Childhood Cataract

Patient Record System for Africa

MS-HCI Project Report

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M.S. in Human-Computer Interaction

1. Introduction:

In Africa, although the numbers are small, childhood blindness remains a major problem since the impact of blindness on children lasts a lifetime. Furthermore, it is estimated that 60% of children die within a year of going blind [1]. Over half of the childhood blindness in Africa is caused by congenital cataracts, which can be corrected if caught early. These children need to be operated as early as possible to ensure that the development of the visual part of the brain has enough and correct visual input. The follow-up examinations are also important, as children's eyes will need new pair of glasses or treatments for optimal correction at different growth stages. Currently, in many African countries, the medical data are collected manually with pen and paper. The drawbacks of this approach include: data integration is tedious, searching for patients in the records is time consuming, and hard to maintain consistency.

2. Background:

There have been considerable efforts by governments, non-governmental organizations to use Information and Communication Technologies to help strengthen the health care system. Broad categories of interventions include informing populations about health issues [2, 3]. Partnering with Emory Global Vision Initiative, we seek to design and develop a system to facilitate the cycle of "early referral", "treatment", "follow up" and then "rehabilitation" to deal with the childhood blindness problem in Africa. We also envision the system to help collect and calculate the statistics from the medical data so as to potentially stimulate the data sharing between different research groups internationally for improving the medical research. The design of the system would base on current experiences from the pediatric hospitals in Africa to fit, complement, and strengthen their existing and real work practices.

3. User Requirements:

Before jumping into ideation phase of the project regarding design ideas, technology choices, or possible interactions of the system, we have to ask about the users and the stakeholders: who they are, what characteristics they have, and then link back to the problem that we are going to solve. Since the service system is designed for the medical staffs or health workers in various African countries, the instrument selected for collecting data is

limited to be done through Skype call interviews and discussions. The collected data is analyzed mostly following contextual design approach since we are more interested in capturing the contextal information regarding the rationale or the motivation behind a specific tactic or decision being made in order to get the context in a holistic manner.

We started by understanding how medical staffs from Kilimanjaro Christian Medical Centre (KCMC) in Northern Tanzania accomplish their daily work practices. Rather than asking directly about their expectations for the system, we wanted to identify the challenges encountered during their daily tasks from learning about the existing workflows and their feedback about the existing systems or tools they currently applied.

We listed all of the types of stakeholders that may influence this project including their characteristics and how their roles may impact the project:

- **Emory Global Vision Initiative**
  - The hub connects Georgia Tech, community volunteers, and the medical teams in African countries. The system will be deployed in various African countries and be jointly maintained by Emory and Georgia Tech.
- **Ophthalmologist/Coordinators in Africa**
  - Apply this system to electronically record patients' personal information, surgery details and schedule the follow-up visits.
- **Community Volunteers**
  - Visit households and utilize this system to refer potential patients by sending patient information and geographic locations to the server in pediatric hospitals.
- **Patients and Their Families**
  - Although not directly interacting with Georgia Tech, patients are also the focus of the project by helping them improve healthcare accessibility. The system contacts patients directly or through the social hub for notifying the referrals or follow up visits.

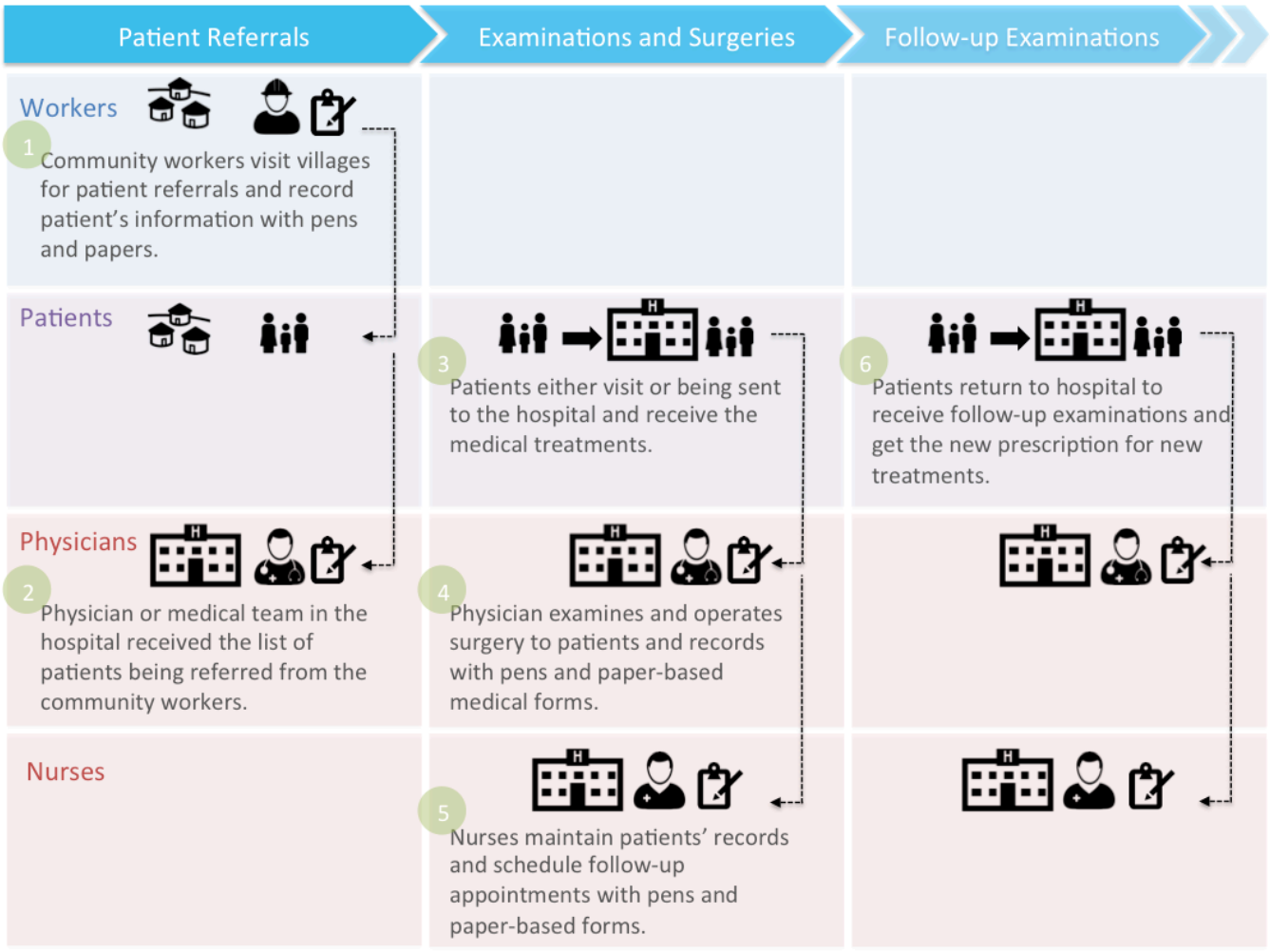

Figure 1. Current workflow of pediatric ophthalmology in several African countries

There are three primary categories of workflow for this project, patient referrals, examinations and surgeries, and follow-up examinations.

The first workflow is "patient referral." Due to limited resources, hospitals in many African countries usually serve a large area of residents. Therefore, the medical team collaborates with local volunteer workers who identify potential patients by visiting households. The workers note down patients' information on spreadsheets with pens, and bring the patient referrals back to the medical team. One of the physicians from Northern Tanzania mentioned that in some cases it is very difficult for workers in the field to record patients' location due to lacking of street address.

The second workflow is more about the practices at the hospital. Once the patient arrived the hospital, the physician examines and performs surgery. And all the examinations

and surgical records are taken down with pens on the paper-based medical forms. One of the physicians from Emory who has worked in Africa pointed out that this is challenging for maintaining the data correctness or data retrieval, because different physicians or medical staff may spell words differently and introduce the difficulty to data consistency.

One important context of pediatric ophthalmology is that children are still growing including their eyes; hence, they need regularly return to hospital for follow-up examinations and new prescriptions. The third workflow is about follow-up appointments and examinations. Before discharging the patient, the medical staff schedules the next follow-up visit (usually around six weeks later) for the patient. The patient ideally should return hospital on time, but most of the physicians during our interviews/meetings indicate that the return rate for follow-up visit is relatively low in most African countries. They all agree that multiple reasons could lead to this result, but we can brainstorm a way to remind patients, make them feel the medical team does care about them, or let them realize the importance of the follow-up examinations.

In order to ensure better referral, recording and follow-up of children with congenital cataracts, the system is envisioned to include several different components of the continuum of care for these children. The target users of the system include the local volunteer workers who referring patients in the field, the medical team inside the hospital who recording the medical data and scheduling the follow-up visits. The system requirements can be summarized to meet the workflows below:

1) Patient Referrals –

1. Community workers visit villages for patient referrals and send patients' information by SMS to the web service.
2. Physician or medical team in the hospital retrieve patient referral list and their visiting status on the web page with the tablet or laptop.
3. ** Patients will routinely receive SMS indicating they've been referred and encourage them to visit the hospital soon.

2) Examinations and Surgeries –

4. Patients either visit or being sent to the hospital and receive the medical treatments.
5. Physician examines and performs surgery to patients and records medical data on the tablet.
6. Nurses maintain patients' records and schedule follow-up visits on the tablet. The

web service will send SMS reminders to patients.

3) Follow-up Examinations –

7. Patients would receive SMS before or routinely for the upcoming or missed appointment to encourage them returning to the hospital.

After we gathered the context information about the workflows from different types of stakeholders, we depicted users' work practices as a customer journey map to show the users' requirements and the problem that we are trying to deal with. (See Figure 1.) And then we walked through the diagram together in the meetings to make sure everyone agreed with how the diagram captured their work and needs. Finally, based on the data and feedbacks we had, I started to look for the suitable technologies that can be used to support users and ultimately benefit children with congenital cataracts in Africa.

4. System Design:

After reviewing the requirements, we had consensus that the system would need to achieve two primary goals in terms of functionality: "recording medical data" and "reminding patients for their follow-up visits." Medical teams from Emory told us they have been donated plenty of Google Nexus 7 tablets; therefore, it would be good to have the system built running on Android devices.

At the beginning, we ever thought about designing the reminder experience similar to "Google Calendar": the application would pop up a notification on Android device's notification bar for upcoming scheduled events. However, the penetration of Android devices is just not there yet in most African countries. Also, the mobile network coverage could be another challenge. Therefore, we decided to design and implement the system with two primary portions, the **Data Collection** portion for collecting medical data, and the **SMS Service** portion for patient referrals and sending reminders to patients about their referral and follow-up appointments.

Data collection:

We started the design by reviewing the existing medical form being used in African countries. We referred the existing paper-based medical form from Kilimanjaro Christian Medical Centre (KCMC) in Northern Tanzania (see Figure 2, below).

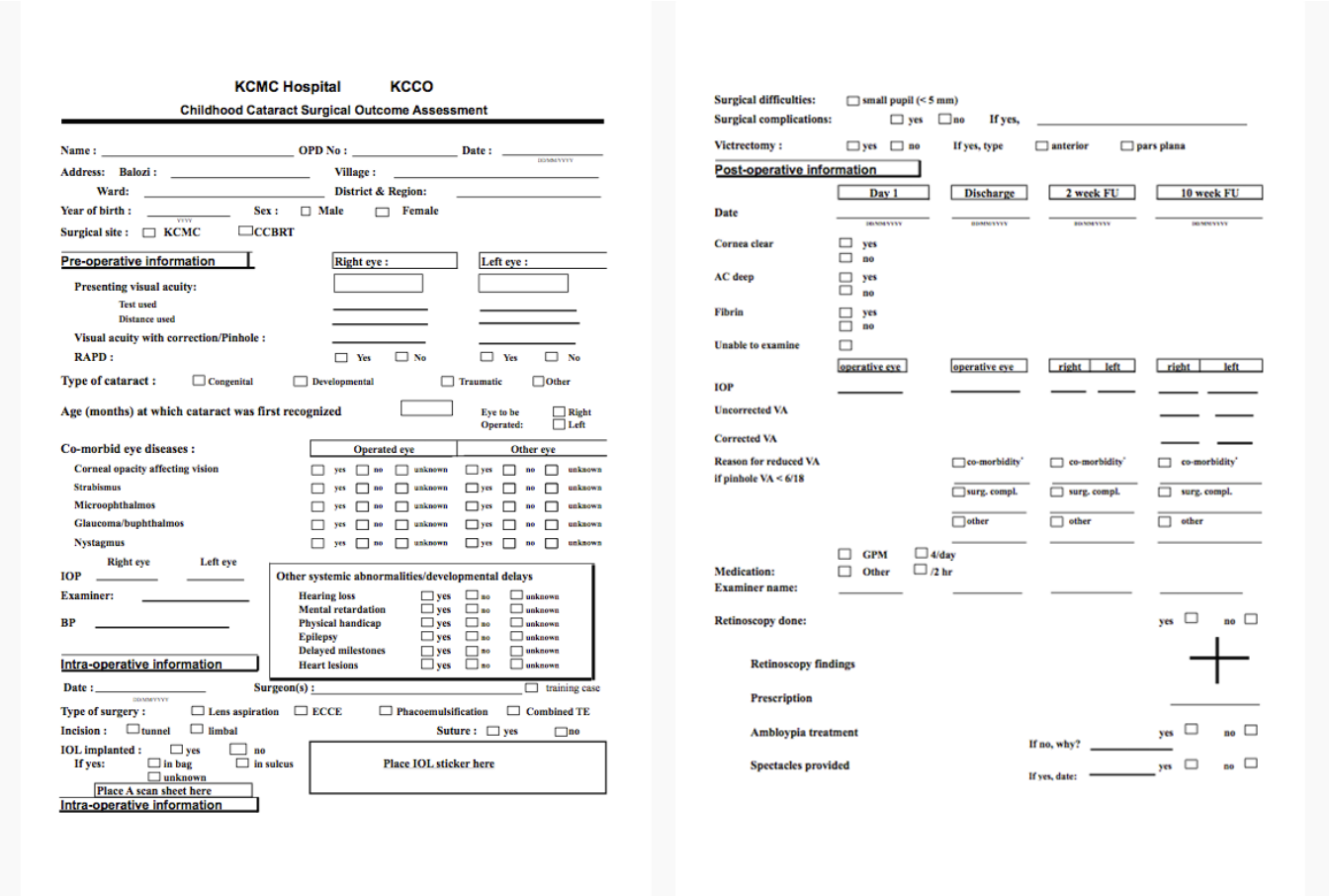

Figure 2. Paper medical form - from Kilimanjaro Christian Medical Centre (KCMC) in Northern Tanzania

Form Design:

After going through the medical form in detail with the medical teams from both Tanzania and Emory, we decided to separate the medical form from one lengthy form into several distinct forms through grouping similar fields and questions based on similarity and different stages of the medical treatments. By doing so, we can reduce the cognitive load by helping narrow down the focus to certain range of questions for different treatment stages so that medical staff does not have to glance through some irrelevant questions for data fields. Another advantage is that for electronic data collection, shorter data set will be better for data submission for reducing the data redundancy during the transmission.

We separated the original medical form into five electronic forms as listed below and iteratively designed them based on different stages of the medical treatments:

1. **Pre-operative Form**
2. **Intra-operative Form**
3. **Post-operative Form - Day 1**
4. **Post-operative Form - Discharge**
5. **Post-operative Form - Follow-up**
6. **Follow-up Appointment Form**

The first form, **1_Pre-operative Form**, is used when patient first visits the hospital. The form collects patient's demographic information, contact information, and all the examinations for both eyes prior to the surgery. The second form, **2_Intra-operative Form**, is used for collecting surgical records for operative eye after the physician completed the surgery. Note that if the surgery is bilateral, the surgeon has to fill up this form for both operative eyes. The third to fifth forms are all considered as Post-operative Forms but for different stages. The **3_Post-operative Form – Day 1** form is the first post-operative form for collecting the examination results from the patient for operative eye. The **4_Post-operative Form – Discharge** form is used for recording the examination results from patient's operative eye before medical team discharging the patient. The **5_Post-operative Form – Follow-up** form is used when patient returns to hospital for follow-up examinations. The **5_Post-operative Form – Follow-up** is almost identical to **4_Post-operative Form – Discharge** form. The only difference is that the former will collect the examinations for both eyes during the follow-up examinations, while the latter is more focusing on the recovery status of the operative eye. The sixth form, **6_ Follow-up Appointment Form**, is created for being used to schedule the follow-up appointments for the patients.

System Architecture – Open Data Kit (ODK):

As to the architecture of the data collection system, we implemented our system on top of **Open Data Kit** (**ODK**), which is a free and open-source set of tools that help organizations author, field, and manage mobile data collection solutions, as the base of the project for better sustainability. ODK consists of two main components: a *mobile-end application* called **ODK Collect** to allow users to collect data through filling-up **pre-defined data forms**, and later submit the collected data in the form formats to the *server-end application* called **ODK Aggregate**. One of the advantages for adopting ODK is that

the tool has provided out-of-box functionalities in both mobile-end and server-end applications so that we can focus on dealing with the challenges to transform the existing paper-based medical form into multiple electronic formats that fit the tablet screen size well.

