HubHug: Final Project Report

PeoplesPICC

3/18/24

1.0: Project Overview

1.1: Abstract

The insertion of a Peripherally Inserted Central Catheter (PICC) is the most common invasive procedure carried out on hospitalized pediatric patients (Flores Moreno et al. 2017). PICC lines are inserted into an arm vein to rest in the right atrium of the heart for the parenteral administration of drugs, such as chemotherapy or antibiotics. As with all medical interventions, PICC lines are associated with serious complications, one of which being accidental dislodgement, an event causing a change in length of the catheter extruding from the insertion site. Dislodgment can interrupt vital treatment (Qiu et al. 2014), increase patient risk of thrombosis by 17-fold (Qiu et al. 2014), increase patient risk of CRBSI (catheter-related bloodstream infection) (Moureau 2018) and contribute to vascular crippling through the loss of insertion sites (Moureau 2018). Additionally, if an in-patient occurrence, the $862.50 per occurrence cost (Tomaszewski et al. 2017) of reinsertion, excluding additional complication costs, is absorbed by hospitals. PICC line dislodgement occurs at a rate of 4.12% in pediatric patients (Qiu et al. 2014), despite its severity. To address this need, our team designed and constructed the HubHug, an external PICC line securement device. The HubHug is composed of a flexible silicone base with bendable prongs that secure the top of the catheter. These features address shortcomings in the standards of care of PICC line external securement relating to *patient comfort* and *nurse usability in the setting of routine care.*

1.2: Description of Problem/Need

PICC dislodgement is a primary concern in the vascular access space, as even small movements of the catheter into or out of the body (0.5-5 cm in neonatal and pediatric patients) can disrupt the proper positioning of the catheter tip in the right atrium of the heart (CITE). Dislodgement creates the need for an additional invasive reinsertion procedure, where the patient must undergo anesthesia and any current drug administration through the catheter must be stopped before the new PICC is inserted (CITE). In addition to the interruption of treatment, dislodgement itself presents a myriad of other risks, including an increased rate of catheter-related blood stream infection (CRBSI) at the insertion site, a seventeen-fold increased risk of thrombosis, and the risk for vascular crippling in the involved vessel, which can be an issue in long-term patients who have a limited number of sites left available for obtaining vascular access (CITE).

Active children are more at risk of accidental dislodgement from sudden movements, but even normal daily occurrences including changing clothes, coughing, and moving in and out of a hospital bed can provide opportunities for accidental snagging and pulling on the catheter (CITE). In addition, weekly dressing changes (where the securement device and clear film dressings are removed and replaced with new ones) give rise to a window of time where the PICC is completely unsecured, so any motion from the patient during this time could be catastrophic.

Dressing changes can be an especially distressing occurrence for pediatric patients, as the adhesive removal process can be painful, and the mechanisms for incorporating the new securement device (insertion/movement of subcutaneous metal-pronged device known as SecurACath, or snapping of hard plastic doors in Statlock) provide securement at the expense of patient comfort. Clinical shadowing and interviews with the vascular access team at Lucile Packard Children's Hospital at Stanford have revealed that the shortcomings of existing PICC securement devices do not just affect patients. Providers have to hold down the PICC line during the unsecured period to prevent dislodgement, which causes ease-of-use issues when the provider is left with just one hand to prepare and apply the new securement device, all while reassuring the patient, maintaining arm positioning and remaining sterile.

The HubHug PICC securement device was designed to address both issues of patient comfort and wearability, as well as improve provider ease of use and process compatibility during dressing change procedures.

1.3: Project Objective Statement

The PeoplesPICC team has developed a prototype for a new pediatric external PICC line securement device, called HubHug, that centers patient comfort and provider ease of use through the application of a soft, flexible silicone material as well as an innovative one-handed removable backing, which has not previously been done in the PICC catheter securement space. Like other standard of care devices (namely Statlock), our device secures the line at the suture wing portion of standard PICC catheters, utilizing the existing suture holes to hold the wings in place. However, the method of securement in HubHug is entirely different - rather than clamping down on the holes with the traditional Statlock's hard plastic doors, we incorporated a softer, more wearable material that would mold around the shape of the wings to provide securement through compression and friction. A coated, bendable wire is embedded within the silicone, and when folded, provides a securing force from the top that does not hurt the patient.

