

The Prehospital Perspective Focus on: Pain Management by Matthew Ozanich, MHHS, NRP, EMS Coordinator, Trumbull Memorial Hospital

The great American engineer Charles Kettering is credited with saying, “If you’ve always done it that way, it’s probably wrong.” This is a great tribute to American ingenuity, describing the constant thirst for improvement on outdated ways. This raises questions regarding the medical care we provide in the American prehospital setting. Are we properly adapting? What are we doing wrong and why? Though these are perfectly appropriate questions to ask regarding any aspect of prehospital care, this article will focus on prehospital pain management: what our current standard is, how we got there, and how we should improve ourselves.

Influences

To better understand the origin of our prehospital care, we must first understand our influences. Who has the greatest influence on care provided in the prehospital setting? Many would think that ‘emergency physicians’ is the answer. Is this correct? The modern ambulance, containing medically trained staff and responding to emergencies stateside, was born of the 1966 National Academy of Sciences paper *Accidental Death and Disability, the Neglected Disease of Modern Society* (National Academy of Sciences, 1966). Major metropolitan areas began to regularly employ EMS personnel in various formats, mostly fire-based services, in the early 1970s. If EMS as we think of it today originated in the early 1970s, and the earliest emergency physicians were board certified in 1980, how could emergency physicians have possibly influenced the field of EMS (American Academy of Emergency Medicine, 2015)? Emergency medicine was traditionally influenced by surgeons, anesthesiologists, orthopaedics, residents, psychiatrists, and internists (American College of Emergency Physicians, 2014). There is finally a shift occurring where emergency physicians are influencing their own field with emergency medicine directed research. Knowing these facts, it is made obvious that the earliest influences on prehospital medicine were the same influences on emergency medicine: surgery, anesthesiology, orthopaedics, internal medicine, and psychiatry. The field of prehospital medicine, like emergency medicine, will not truly progress until the prehospital providers themselves contribute to the advancement of their profession, with physicians only providing guidance.

Standard of Care

With the slate wiped clean, let us now turn our attention to modern pain management practices. When reviewing a typical EMS protocol they all share a very basic foundation of pain control. Typically they contain morphine and/or fentanyl, with a few exceptions based on physician preference. The typical prehospital dose of morphine is at or below 5mg at a time, and the typical fentanyl dose is 50mcg or less

at a time. While these numbers may work well in a typical pain management algorithm when the patient is laying still after having their injury corrected with surgical intervention or splinting, any experienced prehospital provider will acknowledge that these doses do little to put the patient at ease immediately following the injury. Plus, none of these protocols account for the differing bioavailability of each drug based on the route of administration. This leads to patients who do not receive proper treatment due to underdosing or lack of intravenous access. Locally, under the older Trumbull Memorial Hospital protocol in use until January of 2015, we found that the success rate of a 2-4mg of morphine protocol was around 56%. To clarify, successful pain management under this quality assurance measure was defined as a change in the patient's pain rating by greater than 2 points on the 1-10 scale. Knowing this we can definitively say that 44% of our patients continued to experience almost the same level of pain after pain management was administered. By modern pain management standards, not only is this number not acceptable, it is borderline pathetic. If these dosages mentioned above are the "standard" by which we model our protocols, this means our "standard" is a pitiful 56% success rate. As Dr. Tim Noonan, MD, argued during an emotional dispute over the use of backboards in the *new Prehospital Trauma Life Support edition*, "Someone else routinely using treatments without evidence is not a good reason to do the same," (Noonan, 2013).

Differing Perspectives

There is a substantial difference in the perspectives of pain management between professions that must be considered. When looking at the internist's perspective, there are some major concerns at hand: side effects, chance for addiction, and there is a minimal chance that the physician will cause the patient further pain (iatrogenic pain). From an emergency physician's perspective, though mild concerns relating to side effects and addiction remain, there is a much higher chance for iatrogenic pain due to the procedures necessary to diagnose/treat the patient. When reviewing the EMS provider's perspective, while side effects are always a concern the chance for addiction from one prehospital treatment is deemed unimportant, and the chance for iatrogenic pain is at its highest point. We cause pain assessing the patient; we cause pain splinting the patient; we cause pain moving the patient to the stretcher; we cause pain moving the stretcher to the ambulance; we cause pain bouncing down the road in the ambulance; we cause pain removing the patient from the stretcher to the hospital bed. These are all unavoidable sources of iatrogenic pain, so shifting the goals of prehospital pain management, and the success in achieving those goals, is paramount.