ODK Collect is an android application that allows users to download and fill out forms on android devices. It can be downloaded directly on Google play or installed through adb tool with USB cable from the laptop to the Android devices. ODK Collect supports the following features:

- **ODK Collect renders forms into a sequence of input prompts that apply form logic, entry constraints, and repeating sub-structures.**
- **Users work through the prompts and can save the submission at any point.**
- **Finalized submissions can be sent to (and new forms downloaded from) a server.**
- **ODK Collect runs on Android platform and supports a wide variety of prompts (text, number, location, multimedia, barcodes).**
- **ODK Collect works well without network connectivity.**

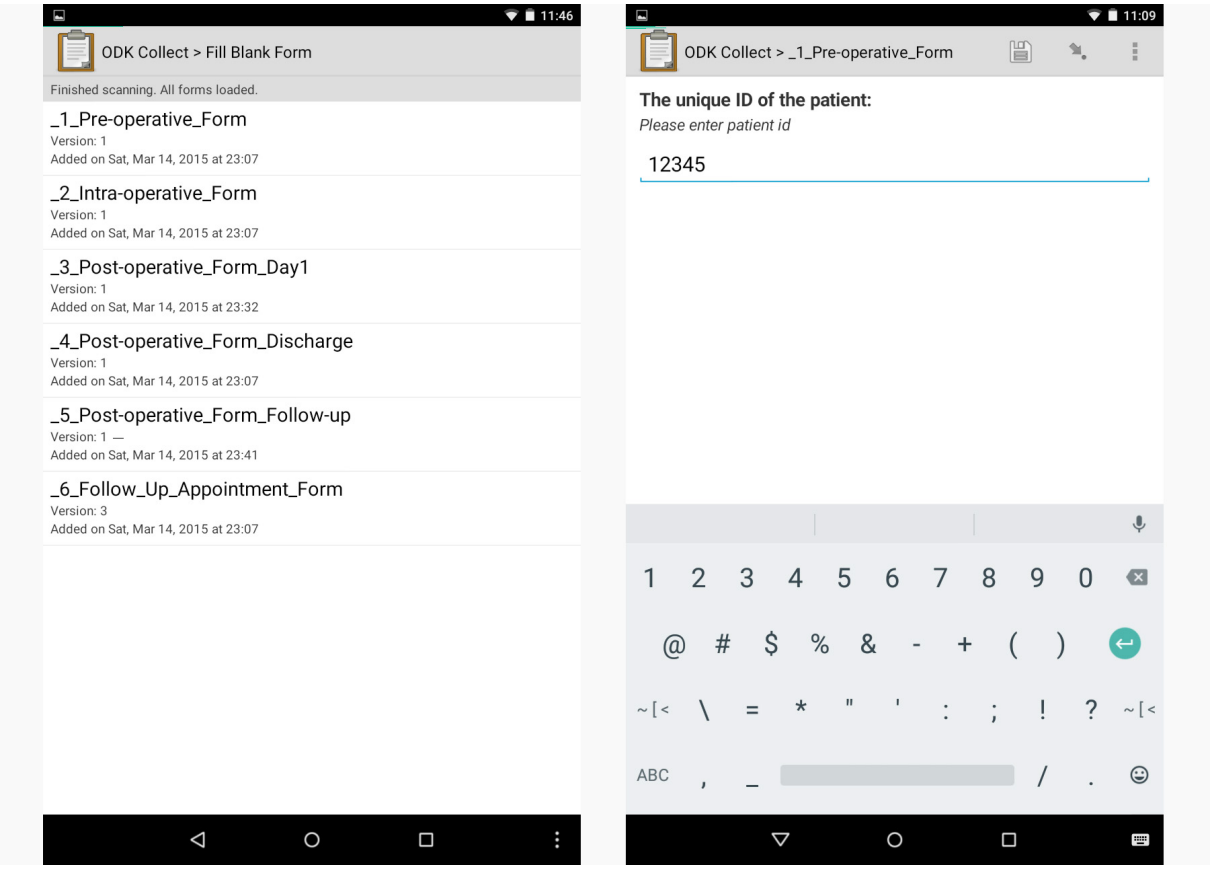

Figure 3. ODK Collect - Blank form list screen (fetched from ODK Aggregate) and Patient ID screen (added at the beginning of each form)

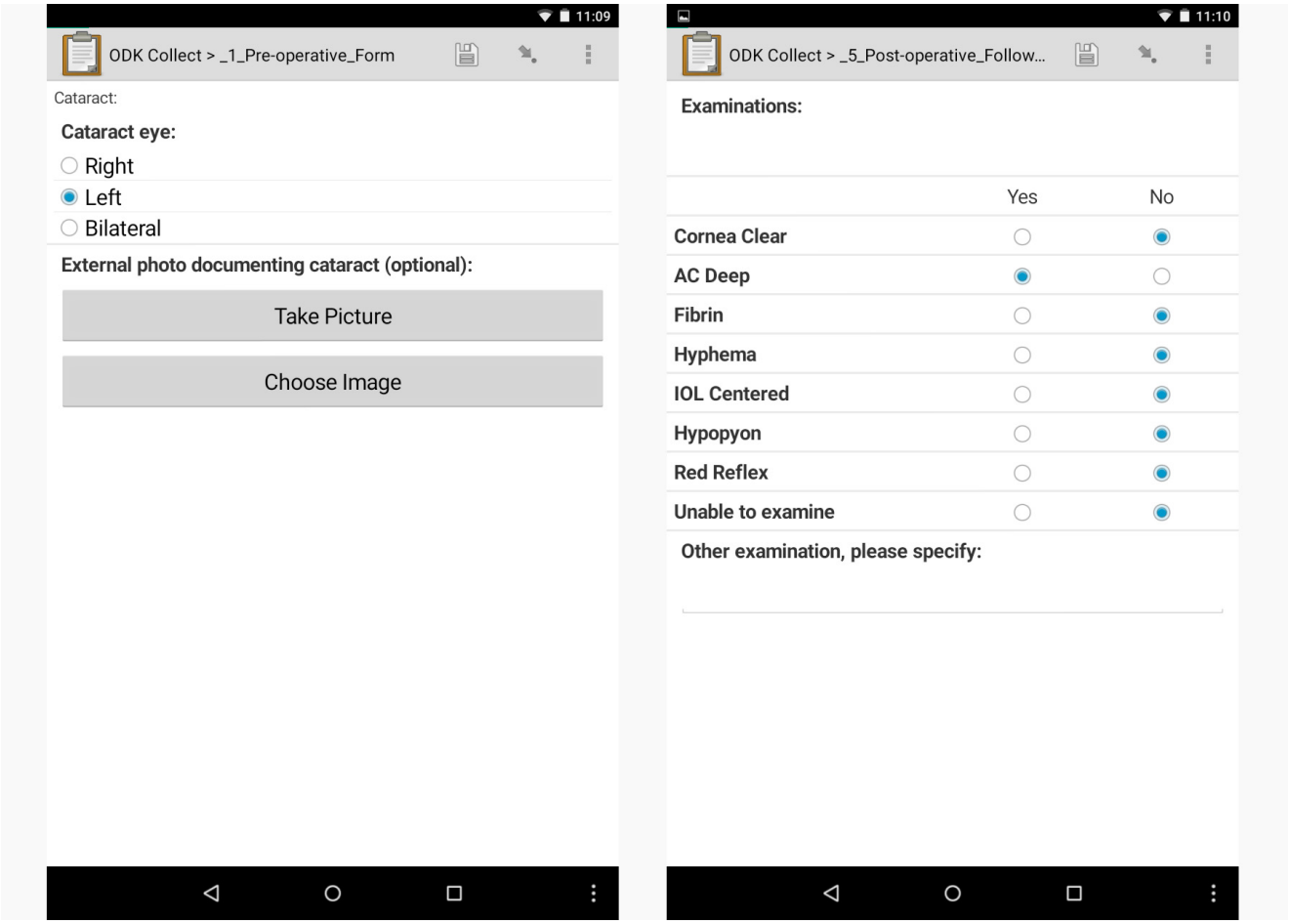

Figure 4. ODK Collect - Utilizing "XForm" format, the form can record photo from tablet's camera and create the multiple-choice questions in table format

ODK Aggregate is the server application that manages the forms that are uploaded and data submitted by ODK Collect, the android application. We deployed ODK Aggregate on Amazon Web Services (AWS) Elastic Compute Cloud (EC2) with Tomcat6 and MySQL as our backend server and database setup. ODK Aggregate supports:

- **ODK Aggregate provides blank forms to ODK Collect.**
- **Accept submissions from ODK Collect and manage collected data.**
- **Visualize the collected data using maps and simple graphs.**
- **Export data (e.g., as CSV files for spreadsheets, JSON files, or as KML files for Google Earth).**
- **Publish data to external systems (e.g., Google Spreadsheets).**
- **Control who has access to your data via user permissions.**

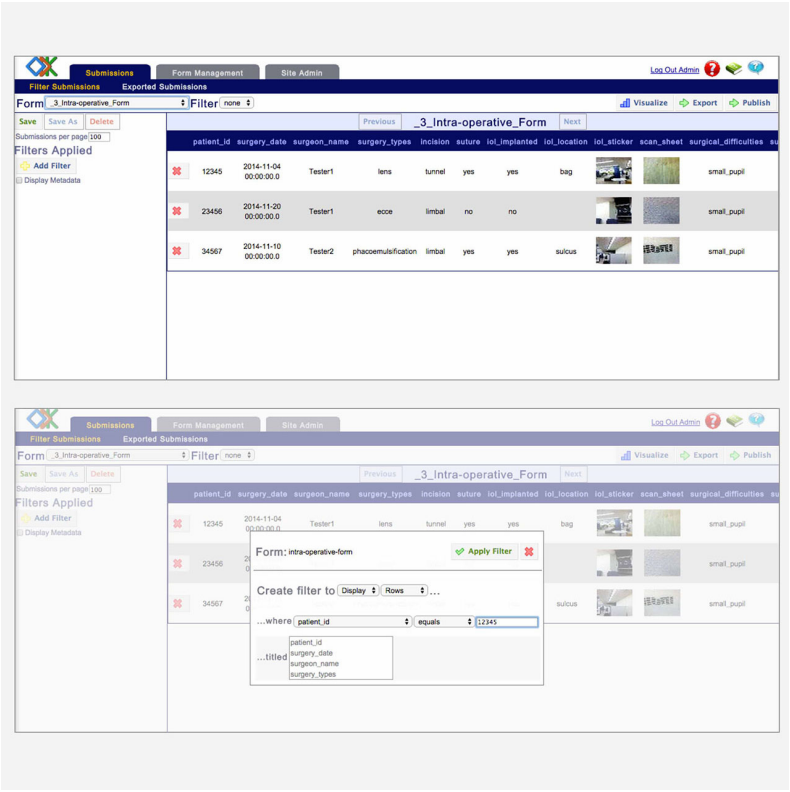

Figure 5. ODK Aggregate - Form submission list and Filtering query for data retrieval

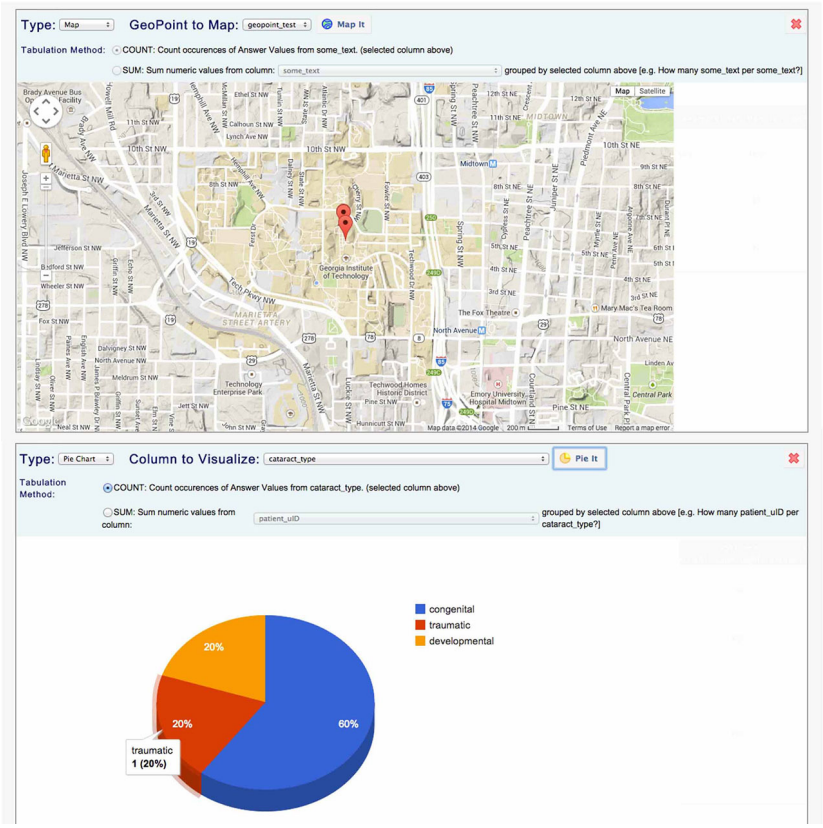

Figure 6. ODK Aggregate - Geographic info (by GPS) and Data visualization

To create electronic forms that are compatible with ODK system, ODK Build is the simplest approach by creating forms in XForm format through drag-and-drop interaction. However, it is not flexible enough for complex form design with branching logic and more suitable for simple form design. In many cases, the question sets on the medical forms are correlated or even sharing some dependency. Hence, we turned to design and implement our electronic form design by using another tool called XLSForm. With XLSForm, we are able to easily edit and design the form with Microsoft Excel and store the file into XLS format and import it into XLSForm to convert into XForm for ODK system. The XForm format provides the functionalities to obey logic, entry constraints, and attached photos as well as location using the phone or tablet's camera and GPS. The preset drop-down menus or multiple selections with radio buttons also facilitate the data input through providing the data options explicitly and improving the data correctness.

SMS Service:

Before starting to design the SMS service for appointment reminders, the physicians from Emory Global Initiative were really excited about this, and decided to expand the requirements a bit further. In the original workflow diagram, patient referrals would need to include patient's location. Since many patients do not have a specified street address, it would be really helpful to use ODK running on Android tablet to capture patients' locations with GPS. However, what about the scalability issue? What if there is simply no enough Nexus 7 tablet for community workers? What if in some countries, the patient's location information is not that important when referring patients? Is it possible that we can also leverage SMS service for patient referral?

For the second version of system workflow diagram, in addition to sending appointment reminders, I also envisioned that the SMS service could allow community workers to send SMS for patient referrals in the field with patient's information such as name and contact phone number. The medical team in hospital can review the referral list along with visiting status showing whether or not the patient has visited hospital for statistical purposes. With the proposed SMS service, the medical team can schedule a future appointment for the patient by submitting the last ODK form: **6. Follow-up Appointment Form**. Prior than the appointment date, SMS reminders will be sent to patient's contact phone about their upcoming visit. The SMS service can also tracks the history of visiting status regarding the missed/visited appointments.

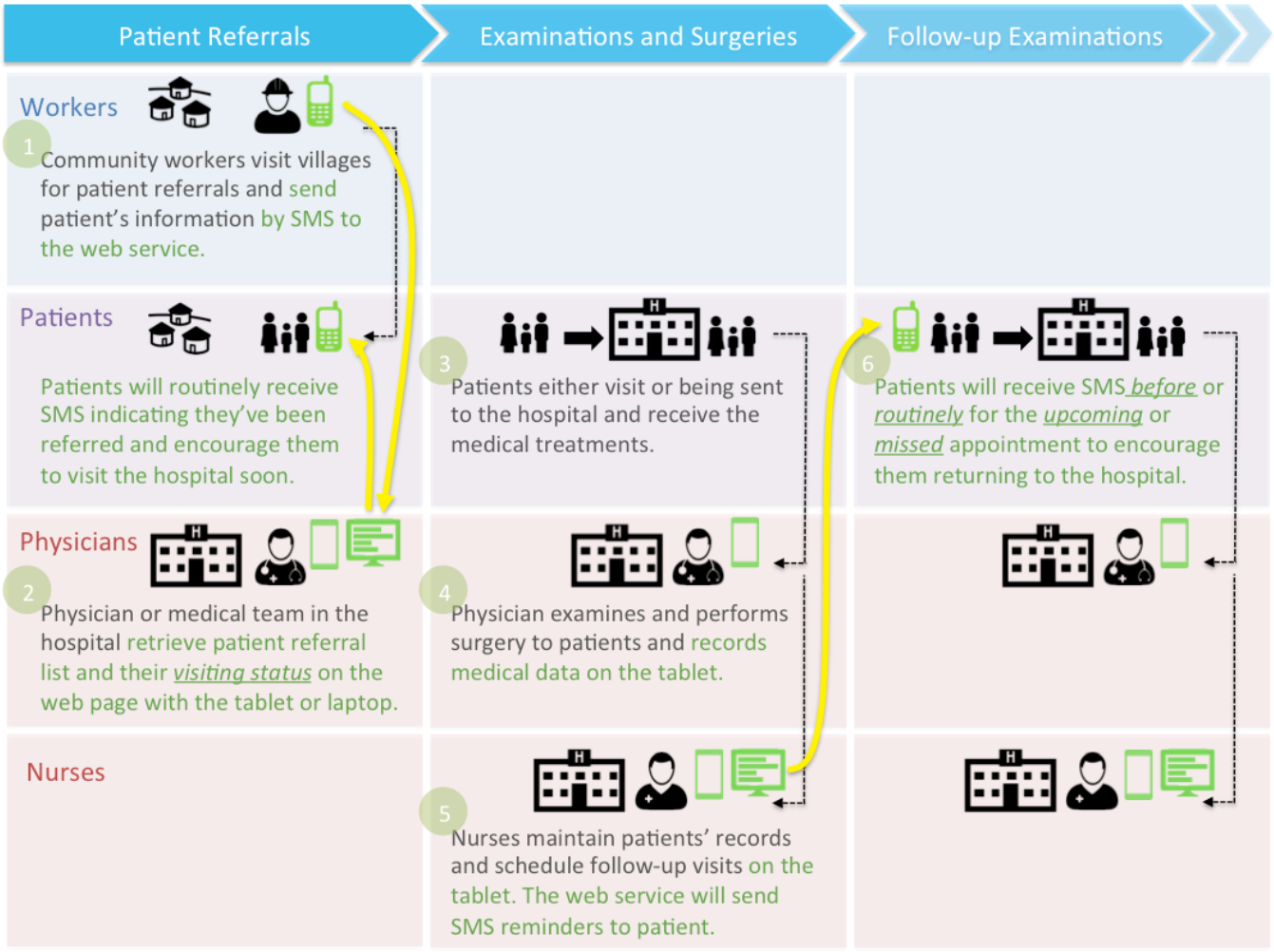

Figure 7. User workflows of the project requirements - with proposed experiences of our system

After doing some research, I decided to leverage an existing free open-source framework called RapidSMS and design the UI and logic on top of it. RapidSMS is built with Python and Django for dynamic data collection, logistics coordination and communication by using basic SMS mobile phone technology.