Through several rounds of rigorous iterative development, our final prototype passes a large majority of our target criteria for our solution, including specifications falling into five main categories: efficacy, usability, safety, patient comfort, and equity, all of which were tested in conjunction with the standard of care device known as Statlock. Our tests in these five categories ranged from pull tests using a force meter in varying directions and conditions, to integrability with various other accessory devices, to user ratings of comfort after 48 hours of wear. Considering the successes of the HubHug device in preliminary testing, we are optimistic about its potential as an alternative to the current standard of care in pediatric PICC securement technology.

1.4:Design Documentation/Innovative Discussion

The Peoples PICC team initially brainstormed ideas for a device that would both be gentle on a pediatric patient's arm and strong enough to secure the catheter. It was also important that the device could be easily applied with one hand. These design criteria came from our visit to the Stanford Lucile Packard Children's Hospital where we met with the vascular access team. During our visit, we noticed the difficulty nurses had with placing the securement device on the patient while maintaining a sterile environment. It was important for the nurse to be holding the catheter still on the patient's arm while switching the securement device and dressings. Therefore, we decided it was integral for our device to be easily operated with one hand. The nurses also discussed the pain and discomfort that children experience with the current standards of care.

Using this as design criteria, our brainstorm led us to a concept sketch of a device with a gel-like material that would allow the nurse to simply press the catheter into the device and secure it with one hand. The "gel" would also seamlessly integrate with an adhesive backing, similar to the adhesive patches currently used to stick securement devices onto the patient.

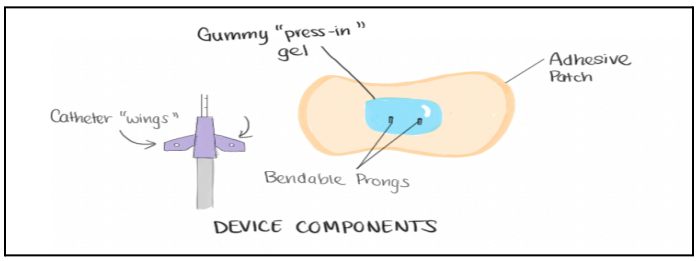

Figure 1: Original concept sketch. Displays a device with a gummy center and prongs that allows the nurse to 'press-in' catheter junction wings.

From the concept sketch, an original prototype was created out of hot glue to visualize the concept. The hot glue prototype was made by pouring a circular dot of hot glue on the catheter hub. When the hot glue hardened and the catheter removed, an impression of the catheter was made (1 in Figure 3). During this time, we also created a CAD and 3D printed prototype of the catheter junction impression (2 in Figure 3). After testing the first two prototypes, it was clear that the material needed to be more flexible and softer on the skin while maintaining the securement of the catheter. After looking into potential materials, silicone quickly became the best option for our next prototype. First, a mold was created using CAD and was 3D printed so that silicone could be easily poured into it. Multiple silicone prototypes were made and we experimented with the hardness of the silicone. The first silicone prototypes (3+4 in Figure 3) were made from Shore A 00-30 grade silicone. Force tests of these prototypes showed that the silicone was too flexible and did not hold the catheter in place. The next silicone prototypes were made with Shore A 00-50 grade silicone (5+6 in Figure 3), which were able to better secure the catheter in force testing. Throughout the silicone prototyping, we also designed supports, both internally and externally, to create more structure within the silicone and address failure points identified during testing. These supports were 3D printed and either placed around the perimeter of the prototype (Figure 2) or directly into the silicone mold before it hardened (Figure 2). We briefly experimented with a higher grade silicone putty for a stronger structure (9 in Figure 3), but found that the material was brittle and broke easily with force testing.

