

The use of intraosseous vascular access

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Executive Summary First introduced by Drinker and colleges in 1922, intraosseous (IO) vascular access was a method used during World War II for accessing the non-collapsible venous plexuses within the bone marrow cavity to provide access to a patient's systemic circulation. This method later fell out of use after the development of intravenous catheters.

Then during the 1980s IO vascular access was again introduced as a rapid way of gaining vascular access for swift fluid infusion particularly during resuscitation attempts of pediatric patients. (Tay & Hafeez, 2011) Plan-Being by implementing a policy for the use of IO vascular access within the Emergency Department of Hays Medical Center (HMC) for critically ill

patients. This would expedite critically ill and severely injured patients in receiving the intravenous fluids and medications.

Currently there is no policy in place for the placement of IO devices as opposed to peripheral intravenous catheters, or central venous catheters. However, if there was a policy in place the staff would know when it was appropriate to insert an IO device, as opposed to having to make a difficult decision based on personal judgment. Do- Create a group of physicians and nurses to write a policy outlining when it is appropriate for the placement of an IO device compared to traditional techniques for gaining venous access. Once the policy has been written implement its use within HMC's ED.

Check- Keep a careful record of when an IO device is placed, in accordance to the new policy. Monitor the outcomes of these patients. Evaluate the effectiveness of the new policy and determine if any changes need to be made. Act- Based on the information obtained during the check phase of this project, management will determine whether the policy will be continued, improved, or discontinued. The Use of Intraosseous Vascular Access in Critically Ill Patients The origin of the intraosseous cavity as an access sight to the circulatory system was originally discovered during World War II.

Medical personnel during this time used an IO route to resuscitate patients suffering from hemorrhagic shock. It was first documented in medical journals by Drinker and colleges in 1922. It was later rediscovered by American pediatrician James Orłowski. During his time working in India, Orłowski observed medical personnel during a cholera epidemic using IO access to save patients in whom IV cannulation was impossible and who might have died without access. He later wrote about his experiences in a

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paper entitled, My Kingdom for an Intravenous Line. Wayne, 2006) Since Dr. Orlowski brought the use of IO access in pediatrics back into the medical spotlight, the implications for its use within the adult population were soon being addressed. In 2005, the American Heart Association stated in its Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care that “ IO cannulation was appropriate to provide access to the non-collapsible venous plexus found in the bone marrow space, thus enabling drug delivery similar to that achieved by central venous access. (American Heart Association) Intravenous access can mean the difference between life and death when dealing with critically ill patients. IV access means that patients can receive fluids, blood products, and life-saving medications. During situations when time is precious, and access is critical is not when nurses should be making their fifth attempt at a peripheral intravenous catheterization (PIV). It also shouldn't be when chest compressions are stopped, so that the doctor can try for a central venous line (CVL).

The average time necessary for PIV catheterization is reported to add up to 2.5-13 minutes and sometimes even up to 30 minutes in patients with difficult to access peripheral veins. (Leidel, Chlodwig & Bogner, 2009) This is one of many reasons why it is imperative to have a policy in place so that the staff knows that IO access should be a go to option rather than a last resort. There are very few contraindications when it comes to the placement of an IO device. However, to untrained medical personnel the thought of having to place an IO device is very daunting.

I didn't realize until this semester that it is within the scope of practice for a RN to place an IO device, but it is absolutely is! “ It is the position of the

Infusion Nurses Society that a qualified RN, who is proficient in infusion therapy and who has been appropriately trained for the procedure, may insert, maintain, and remove intraosseous access devices. " (" The role of," 2009) There is also the fact that of having to explain the procedure to the patient and the patient's family. The fear of needles is a real one.

The thought of an intramuscular injection can send certain patients into a full blown panic attack. So the thought of actually having their bone pierced with a needle is a frightening one. Thankfully most patients who are critically ill enough to necessitate the placement of an IO device are unconscious. In cases where patients are not unconscious, an IO device can be placed with minimal discomfort if proper anesthetic techniques are used. These techniques should be taught along with placement so that nursing staff is aware of how to place an IO with minimal discomfort to the patient.

