Stakeholder Input on the Development of a Residual Limb Monitoring System

Northwestern Medicine® Feinberg School of Medicine

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BACKGROUND

- Socket fit and suspension issues, heat, sweat, and rubbing at the socket-limb interface (Fig. 1) lead to skin breakdown (Fig. 2), impede daily prosthetic use and reduce mobility and quality of life for lower-limb amputees [1].
- Recent development of thin, flexible, 'skin-like' sensors (Fig 3) [2] may address these problems, leading to the development of a residual limb monitoring system.
- To ensure clinical utility of any such system, input from stakeholders is necessary.
- **Objective**: To gather information from certified prosthetists (CP) and prosthesis users (Px Users) about the residual limb problems they encounter, how a residual limb monitoring system might be used in clinical practice, and how it might best be configured.

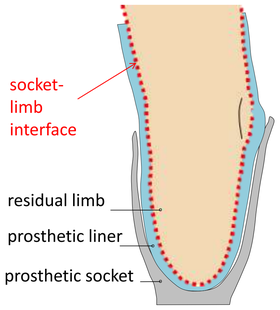


Figure 1

Figure 2

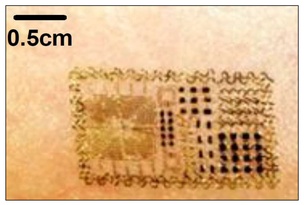


Figure 3

METHODS

Two focus groups were held, one with CPs and one with lower-limb Px Users. Participant criteria are listed in Table 1.

Table 1

• Currently practicing CP/CPO	• Currently using LL prosthesis on daily basis
• ≥ 2 yrs clinical experience with *LL prostheses	• Different levels of major LL amputation
• Different levels of time in practice	• Different types of etiologies
• Work in different practice settings	• Range of time with amputation
N = 8	
18-80 yrs old	
Males and females	

*LL – lower limb

An experienced moderator guided focus group discussions with prepared questions (Fig. 4). Discussions were audio recorded and transcribed. Four investigators performed thematic analysis to assess the focus group transcripts for repeating ideas and themes (Fig. 4) [3].

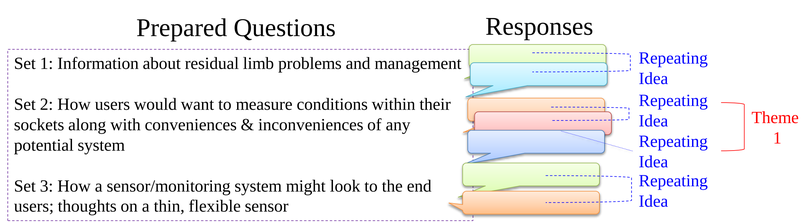


Figure 4

RESULTS

Participant Characteristics

Certified Prosthetists (CP)