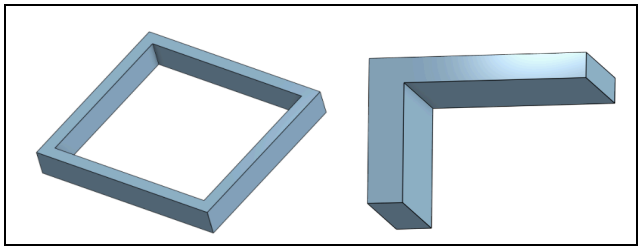

Figure 2: Supports 3D printed to structure the silicone. (Lleft) is an external support that fits around the perimeter of the silicone prototypes. (Right) is an internal support that is placed into the silicone mold before the silicone is cured.

For the next iteration of the design, the square surrounding the perimeter mold was removed to leave only the impression of the catheter wings (7+8 in Figure 3). This created a lighter design that focused on securing only the wings of the catheter, a feature that is universal among all PICCs. To improve securement of the top of the catheter, wiring was added into the silicone mold and extended up out of the prototype, through the holes of the catheter. The wires could then be bent to the sides to secure the top of the catheter. This wiring was improved in the final prototype to include coated wire to protect from sharpness or ripping of the silicone.

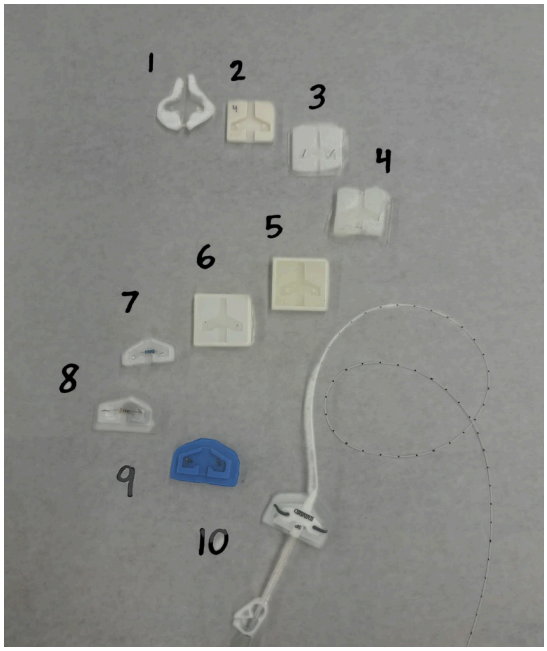

Figure 3: Each prototype displayed and labeled for reference to text.

1.5 Final Prototype

The final HubHug prototype (Figure 4) is constructed from Shore A 00-50 grade silicone and incorporates bendable prongs and an adhesive backing referred to as the primary securement method (PSM) and the secondary securement method (SSM), respectively. The PSM refers to the device components responsible for PICC lumen junction-to-device securement, while the SSM refers to the device components responsible for device-to-patient securement. The PSM and SSM work together to create a fully functional device. Additionally, the HubHug's SSM is fitted with a one-handed adhesive backing.

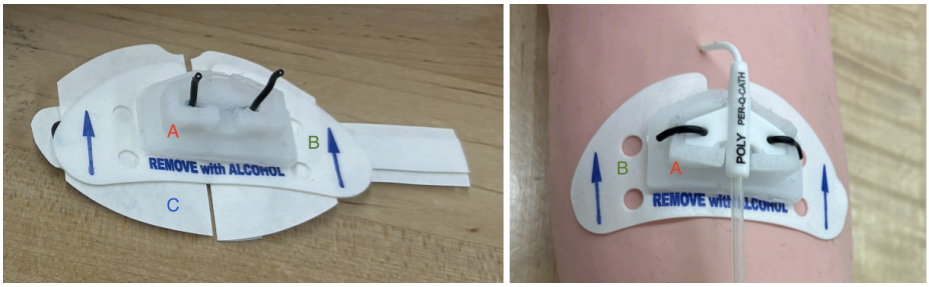

Figure 4: (Left) The final HubHug prototype from an angled view displaying the disengaged PSM (A), SSM (B) and one-handed device prep backing (C). (Right) The final HubHug prototype actively secures the lumen junction of an inserted PICC line via an engaged PSM (A) and SSM (B).

