APAT

NCI Final Year Project Report

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Summer, 2017
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EXECUTIVE SUMMARY

The following document outlines the potential applications, scope, plan and requirements of the APAT (Anaesthetic Pre-Operative Assessment Platform), as well as prospective speculation as to how the project may be further developed.

It is estimated that over 97,000 patients undergo inpatient surgical care in the HSE every year. With recent advances in surgical practices, surgery is becoming both safer and increasingly available. However the practice of anaesthesia is often overlooked, despite the fact anaesthetists kill more patients in the operating theatre than surgeons.[1] We undoubtedly live in an ageing population, meaning that the patients proposed for operative management typically have co-morbid medical conditions.[2] While hypertension and a history of acute coronary syndrome have little influence on surgical practice, they greatly influence the management of the patient from an anaesthetic perspective. Increasingly, patients are having their elective surgery canceled on the day of surgery, as they had previously unidentified risk factors or predictors of patient mortality.

APAT aims to provide anaesthetists with a basic assessment and risk stratification of their patients prior to the day of surgery, allowing time for the medical optimisation of these patients in the pre-operative period, making surgery and anaesthesia a safer process for all.

Two tertiary and one regional hospital have already expressed interest in this specific platform (Beaumont, Connolly and Naas General Hospital). Unidentified high risk patients incur huge costs for the HSE, such as cancelled operation slots, increased length of stay, and occupancy of intensive care and high dependency beds.

As of December 2016, there are no commercially available online pre operative assessment tools suitable for use in the HSE, despite the obvious demand for such.

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1.1 AN INTRODUCTION TO THE PROBLEM AT HAND

The work of the anaesthetist, for the most part, is transparent to the patient undergoing surgery. Unlike the surgeon, who's role and responsibility is clearly understood, very few patients actually understand the purpose of their anaesthesia provider beyond 'putting them to sleep'. Cross sectional surveys show time and time again that a significant proportion of patients are not even aware that their anaesthetist is a doctor holding full registration with the medical council.[3]

The drugs used to provide general anaesthesia are among the most dangerous agents administered in medicine. Not only do they inhibit neuronal conduction within the cerebral cortex (resulting in unconsciousness), but they also cause profound autonomic inhibition, temporarily switching off the bodies ability to regulate its own physiology. Anaesthetists undergo years of postgraduate specialist training to become 'masters of physiology', learning to use various drugs and procedural techniques to maintain patient physiology intraoperatively, keeping patients safe while under general anaesthesia.[4]

Patients typically understand that death during surgery arises from surgical complications. However it's incrediably rare that a surgeon kills a patient in the setting of modern medicine. Myocardial Infarction occurs when the muscular wall of the heart is starved of oxygen, and is a life threatening anaesthetic emergency which accounts for 40% of all cause mortality in surgical patients. Respiratory arrest and septic shock account for the second and third most common cause of mortality respectively (while their exact incidence is not know), and are also considered anaesthetic complications.[1]

The process of preoperative assessment and optimisation are effective in reducing perioperative mortality.[5] 'Perioperative physicians' are anaesthetists with a special interest in meeting and examining patients who are proposed for surgery, allowing them identify patient risk factors which can be used to assess the risk of perioperative morbidity and mortality. They may then instigate evidence based optimisation strategies, which are shown to reduce the risk of poor outcome in high risk patients.

Perioperative physicians use the ASA (American Society of Anaesthesiology) grading system to stratify patients by risk.[6] This grading system uses subjective criteria to place patients into categories, and is a validated method of predicting the chance the patient will die if anaesthetised for surgery. The majority of the population fall into grade 1 - a patient with no known medical conditions undergoing elective surgery. These patients require no optimisation, and carry a low risk of poor outcome (1 patient per 100,000 will die under anaesthesia in this class). Grade 2 - a patient with a medical condition which is sufficiently managed and does not affect systemic physiology, confers a risk of 1 per 100,000 to 10,000, depending on the degree of control. The classic example would be a patient with hypertension (high blood pressure), which is well controlled on anti hypertensive agents. We then see a surge in mortality between grade 2 and grade 3 - a patient with systemic illness which affects patient physiology. These are typically patients who's chronic illness has not yet being diagnosed, or has not being sufficiently managed. These patients carry risks of approximately 1 per 100, which is considered to be unacceptable for elective surgery. However the perioperative physician specialises in the use of lifestyle and pharmacological treatment which minimises the effect of chronic disease on physiology, essentially downgrading ASA 3 patients to ASA grade 2. In the past, patients were admitted to hospital multiple days prior to their operation to allow the anaesthetist time to adequately monitor, investigate, diagnose and treat the patient. Over the past 10-20 years, modern healthcare has adapted the DOSA (day of surgery admission) model, whereby patients only arrive into hospital the morning of their operation. While DOSA offers many benefits (protects patients from the risks that come with prolonged hospitalisation, frees up public hospital beds, improves patient satisfaction), it moves the preoperative assessment into the community.

Different healthcare systems have adapted their preoperative assessment to fit the DOSA model. The NHS in the UK has established preoperative clinics which are run in the community, staffed by perioperative physicians, general practitioners, staff nurses and public health nurses.[7] In the USA, the anaesthesiologist or nurse anaesthetist is present at surgical outpatient clinics to assess patients at time of booking. While both methods are effective, they carry additional cost. Irish hospitals, for the most part, run a hospital based preoperative assessment clinic, yet do not have the resources to assess every patient. Instead, the surgeon asses' the patient from an anaesthetic perspective, and decided which

patients require referral to the preoperative clinic. Our literature review reveals that this model is not effective, as an unacceptably high proportion of high risk patients are missed, while a large volume of low risk patients are inappropriately referred. In a health care system which struggles to provide the resources to meet demand, focus of the resources available is of paramount importance.

Failing to identify high risk candidates may result in preventable perioperative death. While high risk patients often slip through the assessment stage as described above, they are mostly picked up when they arrive in the operating theatre by the anaesthetist. However if an ASA 3 or 4 patient is identified on the morning of surgery, it is too late to begin optimisation. The case is typically canceled, and the patient is sent for optimisation (optimisation takes 30 - 365 days depending on the patients conditions). This results in the wasting of operating theatre time, and the patient goes back to the bottom of the waiting list. Knowing about a patient in advance allows the anaesthetist to tailor an anaesthetic regimen to minimise risk. However they must know about the patient in advance to prepare equipment and drugs, a luxury not afforded by the DOSA model. Meanwhile ASA 1 and 2 patients are being referred to the pre operative assessment clinic by their surgeon,[8],[9] wasting HSE resources as they will not benefit from assessment and optimisation strategy.

APAT, or anaesthesia preoperative assessment tool, is an online service which will ask a patient a series of questions, and use a previously validated logical model to accurately assign a patient an ASA grade. The data is then made available to the perioperative physician, allowing them to appropriately call high risk patients for optimisation consultation. APAT will better allow perioperative physicians identify patients who will most benefit from further assessment, and prevent the squandering of resources on low risk patients who do not benefit from assessment and optimisation.

1.2 MOTIVATION FOR THE PROJECT

I've always struggled making big decisions. Following the leaving certificate, I began undergraduate medicine in the Royal College of Surgeons (2012). It was a difficult choice to make, and I had spent much of the year contemplating switching to either Computer Science or Engineering. In the end, I decided to start my journey on a 4 year BSc in computing, but wasn't ready to drop medicine, so I continued both, planning to try them simultaneously and then drop whichever course I felt was less fulfilling. That didn't go to plan, and here I am 4 years later, having just completed my final year exams in both courses one week apart. I fell in love with both subjects, and couldn't let one go. The curiosity that would have followed me for life had I dropped one, outweighed the burden of work that came with studying for concurrent degrees.

During the time I've spent working in hospitals, I've noticed a distinct lack of IT infrastructure and the poor quality implementation of what infrastructure is in place. This has furthered inspired me to study both disciplines, with a view to bridging the gap between developer and doctor in the Health Services Executive.

As a practicing doctor, I find myself doing the same tasks over and over again. When assessing patients in all areas of medicine, we're using objective measurements fed into predefined scoring systems. The 'art' of medicine has died, and in its place, evidence based medicine is making the decisions. While this is a less interesting practice for the doctor, it does result in improved patient outcomes (homogenisation of care, use of gold standards). It also opens the door for decision support software in the healthcare environment. I find myself using medical calculator scoring apps all day in work, and with an extra step of automation, me (the doctor) could be removed from the equation - why don't I simply hand the calculator to the patient and ask them to input their data?

Across the broad range of medical specialties I've had the opportunity to practice in, I've fallen in love with anaesthesiology. My combined passions for anaesthesia, and bringing decision support to the patient in healthcare have inspired me to develop APAT. I feel that to those who don't work in a hospital, the benefit of APAT sounds modest at best. Yet working with surgeons and anaesthetists, I've seen hundreds of operations canceled last minute because the patient has an unknown medical condition which is only discovered as they're being wheeled to the operating theatre. We spend the morning canceling cases in the theatre, then have to go back to clinic to tell patients the waiting list for their surgery will be 6 months. It's heartbreaking to see such resources squandered due to such preventable

issues. I have no desire to ever make money from APAT, I simple want to see smoother patient flow through the OT, with less unnecessary cancelations, and ultimately better and safer peri operative care for everyone.

I have taken up an academic NCHD (non-consultant hospital doctor) post this year, where I will have 35 days of protected research time, as well as a €2,000 research grant and department cooperation to pilot APAT, hoping to publish my findings in a peer reviewed scientific journal (British Journal of Anaesthesia).

1.3 PROJECT SCOPE

The scope of this project is not only to develop the APAT system, but also to begin the application for research grant and study design for implementation of the project.

APAT must be able to preform a patient assessment. This encompasses the ability to collect patient information directly from the patient at home, process the information, stratify the patients risk, and convey that risk back to the anaesthetist and surgeon.

In order to collect patient data, the patient must be able to access the tool as a website, which will ask the patient questions, and collect their responses. The patient should then be able to submit their responses, to be stored and analysed by the tool. The ability for the patient to log into the website is not within the scope of the project, as such functionality would introduce a potential for loss of data privacy.

The information should then be analysed by the system. This must be carried out using a previously validated logical model, and produce a risk stratification in a format which is familiar to the anaesthetist. The model we have chosen is that proposed and validated by Zudimea et. al,[10] which offers the risk in the form of the patients ASA category. You may notice at times the questions asked by APAT to the patient are phrased awkwardly, however this is how they were phrased in Zudimeas implementation, and thus to guarantee we are using an evidence based model, our questions and potential answers are consistent with those used in the initial model.

