ORISE - Build The Future Student Competition

NICHOLAS - PENNSYLVANIA
Did You Know?

MEDICAL ERRORS ARE THE 3RD LEADING CAUSE OF DEATH IN THE UNITED STATES. - JOHNS HOPKINS UNIVERSITY
Engineering Design Process
Phase 1: Ask

- Define and solve a problem in the community
- I chose to focus on providing a needed medical solution that will improve the lives of all community members nationwide
Phase 1: Ask

THE ISSUE

- Complications arise from medical errors due to a lack of knowledge about a patient's pre-existing medical conditions.

  - A Johns Hopkins study found that medical errors are the cause of 250,000 to 440,000 deaths each year in the US (Sipherd 2018). Another Johns Hopkins survey found that medical errors are responsible for 9.5% of all deaths each year in the United States.

- The golden hour is critical for patients in emergency situations.

  - Golden hour: time between the call for help to the time of treatment in an emergency.

  - Effective response and care is crucial for a patient's survival and recovery.

PROPOSED SOLUTION

- Create a technological device that will help maximize the golden hour and minimize medical treatment errors.

- Enlighten medical care providers with the patient's critical medical information to minimize the time of treatment upon arrival to an emergency scene, especially if a patient is non-responsive.
PHASE 2: RESEARCH
CONDUCT A SURVEY OF LOCAL MEDICAL CARE PROVIDERS TO DETERMINE THE NEED

OCCUPATIONS OF INDIVIDUALS SURVEYED

- Emergency services: 48.4%
- Medical: 28.1%
- Personal living care: 4.7%
- Law enforcement: 5.3%
- Educational (nurses): 2.5%
Phase 2: Research Survey Results

Knowing a patient's critical info in an emergency situation:
- Not critical: 2%
- Somewhat critical: 7%
- Extremely critical: 91%

Importance of time in emergency situation:
- Not important: 2%
- Important: 16%
- Very important: 84%

Lack of knowledge has led to further complications:
- Rarely: 62%
- Sometimes: 38%

Open to using PHD:
- Yes: 93%
- No: 7%

Lacking critical info when treating a patient:
- Rarely: 13%
- Sometimes: 16%
- Often: 71%
In the extensive survey of medical professionals:

- Over one-third stated they experienced an emergency where a lack of information led to further complications for a patient.
- 100% recognized time as being very important in an emergency.
- 85% lacked helpful information when providing care.
- When administering emergency care, 100% acknowledge knowing a patient's information such as allergies, current medications, past medical conditions, and identification as extremely critical.
- 95% would be open to using new technology to access critical information.
Phase 2: Research

What Already Exists

- Medical ID Bracelet – bracelet you wear on your wrist that alerts emergency responders
- QR Code Helmet – QR code stickers that are placed on workers helmets and store personal and medical information
- Military Dog Tags – necklaces with tags that identify soldiers and contains basic information

Problems

- A wristband, sticker, or necklace is subject to falling off, being damaged, or breaking
- PHD would solve these concerns
Phase 3: Imagine

Solution

- A device that connects first responders and medical personnel to a patient's medical information through the touch of a fingerprint to provide the quickest and most effective care at the scene of an emergency.

Why?

- My solution can potentially impact everyone.
- Anyone can get in an accident or have a medical emergency at anytime and anywhere.
- Any lack of knowledge a first responder has regarding a patient's medical history and current medical treatments when arriving on the scene of an accident can potentially lead to catastrophic errors.
- Each person has 10 individually unique fingerprints that are durable and not as susceptible to damage or being lost.
Plan

DESIGN THE PROTOTYPE

ESTABLISH METHODS TO REGISTER USERS
Phase 4: Plan
Design The Prototype

- Interviewed a local paramedic, Mr. Doug Keffer, to determine the most crucial information needed immediately after arriving to an accident.

- Researched components to be used to build a prototype to capture, store, and share the targeted data.

- Research security to help protect the information stored in the database.