It needs to be noted that " the pain associated with insertion of the EZ-IO needle is similar to that associated with insertion of a large peripheral intravenous needle and may be alleviate with infusion of lidocaine solution. " (Luck, Haines & Mull, 2010) Unlike PIVs and CVLs, IO access can be obtained from multiple sites with less chance of being unsuccessful. The locations include: proximal tibia, distal to the tibial tuberosity, distal end of the radial bone in the upper limb, proximal metaphysis of the humerus, distal tibia, proximal to the medial malleolus, distal femur, above the femur plateau, the sternum, and also the calcaneus (Tay & Hafeez, 2011). However, IO access is typically obtained via the proximal tibia or proximal metaphysis of the humerus. There are currently three different ways to gain IO access. The first and oldest way is a manual insertion of the IO device. In this way the device

is placed using the force applied by the clinician, and is done in a rotating motion. The second technique is the use of an impact device.

In this case, a spring-loaded IO device is to insert the needle into the bone using direct force. The last technique is a powered drill. The small, handheld device drills the IO needle into the bone with a high-speed rotating motion. Plan To implement a policy within the Emergency Department at Hays Medical Center that clearly outlines when the placement of an intraosseous access device should be used as opposed to more traditional techniques for gaining venous access. A committee would be assembled to look at the research on IO placement.

This committee would consist of three physicians and three nurses, and will be given three months to write a policy for the department. This committee will determine in which situations an IO should be placed. The American Heart Association guidelines for intraosseous vascular access should play a major role in this decision. Once criteria has been chosen a checklist will be created that can be hung on the walls of the trauma rooms and handed out to staff. This checklist will aide in helping the staff to be able to more quickly determine in which situations placement of an IO is within the department's policy.

The appointed committee would also be in charge of deciding on which type of IO device the department should use. They will research the availability of the device chosen and what the cost will be to stock the department with the device. Do Once the research is gathered, the assigned research committee will reassemble to compose the policy that will become implemented within the Emergency Department. After the policy has been

written, a mandatory unit meeting will be called to introduce the new policy and answer any questions that the staff might have.

During this meeting, a demonstration will be given on the correct technique for IO placement, depending on which type of device is chosen during the planning phase. After the demonstration the staff will then be asked to practice placing IO devices using practice bones. One member of the department will then be voted upon to keep track of which patients coming through the department have IO devices placed. They will keep track of for the next six months. The data collected will include any outcomes that the patient experiences, good or bad, in regards to their IO placement.

Check The member of the department will look at the data collected from the outcomes of patients who had IO devices placed within the ED in the last six months. This data will then be taken back to the originally assigned committee. The committee will be responsible for analyzing the data. They will look at the outcomes and determine if changes need to be made to the original policy. They will also look at the outcomes to determine if there need to be changes made in the placement technique used by the department.

For example, is the rate of successful placement higher or lower when done via the humerus verses the tibia? Or is there a problem with post procedural infection? Should the technique be changed from aseptic to sterile? Etc... They will also ask staff within the department to fill out a survey indicating their comfort level in placing IO devices. Act Depending upon the findings of the committee they can either be decided to leave the policy in place, as is. The committee could find that the policy needs to be altered and then reviewed in another six months' time to see if the changes were effective.

Or they could find that within the ED at Hays Medical Center IO devices for venous access should not be used although the review of literature will prove why this outcome is highly unlikely. Research to Support Change An article published in the Journal of Emergency Medicine, collaborated by three different physicians who work in Emergency Departments in Philadelphia talks about the technical side of intraosseous access. The article states that “intraosseous vascular access is indicated in the critically ill patient of any age when rapid and timely access via the intravascular route cannot be established or has failed. The article goes on to list conditions in which this might occur, including: cardiopulmonary arrest, shock, sepsis, major traumatic injuries, extensive burns or edema, and status epilepticus. (Luck, Haines & Mull, 2010) Indications may also include obese patients on who multiple PIV attempts have failed. Because studies have shown that IO infusions have the same onset of action, as that of intravenous infusions the authors recommend that the dose used for IV fluids and medications should remain unchanged when using the IO route.