In the hospital setting, the HubHug would be integrated into a standardized full dressing protocol (FDP). This includes a Biopatch around the insertion site and a Tegaderm covering both the Biopatch and the HubHug. See **this video** to watch the HubHug, integrated in a FDP, effectively secure a PICC line inserted into a phantom arm model.

Our final prototype is informed by the iterative design process (Section 1.4) and discussions with vascular access team nurses at the Lucile Packard Children's Hospital. The three main components of HubHug outlined in Figure 4, are described in more detail below:

A. **Primary Securement Method (PSM):** Our PSM consists of a Shore A 00-50 silicone base, equipped with two 3D printed internal supports constructed in CAD. These supports provide structural support to failure points identified in force testing. The flexibility of the silicone proves more comfortable than the plastic currently on the market. Additionally, coated wiring was embedded within the silicone, creating a bendable prong securement mechanism to secure the catheter from upward pulling forces. When in use, the lumen junction is pushed into the base, securing the wings, and the prongs are bent outward. The user can engage this mechanism with one hand.
B. **Secondary Securement Method (SSM):** Our SSM consists of an adhesive patch that was removed from a current standard of care, Statlock, labeled as hypoallergenic and latex-free ("StatLock PICC Plus Stabilization Device," n.d.). When in use, this can be applied directly to the patient's skin. The SSM is attached to the PSM with superglue, ensuring strong connection between PICC junction and patient.
C. **One-Handed Adhesive Backing:** This component consists of three pieces of wax paper, facilitating a three-step removal that can be performed with one hand. First, the user peels off wax paper #1 and can stick the back of the device onto the sterile table or section. Once this is done, the user can remove step 2, exposing half of the device adhesive. Then the user can remove the device from the table, place the exposed adhesive on the patient's arm, and complete the application by removing step three and sticking the rest of the device to the patient arm. This can all be done with one hand

while the other hand is holding the PICC in place to prevent dislodgement or motion during the dressing change.

1.6 Proof of Concept

Following the development of the final HubHug prototype, we created a rigorous set of quantitative specification tests to evaluate the effectiveness of the device across five major categories: Efficacy, Usability, Safety, Comfort and Equity. These categories were assigned clear measurable outcomes (See Figure 5) to identify device success. For more detailed results, refer to M4 Trace Matrix.

Measurable Aspects for Device Success	
Efficacy	Less than 5% difference compared to Statlock (or can withstand ≥13 N of force, when applicable).
Usability	One-handed application/removal within 7 minutes.
Safety	Safety ratings at least on par with Statlock. (Successful integration with current safety precautions i.e. Biopatch)
Comfort	Higher user comfort ratings within a specific timeframe.
Equity	Dimensions not exceeding 70 x 85 x 10 mm for pediatric fit.

Figure 5: Table showing the Measurable Aspects for Success within each broad testing category

After experimentation in each category, we were able to produce data highlighting the overall effectiveness of the device. Our key proof-of-concept data points are outlined below:

- **Efficacy:** When integrated into a FDP, our final prototype (orange bars in Figure __) is capable of withstanding forces greater than the pre-set threshold of 13N in all relevant directions.

