Using Technological Politics to Examine Adoption of the Accuro Ultrasound Device

STS Research Paper

Presented to the Faculty of the

School of Engineering and Applied Science

University of Virginia

By

Jacob Matriccino

April 10th, 2020

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.

Signed: _____

Approved: Benjamin J. Laugelli Date _____

Benjamin J. Laugelli, Assistant Professor, Department of Engineering and Society

Introduction

The Accuro is a handheld ultrasound injection guidance device manufactured by Rivanna Medical. Traditionally, imaging guidance methods such as x-rays or CT scans were used to guide physicians. However, the radiation associated with these imaging modalities prohibits their use for procedures on pregnant women. Thus, physicians use manual palpation of the spine in order to identify a proper injection point. The Accuro is attempting to replace this technique through the use of ultrasound imaging, which is safe for pregnant women and fetuses. The Accuro utilizes algorithms to analyze the raw ultrasound data, identify underlying spinal topography, and indicate whether a certain place along the spine is appropriate for injection. The doctor or anesthesiologist can then use a grooved attachment on the front of the device to imprint the patient, connects the imprints to mark the injection point, and inject the patient.

While the technical capabilities of the Accuro for injection guidance are well documented, the device's social and political capabilities are less well known. For example, as the advantages of ultrasound-guided spinal injections for procedures on pregnant women become more apparent, more physicians are being asked to learn the new device. However, to attribute the lag in adoption of new medical devices only to learning curve and human psychology is to ignore the influence of sexism and other biases on physician decisions. Pregnant women, a major target patient population for the Accuro, are inherently female, increasingly racially diverse, and increasingly obese ("Births, by mother's race/ethnicity," n.d.; Steele, 2018). These demographic groups have been shown to be vulnerable to clinician bias (Hoffman, Trawalter, Axt, & Oliver, 2016; Phelan et al., 2015; Samulowitz, Gremyr, Eriksson, & Hensing, 2018). The status quo of manual search via palpation has been maintained through a combination of ignorance and disregard for the excess pain associated with this injection guidance technique. This is likely due

to the bias in treatment of pain for female patients (Samulowitz et al., 2018). If the Accuro continues to be thought of exclusively in technical terms, its effects on power dynamics between doctors and patients and its work exposing clinical bias will go unnoticed.

Contemplating these social aspects using Langdon Winner's Theory of Technological Politics provides a more complete understanding of how medical device adoption can be affected by existing biases against certain patient populations within medicine. I argue that the adoption of the Accuro exposes biases in medical treatment, shifting the power relations between the doctor and the patient by empowering the patient. Using Technological Politics, I will demonstrate that the Accuro has a political dimension by showing how doctors currently exert power through leadership and how patients are being empowered through the introduction of the Accuro device.

Literature Review

While several scholars have examined the adoption of medical devices, they have not adequately considered the role of sexism and other biases in device adoption or lack thereof. Most scholars discuss factors such as doctor psychology, administrative systems, and cost as reasons for reluctance to adopt new medical devices.

One example with a focus on doctor psychology is a study conducted by Safi, Thiessen, and Schmailzl which analyzes the acceptance of and resistance to new medical technologies (Safi, Thiessen, & Schmailzl, 2018). The study found that the adoption of new medical technologies depended on individual opinions on the factors relating to the technologies. For example, the study found that some practitioners thought the technology would interfere with their diagnostic autonomy and patient relationships. Others favored the technology because it helped them interact with their patients better. The study authors also found that it is important

for all stakeholders, such as doctors, patients, and management, to be involved in the adoption of a new medical technology so as to increase the likelihood of adoption. Overall, they conclude by saying that adoption of new medical technology depends on an understanding of a physician's and other professional's anxiety and insecurity. However, the study's authors fail to examine the potential for a professional's psychology to involve unconscious bias in the treatment or understanding of patient pain. This could be an important part of understanding why a device is not adopted outside of the doctor's insecurity about diagnostic authority.

