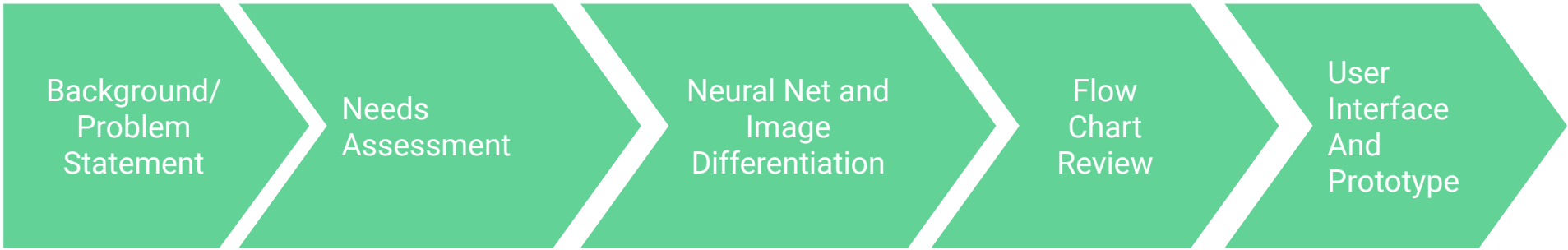
# Burn Resuscitation and Management for Early Responders

BMExtra Group:
Jacob Ayers (BME), Hannah Kang (BME), Dominique Szymkiewicz (BME), Nora Ward (BME), Thomas Yates (BME), Eric Yeats (CompE)

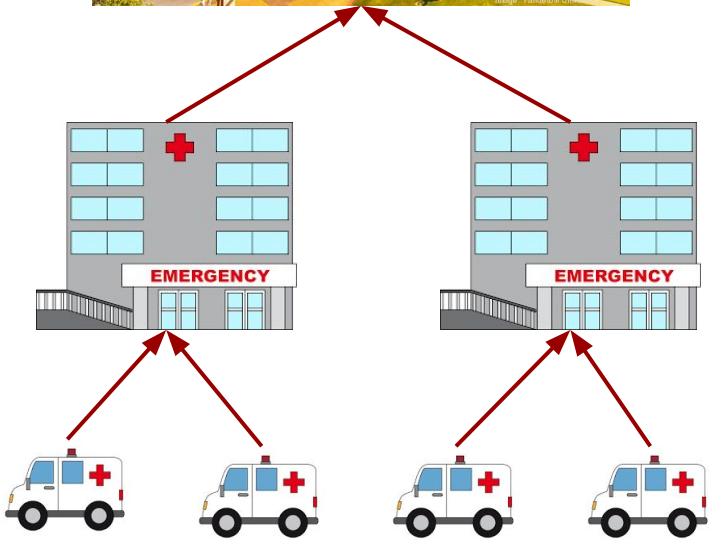
Contact:
Avinash Kumar M.D.

# Presentation Overview



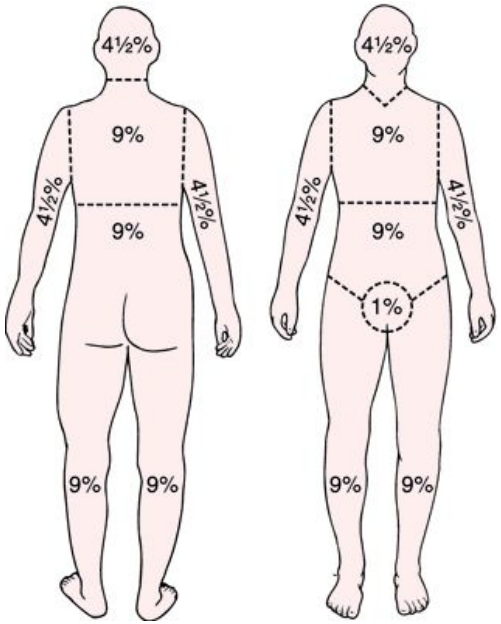
# VUMC Burn ICU

- Vanderbilt Burn ICU
  - Level 1 Burn Center
  - 630 new admissions per year
    - Majority transferred from E.R.
  - Primary Contact: Dr Avinash Kumar

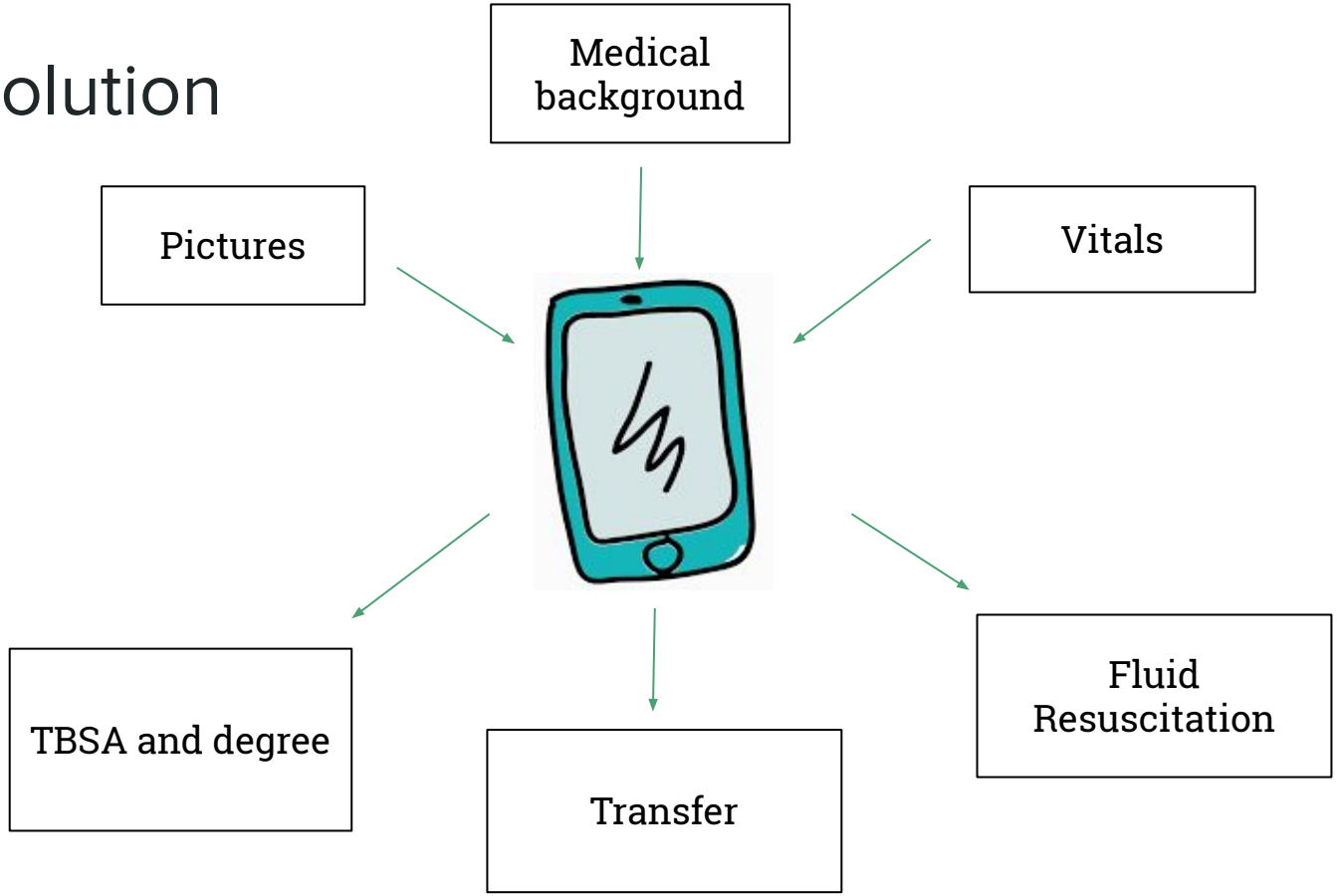


# Problem Statement

- Current System:
  - Wallace Rules of Nine (Adult)
  - Rules of Eight/Palm method
- Problems:
  - Overestimation of burn percentage
    - 79% of TBSA was estimated inaccurately
      - ½ of these burns overestimated by ≥ 5%
  - Overburden Burn centers with patients
  - Does not account for different body types
- **Goal: Develop system to rapidly and accurately determine TBSA**