The anaesthetist must be able to view assessments once they are preformed. The doctor, unlike the patient, must be able to log in to access data not made available to other public/ guest users. This should be in the form of a web application, as anaesthetists frequently have to use different terminals throughout the day (and often their mobile browsers).

Once developed, APAT must be validated as being an accurate tool in peri operative risk assessment (compared to the gold standard - ASA assessment by consultant or specialist registrar anaesthetist), and must also confer objective measurable improvement in patient and system outcomes. A comparative study will be carried out this year in University Hospital Limerick, Beaumont Hospital, Naas General Hospital and possibly the Bons Secours hospital. These hospitals were chosen as they include one central model four centre (Beaumont), one regional model 4 centre (Limerick), one model 3 centre (Naas), and one private hospital (Bons Secours). This offers us a more diverse patient population from which to recruit.

The second stage will be to conduct a randomised controlled clinical trial, whereby patients are randomised to either undergo APAT assessment or to undergo current practice (no assessment), with the hypothesis that those in the APAT group will have more favourable peri operative outcome, and less system failure events (canceled or delayed operations).

1.4 TECHNICAL SUMMARY

APAT takes the form of a single web application, with multiple interfaces intended for various user groups. The web application is developed on the Ruby on Rails platform, using Ruby 2.4.0.

Data is stored in the Postgress database in the deployment environment, and SQLite3 in development. Data transfer is tunnelled by secure encrypted protocol (SSL) in the deployment environment.

The application has 4 dependencies, which in Ruby on Rails, are imported as gems. Devise facilitates user login and authorisation. Rails_Admin supports the admin dashboard. Bootstrap_SASS gives basic structure to the interface design. JQuery is used for table sort functionality in the front end.

1.5 TESTING SUMMARY

The application will be initially tested using mock patient data. In the interest of patient confidentiality we must ensure data security before considering testing with genuine identifiable patient data.

Security: It is essential that the platform can guarantee gold standard confidentiality of data, as records are likely to contain sensitive confidential patient information.

Reliability: From a clinical perspective, it is not enough to simply rely on the study published from the Netherlands, as we have introduced multiple confounding factors in our implementation of the cASA algorithm. We will thus need to test the accuracy of the platform against the current standard (face to face interview with an anaesthetist). This should be done at Randomised Control Trial with measures taken in order to minimise potential sources of bias.

It is our goal to ultimately evaluate the application from a technical and clinical perspective in an Irish hospital. To do this, we would ideally achieve approval from the College of Anaesthetist in Ireland, as well as ethical approval from a local ethics committee. We hope to compare the platform clinically in comparison to previous cancelation figures from the hospital, and submit the writeup to a peer reviewed journal for publication.

2. Requirements

2.1 USER REQUIREMENTS DEFINITION

We consider the requirements of both the patient and anaesthetist individually, as we are aware there may be marked discrepancies between the two users.

The patient consumer requires an easy to access / easy to use interface. The demographic of patients undergoing surgery in the HSE is incongruent with that of the computer literate generation. The interface should be accessible via web browser from any point, as many patients have impaired ability to travel.

The anaesthetist requires a more complex and secure interface. Large amounts of patient data will be rendered to his/her view of the platform, and thus must not be accessible to the general public. The view should be efficient at organising patients and their data in a fashion that makes it easy to retrieve specific bits of information.

A third potential user would be a researcher, looking to pull data from the system in order to audit either the system itself, or to use data collected for independent study. While this is not a primary functional requirement at time of development, we must keep this potential user and their needs in mind during the development process. We will consider this user during discussion of system evolution.

2.2 REQUIREMENTS SPECIFICATION

2.2.x Summary of Requirements

• The platform must be usable by all patients, including the non-computer-literate population.
• Data collection must be thorough, allowing for accurate estimate of anaesthetic risk.
• Logic used to calculate risk and stratify patients must be consistent with that described by high quality peer reviewed scientific literature.
• Output data for the anaesthetist must be in a format used commonly by practitioner's world wide (American Society of Anaesthesiology Classification System).

2.2.1 Functional Requirements

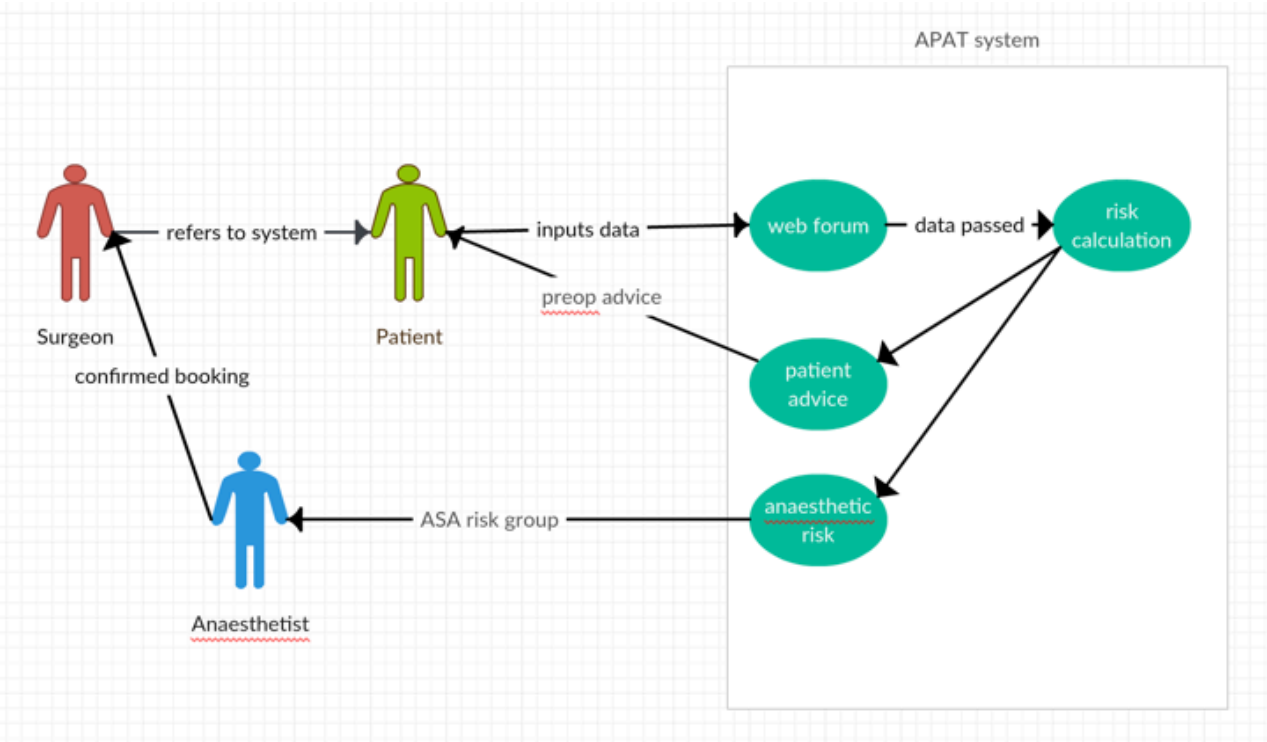
The following list outlines the functional requirements of the platform in ranked order of importance, relative to each other.

1. Web form survey for the patient
2. Logic describing the stratification of patient risk
3. Output interface for the anaesthetist
4. Interface advising patients on measures to be taken in the days before surgery
5. Ability for anaesthetist to invite high risk patients in for formal face to face screening
6. About Us information and Contact details on the web page

The web form is where the stream of information begins. The patients will be invited to complete the form by the surgeon who meets with them in clinic, and books them for surgery. The patient should be given the URL of the form, then complete it at home. The form only meets it's functional requirement if it able to capture enough data from the patient to allow for the accurate stratification of patient anaesthetic risk.
The form should not require a patient to log in, as the form is designed to be used only once by each patient, and thus there is no benefit of user accounts for patients.
The form should capture data in objective categorical fashion, using drop down menus and radio buttons. Text input should be limited, as this data is less usable by the platform when it comes to calculating patient risk.
Upon completion of the form by a patient, data must then be securely passed on for stratification of patient risk. This may be achieved by front end logic on the client side, or back end logic running on the server side application server.

2.2.2 Use Case Diagram

The below diagram depicts the flow of the primary use case of the platform



2.2.3 Requirement 1: Patient inputs data to web form

2.2.3.1 Description & Priority

The ability for the platform to collect data in the form of a simple web page with multiple inputs is the primary requirement of the application. Data relevant to patients anaesthetic risk will be requested from the patient.

2.2.3.2 Use Case

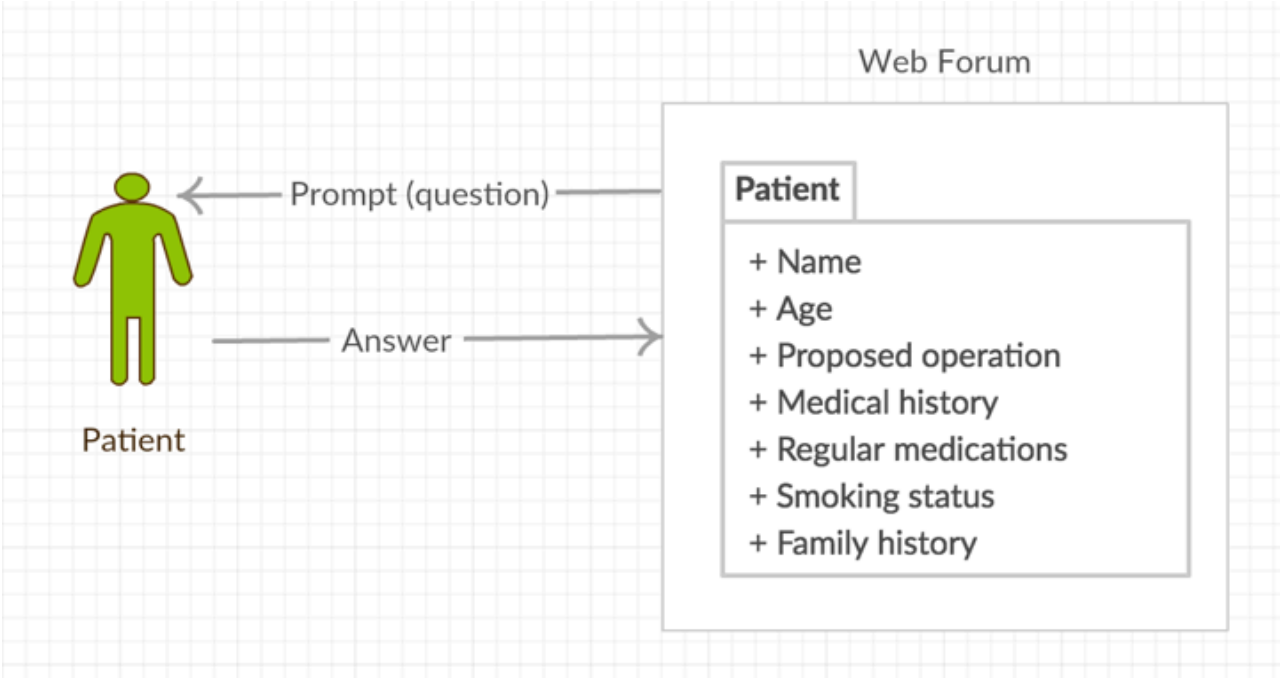
Scope

The scope of this case is the collection of medically relevant data from a patient, through questions with pre defined categorical answers (eg. Gender, smoking status, medications).