Another study on the adoption of new medical devices looked at the mechanisms underlying the adoption of medical devices through the experiences of hospital staff (Roback, Gäddlin, Nelson, & Persson, 2007). This study found that the adoption process was usually started by vendors, but practitioners asked colleagues for advice and information. Furthermore, there was often not system-wide integration of devices. Even with effective system-wide introduction, there was often a lack of follow-up to understand the integration of devices into work practice. This evidence seems to point to hospital administration as a potential problem area in the adoption of new medical devices. Overall, the researchers found that three factors are crucial to the adoption of medical devices: the subjective expected value of the device, information and learning about the device, and the innovativeness of the adopting unit. The expected value of the device is likely being balanced with the cost of the device to the hospital or healthcare clinic. The other two factors involve doctor psychology in learning new technology and administration willingness to adopt new innovations. This study fails to mention that the expected value of the device may be biased by a lack of understanding of the pain of a current procedure. If a doctor does not think that a procedure is painful, then he or she will not consider a device to update the procedure valuable.

Both these teams of researchers believe that understanding doctor psychology plays a major role in a new medical device's adoption or lack thereof. Roback and her co-authors additionally give weight to administrative systems and cost as factors in new medical device adoption. However, to attribute the adoption of new medical devices only to human psychology, administrative systems, and cost is to ignore the influence of sexism and other biases on physician decisions. While the currently considered factors are important to understanding device adoption, I will focus my analysis on sexism and other biases. In doing so, I will demonstrate the importance of understanding the role biases play in the adoption of medical devices.

Conceptual Framework

To analyze how biases affect the adoption of medical devices, I will use Langdon Winner's Theory of Technological Politics as it relates to the Accuro handheld ultrasound device to provide a more complete understanding of how medical devices expose long standing biases in medicine. Technological politics examines the inherent political dimensions of technology, whether intended or unintended, which alter the power dynamics between groups of people depending on their demographics (Winner, 1980). In this case, the term politics means the distribution of power in relationships and the activities that occur within that distribution. This power is exercised in five different ways: coercion, seduction, force, manipulation, and leadership (Brey, 2008). The distribution of this power is altered by the design of technology. Technology refers to, as Winner puts it, "… all of modern practical artifice…" (Winner, 1980). However, a more simple, operative explanation is also provided by Winner. He uses "technologies" to mean large or small devices or hardware systems of a certain kind.

In the Theory of Technological Politics, all technologies have politics regardless of the inventor's intentions or lack thereof. This means that all artifacts, whether they are systems or individual devices, affect the distribution of power in relationships between people or groups of people. Force can be exercised in five ways, all of which lead the less powerful party to act in a way that they would not have otherwise. The first two, coercion and seduction, are effectively stick and carrot approaches, respectively. In coercion, a threat is used to suggest to people that they act a certain way; while in seduction, a reward is used to suggest an action (Brey, 2008). Power can also be exercised by force, in which a choice is entirely removed, forcing an action upon a party. Manipulation is similarly used to encourage an action which the party would not otherwise do but does anyway, without the party knowing that it has been manipulated. Finally, leadership is when a powerful party causes less powerful parties to do an action which they would not otherwise do because of the powerful party's authority or the acceptability of the action.

On top of the five methods of exerting power, there are five methods of differential empowerment caused by technology (Brey, 2008). The first is differential access to technology. Another is empowerment directly through establishment or maintenance of power relations. Additionally, technological artifacts empower by catering to a party's specific interests and characteristics. Another method of empowerment is changing the socio-economic value of a party's skills or resources. Finally, technology can empower through creating unilateral dependencies between parties. Brey argues that these unilateral dependencies are inherently asymmetric, resulting in power dynamics between two parties.

I will analyze the Accuro handheld ultrasound device through the lens of Technological Politics by first explaining the power dynamics currently in existence in the administration of

epidural anesthesia using the leadership method of exerting power. Then, I will look at how the Accuro exposes the empowerment of the parties through its introduction into the system of healthcare.