# Our Solution

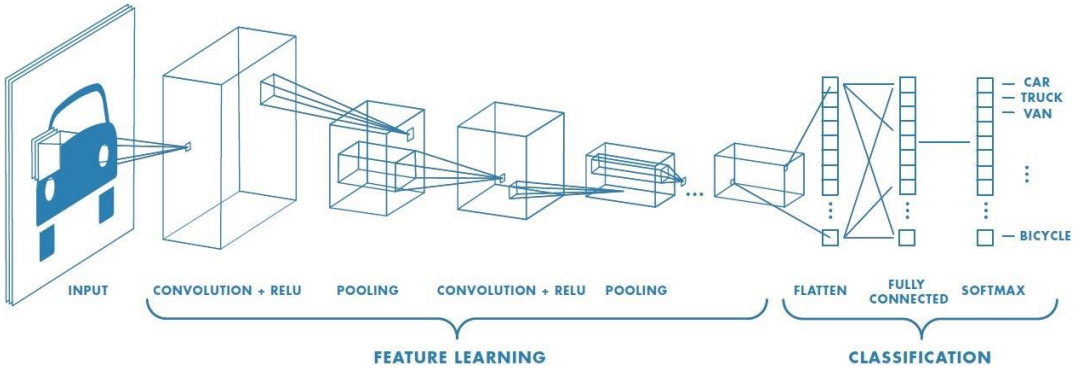


# Needs Assessment

1. Infrastructure Compatibility
2. Safety
3. Patient Efficacy
4. Performance Capabilities
5. Cost Efficacy

# Neural Network Model

- Convolutional Neural Network
  - 50x50x3 Images ➜ Softmax Output



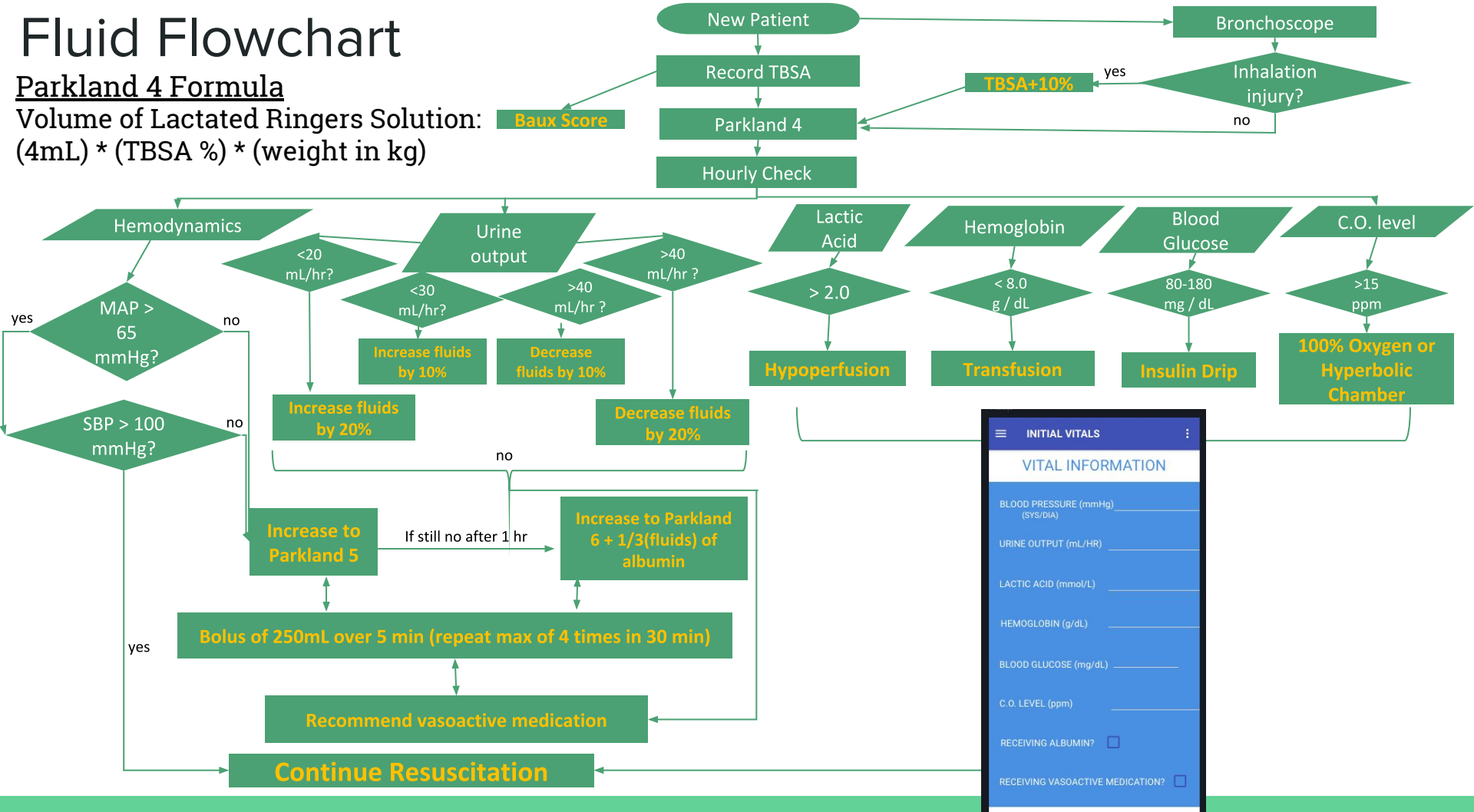
# Neural Net Update

- Neural Net Trainer v2 Update
  - Through 50 Epochs with 18228 subimages:
    - Maximum Accuracy = ~83%
    - Minimum Loss = ~.496
  - Reduced Features to 100/Conv Layer
  - Saved into .pb file for mobile version
- Neural Net Predictor v3 Update
  - Input any image
  - Image is split into 50x50 subimages and classified
  - Reconstructed and colored based on classification
  - Control BSA Error: 7%-17%
    - This error translates to .3%-3% error in TBSA