I designed the system architecture as deploying RapidSMS web application and ODK Aggregate at the same Amazon Web Service EC2 server. By doing so, RapidSMS can automatically generate SMS reminders by pulling out patient's data that previously been sent through ODK on the Android tablet from the same MySQL database.

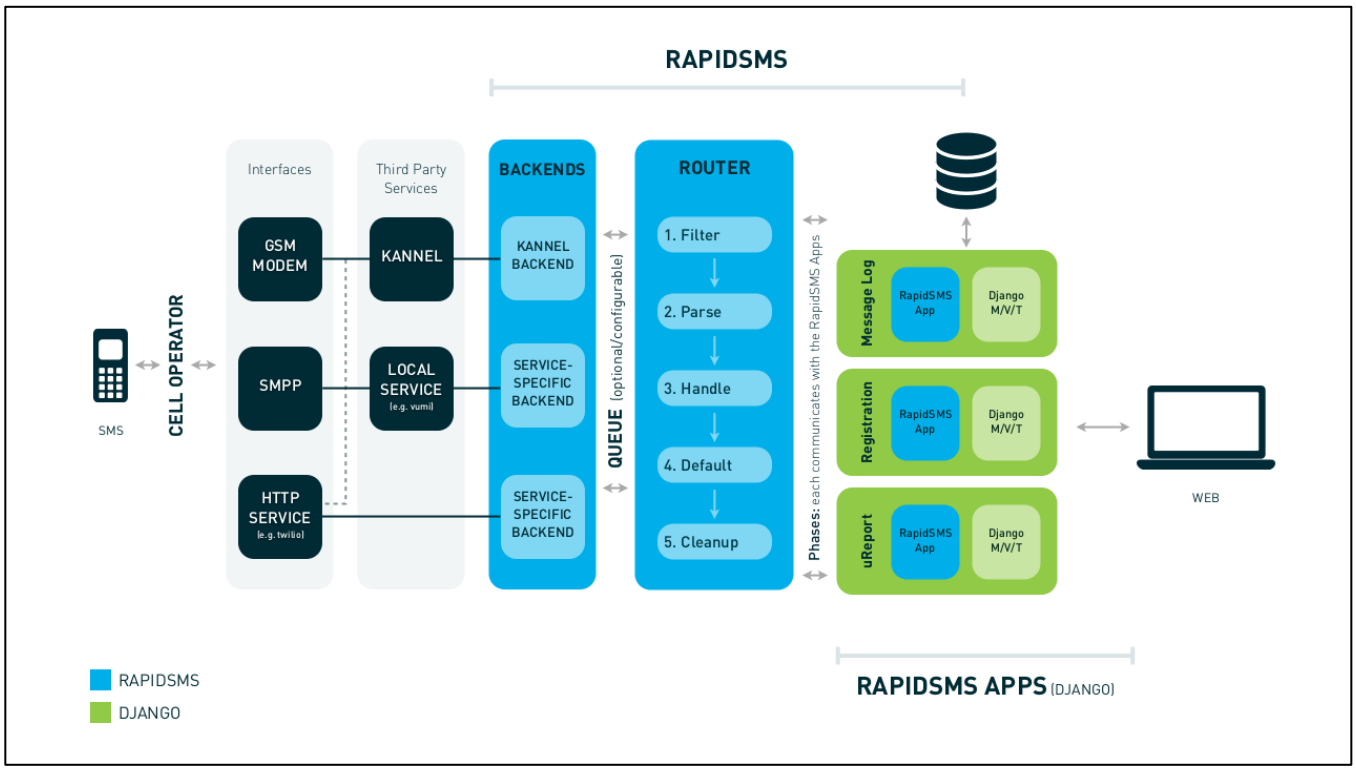

Figure 8. RapidSMS - architecture overview

The diagram in Figure 8 (above) shows the overview architecture of RapidSMS. RapidSMS can be divided into three core components:

- **Application (the green part)**
- **Router (the blue part)**
- **Backend (the gray part)**

The Application portion performs the feature logic about SMS messages and creates a web interface with Django views. The Router is the message-processing component of RapidSMS, which provides the infrastructure to receive incoming, send outgoing messages, and the connection to applications and the backend. The Backend receive messages from external sources (inbound SMS) and deliver messages from applications to external sources (oubound SMS). For development purposes, I developed the system with Tropo HTTP backend for SMS service thanks to its developer account (Ten dollar deposit with unlimited SMS text). When deploying the system in Africa, the recommended backend will be Twilio because it has better service coverage in Africa (Clickatell backend is not recommended because it lacks an inbound SMS service).

I started my UI design by sketching the low-fidelity interface with pencil and papers of the desktop view. Here I just show the paper prototype from the final iteration from five different versions. On the navigation bar, there would be a few buttons to switch between "Appointments" and "SMS Referrals". On the left hand side, I envisioned having drop down lists for selecting the data filtering function to manipulate the list shown on the right hand side. On the top of the list, there will be a button for exporting the filtered list as a spreadsheet (CSV) file for download.

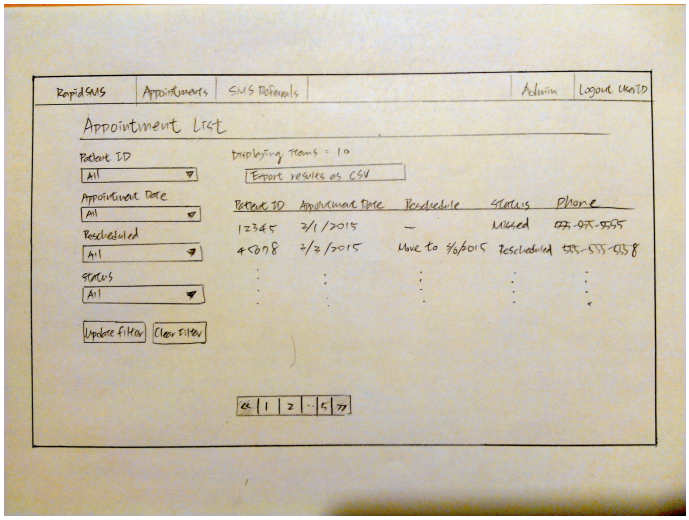

Figure 9. Lo-fi mockup for Appointment SMS Service - Desktop View

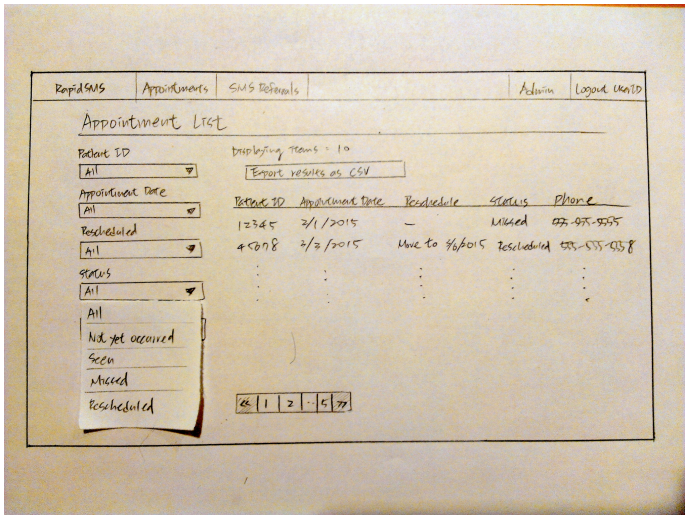

Figure 10. Filtering appointment list data by "Visiting Status"

Since the medical team will often input medical data with Android tablet using ODK, they would also access the SMS Service webpage through Android tablet. I also created a few low-fidelity mobile view mockups with pencil and paper. On mobile view, the navigation bar should be folded and replaced by a menu button (see Figure 11 below). Users can switch between "Appointments" (appointment list) and "SMS Referrals" (referral list) through clicking on the menu icon first to expand the menu options, and then select the corresponding one (see Figure 12). The drop-down lists for selecting the data filtering function will be placed at the top-half of the screen (see Figure 11). On the top of the list, there's a button for exporting the filtered list as a spreadsheet (CSV) file for download. For filtering function, users can select the filtering attributes these four drop-down menus. Notice that the "Status" field will be a little different between "Appointment List" (Figure 13) and the "SMS Referral List" (Figure 14).

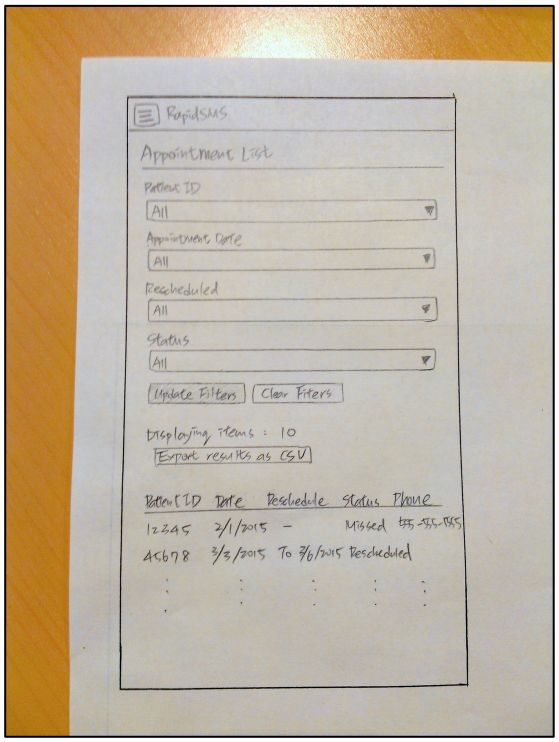

Figure 11. Lo-fi mockup for Appointment SMS Service - Mobile View

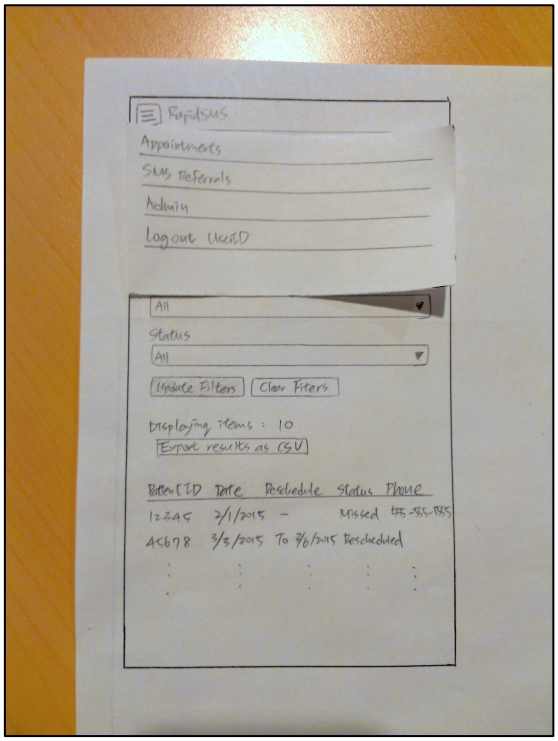

Figure 12. Expanding the menu for showing navigation options

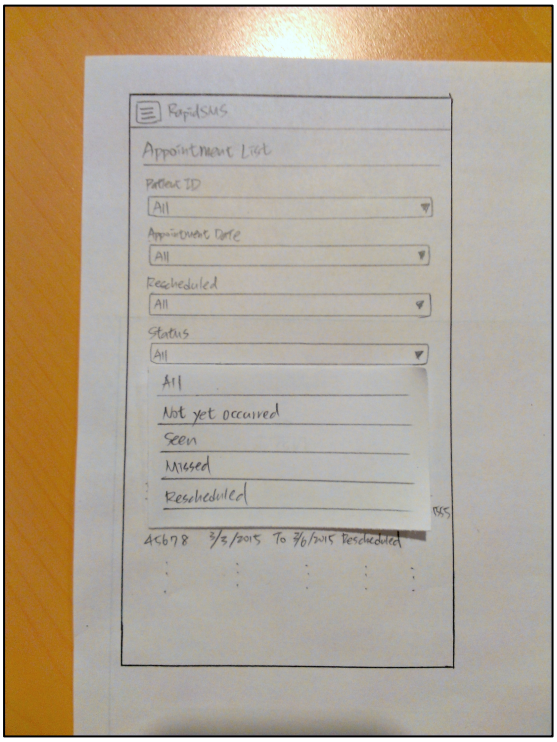

Figure 13. Filtering appointment list data by "Visiting Status"

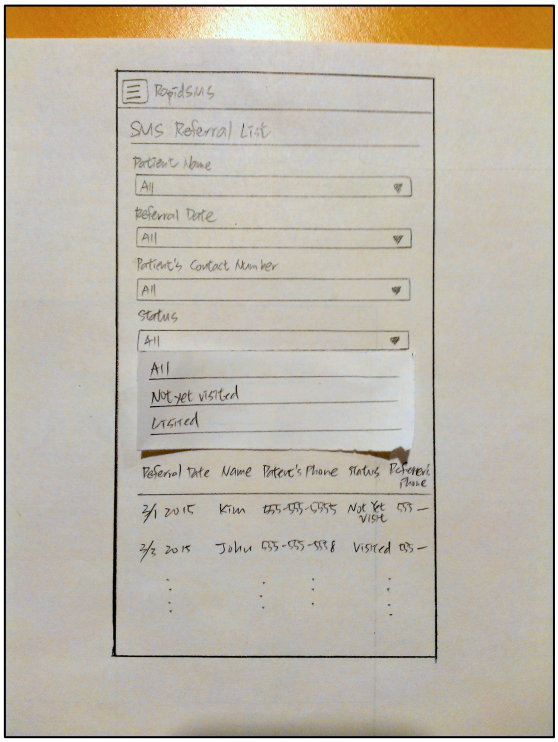

Figure 14. Filtering referral list data by "Visiting Status"

We presented different design alternatives during the meetings with the medical team from Emory and change the design based on the feedback. After we all agreed on the most promising lo-fi mockup, I started to work on implementing the system accordingly. Right now, all the proposed features for the SMS service has been completed and tested. The SMS Service is running on the same Amazon AWS (EC2) with ODK Aggregate. By doing so, the SMS and ODK service and running collaboratively with shared database.

For example, the "visiting status" update mechanism for both "Appointment List" and "SMS Referral List" are based on ODK form submission. In short, for "Appointment List", if the patient's ID existed in the "Post-operative Form - Follow up" form submission after the appointment date, the visiting status will be updated as "visited". The updating logic for "SMS Referral List" is similar, of the patient's name AND patient's phone existed in the "Pre-operative Form" form submission after the referred date, the visiting status will be updated as "visited".