Description

The use case describes a patient entering data on their computer at home over their internet connection.

Use Case Diagram



Flow Description

Precondition

The patient has been given the URL to the web form by their surgeon. They are connected to the website via their home internet connection. The website has rendered a form of questions to the patient.

Activation

The use case starts when the patient loads the web form.

Main flow

1. The system creates a new Patient object with it's relevant variables.
2. The system prompts the patient with the first question.
3. The patient answers the question.

4. The system stores the answer in that Patient objects relevant variable.
5. The system asks another question.
6. The user answers the question.
7. The forgoing is the procedure for the other questions.
8. The system identifies that all questions have been asked, thanks the user, and saves the patient object.
9. The flow is completed.

Alternate flow

A1 : Incomplete data entry

1. The system creates a new Patient object with it's relevant variables.
2. The system prompts the patient with the first question.
3. The patient answers the question.
4. The system stores the answer in that Patient objects relevant variable.
5. The system asks another question.
6. The user is unable, for whatever reason, to answer the question.
7. The system moves to the next question.
8. The system marks the Patient object as being incomplete.
9. The system identifies that all questions have been asked, thanks the user, and saves the patient object.
10. The flow is completed.

Termination

The system passes the Patient object and it's variables to the logic (next case).

Post condition

The system thanks the user and goes into a wait state.

2.2.4 Requirement 2: Identification of High Risk Patients

1.1.1.1 Description & Priority

The platform must facilitate the identification of high risk (ASA 3 and 4) patients in advance of their proposed date of surgery.

1.1.1.2 Use Case

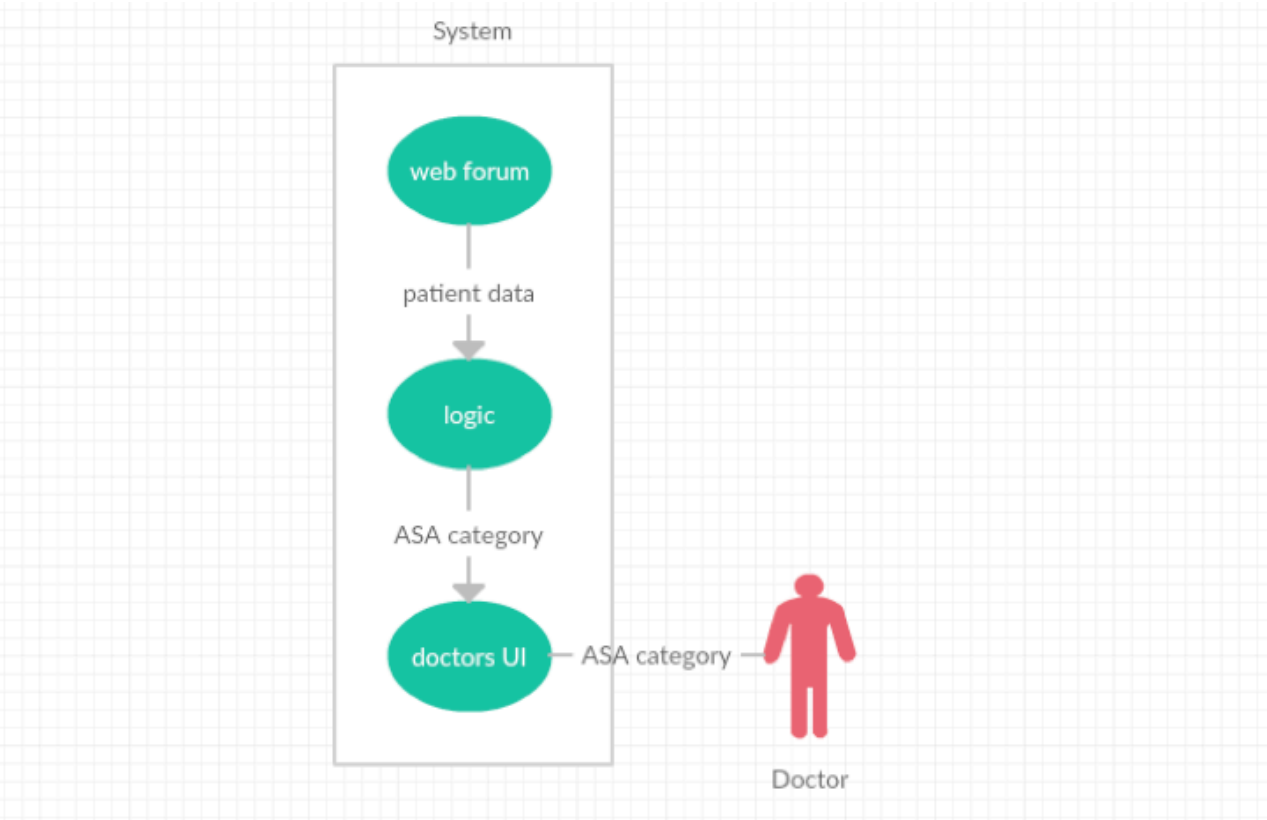
Scope

The scope of this use case is to display high risk patients to the anaesthetist, allowing them make appropriate provisions for the case.

Description

The use case describes the calculation of a patients ASA risk, and the reading of the risk by the anaesthetist,

Use Case Diagram



Flow Description

Precondition

The patient has completed the web form of data as requested by their surgeon.

Activation

The case begins when the form data has been submitted to the application logic by the patient.

Main flow

1. The patient data is passed to the application logic.
2. The logic calculates the patients ASA classification.
3. The classification, along with the patients identifying information is passed to the anaesthetist's interface.
4. The anaesthetist then views the information.
5. The anaesthetist makes any necessary provisions based on the ASA classification.

Exceptional flow

E1 : Handling of incomplete data entry by patient

1. The patient data is passed to the application logic.
2. The logic identifies an incomplete data set.
3. The warning, along with the patients identifying information is passed to the anaesthetist's interface.
4. The anaesthetist then views the information.
5. The anaesthetist organises a face to face interview with the patient.

Termination

The anaesthetist has read the patients ASA category.

Post condition

The system goes into a wait state (awaits the next patients data).

2.2.2 Non Functional Requirements

Non-functional requirements are critical to the success of this project. A web form that is too convoluted for patients to use, or an output interface that is not in keeping with anaesthetic convention will result in departments of anaesthesia refusing to implement the system into their routine practice. Security of patient data is of course of the upmost importance, as sensitive information along with unique patient identifiers will be passed over the internet.

2.2.2.1 Performance & Response Time

When the patient initially navigates to the URL provided to them, the application server should ideally start up rapidly. With funding, a business application server may run continuously, thus ensuring the response time requirement is met.

The system must be able to provide anaesthetists with the records they're looking for in a timely fashion. This means that the models used by the web application must be consistent with the database, and query generation must be optimised.

The system should be quick and responsive for both the patient and the anaesthetist. This may be achieved by computing the patient risk after the patient has closed their browser window, but before the anaesthetist looks at the result. Thus neither party should be aware of the delay caused by calculation and stratification of patient risk.

2.2.2.2 Availability requirement

Availability should be easily achievable as the majority of patients have access to an internet connection. Elderly patients typically have a dependent, whether family, friend or health care assistant, who will be able to aid them in accessing and using the system. Every department of anaesthesia will have hardware capable of supporting the platform (a computer with internet connection); this is not of concern.

The application server should have >99% uptime, allowing time for maintenance. With further funding we could look to reduce this further, however as of writing this report, we will be cutting costs by accepting some downtime.

We consider the proposed deployment environment - HSE hospitals. Each hospital employs an independent IT department, which hosts and supports a series of web applications on a local server, serving over the hospitals own intra-net. This improves security over the traditional off site server serving over the internet model. These internal servers do go offline

for scheduled maintenance, however it is typically arranged with the relevant clinical teams, so as to minimise impact on workflow. APAT should be taken offline for scheduled maintenance outside of theatre operating hours only, and should be available to theatre staff during the day at all times.

2.2.2.3 Robustness requirement

The system must be robust to incomplete data entry from patients. While we can not expect accurate stratification of patients who enter incomplete survey forms, the system must flag these patients as being inadequately assessed, so the anaesthetist may organise a face to face assessment.
Anaesthetists must me warned before deleting a patient record so as to prevent accidental loss of data. Records deleted should be logged by the application, which is viewable by the developer, to identify missing records in the event of accidental deletion.

2.2.2.4 Security requirement

All data transfer from the patient to the anaesthetist must be implemented using gold standard data encryption (SSL), in order to assure the project is approved by ethical committee, and all patient data is kept secure from potential cyber attacks.
Patients should not be able to log into the system, as they may inadvertently give their log in to someone else. Doctors accounts should be password protected (using a hash key function), and only an administrator should be able to make new doctor accounts.
We consider the human factors of password protection. While interviewing two of our test candidates (Professor Ger Curley, Dr Ahmed Zuberi), both doctors confessed that when software forces them to regularly update their password, they write the password down on a piece of paper which they leave beside their computer. The risk benefit to forced password changes therefore concludes that users should not be forced to change their password.

2.2.2.5 Reliability requirement

The system must be available to patients every day at all times with the exception of scheduled downtime for any maintenance. The anaesthetists interface must be capable of caching patient data ahead of scheduled downtime as data must be available 24/7 due to the urgent nature of surgery. This is a service typically offered by the HSE information

technology department. In the event of logistical failure of this failsafe, records may be exported to .csv files, and hard copies given to the anaesthetists during downtime.

2.2.2.6 Maintainability requirement

The logic used to stratify risk must be updated to reflect any changes in anaesthetic practice, adapting to new discoveries published in peer reviewed literature.
The admin dashboard feature must allow creation and deletion of user accounts as doctors join and leave the hospital group.

2.2.2.7 Portability requirement

Patients must be able to use the web form on any operating system. The anaesthetists interface should run on windows XP or above, as many departments have not updated their OS for over 10 years. The size or resolution of a screen should not create a barrier to use, as the interface should be responsive and optimised for viewing on any device.
Our interface does not use any browser dependent frameworks, and thus we expect it to be compatible with any web browser.