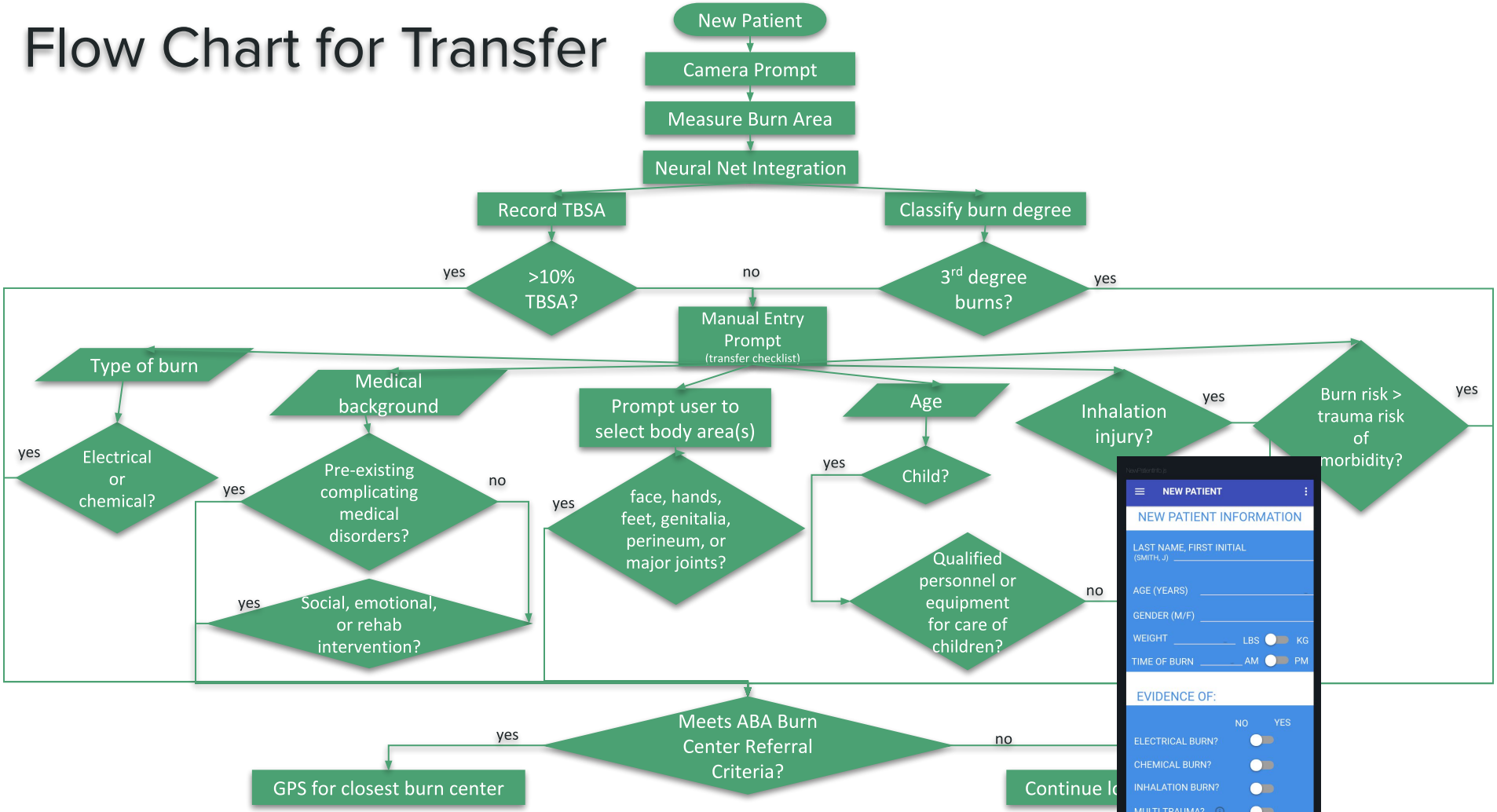
# Fluid Flowchart

## Parkland 4 Formula

Volume of Lactated Ringers Solution:
(4mL) * (TBSA %) * (weight in kg)



