Using Artificial Intelligence (AI) to Identify Wound Etiology – A Preliminary Study

Guler O[1], Wu K[1], Cheng P[1], Kim P[2], Hong JP[3], Kirsner R[4]

1. eKare Inc. Fairfax, VA; 2. Medstar Georgetown University Hospital, Washington, DC; 3. Asan Medical Center, Seoul, Korea; 4. University of Miami Miller School of Medicine, Miami, FL

INTRODUCTION

- Misdiagnosis of wound etiology occurs frequently, especially in settings where specialized wound care is lacking. Misdiagnosis often leads to errors in treatment and adversely impacts patient outcome by wrong or delayed treatment.
- Using a subset of eKare's chronic wound data repository, we applied the latest developments in deep learning to test artificial intelligence's (AI) ability to identify common wound etiologies.

METHOD

- The proposed deep learning framework combines for the first time wound image data with patient demographics data to predict wound etiology utilizing deep convolutional networks (DCN) together with deep neural networks (DNN) (see Figure 1). The hybrid model accepts image and patient demographics (gender, age, wound location, wound dimension, etc) as input and predicts etiology of a chronic wound as output. In this work we trained the supervised classifier on four categories-- burn, pressure injury, venous ulcer and diabetic ulcer.
- For this preliminary study, a subset of wound images with accompanying patient demographics data were exported from eKare's data repository. The data set was reviewed by MD to ensure correct classification. The data was split into trainings set and validation set comprising 2,100 and 100 images, respectively.

SETUP

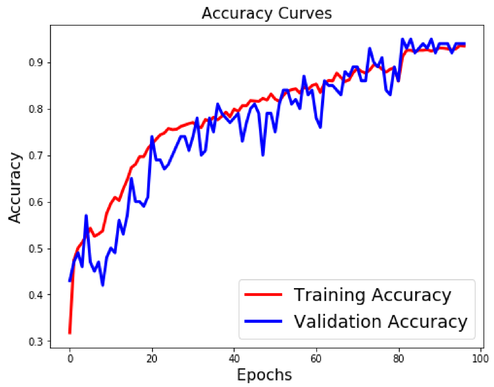
- Keras [1], an open source Python deep learning library was used to develop the machine learning framework in the Python programming Language. The model, a combination of DCN and DNN was trained utilizing early stopping with learning rate adaptation on plateaus, 100 epochs long with batch size 32 using the Adam [2] optimizer and categorical cross entropy as the loss function.

RESULTS

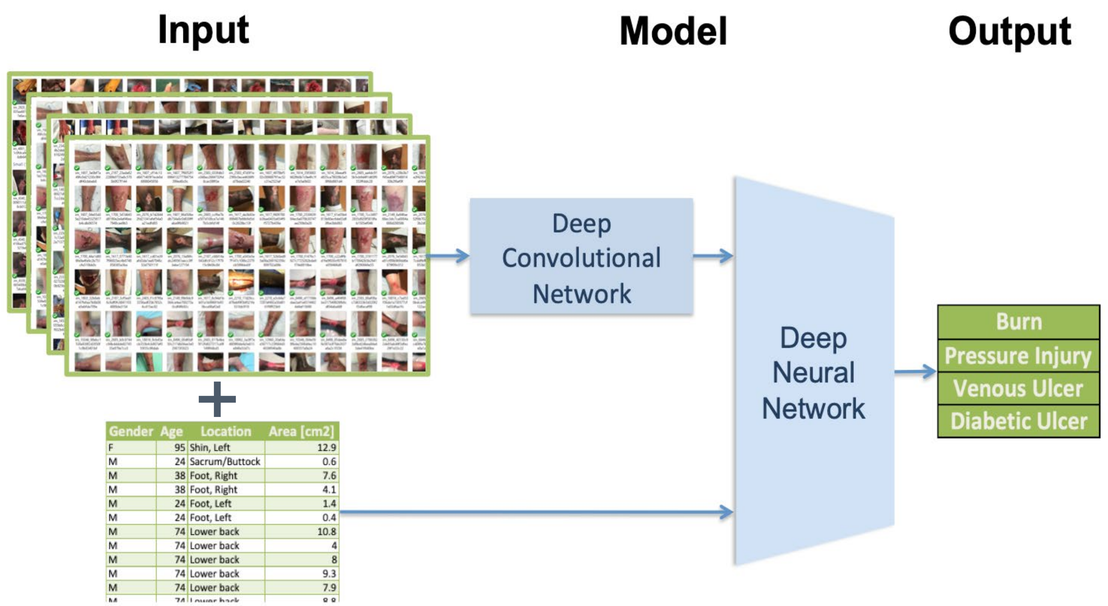
- The proposed hybrid model achieves an accuracy of 94 % in differentiating burn, pressure injury, venous ulcer, and diabetic wound.
- Table 1 shows a sample of misclassified wound types together with the probability metrics. The probability metric is a measure of how confident the AI model is in classifying the wound. All confidence values are below or equal to 80% and errors are on wounds mainly located on the foot. The AI model making mistakes on small and visually similar wounds is a sign that the model can be improved further.

Location	Correct	Predicted	Confidence
Shin	Venous	Burn	49%
Ankle	Pressure Injury	Diabetic	60%
Toe	Pressure Injury	Diabetic	70%
Foot	Pressure Injury	Diabetic	78%
Toe	Diabetic	Pressure Injury	80%

Table 1: Misclassified wounds.



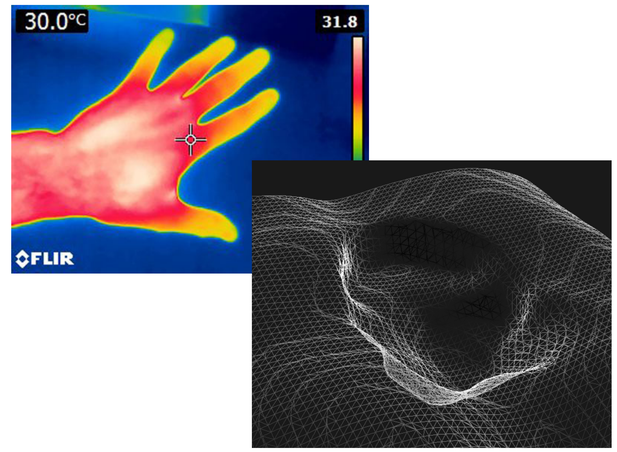
- Figure 2: Figure shows the accuracy of the machine learning model during training of the network. Graph shows the training accuracy in red and the validation accuracy in blue. Validation was performed on 100 wound images in each weight update step (epoch).



- Figure 1: Figure shows the machine learning architecture. The hybrid model accepts image and patient demographics as input and predicts chronic wound type as output.

CONCLUSION

- This early application of artificial intelligence on etiology identification demonstrates the potential of AI in wound care.
- Future work will focus on improving the robustness and generalizability of the DCN/DNN hybrid model with more images and data augmentation, including the use of infrared image, depth map, and other clinical input.
- Further, other wound etiologies (e.g. atypical vasculitic wounds) as well as mixed etiology wounds could be potentially identified for proper treatment implementation.



REFERENCES

[1] F. Chollet and others, "Keras." 2015. https://keras.io

[2] D. P. Kingma and J. Ba, "Adam: {A} Method for Stochastic Optimization," CoRR, vol. abs/1412.6980, 2014.

CONTACT

Kyle L. Wu, MD, MBA

eKare Inc.

Email: kwu@ekareinc.com

Website: www.ekare.ai