Fall Cushion for Hip Fracture Prevention
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\section*{INTRODUCTION}

\subsection*{Background:}
- 54 million older Americans (65+) are currently at risk of intertrochanteric hip fractures (IHF) resulting from a fall\textsuperscript{1}
- 300,000 older individuals are hospitalized each year for hip fractures\textsuperscript{2}
- IHF causes a $2.63 billion economic burden on the American healthcare system\textsuperscript{1}

\subsection*{Problem / Gap:}
- Devices that prevent fall injuries like grab bars and fall mats are dependent on location
- Wearable fall injury prevention devices like TangoBelt\textsuperscript{3} and Hip'Guard\textsuperscript{4} can be noticeable, expensive, and uncomfortable

\subsection*{Needs statement:}
To reduce occurrence and injury extent of hip fractures among those who are at risk of falling, particularly in the elderly community, by creating a comfortable, unobtrusive fall cushion that is affordable, aesthetically pleasing, and user-friendly.

\section*{PROPOSED SOLUTION}

\subsection*{Final Design:}
- Discreet undergarment with attached inflatable airbags
- Nylon horseshoe-shaped cushion for maximum diversion of force from hip joint
- Fanny pack containing canisters, electronics and gyroscope / accelerometer sensors
- Reusable & washable girdle

\subsection*{Pressure Testing:}
- Used a manometer while the CO\textsubscript{2} canister discharges to measure the pressure while the device is inflated
  - Pressure range reached in cushion: 1.1-1.4 PSI

\subsection*{Impact Testing:}
- Used the force work equation to calculate that a 45lb plate dropped at 0.7m produces a 5200N impulse
  - 5200N is the median value of the femoral force in an unexpected sideways fall for an average person\textsuperscript{7}

\subsection*{Electronics & Latency Testing}

\subsection*{Accurate Fall Detection Testing:}
- How often does the algorithm detect a fall correctly?
  - The current fall detection algorithm can detect falls accurately, 80% of the time (16 times out of 20 trials)

\subsection*{Latency Testing:}
- Due to limitations in junction strength, latency from detection to inflation had to be estimated
  - Once air valve was opened, the cushions inflated within 2-3 seconds
  - Once a fall is detected, the algorithm takes approximately 5 milliseconds to send the signal to the solenoid
  - Response is limited by the baud rate of 9600ms for the microcontroller

\section*{GENERAL FEASIBILITY}

\subsection*{Cost:}
- Manufacturing costs estimated at about $87.15/unit
- Cost to customers is predicted to be less than $200
  - Hip'Guard priced at $800\textsuperscript{4}
  - TangoBelt priced at $1500\textsuperscript{3}

\subsection*{Table 2: Cost to Produce 100k Devices Annually (per unit)}
\begin{tabular}{|c|c|}
\hline
Components & $87.15 \textsuperscript{4} \\
Assembly (labor) & $20.00 \textsuperscript{5} \\
Quality Assurance and Testing & $5.00 \textsuperscript{5} \\
\hline
Total & $112.15 \textsuperscript{6} \\
\hline
\end{tabular}

\subsection*{Reimbursement:}
- Fall prevention devices (both our device and our competitors) are not listed on the covered medical devices list from the Centers for Medicare and Medicaid Services\textsuperscript{\textsuperscript{7}}

\subsection*{Patentability:}
- US Patent US5500952A is a “Hip Inflation Protection Device” we believe resembles our project\textsuperscript{6}
- Key differences between this device and our own include that our device is not a belt and does not include a pleated, folded cushion that expands

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