Artificial Intelligence Based Burn Resuscitation

Jacob Ayers[1], Dominique Szymkiewicz[1,2], Hannah Kang[1], Nora Ward[1], Thomas Yates[1], Eric Yeats[3]

Department of Biomedical Engineering[1], Department of Neuroscience[2], Department of Electrical Engineering and Computer Engineering[3]

Advisors: Avinash B Kumar, MD, Matthew Walker III Ph.D

BACKGROUND

Wallace Rules of Nine is the most frequently used tool used by trauma and emergency medical personnel to estimate the total burn surface area (TBSA) of burn victims. TBSA measurement and hourly updates of various vitals are important for determining the initial and ongoing volume of fluid needed for resuscitation, and deciding whether transfer to a burn center is necessary. Due to error across physicians, approximately 79% of TBSA estimations are inaccurate (½ of these burns are overestimated by ≥ 5%). Burn ICUs frequently see gross under- or over-reporting of TBSA% leading to inaccurate calculations for fluid volume for resuscitation and unnecessary transfers to tertiary centers.

PROBLEM STATEMENT

Our goal is to create a diagnostic tool in the form of an Android app to rapidly and accurately determine TBSA while accounting for patient specific parameters, existing medical protocol, and American Burn Association (ABA) criteria for transfer to help improve the burn resuscitation and management for early responders.

NEEDS ASSESSMENT

- Infrastructure Compatibility
  - Must not interfere with existing systems and protocols
- Safety
  - Patient safety and privacy must not be compromised
- Patient Efficacy
  - Conservative application recommendations
- Cost Efficacy
  - Should not be high cost or require specialized complements

CLINICAL FLOWCHARTS – FLUID RESUSCITATION

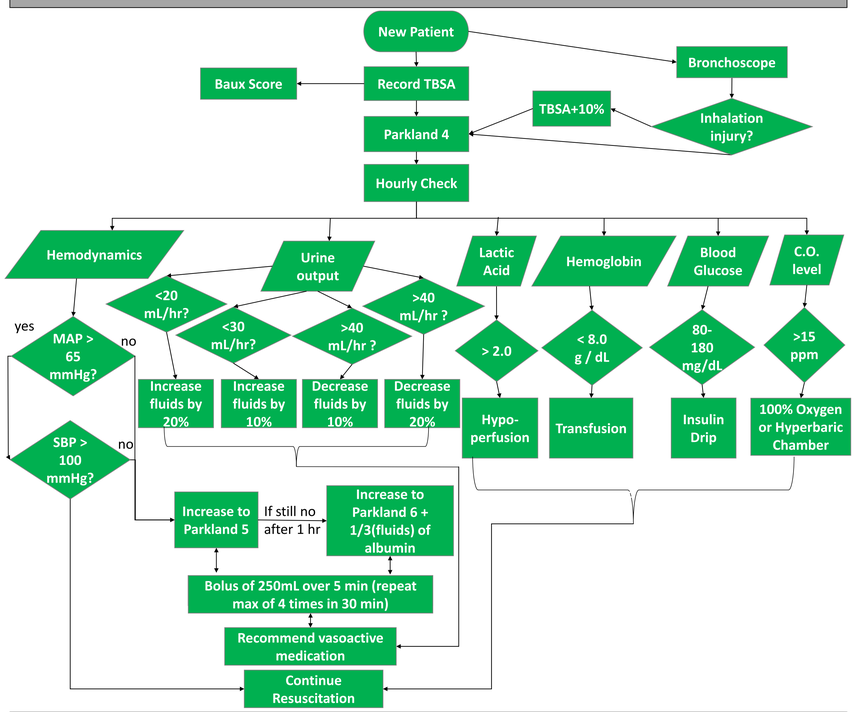


Fig. 1 is the fluid resuscitation protocol that is used for burn patients. Key vitals are continuously monitored to determine what level of fluid is needed over time.

OUR APPLICATION

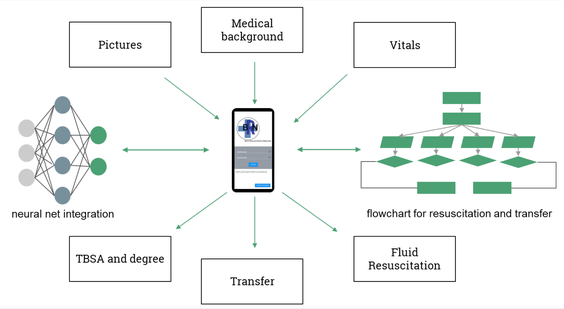


Fig. 3 is an overview of how our application works. It will intake photos of the burned areas, patient medical information and initial vitals, and will output the TBSA and burn degree, a transfer recommendation and fluid recommendations.

CONVOLUTIONAL NEURAL NETWORK

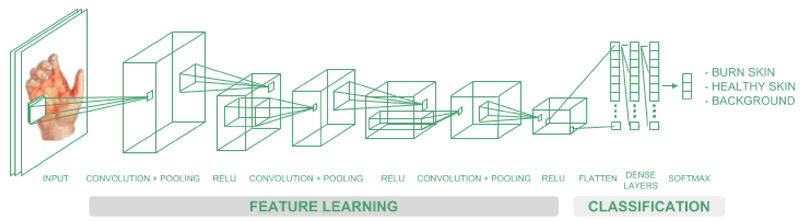


Fig 4 is a depiction of how our neural network operates. Images are broken into 50x50 sub-images that the network scans to identify powerful features. The features are then used to produce another 'feature image', which is more information rich. After several iterations, important information is condensed before fully connected layers learn the important features and classify the sub-image as burned skin (red), healthy skin (blue), or background (white).