2.2.2.8 Resource utilisation requirement

The platform will not require departments of anaesthesia to update hardware or firmware, but rather run on existing resources in the department. We will utilise the HSE information technologies application server, which supports ruby on rails as standard. Deployment to HSE servers is scheduled for a later time point (first quarter of 2018), and thus is beyond the scope of this report.

Interface Design

3.1 Interface Requirements

The following section describes how the patient and anaesthetist will interface with the platform. We will also prospectively outline how a researcher may interface with further versions of the platform.

3.1.x GUI

The data collection flow will be based around a web page GUI offered to the patient. The GUI should be laid out using HTML 5 and marked up with CSS 5. The GUI will consist of a landing page, and then a data entry form. The form will consume information using text input, radio buttons, check boxes and drop down menus. Question wording will be kept simple, and should employ simple memory prompts for the patient as used in classical face to face history taking.

The anaesthetists interface will be fashioned to a GUI, allowing the anaesthetist to see what risk group their patients are in. It should use colour to allow the anaesthetist easily identify high-risk patient.

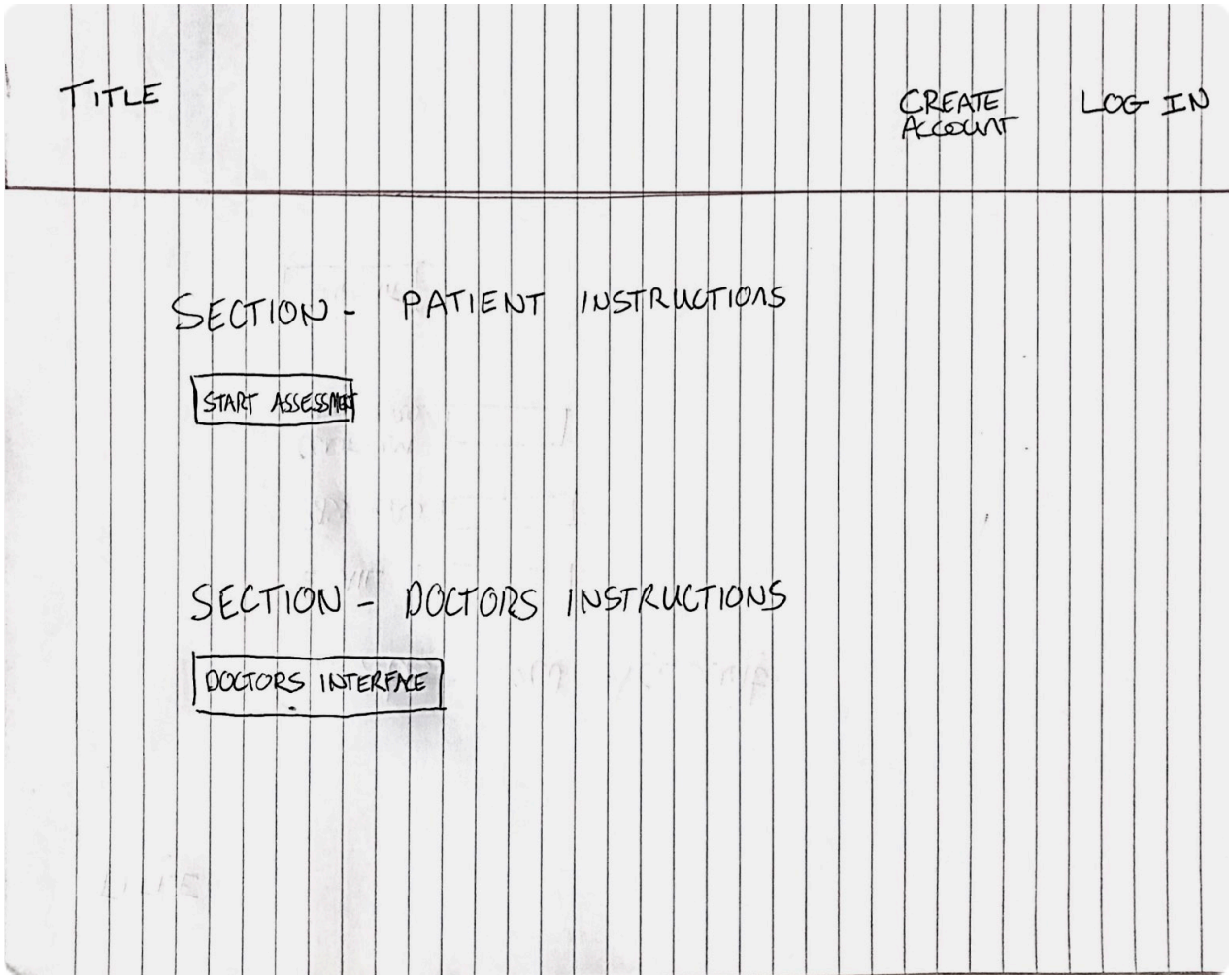
3.1.1 Wireframes

Wireframe development is an essential step in user interface design. Pen and paper are our wireframe media of choice, as they allow the designer unlimited freedom in layout design and description, while being quick, easy and free to draft and redraft. The interface shall consist of the following components:

- Landing Page
- Login and Sign up Page
- Assessment Page
- View Patients Page
- Other (manage account, view patient details, other simple pages providing CRUD functionality).

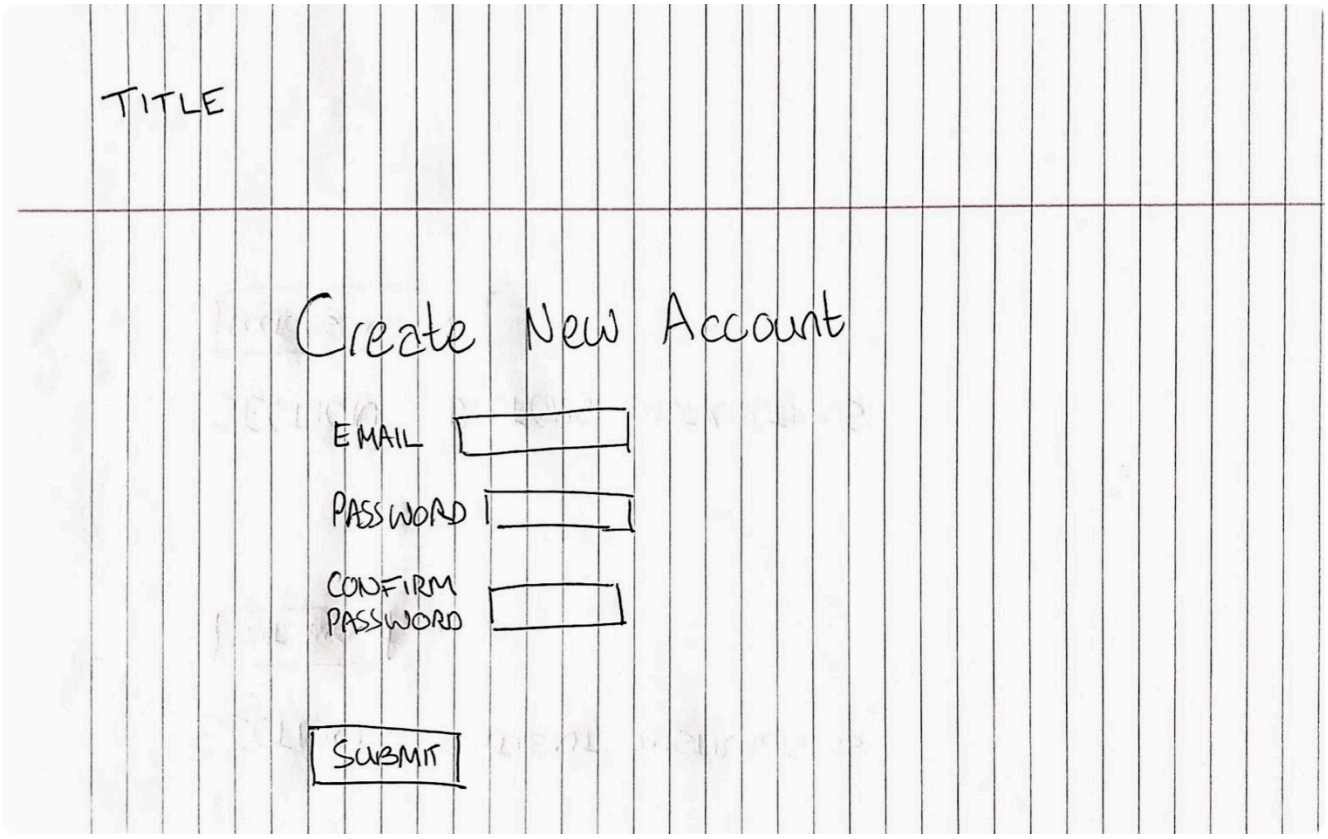
3.1.1.1 Landing page

The landing page must first and foremost assure the user (doctor or patient) that they have found the correct resource. It must then advise the user as to what type of user they are (doctor or patient) and guide them to either complete an assessment (patient) or to log in (doctor) to view patients assessment results.



