INTRODUCING

InfuseView

an information dashboard for IV infusion systems

PROCESS BOOK

HCDE + SENIOR CAPSTONE + JUNE 2017

Designed by Joshua Yao

SUMMARY

How can IV systems better communicate information to medical staff?

In this project, my team was assigned the task by the Seattle Children's Hospital to discover how an interface could display the Alaris IV infusion system's information better. The result would reduce problems and potentially save lives.

Through 10 weeks of vigorous research, ideation, prototyping, and testing my team developed an interface that visualized the IV data in **a simple, accessible, one-stop experience.**

MEET THE
TEAM

YUKA ASANUMA

Background in UX and visual design

JOSHUA YAO

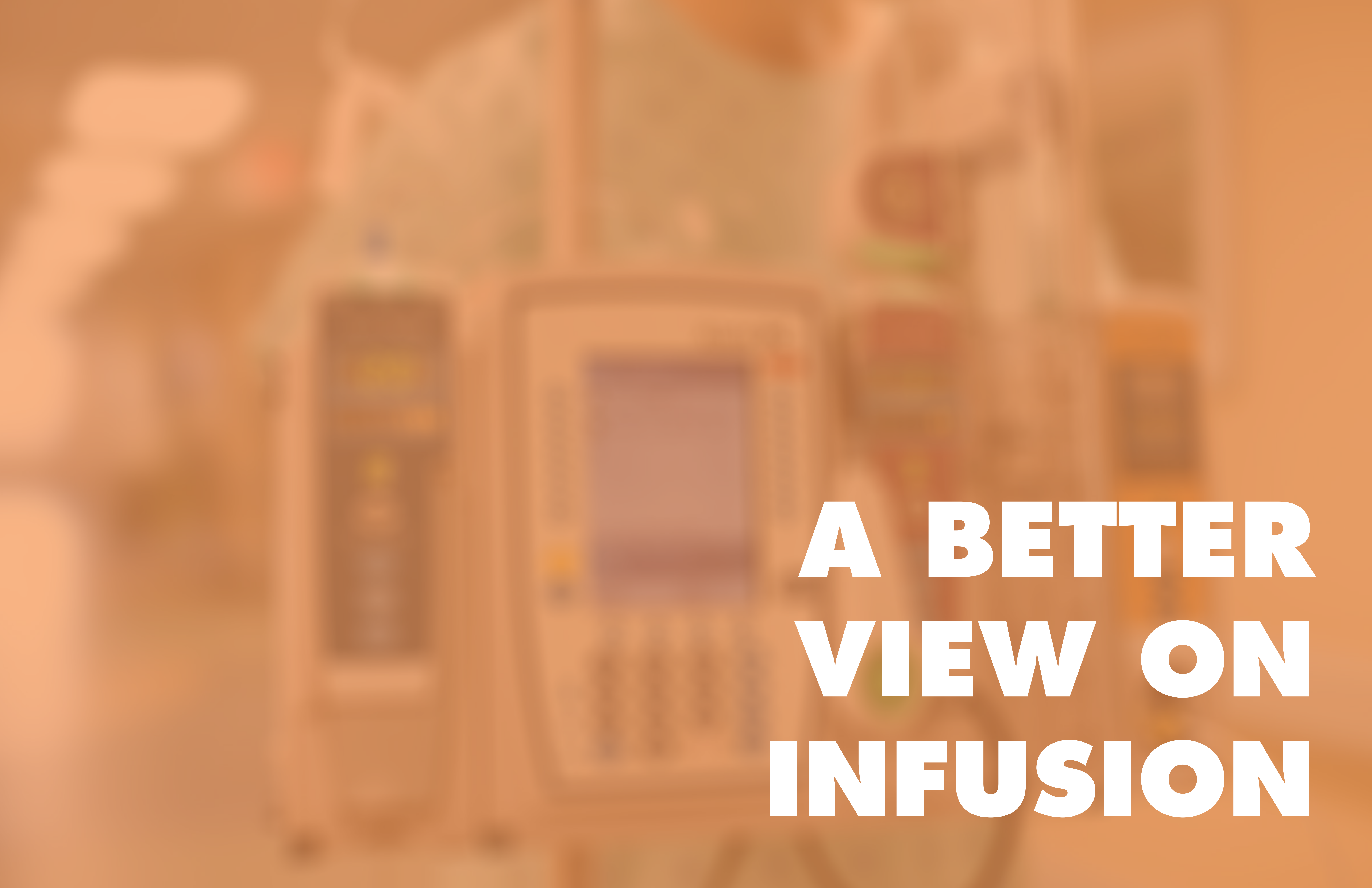
Background in UX, visual design, and programming

PAULINA TSAI

Background in UX and programming

SPECIAL THANKS TO THE FOLLOWING FOR THEIR SUPPORT

Justin R. Hamacher, Instructor
Mark Zachry, Instructor
Dr. Jeremy Geiduschek, Director of the Department of Anesthesiology & Pain Medicine at Seattle Children's Hospital
Dr. Lance Patak, Assistant Professor of the Department of Anesthesiology & Pain Medicine at Seattle Children's Hospital


A BETTER
VIEW ON
INFUSION

EXPLORE THE CONTENTS

INVESTIGATION

Our investigation of the user, context, and needs

IDEATION

Our transformation of research data into design information

CREATION

The creation of our design backed by our research and ideation

INVESTIGATION

The search to determine the needs and requirements for our design

With the goal of creating an effective design, my team conducted a number of primary and secondary research sessions focused around the IV infusion systems.

Using our gathered research, we were able to understand the **needs** and structure **goals** for our interface design.

INVESTIGATION

CLIENT INTERVIEW

The first step was to meet with our client, the Director of the Department of Anesthesiology & Pain Medicine at Seattle Children's Hospital. Our goals of the meeting were to understand the problem and to discover our client's vision for the product.

At the end of the meeting, we were able to identify the needs of our target audience, and begin further investigative work on the issue at hand.

The issue was clear. The mass of pump modules and screens for a single patient wasted too much time and hid too much information for a busy doctor. This caused problems with patient care and on occassion **had put lives at risk**.

INVESTIGATION

SECONDARY RESEARCH

After establishing our goals, we conducted secondary research to increase our understanding on the topic and search for information that could further inform our design. For our secondary research, we looked into scholarly articles, conducted competitive analysis, and more.

In our literary analysis, we discovered regarding medical device interaction and the design recommendations that revolved around it. We would later use what we found to establish our design. Below are some key examples we found through our secondary research.

COLORS

In an article by FORMA, a medical product company, they discussed coloring conventions for medical devices. From that we had a few key discoveries:

• Blue and green are calming colors, which is something you would want in an anxious environment

• Warm colors are good accent colors, which can be used for attracting attention or color coding.

• Pure white shows cleanliness and purity, but too much of it can be overwhelming, especially in rooms with strong lighting.

• Consider color blindness, especially the most common being red-green color blindness.

DISPLAY DESIGN

Cynthia Ferrell, the CEO of Optrex America, discusses some requirements for display in the medical field in an article we found:

• High-contrast displays are necessary for quick legibility.

• Screen must be glare-resistant, since many areas of the hospital have strong ambient lighting, such as the operating room.

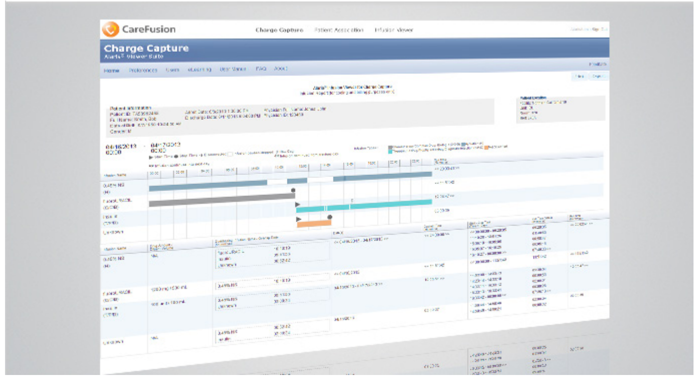
• If portable, a longer lasting battery is required.

Use touchscreen when allowing users to make choices.