They go on to state that other studies have shown that the results of several different blood test values drawn from bone marrow aspirates are comparable to those taken from venous samples. These include blood gas analysis, blood group typing, and electrolyte, drug, and hemoglobin levels. (Luck, Haines & Mull, 2010) The authors also talk about the relatively few contraindications for IO insertion. These include a fracture to the bone that the IO device is to be placed, an extremity with a vascular injury, placement to an area with an overlying skin infection or burn.

IO insertion is also contraindication in patients with certain conditions that make their bones fragile such as osteogenesis imperfect and osteoporosis. The last contraindication is a new IO insertion where another IO needle may have recently been placed. This is because the opening left by the last needle can cause fluids to extravasate. In their research of other studies, the authors found that success rates for IO insertion vary between 75%-100%, and successful infusion achieved within 30-120 seconds in the majority of cases. Luck, Haines & Mull, 2010) The most common complication was found to be extravasation of blood, fluids, and drugs into the soft tissues surrounding the site, but this occurred less than 1% of the time. With a 0.6% chance of incidence, the most serious adverse complication was osteomyelitis. However, this was attributed to prolonged infusion. For this reason, it is recommended that the IO need be replaced by either a PIV or a CVL once the patient has stabilized and no longer than 24 hours after IO placement. (Luck, Haines & Mull, 2010)

This article concluded that the use of IO access devices is a safe, reliable, and timely way of attaining vascular access. Although vital for critically ill and injured patients, it is also a technique that can be applied in non-emergent cases where multiple attempts at peripheral and central IV access has been unsuccessful. (Luck, Haines & Mull, 2010) In a study conducted by physicians at the University of Medicine Berlin's Department of Emergency Medicine, they looked at ten consecutive adult patients who each received an IO device and also a CVC placement during a resuscitation situation.

The results showed that the success rate on first attempt was 90% for IO access versus 69% for CVC placement. They also found that the mean time

required for the IO access procedure was significantly shorter, 1-3 minutes, compared to the mean CVC placement time of 4-17 minutes. While conducting this study, one IO cannulation failed “ due to operator mishandling by not selecting the correct insertion site at the proximal humerus. (Leidel, Chlodwig & Bogner, 2009) The physicians of this study also noted that four CVC cannulations failed on the first attempt at insertion and had to be reattempted. The study then went on to state that the failed placement of one IO cannulation was the only complication regarding the IO devices placed. There was “ no malposition, dislodgment, bleeding, compartment syndrome, arterial puncture, haeatothorax, pneumothorax, venous thrombosis, and vascular access related infection observed. ” (Leidel, Chlodwig & Bogner, 2009)

In conclusion the researchers go on to state “ IO vascular access is a safe, reliable, rapid option in the acute setting of adult patients under resuscitation with inaccessible peripheral veins in the emergency department... Therefore, a change in practice from CVC to immediate IO access for the initial emergency resuscitation should be strongly considered as a reasonable bridging technique to increase patient’s safety in the emergency department. ” (Leidel, Chlodwig & Bogner, 2009) Another study found was performed by physicians and researchers in the Department of Emergency Medicine of Singapore General hospital.