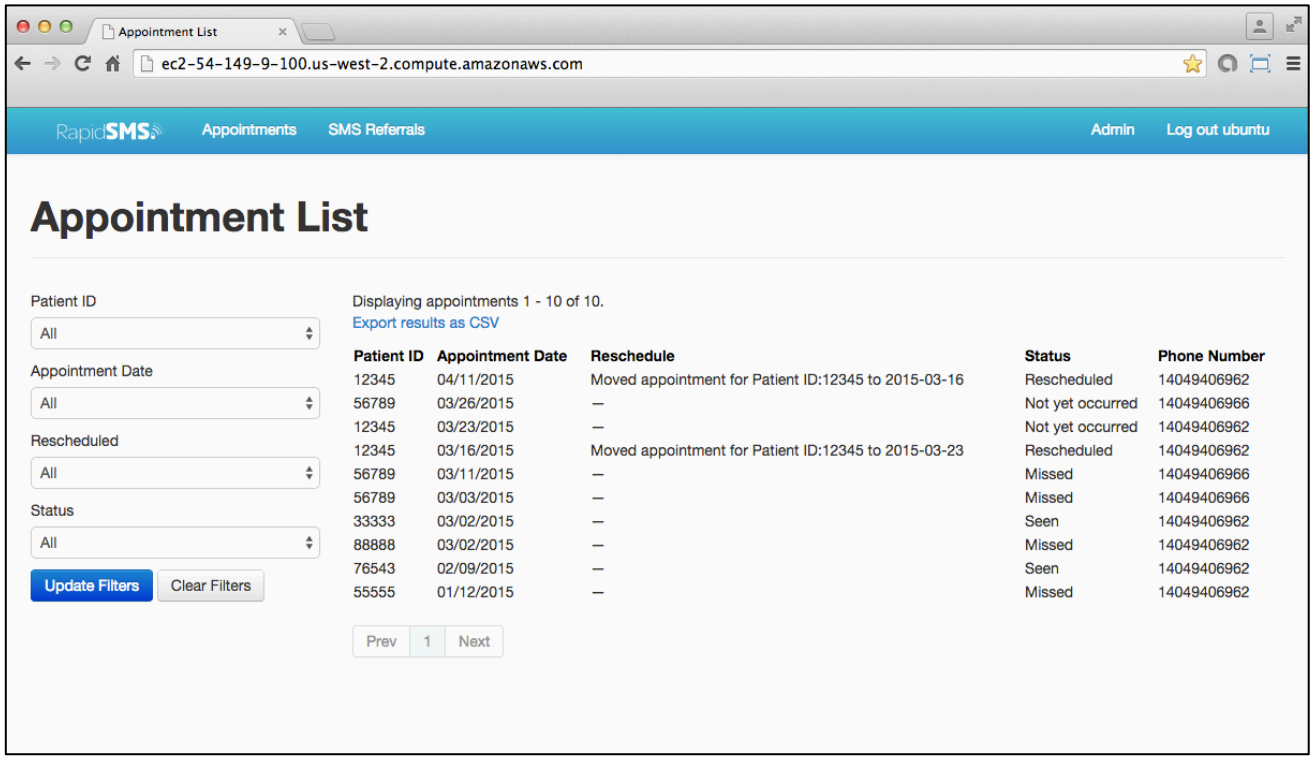

Figure 15. Pre-final Desktop View UI for SMS Service - Appointment List

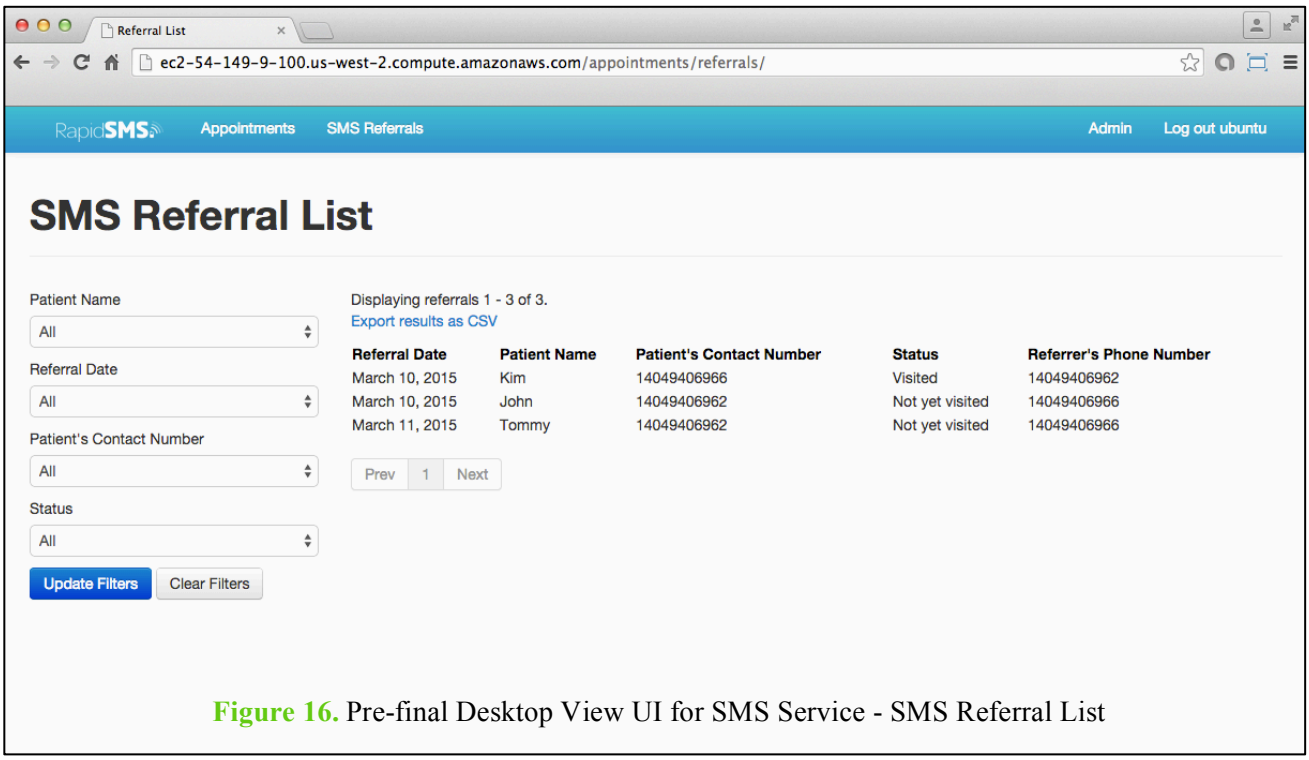

Figure 16. Pre-final Desktop View UI for SMS Service - SMS Referral List

For mobile view, with Twitter bootstrap, it is easy to change the layout according to the screen resolution. Here I list a few screenshots showing the UI with Android Nexus 7 tablet.

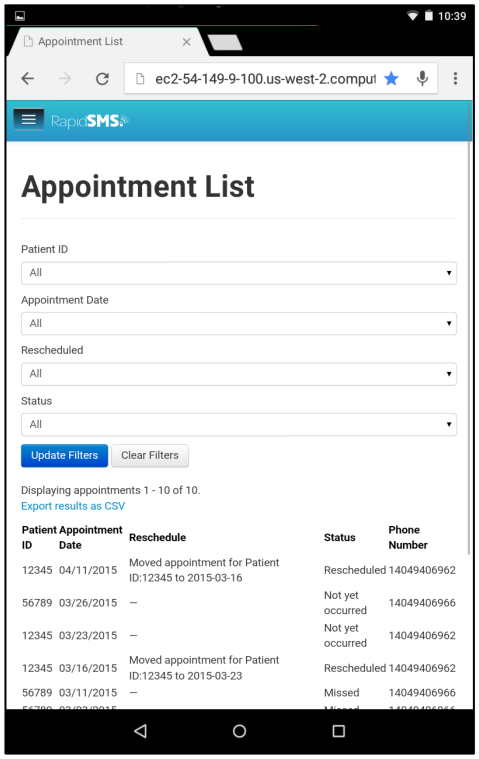

Figure 17. Pre-final Mobile View UI for SMS Service - Appointment List

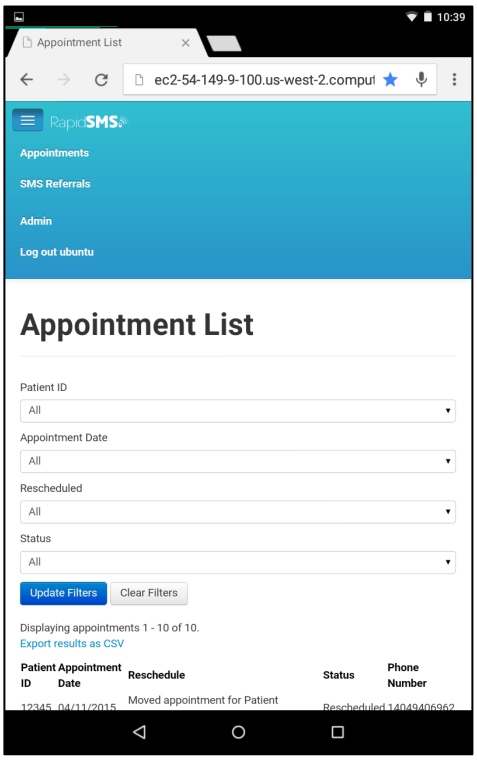

Figure 18. Expanding the menu for showing navigation options

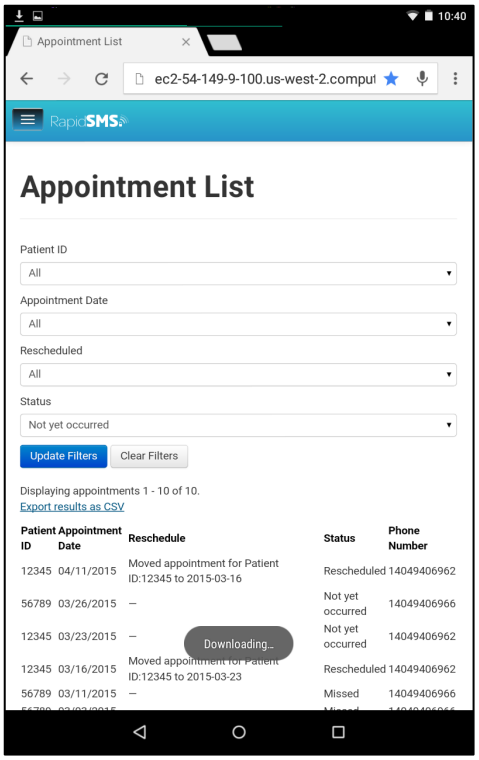

Figure 19. Export and download the filtered appointment list as CSV file

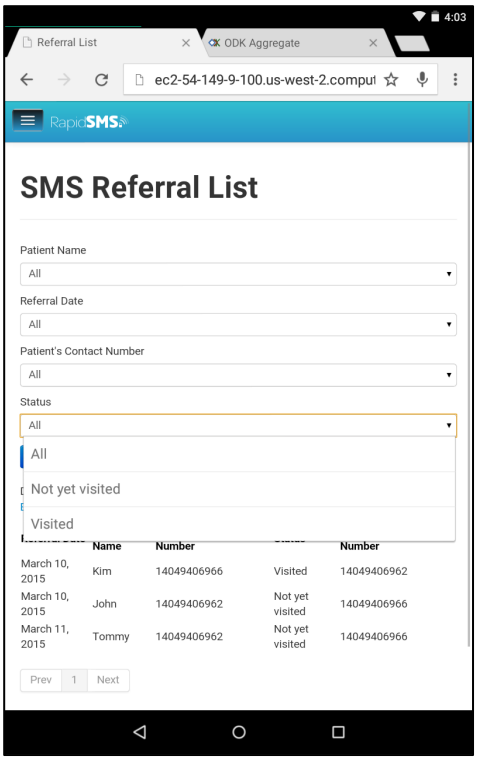

Figure 20. Filtering SMS patient referral list by "Visiting Status"

5. Usability Evaluation:

Recall that our system consists of two primary portions, the **Data Collection** portion for collecting medical data, and the **SMS Service** portion for patient referrals and sending reminders to patients for their follow-up visits. For the **Data Collection** part, the target users will be the medical teams working in African countries or the members from Emory Global Vision Initiative. For the **SMS Service** part, in addition to the aforementioned medical team, the target users will also include the volunteer workers from local communities in Africa. Since the system is designed based on multiple versions of workflow diagram from the hospitals in Africa, ideally we should conduct the tests with the medical team and the volunteer workers in Africa because they are going to be the actual users.

But one of the greatest challenges of our project is that not all users are geographically available to participate through the whole journey of the project. Therefore, we adopted several approaches from the earliest stage of the project to alleviate the impact of their absence. Thanks to modern information technology, we were able to keep interacting with remote users from the "discovery and ideation" stage through to the "design and implementation" stage as much as possible with instant messages, emails, and videoconferencing via Skype. In addition, utilizing the service diagram (customer journey map) for visualizing the user workflows, we were able to manage and make sure all the stakeholders understand the problem and the project scope. However, we can foresee that by conducting the usability evaluations in remote settings could miss of opportunities to capture users' feedback and context information. Hence, we decided to leverage the concept introduced in [4] of relying on surrogate users models. We recruited participants from Emory Global Vision Initiative for our usability evaluation.

For experimental design, we wanted to focus on the system design in terms of usability to see whether or not the user interface design or the interaction design of the system is understandable, makes sense to the medical teams, and also fits well to the existing workflows in African countries of pediatric ophthalmology. Regarding the successfulness of our designing approaches reply on remote communications, service diagrams, and the surrogates' perspective, this aspect of evaluations will be deferred until the system being deployed in the field and then tested with the native users.

Notice that for the **Data Collection** part of our system, we implemented our medical form designs on top of an open-source tool set called Open Data Kit (ODK). Due to the limited resources and timeline for this project, the teams from Emory Global Vision Initiative agreed on keeping the interaction design of the mobile-end application (ODK Collect) itself as-is for now, but focusing on designing and implementing the layout of the medical forms and how to efficiently fill in data for less error prone. Hence, the usability evaluation for **Data Collection** part of our system will focus on the design of those electronic medical forms rather than criticizing the interaction of the ODK Collect.

Experiment Design:

The usability evaluations were conducted during the last week of March and the first week of April with four pediatric ophthalmologists and one registered nurse from Emory Global Vision Initiative at Emory University Hospital.

We came up multiple benchmark tasks based on the workflow diagram for the different stages of the pediatric ophthalmology treatment. Prior to the evaluation, we walked through the workflow diagram with the participants for briefly introducing the backgrounds and different stakeholders being involved of pediatric ophthalmology in African countries. During the evaluations, we asked each participant go through all the benchmark tasks by filling in mock patient data following the order of the workflow diagram. And then we conducted semi-structure interviews and shared out our post-test questionnaire with the participants and gathered their feedback using both quantitative and qualitative approaches.

When the participants were going through the benchmark tasks, I sat beside them and took notes for any difficulty or operational error during the completion of the tasks. For the post-test interviews, the questions were mostly open and qualitative in nature. And for the post-test questionnaire, we applied seven Likert scale for the quantitative answers. Each session for one participant lasts for around one hour. Please see the evaluation guideline, questionnaires, and the mock patient's data in appendix.

Study sites:

The evaluations were conducted in the participant's office at Emory University Hospital. Both Wi-Fi and cellular reception for Android tablet (Google Nexus 7, 1st generation, Android version: 5.1) and mobile phone in the test area are both excellent (full reception bars).

Benchmark Tasks:

The system consists two primary portions, the **Data Collection** portion for *collecting medical data*, and the **SMS Service** portion for *patient referrals* and sending reminders to patients for their *follow-up visits*.

We designed the first five electronic medical forms based on the original paper-based form from Kilimanjaro Christian Medical Centre (KCMC) in Northern Tanzania for different

stages of the medical treatments. And the sixth form, "Follow-up Appointment Form", is added for linking **Data Collection** system and the **SMS service** together. After submitting this form to schedule a follow-up visit date, the SMS service will generate and send the SMS to the patient for reminding purpose.

1. **Pre-operative Form**
2. **Intra-operative Form**
3. **Post-operative Form - Day 1**
4. **Post-operative Form - Discharge**
5. **Post-operative Form - Follow-up**
6. **Follow-up Appointment Form**

For the usability evaluation, we followed the aforementioned order of the workflows to go through the process with a fictitious patient named, "George Burdell". We also handed out a guideline for each benchmark task along with additional mock medical data to the participants for reference.

6. Findings and Design Changes:

In this section, we walkthrough each benchmark task with the usability problems being identified from our observations or their feedback.

1. The community worker identifies a patient and tries to refer the patient with required patient information by using SMS text message.

a) Please try to refer the patient by using SMS and send it to "404-850-9528" (SMS service):

** **Command format:**

appt new eye *FirstName_LastName PatientPhoneNumber*

ex. appt new eye George_Burdell 14049406962

1) Patient Referrals –

Findings:

In this particular task, most of the participants completed sending SMS for patient referral without any problems. One participant didn't put underscore between patient's *FirstName* and *LastName* so that the system bounced back a SMS for suggesting the correct command format. Since these benchmark tasks could be used as a part of training materials in the future when deploying the system in the field, we correct the command guidance and mark the underscore in red for alerting.

For SMS error proof, originally the SMS service bounced back the first SMS for the correct referral command, and then the user had to send the referral command to get the second bounce-back SMS for the command parameters. The reason for this design is due to the length of the original instruction cannot fit in a single SMS.

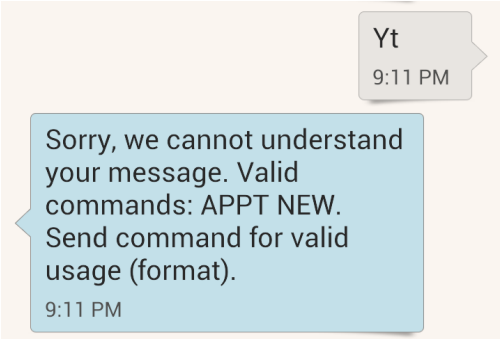

Figure 21a. The original design – the first bounce back SMS for indicating the correct referral command: APPT NEW

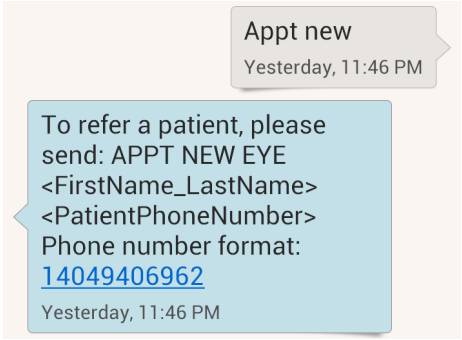

Figure 21b. The original design – the second bounce back SMS for sharing required referral parameters: APPT NEW EYE <FirstName_LastName> <PatientPhoneNumber>

In addition, all the participants suggested taking out the "two-stage" interaction for prompting the SMS command since users may not aware they have to send SMS back-and-forth to get the correct command format. Thus, the latest SMS command prompt has been modified with a much concise description to fit in one SMS (see figure 22). Also, two participants suggested removing "<" and ">" from the command prompt because users may think they are also a part of required symbols. (One of the participant who did type in the "<" and ">" symbols as a part of the referral command.)

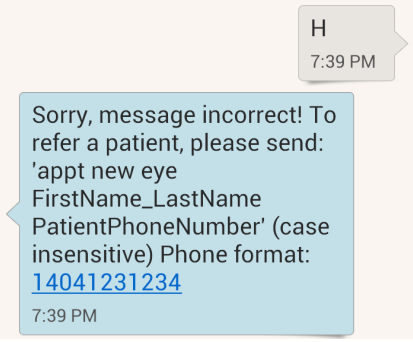

Figure 22. The latest version of the bounce back SMS for referral command and required parameters: appt new eye FirstName_LastName PatientPhoneNumber

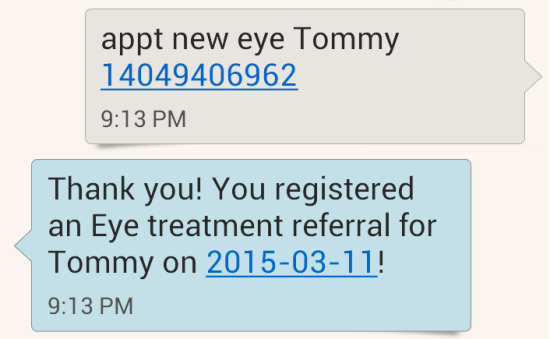

Figure 23. The SMS for successfully refer the patient.

