MEASURING AT-HOME PATTERN RECOGNITION PROSTHESIS USE FOR A TRANSHUMERAL TMR PATIENT
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INTRODUCTION
Many transhumeral myoelectric prosthesis users have low tolerance of their prostheses citing poor control as a major reason for low wear times (Biddiss, Chau, 2007). Targeted Muscle Reinnervation (TMR) is a surgical technique well suited to improve the ability for upper-limb amputees to intuitively control myoelectric devices, especially when pattern recognition (PR) is applied (Kuiken et. al., 2009).

This case study investigates prosthesis actuation during wear time for a transhumeral TMR amputee using PR control in his at-home, everyday setting.

METHOD
The subject gave informed written consent for a research study approved by the Northwestern University's Institutional Review Board. His prosthesis comprised a powered elbow, powered wrist rotator, and electronic terminal device. A custom PR microcontroller using 8 EMG inputs from a custom, consolidated electrode system classified 6 motion classes along with ‘No-Motion’. Usage/log data was recorded and stored on the controller’s memory for later analysis.

Data logs from when the prosthesis was worn and powered on more than 30 minutes were considered; yielding 10 reports from one month of at-home use. Data of interest were the counts of actuation commands, binned into 5% speed groups (0-100% available output command speed), for the 6 motions. Actuation commands less than 5% of output speed range were grouped with No-Motion as these are not likely to cause prosthesis movement.

RESULTS
The prosthesis was powered on during time worn for an average of 104.5 minutes per donning. Total time powered on was 18.6 hours. Figure 1 shows the relative actuation of each of the motions.

DISCUSSION
Hand close was the motion most often commanded and accounted for 31.5% of the actuation commands. This result is expected when considering the activities of at-home use where well controlled grasping and holding of objects is needed. Elbow and wrist motions account for less than half (47.5%) of total actuations indicating these are used in gross positioning.

For each of the 3 DOF, one motion was actuated more than its antagonist counterpart. This may indicate that median control speeds for opposite motions are different or that the user continues to actuate once reaching the limit; as examples, commanding hand close once closed in order to generate grip force, or because the subject opened the hand faster than he closed.

The distribution of actuation speeds is not flat, nor linear. The tendency toward slower actuations indicates good control of the prosthesis. A small spike in distribution at maximum speed indicates that our subject had ballistic/extreme intentions about 1% of the time.

Logged usage data is a debated topic in our field. This case is a study of a small piece of the vast amount of information currently being collected. In the near future, we hope to be able to identify trends from multiple users, for longer periods of at-home use, and compare PR to conventional myoelectric control.

CONCLUSION/CLINICAL APPLICATIONS
Investigating at-home usage data of PR-controlled prostheses will expose trends in control and lead to developments aimed at increasing powered prosthetic acceptance by upper-limb amputees.

REFERENCES