Sentinam Innovations

School of Engineering Science
Simon Fraser University
Burnaby British Columbia

December 17, 2015

Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Sentipump Post Mortem Report

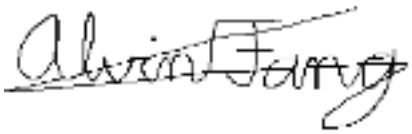
Dear Dr. Rawicz,

The attached document, Sentipump Post-Mortem Report, outlines a review of the development and integration process followed by our team for our Capstone project. We implemented an infusion pump for IV drips, with remote monitoring capability. We improved upon the current infusion pumps, by making our product smaller, less expensive, and with a capability to be remotely monitored.

This document highlights the phases of development of the device, the deviations from the initial design plan, adherence to budget and timeline, and the future plans for the company and the product. In addition, we also include our personal reflections about the course and the project, including lessons learnt and experience gained.

Our team, committed to this project, consists of five high-achieving, motivated, and resourceful senior engineering students, covering a diverse range of engineering options and backgrounds. The members are Alvin Fang, Pranav Malik, Baljinder Singh, Chelsey Currie, and Nyann Moe. If you wish to contact me, please reach me at kpfang@sfu.ca. Thank you for your time and consideration.

Sincerely,



Alvin Fang
Chief Operational Officer
Sentinam Innovations

Enclosed: *Post Mortem Report for Sentipump*

Post Mortem Report for a Remote Monitored IV for Home Care

Project Team: Alvin Fang
Chelsey Currie
Pranav Malik
Baljinder Singh
Nyann Moe

Contact Person: Alvin Fang
kpfang@sfu.ca

Submitted to: Andrew Rawicz – ENSC 440
Steve Whitemore – ENSC 305
School of Engineering Science
Simon Fraser University

Issue Date: December 17, 2015
Revision: 1.1

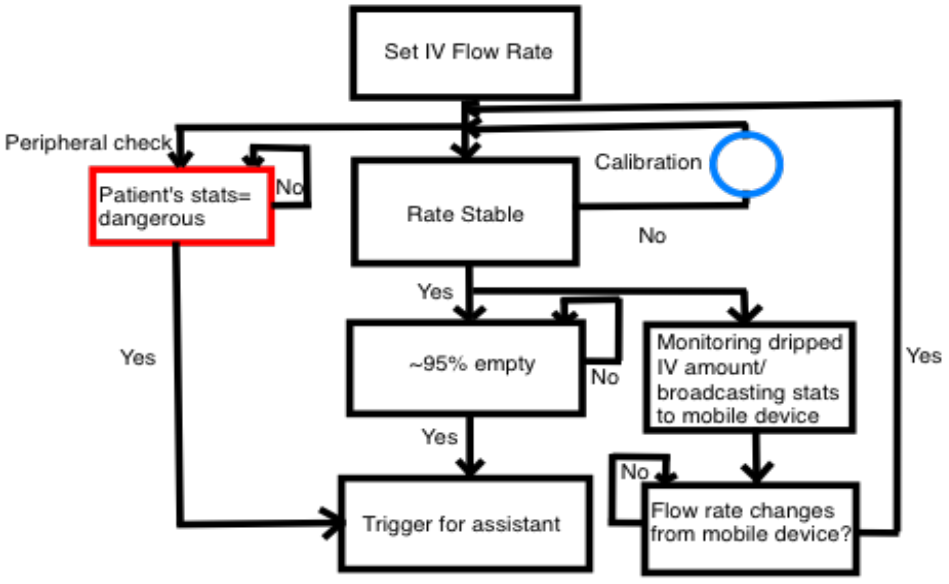
Table of Contents

1. Introduction

Throughout the course of the semester, the members of Sentinam Innovations have worked round the clock to develop and implement the idea for Sentipump, a remote monitored IV drip, intended for home care use. Five individuals with diverse backgrounds and skills have come together to complete the realization of the idea for Sentipump. This report highlights the various phases of development of Sentipump, the problems faced by the team, and the solutions implemented to overcome the problems and ensure a reliable and safe design. Furthermore, the personal experiences and reflections of each individual involved in the creation of this product are also documented in this report.

