

Apron Gown Research and Development Process for Home Labor and Delivery Midwives

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Introduction

Across the US, home labor and delivery (HLD) noticed its largest increase in 30 years during the pandemic (Gregory et al., 2022). Midwives, an understudied population of healthcare workers who specialize in women care during pregnancy, are the primary practitioners for these home settings with a total of 14,215 practicing currently in the US (American Midwifery Certification Board, 2023). Women who prefer HLD often seek a more intimate and personalized birthing experience in a less clinical environment due to previous traumatic hospital experiences (Gillen et al., 2023). To provide women such experience, common medical personal protective equipment (PPE) is not chosen as a primary protection option by midwives due to its immediate resemblance to a clinical environment (Marceline, 2017). Aprons have been worn as PPE for centuries by midwives (Kontoyannis & Katsetos, 2011). However, current medical PPE aprons for healthcare workers do not meet midwives' specific needs for the context of HLD. Additionally, commercial aprons for other occupations, such as artists, chefs, and barbers, do not provide adequate protection for these practices, although they are utilized by midwives for HLD. The purpose of this study was to research, prototype, and propose a PPE apron gown solution for midwives for HDL medical practice.

Guiding Framework

To fulfill this purpose, a user-centered design methodology that includes a functionality, usability, look-and-feel, and evaluation (FULE) phase (Lieberman-Pincu & Bitan, 2021) was adapted as it provides an effective outline for the specific development of medical equipment.

Method and Findings

Functionality Phase. Background data collection, functionality requirements, and design goals were first determined to provide a foundation for the apron gown solution. Video-based observations of six HLDs were conducted to identify the apparel and PPE worn by midwives and body movements performed. Data saturation was reached at the sixth video (Saunders et al., 2018). Observations revealed that a majority of midwives wore casual apparel consisting of pants, t-shirts, and skirts in a range of colors and prints. The main type of PPE worn were gloves and non-medical aprons (e.g., cooking aprons). Midwives' common body movements included standing, leaning, bending, squatting, kneeling, and sitting. A pilot online survey with nine healthcare workers was also conducted to understand the perceptions of PPE gown user needs and potential areas for gown improvement that could be implemented into the proposed apron design. The survey revealed that a majority of gown users felt protected against harmful fluids (44.4%), believed PPE gowns were somewhat easy to don (66.7%) and doff (55.6%), perceived the fit of gowns to neither be poor nor good (55.6%), and were neither satisfied nor dissatisfied (55.6%) with the aesthetic of gowns worn. Based on the background data collected, functionality requirements were determined, which included a) mobility, b) protection, c) storage, and d) fluid resistance. A description of the design motive, technical solution, components, user, and environment were also identified.

Usability Phase. A market analysis, usability requirements, and initial design concepts were developed to meet the needs of midwives for HLD. Seven medical PPE aprons on the market were analyzed to determine the main design features and closure types used. The main features included over the head openings, arm and shoulder strappings, mid neck and knee length coverage, plain bodies, and non-woven materials in pastel medical colors. Ties at the back waist were the main closure used for adjustability and one-size fits all purposes. Based on the market analysis, usability requirements were determined, which included a) donning, b) doffing, c) adjustable closures, and d) fit comfort. Two initial apron gown concepts, with technical specifications, were then developed to meet functionality and usability requirements.

Look-and-Feel Phase. Aesthetic requirements were determined based on background and market data and implemented into a final design concept. These requirements included a) color, b) print, c) material hand, and d) silhouette. A final apron concept, with technical specifications, was developed to meet look-and-feel requirements based on the findings from the previous two phases. The final design concept (see Figure 1) was a paneled apron gown featuring a high neckline, below-the-knee length, split leg center front with vertical snaps, adjustable leg ties, side flap pockets, and a single-sided adjustable snap waist flap closure. A ripstop material in non-medical colors and calming prints is suggested for future implementations.

Evaluation Phase. A virtual and physical prototype of the final apron gown concept was developed to evaluate the FULE requirements outlined. First, a 3D prototype was simulated using Browzwear V-Stitcher. Second, a physical prototype was constructed from a lightweight broadcloth fabric using the 2D CAD pattern developed in the 3D environment. Fit evaluations were conducted at each prototyping stage to assess the fit of the apron gowns. Tension and pressure maps were used to assess the virtual fit of the 3D prototype, which was acceptable as no high pressure and tension areas were observed.

A dressform with the same major measurements of the virtual avatar was used to assess the fit of the physical prototype and was observed to also be acceptable as it accurately represented the intended fit and functionality. The researcher then evaluated the final apron gown concept to ensure it fulfilled midwives' needs. The split leg feature provides mobility at the lower body, allowing the user to perform the required body movements during HLD. This may include squatting to respond to mothers' changing birthing positions, as well as kneeling into ground-level birthing pools. Appropriate coverage is provided by the high neckline and below-the-knee length to protect the upper and lower body from bodily fluids. The adjustable leg ties ensure the apron gown remains secure during HLD, further enhancing mobility and protection. The side flap pockets provide storage capabilities for medical tools and personal items, and the single-sided adjustable snap waist flap closure at an accessible area provides ease of donning and doffing and fit customization. Fluid resistance, color, print, and material hand requirements were not addressed in the physical prototype as it fell outside of the scope for this study but were presented in the virtual prototype (see Figure 1) as suggestions for future implementations.

Conclusion, Implications, and Future Directions

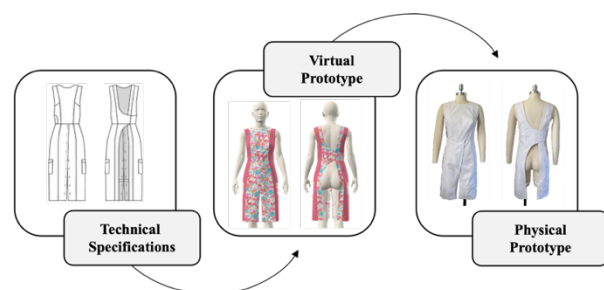


Figure 1. Apron gown development process.

This study addresses the need for alternative PPE to facilitate HDL medical practice. The proposed apron gown is a viable option for midwives as it addresses FULE requirements to potentially enhance their safety and expectant mothers' experience in birthing settings where PPE protocols are not required. Furthermore, this study highlights the importance of adopting user-centered methodologies in medical equipment design, emphasizing the need to cater solutions to the specific needs and contexts of understudied healthcare workers.

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