Problem Definition & Design Thinking

Title: Structural Health Monitoring

Problem Statement:

Intensive Care Units (ICUs) care for critically ill patients who require continuous, real-time monitoring of vital signs such as heart rate, oxygen saturation, blood pressure, and respiratory rate. Traditional ICU monitoring relies heavily on manual oversight and bedside alarms, which are prone to alarm fatigue, human error, and delayed intervention—especially during high patient loads. There is a growing need for AI-enabled ICU monitoring systems that can analyze real-time data, predict patient deterioration, and improve clinical decision-making and patient safety.

Target Audience:

- Hospital Administrators – Aiming to improve patient outcomes while managing operational efficiency and costs.
- ICU Doctors and Nurses – Requiring accurate, real-time alerts and decision-support tools to manage critical cases.
- Medical Device Manufacturers – Developing next-gen ICU monitoring systems with smart sensor integration.
- AI & Health Data Scientists – Focused on developing algorithms for early detection of health deterioration.
- Healthcare Policy Makers – Looking for technology to improve care quality and optimize healthcare infrastructure.

Objective:

- Enhance Patient Safety – Use AI to detect subtle signs of deterioration before visible symptoms appear.
- Reduce Alarm Fatigue – Minimize false alarms and prioritize critical alerts.
- Enable Predictive Care – Anticipate patient crises such as sepsis, cardiac arrest, or respiratory failure.

- Support Remote Monitoring – Allow healthcare professionals to monitor multiple patients from a centralized location or remotely.
- Integrate AI & IoT – Build a connected, intelligent ICU system that feeds real-time data to machine learning models for early interventions.

Design Thinking Approach

Empathize:

Understand the real-world challenges of ICU professionals and patients.

Key Actions:

- Interview ICU nurses, doctors, and technicians about their day-to-day workflows and pain points.
- Observe alarm systems, shift workload, and handover processes.
- Collect feedback on common causes of delayed responses or clinical oversights.

Define:

Summarize core issues based on stakeholder insights.

ICU teams need a smart, reliable, and real-time monitoring system that prioritizes critical alerts, reduces alarm overload, and assists in predicting patient decline before it's clinically visible.

Ideate:

Brainstorm solutions to address the defined problems.

Idea Examples:

- AI-enhanced monitoring dashboard that ranks patient risk in real time.
- Wearable biosensors (e.g., wireless ECG, SpO2) for continuous, non-invasive monitoring.
- Predictive analytics model for early detection of sepsis or respiratory failure.
- Centralized nurse station display with trend visualizations and anomaly heatmaps.
- Integration of mobile notifications or smartwatches for alerts.

Prototype:

Create tangible versions of your ideas for initial validation.

Prototypes Might Include:

- A UI mockup of the smart ICU dashboard showing real-time vitals and risk alerts.
- A working wearable sensor system using Raspberry Pi or Arduino to simulate vitals tracking.
- A machine learning model (e.g., LSTM or Random Forest) trained on ICU datasets to detect patient deterioration.
- An app or web portal for remote monitoring by doctors.

Test:

Test the prototypes in simulated or real ICU environments to gather user feedback.

Testing Goal:

- Simulate abnormal vital patterns and validate alert accuracy.
- Share the dashboard with ICU staff and collect usability feedback.
- Evaluate the performance of the ML model using ICU datasets (measuring precision, recall, and false alarm rate).
- Measure user satisfaction and response times to AI-triggered alerts.