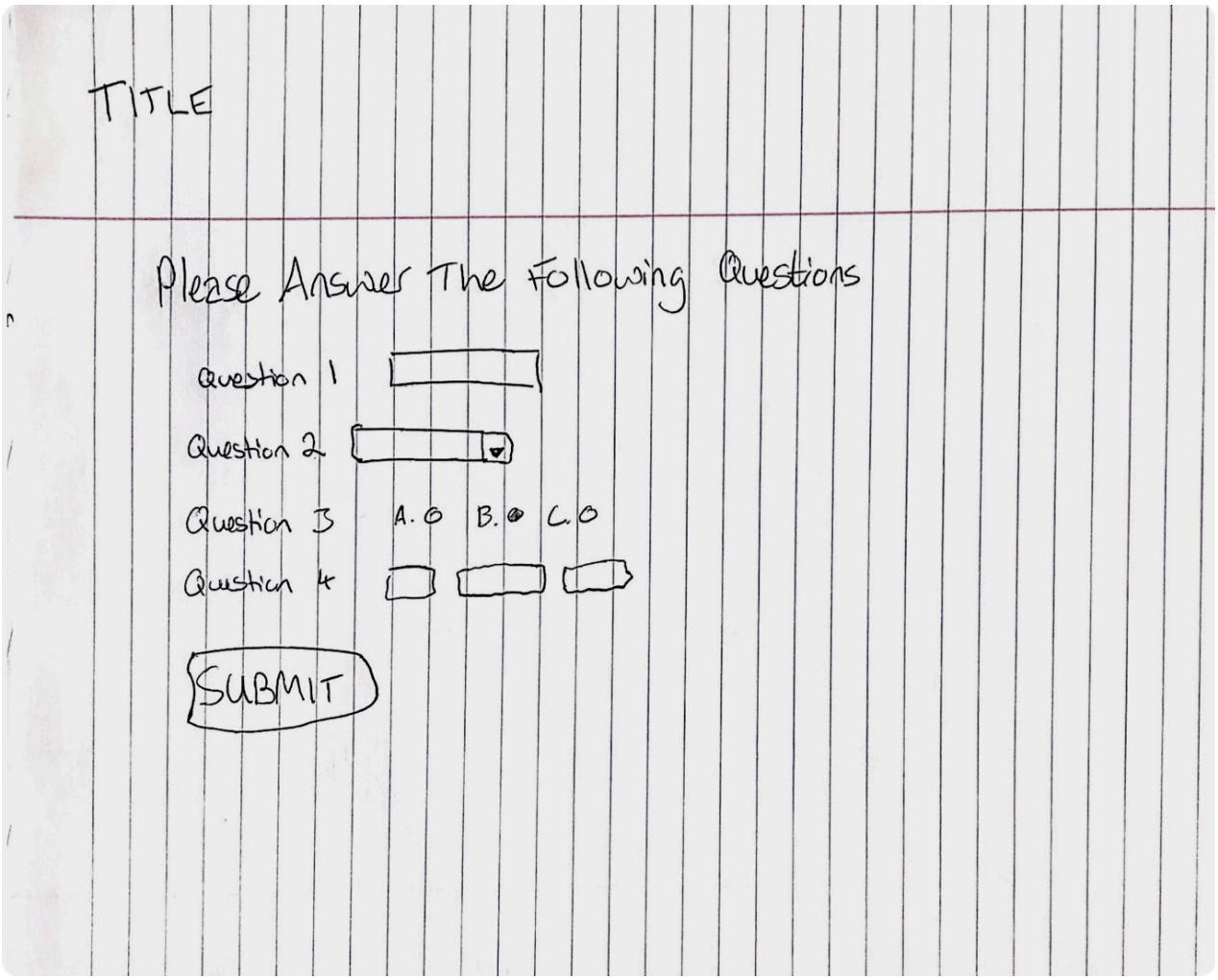
3.1.1.2 Log In / Create Account

The log in page is intended for doctors use only, and this should be clearly stated as patient may expect the ability to log in. The page should handle the inputted email address and password. The input should be sanitised in real time. A checkbox should allow the user choose to have their email credentials remembered on that machine using cookies.



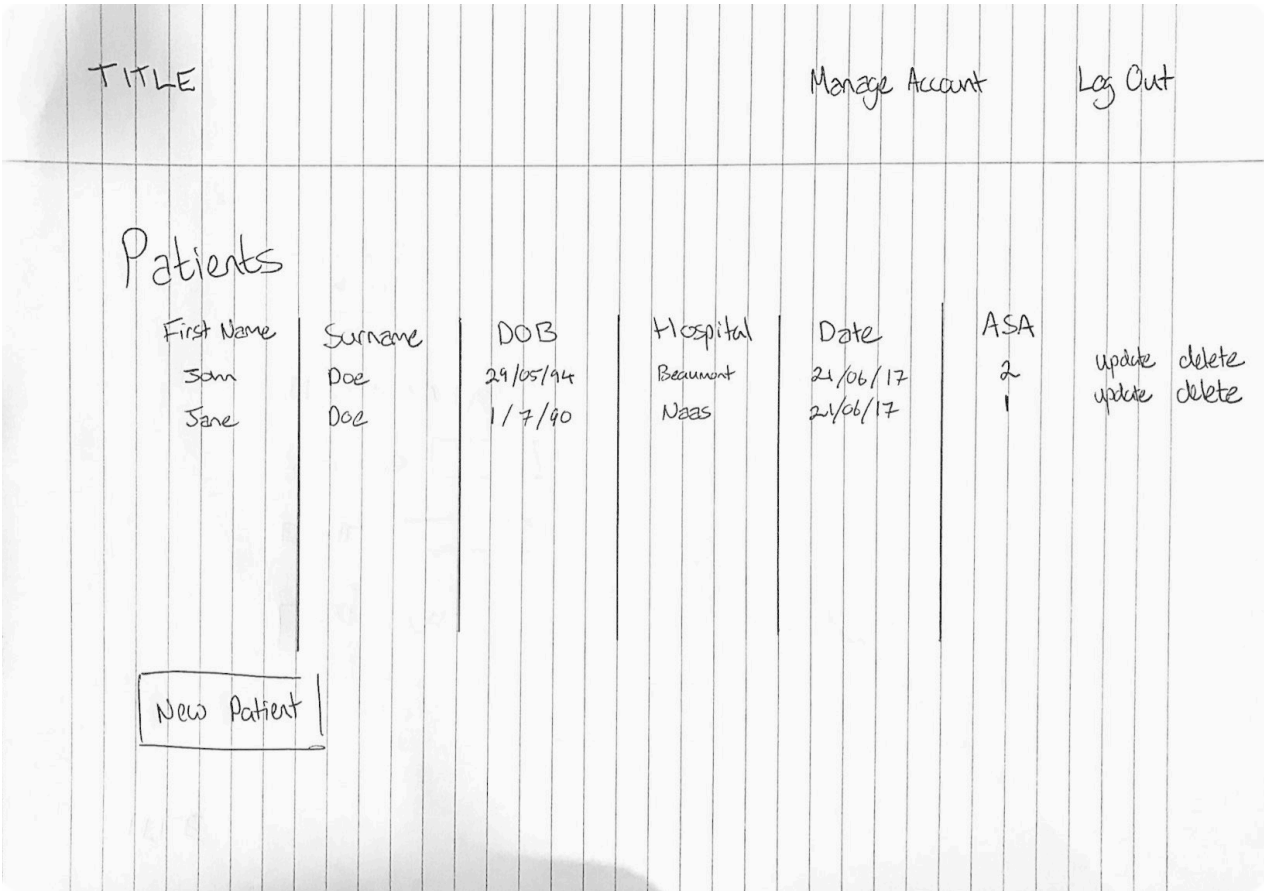
3.1.1.3 Assessment

This page is intended for use by the patient. The patient should be directed here by the landing page. The page should offer a series of questions, and facilitate user input to handle answers. The type of input offered must be appropriate to the expected data type (eg. calendar for dates, dropdown menus, minimal free text areas). The layout of this page must be incrediably clear, with absoloutly no GUI ‘clutter’ to distract users or convolute the process. At the end of the series of inputs, there should be a submit button, clearly highlighted to the user. Attempting to submit an incomplete or invalid application should yield a warning message.



3.1.1.4 Patients

Anaesthetists who are logged in should be able to view the patient page. This page will list patients assessment results in a table, including their calculated ASA. The table should be clearly laid out, using alternating row colours to make it easier to derive information from visually. It should be sortable by all columns. Each row should have buttons providing CRUD functionality, each having its own interface. There should also be a button directing the user to the assessment interface allowing them to add a patient record.



3.1.2 Application Programming Interfaces (API)

The initial iteration of the project will not involve development of an API. An API may however be developed at a later stage as it may be used to allow for data extraction by a researcher. This is not a primary functional requirement of the platform.

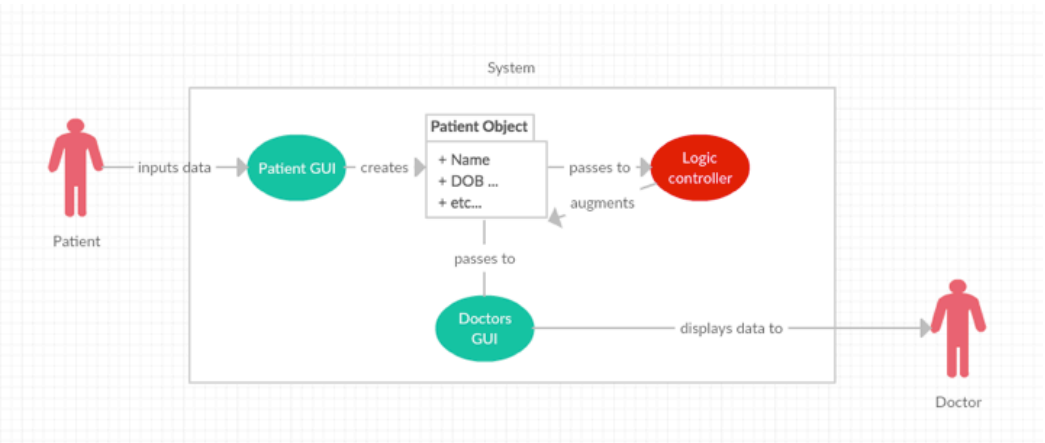
Such interface should offer data output in logical format such as comma separated values (as this suits the tabulated structure of the data models). The API should be integrated with R in the form of a library, as this would be the technology of choice for researching and analysing data collected by APAT.

It is important to note that patients will be prospectively consented for such functionality and analysis when their data is collected.

4. System Architecture

The system architecture will be based on two interfaces with a single logical controller managing and passing data between them.
The patients interface takes the form of the assessment page. This is a simple HTML/CSS form rendered by the Ruby on Rails controller, identified by the new patient route. This form captures patient data, and uses it to create a new patient model/object.

The anaesthetists interface consists of a table with search functionality, listing all the existing patients who are yet to go for surgery.



When a new patient model is created or updated, a callback occurs. A callback is a method that is invoked when a pre specified data entity is augmented in some way. In this case, the method invoked is the calculateASA method, taking the patient record as the data model argument, and is called when a patient record is created or updated, before it is saved to the server. This is an efficient method of assigning ASA, as the method is only ever run when a patient record has been changed, and a patient record will not be saved if the method fails to execute, ensuring data integrity.

Patient objects will be objects that describe a patient using classical object orientated programming style. The objects are created as models, for which Ruby on Rails will create scaffolds, arranging the database in a way that is transparent to the developer. This ensures database efficiency, as the database is designed to hold the predefined models in the most efficient manner possible.

4.1 CALLBACKS

The Ruby on Rails framework supports a wide variety of callback functionality. This was a key deciding factor in choosing Rails as our development technology. Prior iterations of the web application using PHP had failed, as front end scripting doesn't offer smooth execution of methods or functions as subroutines. Ruby on Rails allows us to run the method at the exact point in the objects lifecycle; this precision is no offered by PHP/JS.

We use a callback to run the calculateASA method on patient models, as the model is updated or created. It is importatn that we have specific control over when the calculateASA method runs. We want the method to run when the patient has submitted data, it has reached and been approved by the controller, but has not yet been written to the database. The before_create and before_update callbacks allow for this:

```
class Patient < ApplicationRecord

  before_create :calculateASA
  before_update :calculateASA
```

The above code is contained in our model, which defines a patient object. calculateASA is a method which we also define in the patient model, and is documented in the following section.