2. Current State of the Device

As stated in the design specifications report, Sentipump is an enhanced infusion pump for IV, which allows the rate of flow of the IV fluid to be monitored and changed remotely through a smartphone or tablet. In addition, the built in temperature and pulse sensors also allow the patient's body temperature and heart rate to be displayed and monitored, both on the physical device and on the mobile application. The system overview flowchart shown below summarizes the functionality of Sentipump.



Overview of the Sentipump functionality.

3. Deviation from Initial Design Plan

The prototype meets the all the functional requirements highlighted in the proposal and functional specifications document. Due to constraints in time and budget, we were not able to develop a proper casing for Sentipump, to power it up using batteries, and to make it compact and portable as mentioned in the proposal.

Our prototype consists of a basic plastic case, containing two prototyping boards. The two boards house the circuits for the drip counter, and the LCD screen, connected to the Arduino microcontroller. We were able to use an actual IV bag, IV pole and the required tubing as promised in the proposal.

Due to incompatibility of the flowmeter sensor with the Arduino microcontroller, we had to design our own drip counter circuit. This circuit uses a photo emitter-detector setup with the help of infrared LED's to detect the number of drops in the drip chamber of the IV tube. This data is then converted to Arduino readable format, and the Arduino then calculates the rate of flow and displays it on the LCD screen.

4. Mobile App

We had initially proposed to implement our remote monitoring app with the help of WiFi technology. However, in the case of the Arduino WiFi shield, the code libraries provided by Arduino cannot be used to flexibly connect to any network the user wants, because the network accessed has to be hard-coded. In addition to this lack of flexibility, the library does not inherently support the username/password authorization login method on SFU campus. Alternatively, using an Arduino Ethernet shield requires an Ethernet cable connection to a router, which is an inconvenient restriction in placement since our microcontroller will be attached to our infusion pump, and it this requirement is unlikely to be fulfilled both for our demo and in a production environment.

Therefore, we decided to establish a connection using Bluetooth. Bluetooth is more cost efficient than WiFi or Ethernet, and the Bluetooth shield uses fewer pins on the Arduino, leaving space for other components like the LCD and the drip counter.

We were not able to fully implement a user authentication mechanism for the app. Currently there is a system that asks for the user's ID, but in order to make modifications to the user details, we would have to implement a database server and a web page, which was not possible due to time constraints.

5. Future Plans

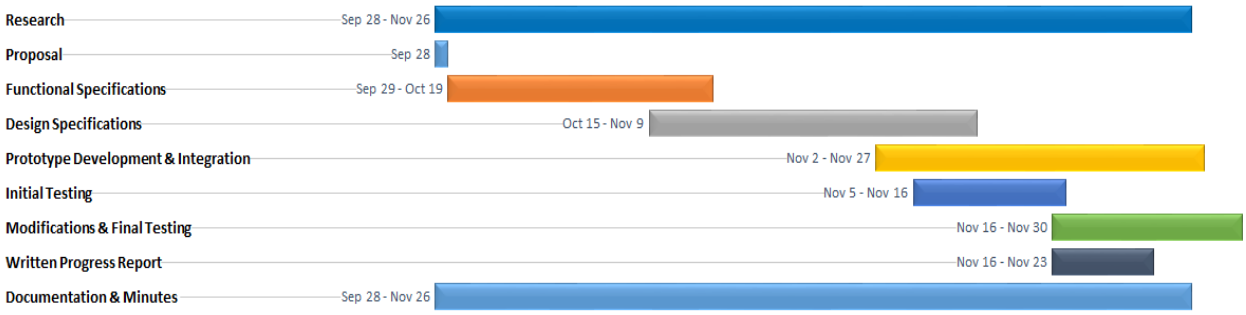
We believe that Sentipump has solid potential in the market for medical devices, but needs to undergo the following changes before being introduced in the market:

- **Packaging the device:** To make the current prototype compact and portable, we would have to build a custom case to house the circuitry and the LCD screen. This would also enable us to power the system through backup batteries instead of depending only on the power supply.
- **Enhancing the User Interface:** We will be implementing a keypad and a dial to make it easier to change values of flow rate, and also to browse between menu items faster than the current refresh rate of the LCD screen.
- **Using a Flowmeter Sensor:** We will be replacing our existing drip counter circuit with an industrial grade flow sensor, to enable us to achieve higher precision required to meet the standards required for medical devices.
- **Implementing User Authentication:** A username and password screen will be added to both the physical infusion pump and the remote app. This will provide accountability and ensure security of the patients by making sure that the device can only be operated by a certified healthcare practitioner or a doctor.