Pathophysiology of Acute Pain

The key to understanding successful pain management comes from expanding one's knowledge not only of pharmacology, but of pathophysiology as well. Pain is a very primitive part of the human nervous system. It is carried through channels in the spinal cord that are considered clumsier, slower channels known as the Spinothalamic Tract. These channels are so slow and clumsy that they require additional mechanisms such as reflexes to assist them with immediate responses to

a stressor. They're also so slow that they can be manipulated by certain processes such as the sympathetic nervous system, pain signal gating, the immune system, and the release of endorphins. This article will only focus on changes regarding the sympathetic nervous system.

When an injury occurs, the sympathetic nervous system is activated. This is the "fight or flight" response, designed to allow us to either overcome the stressor or flee from it. This is a wonderful protective mechanism that has kept mankind alive through many difficult situations. The heart rate elevates, the respirations elevate, and circulation shunts in order to protect the most vital of organs. Subsequently, pain is also suppressed. This is necessary for us to either fight or flee, because if we were aware of our injury we would be able to perform neither of those actions. However, at some point it is necessary to our survival to be aware of the injury we sustained so that we may do something about it. Therefore, shortly after the initial insult, our sympathetic nervous system turns from pain suppression to a phenomenon known as the pain "wind-up," whereby it amplifies the pain we experience to draw attention to that injury. It just so happens that the amount of time required for pain "wind-up" to take affect is also the same amount of time it takes an ambulance to respond to a location; only a few minutes. This means that right as the EMS provider is arriving on scene and initiating care, the patient will be experiencing the highest amount of pain. If this is true, and if this is a commonly known fact, why is the pain management provided in the prehospital setting identical to the pain management the patient receives following treatment for their injury, when the pain "wind-up" effect is drastically reduced and the patient is seated comfortably in a hospital bed free of further motion? The answer lies in the prehospital provider's ability to convince physicians that their pain management is subpar, and for physicians to have an open mind to the prehospital caregiver's experiential knowledge. Let us explore several options available to the prehospital setting, which may provide higher rates of actual pain control.

Prehospital Pain Management Goals

Before delving into the fun-filled world of pharmacology, a set of goals must be established. What do we hope to accomplish from the pain management algorithm? It seems unrealistic to achieve a pain score of 0, because pain is such a subjective topic. What number is acceptable? Do we even need to focus on "numbers" in the first place? Think back to school, when your all-time favorite EMS instructor told you to forget about the pulse oximeter, forget about the capnography, forget about the lactic acid reading... Focus on the patient. Tools are excellent, but they only confirm what you should already know based on adequate assessment. Your patient reports 8/10 pain but they are resting comfortably and haven't stopped texting on their cell phone. Do I "snow" this person under with 200mcg of fentanyl? Absolutely not. Or, your patient reports 4/10 pain yet they are writhing and sweating on the cot, unable to find that position of comfort they so badly require. Following the Golden Rule, I'd want that 200mcg of fentanyl if I were in their shoes; wouldn't you?

The point is to base the need for pain management from adequate assessment of the patient's suffering. If they are suffering, give them pain management. If they are relaxed it may not be necessary, or adjust your dosing accordingly. Patient comfort is documentable, measurable, and achievable, but complete pain control is unrealistic. We can create protocols designed to make the patient comfortable depending on their situation, so let's make this our goal while we explore options.

Proper Injury Care

Treating injuries effectively is the first step to providing effective pain relief. Within reason and while ensuring that all immediate threats to life are addressed, ensure that injuries are cleaned, bandaged, and splinted appropriately. Placing the patient in a position of comfort and the patient's injury in the position of function are key actions. It should also be a strong consideration to have an advanced provider administer pain medication prior to splinting, when appropriate. The movement and handling before, during, or after splinting can be extremely uncomfortable for the patient. Often advanced providers will wait far too long before considering pharmacological pain management. Pain should be anticipated and controlled prior to painful procedures, not after all of the painful movement occurs and the patient is resting in the back of the ambulance.

Emotional Support

Illness and injury take a heavy toll on the human psyche. We're sick or injured, we fear death and the unknown, and we feel different from everyone else. Stress activates the sympathetic nervous system, and the sympathetic nervous system amplifies our pain. Providing emotional support to the patient, whether it is light touch, mild laughter, a smile, or just showing the patient empathy can go a long way in managing the patient's pain (Goli, Asghari, & Moradi, 2014). Patients who are in a good mood respond more effectively to pain management techniques. Not only will emotional support reduce the activity of the sympathetic nervous system and prevent pain "wind-up," it also causes the release of endorphins. Endorphins are the body's natural opiate, binding to sites where morphine and fentanyl bind. Endorphins themselves can reduce the amount of pain experienced by the patient, and when opiates are given by the provider they will have potentiating effects, making the opiate more effective. Add emotional support as the next step in the pain management algorithm.

