Post-Operative Care Assistant Research Report

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Executive Summary

While patients who go through skin surgery receive resources and support from the clinic throughout the surgery process, they often struggle to take adequate care of themselves following an operation. Our team has been working to find a solution that will better assist patients during the post-operative care period. Our research aimed to understand the pain points during the journey of a patient, from when they were diagnosed to the recovery period. To investigate further into what the post-operative care process entails, we conducted a literature review, multiple contextual inquiries at the clinic, several interviews with various hospital staff, a card sorting exercise for patients, and a heuristic analysis and usability testing on last year's team's final product - Hebo. From our research, we gained the following key insights:

- *Patients need more help when they start with hands-on post-operative care on their own.*
- *Patients need to be assured that what they are doing / feeling is normal.*
- *Patients' feelings and emotions affect their post-op decisions.*
- *Patients want personalized care.*
- *Visual representations and written out text are important for post-operative care for the predominant demographic of skin cancer patients*
- *Some patients hesitate to seek for help from family/staff due to personal reasons. (e.g. being too independent, not wanting to burden family, thinking they are probably fine)*
- *Patients want immediate response to their questions while clinic staff don't want their workflow to be interrupted*
- *Patients require simpler ways to find post-operative care dos and don'ts*

Based on these findings, we believe that our solution should focus on improving efficiency for hospital staff's current workflow, as well as personalization and accessibility for patients. Moving forward, we will need to choose a platform for our solution crafting and iterating on several different prototypes.

Introduction

Client

Bryan T. Carroll, MD, PhD, is a dermatologic surgeon and director of the Dermatologic Surgery clinic in the Falk Medical Building at UPMC Presbyterian. He specializes in Mohs surgery and cutaneous oncology for the treatment of skin cancer.

Problem Statement

After a patient undergoes Mohs surgery, they typically have questions and concerns about their postoperative treatment. Before and after surgery they are given explicit instructions on how to care for themselves and also provided with an instruction sheet to take home with them. Unfortunately, many patients struggle to remember and to interpret the basic instructions that are provided to them. Therefore, patients require support from clinical staff over the phone or in the clinic to address common concerns. Moreover, staff members often have to dedicate significant portions of time to communicate information already provided to the patients.

Our team has begun working to find a solution that will better assist patients during this post-operative period. Our research has been geared towards understanding the drawbacks of the previous BHCI capstone team's solution, who worked on this project last year, as well as filling in the research gaps that they may have missed.

Stakeholders

Our research and design will be focused on creating a solution that best fits the need of physicians, nurses, patients and patients' families. We plan to provide a tool that saves nurses time and better conforms to their workflow. The tool should allow physicians to offer personalized post-operative instructions to patients, and help patients take care of themselves after surgeries.

We created a stakeholder map dividing our stakeholders into several parties, based on their interactions with patients in post-operative care. The surgeon who carries out the surgery; UPMC staff who help patients change dressing, call patients for check-up and answer questions; patients' immediate family, extended family, and friends and community who might take care of them during the post-operative process.
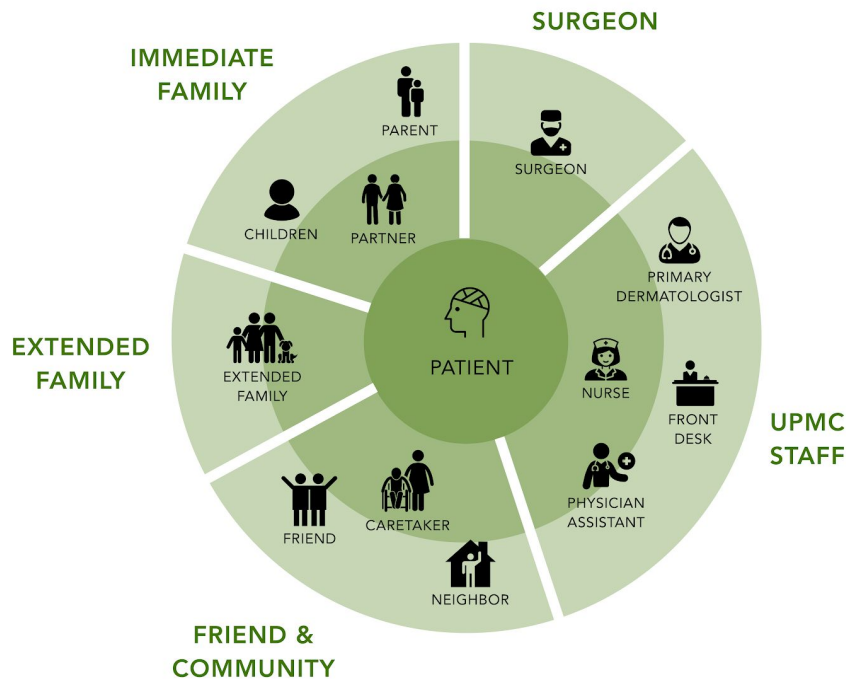
Stakeholder Map

Background

Mohs Surgery

Mohs surgery is considered one of the most effective techniques for treating many common types of skin cancer. The procedure is performed in multiple stages with extensive waiting time for the patient in between each stage. A surgeon will begin at the known cancerous area, removing a layer of tissue. Each layer of tissue removed is then examined under a microscope in an on-site lab. If any cancer cells remain, the surgeon identifies the cancerous regions and removes another layer of tissue, while sparing as much healthy tissue as possible. This process is repeated until no more cancer cells can be identified. The area is then closed up and dressed with bandages. One of the most significant advantages to this surgery is that it allows for highly effective removal of cancer cells, including those in more cosmetically and functionally important areas. Many of the surgeries performed are around the head and neck region, including the eyes, nose, lips, ears, and scalp, so many surgery sites are in noticeable

or more difficult to hide areas. Moreover, this kind of surgery is minimally invasive, so the patient can return to their routine as quickly as possible.

Outpatient Surgery at UPMC

In a large and reputable hospital like UPMC, many surgeries do not happen under the watch of a patient's primary physician. For an outpatient surgery that lasts no longer than a few hours, this means that patients will meet their doctor for the first time, have their surgery, and go home all in the same day. While this contributes to the efficiency of larger hospitals like UPMC, it may be overwhelming to the patient. UPMC doctors make an effort to follow processes that ensure that the patient is still being looked after, given personalized care, and fully briefed on what they need to do before, after, and during surgery.

UPMC nurses will make pre-operative calls a few days before the surgery to everyone of their patients in order to review what will go on during the surgery and to assess the patient's preparedness. Another assessment and informational appointment is held in person at the doctor's office right before the surgery. This is not only to review once more what the surgery will be, but also to answer any questions the patient has and to go over wound care instructions to be followed during the healing process post-surgery. Following the surgery, a staff member will review the wound care instructions with each patient before sending him or her home. Finally, a nurse will call patients within 24 hours of their surgery to check up on the patients and to answer any remaining questions before setting up a schedule for weekly and monthly follow-up appointments. The process alone is extensive and time-consuming for all members of the staff involved.

Research Methods

When defining the scope of our problem, we found that there were three main stakeholders we will need to design for: doctors, nurses, and patients (including caretakers). To find a solution that would balance all of their needs and goals, we need to understand the different perspectives of post-operative care from their points of views. Utilizing the information provided from the last BHCI team, we found holes in their research that we wanted answered as well as wanted to gain more insight on what worked and what did not work from their prototype.

We started with a comprehensive literature review to not only understand the current post-operative care process, but also gain knowledge on pain management and the current relationship elderly people have with technology. We also researched the kinds of accommodations that that current target age of patients would need. Focusing primarily on their vision, hearing, motor, and cognitive abilities. Information from this literature review helped supplement our first-hand findings and filled in some aspects that we did not fully understand from our client meeting.

