Abstract

Chapter 1 Introduction

The Ureteral Stent Tracker Application is a project aimed at developing a digital solution to enhance the monitoring and tracking of ureteral stents. Ureteral stents are commonly used medical devices inserted into the ureter, a tube that connects the kidneys to the bladder, to address various urological conditions, such as facilitating urine flow in the presence of kidney stones, bypassing blood clots, and providing a pathway for urine in patients with ureteral tumours.

The purpose of this application is to provide a reliable and efficient tool for healthcare providers and patients to track and manage the lifecycle of ureteral stents, ensuring timely replacements and improving patient care. For removal or replacement of ureteral stents, it is recommended to undergo the procedure every 3 to 6 months (Ureteral stent placement, 2021). Upon reaching the designated replacement date, it is crucial to replace the existing stent with a new one to prevent complications such as stent migration, encrustation, stone formation, and fragmentation.

A study by Ulker et al. (2019) included 44 patients in group-1 and 43 patients in group-2. Among them, 22.7% of patients in group-1 and 27.9% in group-2 did not return for the scheduled stent removal. In group-1, these patients were identified using the Ureteral Stent Tracker (UST) and called for stent removal on the same day. After a maximum waiting period of 6 weeks, the mean overdue time for stent removal was 3.5 days in group-1 and 20 days in group-2 (p = 0.001). In group-2, 3 patients (6.9%) were

lost to follow-up, while no patients were lost to follow-up in group-1 (p = 0.001). This study proved how effective of using the ureteral stent tracker application was.

Thus, a ureteral stent tracker is very important and required to remind the patients about the ureteral stent replacement date to prevent them forget about the date.

Problem Statement

1. Insufficient implementation of a structured assignment process can lead to ineffective matching of patients with doctors, resulting in compromised patient outcomes and dissatisfaction.

2. The current system lacks the capability for nurses to conveniently check the stent replacement date and notify doctors and patients as the existing notification method is ineffective since there still have delayed stent removal was observed in 6 cases over 100 cases, accounting for 6% of the total.(Tokas et al., 2021)

3.Nurses are currently unable to assist patients in making appointments with doctors or access appointment information through the available application. This limitation hinders the efficiency of the process.

Objective

The main objective of this project is to develop a web-based ureteral stent application to reduce the number of patients that forget to replace or remove their ureteral stents. To

achieve this, there are three sub objective which is:

1. To develop a doctor assignment module for managing which the admin can choose the available doctors and assign them to patient.

2. To develop multi-channel notification module for notifying doctors and patients about the ureteral stent replacement date.

3. To develop appointment booking module to enable nurses assist patients to make appointments

Chapter 2 Literature Review

2.1 Introduction

In this chapter, I will cover the ureteral stent, diseases that need ureteral stent which is urolithiasis, the food habit that would cause urolithiasis, the effect if no changing the urethral stent in scheduled time, ureteral stent tracker, the importance of accurate tracking for stent placement and monitoring in the urethra, existing ureteral stent replacement tracking and monitoring application and their tracking mechanism, key features of effective Ureteral Stent Tracking System, requirements of effective Ureteral Stent Tracking System and the comparison matrix of the existing ureteral stent tracking system.

2.2 Food Intake that causes urolithiasis

Urolithiasis can be caused by various factors, and one of the contributing factors is our dietary habits. One of the dietary habits that increase the risk of kidney stones is salt consumption.According to the study by Icer and Gezmen-Karadag (2019), the risk of kidney stone formation is increased in patient groups with a high salt consumption habit, as it enhances the excretion of urinary sodium and calcium.

Besides, this study also proposed that a high intake of meat may elevate the risk of stone formation by promoting increased acid production and fat intake. Red meat, organ meats, and shellfish contain significant levels of purines, which is a natural chemical compound. Consuming these foods in high amounts increases the production of uric acid and places a greater burden on the kidneys to eliminate acid. This higher excretion of uric acid results in more acidic urine, which creates a favourable environment for the formation of uric acid stones. (Kidney Stones | Diet Plan and Prevention, 2022)

Furthermore, according to Bihl and Meyers (2001), hyperoxaluria is another condition linked to the development of kidney stones. Oxalate, which is a byproduct of metabolism, is mostly sourced internally and is excreted in urine without undergoing any changes. Consuming foods high in oxalate, such as rhubarb, standard teas, nuts, beans, spinach, coffee, and chocolates, can raise the concentration of oxalate in urine to 670 µmol/day (normal value is 440 µmol/day). However, concentrations exceeding 890 µmol/day indicate enteric oxaluria (related to malabsorptive small-bowel diseases), mild metabolic hyperoxaluria, or primary hyperoxaluria.

Apart from that, beverages are also one of the factors that can cause kidney stones. Consuming high amounts of sugar-sweetened cola and noncola beverages was associated with a 23% and 33% increased risk of developing kidney stones, respectively. Artificially sweetened non-cola drinks also showed a slightly higher risk.(Ferraro et al., 2013)

Lastly, Water intake, vegetable intake and meat intake also will influence the formation of kidney stones. The study found that male patients tend to consume higher amounts of meat products, while their intake of fruits and vegetables is lower. However, these differences were not statistically significant. Dietary protein intake, especially from animal sources, contributes to the production of acid through sulfuric acid metabolism. Furthermore, female patients in the study consumed lower amounts of water compared to healthy females, but this difference was not statistically significant. The findings suggest that the higher consumption of meat and a lower intake of fruits, vegetables, and water in the patient group may potentially increase the risk of kidney stone formation. (Icer & Gezmen-Karadag, 2019)

2.3 Urolithiasis

Urolithiasis refers to the development of calculi or stones within the urinary tract. This condition involves the creation of mineral deposits within the urinary system, typically occurring in the kidneys or ureters, but can also impact the bladder and/or urethra.(News-Medical.net, 2022) A study showed that the occurrence rate of urolithiasis in Sarawak is 4.04%. Both males and females are affected equally, with 61.4% of cases observed in individuals aged 25-64 years. Notable risk factors for urolithiasis include hypertension, a high salt diet, personal history of urolithiasis, and a

family history of urolithiasis.(Perumal et al., 2022) As we know that the diet of Malaysia usually contains a high quantity of salt to ensure the food tastes good, but it will increase the cases of urolithiasis happens in Malaysia. When patients that have been diagnosed with urolithiasis, they require to put a ureteral stent inside their urinary tract to prevent the blockage happen due to the stones formation. Besides, there is another study show about the worldwide statistic about urolithiasis. The likelihood of developing stones varies across different regions of the world, with rates ranging from 1-5% in Asia, 5-9% in Europe, 13% in North America, and 20% in Saudi Arabia. (Epidemiology of Nephrolithiasis, 2000)

2.4 Ureteral Stent

A ureteral stent is a short, flexible tube inserted into the ureter to relieve or prevent blockages that hinder urine flow from the kidney to the bladder. It is commonly used for kidney stone therapy. Ureteral stents can be made from different materials such as polyurethane, silicone, and hydrogels. Silicone stents have been found to be associated with lower pain intensity compared to polyurethane stents. (Gadzhiev et al., 2020) Ureteral stents serve various purposes, including bypassing kidney stones, enabling urine flow in the presence of blood clots, and providing a conduit for urine in the case of ureteral tumors. Ureteral stents can also be used for drug delivery and radiation treatment near tumors. (Barros et al., 2016) Overall, ureteral stents play a crucial role in managing urinary tract conditions and facilitating urine drainage.

