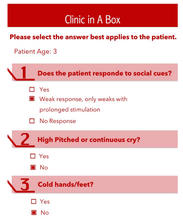
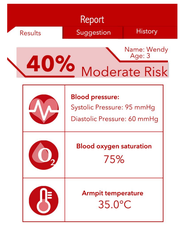
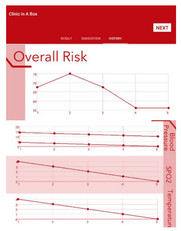
UI Design





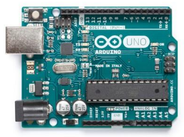


The aesthetic design of the application uses red as the theme color, and bandaid as the basic design element to deliver the main concept of this healthcare design. The infinity mark in the logo represents that the device is a standalone design, operating without external internet and professional technician. The overall design utilizes minimum color effect and simple texts to maintain its straightforwardness and intelligibility.

The software component of the interface consists of four main parts: the welcome and login page, the questionnaire page, testing pages and the report page.

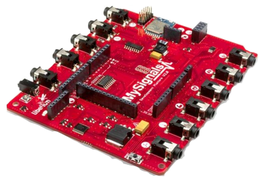
- Login page: users can import their account information to be stored in the database as a new user, or retrieve history report of an existing account from the database.
- Questionnaire page: users will be asked to fill in a questionnaire, which includes five basic diagnosis questions. The answer will be parsed and analyzed using a back-end algorithm to provide an accurate diagnosis report.
- Test pages: in these pages, the system will instruct users to perform blood pressure test, blood oxygen test and temperature test with intelligible graphics and text. As shown in figure above, the sensor will be indicated and detailed instruction will be displayed on these pages. Moreover, the logos and progress bar at the bottom will demonstrate the current test progress.
- Report pages: after analyzing the questionnaire answers and performing the medical tests, diagnosis report will be generated and displayed on the screen. A report will be stored in a back-end database for future access. Moreover, the suggested medical care and previous report history will be presented alongside, if applicable for this specific patient.

Hardware Platform & Sensors



This part consists of a hardware development kit and three different medical sensors. The goal of these components is to simulate selected tests for early sepsis measurements, and transmit test results back to the back-end module. The hardware module is corporated with Arduino IDE through a USB port. Detailed functions are listed below:

- Arduino IDE: the microcontroller with open-source software that assists data transmission. Preload functions are featured to store and upload test results from physical sensors. Before the device being introduced to patients, all programs related to Arduino should already be loaded. The triggle for arduino to start transferring data back will be the “Start” button for each test.The control algorithm is in the back-end software layer.



- Mysignal Platform: The hardware development kit is used to retrieve patient vitals. Users need to attach sensors to process the tests, capture test results and deliver them through arduino.
- Three test sensors: According to the NICE guidelines of early stage sepsis, the following measurements are considered as critical for diagnosing and monitoring patients:
  - blood pressure, armpit temperature, blood oxygen test

Clinic In A Box

Portable Diagnosis for Early Stage Sepsis

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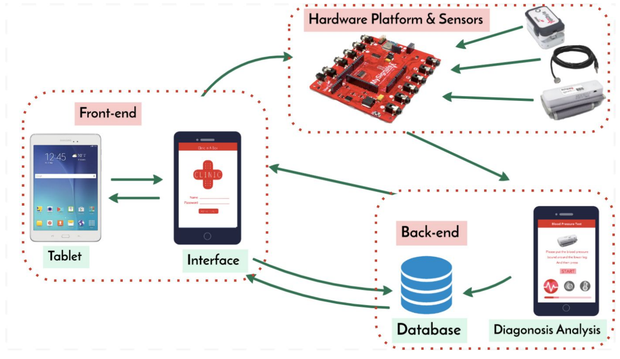
Background & Motivation

Sepsis infection is one of the major cause of newborn deaths. The Clinic-in-A-Box project aims to reduce neonatal mortality in rural regions. It functions as a remote clinic with the ability to diagnose and treat early stage sepsis. It is low-cost, easy-to-use and portable.

System overview



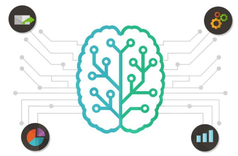
Software Layer

The backend module is responsible for data processing and storage. The two major components are software algorithm and SQLite database. The back-end software is implemented on the Android operating system, with the ability to communicate and transmit data with the front-end interface, process and store user information, and control the medical device to perform physical tests.

1. Algorithm

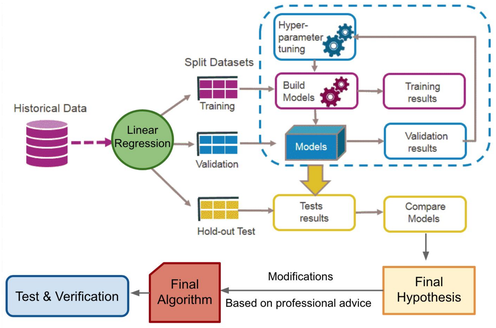
For backend software layer, the team first implemented a simple questionnaire, asking about the patient’s basic symptom, and a backend algorithm to calculate the risk percentage of this patient. The software algorithm is able to perform the following functions:

- **Data transfer:** send and receive user data to/from front-end interface, medical platform & sensors, and SQLite database
- **Control algorithm:** synchronize and send signals to medical hardware platform to start physical tests
- **Diagnosis algorithm:** combine questionnaire answers with physical test results, develop and implement an accurate algorithm to calculate the risk percentage of Sepsis
- **Report generation:** process, organize and present user data in three separate tabs (User History, Test Results, and Medical Suggestions)



The software algorithm is written in JAVA, according to the information provided by UofT nursing department. The development of diagnosis algorithm involves both human professionals and machine learning techniques. The hypothesis sets are chosen based on past cases of neonatal Sepsis. The algorithm training is done using the patient data, and the final decision is made to maximize the accuracy of predicting the risk percentage of getting Sepsis.

The risk percentage algorithm is based on a linear regression machine learning model. We used historical data with symptoms and risk to train and select the model, tested and validated using other use cases. Then, we discussed with the nursing department, adding additional conditional checks for important criteria, such as blood oxygen and mottled skin condition. Lastly, this model is checked and verified. To ensure our accuracy, we used a set of data to approximate the risk percentage, compare results generated by our algorithm with the prediction made by human expert.



2. Database

The back-end database is implemented in SQLite, embedded with our Android application. The introduction of database is to store patients’ information along with their test data. The database has two separate tables for data storage:

- **Patients Table**: record the patient’s first name, last name, password, and age at the time of registration. In addition to that, it automatically assigns a unique user ID to each user in order to log into the system and retrieve history test results.

Column Names	PatientID	First Name	Last Name	Age	Password
Sample Data	1	Admin	Admin	3	123

- **Tests Table**: include answers of five multiple choices from the Questionnaire (**Q1-Q5**) and three physical tests conducted through external medical devices (**P1-P3**). The risk percentage of getting Sepsis is calculated by the Algorithm, later passed and stored in the database along with other test results.

Column Names	TestID	PatientID	TestDate	TestAge	Q1	Q2	Q3	Q4	Q5	P1_1	P1_2	P2	P3	Risk Percentage
Sample Data	1	1	20180322	4	1	2	1	2	2	1.1	1.1	2.2	3.3	30