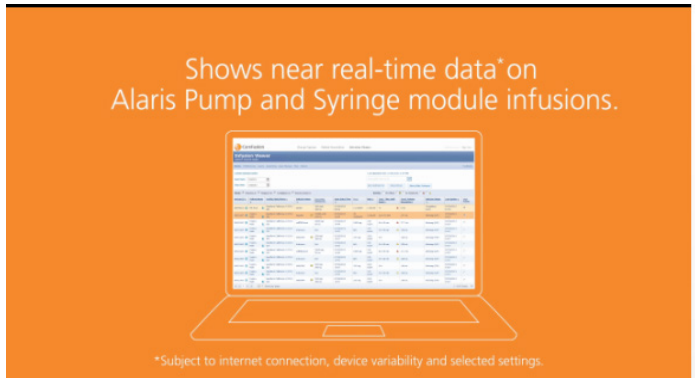
FORMA. (n.d.) Choosing Medical Product Colors.
Ferrell, Cynthia. (2010, May 01). Advancing medical device displays. Medical Design.

Another part of our secondary research was **competitive analysis** for similar devices already on the market.

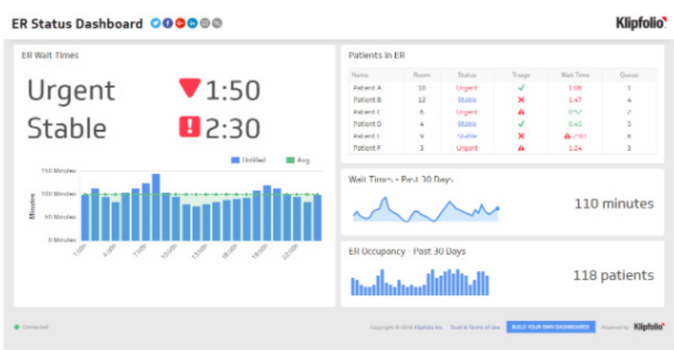
For this, we identified and analyzed three medical interfaces:



Alaris Viewer Suite for Charge Capture



Alaris Viewer Suite for Infusion Viewer



Klipfolio ER Status

From our search, we discovered there were **no** products that serve the same purpose as the interface we were designing. However, from the three different medical interfaces, we were able to procure some design recommendations based on their similarities and what they each excelled at.

INVESTIGATION

FIELD STUDIES

To begin our primary research, we first started off with field studies. We conducted these by observing medical staff interacting with the Alaris IV infusion system in different contexts. Our goals was to see exactly how interactions occured, how long uses took, what interactions were most common, and more.

Our field studies revolved around the Cardiac Operating Room (OR) and the Cardiac Intensive Care Unit (CICU). Both were conducted through **pure observation**, as we watched how the current Alaris IV infusion machine was being used. When the observation period was nearly over, we used **contextual inquiry** to further develop our observations. We took careful notes of what we learned and compiled it together, preparing questions for the next phase of our research.

Observing an IV infusion system within an operating room.

INVESTIGATION

FIELD INTERVIEWS

After processing what we learned from field studies, my team and I wanted to augment and confirm that information with primary users through field interviews. We approached common users, such as doctors and nurses, and asked them a number of questions both regarding what we already knew and also what we wanted to know more about.

We formally interviewed two professionals in the medical field:

- **Dr. Jeremy Geiduschek**, Head of Anesthesiology and Pain Medicine
- **Jimmy Butt**, a member of the Pharmacy Informatics team

Dr. Jeremy Geiduschek

In our interview with Dr. Geiduschek, we focused our questions around his interactions with the infusion system, what he valued most regarding it, as well as any vision he had for the future.

We used this interview to better understand a doctor's viewpoint so that we could ensure that we could design from a user-centered state-of-mind. We would use this interview to establish our doctor persona for the **primary user** of our design.

Jimmy Butt

In our interview with Jimmy Butt, we focused our questions more around the technical specifications of the Alaris IV system, so that we could know exactly what the system was capable of and what we needed to account for.

We used this data to help flesh out our **design requirements**.

MOVING FORWARDS

There are clearly problems with the current readability and visualization of the IV infusion machines. With the issues identified, the next step is to design solutions for them.

IDEATION

The evolution of research data to design information

With proper knowledge regarding the system and a good sense of the design direction to move in, my team moved into the next stage: **ideating the design solutions.**

With strong design solutions, we could compile and prototype them, which would bring us just a step away from a final design.

IDEATION

PERSONAS

The very first step of our ideation stage was to establish our personas. Personas would serve as the base of our design, our target audience, and the deciding voice in all design choices. Most importantly, personas allows us to **design from a user-centered mindset**.

We developed our personas based on user-research and our observations from our previous field studies. We also established both primary and secondary personas. Primary personas would serve as the main focus audience, while secondary personas would help keep us aware of the possible user affected by our design.

In total, we created **three personas**: two primary, and one secondary.

Erica Larson

"I want to save children's lives."

Age 26
Occupation Nurse
Marital Status Single
Location Seattle, WA

Primary Persona

Erica's Story

Erica is a resident nurse and she does her job well. With five years of professional experience, she is extremely attentive to patient needs and is always ready to help when asks. She balances this attention to patients and patients' families with the duties she needs to accomplish, such as setting up an Alaris IV pump machine from scratch, meaning setting the medicine in the machine, putting the medicine in the right areas, connected them to tubes, and more. These machine have to be set up for each patient, and switched out with a new machine setup every four days. Usually, if she was able to work uninterrupted, it would take about an hour to set up the machine. However, that rarely happens, if at all, as she constantly needs to run around helping doctors, attending to patients, and responding to alarms. With working on the machine only a bit every so often, it often takes hours to complete it. With that, the machines constantly need to be checked and attended to, since their alarms don't display warning quite well enough and constantly are interfered with by patients. For her, she sometimes feels that the machine demands as much attention as a patient.

Goals

- Make the patient comfortable
- Make someone's day a little brighter

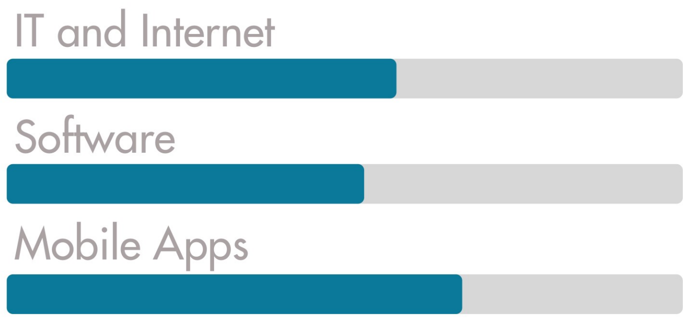
Motivation

- Provide the best care to patients
- Save lives

Frustrations

- Alarms constantly sounding off
- Getting the wrong syringe size of medicine volume
- Patient families being uncooperative with staff
- Mess of wires with the pumps
- Constant interruptions make it hard to accomplish longer tasks

Technology Expertise



Use of Technology

- Pager
- Alaris IV pumps
- Monitors at the nurse station
- iPhone 7

Jerry Welsh

"I want to make sure every patient gets the best care possible."

Age 40
Occupation Anesthesiologist
Marital Status Single
Location Seattle, WA

Primary Persona

Jerry's Story

Jerry is a quickly moving through his career in the medical field and he takes pride in his work. He handles the important task of administering medicines to the patient through either gas or infusions during surgery. During this time, he has to be present for the entire duration of the operation, making it a burdening, but sometimes boring work process. Nonetheless, even when he is simply waiting for the operation to finish, his eyes are always scanning many various machines and screens, looking out for any alert. One day, while in the middle of an operation, an alarm on the infusion machine goes off. A loud solid beep. While Jerry leaps into action, the lead surgeon glares, obviously annoyed by the siren. Searching the many machine, he searches for the solid red warning light, but he can't find it. The noise increases, and panic rises in Jerry's chest. The alarm could be anything, but most likely it was a medicine that wasn't going through to the patient. The medicine could be unimportant, but it also could be something life-sustaining. Jerry looks around frantically. Finally, he notices a faint red light on the bottom of the stand, washed out from the bright operating room lights. He silences the alarm and then quickly switches out the module for a new one, already prepared with a fresh bag of medicine. Just another day in the operating room.

Goals

- Do his job efficiently and perfectly
- Ensure that every operation goes through without an issue

Motivation

- Move up in the career ladder
- Save lives
- Pride in work

Frustrations

- Needing to constantly observe machines during extremely procedures
- Alarms constantly sounding off
- Mass of wires and machines make the workspace small and cramped

Technology Expertise

IT and Internet

Software

Mobile Apps

Use of Technology

- Alaris IV pumps
- Medicine cabinets/syringes/etc
- Anesthesia administration machine
- Patient status screen
- Breathing support machine

Jennifer Johnson

"I want to see my son."