Ureteral stent needed to be replaced every 3 to 6 months. (Ureteral stent placement, 2021) Based on study by A Ringel 1, S Richter, M Shalev and I Nissenkorn in 2000, 90 patients with 110 stented kidneys were evaluated. The stents were left in place for

varying durations, ranging from 3 to 12 months, and patients were monitored with imaging tests every 3 months until the stents were scheduled to be removed or complications arose. The study found that 10% of cases had stent fragmentation and 8.2% had stent migration. In 9.1% of cases, the severity of hydronephrosis did not change, but the stents had to be removed due to flank pain or urinary tract infection with fever. Hydronephrosis developed or worsened in 5.4% of cases after stenting. Overall, 32.7% of ureteral stents had to be removed due to late complications.

Besides, mechanical issues with stents, including stent migration, encrustation, stone formation, and fragmentation, are the main difficulties. Stents serve as foreign bodies and can result in renal failure, urinary tract infections, and pyonephrosis. (Ray, R.P. et al., 2015) Thus, in order to decrease stent-related complications and morbidity, ureteral stents should be removed as soon as feasible after serving their purpose or replaced regularly as required.

2.5 Ureteral Stent Tracker

A ureteral stent tracker is a technology or system designed to monitor and track the ureteral stent that inserted into ureter. There are some examples of ureteral stent tracker application used around the world today.For instance, Urostentz App, Web-Based Stent Registry with Automatic Recall Application and Stent Tracker. The main reason of developing ureteral stent tracker is to remind the doctors and patients about the date to exchange the ureteral stent. In a study with 194 patients, ureteral stents were placed and tracked using the "Stent Tracker" app. Out of the total stents,

149 (77%) were successfully removed as planned, 17 (9%) were overdue, and 27 (14%) were scheduled for future removal. Additionally, one patient (0.5%) was lost to follow-up due to unavailability and lack of a permanent address.(Molina et al., 2017)This show that ureteral stent tracker is important to develop to prevent the patient and doctor forget to remove ureteral stent from body.

Regarding of remove or changing ureteral stent time, it needed to be replaced every 3 to 6 months. (Ureteral stent placement, 2021) When the replacement date arrives, ureteral stent need to be replaced with another new one to prevent ureteral stent migration, encrustation, stone formation, and fragmentation. When there is ureteral stent tracker, patients with the ureteral stent would be reminded when the replacement date is near. For example, Stent Tracker system send SMS notifications to patients one day before the scheduled stent removal date, on the day of stent removal, and also after the stent has been removed. These messages include the name of the user and the hospital. (Ureteral Stent Tracker | Digital Stent Registry, n.d.) So, the patients would not forget to go to hospital for replacing the ureteral stent. Doctors also can use the ureteral stent tracker to know how many patients that need to replace the ureteral stent in a day. Nurses can use ureteral stent tracker to manage numbers of operations per day and they can contact the patients when they are absent for the operations for ureteral stent replacement.

2.6 Importance of accurate tracking for stent placement and monitoring in the urethra

Accurate tracking time for replacing ureteral stent and monitoring using ureteral stent tracker is important. First, accurate tracking time for replacement of ureteral stent before

6 months can prevent the happening of complications due to the ureteral stent. Forgotten to replace or remove ureteral stents can produce a spectrum of issues ranging from haematuria, stent blockage, migration, fragmentation, encrustation, and formation of stones to major consequences such as recurring infection of the urinary tract (UTI), urinary tract blockage, and kidney damage. (Abdelaziz et al., 2018)

Furthermore, Hospital side can monitor the patient condition after inserting the ureteral stent through the ureteral stent tracker. If the patients feel uncomfortable after inserting ureteral stent, they can contact to Hospital sides to make an appointment for checking the reason of uncomfortable and solve it. As a case in point, Urostentz Application provide a questionnaire utilized visual representations of symptoms from the Ureteral Stent Symptom Questionnaire (USSQ) to enhance patient compliance.Additionally, the application allowed patients to request a change in their scheduled appointment. (Tokas et al., 2021) Blockage or migration of the ureteral stent may make the patients uncomfortable would require another surgery to solve the blockage and place the ureteral stent to the right position again. Accurate tracking time for replacing or removing of ureteral stent also can prevent the unnecessary uncomfortable experienced by the patients. Moreover, adhering to accurate tracking of stent replacement time ensures that healthcare providers follow established guidelines and promoting consistent and evidence-based care. By complying with these clinical guidelines, healthcare providers strive to achieve the most favourable outcomes for their patients.

2.7 Ureteral Stent Replacement Application Tracking and Monitoring Application

Since we discussed already about the harm of late replacement of ureteral stent, it shows that it is required for existing application that can notify patient to make appointment in hospital to replace the ureteral stent every 6 months. These are some application that had similar goal with the application that we need to do.

