INTRODUCTION
The individual pursuit is a 4km cycling time trial performed on a velodrome during the Paralympics. The cyclists must use their physiological system to energize the bicycle and overcome aerodynamic drag (primarily) to achieve the fastest possible time. Persons with amputation appear to be at a disadvantage. These individuals are challenged to energize the bicycle (Childers et al., 2011a) yet the aerodynamic drag are reduced because the prosthesis has less frontal area than the limb it replaces. The lower aerodynamic drag (CDA) may offset the physiological disadvantage. Therefore, it is unknown if Paralythetes have a true disadvantage in the individual pursuit.

Mathematical modeling was used because it allows for manipulation of specific variables and doesn't have the inherent difficulty associated with controlling for physical capability across human subjects. The hypothesis is cyclists with amputation will not be able to attain performances similar to intact cyclists.

METHOD
Procedures: A forward integration model will be used as the basis for the Parathlete model. The model is calibrated to predict cyclist velocity based on cyclist power output, CDA of the cyclist, velodrome geometry, weather conditions and bicycle setup to within +/- 0.014 m/s (Childers, et al., 2011b).

A power profile for the individual pursuit was used to recreate Jack Bobridge’s world record time of 4:10.5 was adjusted to account for a TTA by scaling power output and scaling bicycle/rider frontal area (CDA).

The profile was adjusted for a cyclist with TTA based off pedaling asymmetry data (Childers et al., 2011a). The rationale being the sound limb is the dominant limb and this limb is physiologically intact. A pursuit is an event where the cyclist is well motivated and requires maximal output from the human motor system. Therefore, the sound limb will be operating at maximal output and the output of the amputated limb can be estimated based on pedaling asymmetries. Cyclist CDA was adjusted by scaling the baseline CDA by changes in frontal area due to the prosthesis design (Table 1).

Data Analysis: A random Monte Carlo analysis was performed to understand how uncertainty in power adjustment and CDA variables affect model results. The uncertainty (1 standard deviation) in model output was considered a measure of model “precision”.

RESULTS
The model predicted 4km pursuit performances of 4:10.5, 4:20.0, 4:27.7, 4:08.0 for the Baseline, TTA, TTA-CC, and TTA-OPT conditions, respectfully. Model precision was calculated at 3.7 seconds.

DISCUSSION
The model predicted performance improvement exceeding an intact cyclist (TTA-OPT), however, this was within the precision of the model. We have recorded pedaling asymmetries in cyclists with TTA with various cycling experience (including Paralympians) and in various conditions. Three out of 76 recordings demonstrated asymmetries within 2% of 7.0% reinforcing the relative rarity and improbability of this scenario occurring during competition.

CONCLUSION
It appears “possible” but not “probable” a Paralythetes with a TTA could perform a Pursuit faster than an intact Olympian. In a best case scenario, the TTA cyclist’s modeled time decreased (TTA-OPT) yet this was within the model’s precision and therefore not significant. Paralythetes with a TTA could improve performance by optimizing the prosthetic design and integration with the human/prosthesis/bicycle system but, at best, they can perform on an equal basis with intact cyclists.

CLINICAL APPLICATION
These results demonstrate a cyclist with a TTA should be allowed to compete against cyclist with intact limbs at any level of competition.

REFERENCES