Analysis

For pregnant women, needle placement guidance cannot use radiation. Thus, physicians manually palpate the spine in order to identify a proper injection point. Palpation involves a clinician using his or her fingers to externally identify anatomical structures in a person's body. The physician then injects the spine at the appropriate location. The Accuro device is attempting to replace palpation as the dominant form of epidural injection guidance for the pregnant population. In doing so, the Accuro has exposed power dynamics currently in existence between patient and doctor and the capacity of the Accuro to change these dynamics. In doing so, it has exposed biases in the treatment of certain patient groups. I will use Technological Politics to establish the Accuro as a political device as well as a technical device. Additionally, the following sections demonstrate how doctors currently exert power and how empowerment in the doctor-patient relationship is changing as a result of the introduction of the Accuro.

How Doctors Currently Exert Power

Doctors use the current needle placement procedure to exert power through leadership. According to Brey, one method of exerting power in relationships between people or groups of people is leadership. Leadership involves a powerful party causing a less powerful party to do an action which they would not otherwise do because of the powerful party's authority or the acceptability of the action (Brey, 2008). Thus, through the exercise of leadership, a party empowered by the political dynamics currently in place can force an action upon the less powerful party due to his or her authority or the action's perception as acceptable. There are

three main types of authority considered by Brey: charismatic, traditional, and rational-legal. In the case of epidural injections, the authority belongs to the physician. This authority is primarily rational-legal authority. Because the physician is a licensed doctor, who has studied for years in medical school, and works within the bounds of medical practice laws, her or she is given authority.

This authority is exercised in doctor's offices and hospitals across the country. For example, Dr. Rebecca Minehart and residents training at Massachusetts General Hospital had a patient who, due to various medical problems, needed an epidural (*Dr. Rebecca Minehart—Resident training with Accuro at MGH,* 2017). This epidural could be done in one of two ways: using the traditional blind palpation technique or using the Accuro ultrasound device. According the Dr. Minehart, the residents, "… decided that they thought that they wanted to try without the Accuro." It is important to note how the patient's opinion was not considered in that statement. In the decision-making process of what epidural guidance technique to use, the patient was not consulted or even considered. Her needs and feelings regarding care were not taken into account. Dr. Minehart and the residents decided, using their rational-legal authority, to use the palpation guidance technique regardless of patient preference. The consequences of this decision were, according to Dr. Minehart, that the first injection was not in the epidural space and, "…[the patient] was uncomfortable…" (*Dr. Rebecca Minehart—Resident training with Accuro at MGH,* 2017). This procedure resulted in the first injection failing to deliver pain relief. The residents then used the Accuro, which exposed that the patient had scoliosis and allowed for the injection of a working epidural. This epidural was, "… just in the nick of time." Notice again how the patient's feelings about this timing are not mentioned. In the entire retelling of the procedure how the patient felt is only mentioned once by Dr. Minehart. However, she does not mention

how the patient felt about the delay in receiving pain relief. Use of the Accuro initially could have prevented the brinkmanship of the residents, who waited until the last second to properly administer pain relief.

To adequately establish the power dynamic and use of the power of authority, the decision to use blind palpation over the Accuro would also have to go against the wishes of the patient. Although in this case the patient was probably unaware of the advantages and disadvantages of the two methods, it is worth examining which method the patient would likely have chosen. First, consider the manual palpation method. Although this technique is used widely, it has limitations. The technique has demonstrated a back pain complication rate and needle relocation rate of 20% and 7.1%, respectively (Arendt & Segal, 2008; "Clinical value," n.d.). Relocating the needle causes pain for the patient due to the additional injection required and, if the injection is for anesthetic purposes, causes more total pain due to a further time delay in receiving pain relief. Overall, the technique exhibits a failure rate of 12%, meaning that the epidural injection did not provide pain relief to a patient who desperately needed it on the initial injection alone in nearly one out of eight cases (Arendt & Segal, 2008). This failure resulted in either moving the needle in its place or relocating it, both of which take more time and cause more pain for the patient. The Accuro technique, meanwhile, exhibits a back pain complication rate of 10%, half the complication rate of the palpation method ("Clinical value," n.d.). Additionally, use of the Accuro produced an 11% greater first-insertion success rate among all patients (Singla et al., 2019). Overall, the method attains a failure rate of 6% or less, which is half of the palpation failure rate ("Clinical value," n.d.).

