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DESIGN INSIGHT

An IV system designed for ambulation: Introducing Motivity, a device to get patients moving

Rachel Monane, David Gordon, Sara Belko, Maitri Doshi, and Robert Pugliese

Health Design Lab, Thomas Jefferson University, Philadelphia, PA, USA

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Corresponding Author:
Rachel Monane
Health Design Lab
Thomas Jefferson University
Philadelphia, PA
USA
rxm525@jefferson.edu

SUMMARY
We observed and interviewed a nursing team on an inpatient Medical/Surgical Step-Down hospital unit to solicit feedback regarding common issues patients encounter with hospital intravenous (IV) poles. The interviewees raised issues that occur in every interaction, including product components like rickety wheels, bases, and poles; difficulty turning and navigating through doorways; and challenges moving the pole while avoiding foot injuries for their patients. Our team's research objective was to create an IV system designed for ambulation, improving patient and provider experiences, safety, and utility.

Key Words
Drug Infusion system; intravenous pole; early ambulation; accident prevention; post-operative mobility

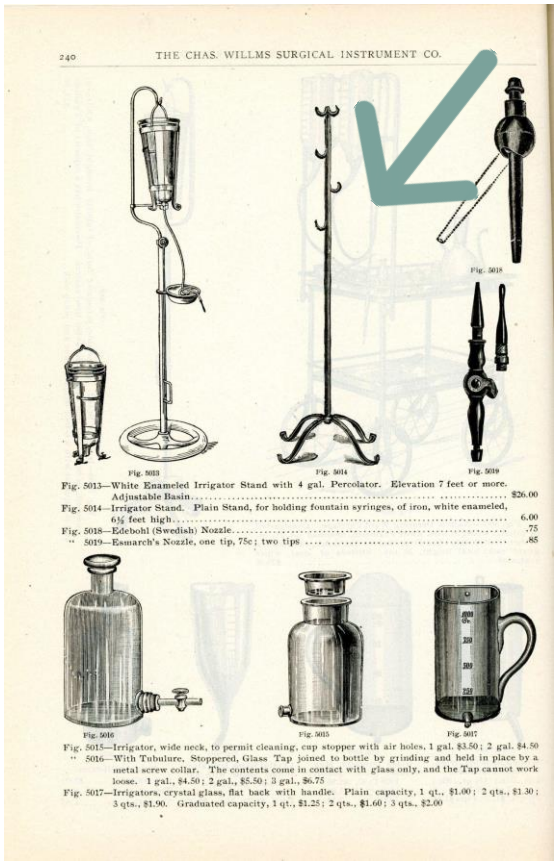
INTRODUCTION

Patient ambulation can lead to quicker discharge, reduced complications, and better long-term outcomes.[1,2] Health benefits include improvements to many organ systems and experience factors like patient autonomy. Conversely, not ambulating can have negative implications, increasing the risk of complications in patient recovery, like deep venous thrombosis.[1] The medical community has come to recognise the importance of walking, especially after surgery, and trends point toward ambulation only increasing.[3] Currently, numerous challenges exist for patients attempting to walk within a hospital unit, including wearing a pocket-less hospital gown and hospital socks, navigating through doorways, and around a frequently cluttered environment, with various medical peripherals (including intravenous [IV] lines, pumps, and catheter bags) in tow.

SUMMARY

While healthcare delivery has rapidly evolved, the IV pole has remained largely the same since the early 1900s, except for the addition of wheels (Figure 1).[4] We observed an inpatient Surgical Step-Down Unit nursing team and conducted interviews with staff to solicit feedback regarding common issues patients encountered with hospital IV poles. Issues for patients ranged from product components of rickety wheels, bases, and poles, to difficulty turning and navigating through doorways, and to challenges moving the pole while avoiding foot injuries. Seeing these difficulties, our objective became to create an IV system designed for ambulation, improving patient and provider experiences, safety, and utility.

Figure 1: IV pole "Irrigator Stand" illustration from 1900s medical instrument catalogue