We then conducted a heuristic analysis of Hebo - the mobile chatbot designed by last years' BHCI team (see Appendix I). This helped us identify successes and restrictions of the chat, pinpoint additional user research we needed to conduct and find possible areas of improvements or new directions of design. We also ran a think-aloud of Hebo with patients during out clinic visit, and observed how patients perform the tasks given, thus discovered some existing issues the design of Hebo.

To gain a more thorough understand of what patients and clinical staff undergo, we did job shadowing in the UPMC Falk clinic, observing surgery, lab work, dressing change, patient guidance, etc. This helped us to identify current processes and breakdowns. We also performed contextual inquiries and interviews (see Appendix III and IV) with patients and clinic staffs, including surgeons, nurses, residence doctors and assistant physicians. During the interviews, we prepared card sorting activities (see Appendix II) for both patients and clinic staffs, and asked them to rank what they feel - for patients after surgery and for nurses and physicians when they received phone calls from patients. The card sorting activity helped better understand their feelings and emotions and thus identify their implicit needs during post-operative care.

Synthesis

After we conducted our initial phase of research we began to synthesis our findings. We began by creating personas for the three main types of patients families ages 60-80: those with families who are supportive and will function as a caretaker post operation, those who live alone but are capable of following the instructions independently, and those who need significant hands-on help from the clinical staff. These personas will help us make sure we are designing for the various different type of patient.

Patient Journey Map
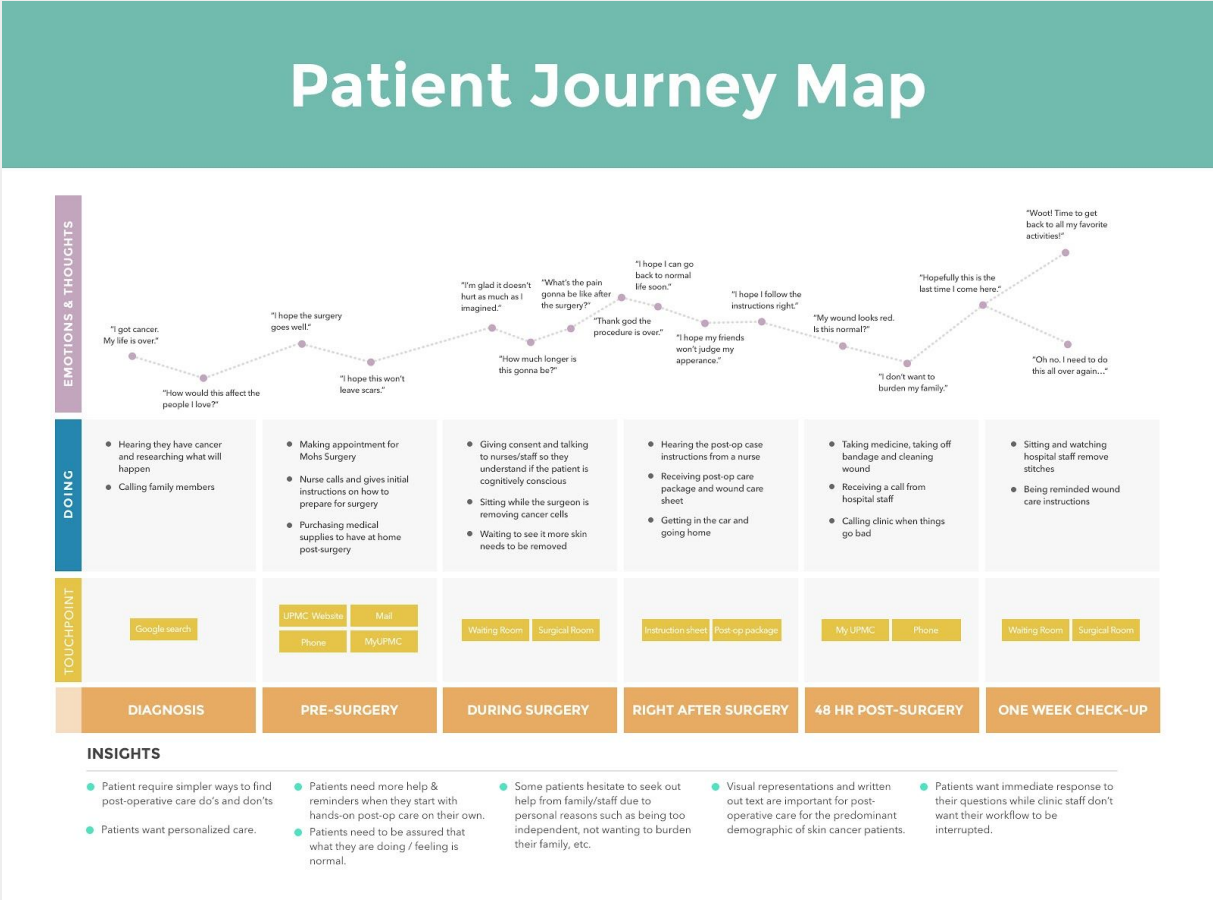
Customer Journey Map

We then conducted a journey map for nurses and patients, which will help us better understand the goals and needs of these stakeholders. We looked at the surgery procedure by the six phases: diagnosis, pre-surgery, during surgery, right after surgery, 48-hour post-surgery, one-week check-up and later. For each phase, we discussed patients' emotions and thoughts, their tasks and touchpoints, in order to better understand each part of the surgery process and discover opportunities. Based on that, we used sticky notes to discover existing pain points in different phases of surgery, especially the post surgery phases.

Lastly, we synthesized the pain points we found by grouping them together and discovering insights from each group. For each pain point we identified, we also brainstormed possible design ideas to solve the problem, and will later use them for our ideation process.
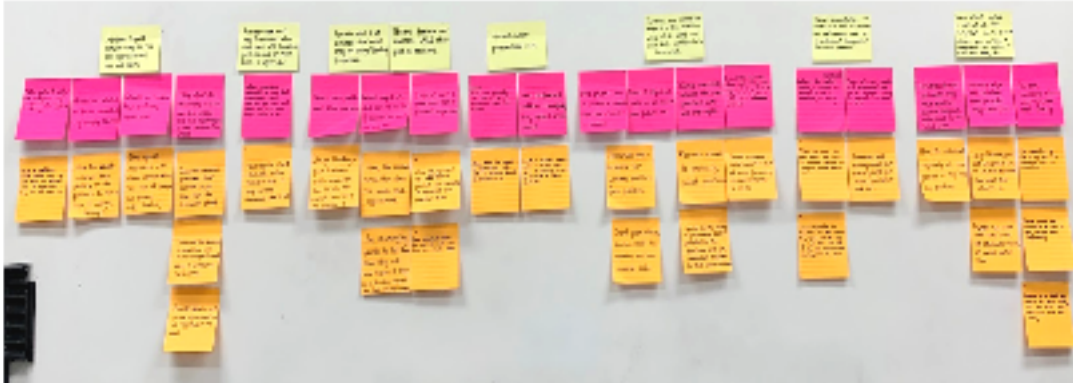
Pain point synthesis and design opportunities

Takeaways

Patients need more help when they start with hands-on post-operative care on their own.

After a patient's surgery, they receive a pressure bandage which they are instructed not to remove for 48 hours. Therefore the initial 48 hours of their post-operative care process is specifically for managing pain, taking their medication, and applying ice. They also need to remember to not shower and to not lift heavy weights but the majority of their post operative care process occurs after the first 48 hours. That is when they begin the hands-on post operative care process such as removing the pressure bandage, cleaning their wound, and reapplying the wound care. This is also the first time they see their wound and see the leakage and bleeding. During this time they begin to panic about the post operative care process, and this is the time when they want the additional assistant and to hear about the instructions again.

