unlikely event that illicit activity is reported to me during this study I will be obliged to report it to appropriate authorities

Appendix 3 Consent Form

TRINITY COLLEGE DUBLIN

INFORMED CONSENT FORM

LEAD RESEARCHERS: Mike Keenan (08260384)

BACKGROUND OF RESEARCH: The research involves the development of a clinical decision support system to aid student midwives in decisions making during risk assessment of women based on Obstetric history during initial consultation. The learning tool should interact with the students as they enter information obtained through predefined scenarios, informing the student of the best possible decision at each stage. The system, built in conjunction with a team of academic midwives based in Trinity College will attempt to enhance decision making in student midwives during risk assessment. The systems will be evaluated by a group of voluntary Staff and Students

PROCEDURES OF THIS STUDY: Students will be given an information sheet with a fictional conversation between a women and a midwife. This conversation will record the women's initial visit to the midwife where relevant obstetric, gynaecological, social and medical history is taken. Students will be asked to enter the variables obtained during this conversation. The data is to be entered into a computer application designed to guide the risk assessment and referral process. Students will be asked to fill out an evaluation survey after the exercise is complete. The session should last no more than 20 minutes. There is no risk to the participant.

PUBLICATION: Individual results will be aggregated anonymously and research reported on aggregate results.

DECLARATION:

I am 18 years or older and am competent to provide consent.

I have read, or had read to me, this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction and understand the description of the research that is being provided to me.

I agree that my data is used for scientific purposes and I have no objection that my data is published in scientific publications in a way that does not reveal my identity.

I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights.

I understand that I may refuse to answer any question and that I may withdraw at any time.

I understand that my participation is fully anonymous and that no personal details about me will be recorded.

<If the research involves viewing materials via a computer monitor> I understand that if I or anyone in my family has a history of epilepsy then I am proceeding at my own risk.

I have received a copy of this agreement.

PARTICIPANT'S NAME:

PARTICIPANT'S SIGNATURE:

Date:

Statement of investigator's responsibility: I have explained the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

RESEARCHERS CONTACT DETAILS: [Tel:0864085802](tel:0864085802) Email: Mike.Keenan@tcd.ie

INVESTIGATOR'S SIGNATURE:

Appendix 4 Simulations

Sample Simulations

Name: Mrs Brown

Height: 170cm

Weight: 65Kg

Age: 26

This is My First Pregnancy, 11 weeks today

My Medical History

No history of hypertension

No History of Epilepsy

No history of Diabetes

Heart Disease in family but none experienced myself

No known respiratory diseases

No Clotting disorders

No history Renal Disease

No endocrine disorders

No known Hematological disorders, currently 10.5g/100m

No significant antibodies disorder

No history of substance misuse

No known virology disorders

No mental health problems in the past

Not attending a medical clinic for any reason.

My Gynaecological History

No fertility issues

No cervical incompetence

No uterine fibroid

Never had gynaecological surgery

No known gynaecological anomalies

No miscarriages

My Social Background

No history of drug abuse

I have family support at home

I live within the city, so yes within the covered area

I'm Irish and English is my first language

I have not experience domestic violence

Name: Mrs White

Height: 164cm

Weight: 70Kg

Age: 37

This is 4th Pregnancy, 12.5 weeks today

My Obstetric History

I did have an elective CS on my first baby, 2nd and 3rd were spontaneous vaginal births

No other complications apart from CS on 1st birth

No still born or neonate deaths

All babies were between 3 – 4 Kgs

No shoulder dystocia on any previous births

No premature labour

Manual removal of placenta not required

No tear

This is a singleton pregnancy

No history of Group B Haemolytic Streptococcus

My Medical History

No history of hypertension

No History of Epilepsy

No history of Diabetes

No History of Heart

No known respiratory diseases

No Clotting disorders

No history Renal Disease

No endocrine disorders

No known Haematological disorders, currently 11.5g/100m

No significant antibodies disorder

No history of substance misuse

No known virology disorders

No mental health problems in the past

Not attending a medical clinic for any reason.

My Gynaecological History

No fertility issues

No cervical incompetence

No fibroid uterus

Never had gynaecological surgery

No known gynaecological anomalies

No miscarriages

My Social Background

No history of drug abuse

I have family support at home

I live within the city, so yes within the covered area

I'm Irish and English is my first language

I have experienced domestic violence at home but do not want anyone to interfere

Name: Miss Green

Height: 165cm

Weight: 86.5Kg

Age: 41

This is my 2nd Pregnancy, 10 weeks today

My Obstetric History

No caesarean section, had spontaneous vaginal birth for 1st child

No other complications during pregnancy or labour

No still born or neonate deaths

My first baby was nearly 5 Kgs

Yes shoulder dystocia on my first born

No premature labour

Manual removal of placenta not required

Slight tear, 2 stitches required

This is a singleton pregnancy

No history of Group B Haemolytic Streptococcus

My Medical History

No history of hypertension

No History of Epilepsy

I did have Type 2 Diabetes, but changed my lifestyle and have that under control

No History of Heart

No known respiratory diseases

No Clotting disorders

No history Renal Disease

No endocrine disorders

No known Haematological disorders, currently 12.6g/100m

No significant antibodies disorder

No history of substance misuse

No known virology disorders

No mental health problems in the past

Not attending a medical clinic for any reason.

My Gynaecological History

No fertility issues

No cervical incompetence

No fibroid uterus

Had 3 stitches after tear on 1st child

No known gynaecological anomalies

No miscarriages

My Social Background

No history of drug abuse

I have family support at home

I live within the city, so yes within the covered area

I'm Irish and English is my first language

I have not experience domestic violence