Age 34
Occupation Project Manager
Marital Status Married
Location Bellevue, WA

Secondary Persona

Jennifer's Story

Jennifer works as a project manager in Bellevue, Washington. She regularly leaves her 2 year old son in the care of her parents while she and her husband are at work. One day during work, her father calls her to inform her that her son has hives and large parts of his body. Jennifer immediately excuses herself from work and rushes over to check on her son. Concerned, she lets her husband know and decides to bring her son to Seattle Children's Hospital.

A nurse hooks some machines up to her son which faintly start beeping to his elevated heart rate. Jennifer becomes even more concerned and frantically ask for a diagnosis. The nurse calmly states that a doctor will be coming by shortly and told Jennifer not to worry. Her husband rushes into the hospital, finds the family, and tries to get an update.

Goals

- See her son smile and hold his hand

Motivation

- Maintain a good work/life balance
- Spending quality time with family
- See her son be healthy and happy

Frustrations

- Not knowing her son's status and how long full recovery will take
- Missing family time

Technology Expertise

IT and Internet

Software

Mobile Apps

Use of Technology

- Macbook Pro
- iPhone 7

AFFINITY DIAGRAMMING & INFORMATION RANKING

ALARMS

- Can't easily identify alarm
- Many alarms/beeping
- Different color alarms/several types of alarms
- Alarm lights on pump/syringe are not clearly visible
- People (patients) silence alarms themselves sometimes
- Families alarmed by beeping
- ICU rooms are soundproof. Can't hear alarms when door is closed
- Near-end alarms are not always important
- Solid green with blinking yellow for mild alert
- Flashing at solid red for severe alarm
- Green light for on, yellow for paused, red for alarm

LABELING

- Each pump identified as A/B/C/D
- Order of pump changes labeling
- Doctors refer by medicine not pump #

PROGRAMMING

- Doctors program for surgery
- Scan QR code for patient ID and prescribed meds
- Modules sometimes switched while machine running
- OR does not have scanner
- Sometimes nurses get the wrong syringe for meds
- Takes about 30min-1hr to setup uninterrupted
- Nurses program for CICU/PICU
- Warnings for guardrails (soft max/hard max)
- Anesthesiologists can go over guardrails

SYSTEM ENVIRONMENT

- Often not all modules are visible
- Forgets about pumps on the back
- Can't be too wide (no space in OR)
- Can't be too tall (won't fit through doors)
- System is usually next to patient's bed
- 4 pumps for each brain (max)
- Usually 6-8 pumps/patient

DISPLAY

- Scrolling text display
- Displays rate, dosage, volume and medicine
- Patient weight is not shown on display that they view most often
- Flashing text is hard to read
- Information split between brain and modules
- Can't shorten medicine name

IMPROVEMENTS

- Animations to improve understanding of data
- Anesthesiologists prefer: rate > dosage > volume left

BATTERY

- When battery dies, goes on standby - stopping infusion but saving setup info
- Alaris might run out of battery when transferring patient

PHARMACY

- Spreadsheet layout for patient data
- Only look at wireless data retrospectively for mistakes

IDEATION

AFFINITY DIAGRAMMING

Using all the information gathered in the research stage, we began affinity diagramming. This process was done through each team member writing a need, requirement, issue, or design recommendation on a sticky note. We then would group similar notes together to effectively "brain-dump" what we knew and identify key issues or needs.

On the left is a rough digitized version of our affinity diagramming. Through this, we identified major problems in the current alarm setup, while also noting important needs to be aware of.

IDEATION

INFORMATION RANKING

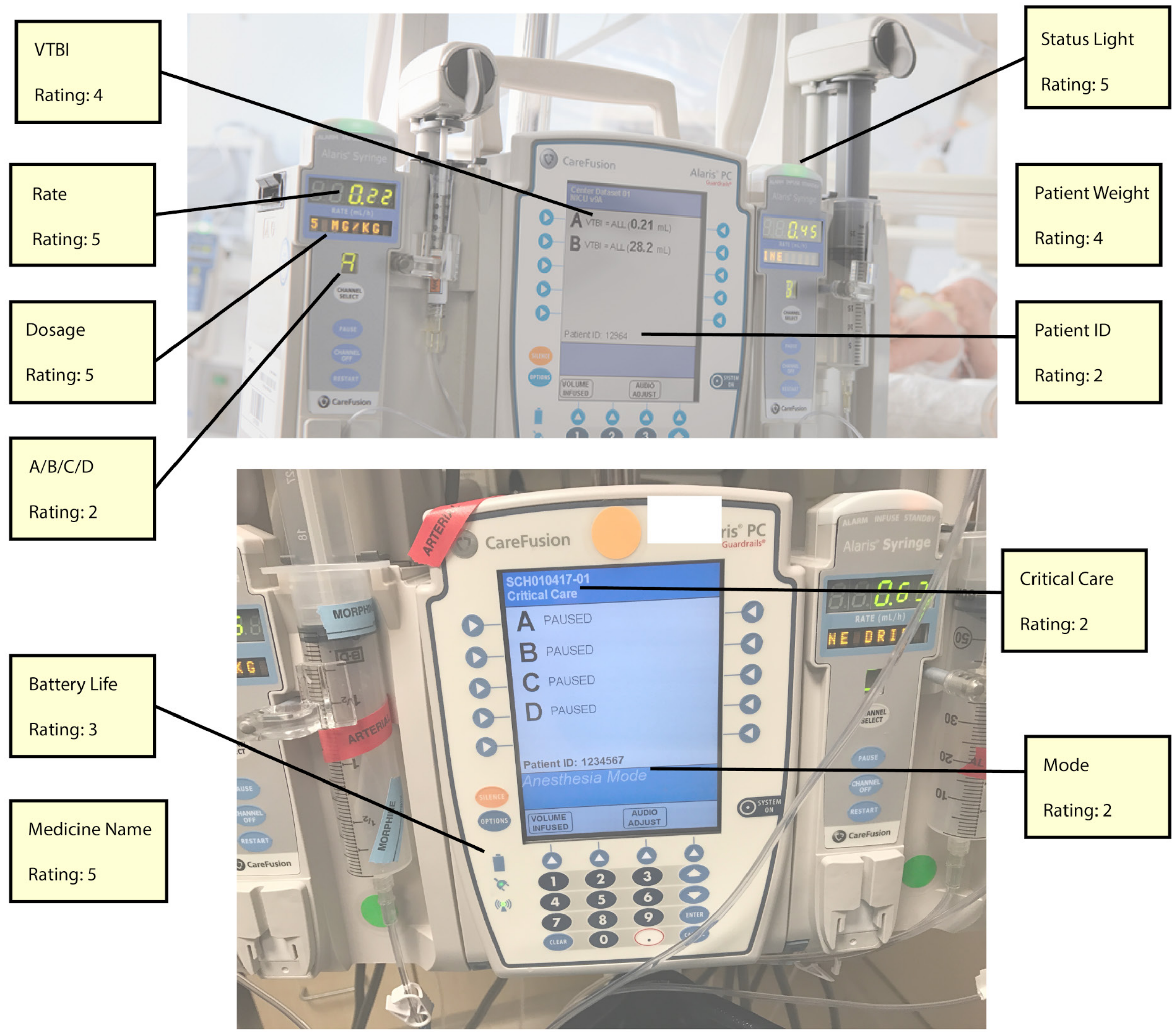
At this point, after identifying necessary needs and key problems, we felt that it was appropriate to conduct a bit of research to ensure we were moving in the right direction.

One of the more important bits of information we wanted to know was how both nurses and doctors, the primary users, ranked the data on the current Alaris IV infusion machine. Because of our inherently busy target audience, we sent an annotated image asking to either confirm or correct the ranking, as shown on the right. This allowed the process to be accomplished quickly.

The information we gained from this step helped further inform the ideation of our design by letting us confidently know which elements to prioritize.

How often you look for this information

Key for rating
5: Almost always
4: Often
3: Sometimes
2: Rarely
1: Not at all



DESIGN SKETCHES

IDEATION

DESIGN SKETCHES

This stage was the most ambitious part of the our project. It required us to transfer all that we learned from our research and ideation into actual reality, while keeping the user in mind.

