The Impact of New Medical Devices on Role Boundaries Between Different Healthcare Occupations

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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STS Research Paper

In 2020, the U.S. medical device market was valued at 176 billion dollars. This market is expected to grow at a rate of 5% annually until 2025 (Grand View Research, 2019). As the number of new medical devices entering clinical settings increases at a rapid rate, the social impact of these devices on medical professionals requires careful consideration because this new technology is capable of altering the division of labor that exists between different healthcare occupations (Petrakaki & Kornelakis, 2016). This redistribution of tasks has the potential to blur the boundaries that have previously delineated occupational roles in the hospital and calls into question who should be trained on which devices. Through the use of a hospital pharmacy case study, I will show that the impact on role boundaries stems from differences in values between groups as well as the prioritization of certain groups' values over others.

I will frame my argument through the use of Actor Network Theory (ANT) and Value Sensitive Design (VSD) principles in order to examine the pertinent stakeholders and their values. I will also address influential factors that shape different stakeholder's values and consider who the ultimate decision-makers should be during the selection process for a new medical device. After summarizing all of the stakeholder values and potential value conflicts, I will propose an optimized model that hospitals can use when selecting and introducing a new medical device to mitigate employee stress.

The Pharmacy Case Study

This past summer, the hospital in my hometown switched to a new intravenous (IV) pump system. Though IV pumps are primarily operated by nurses, the hospital's pharmacists, who have a highly specialized understanding of drug interactions and pharmacokinetics, were tasked with inputting all of the drugs and infusion limits into these new pumps. Despite being the ones to prepare the IV infusion bags, pharmacists rarely interact directly with the IV pumps. The pharmacy team’s lack of familiarity with IV pump interfaces hindered their ability to input the necessary drug information and test that the pumps were programmed accurately. The addition of the IV pump as a direct actor in the pharmacists’ network changed the responsibilities associated with their job and led to an increase in collaboration between the nursing and pharmacy staff.

When deciding on which IV pump system to purchase, the hospital executives only consulted the biomedical engineers, the charge nurses, and the tech companies. Even though the IV pumps had a significant impact on the pharmacists’ job responsibilities, this group of stakeholders was neither directly involved nor considered in the IV pump design considerations or the hospital-level IV pump selection process. Once the pumps arrived, the pharmacists recognized that the pumps had a critical disadvantage compared to the old IV pumps: the new pumps were unable to infuse two medications at once through a single IV line.

Applying ANT to the Case Study

In this case study, it seems fitting to apply ANT, which views humans and non-humans as equal actors that can unite to form networks, to understand how each actor’s actions impacted preexisting networks (Sismondo, 2011). According to ANT, the interests of actors, which drive their actions, require consideration and can be employed and altered to form a “stable” network that has a common aim (Sismondo, 2011). The case study showed how the pharmacists expanded their network to confer agency onto the IV pumps. From an ANT point of view, the primary actors from the case study are the pharmacists, the IV pump, the IV pump manual, the nurses, the medical device company representatives, and the hospital executives. While ANT is an advantageous framing tool because it uniformly weighs the actions of human and inanimate actors, it neglects the influence of culture, values, and issues of trust between actors. Thus, VSD will be applied later on to fill in these gaps.

Figure 1 shows the pharmacists’ network after the integration of the new IV pump system. In this situation, the pharmacists interact with the IV pumps, the nurses, the medications, the patients, the hospital executives, and the tech company representatives. The red lines in Figure 1, represent the new connections formed after the introduction of the IV pump into the pharmacists’ network. Because of the IV pumps, the pharmacists formed new direct connections with the IV pumps, the patients, the tech company representatives, and the hospital executives. The introduction of the IV pumps also strengthened the connection between the pharmacists and nurses by encouraging increased collaboration. This can be seen in how during the initial integration of the IV pumps, the pharmacists rounded with the nurses to ensure that the pumps were functioning correctly. By forming a direct connection with the hospital executives, the pharmacists also developed an indirect relationship with the hospital benefactors.