During our research, utilizing the card sorting exercise, we found that patients right after their operation feel very confident about the post operative care process and are not confused about what they need to do. But after they come back for their one week checkup and redid the card sorting activity, they noted that being confused about the post operative care process was much higher on their list. Patients need to be reminded of the instructions once they begin the hands-on process of the post-operative care process and to be reassured that they can do it alone.

Design opportunity: Patients need to be reminded of the post operative care process when they begin the difficult portion of their wound care. Through our assistant, we need to reiterate the instructions and make sure that when the patient will be doing the

hands-on portion they have been reminded on the instructions and feel confident doing so. An additional idea is to have the assistant give reminders to the patient about when they need to change out their wound and how to do so providing photos and oral confirmation.

Patients need to be assured that what they are doing / feeling is normal.

Bleeding, pain and swelling are the three most common concerns patients have after surgery. During to our interview, some patients mentioned that the level of pain 48 hours after surgery was above their expectation. Some patients and family members overly panic about the redness and bleeding of the wound, and often call the clinic staff describing the condition as "lots of blood", "there's blood everywhere". Meanwhile, having a little blood after skin surgery is normal to doctors, and they need to ask follow-up questions to make sure how much blood actually is. Due to the lack of medical background, patients would sometimes over-react and exaggerate the level of bleeding and pain, which causes difficulty for clinic staff to determine the actual severity of the symptom.

Design opportunity: Patients need a self-assessment tool for bleeding/pain/swelling to help them evaluate how severe their situation is. The tool will describe the possible levels of pain and bleeding in advance and then let the patients rate their pain level on a scale of 1-10. The assessment of bleeding can also be based on comparison between the picture of patient's wound and similar wound pictures in the database, using machine learning models. The self-assessment tool will comfort the patient if it diagnose the condition as normal, and only call the clinic if the condition is actually severe. This will reduce unnecessary calls to the clinic and provide a more objective assessment for doctors to diagnose the condition.

Patients' feelings and emotions affect their post-op decisions.

Instead of only focusing on what patients do, we also looked into how they feel - which turned out to influence their decisions in the post-operative procedure. During the card sorting activity, two patients ranked both "afraid to look into the mirror" and "embarrassed to go out in public" as their top three feelings, indicating that how there look had a great influence on them post-operatively. Some nurses and physicians mentioned that, some patients wouldn't come back to the clinic for the one-week check-up, and when asked about the reasons, some mentioned that they felt weird with their bandage on the face, and thus did not want to go out in public, so they decided that they didn't come. Some physicians also reported seeing lots of panicking (and

sometimes over-panicking) during patients' post-operative calls - some patients might call in and say that "blood is everywhere", while in fact they only had normal bleeding.

Design opportunity: As patients' feelings are extremely important for post-operative care, one thing we want to do is to keep reassuring the patients, especially those who are overly panicking. Helping them understand the natural healing process and normal redness, stitches, swelling or bleeding might be helpful. For those who forgot or did not want to come back to the clinic, it would be nice to have a reminder of the one-week check-up. But we might need to keep in mind that, we need to not only let patients know what to do, but also try to comfort them about their wound and how they look.

Patients want personalized care.

Although patients are given a review of the post-op care instructions by the nurses, some of the patients still have additional questions that need personalized attention. For example, there are patients who need a lot of hands-on help from nurses as mentioned earlier. Compared to taking medicine which has more straightforward instructions, changing bandages turns out to be more challenging for some patients. One patient mentioned that cutting the bandages was a bit concerning at first, because she didn't want to accidentally break her wound. In addition, some personalized problems such as breastfeeding and doing makeup is not covered. When we ran the think-alouds on Hebo - a post-op care app developed by last year's team, the first question raised by a female patient was when she can apply makeup after the surgery. It is important to identify s these concerns post operation to make patients feel all their worries are addressed.

Design opportunity: One idea we have was allowing nurses to input on an application/platform on how often a patient should be checked up on. Instead of having the patient reaching out to nurses, we want to make sure certain patients are given the care they personally need in order to have a smooth and comprehensive recovery process. Another idea was to create a database, where once a clinic is given a particular instruction, it will be recorded for future patients. This would help reduce the future redundant calls and improve efficiency for the clinic to treat more patients.

Visual representations and written out text are important for post-operative care for the predominant demographic of skin cancer patients

The current main method for patients to get additional postoperative assistant from the clinical staff is by calling into the clinic. Most of the time they struggle to get access to

the correct clinic and end up waiting for the clinic to call them back. Typically, the clinic staff does not receive the phone calls directly and waits for the voicemails to be wired to the specific staff member. During our interviews we found that only 1 of every 20 calls is something that needs to be responded to by the staff. An example they stated was that one of the phone calls was from an elderly gentleman who called post surgery because his knee was hurting.

Though once they do get a staff member on the line, they either attempt to remember the solution they were given and fully understand the solutions and then ultimately forget it after an hour, or write down the solution. One of the many examples that we received during interviews was a patient who spent over 30 minutes on the phone with one of the clinical staff members and wrote down all of the instructions she gave him. He then hung up the phone and had to call back 10 minutes later because he could not read his own handwriting. These are prime examples of how phone calls are not the best method for patients to receive post operative care.

We also found that during the interviews patients felt reassured sending in photos. Whenever they felt that the wound looked strange or was too red, they liked to send the doctor a photo and get reassurance from the staff that they were doing everything right. Though we found that doctors and staff do not prefer photos because they feel like they have to respond to it and something the photos are very poor quality.

Design opportunity: During our research, we noticed that patients felt more comfortable calling, even if the answer was provided on the information sheet. We want to be able to provide this personalized care through our solution. We also want to make sure that the only calls that the clinic is receiving are those that are not able to be resolved by information already provided to the patient. We need a solution that can know patients just as well or better than any of the nurses or doctors in order to provide that extra sense of comfort and reassurance. It should be able to keep track of a patient's relevant medical history and the specifics of their surgery in order to provide a post-operative care recommendation that better suits the individual patient needs. Our solution should also record all of the answers so that the patient can look back on it. We also want to have a multimodal solution that provides the information in many different ways since research has shown that elderly patients need multimodal education to fully comprehend new information. Lastly, a long term goal would be to connect myUPMC to the application so that patients can contact the doctor through the application if necessary. To combat the doctors not wanting to receive photos unless necessary, we can use an ML algorithm to compare against labeled photos and only send the photo to

the doctor if there is something to worry about.

Some patients hesitate to seek for help from family/staff due to personal reasons. (e.g. being too independent, not wanting to burden family, thinking they are probably fine)

Many of the identified pain points in the post-operative procedure focused on the times when parents call in to the clinic to ask for help. However, during our interviews especially with clinic staff, we found that post-operative care challenges not only come from times when patients ask for help, but also come from times when they don't ask for help. We digged deeper about the "why" behind this, and found various reasons from different answers from patients and clinic staff: some patients were too independent and don't want to bother other people, including their family, thus did not ask for help; some patients thought they were fine, and thus didn't call to the clinic or do anything. A clinic staff mentioned that there was once a patient with swelling in his nose after surgery, and it was so severe that he couldn't even breathe through his nose. However, since he thought it was fine as swelling is common post-operatively, he did not call the clinic to ask for help. By the time he came back to the clinic for the one-week check-up, he had to go over another small surgery due to the issue and thus his healing process was extended by two weeks. A number of nurses and physicians mentioned that they wished patients like that could more actively seek for help in the post-operative procedure, because if they don't, they might have to go over additional procedures and thus it would take longer to heal.

