

Prospectus

Combined Augmented Reality and Vibroacoustic Stimulation Approach for Reducing Patient Anxiety During In-Office Procedures

(Technical Topic)

Actor-Network Theory and the Impact of the Hospital Consumer Assessment of Healthcare Providers and Systems

(STS Topic)

By

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

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Sociotechnical Problem

As healthcare costs in the US have continued to rise, one cost-effective evolution in care has been the proliferation of in-office procedures and surgeries across medical and surgical specialties (McCarthy, 2003; Rice et al., 2013; Shah, 2019; Young et al., 2012). In-office procedures (IOPs) are defined as those performed under local anesthetic with no general anesthesia or sedation. The benefits of IOPs to medical professionals include higher procedural volume, decreased cost, and improved patient safety and outcomes through avoidance of general anesthesia. Benefits to patients receiving IOPs include decreased cost, decreased time needed for treatment, ability to drive home the day of the procedure, and improved patient safety. For example, in Otolaryngology—Head & Neck Surgery (OHNS), the mean total charges for office-based procedures is \$2,737.17, while the same procedures cost \$7,329.69 on average if conducted in the operating room (OR) (Prickett et al., 2012). Perception of pain, along with other factors such as patient anxiety, stress, and discomfort are barriers inhibiting the further proliferation and adoption of non-pharmacological interventions for IOPs.

The technical solution of the proposed project is to create a non-pharmacologic alternative to manage patient pain, stress and anxiety, thereby increasing the number of procedures that can be carried out in office. The technical solution will consist of two integrated components, an immersive augmented reality (AR) experience provided via an AR headset, combined with an external vibroacoustic stimulation device, which will be adhered to the patient's skin, providing additional tactile stimulation near the operating site.

In order to successfully improve patient experience and ensure the technical solution's integration into the medical sector, the approach cannot be strictly technical. The social, political, and monetary factors involved in defining and assessing patients' experiences with pain must be

taken into consideration. Patient satisfaction surveys such as the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS), allow patients to rate the level to which they felt their providers did everything in their power to minimize the patient's pain ("HCAHPS Questions - What Are the 27 HCAHPS Questions?," n.d.). In 2013, this survey was made mandatory for all hospitals seeking reimbursement through Medicare and Medicaid, furthermore the scores on this survey are often used in internal reviews for provider promotion and compensation (*March 2012 Report to the Congress: Medicare Payment Policy*, n.d.). The significant implications of this policy change fail to be recognized. With a lack of technology-based alternatives for non-opioid based pain management combined with financial punishment for low pain management scores, doctors are left few options beyond prescribing opioids to patients. I seek to determine the degree to which this has led to the prolongation of the opioid crisis.

Failing to acknowledge the healthcare policies that have given patients greater power as consumers would be ignoring the greater factors at play that influence an office's willingness to adopt new technologies and modify pain management approaches due to fear of potential monetary consequences. In examining these factors using the science technology and society framework of actor-network theory, we will gain a better understanding of social, political, and monetary factors that have shaped the standards of pain management. In providing a novel combined sensory approach to managing patient pain and anxiety combined with an understanding of the greater societal aspects at play, I will enable a shift toward non-pharmacological pain management solutions. Such a solution will improve patient outcomes by expanding the non-pharmacological pain management options while also addressing the current

policies in place that limit healthcare providers, who are currently entangled in a network that leaves them few alternatives.

Technical Problem

Across various medical and surgical specialties, in-office procedures (IOPs) are becoming an increasingly common alternative to operating room procedures within various surgical specialties due to their cost-effectiveness and reduced risk of complication (Kao et al., 2019; Miller & Gardner, 2017). IOPs are performed under local anesthetic without general anesthesia or sedation, resulting in faster and often safer procedures by eliminating risks associated with general anesthesia. IOPs are primarily limited by patient tolerance, as there is a lack of currently available non-pharmacologic treatment options for patient anxiety, stress, discomfort, and pain during these procedures. These factors limit the number of patients who are willing to participate in IOPs, which results in the need for full sedation to complete a procedure, which in turn drives up cost of treatment and number of staff needed.

As mentioned, the benefits of IOPs to medical professionals include higher procedural volume, decreased cost, and improved patient safety and outcomes through avoidance of general anesthesia (Miller & Gardner, 2017). Benefits to patients receiving IOPs include decreased cost, decreased time needed for treatment, ability to drive home the day of the procedure, and improved patient safety (Young et al., 2012). In creating a solution that helps to reduce patient anxiety, we stand to gain an increase in the number of procedures that are carried out in office. The use of non-painful sensory stimuli to distract from pain has been shown to have clinical utility in the setting of procedures such as injections and wound dressing changes (Morris et al., 2009; Mott et al., 2008; Sil et al., 2014). However, the coupling of multiple sensory distraction techniques has not been described for IOPs.

The focus of the proposed project is to improve patient experience during IOPs by creating a two-part sensory stimulation device, consisting of a novel vibroacoustic stimulation unit coupled with an AR software application. The AR experience will be a fully immersive, providing the patient with a distraction from the current physical environment through visual and auditory stimulation. The use of AR will balance distraction and sensory engagement while still allowing the patient to interact with their environment and respond to questions posed by the medical staff. The AR application will be a game-like experience, where patients use their eyes to identify targets. The AR headset will be wirelessly coupled with a vibroacoustic unit, a small device will be placed on the patient's skin close to the site of highest pain during the IOP. The applied vibration will temporarily numb the region where it is applied, thereby reducing the amount of sensation that the patient experiences when a needle or surgical instrument contacts the region.