4.2 CALCULATE ASA METHOD

The calculateASA method is called via a callback as described above. The method executes in three conceptual steps.

It begins by declaring and instantiating a counter at value 0. It then moves through a sequence of logical if/else statements, each reflecting a potential answer to each question. Each answer has a weighted value, and if the answer is congruent with the patients selected answer, the counter integer is increased in value by the weigh of that answer.

```
7   def calculateASA
8     #initialise the risk score as 0
9     risk = 0
10
11
12    #Q1
13    if self.q1 == "No abnormalities"
14      risk = risk
15    end
16
17    if self.q1 == "Better than expected"
18      risk = risk -2
19    end
20
21    if self.q1 == "Worse  than expected"
22      risk = risk +2
23    end
24
25    if self.q1 == "Dementia"
26      risk = risk + 2
27    end
28
29    if self.q1 == "Sick"
30      risk = risk +2
31    end
32
33    if self.q1 == "Moribund"
34      risk = risk +24
35    end
36    #Q2
37    if self.q2 == "I can do everything I want"
38      risk = risk-2
39    end
40
41    if self.q2 == "Slightly impaired, but I feel no impairments in daily activities"
42      risk = risk
43    end
44
45    if self.q2 == "Impaired, I can only take care of domestic chores"
46      risk = risk +2
47    end
48
49    if self.q2 == "I am completely dependent on help from others"
50      risk = risk +4
51    end
52    #Q3 CCF
```

This was not a time efficient development process (coding out each potential answer), however, due to the heterogeneous nature of each question and it's potential answers, it was the only identified solution.

After all questions have been considered by the counter, the counter value is translated into the ASA score, using the logic described by Zuidema

.

```
362     #convert score to cASA grade
363     if risk <= 3
364       self.asa = 1
365     end
366
367     if risk >= 3
368       self.asa = 2
369     end
370
371     if risk >= 10
372       self.asa = 3
373     end
374
375     if risk >= 20
376       self.asa = 4
377     end
```

The method exists inside the patient model, and thus there is no need to use a private placeholder value and write to the record, as the execution of the method (the instance) is intrinsically private to that patient class, and references its values using self.value notation.

While not quick to develop, we expect this method to be responsive and generate low server burden, as it is only called in appropriate circumstances, it does not contain complex logic, it does not rely on external dependencies, and it does not need to pass values between other methods or models.

4.3 SYSTEM EVOLUTION

While it is beyond the scope of the initial development of the platform, we must always look to improve the quality healthcare to both our current and future patients. The platform should be developed in a fashion that will facilitate future medical research. This will be achieved using data models designed with data analytics in mind; using categorical data, avoiding free text where possible.

The system will initially offer two interfaces as outlined in the preceding sections; that for the patient and anaesthetist. However we aim to develop an Application Programmer Interface allowing data analysts to carry out research on the data incurred by the application. We must also ask for consent on the initial web form, and store the answer within the patient model. This facility must be dynamic, and flexible to change per request of local ethics comities and HIPPA instructions.

Secure transfer and storage of data is of the upmost importance when handling sensitive patient medical records. While the initial development of the project will employ basic security measures, the system should evolve over time, implementing additional features to improve the security of data.

5. Testing & Evaluation

A brief literature review identifies many different descriptions of testing methodologies. We consider what our testing needs and desired outcomes are, before diving in and picking specific methodologies.

We begin by playing the role of the pessimist, considering reasons why APAT may fail as a concept in our clinical trials. The obvious potential for failure would be that patients are unable to use the website, as the majority of patients undergoing admission to hospital are elderly. While we identified this user cohort early, and have adapted design to suit elderly non-computer literate users, our testing focus should resolve around usability testing by elderly patients, looking to identify steps in the assessment process that may be difficult for elderly users.

Doctors are identified as a difficult market to develop software for. The profession places great value on tradition and heuristics, pass on from the greek era, adapted over time. Having consulted with practicing anaesthetists during the development lifecycle will hopefully prove beneficial in terms of acceptability of interface design, however testing should illicit areas which may be unacceptable to the medical profession.

The development team (ourselves) are the only party given access to the admin section. I have designed it to meet my exact needs, and thus it is unlikely to fail testing. However we will carry out basic testing nonetheless.

With these aims in mind, we consider the different modalities we should adapt in our testing plan.

5.1 TESTING CANDIDATES

For the purpose of testing, we identifie the need for three candidate groups. Each group will require two candidates.

Patients - as outlined above, the most likely opportunity for failure of the project is that the service will be unusable by the patient, and thus it is imperitive that patients are involved in the testing process earl. Patients will be asked to carry out black box testing and usability testing. We have invited two patients, Ms Jane Doe, and Mr John Doe. Patients names have been changed in keeping with HIPPA regulations, however they are two factual individuals who have undergone elective surgery in the HSE. Ms Doe underwent wide local excision of breast cancer in 2017, and Mr Doe underwent arthroscopic debridement of the subacromial space in 2016, and again in 2017. Both patients are over the age of 50 years old. Further details are not provided in the interest of patient confidentially and HIPPA compliance. Informed consent was obtained from both patients for participation in this survey. This activity is not considered medical research, but rather independent market research, and poses no medical risk. Both patients have been discharged from their respective medical centres, and are in good health. Therefore formal ethical approval was not sought, as this in not considered medical research.

Doctors - doctors are notoriously fussy when it comes to interface design. It's important that our service is acceptable to anaesthetists. We will have recruited Professor Gerrard Curley (consultant anaesthetists) and Doctor Amir Zuberi (senior registrar anaesthetist) to test our software from this perspective. Surveying of medical practitioners does not require ethical approval.

Software developers - Myself and Mr Dylan Hobbs will carry out independent functional black box testing, as this is classically performed by individuals with experience in software development. Mr Hobbs has been invited to test the project as an external tester, with no financial interests or potential biases to declare.

We would like to take this opportunity to express our gratitude to the aforementioned parties, for giving up their time to assist our development process.

5.2 BLACK BOX TESTING

Black box testing is a testing methodology based on the ethos that the intermediate steps are not important, but rather places emphasis on the input and output of a function or series of functions.[11] The test candidate is given an input, and asked to run it through a function. The output is then assessed as a performance indicator, with no regard paid to the logs of the system running the process. In laymans terms - we don't care how the system produced the right answer, as long as it did in fact produce the right answer.

There are 3 types of black box testing:

Functional black box testing aims to ensure the functional requirements of a system are met. It is carried out by the software development team, who pass mock data through units of the system, and examine the quality of the output. To achieve this, we used the unit testing functionality provided by Ruby on Rails. The outputs are then examined.

Non functional black box testing, in contrast to functional black box testing, is carried out by non-computing trained users, and aims to ensure a system has met it's non functional requirements. Users are asked to complete specific tasks on the system, and report their output. We hypothesise that if an intrinsically applicable group of users (that is, a group with similar demographics to the patients who will use APAT), are able to complete an assessment, then the non-functional requirements are likely to have been met.

Regression black box testing may take the form of functional or non functional black box testing, and occurs following changes made to the system on the recommendations of prior iterations of black box testing.

Black Box Test: Patient Assessment		
Test ID	1.1	
Test Date: 12/07/2017		Test Iteration: 1.0
Test Candidates	Mr and Ms Doe (patients).	
Objective	The purpose of this test is to study the usability of the assessment process by the patient.	
Pre Test State	The patient has been instructed to navigate to the website, and to fill out an assessment. They have been advised they will not be allowed to ask questions during the test.	
Methodology	The patient should navigate to the website, and use the 'assessment' link on the landing page to get to the assessment page. They should then fill out the text areas as prompted by the questions. They should think click submit. The user should be reassured they have finished the assessment correctly.	
Post Test State	A completed survey should be filled out.	
Expected Output	New patient model, correctly entered into the database with a calculated ASA grade. The ASA grade should be appropriate.	
Test Case 1: Ms Jane Doe	Outcome	Ms Doe successfully completed her assessment correctly, and was assigned an ASA grade of 1 which is appropriate.
	Time Taken	It took Ms Doe 5 minutes and 37 seconds, which is acceptable to her.
	Concerns	None
	Comments	"It was very straightforward, there was no messing around with passwords, and I just followed the steps"
Test Case 2: Mr John Doe	Outcome	Mr Doe sucessfully completed his assessment correctly, and was assigned an ASA grade of 1, which is appropriate.

	Time Taken	It took Mr Doe 7 minutes and 10 seconds, which is acceptable to him.
	Concerns	Attempted log in.
	Comments	“I was confused by the sing in button. I thought I had to make an account first, but then the sign in page told me only doctors could make accounts. I figured it out thought, I was supposed to just do my assessment with no account.” “some of the wording in the questions was confusing. I didn’t know the answers to some questions, so I just guessed the normal answer.”
Developer Considerations	Both users completed their assessments correctly. Mr Doe highlighted an important point; patients may think they’re supposed to make accounts and sign in, which is not the case. It should be highlighted on the landing page that they should go straight to the assessment page, which they complete as a guest user (not signed in). Regarding the phrasing of the questions: This is a concern we identified early in the development process. The questionnaire was designed by Zudiema et.al, and is the validated questionnaire in that study. We believe that if we change the phrasing, we introduce a bias (that is, we’re not using Zudiema’s exact model). The pre validation of the model is a key component of the project.	
Changes Made	We have redesigned the landing page. Now users are greeted with two jumbotron containers. One is clearly labelled patients, and the other doctors. This should encourage patients to proceed to assessment without attempting to sign in.	

Black Box Test: Accessing Patient Record		
Test ID	1.2	
Test Date: 15/07/2017		Test Iteration: 1.0
Test Candidates	Prof. G. Curley & Dr. Amir Zuberi	
Objective	The purpose of this test is to study the ability of two anaesthetists to access the results of a patient assessment.	
Pre Test State	The patient has already completed an assessment, and is to be anaesthetised in Naas General Hospital on the 1st of January, 2017. The patients name is John O'Shea, and he is a high risk candidate (ASA 4), due to his multiple cardiovascular risk factors. The anaesthetist has been provided with a login email address and password.	
Methodology	The anaesthetists should navigate to the website, and sign in. They should then be able to see the result of the assessment on the table. They will search for the patient by name (even if they can already see the patient, to isolate the record. It must be clear that he is ASA 4. The anaesthetist should then investigate the patients questionnaire, and find out why he is such high risk.	
Post Test State	The anaesthetist should be informed about the patient, and have signed out of the website.	
Expected Output	The anaesthetist knows Mr. O'Shea is ASA grade 4, and knows why he his such.	
Test Case 1: Prof. Gerrard Curley	Outcome	Prof. Curley was successfully able to sign in, and access Mr. O'Shea's records. He was able to search, and view the record in full. It was clear to him that the patient was ASA grade 4, but not why.

