**ULTRASOUND IMAGING FOR EPIDURAL INJECTION GUIDANCE**

**TEACHING AND EVALUATING EMOTIONAL INTELLIGENCE IN HEALTHCARE TO PROMOTE PATIENT WELL-BEING**

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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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## Introduction

Epidural injections are a commonly performed medical procedure often used in treatment of chronic pain, pre- and post-operative pain management, and regional anesthesia (Cluff et al., 2002; Eltzschig, Lieberman, & Camann, 2003; Shaw, Watson, Merzel, Gerardi, & Birek, 1996). Injections are either performed unguided or guided via a combination of fluoroscopy and CT scans. Many injections are performed unguided by a physician as this method is the least expensive and most accessible option, in that only the physician and needle equipment are needed. When unguided, the "loss of resistance" technique is used to perform the injection. This technique states that the needle will first face resistance as it punctures through the ligamentum flavum and interspinous ligament and then will lose resistance as the needle enters the epidural space if the injection was done in an acceptable area (Dhansura, Shaikh, Maadoo, & Chittalwala, 2015). The downside of using this method unguided are that up to 38% of injections may be done incorrectly, with certain types of epidural injections being more difficult than others. This prevents medication from reaching its target, and multiple needle sticks may be required to correctly access the epidural space, increasing patient pain and the length of the procedure (Karmakar, Li, Ho, Kwok, & Chui, 2009). Available alternatives are to use fluoroscopy and CT imaging. These technologies allow the physician to view the needle during insertion, ensuring proper location of puncture and that injected fluid is going into the epidural space. This reduces procedure time, minimizes patient discomfort, and increases assurance of procedure success. The downsides are the cost of the procedure, inaccessibility to equipment, and patient radiation exposure (Gupta & Gupta, 2015; Wagner, 2004).

Rivanna Medical, LLC is developing an ultrasound device specifically for epidural injections which produces real-time imaging of the spine. This technology will serve as a less

expensive and safer (radiation free) option than current imaging methods and will be more accurate yet equally practical when compared to unguided injections. I will be working with Rivanna Medical to design sub-components of the device as well as develop methods for and execute reliability testing. To meet the goal of an affordable device my team and I will be taking cost of materials into consideration when choosing a motor, 3D printing test fixture components, and choosing an acoustic coupling fluid in order to maximize functionality with cost. Through my role in developing affordable and patient-centered technology with Rivanna Medical's ultrasound device and through researching the role of emotional intelligence in healthcare I will produce a technology and educational recommendations seeking to better patient outcomes.

**Ultrasound-Guided Epidural Injections**

Current options for performing epidural injections leave physicians choosing between an easier, less expensive, yet often inaccurate procedure and a more expensive, more accurate procedure (when the technology is available). In cases where unguided injections are used, risk of an incorrectly placed needle is increased, meaning that the needle is not inserted deep enough to reach the epidural space (the space just outside the sac containing the spinal cord). This results in the medication not being injected into the correct place, and thus it will not provide the intended pain relief. It should be noted that the common perception of epidural pain relief is its use in labor and delivery as regional anesthesia (complete numbing in localized areas) and that this use is very different from epidurals given for chronic and surgical pain relief. Injections given during labor and delivery are performed unguided but the physician and patient know when the needle is placed correctly due to the quick onset of pain relief (Hawkins, 2010). In chronic pain management and surgical preparation, the purpose of the pain medication is not as a

regional anesthesia so a lower quantity of medication will be used. In these cases, the patient will not notice that the needle is incorrectly placed at the time of injection, but ultimately will not receive proper pain relief.

In cases where fluoroscopy and CT guidance are used the increased procedure price affects hospitals, patients, and other entities such as insurance companies. It is easier for larger, more affluent hospitals to provide guided epidural injections. For example, approximately 69% of academic institutions opt to provide fluoroscopy- and CT-guided epidural steroid injections whereas approximately 93% of private medical groups tend to use this imaging method (Cluff et al., 2002). Using fluoroscopic guidance adds between $120-$170 per injection (Interventional Pain Clinic, 2018). With most patients receiving injections every three or six months this adds an extra $240-$320 for biannual injections and $480-$640 for quarterly injections. These cost estimates are specifically for the injections and do not factor in the general office visit fees.

Ultrasound guidance has proven a viable alternative to fluoroscopic and CT imaging for epidural injections, poses fewer risks since no radiation is involved, and is potentially less expensive (Yang et al., 2016). Rivanna Medical, LLC is currently developing a small ultrasound device specifically designed for guiding epidural injections. The goal is to produce a technology which allows for more accurate injections than when performed unguided but to be more affordable and safer than fluoroscopy and CT imaging.