It is a large urban hospital that handles nearly 120, 000 patients annually. 9% of these patients are priority 1 patients, or patients that need resuscitation. The inclusion criteria for this study were “ patients who presented to the ED with age greater than 16 years or > 40kg body weight

requiring intravenous fluids or medication and in whom an intravenous line could not be established in two attempts or 90 seconds. They also had to be seriously ill or injured and meet at least one or more of the following: altered mental status, respiratory compromise, haemodynamic instability, or cardiac arrest. (Ngo, Oh, Chen, Yong & Yong, 2009) The study ran from March 1, 2006 through July 30, 2007. During this time 24 patients were met the qualifications for this study. Of all the IO cannulations, only three attempts failed on the first attempt. No failures were recorded on the second attempt. The researchers also did a comparison between junior operators and senior operators and found that there were no disparity regarding success rates between the groups, they both had a 100% success rate. The average insertion time for both groups was approximately five seconds. Ngo, Oh, Chen, Yong & Yong, 2009) There were only two complications regarding the insertion of an IO device with this study. The first was when an operator's glove was caught on the need during insertion. However, this could have been prevented if the operator was holding the drill properly. The other complication noted was that of extravasation of fluid at an insertion site. This is the most common type of complication, and is seen when the need is misplaced or there is an excessive amount of movement during or after the insertion. Ngo, Oh, Chen, Yong & Yong, 2009) The results of this study concluded that " the EZ-Io is a feasible, useful and fast alternative mode of venous access especially in the resuscitation of patients with no venous access or when conventional intravenous access fails. Flow rates may be improved by the use of pressure bags. Complications encountered such as

extravasation of fluid and gloves being caught in the drill device can be easily prevented. ” (Ngo, Oh, Chen, Yong & Yong, 2009)

The third research article was a prospective, observational study conducted by researchers in the Department of Emergency Medicine at Singapore General Hospital in Singapore. The study was conducted on a convenience sample of 25 medical students, physicians and nursing staff. They were recruited to secure intraosseous access using the EZ-IO powered drill device. Unlike the previous two studies they only need to secure access on a plastic bone model rather than a live patient. (Ong, Ngo & Wijaya, 2009)

The study participants were allowed multiple attempts in placement with the aim of ensuring success in placement. Their placement times were measured by an independent observer with a stopwatch, from the time the participant placed the need set into the driver and attempted to insert the needle with the ES-IO into the plastic bone. The participants then recorded their perception on the difficulty of insertion using a visual analog scale with 0 representing very easy and 10 representing very difficult placement. (Ong, Ngo & Wijaya, 2009) The results showed 96% success rate for placement.

Twenty-three of the 25 participants only required one attempt at place the IO device, and only one participant was unsuccessful at securing placement of the device. This failure was attributed to “ unfamiliarity with the equipment and procedure, and hesitating beyond the allocated time given for insertion. ” (Ong, Ngo & Wijaya, 2009) The results of this study also showed that the mean placement time was 13. 9 seconds. The researchers also found that 87% of their participants reported that using the EZ-IO was easier compared to intravenous cannula. Ong, Ngo & Wijaya, 2009) The researchers of this

study concluded that “ the I/O access device (EZ-IO) evaluated in this study appears to be easy to use with high success rates of insertion with inexperienced participants. There is potential for use in the Emergency Department. (Ong, Ngo & Wijaya, 2009) The next piece of research was a randomized trial conducted by Dr. Reades from Methodist Hospital System, in Dallas, TX, Dr. Studnek from Carolinas Medical Center and the Center for Prehospital Medicine, Charlotte, NC, S.

Vandeventer from Mecklenburg EMS Agency, Charlotte, NC, and Dr. Garrett from Baylor Healthcare Systems, Department of Emergency Medicine, Baylor University Medical Center, and Dallas, TX. The purpose of this study was to determine whether the tibial or humeral placement site was more effective for intraosseous placement during out-of-hospital cardiac arrest. “ All patients eligible for inclusion in this study had their first attempt at vascular access randomized to one of 3 locations: proximal tibial intraosseous, proximal humeral intraosseous or peripheral intravenous. (Reades, Studnek, Vandeventer & Garrett, 2011) Randomized note cards were distributed to the paramedic staff at the beginning of their shifts, and told them which access site was to be initially used if they came had a patient who met the inclusion criteria. There were two outcomes that were being monitored in this study. The first was a first-attempt success at the assigned method of vascular access. This qualified in one of two ways, either as an initial success or an overall success.