From our research and ideation, we found that we needed three elements within our design:

- Pump module status view for each pump
- Accessbile dashboard layout
- History panel

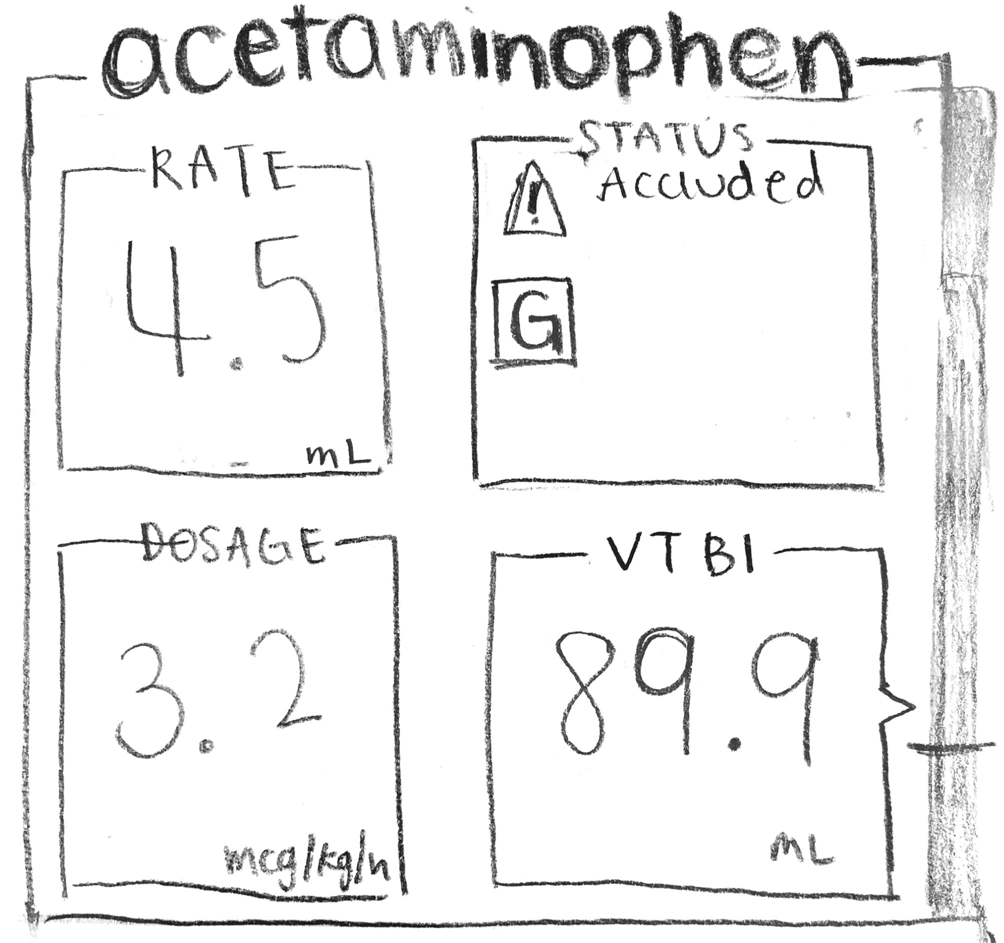
To encourage unique thinking and design, we each separately sketched numerous design for each element and brought them together for peer review. We sketched and critiqued with our primary personas in mind.

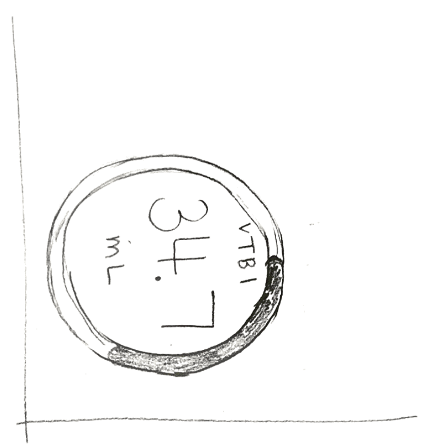
IDEATION

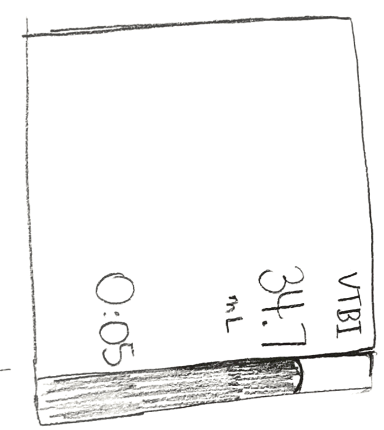
DESIGN SKETCHES

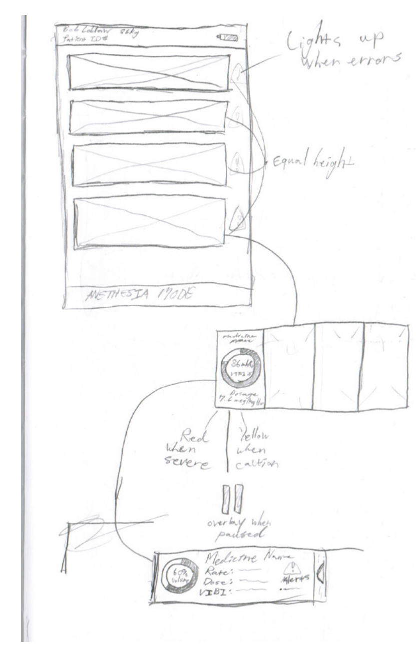
The modules were the most difficult part of the design since it was the part that nurses and doctors looked at most often. It had to be easily readable in high-stress situations, quickly understandable, accurate, and clean. It also had to be easily identifiable between the many other pump modules

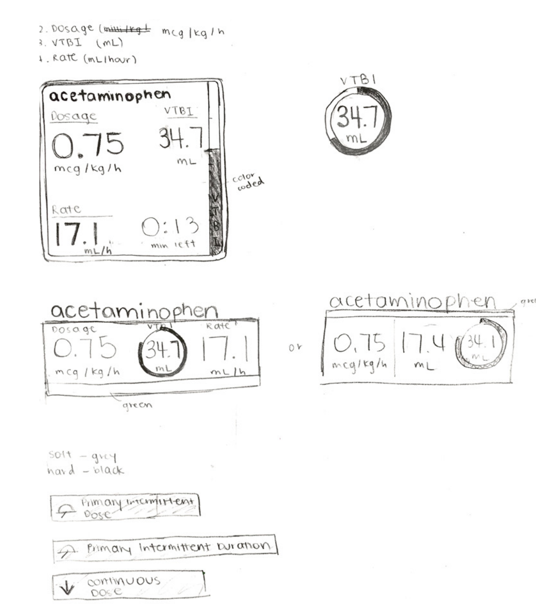
We chose the design on the right because it displayed necessary information cleanly, while also prioritizing data that was important to our target audience. It also fit cleanly with other modules, so it was easily readable from a user's perspective.