2. The medical team in the hospital can review the referral list on the system and see if the patients being referred visited the hospital or not.

Imagine you work in the hospital and want to check the referral list to see if the patients had already visited the hospital or not.

a) **Please review the list of patients being referred on the system.**

b) **If you would like to contact the patient "George Burdell" who hasn't visited the hospital, are you able to find his contact phone number?**

c) **Please get the list of patients being referred on "3/29", and exported the list as a spreadsheet (CSV file).**

Findings:

In this task, we asked participants to walkthrough the web app of the SMS service for SMS Referral List on the Android tablet. One participant interestingly scrolled down the screen directly and tried to read through the referral list to look for the pieces of information they were interested without even reading or playing the filtering options for querying. To alleviate this problem, we added the introductory description right

below the heading to clearly explain the filtering functionality for querying the information.

Also, another participant could not figure out how to export and download the filtered list as a spreadsheet. The participant told us that in fact she did ever notice the clickable text "Export results as CSV" but she was not sure about what "CSV" stands for. Hence, we changed the description as "Export results as a spreadsheet (CSV file)" to avoid using any potential jargon to the end users.

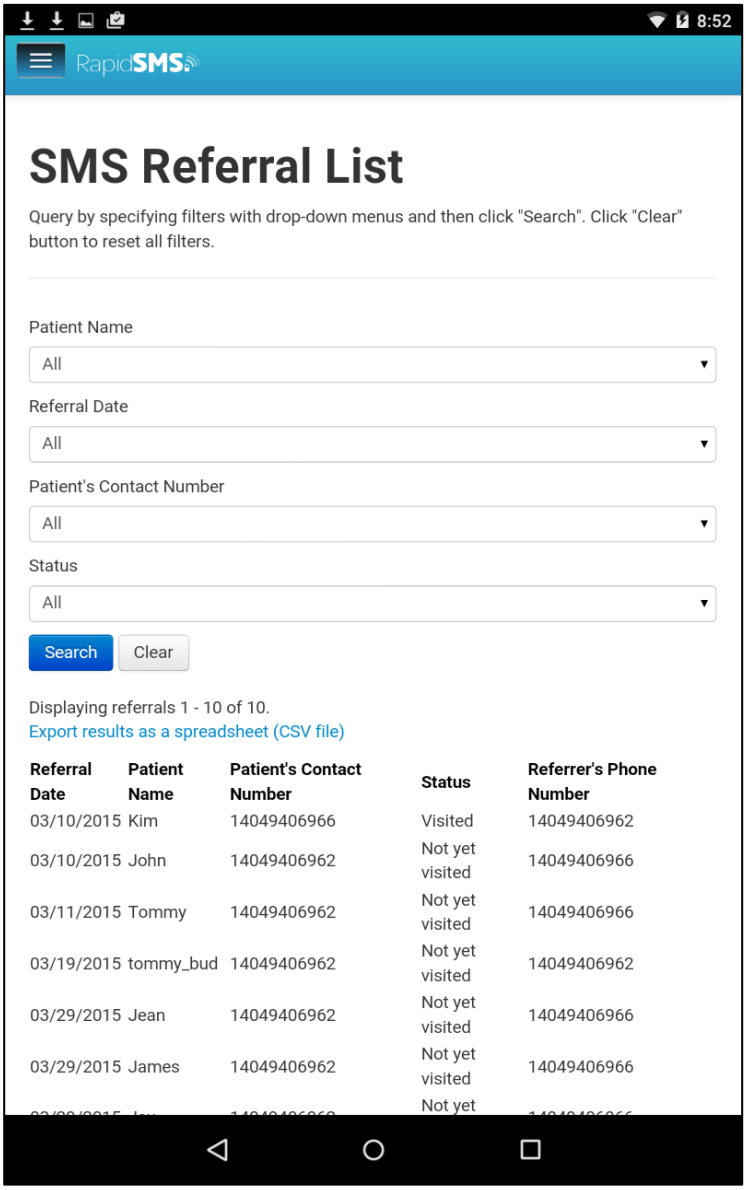

Figure 24. Final Desktop View UI for SMS Service - SMS Referral List

3. The patient being referred would receive a SMS bi-weekly to remind about the visit to the hospital.

Imagine you are a patient being referred.

a) Are you able to understand the description of the reminder SMS about the visit to the hospital?

Findings:

In this task, we asked participants' about their opinions to the description of the referral SMS reminder. Although the target African countries for our project such as Uganda and Malawi consider English as one of their official languages, notice that in production settings, the actual language could be translated to native African language. But the idea for this task is to find out the way to remind patients in a clear, straightforward, and also in a welcome manner.

We designed the referral SMS reminder to be sent to the patients in every 14 days. Hence, in the original SMS reminder, we express this explicitly as shown in Figure 25. However, all the participants considered "routinely sent" could in fact confuse the patients and suggested taking them out. Thus, the modified version of referral reminder is shown in Figure 26.

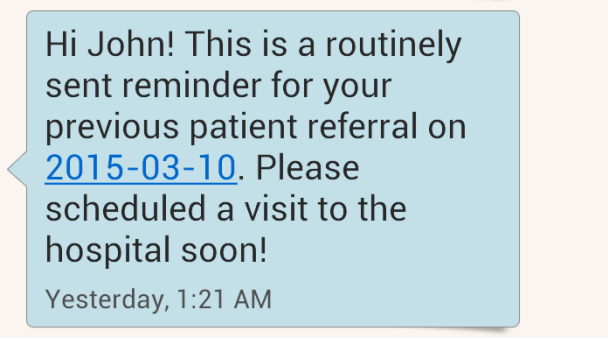

Figure 25. The original version of referral reminder.

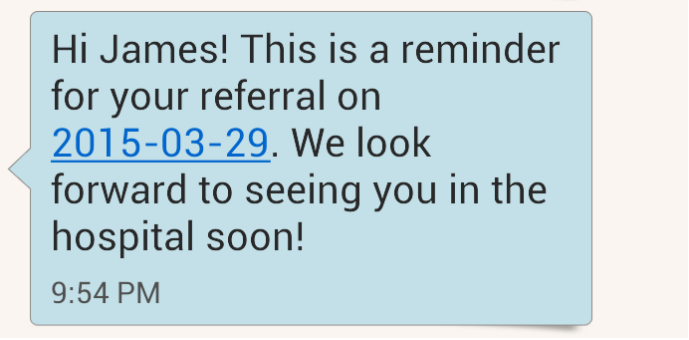

Figure 26. The modified version of referral reminder.

2) Examinations and Surgeries –

1. **The patient being referred visits the hospital for the first time. The medical team fills up the patient's basic information and performs clinical examinations before the surgery.**

   a) **Please fill in patient's information and examination results into "_1_Pre-operative_form" with the Android tablet.**

2. **After perform the surgery, the medical team fills up the surgery information to the system to record any additional findings or difficulties.**

   a) **Please fill in surgical information into "_2_Intra-operative_form" with the Android tablet.**

3. **Before discharging the patient, the medical team performs additional examinations and fills up the results as a part of patient's medical history.**

   a) **Please fill in examination results into "_3_Post-operative-Day1_form" and "_4_Post-operative-Discharged_form" with the Android tablet.**

4. **Since the patient is still growing, the follow-up visits are essential to the treatment process. The medical team will schedule the next follow-up appointment after completed all the examinations.**

   a) **Please fill up "_6_Follow-up_appointment_form" on the Android tablet to submit the next scheduled visit for setting up the SMS appointment reminder.**

   b) **If you accidently type in the incorrect patent's contact number. Do you know how to correct the appointment information?**

Findings:

For this part of evaluation, we asked the participant to fill up all the medical forms one by one from going through pre-operative examination to scheduling a follow-up appointment before discharging the patient. Since we have gone through eight iterations of form design modification with the medical teams both from Emory Global Vision Initiative and KCMC in Northern Tanzania, most of the participants were satisfied with the form designs and successfully filled in all the data without hitting any major issues. Most of their feedback was more related to personal preference such as grouping some questions together or displaying the data fields in the order they prefer.

For example, for visual acuity examination, there are "uncorrected visual acuity" and "corrected visual acuity". And there are two measuring methods: "distance" and "near" for checking the visual acuity (see Figure 27, in next page). Hence, some physicians prefer grouping "uncorrected visual acuity (distance)" and "uncorrected visual acuity (near)" together and then "corrected visual acuity (distance)" and "corrected visual acuity (near)", because they used to conduct the examinations first asking patient not wearing glasses for "uncorrected visual acuity", and then asking them wearing glasses for measuring "corrected visual acuity". However, others prefer grouping "uncorrected visual acuity (distance)" and "corrected visual acuity (distance)", and then "uncorrected visual acuity (near)" and "corrected visual acuity (near)". It is because they said in many occasions they simply skip the measuring for "near" visual acuity. By grouping the data fields with "distance" and "near", they can simply fill in the measurement result in one category and then skip the rest of the fields.

There is no simple right or wrong answer to this kind of feedback since they all have good reason to justify their preference. Thus, we have to further consider the context of what kind of examinations or who will be the one to conduct those measurements in the field to decide this kind of data field ordering preference. But the participants also point out that they think the ordering should be a minor problem since in either ordering they both can easily fill in or skip certain fields of the data if not applicable.

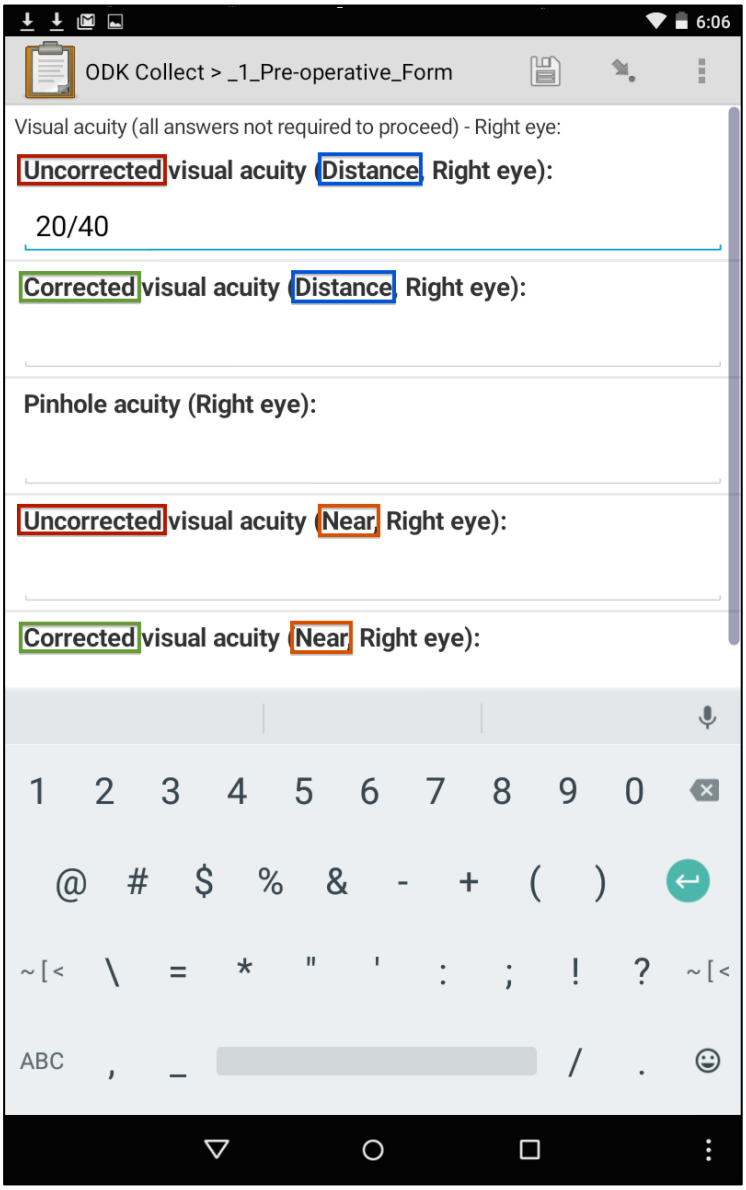

Figure 27. One of the data fields from "1. Pre-operative Form" – Visual acuity. The data fields can be grouped by measurement in "Distance" and "Near", or by "Uncorrected" and "Corrected".

Also, based on the users' feedback through the evaluations, we found that if the space is not an issue, radio buttons are generally better than drop-down menu for helping users quickly identify and fill in the desired option (see Figure 28 and Figure 29 on next page). This not only speeds up the process but also help reduce making errors.

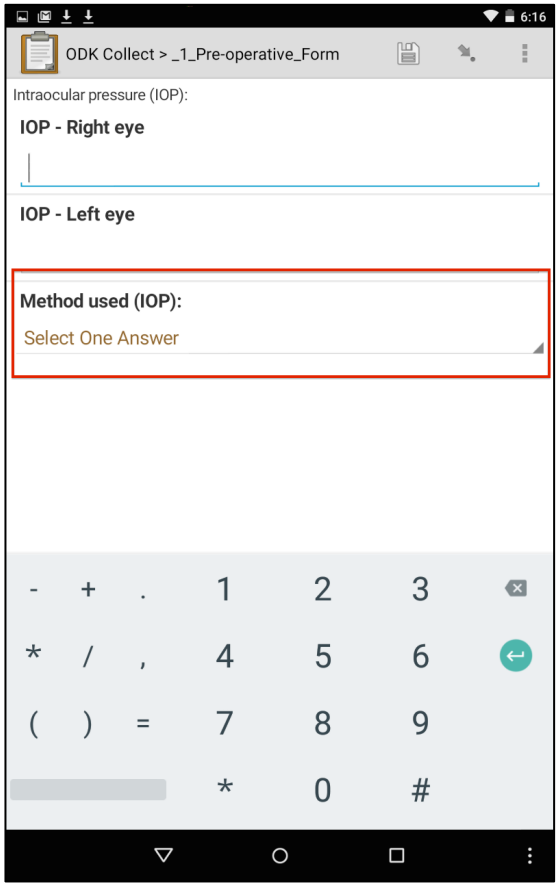

Figure 28. "1. Pre-operative Form" – options with drop-down menu

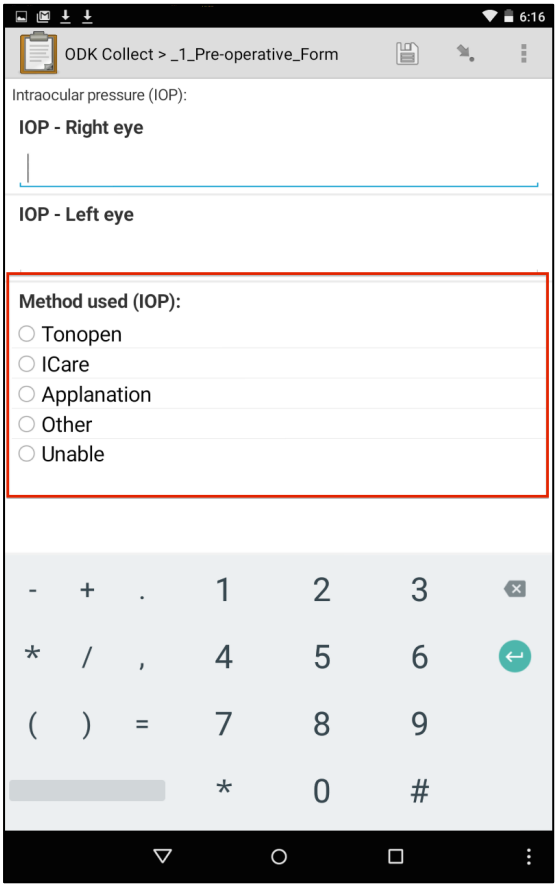

Figure 29. "1. Pre-operative Form" – options with radio buttons

Another findings from the evaluation is that for some correlated questions, it would be better to list them with branching logic so that users would less likely feel confused and easily pick up how these data should be filled in.

For example, a data field in "**1. Pre-operative Form**" is about "the age when cataract was first noticed". In original form design, we simply placed both fields for "age (in year)" and "age (in month)" at the same page. The idea is that if the patient were less than one-year-old, then we have to input the age in month, otherwise we just need to record the age in year (see Figure 30 on next page).