Design opportunity: For patients who are too independent to bother other people, a simple and convenient way to answer their questions is needed, thus they won't feel like bothering people when they seek for help. On the other hand, many "didn't call" cases were due to patients' inaccurate evaluation of their wound, thus letting patients know the severity of situation with their wound is extremely important. We can design a self-assessment tool for patients, and give them a rating of severity in cases of bleeding, pain, swelling, etc. Whenever the rating is above some threshold, the assistant would suggest them to take certain actions or check with the clinic for further help.

Patients want immediate response to their questions while clinic staff don't want their workflow to be interrupted.

After patients undergo Mohs surgery, they often have questions and concerns about their postoperative treatment. myUPMC, the online patient portal provides a guaranteed response in 48 hours, but according to our research, many patients want to hear an

immediate response. When a patient calls the clinic or sends a message through myUPMC, the physicians and nurses might be doing surgeries and not available to answer the patient's concerns immediately. Meanwhile, most clinic staff feel that phone calls can interrupt their normal workflow when they could be doing more surgeries and helping more patients. The nurses also mentioned that many of the postoperative questions are very straightforward and common among different patients. Most of the time they are answering the same questions over and over again.

Design opportunity: We noticed in the current postoperative phone calls, many of the questions and concerns from patients are duplicates. This causes lots of unnecessary workload to physicians and nurses and could interrupt their normal workflow. A solution could be designing a system that records answers to previously asked questions in the database and avoid forwarding the same questions to nurses and physicians. The system should only send notification to doctors or nurses when the question has not been answered before. This will provide immediate answers to patients for commonly addressed questions, and save time for clinic staff from answering duplicate questions.

Patients require simpler ways to find post-operative care dos and don'ts

From our research, we discovered that older patients prefer the reference sheet or speaking out loud to using a smartphone application. Since most of the clinic patients who undergo the surgery are the elderly, it would be necessary to incorporate a platform where older patients are able to ask for post-op instructions in a simple way. In addition, we have also found that some patients don't follow or are reluctant to follow instructions. When it comes to changing bandage which is a lot more complicated than taking medicine, some patients will think that it is better to have professionals do it instead of doing it themselves. They will then either set up a new appointment with the clinic or delay the bandage changing, which would either increase the clinic's normal workflow or cause consequences such as wound infection. Another finding we have is that only about 10% of the questions asked on the phone are not addressed in the instruction sheet. The redundancy in calls have caused frustration and inefficiency on the clinic's end. If the time can be freed up, hospital staff will be able to assist more patients in the clinic.

Design opportunity: Moving forward with our design, we wanted to develop a platform that allows users to not have to interact with an application if they want to. For example, platforms such as Alexa or Google Home allow a user to ask questions without having to open an application on their phone. In addition, we wanted to have our post-op care assistant keep checking on patients to make sure certain important wound care steps

are being strictly followed, such as changing the bandage 48 hours after the operation. To address the problem that most patients who call in ask questions that are already on the instruction sheet, we wanted to generate common questions that the patients might have from the instruction sheet so patients can refer to them by simply interacting with the assistant rather than call in to the clinic. We could also translate the medical instructions into more straightforward, easy to understand explanations for patients to access later. To better supplement the text, details and visual representation could also be useful for patients to better understand the post-op instructions.

The predominant demographic of skin cancer patients, the elderly population, calls for an emphasis on accessibility and simplicity.

While skin cancer can affect a wide demographic of patients, the most popular groups impacted are those ages 60 and older. We found that this population exhibit low proficiency of new technology, specifically, there needs to be a simplified user experience. Many elders have some form of impairment in regards to their vision, hearing, motor, or cognitive abilities. It is common for presbyopia to set in starting around the age of 40, where the lens of the eye begins to harden, increasing difficulties of reading small and close text. Color vision also deteriorates over time, making shades of colors, especially blue, more difficult to distinguish from one another. In regards to hearing, a condition known as presbycusis causes hearing-loss as age progresses. According to the National Institute of Deafness and Other Communication Disorders, approximately one in three individuals in the United States between the ages of 65 and 74 has hearing loss. Motor impairments, for example arthritis, is also typical of elderly populations, making precise motor control movements difficult to achieve. In terms of cognition, short-term, episodic, working, and prospective memories are known to deteriorate as age progresses. Issues with memory can be especially challenging in relation to the post-operative experience.

 Although technology is moving towards improving the accessibility experience for those with impairments, there is a lot of room for improvement. During the interviews we found that elders have a positive view towards technology, one patient even noted, "I am open to any new technology coming down the road, if it makes the patients like me better then why not." Though there is a significant amount of disconnect because there typically is no welcoming support to connect elders with how to use certain technologies and many feel uncomfortable and hesitant to experiment. Overall, our research has shown us that designing for an older age group will be accompanied by an inherent need for a more accessible and basic product.

Design opportunity: Moving forward with our design it is important to consider these accessibility issues for elderly patients. As a team we need to consider to what extent we would emphasize simplicity and accessibility in whatever solution we pursue. The aspect of accessibility could take into consideration impairments of vision, hearing, motor, and cognition. This need stems from an older patient potentially not being familiar with the type of technology. Moving forward, we can consider looking at solutions based on what forms of technology provide the most accommodations for accessibility and what impairments we want to cater to for our target user base.

Conclusion

Guiding Questions

1. What media and design will be best to communicate post-operative care to patients?
   - Since many of the skin cancer patients struggle with other impairments and familiarity with technologies, a major concern moving forward is knowing what medium would best allow us to communicate post-operative care effectively to the patients. It is also important to understand the needs of the doctors and nurses, specifically in administering the post operative care instructions. We plan to brainstorm various methods of communication, and to validate these methods by utilizing rapid prototyping methods, such as paper prototypes and storyboards in our next phase.
2. How can we ensure that the solution provides as much reassurance as a physical phone call to a nurse?
   - From our findings, personalized care and the human factor of the post operative care calls play an important role in reassuring patients of their issues. Achieving this level of reassurance is crucial in maintaining the quality of care provided by doctors and nurses. A guiding question we wish to explore is how this reassurance and care can be sustained and potentially improved, but with a decrease in patient to nurse phone calls. We plan to explore what aspects of a post operative care call creates that level of reassurance for patients and how this could be replicated within our assistant.
3. How can we engage and teach patients?

- A potential area to look into is research of effective learning and teaching methods. The current way of delivering post operative instructions encounters varying levels of effectiveness. An essential part of our solution should help engage and teach patients about the post-operative care process, so that they have a better understanding of what they should do when they encounter problems.
4. Will our solution require more HIPAA compliance as we start to collect more information and seek out a need for a patient-personalized solution?
   - Our solution needs to be compliant with HIPAA and respect patient healthcare regulations. If the solution moves toward more personalized care for the patients, we would need to follow HIPAA regulations. As we begin to prototype and explore a solution, we need to keep in mind any external factors that are impacted by our designs and implications. A potential design idea is to incorporate myUPMC into our application which will require HIPAA compliance.