Considering these statistics, it seems likely that the patient in this case would choose the Accuro method of epidural injection guidance, considering its complication rate and failure rate

are half that of the palpation method. Additionally, the spinal placement time is 1.5 minutes shorter using Accuro, meaning pain relief is delivered faster ("Clinical value," n.d.). Despite this assumed choice on the part of the patient, Dr. Minehart and her residents decided to first administer an epidural guided by palpation. Using their rational-legal authority, they made a decision against the patient's probable wishes. Now that it is known who made the decision, it is also important to explore why a care decision is made in that manner and how the power dynamics of the decision are changing.

How Empowerment is Changing

The empowerment in the doctor-patient relationship is changing due to the introduction of the Accuro. According to Brey, technology can cause differential empowerment in five different ways (Brey, 2008). The empowerment method most relevant to the discussion of the Accuro and epidural injections is the third method. This method involves technological artifacts which empower by catering to a party's specific interests and characteristics. First, it is important to establish the characteristics of the patients of epidural spinal injections that are most likely to be treated with Accuro. The main patient population consists of pregnant women receiving an anesthetic injection during labor. This patient population is inherently female, increasingly racially diverse, and increasingly obese ("Births, by mother's race/ethnicity," n.d.; Steele, 2018). These demographic groups have been shown to be vulnerable to clinician bias (Hoffman et al., 2016; Phelan et al., 2015; Samulowitz et al., 2018). The status quo of manual search is maintained through a combination of ignorance and disregard for the excess pain associated with this injection guidance procedure, likely due to the bias in treatment of pain for female, racially diverse, and obese patients (Samulowitz et al., 2018). However, the Accuro has empowered these patient populations by catering to their characteristics and specific interests.

One example of bias can be seen in the first-insertion success rate among obese patients. When compared to the blind palpation method, use of the Accuro achieved a 26% greater first-insertion success rate among the obese patient population (Singla et al., 2019). This can be compared to an 11% increase in first-insertion success among all patients. The greater first-insertion success rate means that around one out of every four patients that previously would have a failed first epidural with palpation now obtains a successful first insertion with Accuro. This is compared to around one in ten patients generally. This implies that there was more ground to gain in improving success rates for obese patients than for patients generally. This idea is supported by a case study conducted by Beth Ann Clayton at the University of Cincinnati. According to Clayton, "Clinical benefits of Accuro are particularly pronounced in the morbidly obese population where palpation alone cannot reliably identify an appropriate needle insertion site." (Clayton, n.d.). This quote implies that since palpation and epidural anesthesia's introduction, the procedure has been unreliable for obese patients. However, with the adoption of the Accuro, this bias against obese patients has been exposed. The Accuro empowers this patient group by catering to their characteristics. In this case, one of their characteristics is a spinal anatomy which cannot be adequately palpated. The device also caters to the interest of the group: a reliable epidural injection method. The newly empowered group can, if appropriately educated, demand treatment using the Accuro, thereby subverting the authority of the doctor.

The adoption of the Accuro highlights biases and empowers patient groups that suffered from bias by catering to their characteristics and needs. However, some think that the lag in adoption of medical devices can be more attributed to human psychology. They argue that physicians are traditionally resistant to changes in their techniques, especially when the changes are mindset shifts (Shryock, 2018). The use of the Accuro, which requires a transition from

physically locating an injection point to using a technological device to scan for an injection point, can be considered a mindset shift. But this view fails to consider the body of scholarship on clinical bias in treatment of pain for female patients specifically (Samulowitz et al., 2018). If a female patient's pain is not taken seriously, a doctor may not believe a new medical device to relieve that pain is necessary. Doctors may be resistant to technique change, but they would only encounter that technique change after they understand their current technique as problematic. If doctors fail to perceive or adequately respond to pain in female patients, then a painful procedure, such as an epidural injection, will be maintained. Only after the problem is identified can doctors resist the technique, so clinical bias is the limiting factor in this situation.