There is an application called Urostentz App used for digital stent registries and patient communication. Urostentz App can be logged in by doctors and patient. Doctor need to help patient to register account for this application. The stent tracker system involves patient registration with demographic information, stent details, and planned removal date. Patients have access to a dashboard with a symptom questionnaire and personal profile. A visual symptom questionnaire is available for patients experiencing symptoms related to stents or persistent symptoms after stent removal. Clinicians can view a dashboard showing the daily schedule for stent removal and updates on patients' progress. (Hameed et al., 2021)
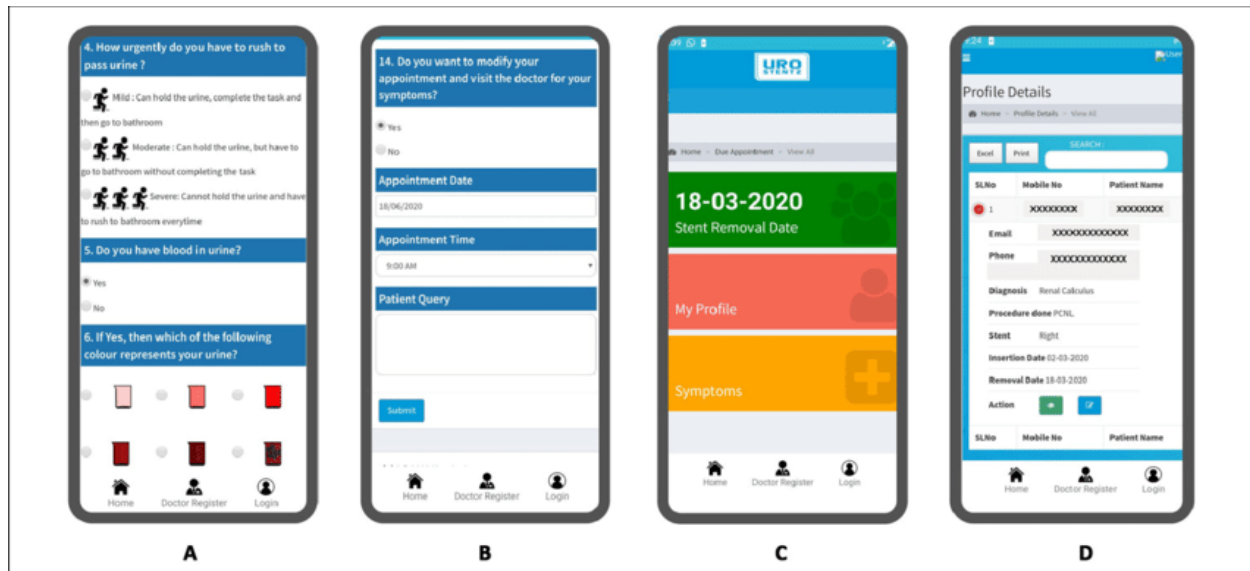
The picture shows the user interfaces of Urostentz App, which A shows the symptom questionnaire user interace. B shows the appointment user interface, which it allow the patient to change the appointment date. For C, it is the main user interface of the patient which shows the stent removal date, profile button and symptoms questionnaire button. Lastly, D shows the user profile of the patient and patients also can update their personal information.

Besides, there is another web application called Web-Based Stent Registry with Automatic Recall Application. (Mark F. Lynch a et al., 2007) The Electronic Stent Register (ESR) is integrated into the hospital's electronic patient record (EPR) system to prevent duplication of patient data. When a stent is implanted, a "stent episode" is created in the ESR, capturing details like stent type, size, implanter, and maximum stent life (MSL). The MSL serves as a deadline for stent removal and activates the Stent Extraction Reminder Facility (SERF). SERF queries the ESR daily to identify patients

whose stents have surpassed the MSL or have approaching removal dates without action. If deadlines are missed, SERF sends automated reminder emails to the staff to schedule a new removal appointment. SERF continues sending emails until the stent removal event is updated in the ESR. The ESR has been modified to read barcodes on patient notes and stent packaging from specific suppliers, allowing seamless data input for various parameters like surgeon name and MSL.
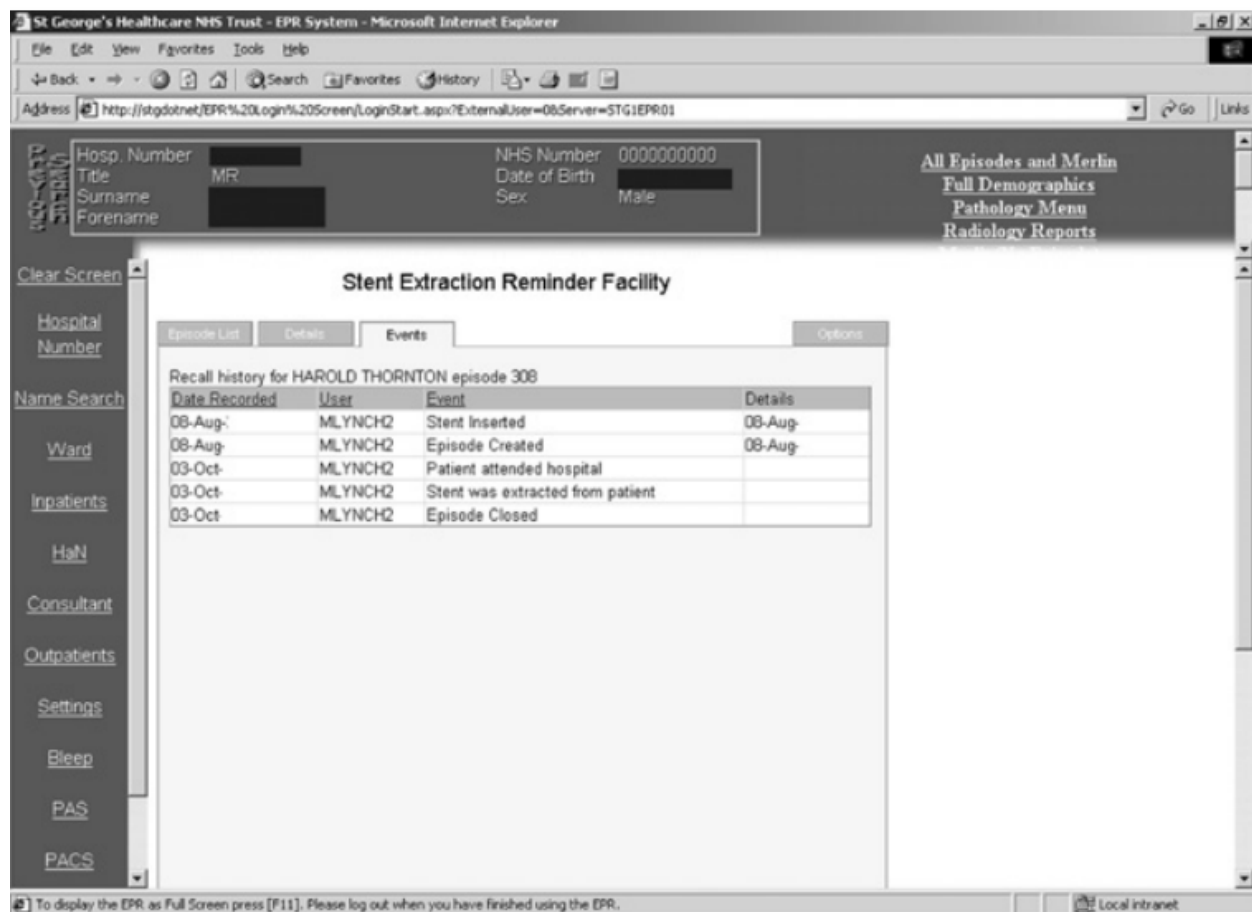
The picture show page from EPR showing ESR after the closure of stent episode. These data were saved within the stent register as a permanent record.