Early Design Ideas

Based on the pain points and insights from our research, we vision our potential solution to be a care assistant that
- Generates answers to common questions that patients might have from the instruction sheet or previously answered questions
- Gives verbal and text instructions supplemented by visual representations
- Has regular timed reminders that keeps checking on patients and reminds them to change bandage / apply Vaseline / clean wound / come to clinic appointments / cannot do heavy lifting
- Uses straightforward, easy-to-understand instructions and encouraging words to let the patients know they will heal faster if they follow the instructions carefully and regularly go back to the clinic to check their wounds
- Provides an accurate assessment of patient's pain / bleeding / swelling condition
- Allows patients to take photos of their wound and compare to previously labeled photos in the database using machine learning
- Connects to myUPMC so that patients can send message to doctors with questions not been answered before / photos of wound condition that the assistant cannot diagnose automatically
- Has caretaker be able to log into the application and see instructions
- Provides a simple interface that even the elderly patients who are not familiar with technology can feel comfortable interacting with

A list of potential technologies from our brainstorm session includes:

1. Conversational User Interface
    - According to our research, many elderly patients are not familiar with the smartphone applications. Conversational User Interface, such as Amazon Alexa and Google Home, is an extremely simple interface that provides the most straightforward interactions.
    - 50% of the patients at UPMC already have or are going to have Amazon Echo (Alexa) at home. Every waiting room in UPMC now has a Echo device. This provides nurses an easy way to teach the patients how to install and interact with the assistant.
    - The smart speakers are more affordable than smartphones and wearables.
2. Wearable Device
    - The wearable device such as Apple Watch or Fitbit has a conversational interface that allows patients to ask questions directly.
    - The patients have wearable device with them all the time compared to smartphone or smart speaker, so they can interact with the assistant anywhere and anytime.
    - The wearable device measures the patient's vitals information (heart rate, blood pressure, etc.) which can be utilized to design more personalized care instructions.
    - The drawback is that most of the patients do not own a wearable device and it is more expensive than smart speaker.
3. Smart Home
    - A combination of mobile / tablet interfaces and smart speakers (Amazon Alexa / Google Home).
    - The mobile / tablet interfaces are for more complicated input or output, such as images.
    - The smart speaker is for delivering simple verbal instructions.
    - The advantage of this combination is that while maintaining a simple interface to elderly patients, it also allows for visual representations that supplement the verbal explanations.
    - One drawback is the setup will be more complicated than a standalone Conversational User Interface or mobile app.
4. Wound Care Tutoring App
    - A mobile application that teaches the patients and their caretakers how to take care of themselves after surgery.

- The tutoring app can be designed to be engaging and explain postoperative care instructions in a straightforward, easy-to-understand manner.
- The tutoring app can also teach caretakers about important things to notice during postoperative process, and how to take better care of the patient.

Next Steps

At this point, we have performed a significant amount of research, gathered insights, and generated a list of early stage design opportunities and potential technologies. Our next phase in the development process involves finalizing on the technology idea and brainstorming potential designs of the final product. This will be an iterative process in which we will vision our design ideas, create storyboards, test with users and keep iterating on our design. For each iteration we will perform walkthroughs of our storyboard with the stakeholders in order to determine whether the design idea fits their need. Finally, we will create paper prototypes for several solutions that we want to continue exploring, and perform user tests with the paper prototypes.

Once we decide on which technology to use (CUI, mobile, smart home, etc.), we will further explore potential platforms, tools and APIs for our final implementation.

Appendix I: Heuristic Evaluation for Hebo

HE-01: Speak button lack feedforward and feedback *(Level of Severity 3/3)*

This violates both the "**visibility of system status**" heuristic and the "**help users recognize, diagnose, and recover from errors**" heuristic. The button only has a static circle and does not have any feedforward for users to click the button, some users might not be aware that they need to click on the button for it to recognize speaking. Also, there's no indication of its status, so users have no idea if it's recording or not. Better indication of the recording status is needed. More visual hints for users to click the button and then start speaking is also necessary.

HE-02: Some messages are too long and do not fit in screen *(Level of Severity 2/3)*

This violates the "**flexibility and efficiency of use**" heuristic. Some messages are extremely long and could not fit into the screen, thus users need to scroll down to see the rest of the instructions. However, this could be easily overlooked and it's inconvenient to scroll back and forth. Better deliverable of instructions is needed - either shortening the text or organizing them in a more easily perceivable way.

HE-03: Talking speed of app is slightly too fast *(Level of Severity 1/3)*

This violates the "**user control and freedom**" heuristic. Although the talking speed of the Hebo app might be acceptable to younger people, for a big part of its target audience the speed of talking is slightly too fast. Elder users might find it hard to follow, especially when the messages contain professional terms and information like wound care. It would be nice to allow users to adjust the speed of talking of the app, and potentially reiterate important tasks to do in cases of long and complicated instructions.

HE-04: Too many error messages displayed to users *(Level of Severity 1/3)*

This violates both the "**help users recognize, diagnose, and recover from errors**" heuristic. Right now the error messages tell no information about the error or how they could better phrase the questions for the app to understand. When patients' questions could not be answered and they keep seeing the same error messages on the screen, they might get extremely frustrated and give up using the app. Thus, more directions of how they could better ask questions or alternative suggestions might be helpful.