The Gate Control Theory of Pain postulates that only a limited number of simultaneous sensory stimuli can be processed by the central nervous system and therefore non-painful stimuli, such as vibration or virtual distraction (i.e. virtual or augmented reality), can eliminate or lessen the perception of concurrent painful stimuli (Braz et al., 2014; Treede, 2016; Zhang et al., 2018). We will draw on this theory in conjunction with prior research within the field of transcutaneous electrical nerve stimulation (TENS), which relieves pain by transmitting mild electrical currents to stimulate low threshold nerves through small transducers adhered directly to the skin (Jones & Johnson, 2009). Such approaches have been shown to stimulate the mechanical receptors in the area of applied vibration, thereby reducing the amount of pain the patient experiences (Bjordal et al., 2003). The device will be constructed to provide biphasic vibration to the skin through the

generation of 180Hz and 250Hz waves, which have been shown to be the optimal range for distractory tactile neurostimulation (Manfredi et al., 2012).

Social Problem

Medicine seeks to improve patient outcomes and quality of life, with effective pain management as one of the central objectives. In recent decades, there has been a shift in how physicians assist patients in managing pain, predominantly in increase opioid prescribing (Compton & Jones, 2019). Since 1999, there has been a steep rise in opioid usage within the United States, leaving many patients addicted and causing what is known as the opioid crisis. When analyzing what factors brought about this crisis, there are a few actors that are commonly cited. The recognition of opioids as an acceptable treatment for non-cancer related pain, marketing by pharmaceutical companies, failure to publicize the addictiveness of opioids, and failure to adequately educate physicians on pain management approaches have all contributed to the ongoing epidemic (Chou et al., 2009; Compton & Jones, 2019).

Identifying these factors has helped us understand some of the initial causes of the crisis, but even with regulation on marketing and improved pain management education, the number of Americans addicted to opioids continues to increase (Centers for Disease Control and Prevention, 2020). Further work must be done to identify factors contributing to the continued upward trend in opioid addiction. As of the fiscal year 2013, HCAHPS, a survey meant to capture key elements of patient satisfaction, was made mandatory for all hospitals looking to seek reimbursement by the Centers for Medicare & Medicaid (Lee et al., 2017; Medicare Payment Advisory Commission, 2012).

One key element included in the survey is pain management. The phrasing of the questions related to pain are particularly problematic, insinuating that the hospital staff are

responsible for taking any measure necessary to reduce patient pain. Question 14 of the survey reads “How often did the hospital or provider do everything in their power to control your pain?” (Adams et al., 2016) This survey has direct implications on government reimbursement as well as staff promotion and compensation. Failing to acknowledge the implications that HCAHPS has on hospital reimbursement and physician compensation leaves us with an incomplete understanding of sustaining factors contributing to the opioid crisis.

I argue that the unforeseen consequences of mandatory participation in HCAHPS gave unprecedented power to patients as consumers, thereby modifying the way hospital staff viewed their patients’ pain. With a lack of adequate non-pharmacological alternatives to pain management, providers continue to rely on opioid prescription to reduce patient pain. Drawing on the science technology and society framework of actor-network theory, which examines how a human network builder seeks to accomplish a goal through the linking of many human and non-human actors, I will examine the establishment of the HCAHPS survey, as well as the regulatory, monetary, and human factors involved in the network that led to its failure (Cressman, 2009).

I will use Michel Callon’s concept of translation to define the problematization, interessement, enrollment, and mobilization phases of the network establishment. I argue that Congress was the network builder, defining the roles of other actors by passing the 2013 Centers for Medicare & Medicaid’s policy that contributed to the proliferation of the opioid crisis (Callon, 1984). I will use the Medicare and Medicaid policy recommendations for the year 2013, the HCAHPS survey, statements from medical professionals, reimbursement reports, and opioid prescription statistics to examine the failure of this policy. In this case, I argue that policymakers did not consider the consequences that this change would have in giving patients unprecedented

power in steering the course of their pain management. In granting patients influence to the reimbursement, promotion, and compensation of their caretakers, this policy further exacerbated the state of the opioid crisis.

Conclusion

The technical report will provide an integrated pain management solution that uses multiple forms of sensory stimulation to reduce patient pain, stress, and anxiety experienced during IOPs. This will allow for an increased number of IOPs, which is associated with cost benefits for the patient and hospital, along with improved patient experience through shorter time spent on the procedure. The social component of the project will allow for further understanding of the policies enacted around reimbursement based on HCAHPS, specifically focused on the questions around pain. In understanding the shift in power that made patients consumers, we will see the implications this had on shaping the opioid crisis as well as current pain management approaches.

The insights of this project will allow for a better understanding of both the technical and social aspects at play in the adoption of new therapies targeted at enhancing patient experience. In gaining an understanding of the reimbursement system, policies at play, as well as existing technologies, we will better understand the impact of both human and non-human actors in building a network that was aimed at improving patient experience.

1850 words

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