The third similar application is called Stent Tracker. Stent Tracker is a digital system that facilitates the management of ureteral stents, ensuring patient safety and minimizing stent-related complications. It offers a comprehensive dashboard for easy access to relevant information. The system allows for adding patient details, including their name, mobile number, and language preference for reminders. Cases can be added with stent insertion and removal dates, enabling automated reminders to be sent to patients. The system provides a list of patients with stent removal due on the current day, allowing for SMS reminders to be sent. Additionally, an overdue list helps track cases that have passed their removal date. The system supports SMS notifications in local languages, providing personalized reminders with the user and hospital name. Overall, Stent Tracker streamlines stent management improves care quality, reduces liability, and enhances workflow efficiency.
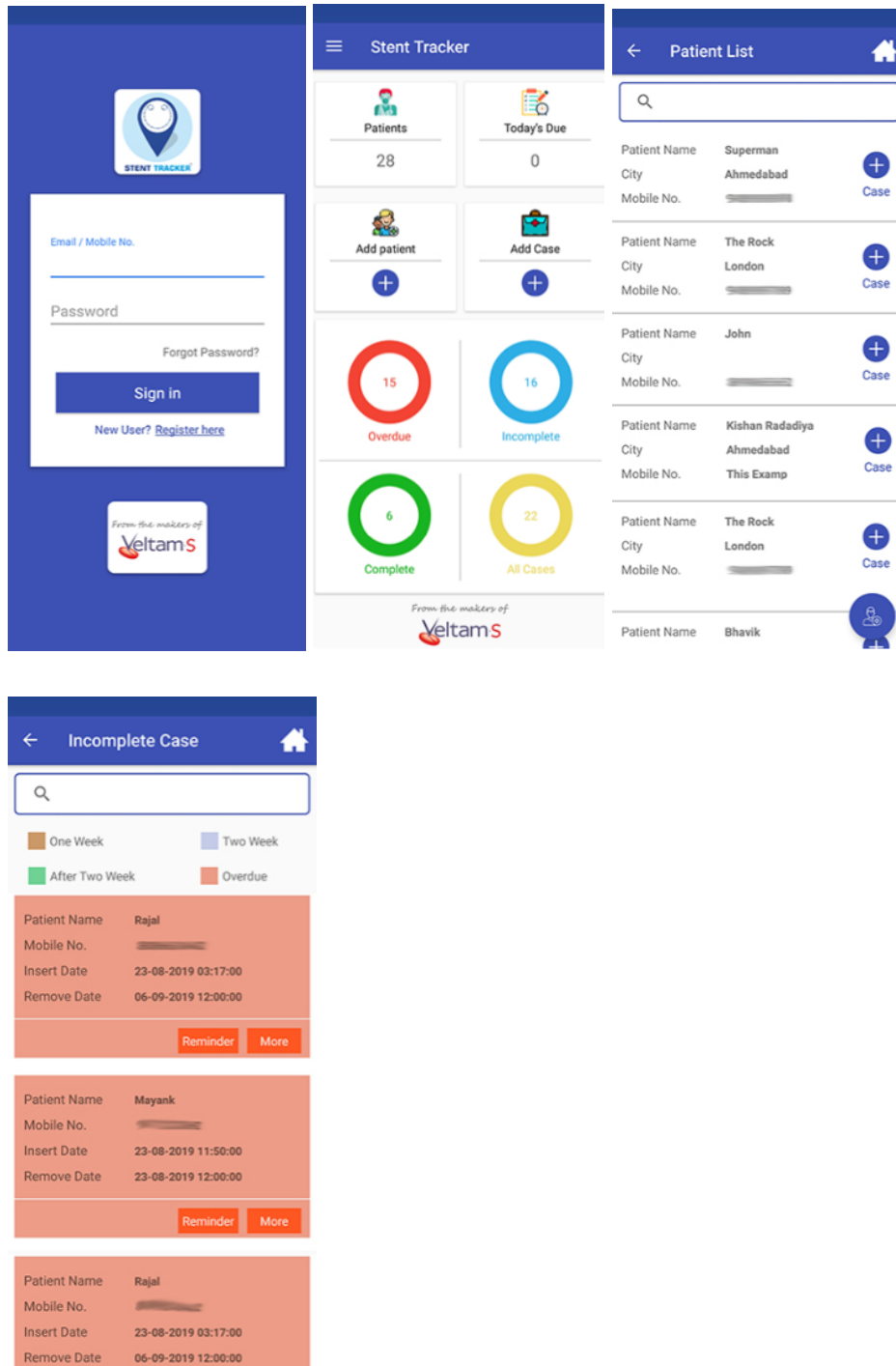
Pictures show the screenshots of the Stent Tracker application. The first picture is the sign-in page. The second picture shows the analysis of the patient which are the number of patients that are overdue, incomplete, and complete, and the number of

patients that are today due. The third picture shows the patient list inserted by the doctors and doctors also can add cases to the patient and register their ureteral stent information into the system. Next, the fourth picture shows the cases list, which each case will be coloured with different colours. If the patient is overdue the due date and does not go for ureteral stent replacement, it will be red colour. The doctors can remind the patients who are overdue by clicking the reminder button, then an SMS message will be sent to the patient to remind the patients to go to the hospital to remove or replace the ureteral stent.

2.7.1 Tracking Mechanism

For Urostentz App, the urologist informs the patients through the Urostentz App.

For Web-Based Stent Registry with Automatic Recall Application, Stent Extraction Reminder Facility (SERF) sends automated email notifications to the responsible clinician to ensure timely stent removal. These emails are sent on a daily basis until the Electronic Stent Register (ESR) is updated following the removal of that specific stent.

For Stent Tracker, doctor can view the ureteral stent removal date in a list in Stent Tracker application. Clinician can send the SMS notifications to the patients based on the language preferred by the patients.

2.7.2 Key Features of effective Ureteral Stent Tracking System

The system can accurately track stent placement details, such as insertion date, size, type, and expected removal date. Besides, automated reminders are sent to healthcare providers and patients to ensure timely stent removal, utilizing various communication channels. Other than that, the system captures and manages patient information, including demographics, contact details, and relevant medical history related to stent placement. Ureteral Stent Tracking System also should integrate with existing Electronic Health Records systems, which enables access to up-to-date patient records. The system should provide reporting and data analysis capabilities for monitoring stent outcomes and making informed decisions.

2.7.3 Requirements of effective Ureteral Stent Tracking System

The system must provide accurate and reliable stent-related data. So, the date would not calculate wrongly and notify patients with wrong date. Moreover, robust security should measures protect patient data and ensure privacy compliance. This can prevent the leakage of patient data. Next, adequate training and ongoing support need to be provided to healthcare providers and staff. Therefore, they can be master to the ureteral stent tracking system.

2.7.4 Comparison Matrix

Comparison element	Urostentz App	Web-Based Stent Registry with Automatic Recall Application.	Stent Tracker

Dashboard	Doctors, Patient, Nurse dashboard	Only Nurse dashboard	Only Nurse dashboard
Symptom tracking questionnaire	Yes	No	No
Medium of notification	Application itself	Email	Automated SMS System
Provide knowledge about ureteral stent	No	No	No
Make appointment	Yes	No	No
Assign doctors to patient	No	No	No

Table 2.1: Comparison of existing Stent and Tracking Web application features

There are 6 criteria that are used to compare among three existing system that used to track patient stents, which are Urostentz App, Web-Based Stent Registry with Automatic Recall Application and Stent Tracker. The criteria compared are application dashboard, symptom tracking questionnaire, medium of notification, provide the knowledge about ureteral stent, function of making appointment and doctor assignment module.