Appendix II: Card-Sorting and Synthesis Session
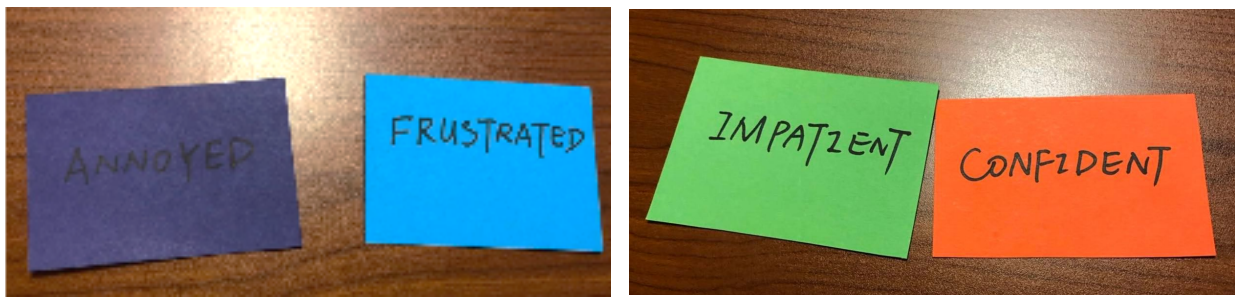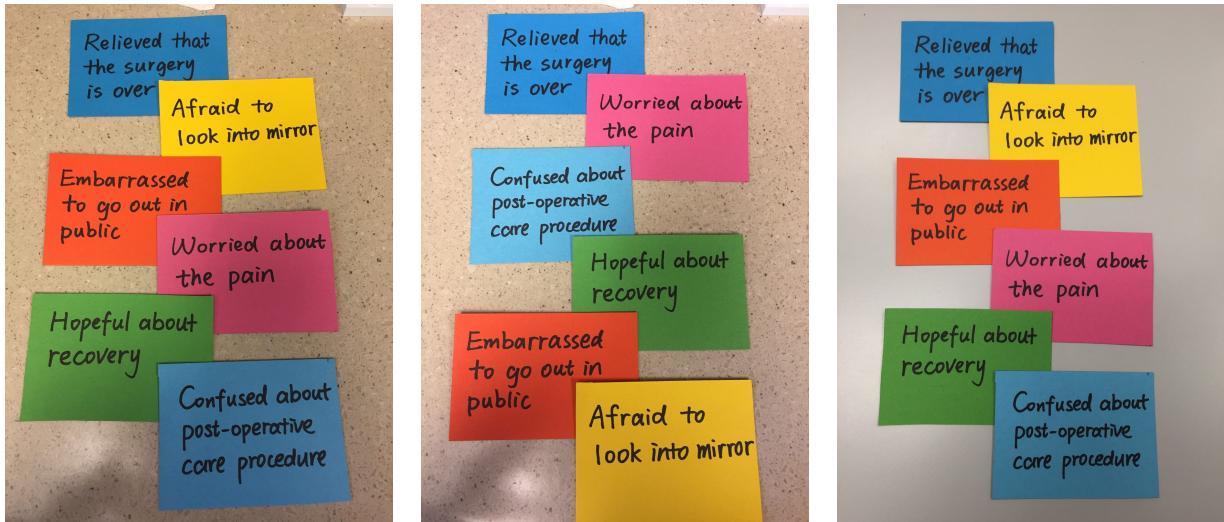
Card Sorting Activity During User Research
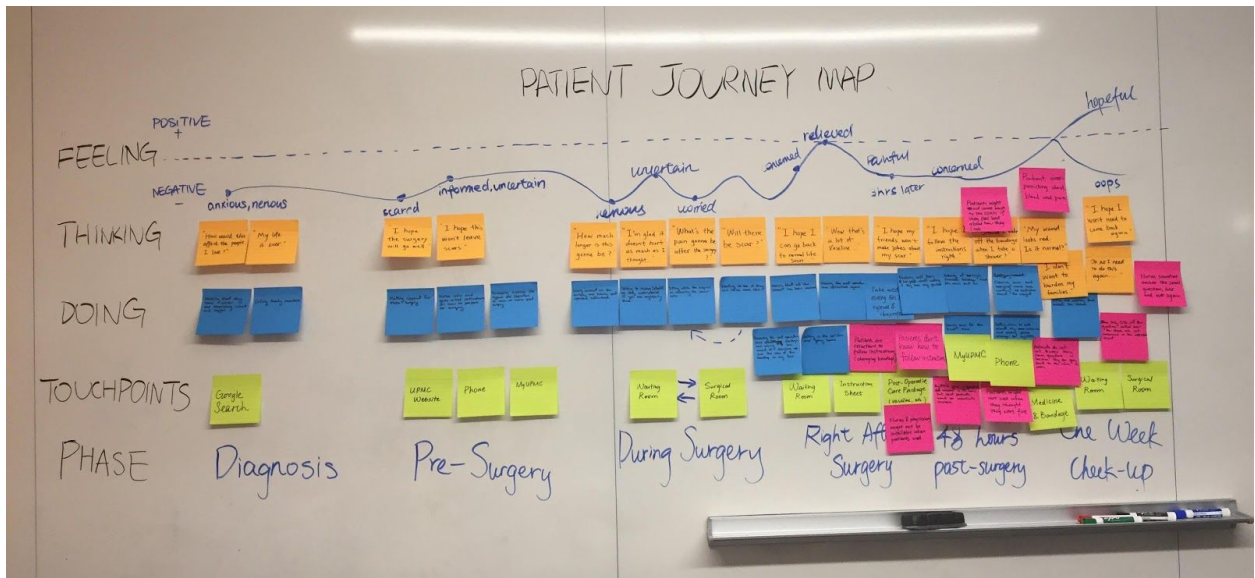
Synthesis Session for Customer Journey Map and Pain Point Identification

Appendix III: Interview Scripts and Questions

Doctor/Nurse

 Hi I'm _____. I'm part of the CMU HCI Research team that is working with Dr. Carroll to research and work to improve the post-operative care process. What that would mean for you in this context, is that by conducting this research, we hope to find a solution that can ___(what the solution will do for this stakeholder)___. So I have the option to record and/or take notes. Would you be okay with being recorded for now? (If yes, record and take notes; If no, take notes). Alright first of all I want to clarify that this data will remain completely anonymous. What that means is that any names or identifiable data taken in this interview will be thrown away and not used, so once we complete this study, none of our data will be able to be linked back to you, and none if it will be published. So to explain a little bit about what will happen during this interview. We want to know what __(e.g. Life is like for you as a nurse). We will shadow you for __(fill in time)__ to understand what your day is like uninterrupted. Once that time is up and we can get a chance to talk, we will ask you some questions about your experience, what we observed, and what you were thinking along the way. Please make sure to tell me any and all details. Something that might seem trivial to you could be really important to our research! Do you have any questions?

Okay, as long as you are still willing to participate in this study, let's begin!

Patients

Hi I'm _____. I'm part of the CMU HCI Research team that is working with Dr. Carroll to research and work to improve the post-operative care process. We would like to ask you questions about your experience after surgery.
Would you be okay with being recorded for now? (If yes, record and take notes; If no, take notes).
Alright first of all I want to clarify that this data will remain completely anonymous. What that means is that any names or identifiable data taken in this interview will be thrown away and not used, so once we complete this study, none of our data will be able to be linked back to you, and none of it will be published. Please make sure to tell me any and all details. Something that might seem trivial to you could be really important to our research!
Okay, as long as you are still willing to participate in this interview let's begin!

Start out with [Tell me a bit about yourself and the surgery you have just undergone...]

Shadowing for Physicians and Nurses

1. Recount any questions or clarifications you wanted to get out of certain processes that happened during your observation of the patient
   a. I noticed that you did __. Why did you do that?
   b. What were you thinking when this happened?
   c. How often do you have to do this?
2. How would you compare what happened today to any other typical days at work?
3. Which daily tasks are the most time-consuming? Which are the most essential to your job?

Interview questions for physicians/nurses

Can you tell me...

1. What did you do yesterday?
2. About how many calls do you get from patients per day/per week?
3. From Monday through Thursday, what's the most memorable call you got?
4. How do you feel about the calls overall?
   ○ Tell me about the past phone call you responded to
   ○ Card sorting exercise
     ■ Annoyed
     ■ Frustrated
     ■ Impatient
     ■ Interrupted
     ■ Anxious
     ■ Helpless
     ■ Calm
     ■ Confident
     ■ ...
5. How does/did calling patients affect your workflow?
   ○ What were you doing right before/right after the phone call?
6. What are the three most common questions patients have?
7. In your opinion what are the benefits of being able to call your patients? What are the negatives?
8. What's the most stressful part of your job?
9. How do you feel about calling patients, as opposed to them calling you?
10. Which part of your work is the most stressful? Which part do you enjoy the most?
11. What concerns you the most in current post-operative care procedures?

12. Do you think the patients are fully equipped to conduct the post-operative care process
13. What are the three most common post-operative care questions/concerns from the patients / nurses?
14. Can you describe the patient you called in last? Demographics, Caregivers, Independence Level, and Tech savviness?
15. What kinds of information are usually best remembered? Worst remembered?

Interview questions for patients

Pre-Surgery

1. What did you do before your surgery?
2. What are you most concerned about going into the surgery?
3. How did you get here today? Did someone come with you?
4. Have you ever had a similar surgery in the past? Tell me more about it.
5. Did you have a phone call consultations? What did the nurse tell you about the surgery during the call?
6. Are there questions you have that you feel like you can't talk to your nurses/doctors about? Can you tell me about it.
7. Do you feel you understand the procedure you are about to receive?
8. What are you most excited about after the surgery?
9. When would you seek for help from nurses and physicians?
10. Do you have a smartphone? Do you use it make calls or for other things too? Have you heard about Alexa?

Post-Surgery

1. How long ago was your surgery? Can you tell me more about your experience that day?
2. What did you do right after surgery?
3. How did you feel after the surgery? What were your concerns/thoughts after surgery? What did you do when you had these concerns?
    a. Card-sorting exercise
        i. Afraid to look into the mirror
        ii. Embarrassed to go out in public
        iii. Relieved that the surgery is over
        iv. Worried about the pain
        v. Hopeful about recovery

        vi.   ...