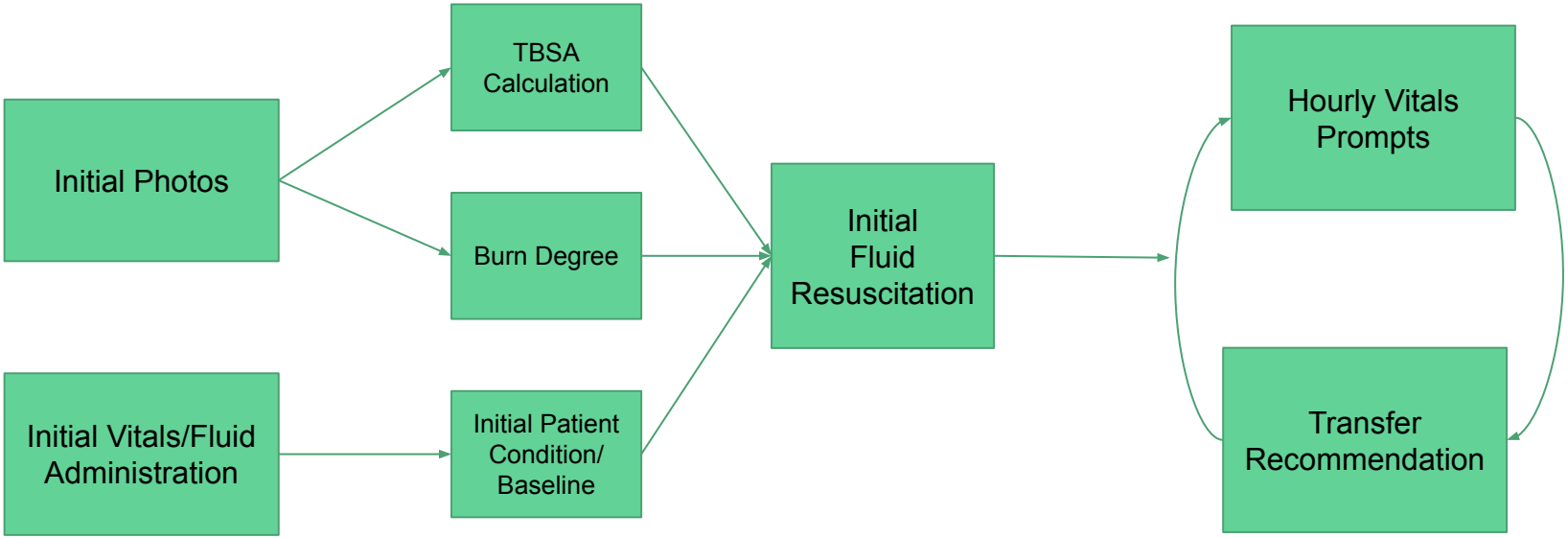
# Flow Chart for Transfer

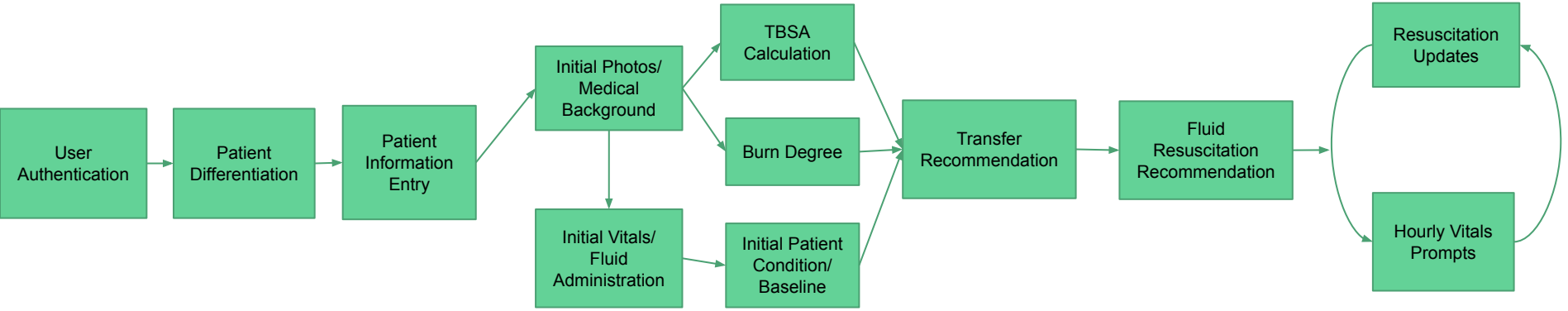


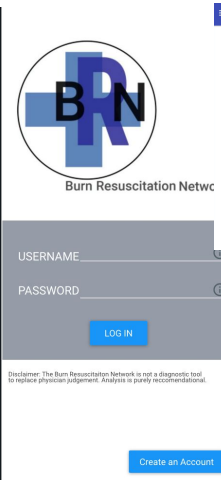
# User Interface - Beginning Prototype

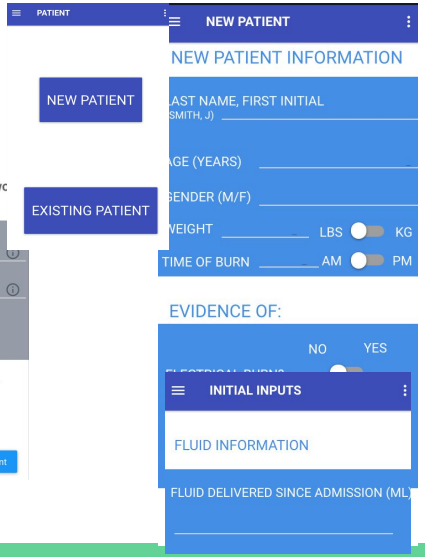
# User Interface - Basic Design Ideas

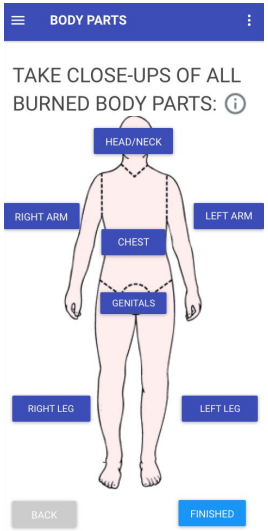
# User Interface - Basic Design Ideas

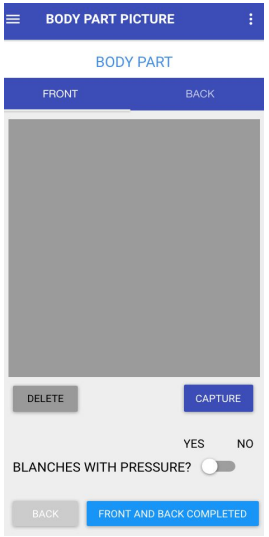


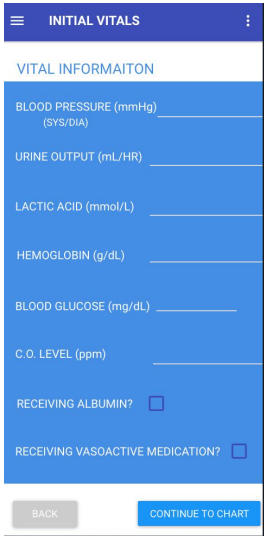

User Authentication
Patient Differentiation
Patient Information Entry
Initial Photos/ Medical Background
TBSA Calculation
Burn Degree
Initial Vitals/ Fluid Administration
Initial Patient Condition/ Baseline
Transfer Recommendation
Fluid Resuscitation Recommendation
Resuscitation Updates
Hourly Vitals Prompts

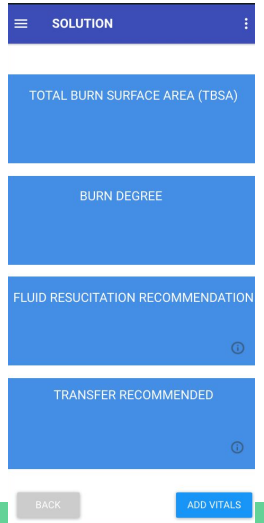

Burn Resuscitation Netwo
USERNAME
PASSWORD
LOG IN
Create an Account

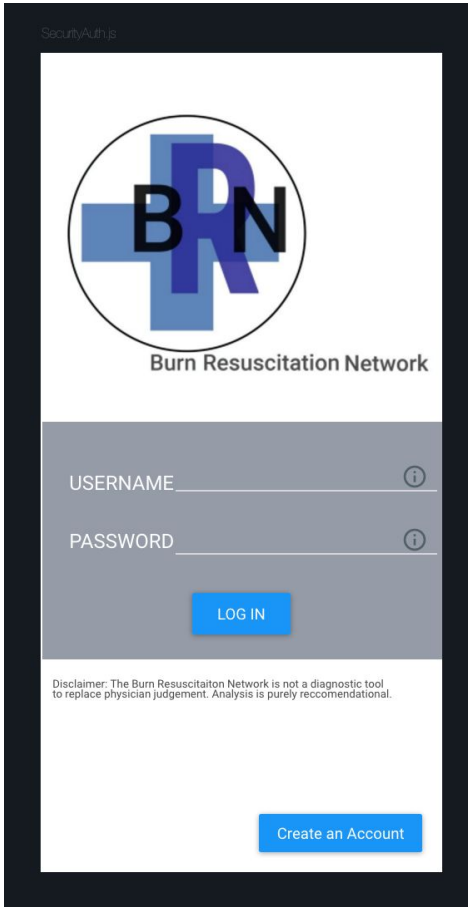

PATIENT
NEW PATIENT
EXISTING PATIENT
NEW PATIENT
NEW PATIENT INFORMATION
LBS
KG
AM
PM
EVIDENCE OF:
NO
YES
INITIAL INPUTS
FLUID INFORMATION
FLUID DELIVERED SINCE ADMISSION (ML)

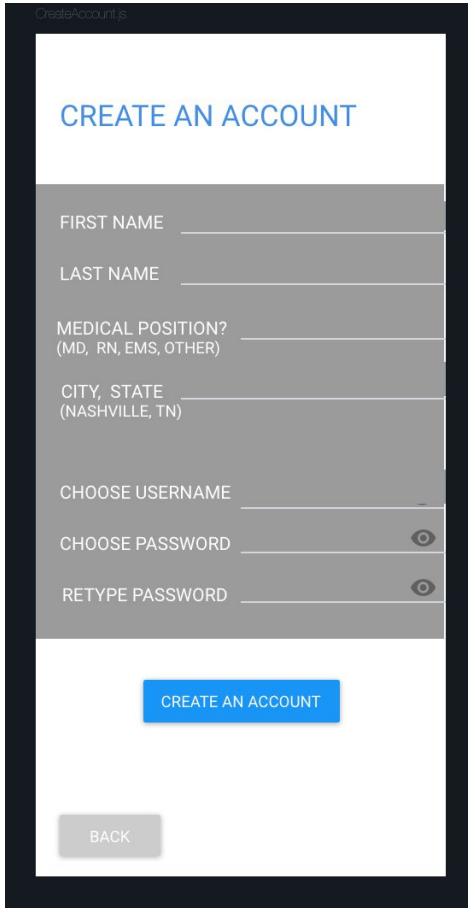

BODY PARTS
TAKE CLOSE-UPS OF ALL BURNED BODY PARTS:
HEAD/NECK
RIGHT ARM
LEFT ARM
CHEST
GENITALS
RIGHT LEG
LEFT LEG
BACK
FINISHED

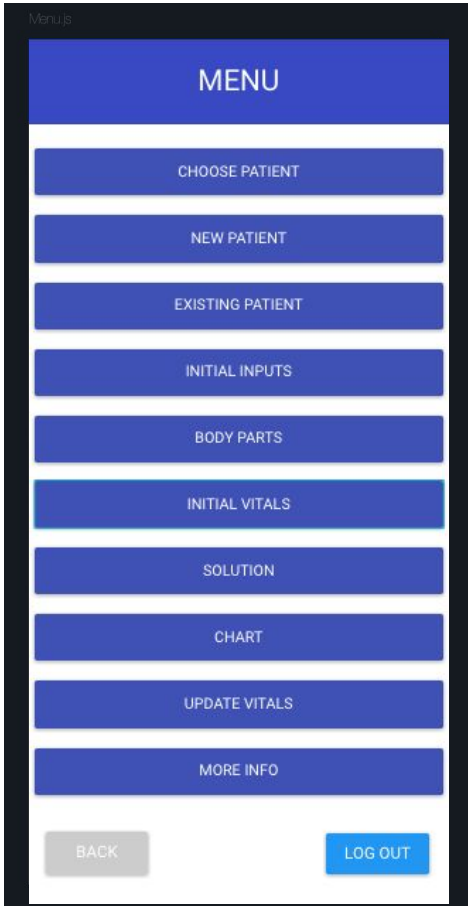

BODY PART PICTURE
BODY PART
FRONT
BACK
DELETE
CAPTURE
YES
NO
BLANCHES WITH PRESSURE?
BACK
FRONT AND BACK COMPLETED


INITIAL VITALS
VITAL INFORMAITON
BLOOD PRESSURE (mmHg)
(SYS/DIA)
URINE OUTPUT (mL/HR)
LACTIC ACID (mmol/L)
HEMOGLOBIN (g/dL)
BLOOD GLUCOSE (mg/dL)
C.O. LEVEL (ppm)
RECEIVING ALBUMIN?
RECEIVING VASOACTIVE MEDICATION?
BACK
CONTINUE TO CHART