USER INTERFACE FRONT END DESIGN

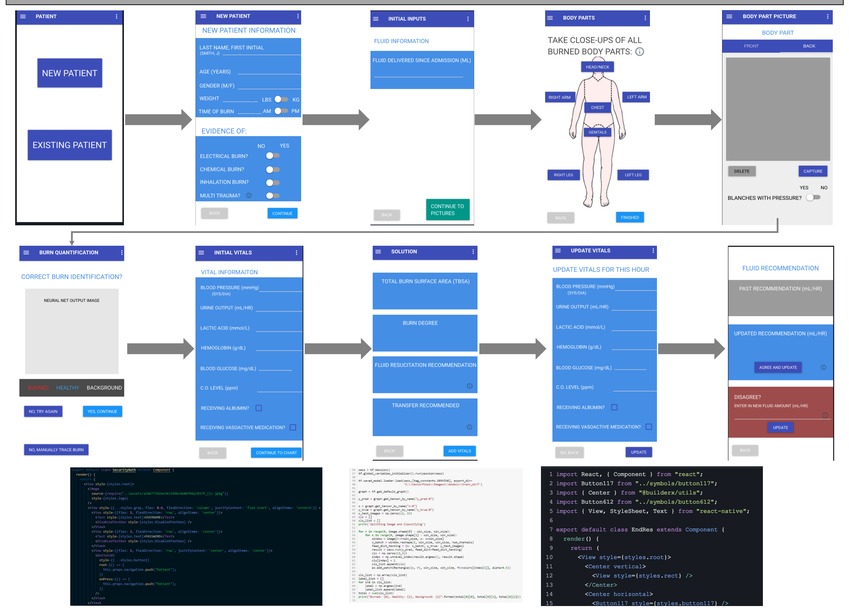


Fig. 5 (top) is an overview of the user interface of our application. Physicians will be prompted to enter relevant patient information to receive an informational solution output. Code examples are also included from the app (React Native and Java), the neural network image labeler (Python), and BuilderX (React Native) (bottom).

CLINICAL FLOWCHARTS – TRANSFER PROTOCOL

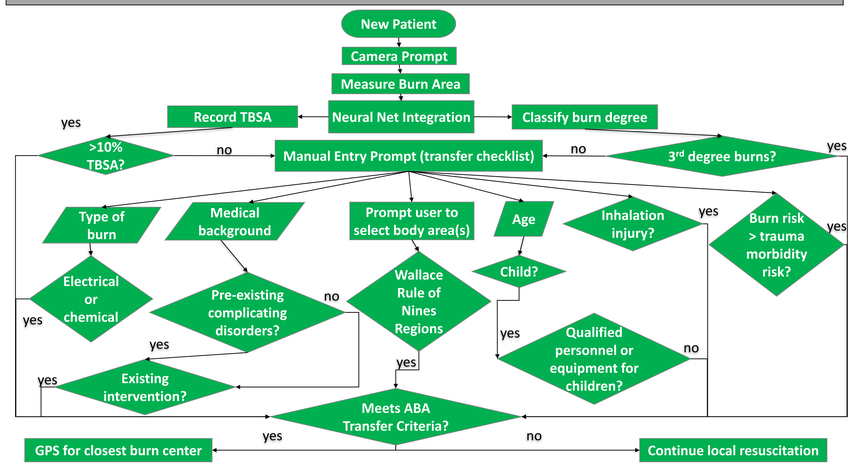
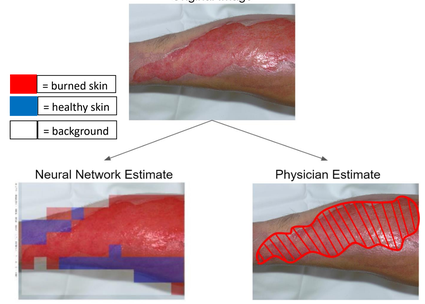


Fig. 2 is the transfer protocol that is currently outlined by the ABA. This flowchart is built into our application as an algorithm that determines if patient condition warrants transfer to a burn center

PROOF OF CONCEPT RESULTS



Initial comparison results elucidated an inter-physician burn surface area (BSA) estimation variation of 10%.

Bland-Altman comparison between the physician created BSA mask and the neural network generated BSA labeled mask resulted in a 15% error within the created mask, which corresponds to an average TBSA error of less than 3%.

Fig. 6 is a comparison of neural network output compared to physician output (left). Data was recorded from neural net TBSA estimates and compared to physician estimates for TBSA (right).

CONCLUSIONS

We have a working prototype of our application on a Samsung Galaxy S8 that interfaces with the phone's camera, encodes the neural net for TBSA approximation, and utilizes the programmed transfer and resuscitation flowcharts. We have started validation in a clinical setting and continue to update our application's functions.

FUTURE WORK

- Ongoing Clinical Validation to Improve Accuracy
- Added GPS Capabilities
- User Authentication Server
  - Require Credentials for Sign In and Secure Data Export

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