4. How did you take care of your wound?
5. Did anyone help you with your recovery?
6. How did you feel about the instructions given to you after surgery?
   a. When did you receive these instructions?
   b. Did you look at the instructions after you left UPMC?
   c. Do you know about MyUPMC and have you used them? Would you prefer online chatting with or phone calling nurses, and why?
7. Why are you back in the office today?
8. How did you feel about the post-operative care process?
9. Do you have any fears that you keep to yourself about the surgery? Can you tell me more about it?
10. What are you looking forward to the most when you walk out of the hospital?

Appendix IV: Interpretation Notes

D: Doctor; N: Nurse; A: Assistant Physician; P: Patient

Note Number	Note
D1-1	She is responsible for on-call, taking calls at night for the entire department.
D1-2	The calls are directly from patients in the evening.
D1-3	Other ways for patient to contact the hospital: Phone call to office -> nurse write down question -> email physician
D1-4	Other ways for patient to contact the hospital: Patient email securely through myUPMC.
D1-5	She sometimes needs to redirect calls to the physician who is responsible for the patient.
D1-6	Most memorable call is a patient who calls in to refill his medicine. But the doctor cannot refill his medicine without his labs (blood test) done.
D1-7	They always tell the patients who need to refill high-risk medicine should have their labs done first. But still many patients fail to do so.
D1-8	The patient who wants to refill medication explains that he is not feeling well so he didn't do the labs (blood test).
D1-9	She usually checks Inbox in the morning to see if there's any patient calls she can reply.
D1-10	Some patient calls take 30 min, which can be a significant time sink.
D1-11	In general answering phone calls doesn't affect her job workflow to see patient 1-on-1.
D1-12	She sometimes feel drained to stay late after work and spend extra hours (3hrs) answering phone calls.
D1-13	She does not get reimbursed for these phone calls after work time, but will get extra money for seeing patient in person.
D1-14	When answering phone calls, she needs to document the electronic records for patient, an administrative step that takes time too.
D1-15	She doesn't get paid for documentation of patient phone calls either.
D1-16	The 3 hr phone call after work includes patient calls, pharmacy calls, pathology reports ready and she needs to call patient, lab results ready and needs to tell patient.
D1-17	She again emphasized the burden of documentation. Usually one phone call take 5-10 min and documentation takes another 5-10 min.
D1-18	Some patients like to tell doctor what's going on in their lives, and these calls can take 20-30 mins long.
D1-19	A call she got yesterday, the patient tells her all stuff going on in her family about their decision on this treatment.

D1-20	Some elderly patient call them just because they want to find someone to talk to.
D1-21	Sometimes an open question can lead to long calls. She start asking if the patient feels pain, was meant to be pain after surgery, but patient redirect conversation to complaining about her joint pain.
D1-22	She doesn't like to talk on the phone and would rather like to see patient and talk in person.
D1-23	She feels depersonalized at times when she is exhausted at the end of her day and needs to pick up her kids, but receives long calls from patients.
D1-24	She feels interrupted when receiving phone calls because she cannot go home after a long day of work.
D1-25	She feels impatient when the patient is talking too much on the phone about irrelevant things.
D1-26	She feels annoyed when she thought she made the instructions clear, but patient does not understand.
D1-27	She feels frustrated when she is covering her some other physicians, and she doesn't know if she should give instruction to patient from her own perspective or from the other physician's perspective.
D1-28	Most common question from patient: medication is not covered by patient's insurance, or is too expensive for the patient to afford.
D1-29	She gave prescription to a patient in January, and only to find in February that the patient's family's combined income cannot afford the medication.
D1-30	She cannot predict as a provider, which medication is covered by the patient's insurance.
D1-31	It would be ideal if there is an electronic medical record that allows doctors to know how much cost of the medication is covered by the insurance and how much needs to be paid by the patient.
D1-32	If at the frontend the system can let doctor know about the price of med on patient, she would ask if the patient can afford the price at the beginning. If would save her so much work to offer alternatives.
D1-33	Another common question from patient is about post-operative care.
D1-34	After surgery, many patients feel worried about the pain and wound becomes red.
D1-35	Patient's questions about post-operative care are usually straight forward.
D1-36	The third common question from patient is to refill medication.
D1-37	A patient saw her 6 months ago calls and asks if she can refill his medication, but she had told the patient to follow up after 3 months, and the patient never showed up, which makes her frustrated. Because the patient should recover much faster if he comes in regularly.
D1-38	The frustrating part about she calling the patient is that 8 out of 10 calls the patient

	doesn't pick up, and she gets voicemail.
D1-39	Some patient's voicemail is full and she cannot leave a message.
D1-40	If a patient doesn't pick up her phone call, she needs to keep calling in morning, during lunch time, and at the end of the day.
D1-41	In the meantime, the patient might call nurses, but the doctor is not available at that time, so she keeps a list of patients to call back.
D1-42	She likes calling patient to tell them about the plans of treatment and the results.
D1-43	Sometimes result can get lost in mail, so she prefers calling patients and tell them directly to make sure they get the result.
D1-44	The great part about myUPMC is that messages from patients gets straight to her (doctor).
D1-45	The patient who calls hospital needs to first listen to a pre-recorded message and then nurse transcribe the question and route the call to doctor. Some calls get routed to the wrong doctor.
D1-46	Some patients don't know how to route in the process of phone call so cannot get their questions answered.
D1-47	Most patients do not abuse myUPMC message compared to phone calls.
D1-48	myUPMC routes results securely.
D1-49	The frustrating part of myUPMC is doctor can see if the patient opens her message.
D1-50	She has some patients who called in and asked for results, but do not open the message in myUPMC. She is confused why they don't open the message.
D1-51	She also feels afraid to see her patients not read her messages on myUPMC.
D1-52	The most common post-operative question is about pain management.
D1-53	Sometimes when the patients said they feel pain after a relatively long period after surgery, she will be worried about if the patient gets infection.
D1-54	Another common post-operative concern from patient is about infection.
D1-55	Some patients call in are worried about their wound looks red, wound drainage, pain or swelling. The patient doesn't know if these are normal or not.
D1-56	Very rarely will the patient ask question about bleeding when they take off dressing.
D1-57	Things that concerns her the most: the doctors and nurses already put lots of energy in educating patient about post-operative care procedure, but patient still have questions.
D1-58	She is concerned that some patients won't call her even if they don't fully understand how to take care of themselves.
D1-59	Doctors are worried that improper post-operative care would cause harm to the patient, get infection, etc.

D1-60	A patient who came in today had surgery on his ear. He asks if he should leave on the bandage while taking shower, which means he didn't clean the wound for 2 weeks after surgery, but he never calls the hospital to ask.
D1-61	She thinks it would be good for patients with legitimate questions to call, and would like less calls about irrelevant questions.
D1-62	There is information written explicitly in the paperwork for patients that they should clean their wound 24 hrs after surgery, but probably doesn't go into details like "take your bandage off when taking shower".

D2-1	He feels concerned for patients' well being when he received phone calls.
D2-2	He feels confident that he can answer patients' questions.
D2-3	He needs to be calm on the phone because patients may have legitimate concern.
D2-4	Bleeding is not rare but also not too common.
D2-5	He feels that there's a need to coach patients that bleeding is common for forehead flips.
D2-6	Some family members freak out when they see blood.
D2-7	Frequently when patients have a little blood that's normal to doctors, patients think there's blood everywhere.
D2-8	Physicians need follow-up questions to make sure how much blood is there actually.
D2-9	Bleeding is a common question he received as a physician.
D2-10	Pain is another common question.
D2-11	It's very rare that patients who follow instructions have unexpected pain or bleeding.
D2-12	Ice and elevation are good treatment for swelling.
D2-13	Some patients ask when to change dressing.
D2-14	Some patients ask what to do if area of dressing is bleeding.
D2-15	Some patients ask what to do if dressing comes off.
D2-16	A patient had swelling and air could flow through his nose, but he did not call because he thought it was not a big deal.
D2-17	The patient's (swelling in nose) healing could have finished if he called in 24h.
D2-18	He's glad when patients call in with legitimate concerns.
D2-19	He's not happy when patient calls in with unimportant issues.
D2-20	He thinks patient self-assessment is higher accuracy than photos due to the quality of pictures.