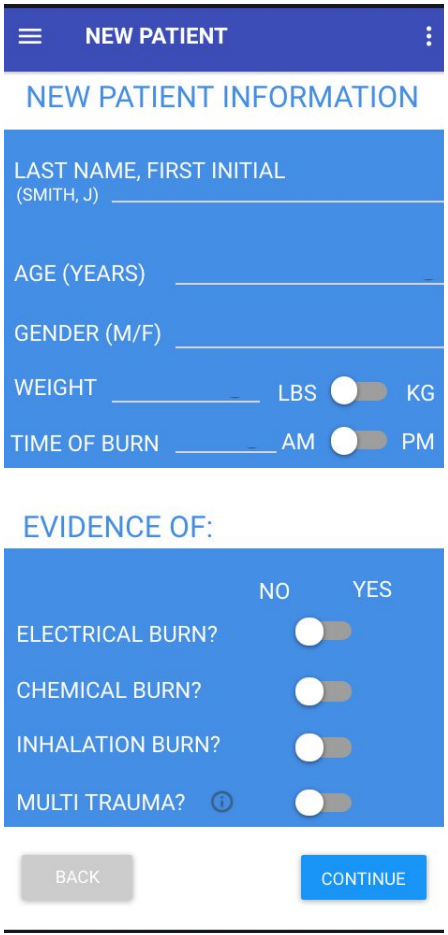

SOLUTION
TOTAL BURN SURFACE AREA (TBSA)
BURN DEGREE
FLUID RESUCITATION RECOMMENDATION
TRANSFER RECOMMENDED
BACK
ADD VITALS

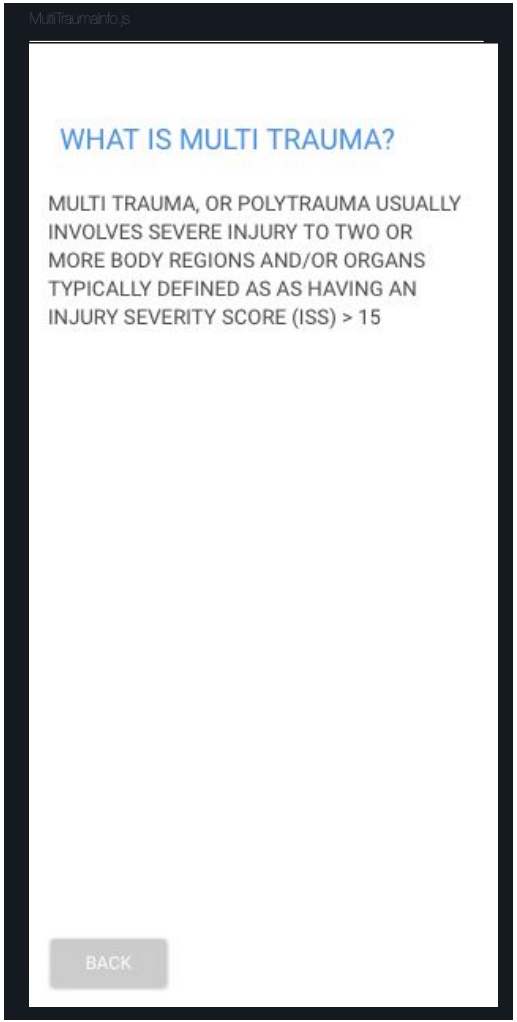

SecurityAuth.js
BRN
Burn Resuscitation Network
USERNAME
PASSWORD
LOG IN
Disclaimer: The Burn Resuscitaiton Network is not a diagnostic tool to replace physician judgement. Analysis is purely reccomendational.
Create an Account

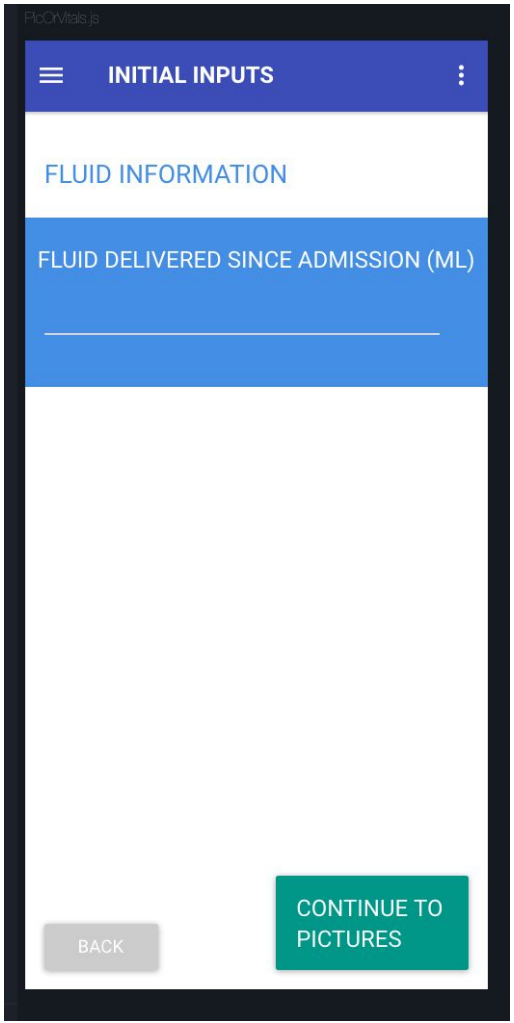

CreateAccount.js
CREATE AN ACCOUNT
FIRST NAME
LAST NAME
MEDICAL POSITION?
(MD, RN, EMS, OTHER)
CITY, STATE
(NASHVILLE, TN)
CHOOSE USERNAME
CHOOSE PASSWORD
RETYPE PASSWORD
CREATE AN ACCOUNT
BACK


Menu.js
MENU
CHOOSE PATIENT
NEW PATIENT
EXISTING PATIENT
INITIAL INPUTS
BODY PARTS
INITIAL VITALS
SOLUTION
CHART
UPDATE VITALS
MORE INFO
BACK
LOG OUT