Once the changes mentioned above are applied to our current prototype, we plan on testing our device with our target audience, namely people who require the use of IV at home. The feedback received from them would help improve our design further, and also give us the perspective of the user which will help us to see if there are any other functions we could add to Sentipump.

6. Adherence to Budget and Time Constraints

6.1 Time



Proposed timeline [1]

Despite our best efforts, we were not able to adhere to the proposed timeline. This was due to certain factors that the team members did not take into account, and also some factors that were beyond our control. These factors included lack of thorough research to find the best options for each component, failure to have backup components, shipping delays, and incompatibility of components with the system.
It took almost twice the proposed time for each phase of prototype development. We started developing the prototype on the proposed date of November 2, but the integration and completion was delayed by two weeks. Similarly, the testing and modifications were consequently delayed, reaching completion only by December 15. The above factors combined with the team's final exam schedule significantly delayed our project.
The actual implementation of the prototype was completed on December 15, two days before the scheduled demo date.

6.2 Budget

The table shown below presents the proposed and actual budget cost. The components shown in the brackets are the alternatives we used instead of the proposed components.

Equipment	Proposed Cost	Actual Cost
IV bags	$5	Borrowed
IV tubing	$50	Borrowed
Valves (Pump)	$20	$15
Flowmeter (Drip counter)	$60	$40
Arduino Microcontroller	$60	$15
LCD Screen	$50	$50
Keypad (push buttons)	$30	$10
Casing	$25	$60
Temperature Sensor	$15	$10
Pulse Oximeter	$45	Not

		implemented
Arduino wireless shield (bluetooth shield)	$100	$65
Overhead and Misc costs	$50	$60
Total	**$510**	**$325**

Our actual budget is less than the proposed budget since we did not use flowmeter, which is the most expensive component, and could not implement pulse oximeter due to time constraint. Also, we borrowed the IV bag and tubing which eased off the cost little more.

7. Workload Distribution

	Work Breakdown Chart				
Task	**Mo**	**Pranav**	**Baljinder**	**Chelsey**	**Alvin**
Administrative tasks		X			X
Packaging			X	X	
Documentation		X		X	X
Parts Sourcing		X	X	X	
System Testing	X	X	X	X	X
Mobile App Development	X				X
Pump Calibration	X	X		X	
Sensor Calibration	X		X		X
Circuit Implementation	X	X	X	X	
Microcontroller programming	X				X

Workload Distribution Chart

8. Interpersonal and Technical Experiences

Chelsey Currie

I feel like we had a very successful group this semester because we had such a diverse group of people. Everyone had a very different background and different strengths; we had a systems engineers, computer engineers, an electronics engineer, and a biomedical engineer. The different viewpoints were very necessary when making an interdisciplinary project like an infusion pump, and I feel like I learned a lot from the other members of my group.

I really enjoyed being in charge of the drip counter circuit. It was great to memorize the circuit, and make important decisions about the sensor based on the research I had done. I feel like my circuit design skills really improved this semester, as well as my soldering skills. I ended up doing almost all the soldering for the project, so it was great practice! I also feel like having a self guided project challenged me because I had to find my own discipline and initiative.

My favourite part of this project was getting into designing the high level design of the pump. I feel like it gave me a good sense of how a research and development team would work in industry. I liked how we would have an idea, and then need to analyze it to figure out what issues there would be if we implemented the idea. The hardest part of the project was editing and testing my circuit design. Sometimes the drip counter circuit would stop working for no apparent reason, and I would have to troubleshoot it. It was a difficult job to look at the output behaviour to try and figure out what was wrong, but I feel like this experience taught me perseverance, and strengthened my understanding of circuit design.

I really enjoyed building the Sentipump, and I would like to continue working with my teammates to develop the idea. I think that we have an interesting project that could add to the infusion pumps that are currently on the market, and I would love to develop it further!

Nyann Moe

ENSC 440/305 definitely pushes the boundaries of friendships. There were times when I believed some of us would no longer be as close as we were. But you learn to work together and get over these obstacles, and when the job is done all is forgiven. Overall it was a wonderful experience working with four talented engineers who are passionate about the various areas of engineering like electronics and biomedical.