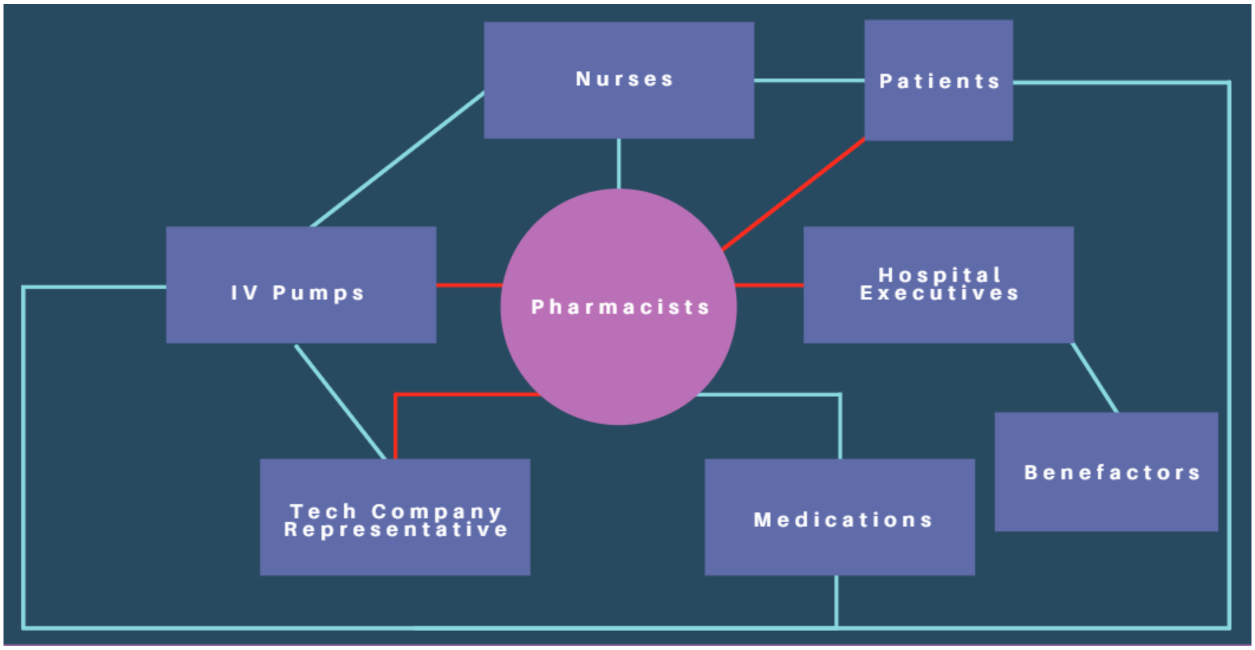

Figure 1: The Pharmacists' network after the introduction of the new IV pump system.

Applying VSD to the Case Study

VSD is a method for designing new technology that prioritizes the human values of the stakeholders during the design process (Friedman et al., 2017). In VSD, there are four prominent criteria that must be accounted for when designing a new technology: the stakeholders, their values, time (i.e. how long will the technology be in the field), and pervasiveness (i.e. how many people are impacted by the technology) (Friedman et al., 2017). VSD also considers the potential value conflicts that can arise between stakeholders (Friedman et al., 2017). Since VSD focuses on the "human-technology relationship," it is a fitting framework to apply to the pharmacy case study, where the formation of a new "human-technology relationship" altered the pharmacists' job requirements (Hendry et al., 2021). VSD's applicability to this study is also supported by the successful implementation of VSD to other medical technology designs such as nocturnal seizure detectors, new medications, and pacemakers (Andel et al., 2015; Denning et al., 2010; Timmermans et al., 2011).

The Stakeholders

The prominent stakeholders in the pharmacy case study are the nurses, the pharmacists, and the hospital executives. VSD encourages designers to consider the direct versus the indirect stakeholders (Friedman et al., 2017). As the names suggest, a direct stakeholder directly uses the technology whereas an indirect stakeholder infrequently interacts with the technology but is still affected by it. In this case study, the nurses and the pharmacists are direct stakeholders whereas the hospital executives are indirect stakeholders. While the tech company did a sufficient job identifying the nurses as one set of direct stakeholders, it failed to account for the pharmacists being direct stakeholders during the programming and setup stage of the IV pump integration process.

The Stakeholders' Values and Value Conflicts

Values

A nursing curriculum reported that there are five professional values that they attempt to instill into each of their nurses: respect for human dignity, integrity, autonomy (both patient autonomy and nurse autonomy), altruism, and social justice (Fahrenwald et al., 2005). A survey of nurses revealed additional values such as trust, activism by partaking in nursing research, and continued education (Weis & Schank, 2000). There is no conclusive report on whether or not nurses' value new medical devices (Zhang et al., 2014). Some nurses praise medical devices' abilities to increase patient safety and comfort while other nurses raise concerns over the negative impact that medical devices could have on their relationships with their patients (Zhang et al., 2014). Similar to the values commonly held by nurses, pharmacists value caring for others, the patient's well-being, integrity, autonomy, making decisions, teaching the next generation of pharmacists, and being life-long learners (Kruijtbosch et al., 2019; World Health Organization, 1997). A study looking at community pharmacists found that overall pharmacists positively value new medical technology (Law et al., 2021). The pharmacists surveyed, however, also voiced some concern about the potential for technical errors in medical technology (Law et al., 2021).