- Outline the registration process.
Phase 4: Plan
Critical Information

Critical Information Provided by PHD

- Blood Type
- Past Surgeries
- Current Medications
- Allergies
- Baseline Vitals
Phase 4: Plan Prototype Components

COMPONENTS

- This technology incorporates an Arduino single-board microcontroller (Arduino UNO)
- Adafruit Capacitive Scanner with a Direct Fingerprint Reader (DFR)
- NodeMCU ESP8266
- Graphical user interface

OUTLINE OF HOW THE COMPONENTS WORK TOGETHER

Adafruit Capacitive Scanner ➔ NodeMCU ESP8266 ➔ Graphical User Interface ➔ Arduino UNO
Phase 4: Plan

Capacitive Scanner

- Uses electrical currents
- Creates an image of the fingerprint through measuring the varying distances of the finger’s ridges and valleys.
- More secure than other fingerprint readers
Phase 4: Plan

**Arduino UNO**

- Open-source microcontroller board
- Equipped with digital input/output pins
- Connected to the fingerprint scanner to carry out desired function
Phase 4: Plan

Node MCU ESP8266

- Integrates 802.11b/g/n HT40 Wi-Fi transceiver
- Connects to Wi-Fi and interacts with the internet
- Can set up a network of its own, allowing other devices to connect directly to it
- Very versatile
Phase 4: Plan

Arduino Breadboard

- Allows for the creation of a temporary prototype
- Easy removal of components (no soldering)
- Connects components electrically
Phase 4: Plan - Security

- PHD will incorporate 2048 bit RSA data encryption technology
- Composed of two pieces – a public key and a private key
- Data can only be accessed by someone with a decryption key
- Would take approximately 6.4 quadrillion years for someone without a decryption key to access
Phase 4: Plan - Registration Process

• Community members would be made aware of the PHD technology and the opportunity to opt into the system

• Users opt in at their local doctor or health care provider

• Health care providers upload and enter the individual's medical information into the PHD database

• Health care providers scan the users fingerprints to link them with their medical profile

• Users have the ability to update information at any time through their health care provider
Phase 4: Plan - Implementing

Scenario

• A car swerves off the road and into a tree
• Medical personnel arrive on the scene and find an unresponsive patient
• A first responder uses the PHD device to scan the accident victims' fingerprint
• The first responder quickly examines their medical information and safely treats the patient

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Phase 5: Create

- The Personal Health Directory (PHD) solution will provide a handheld device in which emergency responders will be able to scan a patient’s fingerprint and instantly gain access to critical information needed to quickly and safely provide the initial phase of care.
Once a first responder scans the patient's fingerprint, a database containing all their personal and medical information will be brought up, thus providing quick and effective care.
Phase 6: Improve

Strengths
- Providing quick and effective care
- Practicality
- Impact for total population
- Durable – fingerprints are not as susceptible to damage or theft

Potential Weaknesses
- Size of device – the device would currently be a bulky tabletop device
- In very rare instances the injury could render the device ineffective
- Connectivity challenges in remote areas
Phase 6: Improve – What Could Be Done Better

- The size of the device can be improved upon by compressing the components into a smaller, more concise, and easily usable handheld device. This would allow the PHD device to plug into any smart tablet or phone. To do this, the next step would be to partner with Selmax, a local plastics engineering and production company in PA to develop a prototype case.

- To improve the connectivity in remote areas, a satellite would be incorporated into the device. This improvement would significantly impact a connectivity problem because it allows the device to be used with fast speed virtually anywhere.
Community Connections Used in Project Development

- Retired PA State Police Officer - Paul Mall
- Active Paramedic - Doug Kieffer
- Health Care Professionals in the Community
- Instructional Media & Communications Specialist, Tuscarora Intermediate Unit 1 - Jigar Patel
- Selmax - A Plastic Engineering Company
Additional Applications:

- Schools – quick access to medical records

- Military – replace physical medical identifiers in the field and provide accurate emergency care

- Covid-19/Pandemic - quick identification of individuals with COVID-19
THANK YOU FOR YOUR TIME AND CONSIDERATION