Development of a Point-of-Care Immunosensing Platform for Quantitative Characterization of Chronic Wounds

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Chronic wounds, defined as wounds which do not follow a normal and timely repair sequence nor are able to restore anatomic and functional integrity within three months, pose significant physical, financial, and social burdens to those afflicted. Upon the most common types of chronic wounds are diabetic foot ulcers (DFUs), which were estimated to affect 6.3% of the global population in 2016[1]. With the 5-year mortality rate following the development of a diabetic foot ulcer nearing 40% and a growing diabetic population worldwide, there is an increasing need to develop quick, accurate diagnosis and monitoring methods for chronic wounds[2].

Current clinical practices at the point of care for the diagnosis and monitoring of chronic wounds are highly subjective, relying heavily on a physician's visual assessment and opinion of the wound environment. As such, lack of quantitative measures past down-the-line laboratory tests can lead to undesirable variability in the determination of characteristics such as infection likelihood and wound severity. As the need for quantitative metrics has become more apparent, researchers have begun identifying strategies for identifying the presence of cytokines and physical biomarkers in the wound environment as methods of characterizing the wound past simple physical inspection. Many current technologies fall short, however, given their inability to provide a multifaceted overview of the wound environment in a method understandable to intended users[3].

We have aimed to develop a conductive nano-fiber based biosensor capable of quantifying the presence of tumor necrosis factor alpha (TNF-α), transforming growth factor beta 1 (TGF-β1), and vascular endothelial growth factor (VEGF) through incorporation of (i) a screen printed and solution blow spun silver and multiwalled carbon nanotube nanocomposite base layer, (ii) relevant surface functionalization for the above outlined antibodies, and (iii) analysis of data representative of measured impedance changes as the sensor contacts wound exudate. Preliminary testing shows the potential for up to a 15.6% difference in impedance following exposure of the sensor to a 50µg/mL solution of its target molecule, indicative of biorecognition in vitro. The sensor is intended to be utilized at the point-of-care for real time assessment of the wound environment in addition to appropriate imaging techniques. Following the collection of sufficient background data, this immunosensor will be used in conjunction with deep machine learning approaches comparing the gathered impedance data with images obtained of the wound site in order to classify the wound as either healing or non-healing, thus presenting the data obtained in a user-friendly manner. Ultimately, the combined immunosensing platform will serve as a quantitative and predictive diagnostic aid, providing more objective observations for the diagnosis and monitoring of chronic wounds.

References:

1. Gianino, E., Miller, C., & Gilmore, J. (2018). Smart Wound Dressings for Diabetic Chronic Wounds. *Bioengineering*, *5*(3), 51. https://doi.org/10.3390/bioengineering5030051
2. Bowers, S., & Franco, E. (2020). Chronic Wounds: Evaluation and Management. *American Family Physician*, *101*(3), 159–166.
3. Gao, Y., Nguyen, D. T., Yeo, T., Lim, S. B., Tan, W. X., Madden, L. E., Jin, L., Long, J. Y., Aloweni, F. A., Liew, Y. J., Tan, M. L., Ang, S. Y., Maniya, S. D. O., Abdelwahab, I., Loh, K. P., Chen, C.-H., Becker, D. L., Leavesley, D., Ho, J. S., & Lim, C. T. (2021). A flexible multiplexed immunosensor for point-of-care in situ wound monitoring. *Science Advances*, *7*(21). https://doi.org/10.1126/sciadv.abg9614