In order to run a successful health system, hospital executives have the difficult task of uniting empathetic and patient-centric values with business values. An interview with a hospital CEO revealed that the major professional values held by hospital executives are accomplishing the mission statement of the hospital, ensuring that the care being delivered is patient-centric, planning for long-term and future goals, and cultivating a safe work environment (Smith, 2016; Tam, 2012). Joynt et al. (2014) found that financial compensation has a direct influence on hospital executive's professional values. This study also determined that compensation was higher in larger hospitals, technologically advanced hospitals, and teaching hospitals (Joynt et al., 2014).

Value Conflicts

The nurses' and pharmacists' shared value of autonomy could be compromised if a hospital executive introduces a new medical device into their work environment without consulting them. As direct stakeholders, the nurses and pharmacists will have to learn how to use the technology and their licenses will be at stake if an operator error occurs with the new device. Autonomy allows employees to make decisions and perform actions that align with their values (Friedman, 1996). Thus, infringement on autonomy could also lead to encroachment on an operator's other values. In the case study, the pharmacists determined one of the design parameters of the IV pump to be flawed and potentially unsafe for the patients if left uncorrected. By excluding the pharmacists from the decision-making process, the hospital executive not only compromised their autonomy but also compromised their value of protecting the patient's well-being.

In the case study, the hospital executive's professional values that drove the decision to replace the IV pumps could have been influenced by his or her hopes of compensation. By prioritizing the technological advancement of the hospital over patient safety, another value conflict could have erupted between the executive and the pharmacists and nurses since these direct stakeholders value patient well-being over the hospital's technological reputation. While the old pumps were less aesthetically pleasing and could not be stacked on top of one another, the infusion limits in the old pumps were well-tested and accurate. The severity of this value-conflict between the hospital executive and the pharmacists and nurses could depend on whether or not the hospital is a large research institution or a small rural hospital. Larger hospitals were found to have more specialists and be more receptive to new technology than smaller hospitals (Kimberly & Evanisko, 1981). This could indicate that healthcare workers that work at large research institutions tend to be more specialized and research-oriented which makes them more receptive to new technology.

In order to avoid value conflicts, it would have been beneficial for the hospital executive to consult with the clinicians and form a list of necessary and beneficial IV pump features. A study from a Canadian hospital used a human factors approach when deciding what IV pump to buy (Ginsburg, 2005). The researchers noted several key characteristics that the clinical team hoped the new IV pump system would possess (Ginsburg, 2005). These pertinent qualities included: lightweight design, easy priming and loading capabilities, and clear visual cues about battery level, pressure level, and other critical information (Ginsburg, 2005). Additionally, several different specialties were included in the user testing portion of this study and user feedback while practicing with the device as well as any errors that occurred were recorded (Ginsburg, 2005).

Time Considerations

Assuming that the IV pump system is not recalled, an IV pump is typically replaced every five to ten years. Most medical devices are single-use because of sanitization issues. IV pumps, however, are able to be reused multiple times since they can be easily cleaned and because malfunctioning parts, such as the battery, are normally able to be replaced. As part of their approval process, the FDA requires that all operators be trained in how to use a new device and that the tech company propose basic necessary training procedures (Food and Drugs, 2020).

Medical technology is produced with the intention of expediting procedures and increasing staff and hospital efficiency. Even highly experienced clinical staff, however, will still require significant time-consuming training on how to use a new medical device without errors occurring. In order to become proficient to the point where operator error will be minuscule, the maneuvers required to use the tool need to become automatic (Thimbleby, 2013). Studies suggest that a significant amount of time is required to reach this level of expertise with a new device. In cases where the device or procedure complexity is high, it can take as long as 125 hours or even twelve weeks to reach an expert level (Jiménez-Rodríguez et al., 2013; Subramonian & Muir, 2004). When deciding to introduce a new device, hospital executives should carefully consider the substantial amount of time that will need to be devoted to training their staff on how to use the device and the cost associated with this training.

Pervasiveness of the IV Pump

IV pumps are widely used throughout the hospital and are present on every hospital unit. IV pump use is also a part of several different healthcare occupations' daily responsibilities. In addition to clinical staff such as nurses, pharmacists, nursing assistants, anesthesiology technicians, and some physicians, IV pumps are also used by biomedical engineers, who have to repair the pumps when they malfunction. The hospital executive should have also considered the IV pump's substantial pervasiveness when deciding to switch IV pumps as well as when selecting which IV pump to purchase.