The second measured outcome was the “ total number of attempts required for successful vascular access, time to successful vascular access, time to first ACLS medication, and total volume of fluid infused during resuscitation.

” (Reades, Studnek, Vandeventer & Garrett, 2011) Overall there were 182 patients randomized to one of the 3 vascular access methods. Fifty-one patients had humeral IO placements, 67 had PIV placements, and 64 had tibial IO placements. The results showed that first-attempt success was greatest in patients randomized to tibial IO access at 91%, compared to both humeral IO access at 51% and PIV access at 43%.

The result of the secondary outcome was also significantly shorter in patients with tibial IO access. These patients had their devices in place and ready to use in an average of 4.6 minutes. Those assigned to the humeral IO access site averaged a 7.0 minute placement time, which was also the same time for a PIV access site. (Reades, Studnek, Vandeventer & Garrett, 2011) This study demonstrated that there is a significant difference in the frequency of first-attempt success when placing tibial IO access devices as opposed to humeral IO access devices or even PIV catheters.

The researchers go on to state that the “ results from this study may help stakeholders such as EMS medical directors choose the most appropriate site for first-attempt vascular access...” (Reades, Studnek, Vandeventer & Garrett, 2011) The last article was a consortium on intraosseous vascular access in healthcare practice, published in a journal entitled critical care nurse. It too outlined the history of IO access, dating back to World War II. It discussed the clinical considerations for the use of IO access, and the clinical situations in which IO access should be considered.

It went on to talk about the types of IO devices and how they’re used. It mentioned the contraindications for IO use, and also the possible complications. All of the aforementioned material was consistent with

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research already discussed. This article lends credibility in support of change because it discusses the education and training needed to implement IO device use in the clinical setting. It states that “ to insert and maintain an intraosseous device in a patient, the clinician must demonstrate adequate knowledge and psychomotor skill competency in the procedure. (Phillips, Brown, Campbell, Miller, Proehl & Young-berg, 2010) The article then went on to discuss the economic considerations that must be looked at when considering implementing an IO insertion policy. It states that “ the cost of intraosseous devices and needles should be compared with the cost of central catheter kits, ultrasound evaluation, and human resources required for their insertion. ” (Phillips, Brown, Campbell, Miller, Proehl & Young-berg, 2010) The authors also note that “ the economic factors must be weighed along with potential complications of therapeutic strategies should be considered. (Phillips, Brown, Campbell, Miller, Proehl & Young-berg, 2010) This article also brings to light the issue of risk management and patient safety. In this day and age where liability concerns continue to drive clinical decisions, it is important to note that delays in treatments are often cited as the cause of injury leading to malpractice claims. If there is an evidenced based option to safely and quickly provide fluid and drug resuscitation, when vascular access is not readily attainable, then it needs to be closely looked at.

After reviewing the data the Consortium on Intraosseous Vascular Access in Healthcare Practice reached eight consensus: 1. Intraosseous vascular access should be considered as an alternative to peripheral or central intravenous access in a variety of healthcare settings, including intensive

care units, high acuity/progressive care units, general medical units, preprocedure surgical settings where lack of vascular access can delay surgery, and chronic care and long-term care settings, when an increase in patient morbidity or mortality is possible. . Intraosseous vascular access should be considered as part of an algorithm for patients treated by rapid response teams in whom vascular access is difficult or delayed. 3. A new algorithm that includes the intraosseous route should be developed for assessing the appropriate route of vascular access. 4. For patients not requiring placement of central catheters either for long-term vascular access or hemodynamic monitoring, intraosseous access should be considered as the first alternative to failed peripheral intravenous access. 5.