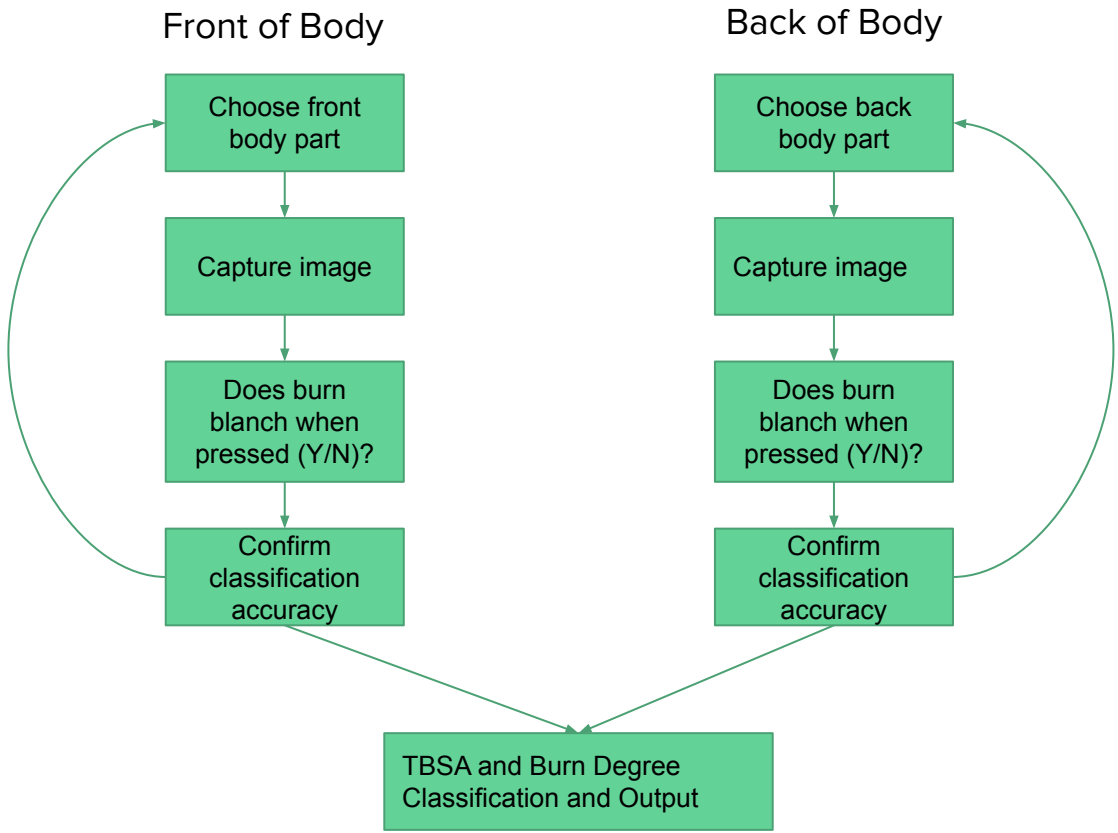

Patient.js
PATIENT
NEW PATIENT
EXISTING PATIENT


NEW PATIENT
NEW PATIENT INFORMATION
LAST NAME, FIRST INITIAL
(SMITH, J)
AGE (YEARS)
GENDER (M/F)
WEIGHT
LBS
KG
TIME OF BURN
AM
PM
EVIDENCE OF:
NO
YES
ELECTRICAL BURN?
CHEMICAL BURN?
INHALATION BURN?
MULTI TRAUMA?
BACK
CONTINUE


MultiTraumaInfo.js
WHAT IS MULTI TRAUMA?
MULTI TRAUMA, OR POLYTRAUMA USUALLY INVOLVES SEVERE INJURY TO TWO OR MORE BODY REGIONS AND/OR ORGANS TYPICALLY DEFINED AS AS HAVING AN INJURY SEVERITY SCORE (ISS) > 15
BACK


PicOrVitals.js
INITIAL INPUTS
FLUID INFORMATION
FLUID DELIVERED SINCE ADMISSION (ML)
BACK
CONTINUE TO PICTURES

# Breakdown of Key Branches - Image Capture

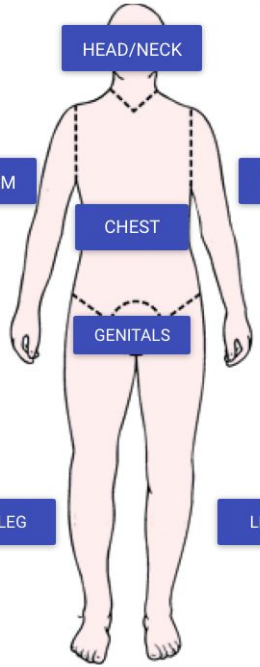



Repeat for other front burns or to retake/reclassify photos

Repeat for other back burns or to retake/reclassify photos

BODY PARTS

TAKE CLOSE-UPS OF ALL BURNED BODY PARTS:




BACK

FINISHED

SpecificBack.js

BODY PART PICTURE

BODY PART

FRONT

BACK

DELETE

CAPTURE

YES NO

BLANCHES WITH PRESSURE?

BODY PART PICTURE

BODY PART

FRONT

BACK

DELETE

CAPTURE

YES NO

BLANCHES WITH PRESSURE?

BACK

FRONT AND BACK COMPLETED

PicOk.js

BURN QUANTIFICATION

CORRECT BURN IDENTIFICATION?

NEURAL NET OUTPUT IMAGE

BURNED HEALTHY BACKGROUND

NO, TRY AGAIN

YES, CONTINUE

NO, MANUALLY TRACE BURN

HowToTakePhoto.js

HELP WITH TAKING PHOTO

WHEN TAKING PHOTO MAKE SURE:

1. ONLY FULL LIMB OF INTEREST IS BEING CAPTURED

2. PLAIN BACKGROUND

3. TRY WITH FLASH

BACK

Trace.js

TRACE BURNED AREAS

BACK TO IMAGE CAPTURE

DONE

INITIAL VITALS

VITAL INFORMAITON

BLOOD PRESSURE (mmHg) (SYS/DIA) _____

URINE OUTPUT (mL/HR) _____

LACTIC ACID (mmol/L) _____

HEMOGLOBIN (g/dL) _____

BLOOD GLUCOSE (mg/dL) _____

C.O. LEVEL (ppm) _____

RECEIVING ALBUMIN? ☐

RECEIVING VASOACTIVE MEDICATION? ☐

BACK | CONTINUE TO CHART

SOLUTION

TOTAL BURN SURFACE AREA (TBSA)

BURN DEGREE

FLUID RESUCITATION RECOMMENDATION

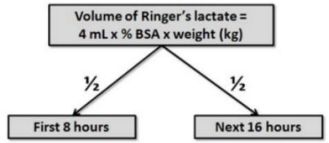
TRANSFER RECOMMENDED

BACK | ADD VITALS

WhyFirstFluid.js

INITAL FLUID EXPLAINATION

BASED ON VITALS, PARKLAND __ WAS USED AND PREVIOUS FLUIDS WERE TAKEN INTO ACCOUNT.




PARKLAND 4 FORMULA IS SHOWN ABOVE. PARKLAND 5 USES 5 ML AND PARKLAND 6 USES 6 ML IN THE FORMULA.

BACK

WhyTransfer.js

TRANSFER EXPLANATION

BASED ON THE FOLLOWING CRITERIA TRANSFER WAS/ WAS NOT RECOMMENDED.