Strategies for Positive and Successful Medical Device Introduction

Three key components for positive technology implementation are having employees opt-in to learning about the new device, providing numerous opportunities for them to practice with the device, and encouraging these operators to reflect on and discuss possible improvements for the device (Edmondson et al., 2001). How the technology is initially presented to a group also plays a critical role in whether or not the prospect of learning how to use this new device evokes enthusiasm or fear in the future operators (Edmondson et al., 2001).

How to encourage employees to opt-in

As shown above, the values for each stakeholder of a device can be vastly different. When marketing the new technology to different healthcare occupations, the hospital should highlight the technology's values that align with those of the clinicians that are being introduced to the device. This will pique the employees' interest in the device and ensure that they experience a positive introduction to the device. In the case of the IV pumps, if the hospital executive had chosen an IV pump with more advanced pharmacokinetic abilities, they could have tailored their pharmacy presentation about the device to emphasize this advancement from prior pumps. When presenting the IV pumps to the nurses, however, the executive could have focused on the ergonomic design of the pump that could make it easier to use.

Hospitals could also embrace the philosophy of Maker Culture in order to increase the number of employees that opt-in to training. According to Maker Culture, anyone can become an "amateur expert" if given the right tools and opportunities to practice (Kuznetsov & Paulos, 2010). Bovea and Foster (2016), who are proponents of Maker Culture, also promote the idea of "do it together" rather than "do it yourself." By cultivating an environment where the employees are working together to learn about the new device and are choosing to learn about the tool for the sake of furthering their expertise rather than because they have to for their job, hospitals will be able to decrease some of the discontentment associated with the onboarding of a new device. To produce this type of environment, a hospital could create a makerspace where the employees could go as teams to practice with the new device or even take the device apart and try to rebuild it. Forming makerspaces during the decision-making process for which version of a device to select, could also be beneficial since it could allow for the limitations of each device to be recognized before purchasing.

Opportunities for practice

Simulation

When learning how to use a new medical device, clinicians need to practice using the device in real clinical situations. This is especially true in fields such as interventional radiology (IR), where the operators need to maneuver long wire and catheter-based devices through a patient's vasculature and use haptic feedback to determine if they are using a safe amount of force (Gould, 2010). Simulators such as the Simbionix ANGIO Mentor, which is used to train medical students and IR residents, allow clinicians to practice using a device in a "patient," without putting any real patient at risk for injury (Pannell et al., 2016). Most simulators are fairly costly, however, medical malpractice lawsuits due to patient injury could be even more expensive (Danzon, 1985). The simulators will also ameliorate some of the stress and pressure on the staff who were tasked with learning how to use a new device.

Teach someone else how to use the device

Studies have shown that "learning by teaching" is an effective way to master new information (Fiorella & Mayer, 2013). According to Fiorella et al. (2013), the act of teaching was more important during learning than the preparatory process before teaching. This indicates that a hospital would only need to set up a system where every new operator gets to teach another new operator how to use the technology. No formal lecture or presentation would need to be given by each new operator in order for them to reap the benefits of learning by teaching. Teaching one another how to use a new device aligns well with many of the clinical staff's values to be lifelong learners and to teach the next generation of clinicians. This method of learning also agrees with the Maker Culture's philosophy to "do it together" (Boeva & Foster, 2016).

Obtaining user feedback

In order to procure user feedback, hospitals could employ "toolkits," which are "design interface[s] that enable trial-and-error experimentation" (Franke & Piller, 2004). These toolkits will allow the clinicians to provide feedback about the device and customize the device to their specific needs in real-time. Once the device has been designed by the staff, the tech company can mass-produce the device for the hospital. By incorporating the employee's feedback during the design process, there will be fewer problems with the device once it is brought onto the floor which will decrease the stress on the clinical team.

Through the use of ANT and VSD applied to a clinical pharmacy case study, it was shown that the introduction of a new medical device alters the employees' networks and can be affected by differences in stakeholder values. While pharmacists and nurses have more values typically associated with healthcare, the hospital executives have more business-like values. This dissimilarity in value systems led to value conflicts and negative IV pump integration. In order to avoid future value conflicts, hospital executives should select devices that align with their employees' values which will encourage the employees to opt-in to learning about the device. The executives should also invest in simulation technology and toolkits to ensure that every employee gets sufficient practice and has the opportunity to offer feedback about the device design. Including a multitude of employees into the design process will lead to the production of a better device that will have minimal adverse effects on an employee's job responsibilities and stress. In technology markets, such as the medical device market, where new products are constantly being outputted, it is critical for companies to consider the values of the stakeholders that will use their product so that the role boundaries of the stakeholders are not seriously altered.

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