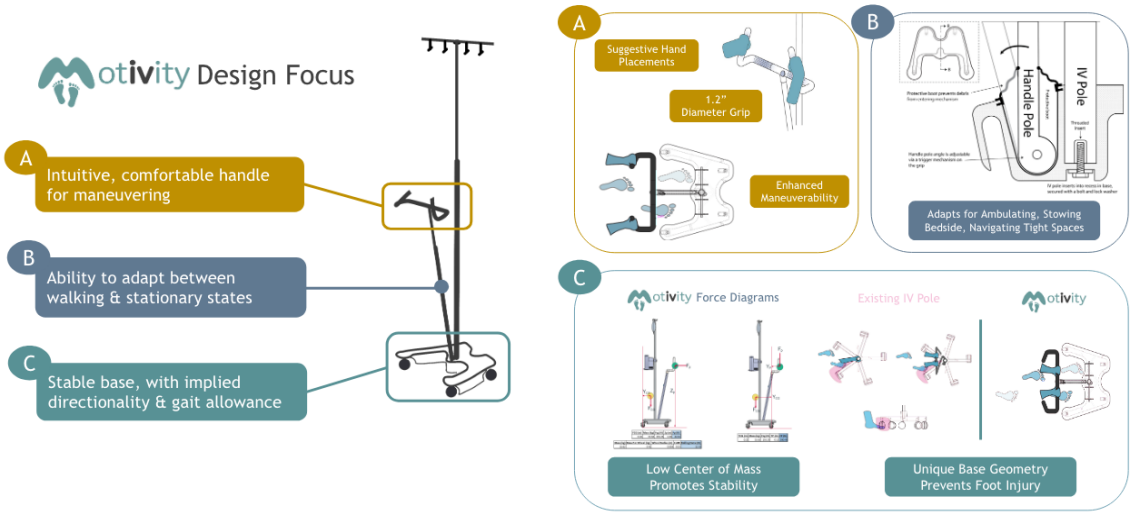


Charles Willms Surgical Instrument Co. Illustrated and Descriptive Catalogue and Price-List of Surgical Instruments [catalogue]. Baltimore (MD): 1905 (240)[4] (Image courtesy of the Siegman Archives at Thomas Jefferson University)

The prototype design focused on three major components: 1) an intuitive, comfortable handle for manoeuvring; 2) the ability to adapt between walking and stationary states; and 3) a stable base, with implied directionality and gait allowance (Figure 2).

Standard IV poles lack any place for a comfortable grip, forcing patients to grab the pole itself, limiting manoeuvrability and making it difficult for the patient to distance themselves from the base. IV pole grips on the market are often too small to be used comfortably, and they hold the patient too close to the base. Our handle has a wide grip, which keeps patients' arms and hands in a natural position and helps patients position the pole in front of themselves. Through discussions with clinical end users and established handle design guidelines,[5] we designed Motivity's handle grip to be 1.2" in diameter for the comfort of users, and suggestive, but not prescriptive, for where hands should be placed, like bicycle handlebars (Figure 2A).

Figure 2: Motivity IV pole prototype design intents



Motivity accommodates different use states within the patient journey:

1. An active state that helps patients walk in the hallway
2. A partially collapsed state to stow in the bedside environment, and (with a small turning radius) to navigate tight spaces like a patient's hospital bathroom

Motivity's telescoping handle pole makes the system completely height adjustable. The handle pole itself can adjust between 0 to 20°, with a grip trigger mechanism, allowing patients to transition from stationary to ambulatory states independently (Figure 2B).

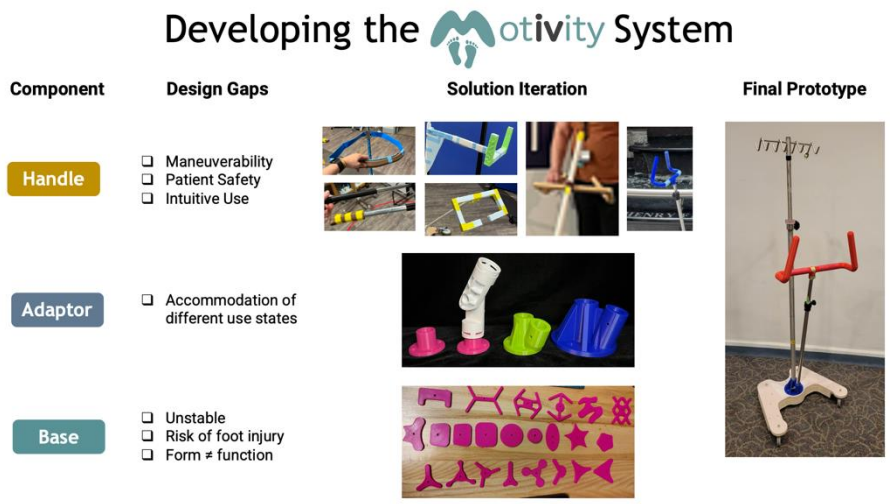
Traditional IV poles have no clear orientation and constrained spaces for patients' feet, causing patients to frequently kick the base as they walk, potentially leading to foot injuries. Occupational therapists also noted concern with patients walking with the pole on their side, creating a centre of gravity external to the patient. Motivity has a base profile with implied directionality, helping the patient to position the system, with prescriptions for intended gait and pole positioning. Motivity also incorporates space in the base to accommodate for the patient's gait (Figure 2C).

