Understanding and Visualizing Key Factors Affecting Diabetic Wound Healing: Look to the RADAR

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Introduction

- Diabetic foot ulcers (DFUs) are a common and serious complication of diabetes.[1]
- Offloading devices, which help to distribute force and reduce pressure across the wound, are the standard treatment for DFUs.[2] Adhering to appropriate use of offloading devices a cornerstone of a strategy to promote DFU healing.
- Current studies focus on determining the offloading device wear time and compliance with the offloading device.

Offloading device

- However, recent findings show that **there are other factors which affect the wound healing.**
- So, it is also important to evaluate other factors such **as wound and diabetes characteristics (wound size, wound score, wound location, A1c level, diabetes type), motor performance (cadence, balance, frailty, number of steps)** and **patient-reported-outcomes (PRO) (cognition, age, BMI)** to provide **personalized care to diabetic foot ulcer patients.**

Method

Parameters collected from participants		
Wound Characteristics	**Motor performance**	**Patient reported outcomes (PRO)**
Baseline wound size	Mobility (# of steps)	BMI
Wound complexity	Frailty	Age
Baseline wound age	Cadence	Cognition (MoCA score)
Wound location	Balance	
A1c level		
Diabetes type		

Each parameter was graded on a scale from 0 to 10 based on thresholds found in the literature (as shown in Table 1).

To visualize the importance and scale of key factors, we used radar plot which demonstrated the grading and the area which has positive association with healing (Figure 1).

Results and Discussion

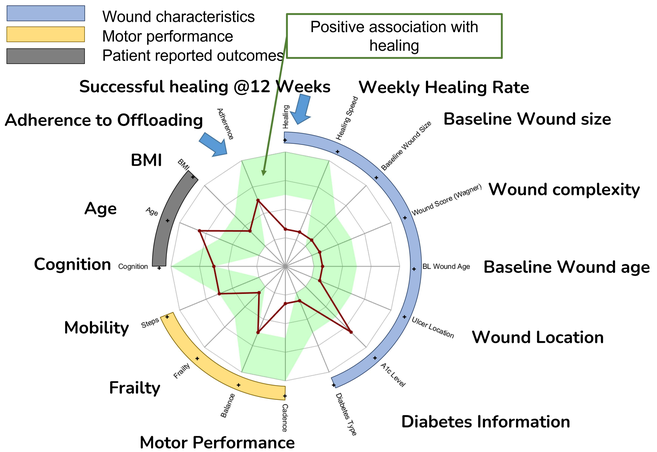

Figure 1: Radar plot to visualize the importance of the key factors

Grading Scale	1	2.5	5	7.5	10	value		
Adherence	Boot use consistent – high step count Boot use inconsistent - high step count		Boot use consistent – average step count Boot use inconsistent - average step count	Boot use consistent – low step count Boot use inconsistent - low step count		Boot use consistency and number of steps		
Healing	0	25	50	75	100	percentage of reduction in wound area	1	good
Healing Speed	0		25	50		percentage of reduction in wound area/week	2	
Wound Size	0		1	5	10	area size	3	average
Wound Score	1	2	3	4	5	Wagner score	4	
Ulcer Location	Forefoot		Midfoot	Hindfoot		location	5	
Cadence	50		60	80		Cadence	6	bad
Balance	1.5		1	0.5		COM area		
Frailty	0		0.25	0.5		TSFI		
Steps	1000	1250	1500	1750	2000	# of steps/hour		
Cognition	5	7.5	10	12.5	26	MoCA Score		
Age	50	55	55	60	65	years		
BMI	18.5	25	30	35	40	BMI value		
A1c Level	5	5.7	6.5	8	10	A1c value		
Diabetes Type	Type 2			Type 1		Diabetes Type		

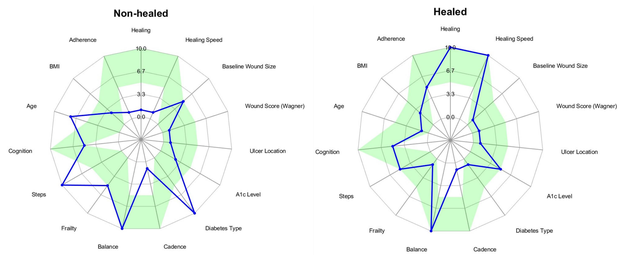

Figure 2: Comparison between Individual Healed and Non-healed Patients

- Data was collected from 38 participants with different wounds
- Data analyzed from 23 participants (10 dropouts, 5 is ongoing)

- Our findings on individual parameters and group averages show that **patients whose parameters are within the shaded area experience more successful healing.**

- Each participant also **has their own parameters affecting the wound healing**.

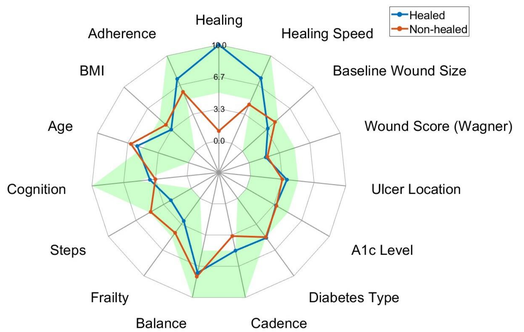

Figure 3: Comparison between Healed and Non-healed Groups.

Conclusion

To provide a successful treatment to the patients, **it is important to evaluate these parameters individually instead of creating a general treatment plan**.

Our preliminary results prove that **evaluating the radar plot for each patient individually could help the clinicians to determine a personalized treatment plan for each patient to provide successful healing.**

Acknowledgement

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References

[1]Rodrigues, B.T. et al., Diabetes and Metabolic Syndrome: Clinical Research and Reviews 2022

[2]Lazzarini, P. A., Diabetes/Metabolism Research and Reviews, 2020.

[3]Sensoria Health. 2022. Sensoria Core.

The study protocol was approved by the University of Southern California Institutional Review Board (protocol number is HS-20-00526).