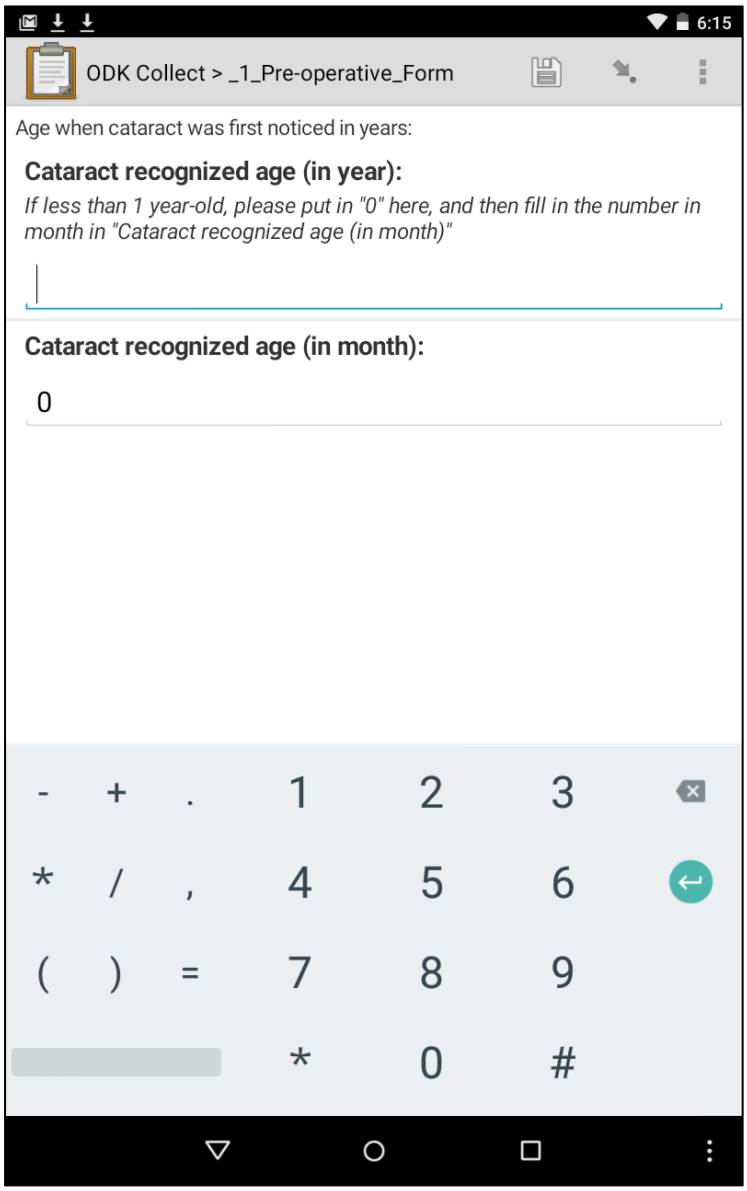

Figure 30. Original "1. Pre-operative Form" design for "Age when cataract was first noticed"

However, we found that two participants had problems when trying to input this data field. They questioned "do I have to log the patient is 2 years and 5 months old or just entered 2 years is fine?" Even after we added the descriptions as the hint, it did not help much for alleviating this confusion. Hence, I adopted their suggestions to put these two data fields on two separate pages and only show the second questions for entering

"age (in month)" on the successive page when "age (in year)" being entered with zero value (see Figure 31 and 32 below).

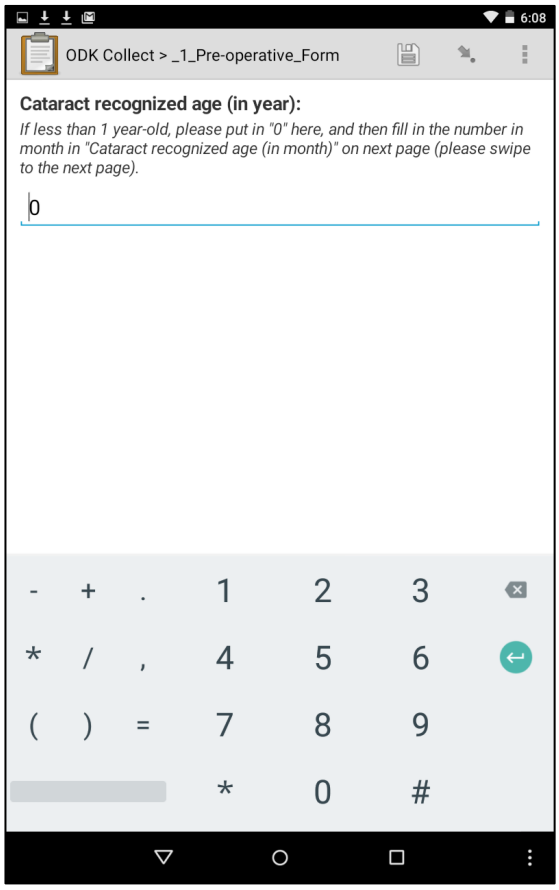

Figure 31. In new "1. Pre-operative Form" design, we separate "Age when cataract was first noticed" with two pages: the first page is for "age (in year)".

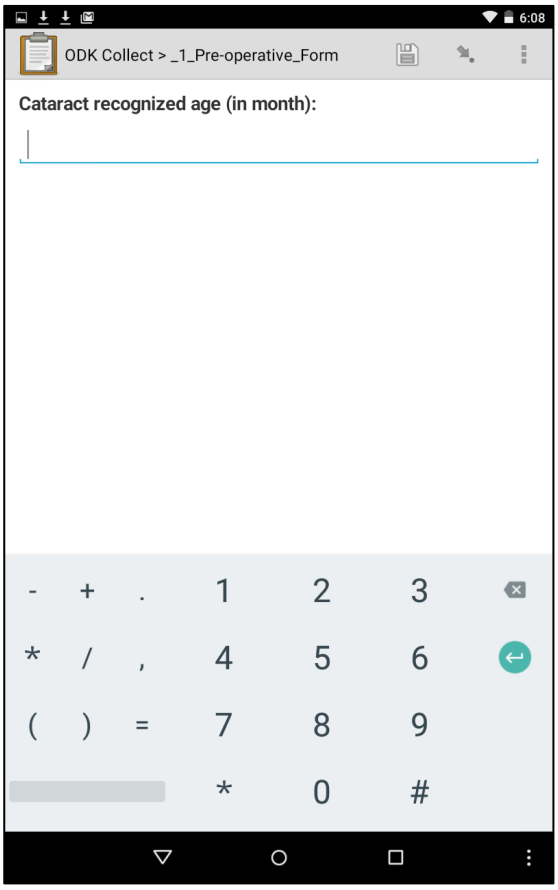

Figure 32. In new "1. Pre-operative Form" design, we only show second page for "age (in month)" when the first page "age (in year)" being entered with zero value.

In "**2. Intra-operative Form**", the surgeon has to submit the form twice for each operative eyes if the surgery were bilateral. In our original design, we added the instruction at the data field for recording the eye to be operated as shown in Figure 33 on next page. But two participants did not notice this hint and asked, "What should I select if the operation were bilateral?" Thus, in our new design, we adapt to users' feedback to add another page for explicitly pointing out this instruction with a specific page immediately after user clicked and opened the "**2. Intra-operative Form**" before

starting filling any data (see Figure 34 on next page) to make sure users can clearly acknowledge this form submission rule.

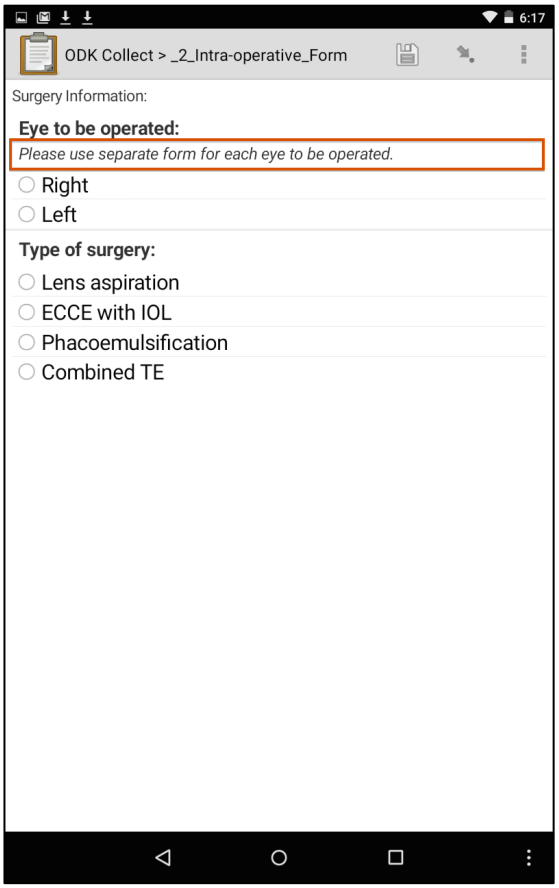

Figure 33. In original "2. Intra-operative Form", we only show the instruction about "submitting a separate form for bilateral operation" under the data field for selecting "Eye to be operated".

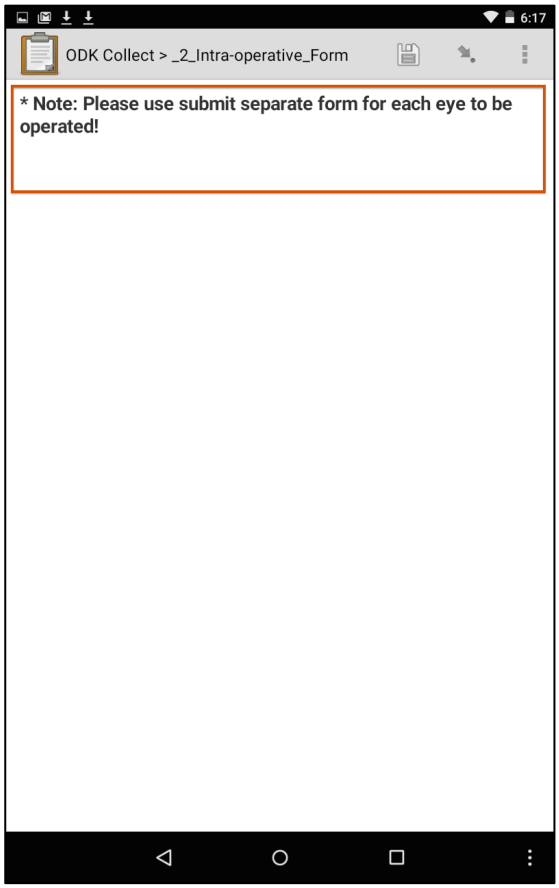

Figure 34. Other than the original instruction description, in new design, we further added another page at the beginning of "2. Intra-operative Form" to emphasize this specific form submission rule.

In "**4. Post-operative Form - Discharge**" form, two participants suggested grouping the options of examination results by "normality" and "abnormality". Not sure the reasons why but the original order of these examinations seems to mix the examination results together (see Figure 35 on next page). Although not affecting the usability, but separates the normal and abnormal results with different sections would be a more reasonable approach. Therefore, the modified "**4. Post-operative Form - Discharge**" is shown as Figure 36 below.

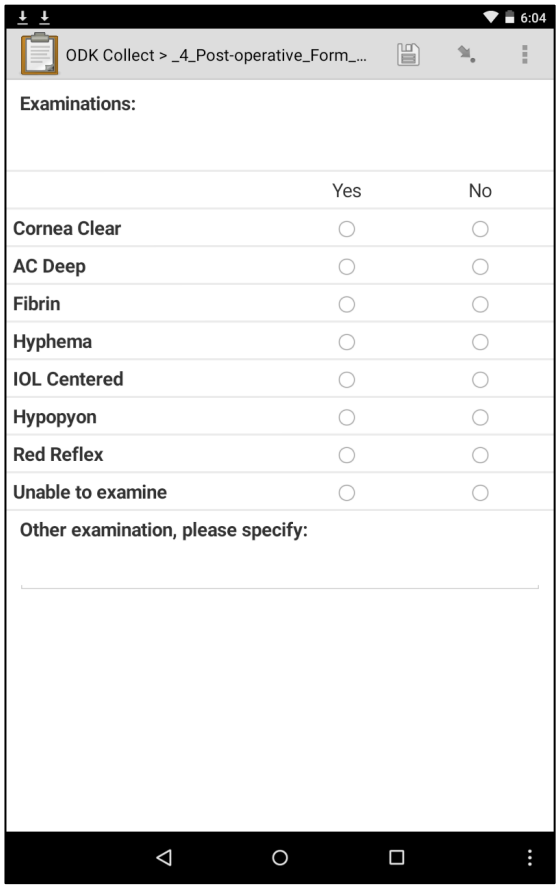

Figure 35. The original "4. Post-operative Form - Discharge" mixed the examination results regardless normality or abnormality.

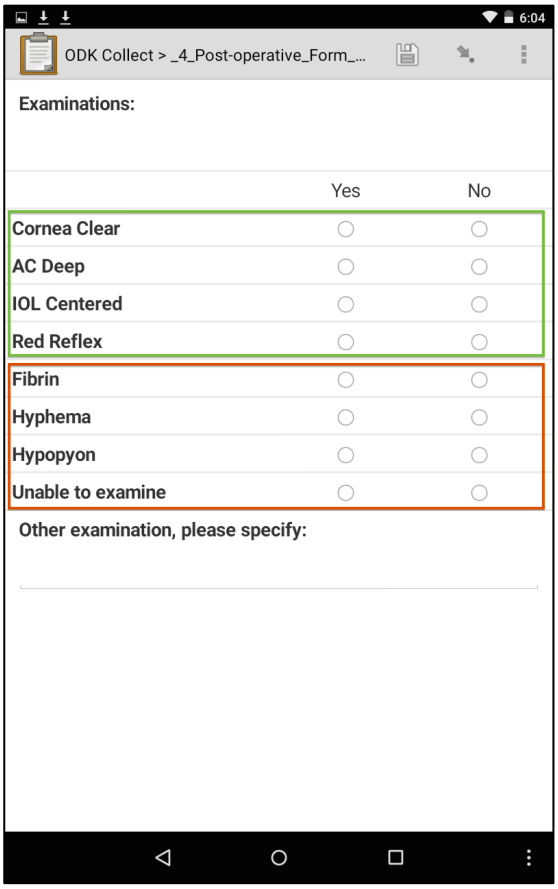

Figure 36. With the help from medical team, the modified "4. Post-operative Form - Discharge" separate examination results according normality (in Green box) or abnormality (in Red box).

Lastly, for "**6. Follow-up_Appointment Form**", although in the original form design, it shows an additional page at the beginning of this form telling users to submit this form again to overwrite and correct the patient's information or appointment date if patients need to reschedule their follow-up visits (see Figure 37) on next page. However, through our observation, most of the participants did not finish reading the whole description and skipped it in a hurry to the next page when first filling this form. When being asked to correct patient's contact number or schedule an appointment change for patient's follow-up visits, most of the participants had to go back to the form and then find out the instruction on the cover page. Only one participant could answer this question without going through the form again.

We asked participants what made them skip the first instruction page. Some said it probably is because the description is too long. But we later noticed that this could be resulted from starting the instruction with "If statement" for "the case" and then sharing "the action". The original instruction saying, "If a patient changes his/her contact phone or appointment date, …" In this approach, when participants read about "the case", they could simply skipped reading "the action" because they assume no need to worry about this case for now. Therefore, we change the order of the description by showing "the action" upfront, and then introducing "the case". In our later unofficial tests, we found this approach helps make the participants read through the whole description and less likely to skip the instruction page. The modified instruction is shown Figure 38 below.

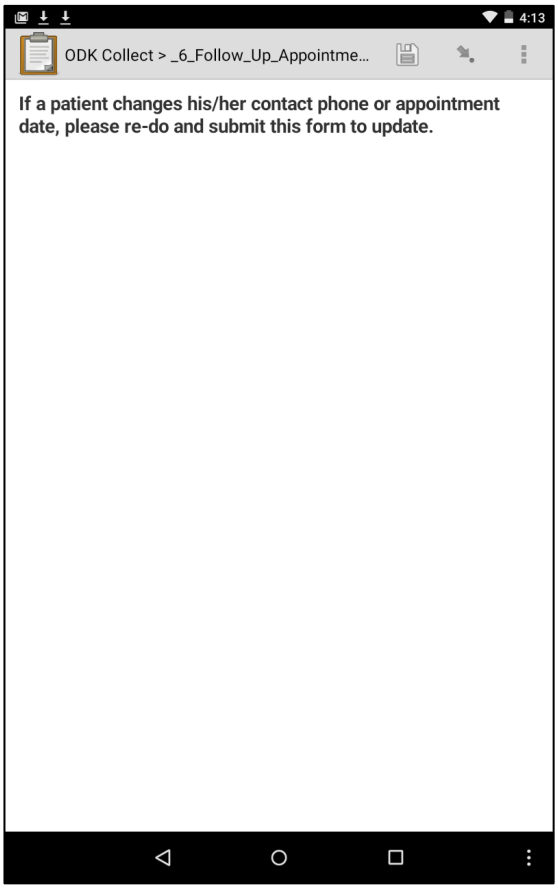

Figure 37. The original instruction page for showing how to correct patient's contact or appointment date – showing "case" first and then the "action".

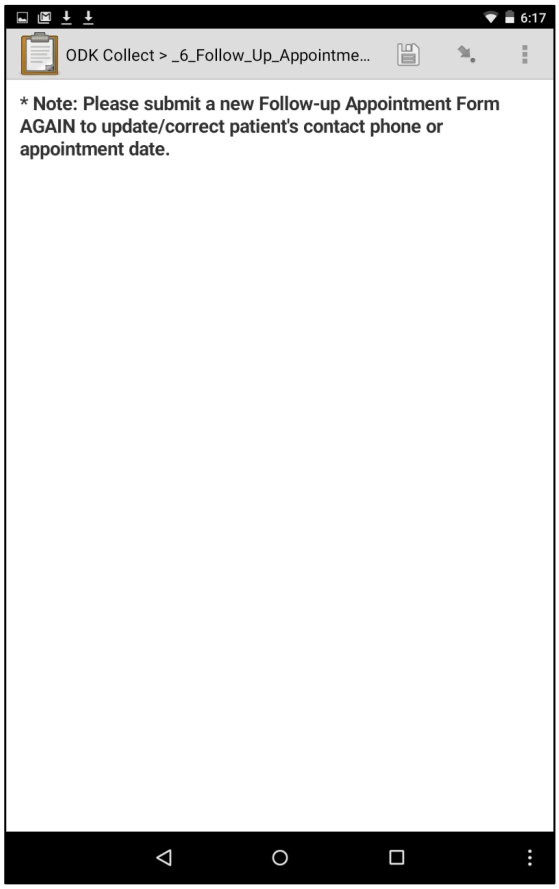

Figure 38. The modified instruction page by showing "action" upfront and then the "case" so that users will less likely skipped the instruction simply because "now it is not the case".