Pharmacological Intervention

When proper injury care and emotional support are not enough to help your patient rest comfortably, pharmacological intervention may be required. The ideal pharmacological solution is a medication that is potent, has a wide safety profile, a short duration of action, minimal side effects, minimal contraindications, and is easily deployable (meaning effective alternative routes). Several pharmacological options are discussed below.

Morphine

Morphine is the crown jewel of pharmacological pain interventions. It is well studied, familiar, cost effective, and readily available. Despite these facts, it doesn't quite fit into the "ideal" pharmacological solution as defined above. Morphine is an opioid receptor agonist, meaning that it stimulates the body's opioid receptors to reduce the transmission of pain signals through the nervous system. Morphine has a narrow safety profile, ranging from approximately 5 to 20mg (0.05-0.2mg/kg) for a standard dose where the benefits outweigh the risks of administration. It has a very long duration of action, ranging from 60 to 90 minutes. There are many side effects associated with morphine use, such as allergic reaction, altered mental status, hypotension, respiratory depression, and the all-too-familiar nausea/vomiting associated with morphine administration. Morphine has many absolute contraindications like allergy (which is common), hypotension, respiratory distress, or increased intracranial pressure. It is listed in FDA pregnancy category C. It is also not easily deployable, having a bioavailability of 40% via intramuscular (IM) injection, 15% if nebulized, and 10% if administered via mucosal atomization device (MAD). Essentially, if the patient doesn't have an IV line then they don't receive pain management.

Hydromorphone

A brief mention of hydromorphone can be made because it is used in the hospital setting and it is a very effective medication for pain management. Hydromorphone is an opioid receptor agonist. It doesn't cause quite as drastic of a histamine response like morphine does, meaning fewer allergies to hydromorphone will develop. It will still be absolutely contraindicated in patients with low blood pressure, increased intracranial pressure, or respiratory distress. Great care should be taken with the airway and breathing status of a patient after administration. Hydromorphone is in FDA pregnancy category C.

Regarding prehospital use, hydromorphone has a substantially better bioavailability from alternative routes than morphine, making it a readily deployable medication (Chang, Moore, & Chien, 1988). However, despite the effectiveness and ease of administration, hydromorphone lacks several of the key elements of an ideal prehospital medication. It has a very narrow safety profile, ranging from 0.5mg to 1mg at a time, to a maximum of 2-4mg. Also, even at normal doses hydromorphone sedates the patient which is not always ideal in the prehospital setting due to the need for physician evaluation upon arrival. On top of the sedation concern is the 2-hour duration of action, meaning that a good 2mg dose of hydromorphone will leave the patient obtunded upon arrival and for a good duration of their emergency room visit.

Fentanyl

A newer trend over the last 5-10 years is the administration of fentanyl in the prehospital setting. Like morphine, fentanyl is well studied, familiar, cost effective, and readily available. Unlike morphine, fentanyl has a very wide safety profile and the dose can be adjusted to fit the needs of the patient. Fentanyl is an opioid receptor agonist. Fentanyl's typical dosing is 0.5-3mcg/kg for pain management, and

up to 10mcg/kg for sedation. It has been safely studied in dosages exceeding 10mcg/kg, though these are experimental doses and not standard practice. One note about dosing that should be considered according to pain management specialists is fentanyl should not be administered in dosages exceeding 100mcg at a time due to the increased risk of chest wall rigidity associated with higher doses. This is also the reason that a fentanyl administration should be slow if given via the intravenous route. Regarding contraindications, fentanyl seems to be much more hemodynamically neutral than other opiates, meaning that histamine response is limited and so is vasodilation. It will not as readily cause hypotension as other opiates. It should still be avoided in increased intracranial pressure and should be used cautiously in patients at risk for developing hypotension after administration. Like other opiates, fentanyl should also be avoided in patients who are in respiratory distress. Fentanyl is in FDA pregnancy category C.