N1-1	There are about 5-6 surgerys a day for a full schedule.

N1-2	Patient X did not want to read the wound care sheet and called and asked when they're suppose to take Tylenol.
N1-3	N1 feels calm but also interrupted when taking calls.
N1-4	Most common questions are when to change the dressing, pain control, and what kind of bandage to use. All are listed on the information sheet.
N1-5	N1 calls patients to make sure they don't have any questions and to make sure they are doing everything correctly.
N1-6	Sometimes takes a week to see myUPMC messages.
N1-7	D2 and A1 are not listed in the myUPMC app to be able to message.
N1-8	Millenials do not like calling
N1-9	N1 wants to spend more time working with patients.
N1-10	Patients forget or are too afraid to wash wound.
N1-11	Some patients don't call in because they did not want to even though the wound is red and swelling.
N1-12	Having someone with them to help them with memorizing the instructions really helps patients.
N1-13	N1 talks to the patients about current events/weather/family to get an understanding of their cognitive ability and if they will need additional assistance
N1-14	The worst remembered things is using ice.
N1-15	N1 wishes the care sheet was better
N1-16	Patients sometimes forget their appointments
N1-17	For patients that need extra assistance they schedule more appointments to help them change their bandage and clean their skin.

N2-1	Most of the operation procedures are in the morning.
N2-2	In the afternoon, there are usually skin checks and random procedures.
N2-3	He's only responsible for picking up phone calls during working hours and doesn't have on call duty.
N2-4	He feels impatient when he gets interrupted by the phone calls.
N2-5	He feels confident that he has the knowledge to answer patients' questions.
N2-6	A patient called in last Friday but didn't get answered until this Monday - the questions could have been answered in a few minutes.
N2-7	A common question is "When am I supposed to take off this dressing?"
N2-8	Another common question is "Do I take off the dressing when I shower and should I wash the wound?"
N2-9	For most wound care questions, nurses can answer immediately without referring to

	other documentations.
N2-10	When nurses pick up phone calls, they have a chart information of patient in front of them.
N2-11	Nurses sometimes also ask for more details when patients ask questions on the phone.
N2-12	Nurses go over the instruction sheet with patients before they leave.
N2-13	Nurses call later in the day of surgery to quickly check if everything is ok.
N2-14	Some patients need family members to come in order to have another party who can understand the instructions.
N2-15	Some patients pretend that they understand the instructions, but actually don't.
N2-16	When the clinic has high volume of patients, answering calls becomes difficult.
N2-17	When someone calls, it's hard to know if it's a 2-min or 20-min call.
N2-18	Some patients had barrier of communication and require more explanation.
N2-19	Some patients forget to apply vaseline after showering.
N2-20	He doesn't know how to stress to the patient that bandaging is very important.
N2-21	Some patients take of bandage because it's inconvenient.
N2-22	Some patients take of bandage because it's uncomfortable.
N2-23	Some patients forget to put bandage back on.
N2-24	Some patients take of bandage because adhesive can be irritating.

A1-1	She sometimes does secretary work
A1-2	She has a large workload including treating patients, checking on patients etc
A1-3	She sometimes has to repeat calls when patients forget what was discussed
A1-4	She was annoyed by the calls bc sometimes it wasn't needed
A1-5	She was confident that she could answer all the questions coming from the calls
A1-6	The calls slowed her workflow down bc she couldn't give clinic help to other patients
A1-7	Most stressful part is to coordinate everyone's care
A1-8	She enjoys being a large part of the taking care of the patients
A1-9	She wishes there's a scheduler to answer calls
A1-10	She wishes there's a way to follow up with regular dermatology
A1-11	She wishes the patients could access someone 100% of the time

A1-12	Patients sometimes ask questions that's already on the instruction sheet
A1-13	Patients can remember physical restrictions best
A1-14	Patients don't always know the best way to follow instructions if they're not step by step
A1-15	She wishes to on an ideal workday, catch up on scheduling and do as many surgeries as they could

P1-1	The surgery was painful for the patient
P1-2	He felt the instructions were very good
P1-3	He received the instructions before and after
P1-4	He didn't have the need to follow up with the nurse
P1-5	He is open to any new technology to assist the post-op process
P1-6	He felt regretful that he didn't catch the problem earlier

P2-1	Pre-surgery, patient was instructed to clear off the day
P2-2	Surgery could be anywhere from 1-8 hours
P2-3	There was some minor discomfort but not pain
P2-4	Patient felt bummed about her appearance post surgery
P2-5	She knew the importance of taking care of wound properly post surgery
P2-6	She used MyUPMC to send a picture of her wound to her nurse
P2-7	She called in to the clinic to make sure they received the pic
P2-8	She read about the surgery expectation prior to coming into the clinic
P2-9	She wants a response faster than 48 hours
P2-10	She was able to follow the instructions well
P2-11	She found everything on the instruction sheet
P2-12	Some people might get nervous about specific instructions (e.g. cutting bandage)
P2-13	She received all the numbers she needed

P3-1	A1 called P3 regularly and they asked them questions then
P3-2	Instructions told P3 everything they needed to know about how to take care of the wound
P3-3	P3 does not use myUPMC but knows some people who do
P3-4	P3 uses siri on their iPhone and is open to new technology
P3-5	P3 felt all of his concerns were covered by the instruction sheet
P3-6	P3 continued to talk to A1 about the redness of his wound and when to stop using

	cream.
P3-7	P3 had his wife at the surgery with him.

P4-1	His daughter in law came with him on the day of surgery.
P4-2	He went home right after the surgery and the drive was about 4 hrs.
P4-3	After he got home, he laid down.
P4-4	His daughter in law helped take care of him with changing his dressing etc.
P4-5	After surgery he has a little bit of anger and nervous, but nothing serious.
P4-6	He looked at the instruction sheet after surgery, the most helpful information is how to take care of the wound.
P4-7	There's nothing he wished was on the sheet that wasn't covered.
P4-8	He doesn't have a computer so never used myUPMC.
P4-9	He had a little drainage so he called in last week to asked about that.
P4-10	He described the overall surgery and post-operative process is good.
P4-11	He is not familiar with technology. He doesn't have smartphone or computer.
P4-12	He thinks the hospital stuff did a great job.
P4-13	The nurse said the patient did not take good care of himself, which was different from what the patient described.
P4-14	The patient is overwhelmed with family issues (his son died and he has a high-risk cancer), so he wasn't taking good care of himself.
P4-15	He didn't follow the doctor's instruction (no lifting) and still did heavy lifting on the farm, which caused his stitches pop open and dry blood everywhere around the wound when he came in a week later.
P4-16	The patient is very independent and he doesn't let his daughter in law to do the farm work for him.

P5-1	P5 was nervous and tired prior to surgery
P5-2	P5 needs to set up childcare for her 3 children
P5-3	P5 had a phone consultation and received a letter in the mail prior to the surgery.
P5-4	P5 is very technologically savey.
P5-6	P5 uses myUPMC but has not used it for this surgery.
P5-7	P5 is afraid of the scary post operation.