INTRODUCTION

Liner selection can be a challenging task for a prosthetist and is typically based on a small list of preferred brands. Choosing among the many liners available is an uncertain process that depends on experience and tactile evaluation of each prospective liner. The purpose of this research was to develop an intuitive and accessible database of liner properties that clinical prosthetists can use to evaluate a patient’s existing liners and identify potential alternatives.

METHOD

The PLA database is hosted at www.linerassist.org. It is comprised of:

Liner Properties: Each of 20 liners from 7 different manufacturers has been evaluated across 7 properties inherent to prosthetic liners, including compressive resistance, shear resistance, stretch resistance, adherence, volume accommodation, thermal conductivity, and cost. Relative results are displayed in a flexible graphical user interface (GUI) that allows practitioners to select a patient’s current liner and compare it to others liners, sorting by desired property (Figure 1).

Property Definition: The properties we measure are derived from test protocols established by the American Society for Testing and Materials (ASTM). Details of the test methods and clinical relevance of each material property are provided to the user to facilitate liner selection (Figure 2).

Practitioner-Patient Interaction: The PLA provides example questions that a practitioner can provide to patients to help determine if specific liner properties may be the source of clinical issues the patient may be experiencing. Questions are simple and take into consideration that many patients have no technical understanding of limb-socket interface mechanics.

RESULTS

Liners currently included in the PLA are categorized by their material types (e.g., thermoplastic elastomer (TPE), silicone elastomer, copolymer, and polyurethane). In general, silicone and urethane liners have the highest compressive resistance, while TPE and copolymer have the lowest. Fabric backings have a moderate impact on compressive resistance and a significant impact on stretch resistance. Adherence (coefficient of friction) is strongly dependent on the material surface finish and does not correlate directly with base material. However, TPE consistently has the highest adherence and polyurethane the lowest.

DISCUSSION

The PLA can be used in practitioner-patient interactions to help determine if existing limb discomfort might be a result of the liner and presents the practitioner with an interactive list of liner alternatives that may address the clinical issues observed. The PLA synthesizes objective data with a practitioner’s clinical experience to enhance the fitting process.

![Figure 1: PLA comparison by specific liner and property (select properties shown)](image1.png)

**Adherence**

Skin adherence is described as the quotient of the force pressing the skin to a liner and the force required to move the liner along the surface of the skin. Skin adherence is defined by a mechanical property called the Frictional Coefficient. A liner with a high frictional coefficient will require a greater force to be moved along the skin. Skin adherence plays an important role during all phases of the gait cycle. A high frictional coefficient may prevent slipping and mitigate pistonning caused by movement of the liner with respect to the skin. However, a high frictional coefficient may also induce high shear stress on the skin with movement of the liner (or socket). Shear stress can lead to soft tissue breakdown in persons with sensitive skin.

**Physical Measurement**

A long, flat liner test sample is placed on a plate and a soft, skin-like material (Creams Cow Leather, VBC Industries) is then attached to a block which is placed on the liner sample. The frictional coefficient is the ratio of the force parallel to the surface required to produce sliding divided by the perpendicular force.

\[
\mu = \frac{F_{\text{Parallel}}}{F_{\text{Perpendicular}}}
\]

![Figure 2: Example of property relevance and technical definition](image2.png)

CLINICAL APPLICATIONS

Differences between liners are often ambiguous. The PLA is intended to overcome this problem. It is a freely and easily accessible tool for informing practitioners of the many liner alternatives and how they differ. As such, the PLA has potential to enhance patient care and promote evidence-based practice.