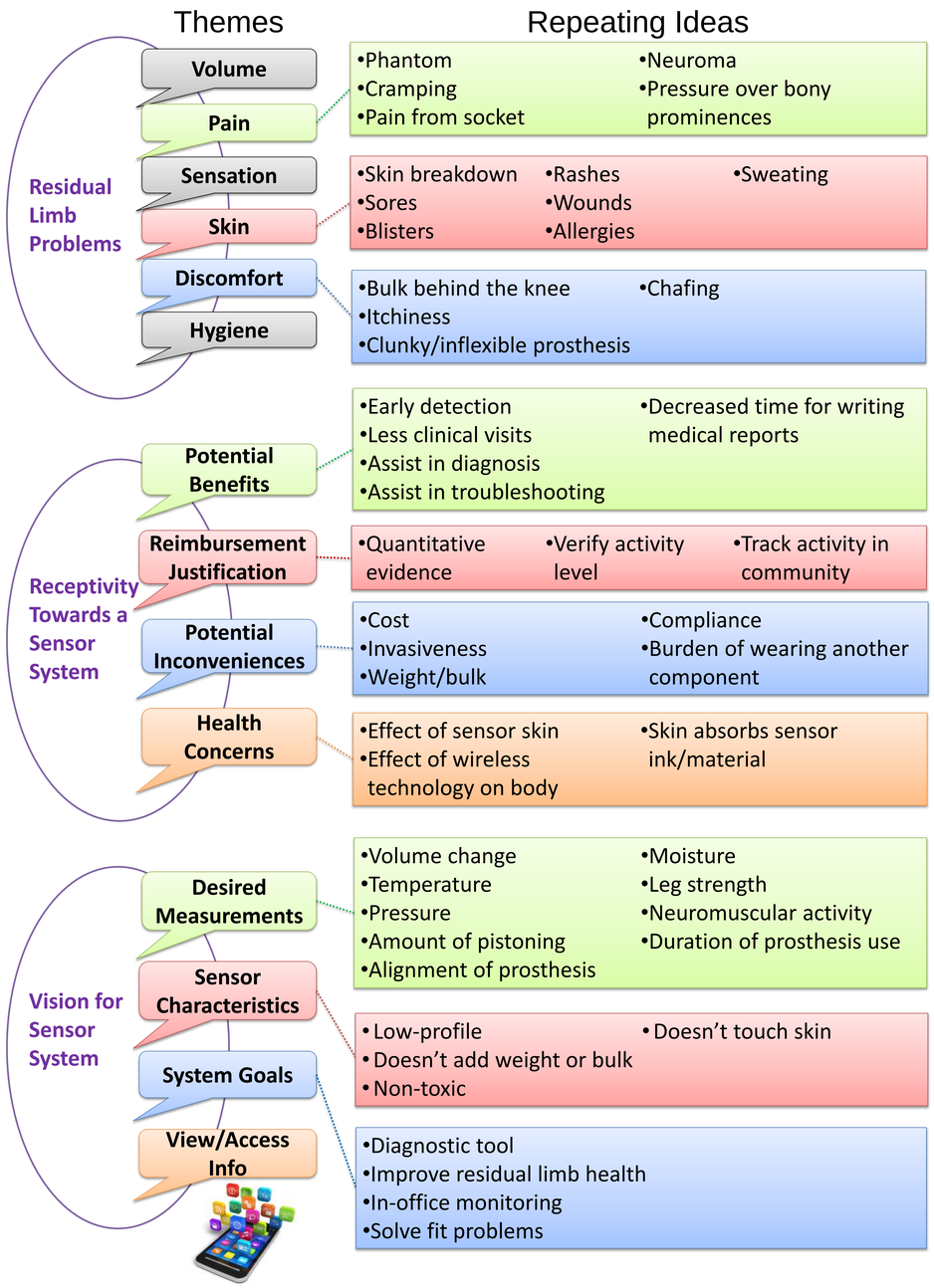
Subject	Gender	Years as CP	Practice Setting
1	F	4-5	A
2	F	4-5	C
3	M	4-5	C
4	M	5	B
5	F	9	C
6	M	13	C
7	M	33	B
8	Failed to attend		

A.Multi-facility practice, publicly owned
B.Multi-facility practice, privately owned
C.Hospital or rehabilitation center

Lower Limb Prosthesis Users

Subject	Gender	Amputation Level	Years as Amputee	Etiology
1	F	TTA	< 1	trauma
2	M	TTA, PFA, TRA, PHA	10	infection
3	F	TTA	> 40	congenital
4	F	TTA	25	trauma
5	F	TTA	12	vascular
6	F	TFA	> 20	trauma
7	M	TFA	13	trauma
8	Failed to attend			

Thematic Analysis



DISCUSSION

- Residual limb problems reported by focus group participants were similar to findings from the literature regarding problems that interfere with prosthesis use [1,4].
- Both prosthetists and prosthesis users indicated that:
  - In-socket temperature and pressure were priorities for measurement.
  - The most immediate benefit of monitoring the residual limb was in troubleshooting socket fit issues.
  - A wireless sensor system to monitor residual limb health should be used in the clinic and *perhaps* short term at home, so long as it is easy to use and inexpensive.

CONCLUSION

- In developing a user-friendly residual limb monitoring system for widespread clinical use, system benefits need to strongly outweigh any inconveniences for either the prosthetist or prosthesis user.
- Focus group input will be used in the development of a residual limb monitoring system using wireless, 'skin-like' sensors [1] that can measure temperature and pressure inside a prosthetic socket, helping to detect issues before they become problematic.

References

[1] Meulenbelt et al. (2006). "Skin problems in lower limb amputees: an overview by case reports." J Europ Acad Derm Venereol 21(2):147-155. [2] Kim et al. (2011). "Epidermal Electronics." Science 333(6044):838-843. [3] Guest et al. (2012). "Applied Thematic Analysis." SAGE Publications, Inc. [4] Klute et al. (2009). "Lower-limb amputee needs assessment using multistakeholder focus-group approach." JRRD 46(3):292-304.

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