I enhanced my communication and time management skills and tried to make sure I was able to give enough time to the project, and also not fall behind on the rest of my classes. I realised, that no matter how much planning, time management or scheduling you do, there is no perfect development cycle. Life always has a way of throwing curve balls. Parts were delayed, parts didn't function at crucial moments and nothing was ever guaranteed although you thought it was done. Even though it took a lot of time and frustration, I am glad we were able to achieve what we had set out to at the beginning of the semester.

I also definitely improved my coding skills, and implemented better coding practices to make it easier for my teammates to verify and debug my code. It was also required that I integrate my code with the code for the mobile application, so clarity and format was definitely important to make debugging and syncing easy. In the end, I would like to see that applying a concept to develop a product, is the best way to learn the concept thoroughly.

I would like to thank the professors, TA's and my teammates for all their hard work this semester, and am elated that we successfully developed Sentipump!

Pranav Malik

I feel very lucky to have had the chance to work with such a diverse group of individuals, who bring so many different skills to the table and are also calm and understanding. We had a lot of fun working together as a group, and it is definitely safe to say that I learned a lot of new things from each and every one of them. I hope they learned something from me as well :).

On the technical side of things, this was my first time working with an Arduino. I learned about the different libraries and also enhanced my debugging skills. My circuit building and troubleshooting skills were also put to test while helping implement the drip counter circuit. I learned more about op-amps, transistors and also photodiodes, which we used to implement the circuit that counted the number of drips going into the drip chamber. I understood the importance of having a solid initial design, and thoroughly researching all the parts before buying them to avoid issues of incompatibility. In hindsight, we would have completed our project a lot sooner had we brainstormed further before coming up with our initial design.

I also realized how wrong we were while coming up with an initial timeline. The actual timeline took almost twice as long due to breaking of circuit components, incompatibility of the sensors and other unforeseen circumstances such as not being able to use water in the lab. Fortunately, we were able to allot ample time for testing to make sure we had a reliable product in the end.

Personally, I honed my project management skills and was able to make sure that we stick to the meeting agendas without veering away. I was able help resolve any conflicts that popped up and honed my patience skills, while trying to help everyone at the same time. The only regret I might have had is that I was not able to work more hands on in certain aspects of product development, but I am glad that I had team members who were more than up to their tasks.

Overall, it was a fun experience and I would love to work with my teammates again in the future, possibly to even take our product to market!

Alvin Fang

Overall it has been a very interesting semester working on this project. We got to work on a great project idea, and experience many aspects of product development, thanks to the mix of hardware and software components we needed to work with. I've never worked on biomedical

devices before, which made this project seem even cooler to me. As someone who usually only works with software, it was a lot of fun working with my teammates, who focused mostly on the hardware. I haven't built circuits in a year or two, and working with them helped me warm up my circuit building skills, as well as learn some neat new tricks with the circuit board.

We formed this team with people we mostly never met before, and it's almost unbelievable how well this has worked out. First of all, our team happens to consist of people with a well balanced range of different backgrounds. We actually had a slow start because we formed the team in the first week of class, and were slow to decide on our project idea. However, after we decided on the idea, everything else came together exceptionally quickly. I was fortunate to join a team with great chemistry - in the days that we had to work late hours, the team's sense of humour and determination kept us going, and made our work much more enjoyable. It's quite a sight to see a mostly randomly formed team work together so well! We were told that we should form a group and start work on the project before the semester starts, and randomly formed teams often suffer from teamwork issues. I think it's safe to say that we did very well to overcome the odds and defy those warnings.

I had a lot of fun working on the Arduino component of our project, and the mobile application for Android devices. I got great experience in researching and planning the design of the project. In this Capstone course, I've been very interested in trying to develop for Arduino, and I'm happy to have been able to do so. It was fun designing the app to communicate with the Arduino through Bluetooth, and see the app and Arduino work together so well. The Android app was developed using Java, and while I have coded a lot in Java before, I gained experience in developing using native android tools and code libraries. Some features I implemented on the app that were most interesting to design include setting up the bluetooth communication system, setting up threads to run tasks concurrently, and handling of multiple constraints with timers and alarms. The not so fun tasks were fixing interface issues, unplugging the bluetooth every time I want to update the Arduino software, and debugging a glitch with the LCD that couldn't be reproduced consistently.