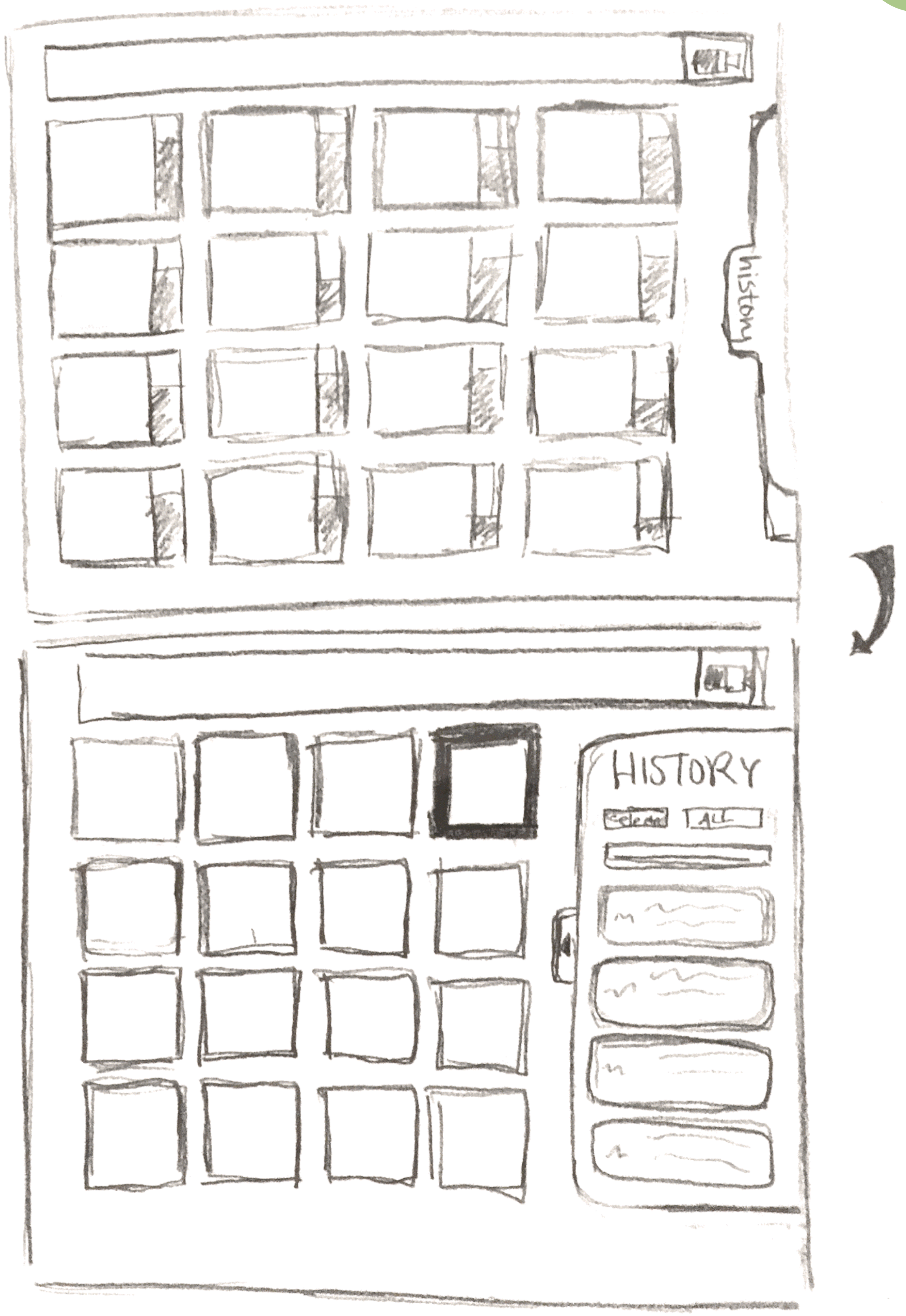




The history panel was a new addition to the interface, meaning that it does not exist on the current Alaris IV infusion system at all. Our reasoning for adding this was because through our field studies we discovered that the pumps would often have their rate changed when moved between different medical units. Sometimes people would forget to change rates back, which could cause health dangers. The history panel would also help users know about past errors or alarms.

Basically, we found that the addition of a history panel would help reduce human error immensely.

We chose to make it a sliding panel which would dissapear when not being used to ensure that the modules, the most important elements, maintained extremely high visibility and readability. With this feature, we were confident that it would massively reduce the cognitive load of medical staff.



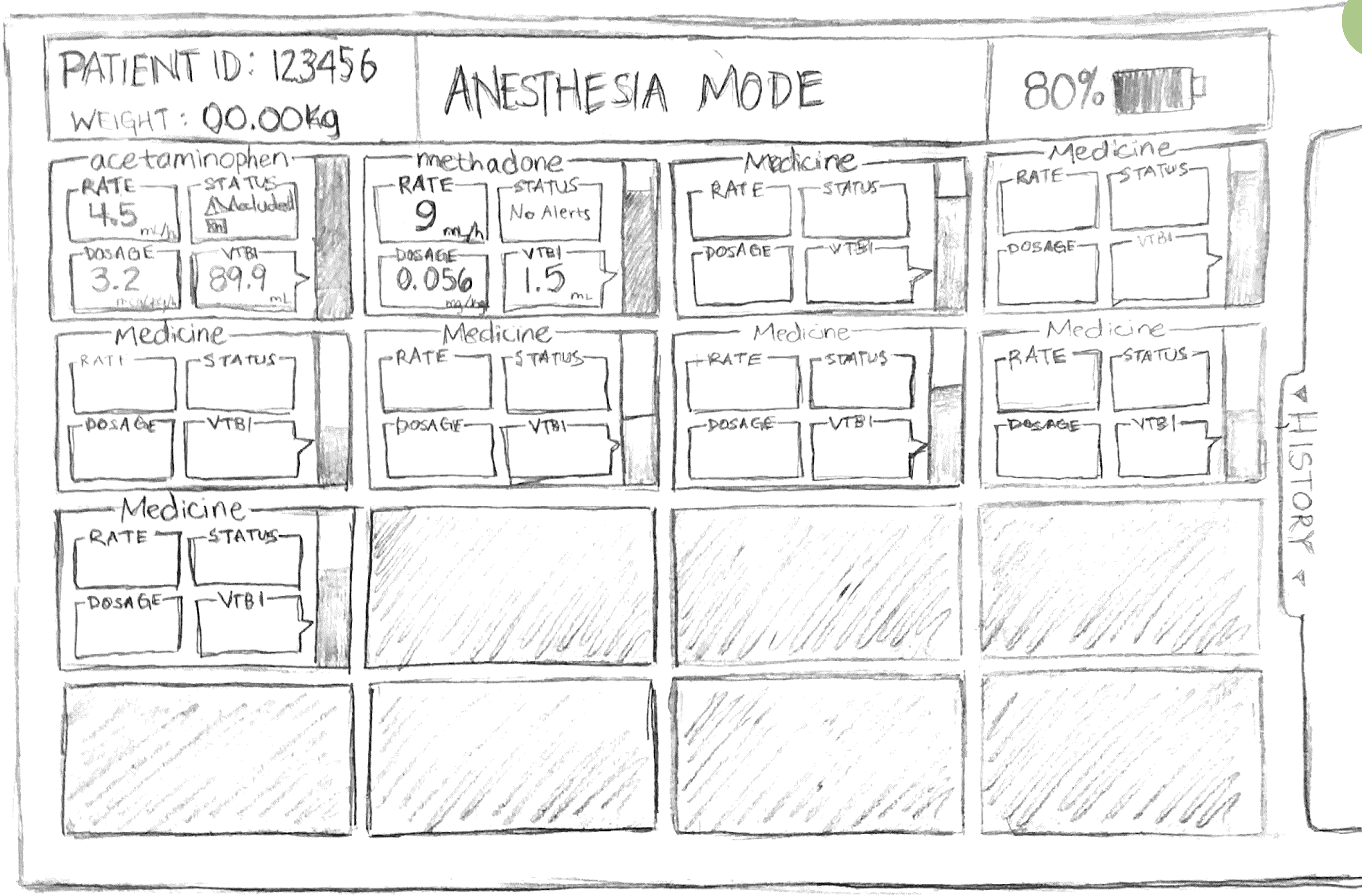
IDEATION

PAPER PROTOTYPE

Confident with our design sketches, we compiled them together in a single view. We added pieces of paper to mimic interaction, letting this interface more closely represent our design. This **paper prototype** could be used for testing and evaluation. We envisioned this design to be usable on a **touchscreen interface**.

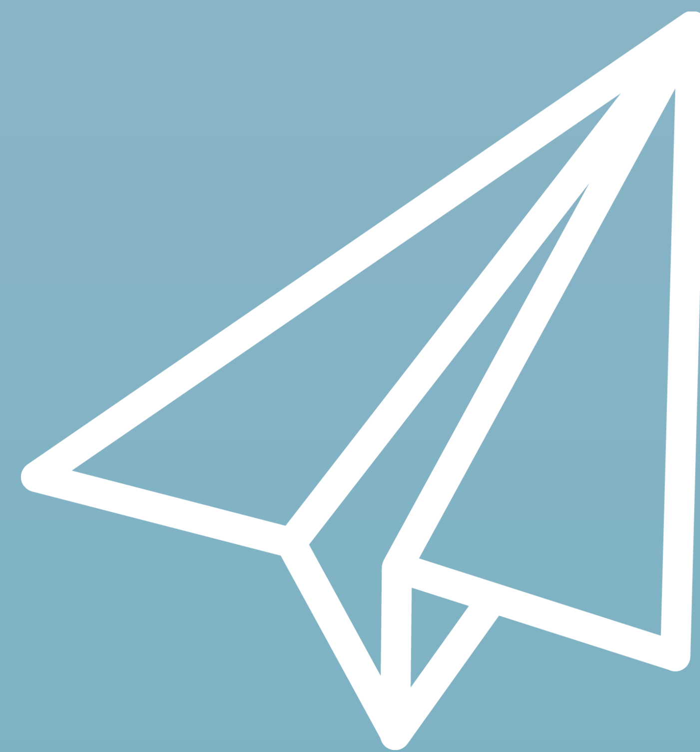
On the top, the interface includes necessary patient information, such as the ID and weight. The current mode of the pumps is boldly displayed on the front, with the battery level on the side. We found that usually the most pumps an intensive care patient would have was about 16, so we designed our interface to allow for that. The history bar is hidden on the side, but easily called out by a single press. Users would also be able to press on the diffrent modules to call out the unique history of that pump.

