Prosthetic Liner Prescription Assistant
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INTRODUCTION
Liner selection can be a difficult task for a prosthetist and is frequently based on a small list of preferred brands. Choosing among several liners is an uncertain process that depends on experience and tactile evaluation. The purpose of this research was to develop a set of tests to characterize liner materials and to deliver results in a clinically helpful interface. Initial focus was on gel liners.

METHOD
Seven different tests were created:

Compressive Resistance: (Instron 5944) Samples were compressed cyclically at 200kPa and allowed to flow without constraints on their edges. Testing frequencies ranged from ½ to 1 cycle/second.

Shear Resistance: (Instron 5944) Samples were sheared cyclically up to 60% strain. Testing frequencies ranged from ½ to 1 cycle/second.

Stretch Resistance: (Instron 5944) Samples were stretched in single extensions up to 20% strain/second.

Adherence: (Hanatek AFT) Leather samples (representing dry skin) were attached to sleds and pulled along a sheet of liner material. Static and dynamic frictional coefficients were measured.

Volume Accommodation: (Instron 5944) Samples were compressed with constraints on their edges, thus not allowed to flow, at pressures up to 500kPa.

Thermal Conductivity: (Anter 2022) Samples were compressed to 69kPa, 138kPa, and 207kPa. Thermal conductivity was measured at 20°C and 40°C.

Durability: Trans-tibial amputee subjects wore a liner for 1 to 6 months with their activity monitored. Once the liner was returned, the above tests were conducted and results compared to those from a new liner.

RESULTS
Comparative analysis in a Finite Element Model showed that gel liners behaved as hyperelastic materials and exhibited some unusual characteristics. They deformed by “flowing” when stressed, maintaining a nearly constant volume in extension, compression, and shear. Some exhibited strong rate dependencies and were up to three times stiffer when compressed at walking rates compared to quasi-static (standing) conditions.

DISCUSSION
The Prosthetic Liner Prescription Assistant (PLPA) is a web based tool to present the material testing data on a relative scale. Liners are grouped into percentile brackets (20% increments) for each metric. Higher ratings do not mean higher quality. Instead, they indicate that a liner has a more accentuated material property. Pop out pages describe individual tests as well as their practical importance.

PLPA is online at: http://depts.washington.edu/plpa/

CLINICAL APPLICATIONS
Most practitioners prescribe liners from a small group that they regularly use. They limit selection because the differences between choices are often ambiguous, requiring that they learn about liners almost exclusively from clinical experience. The PLPA is intended to overcome this problem and be an easily accessible tool to help teach practitioners about the technical versatility of liners and inform them of the available choices to optimize selection to individual patient needs.