2.7.4.1 Dashboard Module

The Web-Based Stent Registry with Automatic Recall Application features a Nurse dashboard that allows nurses to register ureteral stent information, including mandatory maximal stent life and the name of the surgeon. It also enables nurses to remind doctors about the ureteral stent replacement date. However, it does not have the functionality to generate reports.

The Stent Tracker application includes a nurse dashboard that provides a comprehensive view of the number of patients and tracks the number of patients whose ureteral stents have reached the maximum time limit on a daily basis. Nurses can add patients, monitor overdue, complete, or incomplete cases, view the patient list, and generate reports.

As for the Urostentz App, it offers a Nurse dashboard where nurses can add relevant ureteral stent information such as diagnosis, insert date, ureteral stent replacement date, and patient information. Additionally, it provides a Doctor dashboard that assists clinicians in tracking stent-related symptoms (SRS), offering digital remote assistance and access to the patient list. Furthermore, the app includes a Patient dashboard that facilitates patient education, stent tracking, symptom tracking, automated notifications, and the ability to make appointment changes.

Without a designated super admin role to allocate patients to doctors and manage staff permissions, coordinating patient care becomes challenging. The absence of a

centralized authority to oversee and streamline the assignment process can lead to inefficiencies, delays, and potential misunderstandings. The lack of proper organization and coordination may result in ineffective patient distribution and difficulties in managing staff rights within the system.

2.7.4.2 Symptom Tracking Questionaire

Besides, symptom tracking questionnaire is only applied in Urostentz App which the patients can filling the questionnaire and self-checking and the doctors can monitor the condition of the patients.To enhance patient compliance, the questionnaire utilized visual representations of symptoms from the Ureteral Stent Symptom Questionnaire (USSQ). (Tokas et al., 2021) Without a symptom tracking questionnaire, healthcare providers, including doctors, face challenges in effectively monitoring and assessing the condition of their patients.

2.7.4.3 Medium of Notification

In terms of the notification method, the Urostentz App provides direct communication between urologists and patients within the application. On the other hand, the Web-Based Stent Registry with Automatic Recall Application relies on the Stent Extraction Reminder Facility (SERF) to send automated email notifications to administrators. If a patient's stent replacement is overdue by 7 days, an email notification is sent to clinicians. If the issue persists, SERF will send daily email reminders to the staff urologists to ensure timely stent removal. The Stent Tracker application allows doctors to access a list of ureteral stent removal dates and send SMS notifications to patients in their preferred language.

However, there is a limitation in the current notification system, as patients, nurses, and doctors may not frequently check the SMS and email notifications, resulting in the potential for missed stent replacement appointments. Therefore, it is important to have multi-channel features so that nurses can utilize in-app notifications, email notifications, and SMS notifications to inform patients and doctors about upcoming stent replacement dates. Additionally, nurses and doctors can make phone calls to patients who have exceeded the stent replacement date. This multi-channel approach will help reduce the number of patients who forget their stent replacement appointments and ensure timely intervention.

2.7.4.4 Urethral stent knowledge

Apart from that, there is a significant lack of comprehensive educational materials specifically created to provide patients with knowledge and information about ureteral stents. Existing applications fail to offer thorough instructional content on the function, application, maintenance, and potential consequences of ureteral stents, leaving patients uninformed and uncertain. This knowledge gap can lead to confusion, anxiety, and inadequate self-care practices, posing risks to patients who may delay necessary medical care and exacerbate existing conditions due to their lack of awareness regarding potential ureteral stent problems or warning symptoms.

### 2.7.4.5 Appointment Function

At present, only the Urostenz App provides the capability for patients to directly schedule appointments with doctors to address symptoms related to the insertion and removal of a ureteral stent. In contrast, the Stent Tracker and Web-Based Stent

Registry with Automatic Recall Application do not offer this feature. As a result, when patients experience discomfort, they are unable to utilize the application to conveniently book appointments. Instead, they are required to physically visit the hospital and endure waiting times for an available slot. Furthermore, the absence of appointment-making functionality in these applications poses challenges for nurses who are unable to assist patients in scheduling appointments over the phone. This limitation may particularly inconvenience elderly patients. Such a process not only consumes valuable time but also fails to prioritize the importance of timely care.

Chapter 3 Methodology

In this project, the rapid application development model is applied. Rapid application development is an approach that focuses on creating applications quickly using frequent iterations, approvals, and ongoing client feedback. RAD stresses software usability, user reviews, fast delivery compared to long-term planning, and a single initial set of criteria for creating things like custom apps by prioritizing agile and rapid prototype releases. (Rapid Application Development (RAD) Tool | Microsoft Power Apps, n.d.) There are 4 major phases in this RAD methodology, which are Requirement and Planning, User design, Construction and Cutover.(Kissflow, Inc, 2023)

Rapid Application Development (RAD)
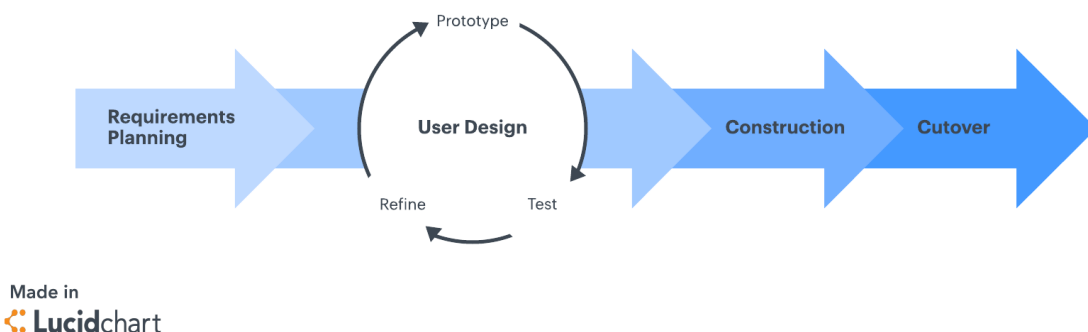
The requirement and planning phase works as a project scoping meeting where key stakeholders collaborate to define the project goals, their expectations towards the project, and identify potential challenges that may arise during development. While the planning phase is relatively concise in comparison to other project management

methodologies, it can ensure the project's overall success. This stage involves effective communication among developers, clients, who will use the software, and stakeholders, which allows them to establish a shared understanding of project objectives and address any existing or potential issues that may impact the development process.

In the User Design phase, it involves several iterations for developing the prototype. Developers rapidly generate prototypes incorporating various features and functionalities, aiming for quick iterations. These prototypes are subsequently presented to clients, who assess and provide feedback on their preferences and dislikes. Thus, developers can modify the prototype based on their feedback. These processes can go through iterative and incremental cycles, continuously enhancing with the additional user interface of the functionality and enabling ongoing improvement, then submit to clients and stakeholders for testing and refinement until all functionalities are been covered.