We tested this interface with both doctors and students, so that we could ensure both medical accuracy and usefulness, while also maintaining accessiblity and intuitiveness. Through this testing, we were able to move forwards to a more final, higher fidelity design.


PATIENT ID: 123456
WEIGHT: 00.00Kg
ANESTHESIA MODE
80%
acetaminophen
RATE
4.5 mL/h
STATUS
Occluded
DOSAGE
3.2
VTBI
89.9 mL
methadone
RATE
9 mL/h
STATUS
No Alerts
DOSAGE
0.056 mg/kg
VTBI
1.5 mL
Medicine
RATE
STATUS
DOSAGE
VTBI
HISTORY

MOVING FORWARDS

With a strong base for our design, our next step is a series of prototyping followed by testing. This fast and iterative process would lead us to a final design.



CREATION

The birth of a design in its true form and the process of its beginning

Armed with tested design elements and a strong foundation, my team could move onto a rapid series of **prototyping and testing**. This would lead us to a final design.

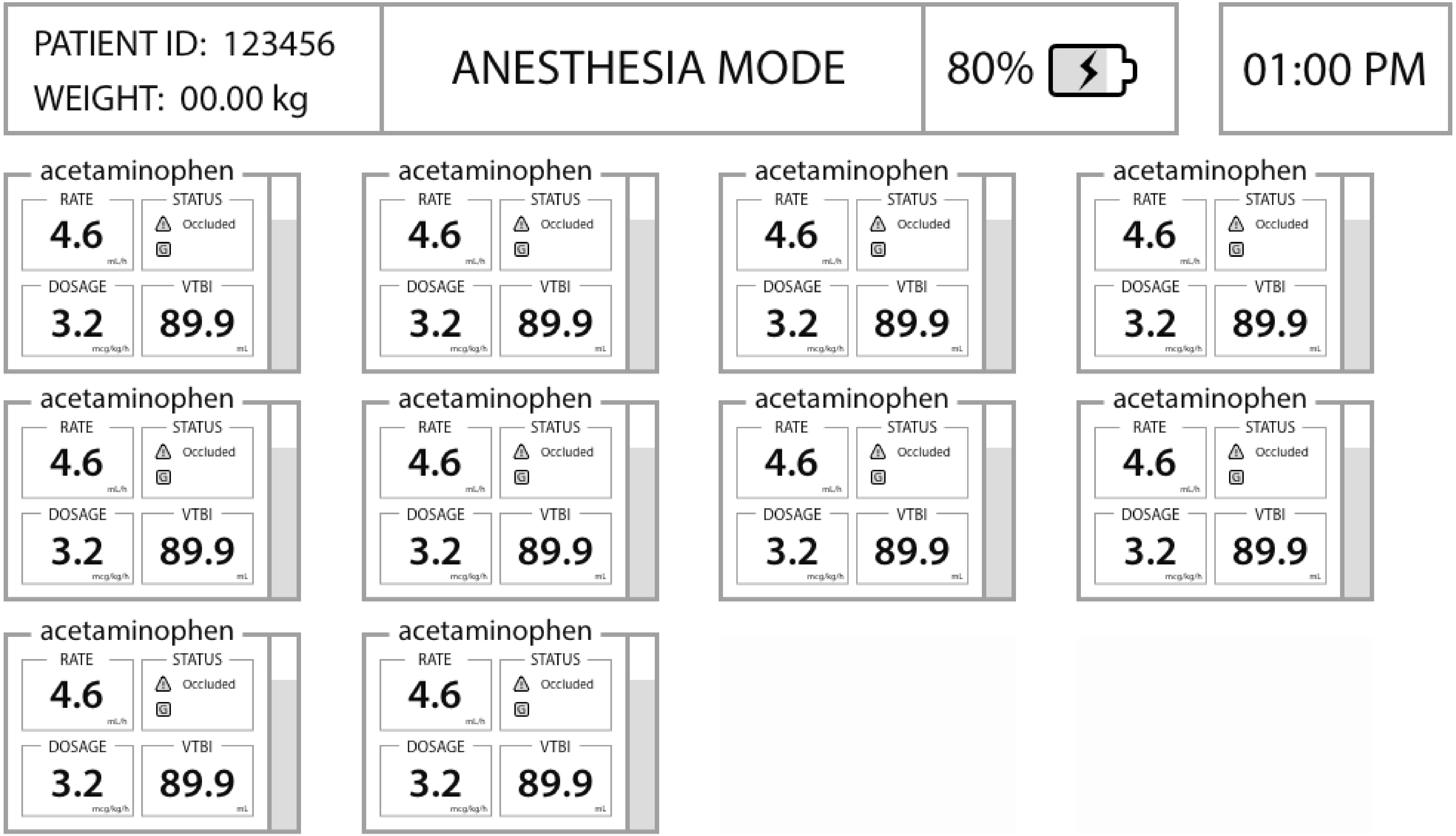
Through this design procedure, we could create a final design that is appropriate for its context and users, while also solving the original issue seamlessly.

CREATION

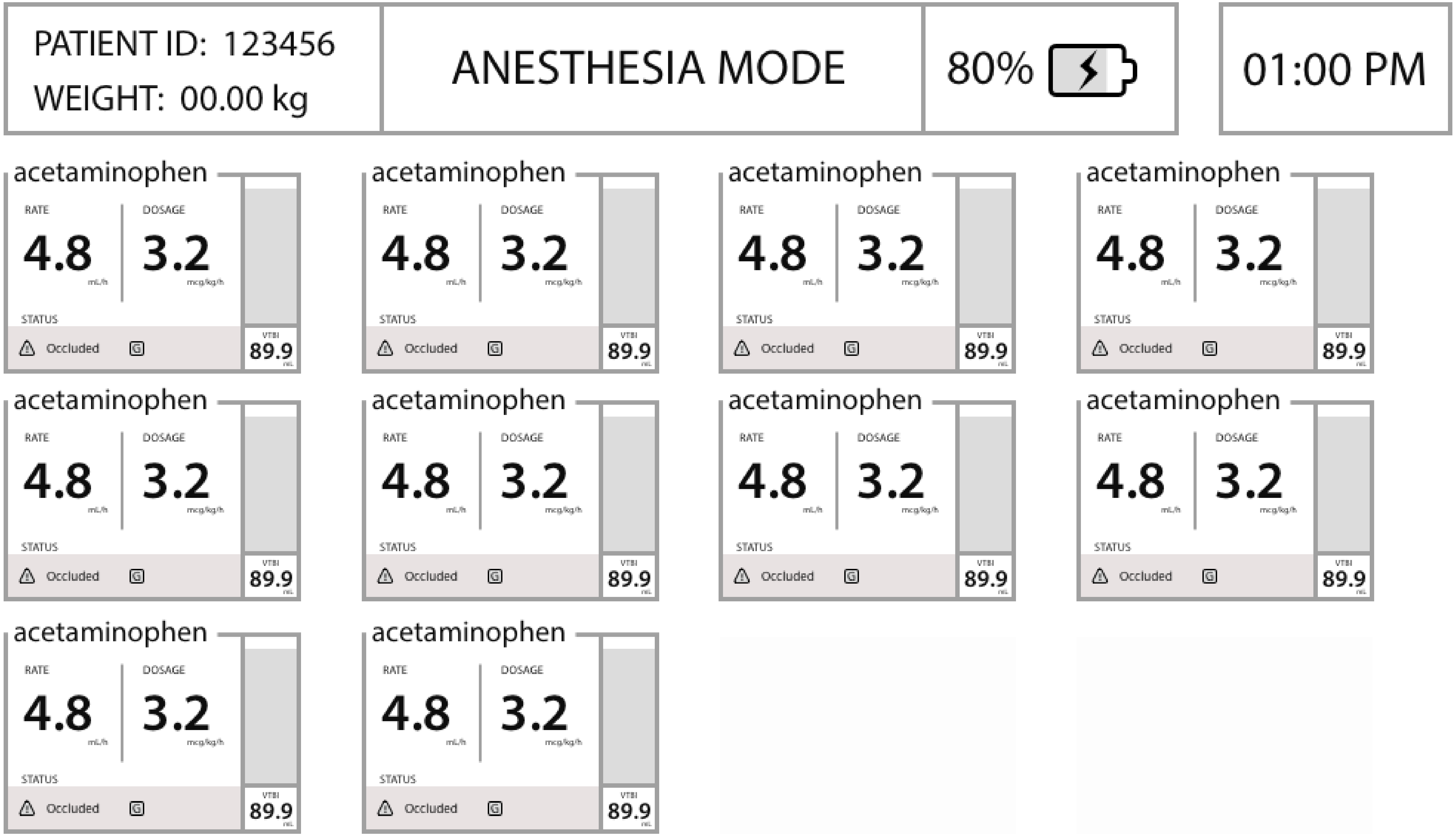
HIGH-FIDELITY PROTOTYPE

Using the feedback we got from our paper prototype, we created a **high fidelity prototype**. A higher fidelity prototype helps us show our client more accurately what our design is and if it matches their vision. Furthermore, a generates a deeper level of testing and feedback, since test participants would critique it more severely with less “left to their imagination”. The high fidelity prototype was made with Sketch.

