INTRODUCTION
The interface between a prosthetic socket and residual limb is often problematic with socket fit and suspension issues leading to skin problems and reduced daily prosthesis use, mobility and quality of life (Meulenbelt et al. 2006). Sensing inside the socket is proposed as a way for prosthetists to both monitor and troubleshoot these socket fit and suspension problems (Hafner & Sanders, 2014). However, existing sensors have limited clinical utility because they are bulky, wired, and sometimes require mounting on the socket or liner in a manner that is uncomfortable and/or destructive (Mak et al. 2010). Recent development of thin, flexible, ‘skin-like’ sensors (Kim et al. 2011) may address some of 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. Hence, the purpose of this study was to gather information from prosthetists and prosthesis 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.

METHOD
Two focus groups were held, one with certified prosthetists (CP) and the other with lower-limb prosthesis users (Px Users). An experienced moderator guided focus group discussions using scripts comprising of 8-9 open-ended questions. The questions solicited information about residual limb problems and management; how users and clinicians might want to measure conditions within the sockets; and how a sensor/monitoring system might look to the end users. Discussions were audio recorded and transcribed. A team of four investigators participated in thematic data analysis (Guest et al. 2012) to assess prosthetists’ and prosthesis users’ perceptions, feelings, knowledge, and behavior of residual limb problems and potential methods for monitoring socket issues and residual limb health.

RESULTS
Participants in the CP group (n=7; 3 females, 4 males) came from a mix of practice settings and had 4 to 33 years of clinical experience. Participants in the Px Users group (n=7; 5 females, 2 males) were diverse in their level of amputation (TTA and TFA) and etiology (trauma, vascular, infection, congenital), and had <1 to 40 years of experience using lower-limb prostheses. Our preliminary analysis suggests that skin breakdown, sweating and volume fluctuation were the major residual limb problems for participants (Fig. 1); suggested useful measures included pressure and temperature; and using a wireless app on a portable electronic device was favored.

DISCUSSION
The residual limb problems reported by focus group participants were similar to findings from the literature regarding problems that interfered with prosthesis use (Meulenbelt et al. 2006; Klute et al. 2009). Both prosthetists and prosthesis users indicated in-socket temperature was a measurement priority and the immediate perceived benefit was in troubleshooting socket fit issues. They were generally in favor of a wireless sensor system to monitor residual limb health in the clinic and perhaps short term at home so long as the system was easy to use and inexpensive.

CONCLUSION
In order to develop a user-friendly residual limb monitoring system for use in the clinic and home environment, the input of end-users is critical. It seems clear that for widespread clinical use, system benefits would need to strongly outweigh any inconveniences to either the prosthetist or prosthesis user.

CLINICAL APPLICATIONS
Focus group input will be used in the development of a residual limb monitoring system using wireless ‘skin-like’ sensors (Kim et al. 2011) that can measure temperature and pressure inside a prosthetic socket, helping to detect residual limb issues before they become problematic.

REFERENCES
Guest et al., SAGE Pub., Inc., 2012.

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