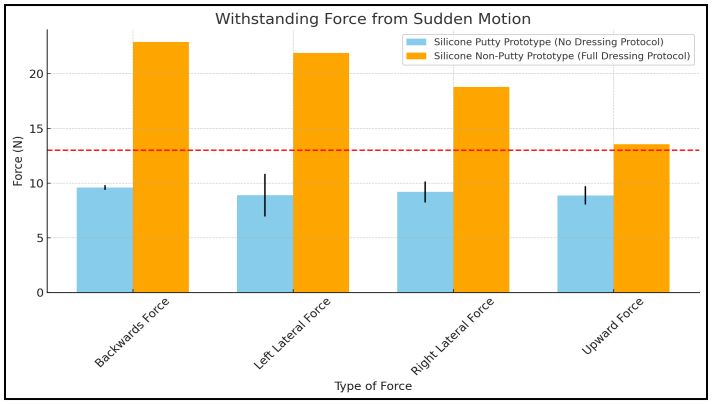

Figure 6: Bar graph showing withstanding force from sudden motion for both the Silicone Putty Prototype (No Dressing Protocol) and the Silicone Non-Putty Prototype (Full Dressing Protocol), with error bars representing 1 standard deviation of data. Dotted red line represents target threshold of force, 13 N. GenAI used for visualizations in Python.

- **Usability:** The device can be applied with one hand within a 7 minute timeframe.

	Accomplished with one hand?	**≤7 minutes?**	**Difficulty score (0-10, 10 is impossible)?**
Application	Yes	Yes	5
Removal	Yes	Yes	3

Figure 7: A table showing a user survey on usability of our device, focusing on application in ≤7 minutes and ease of use with only one hand, simulating real world conditions.

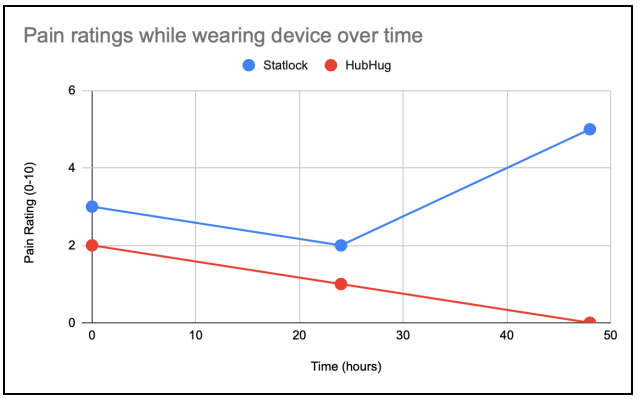

Figure 8: A graph showing pain ratings on a scale from 0-10 over a 48 hour time period. HubHug had lower ratings over all measured intervals (immediately, 24 hours, 48 hours).

- **Comfort:** Our device was rated as more comfortable than Statlock, the current standard of care.

Overall, our results demonstrate high effectiveness in the categories of usability, comfort and safety, with promising results in efficacy (requires additional testing) (See Figure __). There is room for improvement in the equity category as the size of the SSM is still too large.

Overall Success Criterion	**Total % Success**	**Goal Met?**
"Success is defined as outperforming, or being comparable to, the standard of care in ≥70% of all specification tests."	78.37%	Yes

Figure 9: Table outlining the overall success rate and its relationship to the team's quantitative measurement of success.

2.0: Next Steps – IP, Regulatory and Commercialization

2.1 Patentability

Our analysis has identified that most patents directly related to PICC line securement are either held by Becton, Dickinson and Company (BD), which owns StatLock — the current standard of care — or were held by companies that have since been acquired by BD. Working to enter a market with one competitor protected by a variety of patents presents both challenges and opportunities for the HubHug device in terms of patentability and market differentiation.