Conclusion

I have argued that the Accuro has a political dimension by showing how doctors currently exert power in the patient-doctor relationship and how this power is being challenged by the introduction of the Accuro device. Specifically, I identified leadership as the predominant way in which doctors maintain power over patients in the palpation injection scheme. I also identified how the Accuro alters the empowerment of the two parties by catering to specific characteristics and interests of the patient population. The analysis illuminated how a medical device innovation can highlight silent biases and discrimination in the treatment of certain patient groups. This analysis is important because, as doctors and patient populations diversify in race, ethnicity, sexual orientation, and gender identity, more biases may be uncovered, either by the introduction of a medical device to empower patients or through identification of a previously underreported clinical treatment problem. The argument presented in this paper indicates that implicit bias training for medical professionals may be needed so that clinical biases that affect patient care are found and quashed.

Word Count: 3422

References

Arendt, K., & Segal, S. (2008). Why epidurals do not always work. *Reviews in Obstetrics and Gynecology*, *1*(2), 49–55.

Births, by mother's race/ethnicity. (n.d.). *Kidsdata.org*. Retrieved October 30, 2019, from https://www.kidsdata.org/topic/31/births-race/table#fmt=146&loc=1&tf=84,46,8,3,13&ch=7,11,8,507,9,73,74&sortColumnId=0&sortType=asc

Brey, P. (2008). The technological construction of social power. *Social Epistemology*, *22*(1), 71–95.

Clayton, B. A. (n.d.). An Accuro success story: Rapid placement of neuraxial block in morbidly obese paturient to avoid general anesthesia. Rivanna Medical. Retrieved from https://rivannamedical.com/wp-content/uploads/2018/07/Accuro-Case-Study.pdf

Clinical value. (n.d.). . Retrieved October 20, 2019, from https://rivannamedical.com/clinical-value/

Dr. Rebecca Minehart—Resident training with Accuro at MGH. (2017). . Retrieved February 24, 2020, from https://www.youtube.com/watch?time_continue=127&v=Z4GRg77hsbQ&feature=emb_logo

Hoffman, K. M., Trawalter, S., Axt, J. R., & Oliver, M. N. (2016). Racial bias in pain assessment and treatment recommendations, and false beliefs about biological differences between blacks and whites. *Proceedings of the National Academy of Sciences of the United States of America*, *113*(16), 4296–4301.

Phelan, S. M., Burgess, D. J., Yeazel, M. W., Hellerstedt, W. L., Griffin, J. M., & van Ryn, M. (2015). Impact of weight bias and stigma on quality of care and outcomes for patients with obesity. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity*, *16*(4), 319–326.

Roback, K., Gäddlin, P.-O., Nelson, N., & Persson, J. (2007). Adoption of medical devices: Perspectives of professionals in Swedish neonatal intensive care. *Technology and Health Care: Official Journal of the European Society for Engineering and Medicine*, *15*(3), 157–179.

Safi, S., Thiessen, T., & Schmailzl, K. J. (2018). Acceptance and resistance of new digital technologies in medicine: Qualitative study. *JMIR Research Protocols*, *7*(12). Retrieved February 22, 2020, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6299231/

Samulowitz, A., Gremyr, I., Eriksson, E., & Hensing, G. (2018). "Brave men" and "emotional women": A theory-guided literature review on gender bias in health care and gendered norms towards patients with chronic pain. *Pain Research & Management*, *2018*. Retrieved October 30, 2019, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5845507/

Shryock, T. (2018, May 24). Why it's so hard for doctors to change. *Medical Economics*. Retrieved October 29, 2019, from https://www.medicaleconomics.com/article/why-it%E2%80%99s-so-hard-doctors-change

Singla, P., Dixon, A. J., Sheeran, J. L., Scalzo, D., Mauldin, F. W., & Tiouririne, M. (2019). Feasibility of spinal anesthesia placement using automated interpretation of lumbar ultrasound images: A prospective randomized controlled trial. *Journal of Anesthesia & Clinical Research*, *10*(2).

Steele, M. F. (2018). More U.S. women obese before pregnancy. *WebMD*. Retrieved October 29, 2019, from https://www.webmd.com/baby/news/20180104/more-us-women-obese-before-pregnancy

Winner, L. (1980). Do artifacts have politics? *Daedalus*, *109*(1,), 121–136.