3) Follow-up Appointments and Examinations –

1. **The patient would receive SMS reminders bi-weekly about the visit to the hospital.**

   a) **Are you able to understand the description of the reminder SMS about the upcoming visit to the hospital?**

Findings:

Similar to referral SMS reminder, this time we asked participants' opinions of the description of the appointment reminder. For the upcoming appointment, the patients receive SMS reminder seven days before their appointment date. For the overdue appointments, patients will repeatedly receive SMS reminders about their missed appointment to encourage them to return to the hospital soon.

For the upcoming appointment reminder, we also modified the description based on the feedbacks such as putting patient ID information at the end of the sentence and taking out some unnecessary parenthesis as shown in Figure 39 and 40.

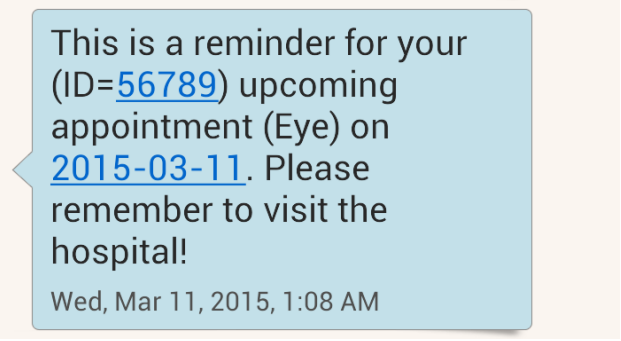

Figure 39. The original version of upcoming appointment reminder.

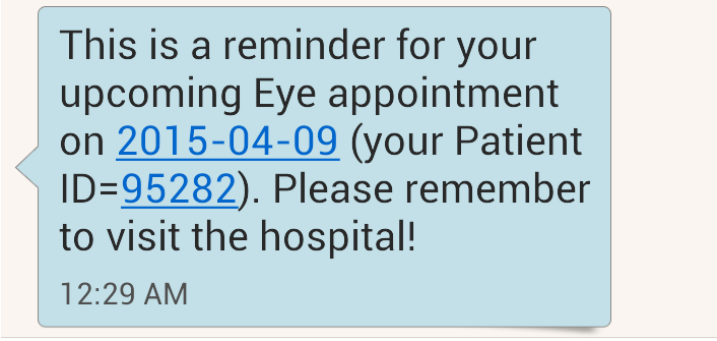

Figure 40. The modified version of upcoming appointment reminder.

Similarly, for reminders about missed/overdue appointment, all the participants said that the phrase "routinely sent" in the original reminder (Figure 41) could be taken out. Therefore, the modified version of referral reminder is shown in Figure 42. And we also moved the patient ID information to the end of the sentence to avoid breaking the reading flow. And we also changed the last sentence to in a nicer and welcome manner to improve the patient experience.

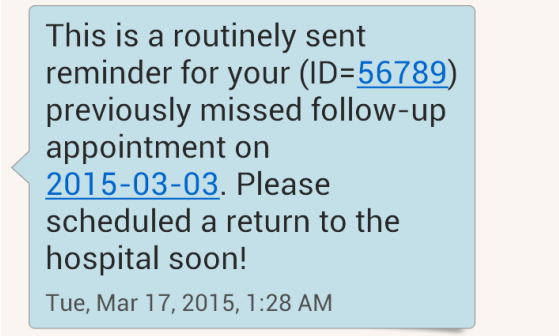

Figure 41. The original version of missed appointment reminder.

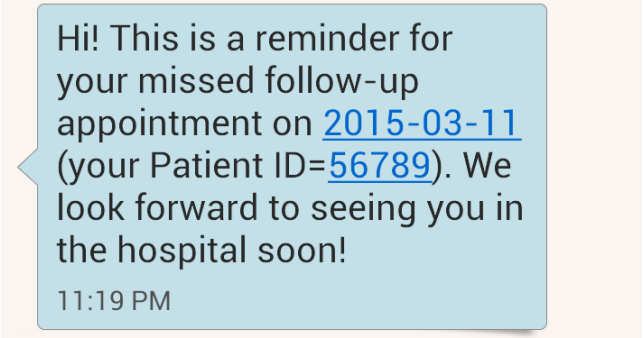

Figure 42. The modified version of missed appointment reminder.

2. The medical team in the hospital can review the appointment list on the system and see if the patients did return to the hospital or not.

a) Please review the appointment list on the system.

b) Please check the appointment information for the patient with ID: "56789".

c) Please check the appointment information on "3/2".

d) Please filter the patient list for those who missed their appointments, and exported the list as a spreadsheet (CSV file).

Findings:

In this task, we asked participants to walkthrough the web service of the SMS service for Appointment List on the Android tablet. Other than the previous findings from the similar UI for SMS Referral List, more problems have been revealed. Three

participants in fact turned the tablet from holding it vertically to horizontally because of the longer patient list for appointments as shown in Figure 43 at below.

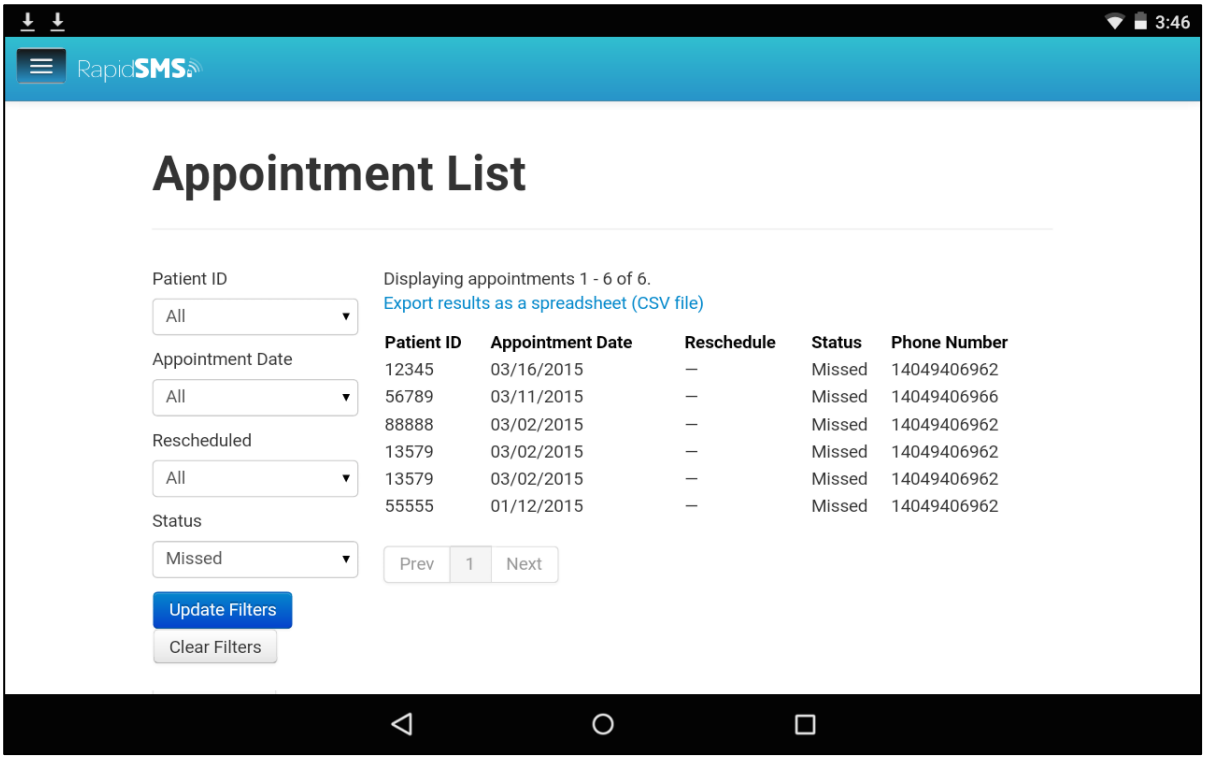

Figure 43. Original SMS Service UI for Appointment List on Nexus 7 Android tablet (in horizontal)

The first obvious problem is the layout for the filtering buttons are crammed together. Another unexpected behavior is the navigation bar still remained collapsed without becoming expanded. The original media query settings for layout responsiveness were not properly set up for the width of Nexus 7 tablet's screen resolution. From the evaluation tests, the results showed that three participants had problem finding the way to switch between Appointment List and SMS Referral List when the navigation bar was collapsed and hiding the options inside the menu button.

Therefore, we modified the responsiveness settings in CSS bootstrap framework for expanding the navigation bar when holding the tablet in horizontal, and change the button layout accordingly for fixing the button alignment issue. The modified SMS Service UI for Appointment List is shown in Figure 42.

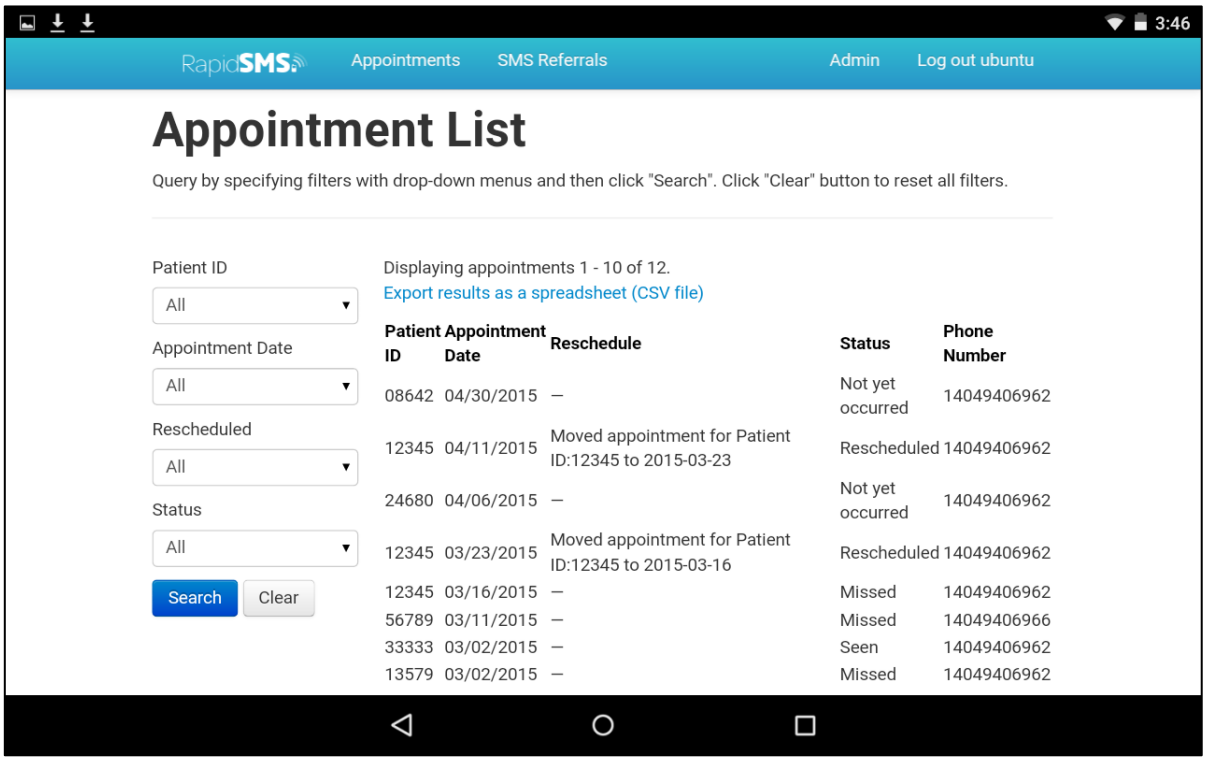

Figure 44. Modified SMS Service UI for Appointment List on Nexus 7 Android tablet (in horizontal) – Add introductory description, change query button layout, change button description, and navigation bar collapse/expand criteria for displaying menu options.

Other than these UI issues, all participants were able to complete the benchmark tasks for filtering specific patient, querying on specific date, getting a list of patients that missed the appointments, and exported the list as a spreadsheet file in CSV format.

7. Results:

After going through the benchmark tasks with participants, we asked participants to go through five questions and gave a number with seven Likert scale for sharing their thoughts about the questions. And then we conducted a brief semi-structure interview about their opinions and suggestions about the system in terms of usability or functionality. In this section, we will share the evaluation results from our post-test semi-structured interview and questionnaire results.

Quantitative questions:

1) **I think the sentences/descriptions on the system are simple and natural**
   (1: Least agree, 7: Totally Agree)

2) **I feel that the text and the font size are visible and readable**
   (1: Least agree, 7: Totally Agree)

3) **I think I can easily correct errors when using this system**
   (1: Least agree, 7: Totally Agree)

4) **Sometimes I don't understand what the system is showing**
   (1: Least agree, 7: Totally Agree)

5) **Do you think this system is useful?**
   (1: Least agree, 7: Totally Agree)

We calculated the average score and the standard variation for the answers of these five questions as shown in Figure 45 below for identifying where we need to further improve in terms of usability.

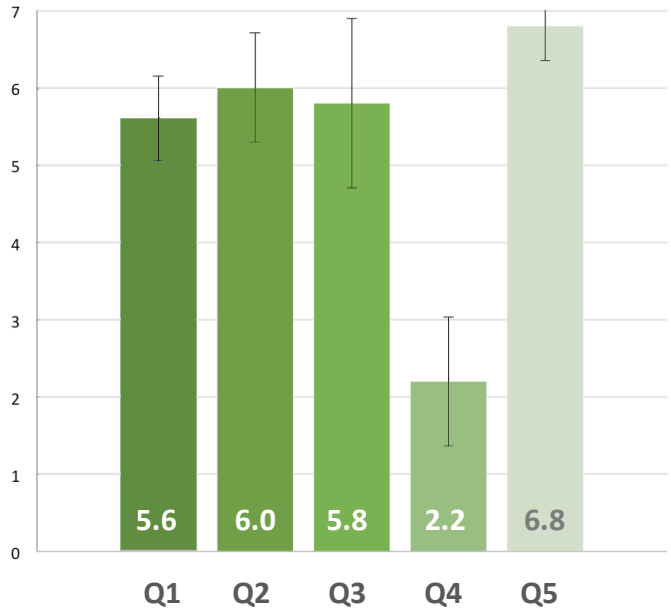

Figure 45. Average scores and variance for 7 point Liker scale

Generally, we did quite well for the first two questions. The descriptions are natural and the font size is readable.

For the third question, although the average score is slightly greater than the first question, it also comes with a greater variance. It is because one of the physicians only gave a "four" due to finding it difficult to correct a patient's contact number when scheduling the follow-up appointment. In our system design, this can be done by resubmitting the "follow-up appointment form" using ODK Collect again to correct the appointment date or patient's phone number. So in our final form design, as mentioned in the previous section, we added an extra cover page with instruction on it (as shown in Figure 38) for the "follow-up appointment form" to clearly show the usage, and iteratively change the way to phrase the instruction to help user easier capture the idea (as shown in Figure 39).

On the fourth question, two physicians mentioned they didn't know if the download had started when they tried to export the referral list as a spreadsheet file. Right now, the service relies on the interactions provided by the browser for downloading the file. In our tests, we asked participants to access the web page of our SMS Service directly on the Google Nexus 7 tablet. On Android, when clicking on download link, the UI will pop up a toast to provide simple feedback about the operation at the lower portion of the screen. (There is also an equivalent interaction design on iOS platform.) During the tests, two users were too focusing on the top-half portion of the screen so they missed the toast feedback. Also, both these two users are iOS users with less Android experience. Therefore, they did not notice the small download icon on the top-left corner of the notification bar indicating the download events. Once we explained and pointed out this behavior with the participants, they were no problem regarding the download behavior. They both agreed this is just a minor case and the improvement should be considered as "nice-to-have" rather than a showstopper. We can still include this finding as one of the items for future improvements but with a lower priority.

For the last question, most of the participants consider this system is helpful and expect the system design should be feasible for pediatric ophthalmology in Africa.

Qualitative questions:

1) **I understand the system's feedback based on my interaction with it**
   (If yes, please specify.)

2) **I feel that there are some parts of the system are inconsistent**
   (If yes, please specify.)

3) **Sometimes I want to do a specific task but I don't know how to**
   (If yes, please specify.)

4) **What was the difficulty for performing each of these tasks?**
   (If yes, please specify.)

5) **What other suggestions do you have for this system?**

For the first question, similarly, two participants expressed their confusion about whether the download session had started or not when trying to export the patient list as a spreadsheet file from the UI of SMS Service. The second question is about consistency. All participants think the system design maintains good consistency without hesitation. For the third question, as in previous quantitative evaluation, one participant cannot figure how to correct patient's contact number for the follow-up reminder.

For the fourth question regarding the difficulty to perform these tasks, most of the participant said no obvious difficulty other than the UI suggestions they shared during the tests. One participant mentioned no significant difficulty other than "not knowing how to do so". However, even so, she does not think this is a serious problem since she considers all these UI and interactions are in fact not complicated. She believes having a brief training session or a quick-start menu at hand should greatly alleviate this problem even for people like her without extensive experience with mobile devices or information technologies.

Finally, for other suggestions, three participants suggested having a training session and a quick-start menu for introducing the ODK Collect, how to fill up and submit forms, referring patient with SMS, and how to check the referral list and appointment list with the

SMS Service. Generally, they are all satisfied and feel excited about the progress and the system and even discussed about the opportunities for other collaborations in the future.

8. Future Visions:

For feature wise improvement, the next major improvement will be having a refined portal to access patient's medical record. Currently, the system depends on ODK Aggregate to access patient's medical records. The user must first specify the medical form and then filter the form submissions by patient's ID. The feedback we gathered from the medical staff of Emory Global Vision Initiative found that the ideal experience would be to allow the medical staff to see all medical records of a patient at once after entering Patient ID without the need to switch among different medical forms.