The next phase is the Construction phase. The construction phase holds significant importance in the development process as developers need to transform a functional prototype into a fully working system. Feedback and reviews by clients and stakeholders play a vital role in identifying and resolving bugs, issues, and necessary alterations. Depending on factors such as client requests or extensive feedback, this phase can be considerably longer as they can change or add their requirement to align with evolving project directions. Besides, unit, integration, and system testing would be

done in every iteration to find the bugs and fix them. Once the stakeholders and client are happy, the developers can stop the construction phase.

In the Cutover phase, it is the implementation stage of the finalized product is prepared for launch. Activities involved such as data conversion, thorough testing, and transitioning to the new system take place, alongside user training. Throughout this stage, developers and clients collaborate to identify and address any remaining system bugs or issues, allowing for final modifications to be made.

Phase	Activity involved	Deliverable
Requirement and Planning Phase	Project discussion	Title and basic understanding of the application
	Project Research	Literature Review
	Requirement planning	Requirement of the application
	Project planning	Objective, problem statement, project scope, timeline, user scope, system scope
	Proposal writing	Proposal documentation
	Proposal presentation	Presentation slides

User Design Phase	Sprint 1	Basic stent management module and basic user authentication and user management module prototype
	Sprint 2	Data visualisation dashboard module and report generation module prototype
	Sprint 3	Multichannel notification module prototype
	Sprint 4	Appointment management module prototype
	Sprint 5	Chatbot module prototype
	Sprint 6	Branch, Role, Group, staff information, staff access permission management module and urologist assignment module prototype
Construction	Modify prototype based on comment	Modified prototype

	Transform into fully working application	Fully working application
	Adress bugs and bug correction	Bugs report
	Testing	Testing result
Cutover	Change the application based on stakeholders' comment	Changed integrated application
	Identify and correct the remaining bugs	Bugs report
	Deployment	Fully functioning ureteral stent tracking and monitoring web application

Requirement and Planning Phase (14 weeks):

First of all, we had a meeting with the stakeholder and gather requirements from stakeholders to understand the desired features and functionalities of the ureteral stent

tracker application. Next, market research was conducted and analyze competitor applications to identify key features and potential areas for differentiation. Three competitor applications were found, which are Urostentz App, Web-Based Stent Registry with Automatic Recall Application, and Stent Tracker. Then, issues faced by these applications were analysed and the issues become an important element for determining the problem statement, objectives and project scope. Besides, literature research about the ureteral stent, and diseases that required ureteral stent, food habits that lead to the diseases have also been done. The reason for doing this literature research is to more understand about ureteral stents and the information needed for producing ureteral stent tracker application. After that, a project plan, including the methodology used and timelines was required to be done. An initial feasibility analysis was conducted and any necessary adjustments were made to the project plan to ensure the project plan is in a good manner. Lastly, the plan will be presented to stakeholders and gather feedback from stakeholders for validation.

User Design Phase

Iteration 1 (2 week)

Design the prototype that contains the basic stent management which allows to add, view and update of the stent insertion and removal date, and stent information in the database. Besides, it is also required to design the user interface for basic user authentication and user management.The wireframes were designed and developed based on the function of stent management, which can add, view and update the stent insertion and removal date in the database. Besides, basic user authentication and user management features were also developed to ensure the security of the information.

Lastly, initial testing and bug fixing was conducted and then submitted to stakeholders to gather their feedback.

Iteration 2 (2 week)

Review their comments about the prototype in Iteration 1 and improve the prototype based on their opinions. Next, design the user interface of the functionality of the data visualisation dashboard and the report function. So, we can design the dashboard and report. Additional details like the stent information and placement details can add to the database to make the database more informative. Data visualization and reporting features used to display stent usage statistics are implemented and it only can be viewed by the nurse. Apart from that, generating reports function allows the nurse can generate the analysis report based on the data visualization also requires to be implemented. Next, testing and bug fixing also be conducted. Lastly, send it to stakeholders to gather their feedback.

Iteration 3 (2 week)

Review their thought about the prototype in Iteration 2 and modify the prototype based on their comments. The requirement of this iteration is to enhance the tracking functionality by allowing for notifications and reminders for stent removal dates. The

user interface of the appointment information dashboard required to be designed. These notifications and reminders are included ways to notify through in-app notification, email, and sms. The multi-channel notification is implemented to notify the doctors and the patient to prevent them forget about the removal date. After that, testing and bug fixing are conducted also and submitted to the stakeholders for their comments.

Iteration 4 (2 week)

Analyse stakeholders' comments about the prototype in Iteration 3 and alter the prototype based on their evaluation results. The objective of this iteration is to add the appointment function to the prototype. The reason for developing the appointment function is to ease nurses to check appointment information and the nurses can help the patients to make appointments when they feel uncomfortable with the ureteral stent. User interface of appointment function are sketched and implemented. Same with the previous iteration, the application will be tested and the bugs discovered would be fixed. After that, the application would be submitted again to stakeholders for evaluation.

Iteration 5 (2 week)

The stakeholders' opinions on the product in iteration 4 also be compiled and analysed After that, change the previous system in iteration 4 based on their comments. The requirement of this iteration is to apply a chatbot in this application. This chatbot can help the patients to have more knowledge about ureteral stents and the function of the ureteral stent tracker. Besides, it also can be used to ease the communication between the nurse and the patient. The user interface of chatbot is designed and developed. Lastly, testing and bug fixing was conducted again and sent to the stakeholders for their remarks.

Iteration 6 (2 week)

The stakeholders' perspectives on the product in iteration 5 were gathered and evaluated. Based on their comments, adjustments were made to functionality and usability. The focus of this iteration is to incorporate a Super Admin role into the prototype. The Super Admin role entails a range of capabilities such as hospital management, staff management, group management, role management, and module access permission. These user interfaces are sketched and will be used as templates for continuing improving prototype. These additions aim to empower administrators with enhanced control and streamline management processes within the application. To implement this, the Super Admin's dashboard and functionalities specific to the Super Admin role will be developed. Testing and bug fixing will be performed to ensure a seamless user experience. The refined version will then be shared with stakeholders for their feedback and further suggestions.
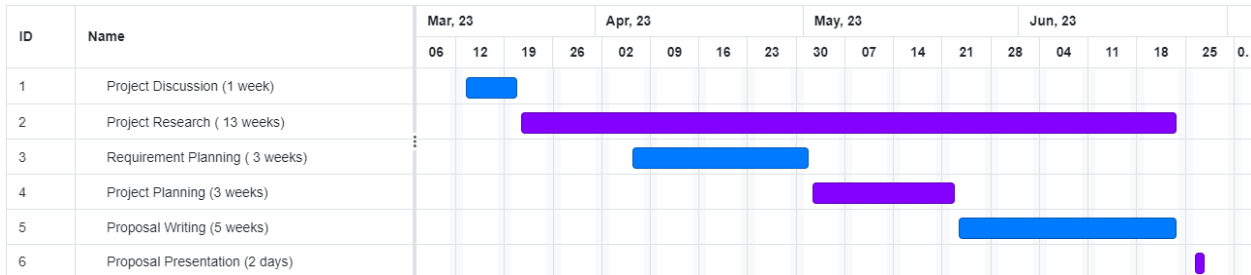
Construction Phase (5 weeks):

Review and gather feedback about the prototype of Iteration 6 of the User Design phase and modify based on stakeholders' opinions. In this phase, the functional prototype will be transformed into a fully working system. All the prototypes would be integrated into a fully working system. Outstanding bugs or usability concerns needed to be addressed. Final testing and quality assurance are conducted to ensure the application is ready for release. Lastly, we need to prepare the application for integration with other modules from teammate. Then, unit, integration, and system testing were conducted and sent to stakeholders for evaluation.