Baljinder Singh

The entire semester of capstone project has been an amazing experience. All my team members are aspiring engineers and have shown professionalism and teamwork throughout the whole project. I learned some new skills and improved on some existing ones.
Our group handled the documentation part very well with each one of us pitching in and some even more than others. I was given the Solidworks part as I was the only one in the group who was familiar with the software. I designed the overall system of how our system will or might look like, maybe not for prototype version but probably for industrial version. I couldn't help my group in the software development stage since I don't have much experience in coding. I was

also responsible for searching up materials for casing for the device and to come up with a design for the prototype version. I also learned a lot about how medical devices work while searching for the infusion pump working. Medical devices had to go through a lot of standards and rigorous testing so as to be deemed safe for use.

Time management is another thing I improved upon. I have learned that planning ahead is very important in completing a project. I have also learned to be understanding. Respecting and listening to your team member's ideas is an important aspect for establishing good team environment.

9. Conclusion

This semester was an excellent learning experience for our entire group. We made a project that we really enjoyed and are proud of, and some of us may even continue developing the Sentipump after this semester is over. Our group's diverse skills helped us when designing and implementing the prototype, and we learned a lot from each other.

10. References

[1] A. Fang, C. Currie, P. Malik, B. Singh, N. Moe, "Project Proposal for a Remote Monitored IV for Home Care," unpublished.

[2] A. Fang, C. Currie, P. Malik, B. Singh, N. Moe, "Functional Specification for a Remote Monitored IV for Home Care," unpublished.

[3] A. Fang, C. Currie, P. Malik, B. Singh, N. Moe, "Design Specification for a Remote Monitored IV for Home Care," unpublished.

[4]

Appendix
Meeting Minutes

Meeting minutes and agenda

September 11, 2015 from 11:00 am to 12 pm

1. Roll Call:
   Everyone present

2. Brainstorming ideas:
   Chelsey: ENSC 372 idea of CPR. Current method of mouth to mouth air not efficient. Air might go into stomach in which case CPR has to be stopped and have to wait 3-4 mins which could be fatal.

   Alvin: web design

   Moe: what do we need to create

   Chelsey: manual solution powered by battery

   Moe: any other ideas

   Pranav: will present in next meeting

   Everyone: Agreed on doing Biomed project with some coding involved

3. Next meeting will be on Monday
4. **Meeting adjourned**

Sentinam Innovations

School of Engineering Science
Simon Fraser University
Burnaby British Columbia

Meeting minutes and agenda

September 14, 2015 from 10:30am to 12:30pm

1. Roll Call:
   Everyone present

2. Brainstorming ideas:
   Everyone presented their ideas and got feedback from everyone else.

   In home sensors (Alvin): security system for home intrusion prevention with app

   Bus drivers pay cut app (Alvin): bus drivers will get their pay cut depending on how late are they

   Blood sugar measuring (Chelsey): testing blood sugar without having to poke with a needle

   ECG monitor (Chelsey): portable ECG monitor with mobile app

   Vein finding (Pranav): looking for a solution to help find veins in kids

   Tonometer (Baljinder): some way to detect diseases by looking for changes in the eye structure

   Walking sonar (Pranav): sonar device to help blind people in navigation

   Blood pressure (Baljinder): measuring blood pressure of old people and wirelessly transmitting it to a hospital so that caregiver can keep an eye on the person's health

   Cleaning impurity water (Moe): cleaning impure water in areas with floods

   Hearing Aid (Moe): the heading says it all

   Drain water (Chelsey): using drain water pressure to generate power (efficiency is the constraint)

3. Next meeting on Friday Sept 18
4. **Meeting adjourned**

Meeting minutes and agenda

September 18, 2015 from 11:30am to 12:30pm

1. Roll Call:
   Everyone present

2. More brainstorming ideas:
   - Navigational belt with vibration feedback. Can input directions. Use GPS or somehow proximity detector for more accuracy -> can be a good hiking device
   - Diving back into medical devices by looking at what can be measured on skin:
     - Temperature
     - Pulse sensor
     - Blood pressure
   - What about in catherter measures? What about risks involved with the heart attack?
   - Needleless blood test
   - We have to look for standards in our proposal