- ☐ CHEMICAL AND ELECTRICAL BURN
- ☐ INHILATION BURN
- ☐ TBSA >20%
- ☐ CHILD OR ELDERLY PATIENT
- ☐ MULTI-TRAUMA

BACK

Existing.js

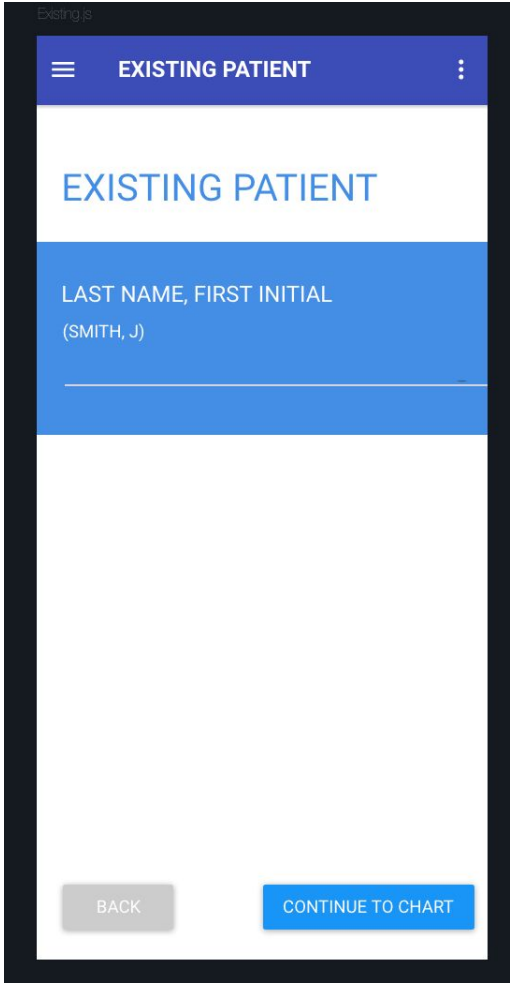
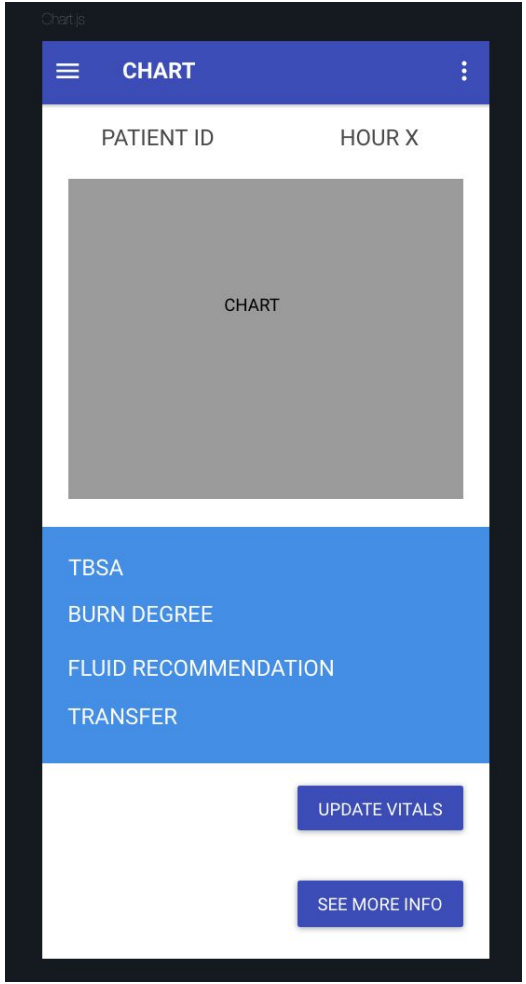
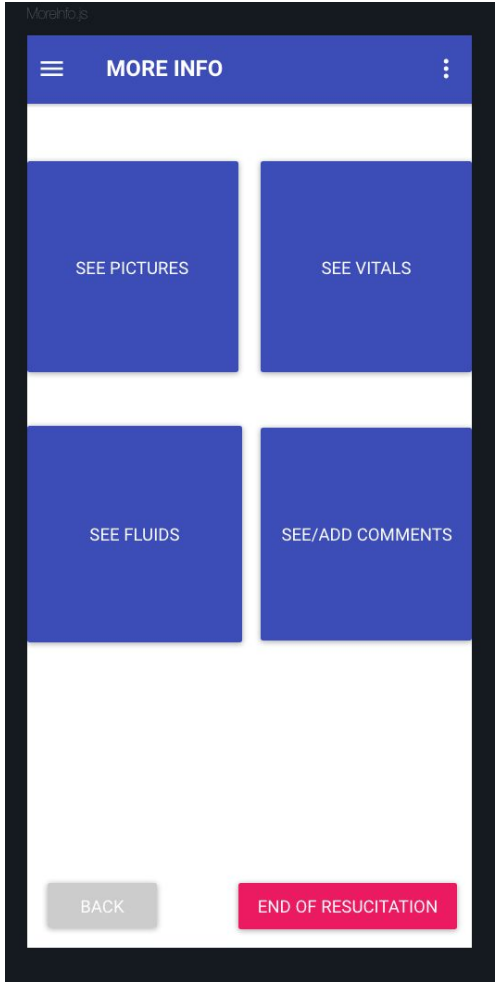



Chart.js




MoreInfo.js



Fluids.js

## FLUID HISTORY

| | |
|---|---|
| VOLUME (ML) | HOUR X |
| VOLUME (ML) | HOUR X |
| VOLUME (ML) | HOUR X |

BACK

VitalHistory.js

## VITAL HISTORY

CHOOSE HOUR

T-1 HOUR

T-2 HOUR

BACK

SpecificVitalPast.js

## VITAL HISTORY FOR HOUR X

BLOOD PRESSURE (mmHg) (SYS/DIA) _____

URINE OUTPUT (mL/HR) _____

LACTIC ACID (mmol/L) _____

HEMOGLOBIN (g/dL) _____

BLOOD GLUCOSE (mg/dL) _____

C.O. LEVEL (ppm) _____

RECEIVING ALBUMIN? ☐

RECEIVING VASOACTIVE MEDICATION? ☐

BACK

PicHistory.js

## PAST PICTURES

PAST PICTURES HERE

BACK

Comments.js

## PAST COMMENTS

BEGINNING OF COMMENT... HOUR X

BEGINNING OF COMMENT... HOUR X

BEGINNING OF COMMENT... HOUR X

ADD NEW COMMENT

ADD

BACK

EndRes.js

NOTE: CLICKING END RESUSCITATION WILL DELETE ALL INFORMATION ON THIS
PATIENT AFTER 48 HOURS IN THIS APPLICATION

ARE YOU SURE YOU WANT TO END THIS PATIENT'S RESUSCITATION?

YES, END AND EXPORT TO PDF

NO, BACK

UpdateVitals.js

UPDATE VITALS

## UPDATE VITALS FOR THIS HOUR

BLOOD PRESSURE (mmHg) (SYS/DIA) _____

URINE OUTPUT (mL/HR) _____

LACTIC ACID (mmol/L) _____

HEMOGLOBIN (g/dL) _____

BLOOD GLUCOSE (mg/dL) _____

C.O. LEVEL (ppm) _____

RECEIVING ALBUMIN? ☐

RECEIVING VASOACTIVE MEDICATION? ☐

NO, BACK

UPDATE

NewFluidRec.js

## FLUID RECOMMENDATION

PAST RECOMMENDATION (mL/HR)

UPDATED RECOMMENDATION (mL/HR)

AGREE AND UPDATE

DISAGREE?

ENTER IN NEW FLUID AMOUNT (mL/HR)

_____

UPDATE

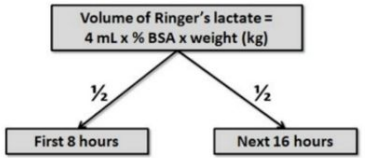
BACK

ExplainNewFluids.js

## FLUID EXPLAINATION

FLUID AMOUNT HAS INCREASED/ DECREASED BECAUSE BLOOD PRESSURE HAS INCREASED/ DECREASED AND URINE OUTPUT HAS INCREASED/ DECREASED.

BASED ON VITALS, PARKLAND __ WAS USED.




PARKLAND 4 FORMULA IS SHOWN ABOVE. PARKLAND 5 USES 5 ML AND PARKLAND 6 USES 6 ML IN THE FORMULA.