Cutover Phase (2 weeks)

Make the changes based on stakeholders' comments about the integrated system. Developers, clients and stakeholders must collaborate to identify and address any remaining system bugs or issues, which it still allows for final modifications to be made. After the final modification, the finalized ureteral stent tracker application is prepared for launch and it can be submitted to stakeholders for deployment.

Chapter 4 Project Planning

ID	Name	Mar, 23				Apr, 23				May, 23				Jun, 23				
		06	12	19	26	02	09	16	23	30	07	14	21	28	04	11	18	25	0.
1	Project Discussion (1 week)																	
2	Project Research (13 weeks)																	
3	Requirement Planning (3 weeks)																	
4	Project Planning (3 weeks)																	
5	Proposal Writing (5 weeks)																	
6	Proposal Presentation (2 days)																	

ID	Name	Start Date	End Date
1	Project Discussion (1 week)	Mar 13, 2023	Mar 20, 2023
2	Project Research (13 weeks)	Mar 21, 2023	Jun 23, 2023
3	Requirement Planning (3 weeks)	Apr 06, 2023	May 01, 2023
4	Project Planning (3 weeks)	May 02, 2023	May 22, 2023
5	Proposal Writing (5 weeks)	May 23, 2023	Jun 23, 2023
6	Proposal Presentation (2 days)	Jun 26, 2023	Jun 27, 2023

ID	Name	2023						2024	
		Jul 2023	Aug 2023	Sep 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024
1	Sprint 1 (2 weeks)		▬						
2	Sprint 2 (2 weeks)			▬					
3	Sprint 3 (2 weeks)			▬					
4	Sprint 4 (2 weeks)				▬				
5	Sprint 5 (3 weeks)				▬				
6	Sprint 6 (3 weeks)					▬			
7	Construction (5 weeks)						▬		
8	Cutover (2 weeks)							▬	
9	Thesis Writing (8 weeks)						▬▬▬		

| ID	Name	Start Date	End Date
1	Sprint 1 (2 weeks)	Aug 01, 2023	Aug 15, 2023
2	Sprint 2 (2 weeks)	Aug 18, 2023	Sep 01, 2023
3	Sprint 3 (2 weeks)	Sep 05, 2023	Sep 19, 2023
4	Sprint 4 (2 weeks)	Sep 22, 2023	Oct 06, 2023
5	Sprint 5 (3 weeks)	Oct 10, 2023	Oct 31, 2023
6	Sprint 6 (3 weeks)	Nov 03, 2023	Nov 24, 2023
7	Construction (5 weeks)	Nov 28, 2023	Jan 02, 2024
8	Cutover (2 weeks)	Jan 05, 2024	Jan 19, 2024
9	Thesis Writing (8 weeks)	Dec 01, 2023	Jan 31, 2024

Chapter 5 Expected results

5.1 Use cases

1. Super admin can log in to the administrator account.

2. Super admin can manage hospital branches' system.

3. Super admin can manage the staff information in the hospital branches.

4. Super admin can assign groups to the staff that has the same role.

5. Super admin can manage the role of the staff.

6. Super admin can set module access permission for the staff according to their roles.

7. Super admin can assign available doctors to the patient.

8. Nurses can log in to their nurse account.

9. Nurses can view a dashboard that will show the daily number of patients that had made appointments for ureteral stent replacement, the number of patients that are close to the replacement date, the number of patients that do not come for ureteral stent replacement after the deadline.

10. Nurses also can manage patient records.

11. Nurses can set the sample answer for replying the question asked by the patient using chatbot

12. Nurses can key in ureteral stent information, time to replace the ureteral stent of patients into the database, view ureteral stent information of the patients and update the information if there is changing element.

13. Nurses can set the notification to doctors and patients to notify them to undergo ureteral stent replacement.

14. Nurses can help patients to make appointments with doctors.

15. Nurses also can generate report about daily number of patients that had made appointments for ureteral stent replacement, the number of patients that are close to the replacement date, the number of patients that do not come for ureteral stent replacement after the deadline.