LESSONS LEARNED

The design team completed over100 hours of nurse and team member observation in the hospital, assessing patients' walking and identifying systemic pain points. To address specific design gaps, and increase prototype fidelity, the team iterated through multiple prototypes for the base, handle, and adaptor components (Figure 3), and constructed the Motivity prototype to bring ambulation-focused design to the IV system. Interviews—with providers caring for inpatient adults, with indications for post-operative in-hospital ambulation, floor nurses, and medical assistants—were also an integral part of design development. The team held seven longitudinal design reviews with unit-based nursing

leadership and consulted with health system supply chain stakeholders, industrial designers, and clinicians.

Figure 3: Prototyping Motivity



Stability was a major factor in our design, as existing poles tend to be unstable and top-heavy. The prototype featured a central pole recess within the base, secured with a bolt and lock washer, and was tested with large shakes, while loaded with pumps and IV bags. Including a silicone cap would protect the moving components in the base (Figure 2B), enhancing its feasibility for infection control in the healthcare setting. Force diagram models support findings from prototype testing and demonstrate that Motivity's lower centre of mass versus the traditional IV pole provides increased resistance to tipping (Figure 2C).

Nine nurses completed a "test drive" of Motivity, navigating through unit doorways, in bathrooms, and around hallway corners, before using a 5-point Likert scale to rate the standard IV pole systems used on their unit and the Motivity prototype. Survey factors included metrics used from a prior study, which field-tested the "Sprout Pole" prototype (an aesthetic IV system to make children feel more at ease, provide positive distraction, and create a connection between the hospital environment and children's overall hospital experience), within a clinical unit.[6] We compared results between surveys of existing IV systems, the Sprout Pole, and Motivity. On all measures assessed, study participants rated the Motivity prototype superior to IV poles on the unit, as well as to the competitor IV system from the Sprout study (Figure 4). Participants used both systems—the existing unit IV pole and the Motivity IV system prototype — and following test drives of each, we collected data via iPad, within an Internet-based survey program. Participants first answered a question block consisting of queries regarding the existing unit IV pole and a second question block regarding the Motivity IV system prototype. Relative to current IV poles, participants rated Motivity more stable (4.2/5.0 vs. 3.4/5.0), had improved perceived walking safety (4.9/5.0 vs. 3.0/5.0), and was more beneficial for patients (4.7/5.0) and nurses (4.6/5.0).

We found solutions were ultimately simplest to iterate by system component (Figure 3). Though the prototype successfully met the design focus objectives identified, we gathered additional insights to be integrated into future iterations (Figure 5). We gleaned the most actionable insights from bringing full-scale prototypes into the clinical space for weekly feedback, serving as a launchpad for design modification inspiration and early detection of possible design pitfalls. Other lessons learned include the necessity for modularity in healthcare product design, the importance of inclusive design, encompassing a vast range of body habitus, and consideration of patients and providers as users.

