INTRODUCTION
While it is generally accepted that ambulating with a prosthesis decreases residual limb volume, it is unknown how different activities (sitting, standing, walking) affect limb volume. The purpose of this research was to compare limb fluid volume changes during sitting, standing, and walking on a group of participants with trans-tibial amputation to see how much each activity contributed to the total fluid volume change.

METHOD
Participants: A total of 17 males and 7 females participated in this study. Subjects averaged 52 (s.d.13) years of age, 179 (s.d.15) cm in height, and 195 (s.d.44) lb in weight. Eleven of the 25 subjects had peripheral arterial disease.

Apparatus: A bioimpedance analyzer (XITRON Hydra 4200) was used to measure extracellular fluid volume in the residual limbs of test subjects. Two current-injecting and two voltage-sensing skin electrodes were placed on the posterior lateral aspect of the residual limb to take the measurements.

Procedures: Subjects underwent a test protocol with equal durations of SIT, STAND, and WALK. Five cycles were performed: 90 s sitting with feet on the floor (SIT), 90 s standing with equal weight-bearing (STAND), and 90 s walking on a treadmill at a self-selected walking speed (WALK).

Data Analysis: Residual limb extracellular fluid volume, expressed as a percentage of fluid volume right after the WALK in the first cycle, was calculated. The sums of the percentage fluid volume changes for each activity (SIT, STAND, WALK) over the test session as well as the change from the start to end of the test session (TOTAL) were calculated.

RESULTS
Fluid volume losses were highest during STAND. Median fluid volume changes were -2.6% for STAND, +1.3% for WALK, and -0.5% for SIT. Correlations with TOTAL session fluid volume change were weak, 0.2, 0.6, and 0.3 for STAND, WALK, and SIT, respectively.

Subjects who lost fluid volume during WALK tended to gain fluid volume during SIT (Figure 1A). We found a moderate correlation between WALK and SIT fluid volume changes (r=0.8).

All subjects with peripheral arterial disease lost fluid volume over the session (Figure 1B) but not during like activities (Figure 1A).

DISCUSSION
All subjects lost fluid volume during STAND because of the relatively high and constant applied socket pressures. Pressure relief during swing phase was sufficient to induce fluid volume recovery during WALK in most subjects. Subjects who did not recover fluid during WALK recovered substantial fluid volume during SIT.

CONCLUSION
Standing is likely a primary source of limb fluid volume loss in people with trans-tibial amputation.

CLINICAL APPLICATIONS
While standing reduces residual limb fluid volume, walking may facilitate fluid volume recovery in many patients.

REFERENCES