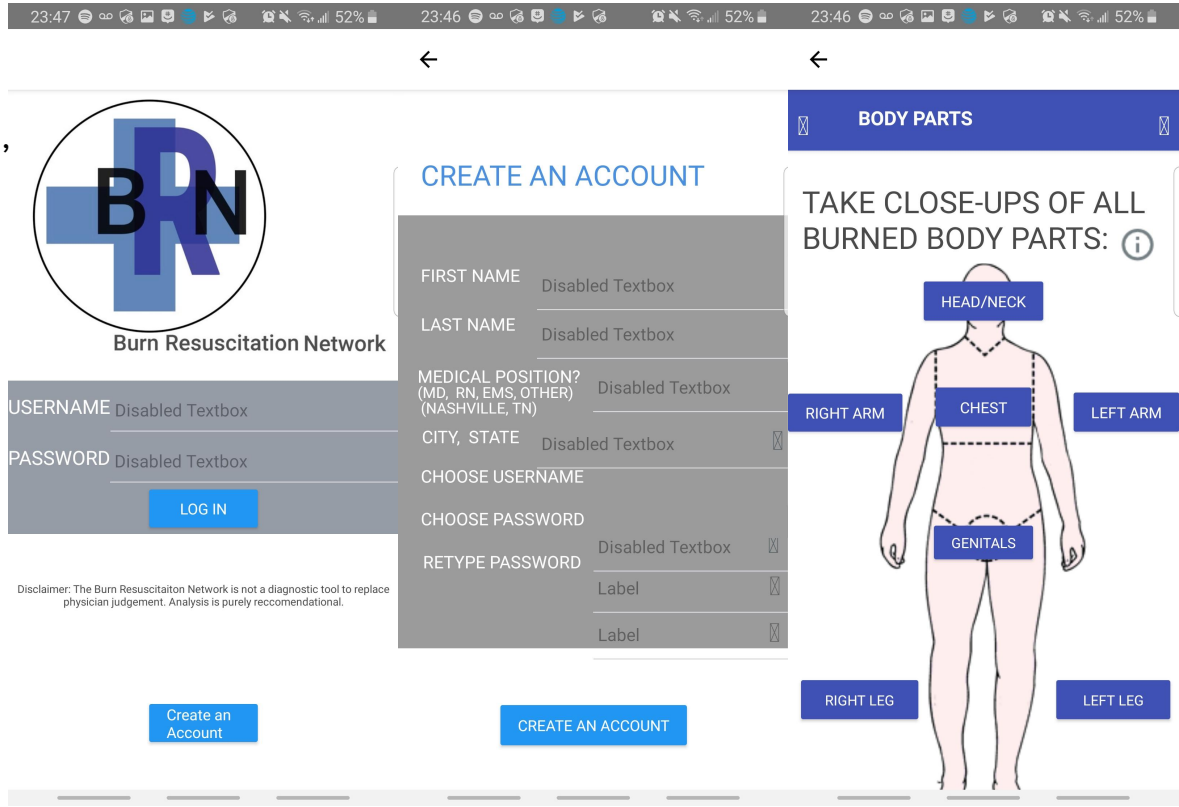
BACK

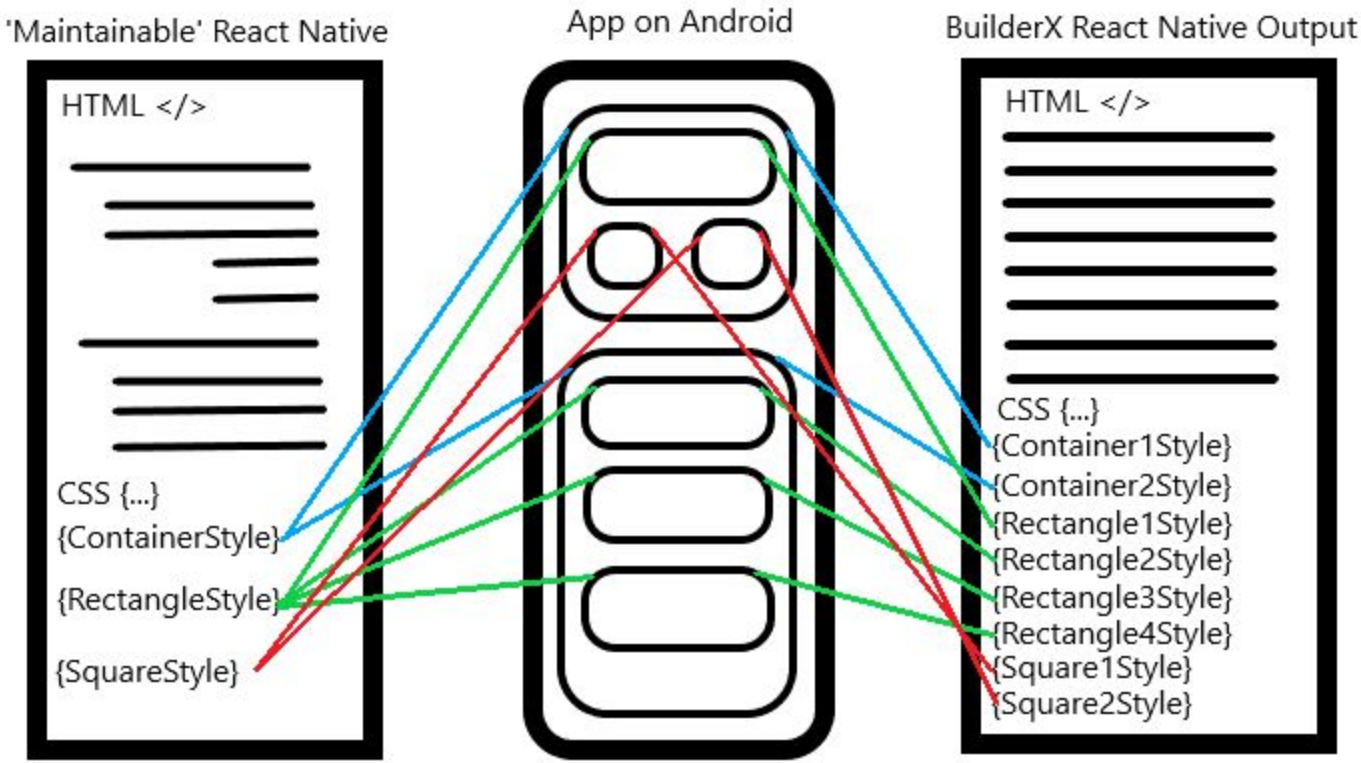
```
import React, { Component } from "react";
import Button117 from "../symbols/button117";
import { Center } from "@builderx/utils";
import Button612 from "../symbols/button612";
import { View, StyleSheet, Text } from "react-native";

export default class EndRes extends Component {
  render() {
    return (
      <View style={styles.root}>
        <Center vertical>
          <View style={styles.rect} />
        </Center>
        <Center horizontal>
          <Button117 style={styles.button117} />
```

# UI Deployment

- Deployed BuilderX React Native code to Android
  - BuilderX export had styling, formatting, maintainability issues
  - Due to ‘component’ redundancy and inflexible layout specification

- Will adjust UI code over Spring Break to fix existing issues and add Camera, NN, and TBSA algorithm




'Maintainable' React Native
HTML </>
CSS {...}
{ContainerStyle}
{RectangleStyle}
{SquareStyle}
App on Android
BuilderX React Native Output
HTML </>
CSS {...}
{Container1Style}
{Container2Style}
{Rectangle1Style}
{Rectangle2Style}
{Rectangle3Style}
{Rectangle4Style}
{Square1Style}
{Square2Style}

```
export default class SecurityAuth extends Component {
  render() {
    return (
      <View style={styles.root}>
        <Image
          source={require("../assets/a3d677392ee343199bc8e0bfbba7037f_(1).jpeg")}
          style={styles.logo}
        />
        <View style={{...styles.gray, flex: 0.6, flexDirection: 'column', justifyContent: 'flex-start', alignItems: 'stretch'}} >
          <View style={{flex: 1, flexDirection: 'row', alignItems: 'center'}}>
            <Text style={styles.text}>USERNAME</Text>
            <DisabledTextbox style={styles.DisabledTextbox} />
          </View>
          <View style={{flex: 1, flexDirection: 'row', alignItems: 'center'}}>
            <Text style={styles.text}>PASSWORD</Text>
            <DisabledTextbox style={styles.DisabledTextbox} />
          </View>
          <View style={{flex: 1, flexDirection: 'row', justifyContent: 'center', alignItems: 'center'}}>
            <Button101
              style={{...styles.button}}
              root={() => {
                this.props.navigation.push("Patient");
              }}
              onPress={() => {
                this.props.navigation.push("Patient");
              }}
            />
          </View>
        </View>
```

# Validation Metrics

- Sensitivity (Burn Images)
- Specificity (Background and Healthy Skin)
- Similarity Metric
  - Compare the “masks” created by code and doctors
- Determine effect on patient care
  - Average time
  - Compare fluid recommendations

# Next Steps

- Deployment into Application
  - UI
  - Neural Net
  - Flowchart Decisions
  - Algorithms
- Validation/Testing