	Time Taken	It took Prof Curley 2 minutes and 18 seconds to find the record and identify the patient as high risk, and a further 4 minutes and 51 seconds attempting to figure out the reason for the patients high ASA grade, which was unsucessful.
	Concerns	The questions aren't labelled correctly on the view patient page.
	Comments	“Great potential, but the questions were just called q1, q2, q3 … with the answer beside them. I couldn’t figure out why the patient was high risk. If they were labelled, it would be brilliant”.
Test Case 2: Dr. Amir Zuberi	Outcome	Dr. Zuberi successfully identified the patient record, identified the patient was high risk (ASA 4), but was unable to figure out why.
	Time Taken	It took Dr. Zuberi 1 minute and 29 seconds to identify that Mr. O’Shea is ASA grade 4.
	Concerns	The questions aren't labelled correctly on the view patient page.
	Comments	“Works well, just fix the labels”
Developer Considerations	This test identified a key flaw in the doctors interface. When directed to the view patient record page, the patients questions and answers are all visible, however the question label simple reads “q1”, "q2" etc… There is no way for the doctor to know what question the patient was asked.	
Changes Made	We have labeled the questions correctly on the view patient page.	

Black Box Test: Exporting All Patient Records		
Test ID	1.3	
Test Date: 15/07/2017		Test Iteration: 1.0
Test Candidates	Dr. John O'Shea	
Objective	The purpose of this test is to study my own ability to export the existing patient records to a .csv file.	
Pre Test State	At least one patient assessment has been completed and is available to view on the doctors interface.	
Methodology	I will attempt to sign in with my administrators account, and access the admin dashboard. I will then export the entire patient database to a .csv file.	
Post Test State	The .csv file is downloaded	
Expected Output	A well formatted .csv file of all patient records.	
Test Case 1: Dr. John O'Shea	Outcome	The .csv file is well formatted for research. It contained all patient records and name value pairs.
	Time Taken	It took me 1 minute and 8 seconds to sign in, generate and download the file.
	Concerns	None
	Comments	None
Developer Considerations	The admin dashboard meets all functional and none functional requirements.	
Changes Made	None.	

5.3 USABILITY TESTING - THE FIVE SECOND TEST

Usability testing, unlike black box testing, audits the user lifecycle at individual predefined steps, aiming to identify intrinsic errors of points of subpar design. We consider usability testing to be more applicable to real life use, as it is important we identify why processes fail, allowing us to focus further development.[12]

We have chosen the Five Second Test as our usability test of choice. Users are exposed to content for only five seconds, then surveyed on their experience.[12] This test focuses on the clarity of the user interface, based on the hypothesis that if exposed to a clear well designed GUI for five seconds, a user will remeber many of the interface components, however if exposed to a poorly designed convoluted interface, the user will demonstrate poor recall of the interface. We exposed users to the patients page and assessment page, and subsequently administered the following survey:

1) What website was that?

2) What page of the website was that?

3) What do you think you were supposed to do on that page?

4) Have you any other comments on the page?

The survey has been adapted to fit our testing needs, and we place highest value on question 3, assessing the users ability to understand what is expected of them on each page. Unfortunately, on anaesthetists users were unavailable for usability testing due to their stringent clinical commitments. We have therefore carried out usability testing with patient groups only. As mentioned above, patients John Doe and Jane Doe are two genuine HSE patients, however their names have been changed with a view to protecting their right to privacy, in compliance with HIPPA and Medical Council of Ireland recommendations.

Five Second Test: Landing Page (patient)		
Test ID	2.1	
Test Date: 15/07/2017		Test Iteration: 1.0
Test Candidates	Patient: Joe Blogs	
Objective	The purpose of this test is to study the ability of a patient to identfiy and orientate themselves to the landing page	
Pre Test State	The patient has typed in the url, and the page is about to load	
Methodology	The user will view the landing page for five seconds only	
Post Test State	The page is taken off the screen	
Expected Output	The user identifies the page as the home page, and is familiar with the components.	
Test Case 1: Ms. Jane Doe	What website was that?	Ms Doe identified the website as the anaesthesia assesment website using the title in the top left corner.
	What page of the website was that?	Ms Doe identified the page as being the page that guides users as what they should do next. The two sections on the page made this clear to her.
	What do you think you were supposed to do on that page?	Ms Doe understood she was supposed to use the “Start Assessment” button in the patients box.
	Have you any other comments?	No
Test Case 2: MR. John Doe	What website was that?	Mr Doe identified the website was a medical themed website, but not sure specifically what it was.
	What page of the website was that?	Mr Doe correctly identified the page as the landing page (“The first page of the website”).

	What do you think you were supposed to do on that page?	Ms Doe knew the instructions were in the box labeled “Patients” (correct), but spent his five seconds trying to read the text. He therefore did not know what to do next, however he knew how to find out this information.
	Have you any other comments?	Mr Doe knew this was a medical website, but not necessarily a HSE affiliated website. He suggested we include a HSE logo.
Developer Considerations	Mr Doe highlighted a great point regarding the use of a HSE logo. This would make it clear to patients that this is an Irish website intended for their use. We may however have to seek HSE approval to display their logo on our website. We will investigate this further.	
Changes Made	Enquire regarding right to display a HSE logo on the landing page.	

Five Second Test: Assessment Page (patient)		
Test ID	2.2	
Test Date: 15/07/2017		Test Iteration: 1.0
Test Candidates	Patient: John Doe, Jane Doe	
Objective	The purpose of this test is to study the ability of a patient to identify and orientate themselves to the patient assessment page.	
Pre Test State	The patient has navigated to the assessment page from the landing page, and the page is about to load	
Methodology	The user will view the assessment page for five seconds only	
Post Test State	The page is taken off the screen	
Expected Output	The user identifies the page as the assessment page, and is familiar with the components.	
Test Case 1: Ms. Jane Doe	What website was that?	Ms Doe identified the website as the anaesthesia assesment website using the title in the top left corner.
	What page of the website was that?	Ms Doe identified the page as being the page of questions that she was supposed to answer. The purpose of the page was clear to her in the context of the application.
	What do you think you were supposed to do on that page?	Ms Doe understood she was supposed to answer the questions, as this was clearly labeled at the top of the page.
	Have you any other comments?	No
Test Case 2: MR. John Doe	What website was that?	Ms Doe identified the website as the anaesthesia assesment website using the title in the top left corner.

	What page of the website was that?	Mr Doe understood she was supposed to answer the questions, as this was clearly labeled at the top of the page.
	What do you think you were supposed to do on that page?	Mr Doe identified the page as being the page of questions that she was supposed to answer. The purpose of the page was clear to her in the context of the application.
	Have you any other comments?	No
Developer Considerations	This test assures us that we have met our non functional requirement in that this page is usable and self explanatory to the user.	
Changes Made	This page requires no further changes based on the findings of this test.	

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7. Appendix

7.1.1 JOURNAL - SEPTEMBER 2016

Jeez, this feels a bit awkward, I've never really used a 'diary' before. I guess I'll just try to trick myself into believing nobody is ever going to read this ever, that makes it a little easier to write about my reflections I suppose?

If you're going to be reading along for the next few months, it's probably not a bad thing to have some idea about my background. My name's John and I'm in my final year of both computing at NCI and Medicine/Surgery in RCSI. I was hoping to do the Data Analytics specialisation for final year - the primary reason for choosing to study computing concurrently was to develop data analytics skills I could apply to biomedical research and statistics. NCI blindsided me with that one I suppose when they only offered Software Development to part timers. I had kind of neglected a lot of the software development skills I was supposed to be learning over the past 3 years as developing software isn't really something I wanted to learn in great detail. This is certainly going to make the FYP a bit more difficult than I'd like, but I'm sure I'll manage.

Having studied at RCSI for the last 4 years, I've developed some very useful skills, such as the ability to work all night without sleeping and never take any time off whatsoever for socialising/ relaxing, which can come in pretty useful I suppose.

I have been finding it more difficult this year to balance the workload from NCI and RCSI. I'm never actually in RCSI, but rather working on placements in various teaching hospitals. The hours are pretty long there, in my fist month back (I started in Beaumont in July), I've been working in excess of 100 hours per week. It's clashing with NCI lectures a bit too, but so far I've been able to catchup on the weekends using the slides on moodle. I am a bit worried about all the continuous assessments. I hate CAs and projects with a passion. I usually sit my RCSI exams about a month before NCI, which means I can fully neglect any computing work, and then spend that month cramming, which has worked out very well for the past 3 years. I'm going to have to step up on my organisation skills this year as the majority of marks will be going for project and CA work, meaning I'll have to set aside time each week to get my projects done and stay on top of lectures I'm missing.

With regard to the FYP, I'm going to get a two week Christmas break from Beaumont, and then I'll be on a low demand General Practice rotation for two weeks after. These 4 weeks will be 'burn month'. I'll be hoping to get 80% of the work done during that time, as I'll essentially be able to work 24/7 on the project.

7.1.2 JOURNAL - OCTOBER 2016

Now that I've done a few weeks of balancing NCI/RCSI workload, I have a better idea of what aspects of my NCI workload I'll struggle with. The projects in the first semester are going to snooker me pretty hard. The actual FYP project wont be too bad, as that's mostly written documentation and idea formation. I had been thinking through my FYP idea for months before actually starting back to 4th year. I figured that my idea has to fit a couple of criteria:

Firstly, I have no idea of how technically complex it needs to be. That means I want to propose an idea that has pretty basic functional requirements initially, but to have lots of extra add on ideas or non-functional requirements I can choose to add in on the advise of my supervisor. This way I can adjust how complex the project will be as I work, adding requirements when my supervisor tells me 'this isn't enough for a fyp', and cutting requirements if I run out of time.

Secondly, I think it would be prudent to chose a project that can get me some sort of recognition in the medical field - killing two birds with one web application! I'm ultimately hoping to pursue a career in anaesthesiology, so I've based my project on that area. At least, I'll hope to write up and publish my methods in a peer reviewed journal and present the application to the College of Anaesthetists Ireland. The obvious downside to working in the med/IT interface is the need for security. As I outlined in my September journal, my software dev skills aren't exactly top of the class. I'm already struggling with this dam chess AI project, before any of the AI components have actually been introduced. I'm a pretty quick learner though so hopefully I'll manage.