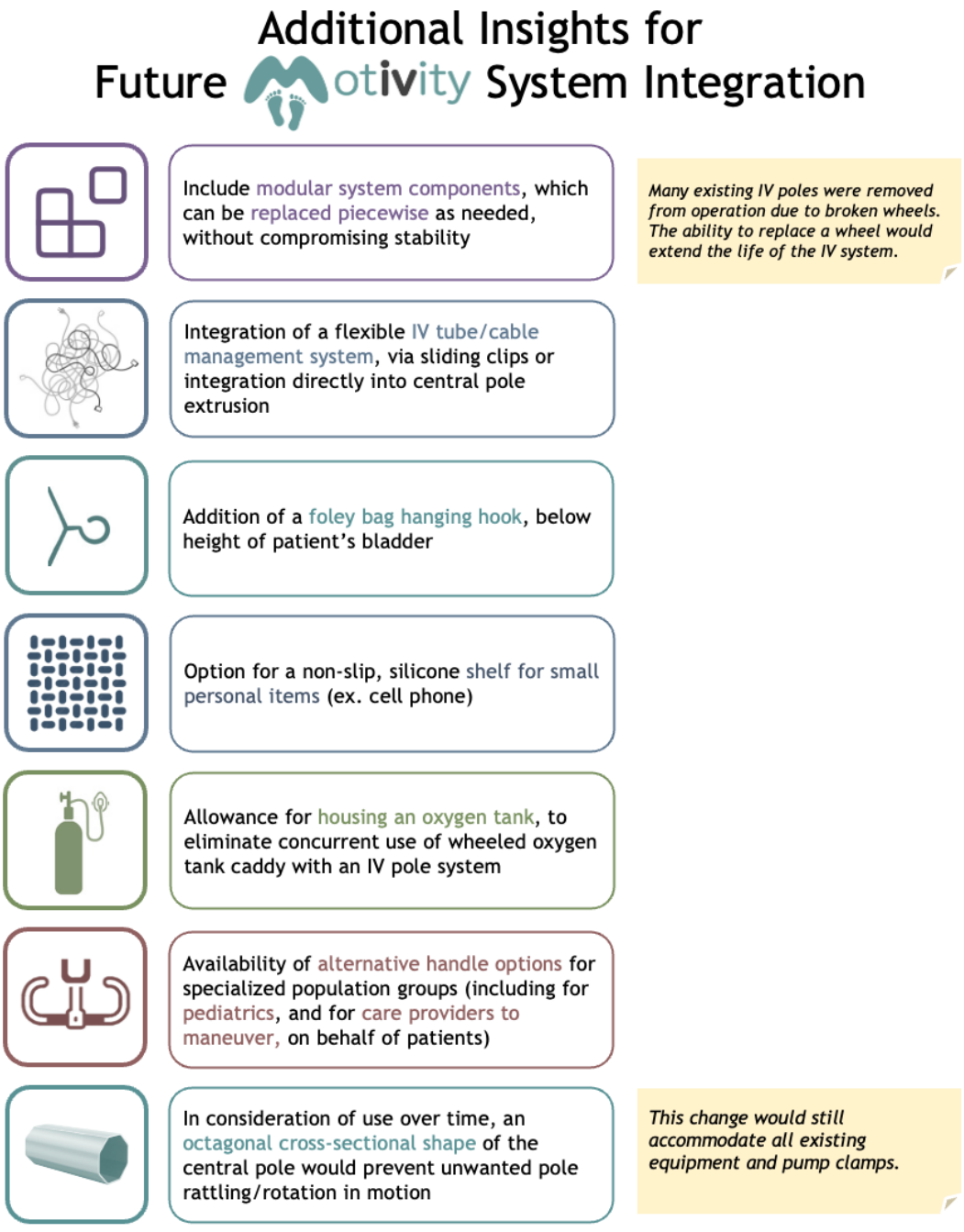
Figure 4: Nursing feedback on Motivity prototype "test drive"

Motivity Prototype Outperformed Existing IV Poles on All Measures Assessed

Factor	Existing IV Pole	Prior Study IV Pole	Motivity
Easy to move around?	3.2	4.1	**4.7**
Would go through doorway/bathroom?	3.2	4.2	**4.7**
Quiet when moving?	2.7	4.2	**4.8**
Stable?	3.4	4.1	**4.2**
Safe for children?	2.7	3.9	**4.1**
Patients would walk safely?	3.0	-	**4.9**
Positive walking experience for patients?	3.0	-	**4.8**
Average of Factors	3.0	4.1	**4.6**
Would implementing be beneficial for patients?	-	-	**4.7**
Would implementing be beneficial for nurses?	-	-	**4.6**

Standard Factor Questions Adapted from Sprout IV Pole Validation Study[6] (Prior Study)
Existing Poles Normalized Between Prior Study (Sprout) to Motivity Ongoing Testing Average

Figure 5: Intents for future iterations of Motivity



DESIGN INSIGHT

This paper presents a great example of the development of an IV System Designed for Ambulation in the form of "Motivity," which has been designed based on a research informed problem. The challenge associated with getting patients moving is well documented and the identification of some of the barriers that prevent/cause issues are well considered. The design team clearly identified that the design and manufacture of the IV pole has not changed in recent history and thus the development of a new system/solution presents the potential to add value by undertaking a user-centred research and design approach. The research/design team approached the design problem in a logical manner, resulting in an interesting outcome that has solved the identified problem through extensive observation research. This clearly demonstrates the value of undertaking a user centered design approach to solve a technical problem ensure that realistic outcomes are produced.

The lessons learned from the approaches undertaken are valuable to researchers, designers, and medical professionals alike by acknowledging how to tackle the redesign of a traditional medical device/product. The comparative design review/assessment also identified how the solution produced addressed several of the key problems and design requirements identified during the research phase of the project. Designers and healthcare providers must fully understand the value proposition of a new product and what value this can have if implemented; the design/research team have been successful in doing so within the design of "Motivity". Key design approaches are well considered and recommended for designers moving forwards especially in relation to design for modularity in healthcare product design, the importance of inclusive design and consideration of patients and healthcare providers/professional's perspectives.

Dr Francesco Luke Siena
Senior Lecturer In Product Design
Medical Engineering Design Research Group Member
Nottingham Trent University
Nottingham, UK

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PEER REVIEW

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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ETHICS COMMITTEE APPROVAL

None