In our system evaluation, we did not go through this part of the workflow, to retrieve patient's medical record, since it was not included in our project scope. It is because the medical team from Emory Global Vision Initiative deprioritized having a refined medical data retrieval UI and considered having the SMS Service capability for referring patients and sending appointment reminders as more essential to the project. Right now, all the features of the SMS Service are completed and tested locally here in North America with the SMS backend provider Tropo. Therefore, the next step will be designing and implementing the refined UI for accessing the medical data submissions from the Android Tablet (ODK Collect) rather than using ODK Aggregate.

We envision the new medical portal would be another web service being deployed on the same Amazon AWS server as the ODK Aggregate and RapidSMS (SMS Service). The new medical portal should interact with the same MySQL database so that it can directly query all the medical data submissions from ODK Collect with the Patient ID. To the database, each electronic medical form is an individual table. Therefore, the new medical portal service should take the query key (i.e. Patient ID) from the user and then handle the multiple queries to all the medical electronic forms.

There will be two approaches to bring up the new medical portal service. One approach is to independently build up all the required features based on several latest web development frameworks to interact with the MySQL database such as using AngularJS and

PHP. At UI level, the new medical portal service should display all the existing form submissions according to the query results of a specific patient ID.

Another approach is to look for other existing open-source software being designed for medical purpose such as OpenMRS. However, the challenge of this approach will be the integration issues similar to what we went through in this project. But the good thing is that as long as the open-source software is backed up by a group of developers who are activity sharing and exchanging their experience, it could be a great resource to help wade through the integration difficulties and also make this system to have better sustainability.

9. Lessons Learned:

Flexibility and Scalability are important. Even within Africa, different countries have different context and different workflows. Therefore, we have to always keep in mind about the flexibility when designing the system and service. This is also true for scalability. It is nothing wrong to start from a workable solution, but we have to consider the case when the scale goes up as well.

The surrogate's experience is valuable. Surrogates can never represent the real users. But surrogates' prospective and experience are tremendously helpful during the design process through out the project. They help come up the project requirements, justify the design decisions, and provide valuable feedback to avoid the system having the obvious feasibility issue to the context of the problem space we are targeting to solve.

Service Diagram is really helpful. Comparing to the traditional system specification documents, the service diagram is really helpful by having more visual elements. It helps different stakeholders easily communicate with each other, make sure everyone share the same understanding about the whole picture of the problem, and also serves well as the system specification by clearly expressing the expecting behaviors from the system in different scenarios and with users from different roles.

Don't radically break the existing workflow. Although not participating in the evaluation, the last feedback from the medical team in Northern Tanzania is satisfied with the workflow diagram with our system. I learned that other than considering the technical feasibility, it is always better not radically break the existing workflow, but rather having the

technology to fit and strengthen the existing workflow so as to improve the system feasibility and potentially increase the level of user's satisfaction.

10. Reference:

[1] World Health Organization. Global Initiative for the Elimination of Avoidable Blindness. Geneva: WHO, 1997.

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[3] Lucas, H. (2008). Information and communications technology for future health systems in developing countries. Social Science & Medicine, 66(10), 2122-2132.

[4] Best, M. L., Smyth, T. N., Serrano-Baquero, D., & Etherton, J. (2009, April). Designing for and with diaspora: A case study of work for the truth and reconciliation commission of Liberia. In CHI'09 Extended Abstracts on Human Factors in Computing Systems (pp. 2903-2918). ACM.

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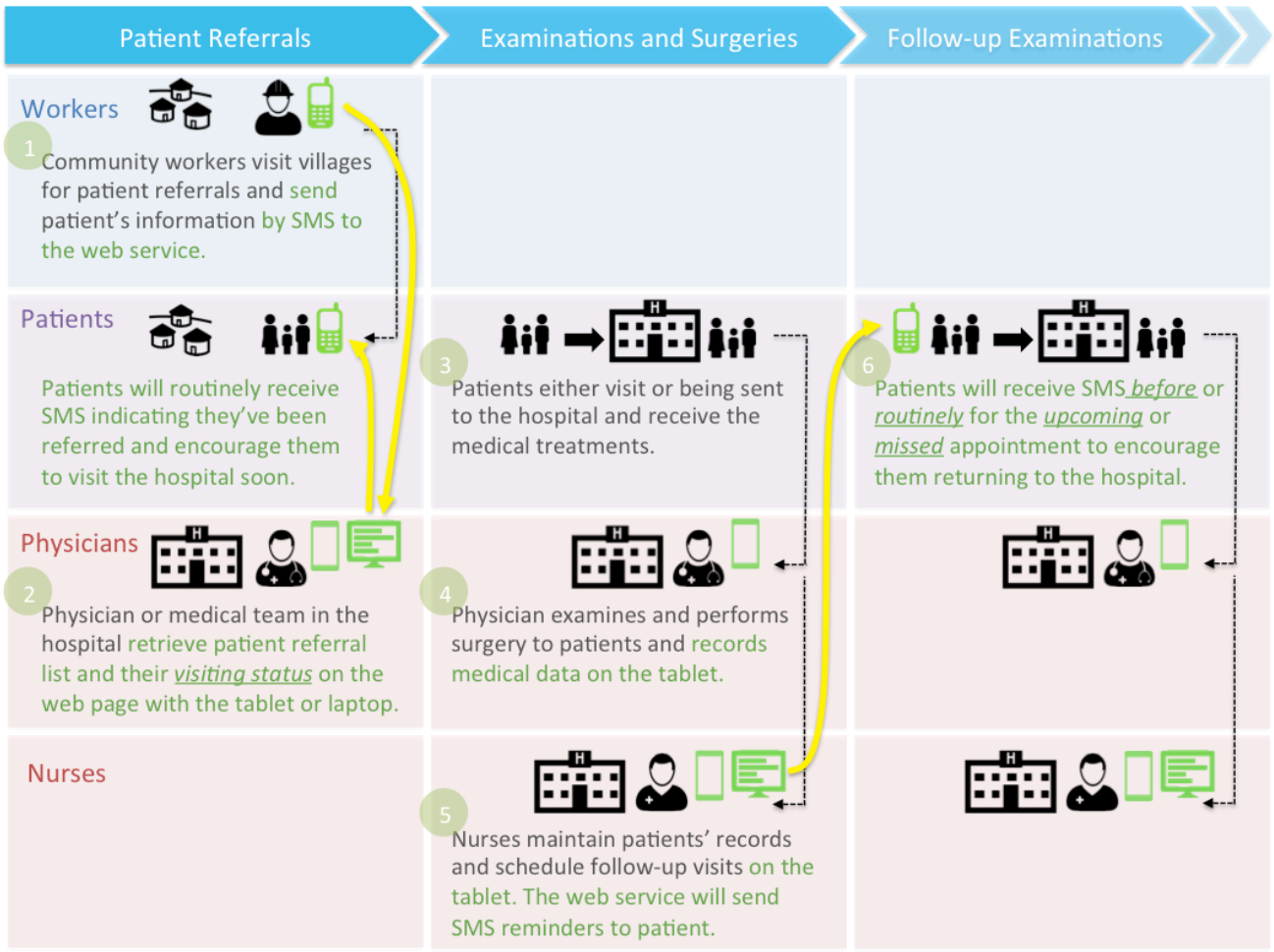
Childhood Cataract
Patient Record System for Africa

Project Evaluation Plan – version 8.0

1. Workflows:



There are three primary stages for this project:

1. Patient Referrals –

1) Community workers visit villages for patient referrals and send patients' information by SMS to the web service.
2) Physician or medical team in the hospital retrieve patient referral list and their visiting status on the web page with the tablet or laptop.

** Patients will routinely receive SMS indicating they've been referred and encourage them to visit the hospital soon.

2. Examinations and Surgeries –

3) Patients either visit or being sent to the hospital and receive the medical treatments.
4) Physician examines and performs surgery to patients and records medical data on the tablet.

5) Nurses maintain patients' records and schedule follow-up visits on the tablet. The web service will send SMS reminders to patients.

3. Follow-up Examinations –

6) Patients would receive SMS before or routinely for the upcoming or missed appointment to encourage them returning to the hospital.

2. Benchmark Tasks for System Evaluations:

The system consists two primary portions, the **Data Collection** portion for *collecting medical data*, and the **SMS Service** portion for *patient referrals* and sending reminders to patients for their *follow-up visits*.

We designed the first five electronic medical forms based on the original paper-based form from Kilimanjaro Christian Medical Centre (KCMC) in Northern Tanzania for different stages of the medical treatments. And the sixth form "Follow-up Appointment Form" is added to link Data Collection system and the SMS service together. After submitting this form to schedule a specific follow-up visit date, the SMS service will generate and send the SMS to the patient for reminding purpose.

(1) Pre-operative Form
(2) Intra-operative Form
(3) Post-operative Form - Day 1
(4) Post-operative Form - Discharge
(5) Post-operative Form - Follow-up
(6) Follow-up Appointment Form

For the usability evaluation, we will follow the aforementioned order of the workflows to go through the process with a fictitious patient, "George Burdell". Please follow the instructions for each task with the mock patient's data in appendix.

1) Patient Referrals –

1. The community worker identifies a patient and tries to refer the patient with required patient information by using SMS text message.

a) Please try to refer the patient by using SMS and send it to "404-850-9528" (SMS service):

** **Command format:**

appt new eye *FirstName_LastName PatientPhoneNumber*

ex. appt new eye George_Burdell 14049406962

2. The medical team in the hospital can review the referral list on the system and see if the patients being referred visited the hospital or not.

Imagine you work in the hospital and want to check the referral list to see if the patients had already visited the hospital or not.

a) Please review the list of patients being referred on the system.

b) If you would like to contact the patient "George Burdell" who hasn't visited the hospital, are you able to find his contact phone number?

c) Please get the list of patients being referred on "3/29", and exported the list as a spreadsheet (CSV file).

3. The patient being referred would receive a SMS bi-weekly to remind about the visit to the hospital.

Imagine you are a patient being referred.

a) Are you able to understand the description of the reminder SMS about the visit to the hospital?

2) Examinations and Surgeries –

1. **The patient being referred visits the hospital for the first time. The medical team fills up the patient's basic information and performs clinical examinations before the surgery.**

   a) **Please fill in patient's information and examination results into "_1_Pre-operative_form" with the Android tablet.**

2. **After perform the surgery, the medical team fills up the surgery information to the system to record any additional findings or difficulties.**

   a) **Please fill in surgical information into "_2_Intra-operative_form" with the Android tablet.**

3. **Before discharging the patient, the medical team performs additional examinations and fills up the results as a part of patient's medical history.**

   a) **Please fill in examination results into "_3_Post-operative-Day1_form" and "_4_Post-operative-Discharged_form" with the Android tablet.**

4. **Since the patient is still growing, the follow-up visits are essential to the treatment process. The medical team will schedule the next follow-up appointment after completed all the examinations.**

   a) **Please fill up "_6_Follow-up_appointment_form" on the Android tablet to submit the next scheduled visit for setting up the SMS appointment reminder.**

   b) **If you accidently type in the incorrect patent's contact number. Do you know how to correct the appointment information?**

3) Follow-up Appointments and Examinations –

1. **The patient would receive SMS reminders bi-weekly about the visit to the hospital.**

    a) **Are you able to understand the description of the reminder SMS about the upcoming visit to the hospital?**

2. **The medical team in the hospital can review the appointment list on the system and see if the patients did return to the hospital or not.**

    a) **Please review the appointment list on the system.**

    b) **Please check the appointment information for the patient with ID: "56789".**

    c) **Please check the appointment information on "3/2".**

    d) **Please filter the patient list for those who missed their appointments, and exported the list as a spreadsheet (CSV file).**

3. Questions:

Quantitative questions:

1) **I think the sentences/descriptions on the system are simple and natural**

   (1: Least agree, 7: Totally Agree)

2) **I feel that the text and the font size are visible and readable**

   (1: Least agree, 7: Totally Agree)

3) **I think I can easily correct errors when using this system**

   (1: Least agree, 7: Totally Agree)

4) **Sometimes I don't understand what the system is showing**

   (1: Least agree, 7: Totally Agree)

5) **Do you think this system is useful?**

   (1: Least agree, 7: Totally Agree)

Qualitative questions:

1) **I understand the system's feedback based on my interaction with it**

   (If yes, please specify.)

2) **I feel that there are some parts of the system are inconsistent**

   (If yes, please specify.)

3) **Sometimes I want to do a specific task but I don't know how to**

   (If yes, please specify.)

4) **What was the difficulty for performing each of these tasks?**

   (If it is difficult, please specify which task and why.)

5) **What other suggestions do you have for this system?**

Appendix

Mock Patient's Data:

Pre-op Form

Form Questions	Sample Answers
The unique ID of the patient:	11111
Date	3/18/2015
Outpatient Department (OPD) Number:	123
Patient's Information	
Patient Name	George Burdell
Year of Birth	2010
Sex	male
Contact mobile phone number:	14049406966
Patient's location	
Address/Village	251 10th Street
Ward	
Visual acuity - Chart used:	Linear
Visual acuity - Method used:	Tumbling-E
Visual acuity - Right eye:	
Uncorrected visual acuity (Distance, Right eye):	20/100
Corrected visual acuity (Distance, Right eye):	
Pinhole acuity (Right eye):	20/80
Uncorrected visual acuity (Near, Right eye):	
Corrected visual acuity (Near, Right eye):	
Visual acuity - Left eye:	
Uncorrected visual acuity (Distance, Left eye):	20/80
Corrected visual acuity (Distance, Left eye):	
Pinhole acuity (Left eye):	20/60
Uncorrected visual acuity (Near, Left eye):	
Corrected visual acuity (Near, Left eye):	
Relative Afferent Pupillary Defect (RAPD):	no
Cataract:	
Cataract eye:	right
External photo documenting cataract (optional):	

Type of cataract:	Congenital
Age when cataract was first noticed in years:	
Cataract recognized age (in year):	4
Cataract recognized age (in month):	
Eye(s) to be operated:	right
Co-morbid eye diseases (Operative eye):	
Corneal opacity affecting vision	no
Strabismus	no
Microphthalmos	no
Glaucoma/buphthalmos	yes
Nystagmus	no
Co-morbid eye diseases (Other eye):	
Corneal opacity affecting vision	no
Strabismus	no
Microphthalmos	no
Glaucoma/buphthalmos	no
Nystagmus	no
Intraocular pressure (IOP):	
IOP - Right eye	20
IOP - Left eye	18
Method used (IOP):	Tonopen
Other systemic abnormalities/developmental delays:	
Hearing loss	yes
Developmental delayed	no
Physical handicap	no
Epilepsy	no
Heart problems	no
Examiner:	Tester1

Intra-op Form

Form Questions	Sample Answers
Patient ID:	11111
Date	3/18/2015
Surgeon:	Tester1
Surgery Information:	
Eye to be operated:	right
Type of surgery:	Lens aspiration
Incision:	Tunnel
Suture:	no
IOL Implanted:	yes
IOL Implanted:	In sulcus
Upload IOL Sticker	
Ultrasound biometry:	
Place A-scan here:	
Place B-scan here (optional):	
Surgery Review:	
Surgical Difficulties:	Small pupil (<5mm)
For "other surgical difficulty", please specify:	
Surgical Complications:	yes
Please describe the surgical complications:	Nothing is easy
Primary posterior capsulotomy:	no
Victrectomy:	yes
Victrectomy:	Anterior

Post-op Form - Day1

Form Questions	Sample Answers
Patient ID:	11111
Date	3/18/2015
Visual acuity	
Visual acuity - Chart used:	Tumbling-E
Visual acuity - Method used:	Linear
Visual acuity - Operative eye:	
Uncorrected visual acuity (Distance, Operative eye):	20/60
Corrected visual acuity (Distance, Operative eye):	20/40
Pinhole acuity (Operative eye):	20/40
Uncorrected visual acuity (Near, Operative eye):	
Corrected visual acuity (Near, Operative eye):	
Intraocular pressure (IOP):	
IOP-operative eye	24
Method used (IOP):	Tonopen
Examinations:	
Cornea Clear	yes
AC Deep	no
Fibrin	no
Hyphema	no
IOL Centered	no
Hypopyon	no
Red Reflex	no
Unable to examine	
Other examination, please specify:	
Examiner Name	Tester 1

Post-op Form - Discharge

Form Questions	Sample Answers
Patient ID:	11111
Date	3/18/2015
Visual acuity	
Visual acuity - Chart used:	Tumbling-E
Visual acuity - Method used:	Linear
Visual acuity - Operative eye:	
Uncorrected visual acuity (Distance, Operative eye):	20/60
Corrected visual acuity (Distance, Operative eye):	20/40
Pinhole acuity (Operative eye):	20/40
Uncorrected visual acuity (Near, Operative eye):	
Corrected visual acuity (Near, Operative eye):	
Reason for reduced VA, if pinhole VA <6/18	Co-Morbidity
Specify	
Intraocular pressure (IOP):	
IOP-operative eye	20
Method used (IOP):	Tonopen
Examinations:	
Cornea Clear	yes
AC Deep	no
Fibrin	no
Hyphema	no
IOL Centered	no
Hypopyon	no
Red Reflex	no
Unable to examine	
Other examination, please specify:	
Retinoscopy done	yes
Retinoscopy findings:> Right eye:	
Sphere	10.25
Cylinder	0.5
Axis	0
Retinoscopy findings:> Left eye:	

Sphere	20.5
Cylinder	0.75
Axis	0
Glasses prescription:> Right eye:	
Right eye:	
Sphere	10.25
Cylinder	0.5
Axis	0
Glasses prescription:> Left eye:	
Sphere	20.5
Cylinder	0.75
Axis	0
Spectacles provided:	no
Spectacles provided date (optional):	
Amblyopia Treatment	yes
Why?	
Amblyopia treatments:	
Amblyopia treatment used:	Patch
For other treatment, please specify:	
Amblyopia treatment dosage information:	
Which eye:	right
How often:	1 to 2 hours a day
Examiner Name	Tester 1