INTRODUCTION
People with trans-tibial limb loss typically experience a reduction in their limb volume over time. This reduction in volume causes the socket to become oversized and may adversely affect clinical outcomes. Even sockets oversized by as little as 1.0% have been shown clinically distinguishable from properly-sized sockets (Sanders, 2012). The purpose of this study was to examine on people with trans-tibial limb loss how daily limb fluid volume loss, daily activity, gait, and comfort were affected by use of an oversized socket compared with a normal socket.

METHOD
Participants: Volunteers with trans-tibial limb loss who wore a prosthesis at least 4 h/day participated.

Procedures: Two prosthetic sockets were fabricated for each participant by a research prosthetist. One was fit to be comfortable with 3.0mm or less sock thickness (normal), the other was made to be 5.0% larger (oversized). 5.0% corresponds to about a 1.8mm uniform increase and has been characterized as an increase capable of transitioning a ‘good’ fit to just an ‘acceptable’ one (Fernie, 1982). Participants wore each socket for a four-week period and then came to the lab for a day of testing. Morning and afternoon limb fluid volume were monitored during 35-minute active test sessions using bioimpedance analysis (Sanders, 2015). Both distal and total residual limb fluid volume were assessed. Activity was monitored between sessions using an Actigraph GT3X+ accelerometer mounted to the prosthetic limb. Gait speed, cadence, prosthetic limb step length, step width, and step time were evaluated using a GAITRite™ walkway (McDonough, 2001).sock comfort was determined using Socket Comfort Score (Hanspal, 2003), Satisfaction, ambulation, residual limb health, utility, and well-being were evaluated using subscales of the Prosthesis Evaluation Questionnaire (Legro, 1998). Collected data were analyzed to compare differences in outcomes between the oversized and normal socket conditions.

RESULTS
Test results showed that of the variables assessed, only morning-to-afternoon residual limb fluid volume loss in the distal section of the limb and Utility differed significantly between the oversized and normal socket conditions (Table 1). The average difference in limb fluid volume loss rate for the oversized compared to the normal socket was 2.5 %/h.

DISCUSSION
The 5.0% size difference between the oversized and normal socket was not sufficient to induce significant changes in gait, activity, or comfort measures (other than Utility), but was sufficient to cause a significant increase in morning-to-afternoon distal limb fluid volume loss. This result suggests that distal limb fluid volume is highly sensitive to socket oversizing. Because oversizing was not severe enough to cause a meaningful change in socket comfort outcomes, we conclude that increased morning-to-afternoon distal limb fluid volume change may serve as a precursor to compromised socket fit and thus an effective indicator of imminent need for socket modification.

CLINICAL APPLICATIONS
Morning-to-afternoon distal limb fluid volume loss may be indicative of socket oversizing and the imminent need for socket modification. Clinical tools to detect volume changes may help inform need for socket changes.

REFERENCES
Fernie, Arch Phys Med Rehabil, 1982;63:162-8
Sanders. Prosthet Orthot Int, 2015. Epub Feb 20