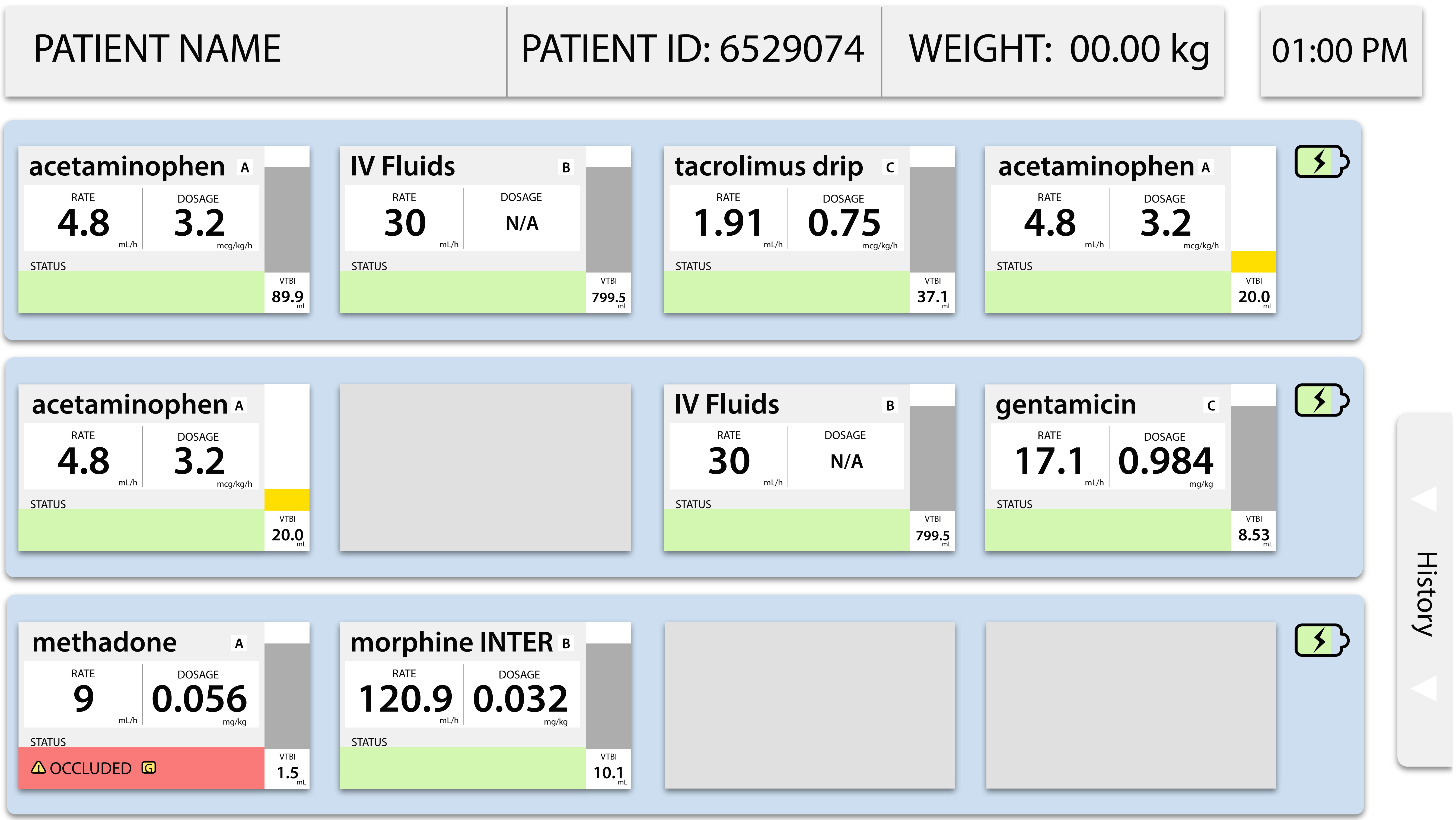
In this process, we began a series of rapid prototypes and testing. We would create a high-fidelity prototype, test it with some users, make changes to it based on feedback, test again, change again, etc. This process continued until we had a design that not only had no glaring issues, but also rated highly by test participants.



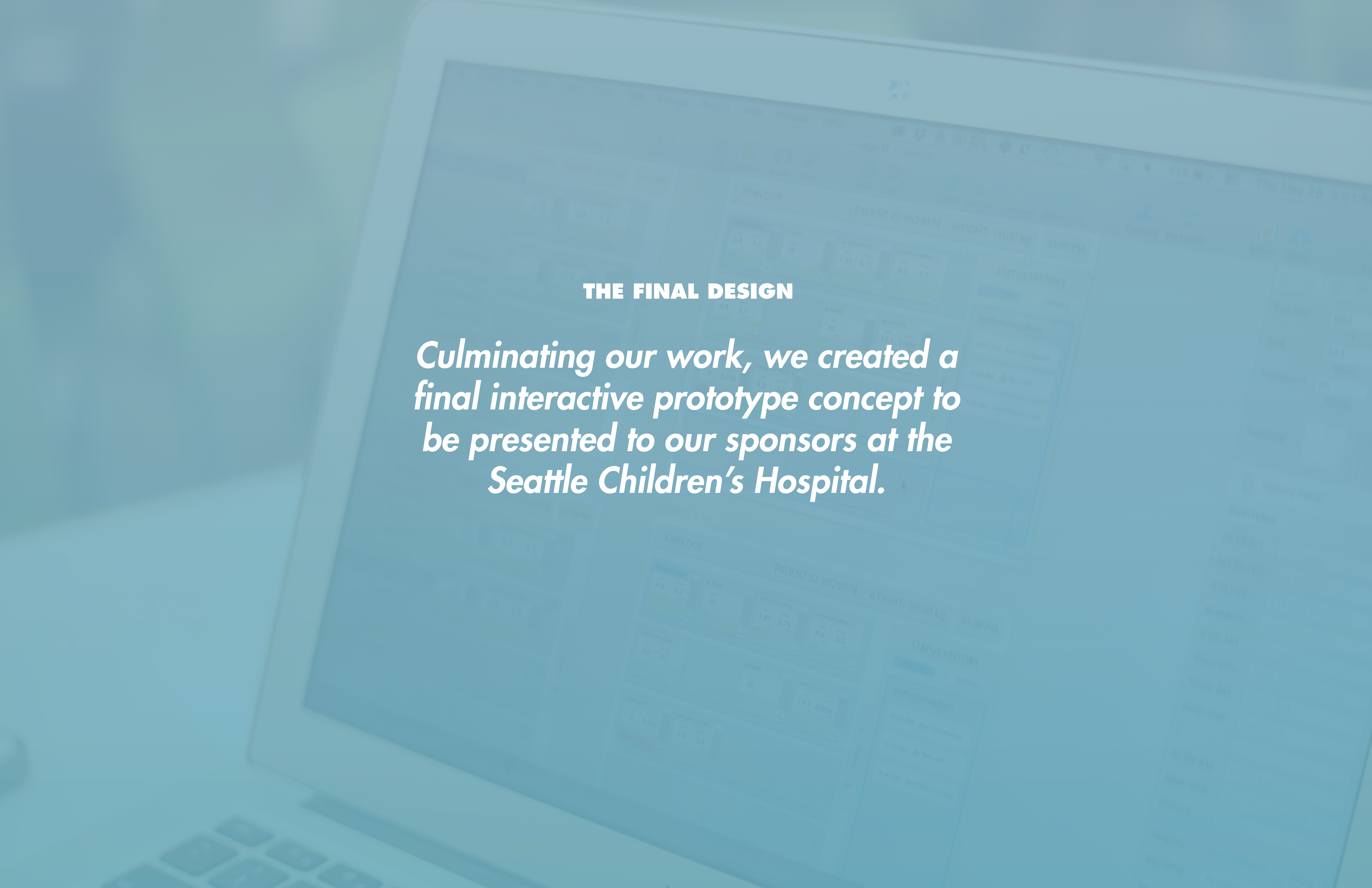
This represents an intial high-fidelity prototype. Before adding further features, we wanted to focus feedback on the layout of the design as well as the readability of the information in the pump module views.