3. Next meeting to be decided

4. **Meeting adjourned**

Meeting minutes and agenda

September 25, 2015 from 11:00am to 12:30pm

1. Roll Call:
   Everyone present

2. Detailed discussion and system overview about Aspirator
   - Stop if too much air flow
   - Monitor constant air pressure
   - Threshold not exceeded pressure limiting mechanism -> back up is full stop
   - Use foot pump instead of hand pump
   - Stop if injury from suction is imminent
   - Must have disposable components
3. Other possible application: suction of mucus for person on ventilator; one caregiver able to use it (need to be kept in mind).
4. Will demo it on a dummy
5. Too simple from TAs point of view
6. Need to think about attaching additional electronics to the device:
   - Heart beat sensor
   - Temperature sensor
7. **Meeting adjourned**

Meeting minutes and agenda

September 26, 2015 from 11:00am to 12:30pm

1. Roll Call:
   Everyone present

2. Change of project: switching to IV Infusion Pump for home use (a big thanks to Shayan for the idea). Talked to Jamal, one of the TAs, about this project. Recommended some features to add.
    - Add internet feature so that nurses or doctors can remotely monitor and control the activity of the pump using mobile app (will be implemented)
    - Pump infuser
    - How to tell it's done?
    - Focus on at home use
    - Add pulse oximeter and temperature sensor
3. Sections for the proposal document assigned to each member
4. **Meeting adjourned**

Meeting minutes and agenda

2 October, 2015 from 10:30am to 12:30pm

1. Roll Call:
   Everyone present

2. Discussion about the system components
   - Alvin: components for the system and requirements for the components
   - Pranav: need safety functions
   - Chelsey: proper grounding
   - Moe: circuit breaker. Electrostatic through heart
   - Chelsey: Peristaltic pump -> pump type to use
   - Moe: issues we may run into if tubing wears out
   - Chelsey: keep both valve and pump
   - All: use only two IV bags for prototype – saline and drug
   - Pranav: The bags better not explode
   - Moe: Let's order parts
   - All: agreed on ordering parts

3. **Meeting adjourned**

Sentinam Innovations

School of Engineering Science
Simon Fraser University
Burnaby British Columbia

Meeting minutes and agenda

October 5, 2015 from 12:30pm to 1:30pm

1. Roll Call:
   Everyone present

2. Discussion time:
   - ➢ Discussing Wi-Fi feature of the device
   - ➢ Discussion between Alvin and Moe regarding how wifi shield is going to handshake with Arduino

3. Let's order:
   - IV bag set
   - Flowmeter
   - Peristaltic pump
   - Stepper motor
   - H-bridge for stepper motor

4. Writing plan
   - Pranav: look at samples over the weekend
   - Plan for the weekend. Sounds fun

5. **Meeting adjourned at around 1:30 pm**

Meeting minutes and agenda

October 6, 2015 from 12:00pm to 1:00pm

1. Roll Call:
   Chelsey, Baljinder and Alvin – Present

2. Dividing sections for the Functional Specs document
3. Not much discussed in this meeting
4. **Meeting adjourned at around 1 pm**

Meeting minutes and agenda

October 13, 2015 from 12:30pm to 1:30pm

1. Roll Call:
   Chelsey, Alvin, Pranav and Baljinder – Present

2. Agenda
   - Even more dividing of sections
   - Including sections and important information that should be included in the document
3. Goal: have first draft of functional specs ready by Friday (Oct 16)
4. **Meeting adjourned**

Meeting minutes and agenda

October 15, 2015 from 12:30pm to 4:30pm

1. Roll Call:
   Chelsey, Alvin, Baljinder and Moe – Present
2. Agenda
   - Picking specific parts to order
   - Research together and then send Moe the list to order/make sure they work with Arduino
3. Important parts to order:
   - IV set
   - Flowmeter
   - Peristaltic pump
4. Cannot buy IV without a license and can't import from US either due to customs restricted
5. Flowmeters
   - Expensive
   - Ideally want flowmeter sensitivity to be around 10uL-10mL/min
6. Couldn't find anything worth ordering
7. Moe left after a couple of hours and Baljinder left after another hour
8. **Meeting adjourned**