One patent that was discovered during our analysis that raised potential concerns is the catheter securement device under US Patent 9358368 B2 held by CareFusion 303 Inc., a BD company. Part of this patent involves explicitly discussing a securement device with an adhesive base for attachment (CareFusion). While this presents a potential challenge given that an adhesive base is critical to HubHug's design, we believe our prototype meets the three key criteria for patent success (novelty, usefulness, and non-obviousness) as highlighted below:

Key Arguments for Patentability:

1. Defining Unique Subsystems: Unlike existing patents, HubHug draws a more explicit line between primary (attaching the catheter to the device) and secondary (attaching the device to the skin) securement methods. This innovative approach to considering subsystems of the device helps redefine our securement device so that we can continuously enhance stability and minimize dislodgement risks within each individual subsystem. In the catheter securement space, we suspect this will have high utility.
2. Patient-Centric Design: HubHug focuses on patient comfort and ease of use for nurses, integrating features to reduce skin irritation and simplify application. This design emphasis on patient well-being while minimizing clinical stress associated with application represents a significant advancement over current devices and demonstrates the system's usefulness and novel approach to securement.
3. Non-Obviousness: The integration of firm wiring within a soft, minimized silicone mold represents an inventive solution, merging the benefits of secure fixation with patient comfort in a non-obvious way that we hypothesize would not be apparent to a skilled practitioner.

Analyzing BD's patent portfolio reveals an offensive patenting strategy regarding catheter design and securement methods driven by acquisitions of smaller companies. However, the team still believes that a gap in comprehensive solutions – addressing both securement efficacy and patient well-being – exists. HubHug's innovative approach fills this gap, offering a value proposition that differentiates it from the wide array of existing BD patents.

In short, HubHug's distinctive features and innovative approach provide what our team thinks is a fair basis for patentability. Our strategy focuses on highlighting these innovations, continuing to meet with legal experts to ensure non-infringement and that HubHug stands out as an essential solution in the catheter securement market.

2.2 Anticipated Regulatory Pathway

HubHug's future experience regarding regulatory pathways can be predicted using current devices on the market, namely StatLock. PICC line securement products like StatLock are traditionally characterized as Class II devices by the FDA, which sets a precedent for similar catheter securement solutions aiming to enter the market (FDA). This classification means that these devices need moderate regulatory oversight given associated risks, but are still highly valuable in patient care by facilitating safer, more reliable catheter use.

Given that HubHug's approach to securing PICC lines does not add significant risk of injury to the process of catheter securement, we believe it will likely fall under the same

regulatory umbrella as StatLock and other catheter securement devices. Considering our low risk profile and alignment with the overarching goal of enhancing catheter securement – the same goal of StatLock – the Class II exempt pathway appears to be the most appropriate for regulatory approval. We hope that this pathway will ultimately lead to a 510(k) exempt status (Cognidox).

Our future strategy involves detailed comparative analysis with standards of care like StatLock to validate HubHug's compliance with established safety and efficacy benchmarks. By affirming substantial equivalence while highlighting our device's unique benefits, we aim to streamline the regulatory process, ensuring HubHug's timely and successful introduction to the market.

2.3 Reimbursement

Given that HubHug is a single-use securement device, it is impossible for the device to be categorized under durable medical equipment (DME) for Medicare/Medicaid reimbursement (covers items intended for repeated use, expected to last at least 3 years, and used for a medical reason). However, this does not eliminate the possibility of reimbursement through other Medicare/Medicaid pathways. For items and services to be considered for Medicare coverage, they must fall within a benefit category established in Section 1861 of the Social Security Act, not be specifically excluded by the Act, and be deemed "reasonable and necessary" for the diagnosis or treatment of illness or injury (Social Security Administration).

To ensure that HubHug is reimbursable through Medicare/Medicaid, our team would focus on demonstrating its medical necessity and efficacy in improving patient outcomes. This would involve gathering substantial evidence of the device's ability in preventing catheter dislodgement, not increasing the risk of infection, and decreasing the overall cost burden associated with catheter-related complications. To allow these trials to take place, it is necessary to continue to pursue relationships with vascular access device teams and interventional radiologists. We expect this to be a large barrier to success, given that trials with a pediatric patient may be more difficult to gain approval for. At the least, we plan to test our device with a broader range of subjects in a laboratory setting.