Techniques of intraosseous catheter placement and infusion administration should be a standard part of the medical school and nursing school curriculum. 6. In evaluating the economic implications of adopting intraosseous technology, the following should be considered: the expense of diagnostic tools to guide and confirm placement, the cost of human resources, the known and unknown risks to patient safety, and the cost of complications related to delayed treatment. 7. Organizational policies, procedures, and protocols that establish the responsibility of insertion, maintenance, and removal of intra-osseous access devices should be developed. . Further research should be conducted on, but not limited to, the safety and efficacy of use of intraosseous access in all practice settings, its economic impact on patient care, and to support the use of intraosseous access in all health care settings. Change Theory The change theory focused upon in this paper is Gordon Lippitt's Theory of Planned change. According

Lippitt, “ Planned change or ‘ neomobilistic’ change is defined as a conscious, planned effort which moves a system, an organization, or an individual in a new direction.

This theory is applies because it can be applied at an individual, group, and institutional level. The basis for Lippitt’s theory of change is center around an agent for change. This agent should be a person skilled in the changed wanted to apply. It is this person who is in charge of planning for the change, initiates the change, and is credited for the accomplishment of change. Lippitt’s theory is centered around 7 phases of change. His phases are not set in stone, and there is no time frame on how long each phase should last. There should be a fluid movement back and forth between these seven phases.

The first step is identification and diagnosis of the problem. In this case, the problem is HMC not having a firm policy in place recommending when the use of IO access devices should be implemented. The second step is the change agent assessing the client systems motivation and capacity for change. In this case, myself being the change agent, I would talk with the administrators of the ED department and determine if they agreed with my assessment for a policy to be implemented. The third step would be the initiator assesses his or her ability in helping the situation.

In this case this flows back to the first step, because I saw the need for change and felt that I was equipped with the skills needed to bring about such a change. The fourth step is the change agent then chooses an appropriate role in the phase. In this case, I would choose to be part of the policy committee who is responsible for researching. The fifth step states

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that the change agent may be actively involved in the implementation of change, serve as an expert in factoring and providing data, or function as a liaison within the organization. I feel like in this case, I would function as a liaison within the policy making committee.

The sixth step consists of maintenance of change. This involved the “ Do” portion of the plan for change. This is where the decisions made by the policy are provided to the department, and the employees become responsible for implementing and maintaining the new policy. The final step is termination of the helping relationship. This step is accomplished when all parts of the PDCA plan have been completed. (Ziegler, 2005) Conclusion In a day and age where medical technology is advancing, the research about IO access devices proves that newer technologies are not always the best for a positive outcome.

IO access applications have great potential in patients who are critically ill, injured, or are incapable of having PIV or CVL access. The fact that IO access is fast, reliable, and safe proves that competent placement of IO devices is a medical technique that all Emergency Departments should have in their repertoire. References (2009). The role of the registered nurse in the insertion of intraosseous access devices. *Journal of infusion nursing*, 32(4), 187-188. American Heart Association. 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2005; 112(24): 57-66. Leidel, B. Chlodwig, K. , & Bogner, V. (2009). Is the intraosseous access route fast and efficacious compared to conventional central venous catheterization in adult patients under resuscitation in the emergency department? a prospective observational

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Timeline for Change 1/20-11/27

Researched the benefits of having a policy about intraosseous access within the ED at HMC 11/28

Spoke with the Director of Nursing for the ED and

the Director of Emergency Medicine about my research findings 12/1A committee of three physicians and three nurses is assembled to draft a preliminary policy regarding intraosseous access 12/1-3/1The committee is given three months to compose their policy 3/2-3/10The policy is given to the Director of Nursing and Director of Emergency Medicine, who present it to the board of directors for approval 3/15A mandatory staff meeting is held outlining the new policy and answering any questions or concerns the staff has 3/16-9/16The new policy is put into effect and data is collected 9/16-10/16The original committee will analyze the data, and changes are made as needed. 10/20The final committee approved policy is present to the Director of Nursing and Director of Emergency Medicine 11/1The Director of Nursing and Director of Emergency Medicine, take the final recommendations for the policy to the hospital board of directors for approval