Meeting minutes and agenda

October 22, 2015 from 2:30pm to 5:30pm

1. Roll Call:
   Everyone present
2. Oral progress report meeting with the TA
   - Commented on our progress
   - Wasn't that happy with the amount of time spent per week on the project
   - Told us to order parts asap
   - Also told us to increase the amount of time spent on project
3. All but Pranav stayed as he had work. Decided to order parts
4. Ordered peristaltic pump from Amazon
5. Also ordered the starter kit for Arduino Uno R3.
6. Compromised on the flowmeter. It is cheaper by more than half the price of the one we were planning on buying. Alvin argued that it is not a compromise. He said we don't need expensive flowmeter for prototyping purposes.
7. Everyone felt relieved after ordering parts
8. **Meeting adjourned.**

Meeting minutes and agenda

October 23, 2015 from 1:30pm to 2:00pm

1. Roll Call:
   Everyone present

2. Brief meeting to discuss Design Spec document
   - Decided what sections to have and who to assign to
   - Decides to go with the same sections as one had for the functional specs

3. **Meeting adjourned**

Meeting minutes and agenda

November 5, 2015 from 12:00pm to 1:30pm

1. Roll Call:
   Everyone present

2. Agenda:
   - Who should do what?
3. Work assigning:
   - Chelsey will be working on fixing pump tubing
   - Moe will program the microcontroller to control the pump
   - Alvin will try to figure out whether Bluetooth/Wifi shield to use
     - Bluetooth is cheap and use less pins but good only for close range
     - Wifi uses more pins but better connectivity
   - Baljinder and Pranav will figure out a way to extract the data from the USB port of the flowmeter
4. **Meeting adjourned**

Meeting minutes and agenda

November 8, 2015 from 12:00pm to 1:30pm

1. Roll Call:
   Chelsey, Alvin and Moe – Present

   Pranav and Baljinder – Absent (Working)

2. Discussion about components:
   - Alvin: Wifi or Bluetooth shield. Issues with pins on Arduino Uno. Not enough pins to accommodate wifi shield. Decided to go with Bluetooth shield
   - Moe: LCD screen problem. Arduino pins don't provide enough power for larger ones. Will use 16x2 segment display with scrolling information
   - Moe: Flowmeter is not compatible directly with Arduino. Will have to use different one.
   - Chelsey: can buy expensive one
   - Alvin: buy cheap one
   - Moe: should integrate temperature and pulse sensors
   - Chelsey: buy push button to stop motor

3. **Meeting adjourned**

Meeting minutes and agenda

November 10, 2015 from 12:30pm to 1:30pm

1. Roll Call:
   Everyone present

2. Agenda:
   - Pump and drip chamber safety discussion

3. Discussion about where should the drip chamber goes – before or after the pump?
   - In worst case scenario, if the tube in the pump tears out, this will introduce air in the solution which is life-threatening for the patient. Putting the drip chamber after the pump will prevent any air to enter the patient's blood stream.

4. Another point is where does the drip counter goes?
   - After failing to find a way to extract the flowmeter data through Arduino, we decided to build our own drip counter.
   - Chelsey came up with the circuit and everyone was wondering how we will use it in the device. So, she explained everything about it

5. **Meeting adjourned**

Meeting minutes and agenda

November 27, 2015 from 2:30pm to 4:30pm

1. Roll Call:
   Everyone present

2. Agenda:
   - Some more things to buy from local electronics store (RP electronics)
   - Calibration and testing to different components

3. Things to buy:
   - Temperature and pulse sensor
   - Prototyping board
   - Batteries (12 V) for powering the drip counter circuit

4. Calibration and testing
   - Need to calibrate the sensors
   - Control the motor with push buttons
   - Whole system testing

5. **Meeting adjourned**

Meeting minutes and agenda

December 4, 2015 from 12:00pm to 1:30pm

1. Roll Call:
   Everyone present

2. Agenda
   - Layout prototype board
   - Calibrate drip counter using housing from 3D printer

3. Need rubber to isolate Arduino from prototype board

4. Need small prototyping board for LCD as it uses too much space

5. Higher precision potentiometer for accurate drop flow rate

6. **Meeting adjourned**

Meeting minutes and agenda

December 6, 2015 from 12:30pm to 4:30pm

1. Roll Call:
   Everyone present

2. Agenda:
   - Drip counter calibration
   - Buying some more parts

3. Drip counter calibration is important for the project.
   - It should be able to detect the drops accurately
   - Make sense of the data fed into the Arduino from the drip counter circuit
   - It took most of the time

4. **Meeting adjourned**