In conclusion, we believe that reimbursement is still possible. A future strategy would involve a detailed submission to Medicare/Medicaid, highlighting the device's clinical benefits and cost-effectiveness. As mentioned above, it would also be necessary to gather as much clinical data as possible. Our strategy involves identifying existing reimbursement codes for similar single-use medical devices or supplies to further strengthen the case for HubHug's reimbursement eligibility.

2.4 Estimated Manufacturing Costs

For HubHug, the estimated manufacturing costs can be broken down into several key components, each contributing to the overall cost per unit. These estimates are derived from industry standards for medical device production, considering materials, manufacturing processes, quality assurance, and volume discounts.

Components and Materials:

- *Silicone Mold:* The primary material for the securement device, chosen for its biocompatibility and flexibility. Estimated cost: $.17 per unit.(~$200/gallon, makes 1,150 molds) (Amazon)
- *Adhesive Strips:* Medical-grade adhesive strips for skin attachment. Estimated cost: $.015 per unit. (~$7/233,000 mm^2, makes 455 units) (Walmart)
- *Packaging Materials:* Includes sterile packaging necessary for single-use medical devices. Estimated cost: $.02 per unit. ($5.95/200 in a box) (Santa Cruz Biotechnology)

Manufacturing Processes:

- *Injection Molding:* The cost for injection molding the silicone body of the device. This includes the setup cost amortized over the production volume. Estimated cost: $.007 per unit (Using ABS as material to estimate, ~$1.30/ pound, unit weight is .006 pounds) (Misumi Group, Rex Plastics)
- *Assembly:* The process of attaching adhesive strips to the molded silicone body and packaging. Estimated cost: $.20 per unit.

Quality Assurance and Quality Control (QA & QC):

Testing and Compliance: Does the device meet regulatory standards, i.e. material safety testing and device function testing. Estimated cost: $.18 per unit. ($18 / 100 units)

Volume Discounts:

We predict that manufacturers will offer discounts for larger production volumes of HubHug. For larger volumes, such as 50,000 units or more, the cost per unit for components, manufacturing, and even quality assurance testing could decrease by approximately 10-20%, depending on the specific agreements with suppliers and manufacturers.

Total Estimated Cost Per Unit

A total manufacturing cost per unit is estimated at $.592 for a production run for fewer than 50,000 units. With volume discounts for larger production runs, this cost could potentially decrease to around $.503 per unit for orders of 50,000 units or more once the bulk discount is factored in.

Initial R&D expenses are significant for medical devices even if not included in the per-unit costs. Present numbers are difficult to predict, but we expect R&D costs to be necessary for the device's development and regulatory approval. However, we do expect these costs to be amortized over the expected sales volume across the product's lifecycle and will revisit financial strategies in later stages of prototype development.

2.5 Market Potential and Impact

Market Size

Our device is targeted towards pediatric patients, for whom the cost of reinsertion procedures following PICC line dislodgement are high. Pediatric PICC placements are an invasive procedure, and are typically performed in an interventional radiology (IR) suite as opposed to at the bedside, raising the financial and health burden on the patient with anesthesia use. Over 2.7 million PICC lines are placed every year in the United States (iData). Though data does not exist regarding the percentage of PICC lines placed in pediatric patients, we can use the proportion of pediatric hospitalizations compared to overall hospitalizations to estimate that approximately 133,000 PICC lines are placed in pediatric patients annually (Kaiser, Statista). With a dislodgement rate of 4% and a median re-insertion cost of $1340.9, the estimated market for preventing reinsertion procedures alone comes out to $7.13 million annually, and factoring in costs due to complications brings our total market size to $103 million (Kaiser, Statista, Dong, Barrier). Outside of our immediate target population, the Hubhug could be potentially adapted to fit adult patients or accommodate different catheter types, reaching the full catheter securement device market of $1.48 billion (Intellectual).

Selling Price

Given our estimated mass production costs and competitor pricing, it would be reasonable to set our selling price at about $6.5 per unit, with bulk discounts for orders of 100+ devices at $5.85 per unit. A majority of profits would be allocated to sales, wages, and further R&D.