For my capstone project the role of my team is to design subcomponents as needed and to develop and execute test methods to ensure that the product meets quality standards. In terms of subcomponents we will be choosing a motor, designing and 3D printing text fixture components, choosing an acoustic coupling fluid, and developing a dosing system for the coupling fluid. The motor will need to be able to provide an appropriate range of speeds and will need to be quiet

enough as not to be a disturbance during the injection procedure. In terms of ultrasonography, coupling fluid and acoustic coupling refer to the interaction of the necessary fluid (commonly called ultrasound gel) and ultrasound waves. Physical properties (such as density and viscosity) and amount of this fluid determine the quality of the image produced. A properly chosen coupling fluid will maximize transmission and reduce reflection of ultrasound waves, allowing for a clearer, more detailed image (Klucinec, 1996). Therefore, my team will need to find a coupling fluid with properties compatible with the machinery of our ultrasound and will need to determine the amount of fluid needed given the size of the machine. The dosing system will take into account the optimal amount of fluid and will expel (or "dose") extra fluid as needed. In all design decisions, aside from making choices which ensure proper performance, our team will also need to take into consideration the cost of all materials and balance effectiveness with cost in order to maximize affordability. Performance standards which ensure patient safety and procedure success cannot be ignored for the sake of lowering cost, but slightly lower performance in other design aspects such as device shape may be acceptable if cost reduction is significant enough. Once all design choices are made, test methods will be written according to performance standards and FDA requirements to ensure the product is safe and can be approved for public use.

**Emotional Intelligence and the Morality of Empathy**

While my technical project focuses on the development of ultrasound technology for use in epidural injection procedures, I will be exploring how emotional intelligence is taught to physicians and how it can be evaluated to ensure that patients are receiving proper emotional and psychological support in their care. In a study by the National Cancer Institute and NIH on

reasons for avoidance of medical care, it was found that after traditional barriers to care (cost, travel, sick leave, etc.) the next most common reason for avoidance was patients having an unfavorable evaluation of seeking care, namely negative perceptions of interacting with doctors (Taber, Leyva, & Persoskie, 2015). Specific examples from the study of interpersonal concerns expressed by patients include disliking how doctors communicate ("doctors often make you feel like you're stupid"), feeling that doctors are impersonal ("paying more attention to computers"), and feeling unheard or that the doctors don't take patient concerns seriously. It is important that these reasons for medical care avoidance are taken just as seriously as traditional care barriers since health care avoidance ultimately leads to poorer patient outcomes. These types of negative interactions are especially prevalent in commonly stereotyped groups, such as overweight individuals (Alegria Drury & Louis, 2002). These populations often consist of the people who most need to be especially diligent about healthcare maintenance. Reducing frequency of these negative interactions is not a difficult task but must be openly discussed and researched in order to bring awareness to members of the medical community. If doctors are more aware of how their words and actions impact patients they could develop better relationships and promote proper health care habits for patients – this is where emotional intelligence education comes in.

For a single physician to demonstrate poor interactions with patients indicates that they have low emotional intelligence. However, the problem of negative interactions with physicians spans beyond a few individual doctors, indicating that there is a system-wide issue, seemingly due to lack of emotional intelligence education. Emotional intelligence is defined as "a set of skills hypothesized to contribute to the accurate appraisal and expression of emotion in oneself and in others, the effective regulation of emotion in self and others, and the use of feelings to motivate, plan, and achieve in one's life" (Salovey & Mayer, 1990, p. 185). Within this

definition, different facets of emotional intelligence can be identified: understanding one's emotions, self-control against criticism, self-encouragement, emotional self-control, empathy and emotional contagion, and understanding of other's emotions (Rego, Godinho, McQueen, & Cunha, 2010). Existing research argues in favor of emotional intelligence in healthcare but evidence that is it actively taught in medical school and during residency training is not clear. Medical and nursing schools have traditionally taught suppression of emotions, which may explain lack of evidence for emotional intelligence instruction (McQueen, 2004). While this may protect the emotions of physicians and nurses in the short-term it prohibits trust and connection between provider and patient. Understanding and mastery of emotional intelligence skills will allow healthcare workers to extend empathy towards patients while maintaining their composure and protecting against personal emotional distress.