I'm still stuck on what technologies to use. Java web app is out, I can even get glassfish to run properly. I feel I got on quite well with ASP.net, and thats certainly a contender at the moment. I think I'd be most comfortable working mostly in the front end, and ideally building the app with php/ js and an SQL server. I could the feed data back to a java desktop application. My only worry with that is ensuring secure transfer of data (passing data between technologies seems like it would be less secure than having it all contained in one ASP.net application. We still haven't been assigned a supervisor yet, which is a bit annoying. We've been told 'there's no reason to have a supervisor until you have a proposal written up', which I feel is utter nonsense. Writing the proposal requires me to have answers to so many questions I'd like to ask a supervisor. Sure we can rewrite the proposal later before submitting it, but that's just killing one bird with two stones having to write the thing twice!

7.1.3 JOURNALS - NOVEMBER 2016

November overall went pretty well.

Firstly, I met with a couple of senior anaesthetists in both Beaumont and Connolly hospital and discussed the project. They all seemed very enthusiastic about the idea, and the department in Beaumont offered to facilitate me piloting the project in their department.

As for development, I've managed to put together a basic html/css form as well as a website. I'll look to get it up and hosted on my web server for the mid term presentation. I've started working on a Java client for the anaesthetists but to be honest, it's a bit of a mess. I probably wont demo it at the mid point, but at least I've realised the pitfalls that one can be expected to make.

Otherwise, everything is going smoothly. Having exams after Christmas is a huge break. A few of the other modules are pretty tricky, especially web services, but I've managed the CAs thus far so hopefully I'm in the clear for semester 1, roll on December!

7.1.4 JOURNALS - DECEMBER 2016

Sorry I'm a bit late getting the December journal uploaded. It's been as hectic as I thought it would be. At least I managed to get some sort of front end built to demo at the mid point presentation. I thought I was going to do pretty poorly, as I really hadn't much built (a basic HTML page and web form), but it actually went really well!

While the website wasn't very technically demanding to build, it was enough to convey the purpose of my idea and how I plan to go about it. I was well posed to answer any questions. I identified that the two examiners weren't from a medical background, so decided that was my home advantage. I managed to direct the entire Q&A away from computing/technical issues, and discuss purely medical issues. I was happy with my exam result, but to be honest, I was far more satisfied with how I was able to control the presentation, directing the examiners into asking the questions I wanted to be asked. It's reassuring that I feel I'm getting better at these face to face exams, as it's a bit like interviewing for jobs, which is just around the corner.

5.5 JOURNALS - JANUARY 2017

End of semester exams all went well. The Strategic Management was a bit tricky, and we wont get results until next Friday, but I'm reasonably confident there should be no surprises.

I didn't really get any of my project done over the holidays. That being said, I presented the project to some of the senior doctors in Beaumont, who were all very happy with it. Myself and Professor Gerard Curely have submitted an application for a three month paid internship rotation to actually implement the software in the HSE next year. There's usually a lot of competition for these jobs, but I think my application stands a reasonable chance.

Ultimately, this means I will be developing my project beyond our finals in May. Taking this into account, I think I'll probably defer my project deadlines to August if the college accept it. I don't think I can handle the stress of doing two sets of finals and the project all at once. I'll be working on the project all summer either way looking to get it ready for use in the HSE in September. I figure it would be pointless not to defer, as I'll be doing the extra work either way.

Hopefully, there won't be too much trouble having the deferral approved by the college.

7.1.6 JOURNALS FEBRUARY - APRIL 2017

My application for deferral has been approved by the registrar of the college. I'm pretty confinement now having had the time to think this decision over, that I've made the right choice. I would have ended up not putting as much effort into either course had I continued them simultaneously for the final semester. I won't be updating journal entries for the next few months, as I'll be parking the project until I get my RCSI and NCI exams finished in May, but I'll keep journal entries over the summer in leu.

7.1.7 JOURNALS - MAY 2017

Exams are finally done! I've taken a week to recover and catch up on what feels like a year of missed sleep. While I haven't been coding or writing up my documentation for the past few months, I have been thinking the project over in my mind. I've also being discussing it with the anaesthetists in Beaumont.

I'm worried that security requirements could be where the application falls down when we come to test it. The previous plan of a separate front and back end passing data to an independents database leaves so many potential security breach points. I think the best thing to do might be to redesign the project to be a single web application with multiple user interfaces, giving a transparency of having two applications (one for the patient and one for the anaesthetist). This way, there will be no extrinsic data transmission between application components (data will all be handled in one application), and the various web application frameworks offer pretty decent intrinsic security (for example, I know .ASP MVC web applications are already used in the HSE, and are considered to adequately secure to hold patient information).

I'm in no rush, I have a very clear idea of what I want to build, and how it maps onto an MVC framework. There are a few options out there (well, lots of options really). I think I'll spend the next week playing around with various frameworks and pick the one I find most enjoyable to work with. Whatever time I lose to picking a framework, I'm sure I'll make back in not messing around with a poorly chosen framework.

7.1.8 JOURNALS - JUNE 2017

I took 5 days to play with 5 of the most popular MVC frameworks for web application development. In the end, Ruby on Rails came out the winner. What I like most about it, is that it cuts out a lot of the actual coding and syntax, allowing me to focus on the conceptual aspect of software development. I really like frameworks that let me do a lot of work from the command line, and I'm on OSx which removes the awkward windows element to using rails.

I'll be using rails anyway for another NCI project, so I suppose it's an efficient use of time to learn it now. I've also been browsing around rubygems.org, and picked out a few nice dependencies that will definitely speed up my development.

Development aside, I've finally graduated from RCSI, and with a first class honours degree. Its pretty surreal. I've also noticed a huge wave of laziness and complacency since graduation, which isn't helping with the development of APAT. Its pretty rough being in coding while the rest of my RCSI class are out celebrating.

7.1.9 JOURNALS - JULY 2017

I knew starting work as a junior doctor would be time consuming, but I had no idea it would be this intense. I had planned to continue APAT development in the evenings and on weekends through July while working, but the hospital doesn't seem to want to let me. My regular shifts are 7am to 9pm Monday to Friday, with no break (not even lunch, I'm living on ricecakes!). Thats before on call; I'm just off the back of a weekend of night call (3 days of 13 hour graveyard shifts). I'm enjoying the challenges, and I'm loving the work I'm doing, but it's really held me back in terms of how much effort I can put into APAT.

I'm happy I have the basics done. All our functional requirements are met, and most of the non functionals are done too. The interface is pretty decent on desktop, and while it's usable on mobile, I haven't had time to warp it up into mobile applications yet. It's a shame, because I'll be doing that anyway, but it will be after my submission date, so no marks for it.

I'm now working towards my final presentation at the end of July. I'm honestly looking forward to it, I really like presenting. Theres something so satisfying about being able to stand up and defend your work on the spot in front of a crowd (if 2 can be considered a crowd). I have to say, NCI has been a great place to practice my presentation skills, and even working in medicine, it's stood to me greatly on many occasions.

7.2 Poster for Presentation

Anaesthesia Preoperative Assessment Tool

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Abstract

It is estimated that over 97,000 patients undergo inpatient surgical care in the HSE every year. With recent advances in surgical practices, surgery is becoming both safer and increasingly available. However the practice of anaesthesia is often overlooked, yet is becoming an increasingly important factor in the assessment of surgical patients. We undoubtedly live in an ageing population, meaning that the patients proposed for operative management typically have co-morbid medical conditions. While hypertension and a history of acute coronary syndrome have little influence on surgical practice, they greatly influence the management of the patient from an anaesthetic perspective. Increasingly, patients are having their elective surgery canceled on the day of surgery, as they had previously unidentified risk factors or predictors of patient mortality.

APAT aims to provide anaesthetists with a basic assessment and risk stratification of their patients prior to the day of surgery, allowing time for the medical optimisation of these patients in the pre-operative period, making surgery and anaesthesia a safer process for all.

Two tertiary and one regional hospital have already expressed interest in this specific platform (Beaumont, Connolly and Naas General Hospital). Unidentified high risk patients incur huge costs for the HSE, such as cancelled operation slots, increased length of stay, and occupancy of intensive care and high dependency beds.

As of December 2016, there are no commercially available online pre operative assessment tools suitable for use in the HSE, despite the obvious demand for such.

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Introduction

It is estimated that over 97,000 patients undergo inpatient surgical care in the HSE every year. With recent advances in surgical practices, surgery is becoming both safer and increasingly available. The practice of anaesthesia is often overlooked, yet is becoming an increasingly important factor in the assessment of surgical patients. We undoubtedly live in an ageing population, meaning that the patients proposed for operative management typically have co-morbid medical conditions. While hypertension and a history of acute coronary syndrome have little influence on surgical practice, they greatly influence the management of the patient from an anaesthetic perspective. Increasingly, patients are having their elective surgery canceled on the day of surgery, as they had previously unidentified risk factors or predictors of patient mortality.

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Technical Details

APAT is developed as a cloud based web application using Ruby on Rails.

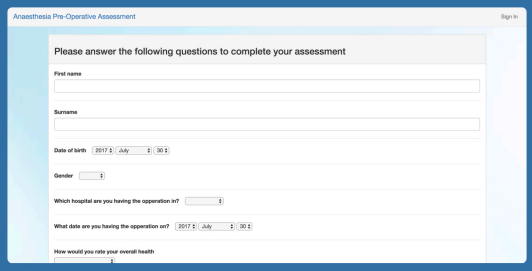
Cloud computing allows both patients and doctors quickly access the platform to enter or retrieve data. It also allows for seamless expansion as new hospitals seek to adapt APAT into their preoperative assessment process.

Ruby on Rails is a popular web application development framework for Ruby. It uses a Model - View - Controller framework, allowing the developer carry over object orientated programming principals into the web application development environment.

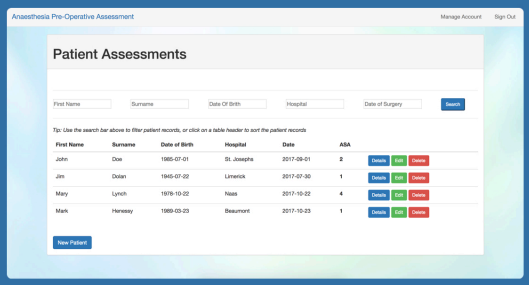
The application is styled using Bootstrap 3.0, as this offers a professional look and feel which is familiar to most users.

Interface

Patients Assessment Interface

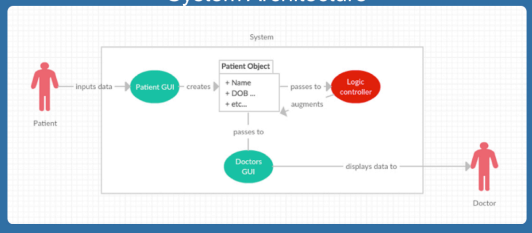


Anaesthetists Assessment Interface



Architecture

System Architecture



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Feidhmeannacht na Seirbhíse Sláinte
Health Service Executive