Distribution Channels

We would operate primarily on direct sales to hospitals and healthcare facilities, following current industry practices as there are no present standardized protocols for catheter

securement processes across hospital systems. We would present actively at conferences to create and facilitate relationships with vascular access teams across the country, who are some of the biggest stakeholders in the adoption of new securement devices within their departments.

Customers

The primary customers for the product would be inpatient healthcare facilities that regularly treat pediatric patients requiring intravenous therapy, namely hospitals. Depending on the translation of the HubHug device into outpatient settings, this could also include pediatric clinics and specialty healthcare providers.

End Users

End users of the product would primarily be healthcare professionals involved in pediatric critical care, including vascular access nurses, interventional radiologists, neonatologists, and other pediatric specialists.

Potential Impact

The HubHug PICC securement device has the potential to significantly impact hundreds of thousands of patient outcomes for the children, families, and healthcare professionals involved in their care. HubHug may reduce catheter dislodgement and its corresponding complications, including an increase in pediatric patient comfort and compliance, and a streamlined catheter maintenance process for healthcare providers. Reducing the number of necessary reinsertion procedures can lead to improved patient outcomes by providing continuous treatment for patients, reduced trauma due to medical complications, and a reduction in the absorbed costs for the hospital systems involved.

Working Section

++ Key Statistics ++

- 4.12% incidence rate of PICC spontaneous dislodgement
    - https://www.sciencedirect.com/science/article/pii/S0020748913003295 (Qiu)
- 2 million non-birth pediatric hospitalization annually
    - https://jamanetwork.com/journals/jamapediatrics/fullarticle/2787156
- The peripherally inserted central catheter (PICC) is the most often invasive procedure applied in hospitalized pediatric patients since up to 90% of patients require parenteral administration of drugs (90% of hospital visits require a PICC?)
    - https://www.elsevier.es/en-revista-boletin-medico-del-hospital-infantil-201-articulo-risk-factors-associated-with-complications-S2444340918000079
- The probability of catheter-related thrombosis of PICCs with spontaneous dislodgment was 17.46-fold higher than that of PICCs without spontaneous dislodgment.
    - https://www.sciencedirect.com/science/article/pii/S0020748913003295
- Pediatric hospitalizations account for 5% of all hospitalizations
    - https://www.statista.com/statistics/459718/total-hospital-admission-number-in-the-us/
- Over 2.7 million PICCs placed yearly
    - https://psnet.ahrq.gov/web-mm/be-picky-about-your-piccs-fragmented-care-and-poor-communication-discharge-leads-picc#:~:text=A%20PICC%20is%20a%20central,cubital%20vein%20of%20the%20arm.&text=Over%202.7%20million%20PICC%20insertions%20are%20performed%20yearly%20in%20the%20United%20States.
- ON PICC LINE COST
    - $862.50 for reinsertion procedures
        - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5304969/
    - $31.32 to correct material costs at bedside
        - Benjamin Quang Zaidel Can you find the link for this?
- Statistics used for market size calculations: ***(all in the 141B Final Report folder of Zotero)***
    - $146 to treat or manage PICC complications/ dwell day (Dong)
    - Mean PICC dwell time in pediatric patients 17.7 days (Badheka)
    - 30% of pediatric PICC patients have at least one complication (Barrier)
    - 1.78 million pediatric hospitalisations per year, 2016 (Kaiser)
    - 36.1 million overall hospitalisations per year, 2016 (Statista)
    - Maintenance costs for PICC lines $3,133.5/ day (Dong)

++ Source-backed Quotes ++

- Potential complications of PICC dressing changes include infection, bleeding, and dislodgement of the catheter. These can be prevented by following proper hand hygiene, using sterile technique, and monitoring the site for any signs of complications.
    - https://www.lecturio.com/nursing/free-cheat-sheet/picc-dressing-change/#:~:text=Potential%20complications%20of%20PICC%20dressing,for%20any%20signs%20of%20complications.

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