Ideally, emotional intelligence training would take place primarily while an individual is still in school and secondarily during on-the-job training (Mercer & Reynolds, 2002). A study from the Brighton & Sussex Medical School found that compassion can be taught both in class and on the job simply by making an effort to be aware of compassion expressed by others, which ultimately encourages oneself to express more compassion (Cathie, Whan, Montgomery, Martin, & Ramage, 2017). By extension, emotional intelligence can be taught and once an individual is aware of the facets of emotional intelligence, their awareness will cause them to act in more emotionally intelligent ways towards patients. This will ultimately cultivate greater intimacy between healthcare providers and their patients, which will result in better communication and patient outcomes (Rego et al., 2010).

Emotional intelligence can be viewed through the empathy framework, the foundation of which is that empathy is neither a moral good nor bad but is neutral since it can be manipulated.

Empathy itself is considered a facet of emotional intelligence and should emotional intelligence take a greater role in healthcare it should be done with the awareness that empathy must strive toward moral good. Empathy itself can be broken into three components: emotional (sharing another's emotions), motivational (caring for another's welfare), and cognitive (placing oneself in another's shoes) (Decety & Cowell, 2014). Given the role of understanding and sharing emotions in empathy, bias can be introduced in that people are more willing to express empathy towards individuals they are similar to. It is important that empathy is taught as a practice in medical schools, not strictly as a result of emotion, in order that health care providers practice to better understand the struggle of others and thus express empathy with greater equality (Dinkins, 2011).

**Research Question and Methods**

My research question will be: what is the potential for emotional intelligence education in the medical field, how (if at all) is it currently taught, and how can it be evaluated to ensure that emotional intelligence plays a role in bettering patient outcomes? I will be collecting evidence through interviews, surveys, and prior literature. Interviews and surveys will be conducted with physicians and medical students in the UVA Hospital system. I have connected with a Cardiac and Thoracic surgery resident who has agreed to interview with me as well as connect me with other physicians to interview and cohorts of medical students to send surveys to. I will ask a variety of questions regarding understanding of emotional intelligence to gauge familiarity with the subject and whether any of the physicians were taught about it in school. I will also ask a few questions on empathy and general patient-physician relationships to get a more well-rounded picture for respondents who are not familiar with emotional intelligence. Example questions can

be referenced in Appendix A. I have not been connected to anyone in the UVA hospital system who teaches emotional intelligence in medical school, although if I were able to make that kind of connection, I would develop a separate set of questions for that interview.

Through prior literature I will seek out studies on the effectiveness of emotional intelligence training. Existing studies indicate that emotional intelligence can be taught in a classroom setting and that there is benefit to teaching EI in a medical context (Gilar-Corbí, Pozo-Rico, Sánchez, & Castejón, 2018; Stoller, Taylor, & Farver, 2013). Specifically I will be looking for studies which collect data through patient-centered communication in order to ensure that patient outcomes are being evaluated (Epstein et al., 2005). Ideally these studies will be within a medical context, but I am open to using studies from other fields if they prove relevant to either emotional intelligence training or empathy in technology and human interactions. My goal through a literature review is to verify the effectiveness of emotional intelligence training in medicine and combine conclusions from the literature review with interview and survey results to determine if there is a practical need for and way to incorporate emotional intelligence training into a medical school context.

**Conclusion**

Current methods of epidural injections are either expensive and pose health risks or are inexpensive and inaccurate. The deliverables from my technical project will be completed subcomponents for Rivanna Medical's ultrasound device (i.e. a completed motor setup, 3D printed test fixtures, and appropriate acoustic coupling fluid) and official documents for our test methods and test method reports once executed. Our work will help the ultrasound device progress toward the public market. On a greater level this will provide the healthcare system with

a safer, more affordable, and more accessible imaging method for performing epidural injections. The deliverable from my STS research will be a conclusion regarding the need for and effectiveness of emotional intelligence training and a recommendation regarding its incorporation in medical school and residency training. The effects of this research and recommendation are to raise awareness of the importance of positive patient-physician interactions and to contribute knowledge towards the goal of bettering these relationships.

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## Appendices

Appendix A: Potential Interview Questions

1. Are you familiar with emotional intelligence and if so, how would you define it?
2. Were you instructed in emotional intelligence during medical school or residency?
3. Do you see a need for emotional intelligence education?
4. Would emotional intelligence training fit better in a classroom setting or as part of on-the-job training?
5. Do you believe empathy and objectivity can go hand-in-hand or are opposing forces in healthcare and why?
6. Have you witnessed a lack of empathy or understanding from peers and if so, how could this best be ameliorated?