5.2 Use case diagram
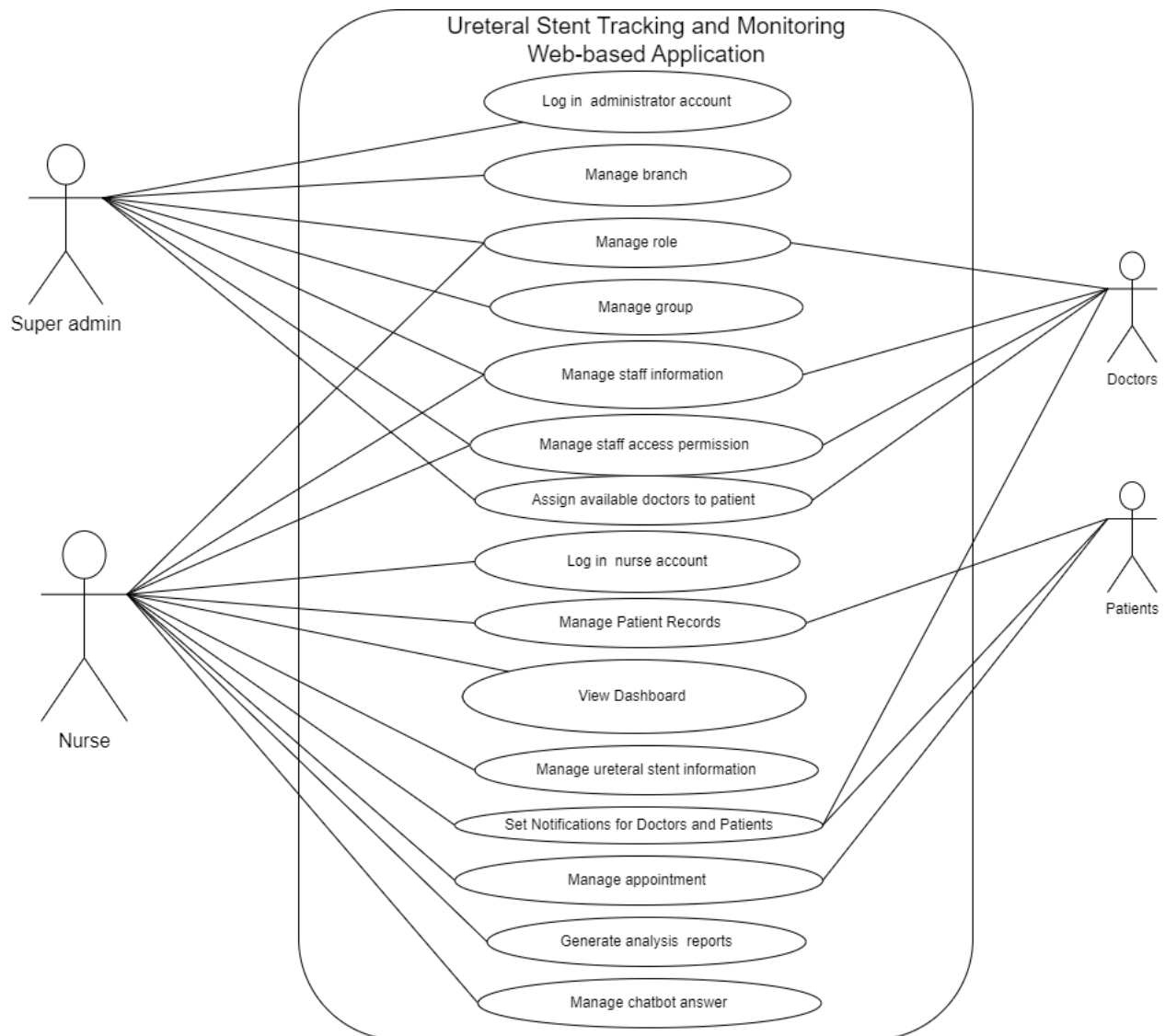
A ureteral stent tracking and monitoring application would be developed to reduce the forgetness of the patients on the replacement or removal date and ease the hospital staff to track and monitor the condition of patients

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Chapter 6 Conclusions

In summary, the Ureteral Stent Tracker project successfully tackles the difficulties involved in managing and monitoring ureteral stents from start to finish. The system provides a streamlined and automated approach to stent tracking, timely replacement reminders, and seamless communication between healthcare providers and patients. By implementing the Ureteral Stent Tracker, healthcare facilities can benefit from an efficient and effective solution that enhances the overall management of stents, ensuring optimal patient care and minimizing potential complications.

References

Antonio, U. S. (2017, July 25). *Ureteral Stents – What you need to know*. Urology San Antonio. https://www.urologysanantonio.com/ureteral-stents

Barros, A. a. A., Browne, S., De Oliveira, C. a. F., Lima, E., Duarte, A. R. C., Healy, K. E., & Reis, R. L. (2016). Drug-eluting biodegradable ureteral stent: New approach for urothelial tumors of upper urinary tract cancer. *International Journal of Pharmaceutics*, *513*(1–2), 227–237. https://doi.org/10.1016/j.ijpharm.2016.08.061

Gadzhiev, N., Gorelov, D., Malkhasyan, V., Akopyan, G., Harchelava, R., Mazurenko, D. A., Kosmala, C., Okhunov, Z., & Petrov, S. (2020). Comparison of silicone versus polyurethane ureteral stents: a prospective controlled study. *BMC Urology*, *20*(1). https://doi.org/10.1186/s12894-020-0577-y

Geavlete, P., Georgescu, D., R, M., Stanescu, F., Cozma, C., & Geavlete, B. (2022). Ureteral stent complications – experience on 50,000 procedures. *Journal of Medicine and Life*, *14*(6), 769–775. https://doi.org/10.25122/jml-2021-0352

Hematuria (Blood in the Urine). (2022). *National Institute of Diabetes and Digestive and Kidney Diseases*. https://www.niddk.nih.gov/health-information/urologic-diseases/hematuria-blood-urine#:~:text=Trials%20for%20Hematuria-,What%20is%20hematuria%3F,urine%20test%20called%20a%20urinalysis

Hofmann, R., & Hartung, R. (1989). Ureteral stents — materials and new forms. *World Journal of Urology*, *7*(3), 154–157. https://doi.org/10.1007/bf01637374

Lynch, M., Ghani, K. R., Frost, I., & Anson, K. (2007). Preventing the Forgotten Ureteral Stent: Implementation of a Web-Based Stent Registry with Automatic Recall Application. *Urology*, *70*(3), 423–426. https://doi.org/10.1016/j.urology.2007.04.022

Mehta, P. (2023, March 6). *Dysuria*. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK549918/#:~:text=Dysuria%20is%20defined%20as%20the,least%20once%20over%20their%20lifetime.

Molina, W. R., Pessoa, R. S., Da Silva, R. F., Kenny, M. C., Gustafson, D., Nogueira, L., Leo, M. E., Yu, M. C., & Kim, F. J. (2017). A new patient safety smartphone application for prevention of "forgotten" ureteral stents: results from a clinical pilot study in 194 patients. Patient Safety in Surgery, 11(1). https://doi.org/10.1186/s13037-017-0123-3

Ray, R. K., Mahapatra, R. S., Mondal, P. P., & Pal, D. (2015). Long-term complications of JJ stent and its management: A 5 years review. *Urology Annals*, *7*(1), 41. https://doi.org/10.4103/0974-7796.148599

Ringel, A., Richter, S., Shalev, M., & Nissenkorn, I. (2000). Late Complications of Ureteral Stents. *European Urology*, *38*(1), 41–44. https://doi.org/10.1159/000020250

Tokas, T., Shah, M., Naik, N., Amaresh, M., Hegde, P., Beary, R. H., Jayadeva, S., & Somani, B. K. (2021). Are Technology-Driven Mobile Phone Applications (Apps) the New Currency for Digital Stent Registries and Patient Communication: Prospective Outcomes Using Urostentz App. *Advances in Urology*, *2021*, 1–7. https://doi.org/10.1155/2021/6612371

Tokas, T., Shah, M., Naik, N., Reddy, S. G., & Somani, B. K. (2021). Use of ureteric stent related mobile phone application (UROSTENTZ App) in COVID-19 for improving patient communication and safety: a prospective pilot study from a university hospital. *Central European Journal of Urology*, *74*(1), 51–56. https://doi.org/10.5173/ceju.2021.0328

Ureteral Stent Placement. (n.d.). Memorial Sloan Kettering Cancer Center. https://www.mskcc.org/cancer-care/patient-education/ureteral-stent-placement#:~:text=Your%20stent%20will%20need%20to,Your%20ureter%20becoming%20blocked

Ureteral Stents: What Are They, Procedure & Recovery. (n.d.). Cleveland Clinic. https://my.clevelandclinic.org/health/treatments/21795-ureteral-stents#risks--benefits

Appendixes