This prototype shows a state during the cycle of testing and prototyping. It shows mostly change in the pump modules, and how we re-examined the visual priority of information, such as the lower priority of VTBI.



This represent our final high-fidelity prototype. Muted green and blue colors with red accents for alerts were chosen due to our secondary research and user feedback. The module grouping by brain was another result of user feedback from the testing cycle.



THE FINAL DESIGN

Culminating our work, we created a final interactive prototype concept to be presented to our sponsors at the Seattle Children's Hospital.

CREATION

FINAL PROTOTYPE

For the final point of our design, we created an **interactive prototype** of our design using Sketch and Proto.io. We used this format to represent the final design of our product to our sponsors at the Seattle Children's Hospital.

Our design creates a centralized one-stop hub for the IV pump systems for a patient. Instead of searching many screens for a medicine or problem, medical staff can now take a single glance on our interface to identify the problem. A process that might take 20 minutes is reduced to less than a minute viewing on a single clear screen.

With this design, we also created a poster and a video to augment our presentation.

Brain Grouping

Each Alaris Brain Module can support up to four IV pumps and syringes, labeled A, B, C, D. The identification and grouping system in the dashboard mirrors the physical layout of the IV system for **easier synchronized usage**.

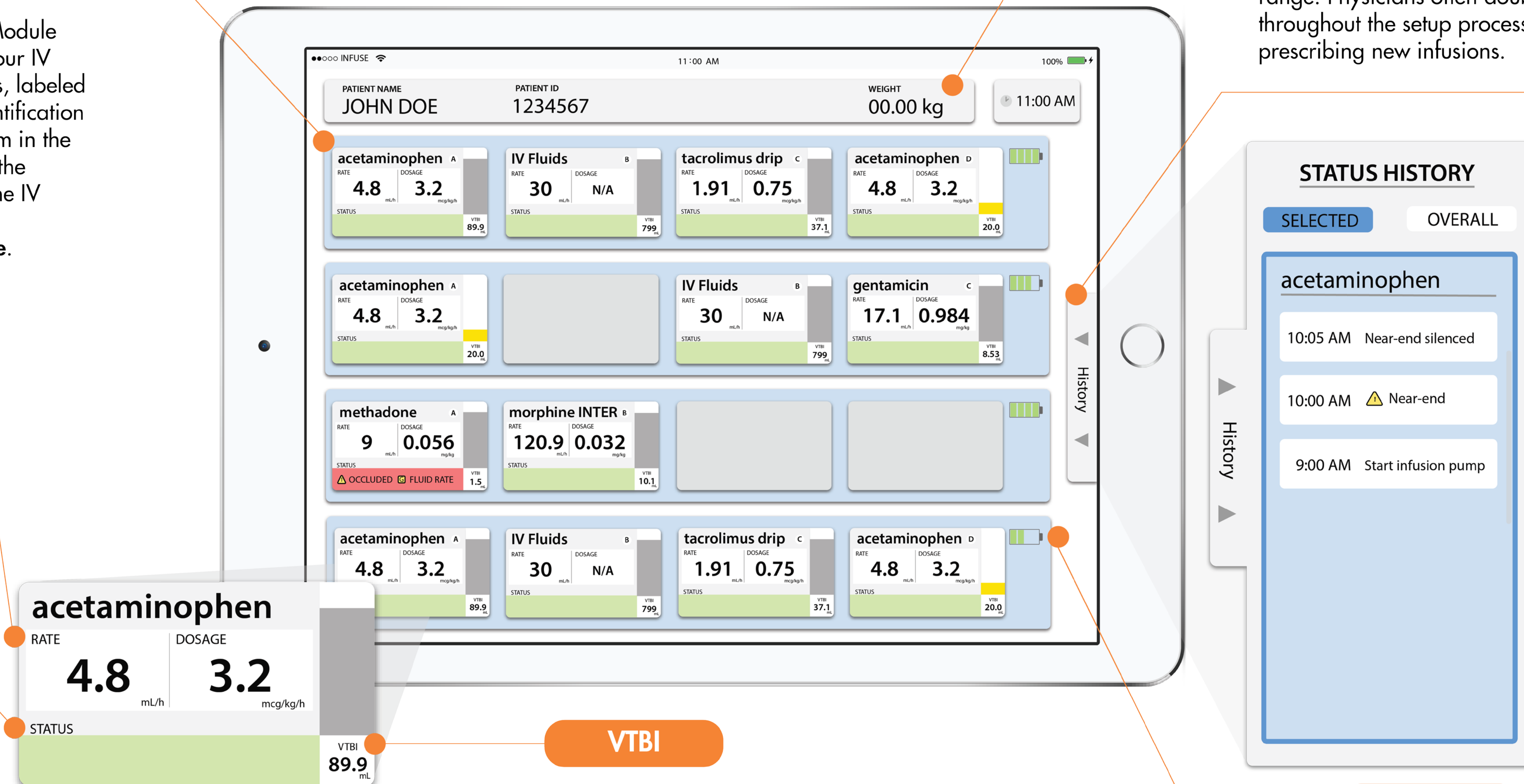
Rate / Dosage

For doctors and nurses, rate and dosage are the **most important IV numbers** when monitoring a patient. We made these numbers clearly visibly so physicians can ensure patients are **safe**.

Status Bar

Currently, physicians are forced to read slow, scanning text to identify alerts. **This can be dangerous in life-threatening situations.** For faster problem solving, we added a status bar to provide a quick and easy way to scan potential errors or warnings.

The status bar also **changes color on varying levels** of alert severity: green indicating no alerts, yellow indicating warnings, and red for severe errors.



Weight

The patient's weight is an important statistic to **ensure the patient's dosage** is within a safe range. Physicians often double check the weight throughout the setup process and before prescribing new infusions.

History Panel

Multiple physicians treat the same patient during his or her stay. The History Panel provides a quick way for physicians to catch up on the patient's recent infusions and a timeline of past alerts, **minimizing possible mistakes and keeping people up-to-date.**

VTBI

The Volume To Be Infused (VTBI) bar **indicates remaining volume** both with a color-coded progress bar and a number (in mL). The progress bar lowers with respect to the actual amount left and turns yellow when the nearly empty.

Battery

Each Alaris Brain Module runs on battery when it's not plugged in and can be **life-threatening** if the battery runs out during an infusion. The battery indicator helps remind physicians to charge the IV system, **preventing unwanted shutdowns**.

This breakdown show an annotated view of our final design, breaking down the main features.

This is the poster we used as a visual aid to present our design to both professionals and those not familiar with the field.

In our video, we contextualize our interface, and display how it can be used in the medical field.
The video can be found online here: youtu.be/PR9yrcB6vyI

CREATION

REFLECTION

Looking back on the design and creation of our design, I can confidently recommend it as a strong interface to solve the problems with IV infusion machines that doctors face. I believe it properly serves our audiences because of its user centered design.

Currently, the interface could only be used with newer Alaris machines that have wireless communication. Otherwise, it can’t take live data from the pumps. In the future, I would hope to search for a way that the interface could be used widely with different IV machines, whether it was wireless capable or not, or even an Alaris pump or a different brand entirely.

As for the design process itself, if I had to opportunity to do it again, I would spend more time collecting data from doctors and surgeons, be it through interviews or prototype testing. Though I am confident with the final design we have now, the design process could have been expidited or smoother with more input from those medical professionals.

CONCLUSION

With our final design of InfuseView, we created an interface that reduces a doctor's cognitive load and help save lives

The basis of our design was successful because of our foundation of designing with a user-centered mindset. Through every set of the process, we considered and viewed the design solution through the lens of our personas to see if it was appropriate.

The result was a strong medical design. It minimized flash that might appeal to outside audiences, but emphasized qualities for our main audience.

Our final product was a user-centered design.

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