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Designing and Testing a Chest Tube Holder to Support Early & Progressive Patient Mobility

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Background

- Health care innovations are too often made without the insights of frontline clinicians.
- As the nation's largest group of health care professionals, nurses are in a unique position to articulate everyday health care issues, challenge assumptions, and create solutions for unaddressed needs.
- We envision a future where nurses are engaged in the process of designing, testing and implementing new technologies, system processes, and health care delivery models.
- The management of chest tubes during patient mobility is an area that needs improvement.
- Chest tubes are bulky, must be maintained in an upright position to function properly, need to be positioned below the patient's chest, are easily tipped over, are prone to inadvertent dislodgement, and are currently designed with non-secure plastic hooks for use during patient mobility.
- Baystate Medical Center (BMC) is a 780 Level 1 Trauma Center and Pediatric Trauma Center for western Massachusetts and is New England's busiest emergency department with over 110,000 patient visits annually.
- The Elaine Marieb Center for Nursing and Engineering Innovation works closely and collaboratively with BMC to help nurses and engineers become interdisciplinary healthcare innovation leaders.

Purpose

- The purpose of this project is to design, develop and test a new chest tube holder to support safe and early patient mobility.

Goals/Objectives

1) Foster Effective Collaboration Between Nurses and Engineers to Design & Develop the Chest Tube Holder (CTH)
- Develop the design through regular collaboration & feedback between nursing & engineering teams.
- Integrate nursing staff's requirements into the design to meet clinical needs and usability standards.

2) Enhance the Safety of Patient Mobility with the New CTH
- Protect and keep the chest tube upright during patient movement and ensure the chest tube holder remains secure and stable when attached to an IV pole.
- Achieve high usability ratings from nursing students using the NASA Task Load Index Tool for ease of use and integration.

3) Optimize Design of the CTH for Practical Application in Clinical Settings
- Ensure the holder is easy to clean and maintain.
- Confirm the holder can withstand impacts and function effectively under typical hospital conditions.

Methodology

- Once the product requirements were created by nursing, the engineering team began to create design options in collaboration with nurses.
- Regular team meetings were important for ongoing design review and feedback, allowing for real-time adjustments and refinements.
- Usability testing was conducted with 23 nursing student-pairs in a nursing simulation lab.
- To simulate patient ambulation with a chest tube, participants were placed in nurse-patient teams and asked to walk around a pre-determined path with a chest drainage system and IV tubing connected.
- The walking path was completed twice by each team, once with a protocol chest tube holder and once using the plastic hooks and without the prototype chest tube holder.
- For both conditions nurse participants completed the NASA Task Load Index Tool, the most widely used cognitive workload scale.
- Participants were also asked to rate their success in task completion and invited to provide additional feedback.
- Our interdisciplinary nurse-engineer team designed and tested a prototype mobile chest tube holder that could quickly attach to an IV pole, was intuitive to use, easy to clean, could withstand accidental impact, protects the chest tube and keeps it in an upright position, and supports patient mobility.

Outcomes

- For the NASA-TLX (range 0-100) cognitive workload items, higher total score=higher cognitive demand/lower overall usability.
- A paired t-test found ambulation with the prototype (M=24.8) to be significantly less cognitively demanding/higher usability ($p<0.001$) vs. without the chest tube holder (M=51.8).
- Success for task completion using the prototype (M=16.9) was found to be significantly higher ($p<0.001$) vs. without the chest tube holder (M=9.9).

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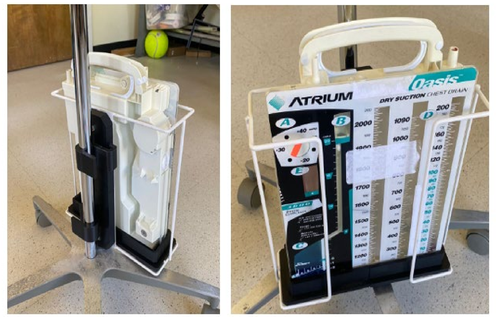

Figure 1: Chest tube holder prototype for testing

Conclusions

- Ambulation with the prototype was significantly easier and more successful vs. without the prototype.
- This product development project highlights the unique value of nurses as real-world healthcare innovation leaders.
- We hope that it can serve as an example for others who are ready to engage in nurse-led, user-driven interdisciplinary healthcare innovation.
- Next steps are to implement these changes, create a final prototype for real-world usability and clinical outcomes testing, and file a patent.
- This project is one of many that promotes interdisciplinary and collaborative environment for frontline nurses to work closely with healthcare engineers.

References

- Benjamin, E., Giuliano, K. (2024) Empowerment Through Academia. AJN, American Journal of Nursing 124(2):p 61-63. DOI: 10.1097/01.NAJ.0001006728.04373.b7
- Giuliano, K., Sup, F., Benjamin, E., & Kristnamurty, S. (2022). INNOVATE: Preparing nurses to be healthcare innovation leaders. Nursing Administration Quarterly, 46(3), 255-265. https://doi.org/10.1097/NAQ.0000000000000529

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