Fentanyl better fits the “ideal” prehospital medication criteria listed at the beginning of this section. As mentioned earlier, fentanyl is potent, familiar, cost effective, readily available, has a wide safety profile, a minimal list of contraindications, and fentanyl has a tremendous bioavailability via alternative routes; 70% via MAD, 90% via IM (Prommer & Thompson, 2011). This means that patients can receive very effective pain management whether or not they have an IV. The duration of action of fentanyl ranges from approximately 30 to 45 minutes, adding to its prehospital benefits.

Ketamine

A newer addition to the prehospital market, ketamine has been in the spotlight and for good reason. Like morphine and fentanyl, ketamine is a time-proven medication with many clinical trials under its belt. What is missing, however, are clinical trials relating specifically to pain management. For decades, ketamine has been used for sedation, generally in the setting of anesthesia or for the purpose of rapid sequence induction. However, when a much smaller dose is administered, the patient remains awake and pain transmission is stopped or slowed. Ketamine belongs to a category of medications known as dissociative anesthetics. More specifically, ketamine is an antagonist of NMDA, a very common glutamate receptor responsible for neurological stimulation in key processes to include pain transmission. Ketamine does, to a certain extent, bind to opioid receptors as well, but this is not the primary mechanism by which ketamine will block pain transmission. It also activates the sympathetic nervous system, thereby increasing respiration rate, bronchodilation, heart rate, and vasoconstriction.

Regarding the “ideal” prehospital fit, ketamine is easy to obtain, cost effective, potent, short duration of action of 15-30 minutes, has a wide safety profile ranging from 5 to 500mg depending on the route administered, and adequate bioavailability of alternative routes being 25-50% MAD, 50% Nebulized, 93% IM (National Highway and Traffic Safety Administration, 2015). The drawbacks are the stigma of ketamine being a street abused drug, and visibility of the side effects. Ketamine tends to cause hallucinations, nystagmus, and nausea. The hallucinations,

sometimes known as the “K-hole,” can be reduced by letting the patient know that they will occur, reminding them that the hallucinations will end shortly, reducing the amount of ambient light, or giving a small dose of benzodiazepine. The nausea can be treated with antiemetics.

Contraindications are few and far between. Notably, it should not be used in schizophrenic patients due to the hallucinations, and should not be used if the patient has a ketamine allergy. Ketamine is commonly listed as FDA pregnancy category B (Elsevier Health Sciences, 2013). With ketamine’s activation of the sympathetic nervous system mentioned above, this makes it an ideal choice for patients who are hypotensive, including trauma victims and patients who require painful procedures such as extrication or cardioversion. While it is commonly thought that ketamine should be contraindicated in patients with increased intracranial pressure, studies show that ketamine actually has a neuroprotective mechanism that makes it an ideal solution for these patients (Bourgoin, Albanese, Wereszczynski, Charbit, Vialet, & Martin, 2003).

Drug Combinations

Drug combinations for effective pain relief are growing in popularity. Some of the more common combinations for pain management that are being studied are fentanyl with ketamine, or midazolam with ketamine. It is known that ketamine reduces the pain “wind-up” effect of the sympathetic nervous system and activates some opioid receptors. Used in combination with an opiate (usually fentanyl) ketamine can potentiate the effects of that opiate. Therefore, a small dose of ketamine (5 to 10mg) may be added to a standard opiate dose (fentanyl 1mcg/kg) for enhanced pain relief. This is a local choice of the EMS system under the medical direction of Trumbull Memorial Hospital. Local quality improvement statistics show a 71% effectiveness in controlling pain by fentanyl alone at 1-3mcg/kg, 81% effectiveness with ketamine at 0.1mg/kg alone, and a 93% effectiveness when the two are combined. The biggest drawback thus far is the combination of fentanyl and ketamine appears to slightly increase the rate of hallucinations experienced by patients.

A practice that is becoming the more preferred option is ketamine administration with midazolam. Though midazolam is a benzodiazepine and has no pain reducing effects, the concurrent administration of these medications allows ketamine to work as an analgesic while midazolam controls ketamine’s side effects, and provides for mild anxiolysis to assist the patients psychologically through their emergency (Sener, Eken, Schultz, Serinken, & Ozsarac, 2011). Trumbull Memorial Hospital has recently implemented this option with the help of local pain management experts. In the newly revised protocol, providers will be able to consider 1-2mg of midazolam prior to a standard 0.1-0.2mg/kg dose of ketamine. According to our local pain management experts, this combination will produce the pain management success of ketamine with a calmer demeanor than ketamine alone, plus reduce the risk of hallucinations. This was just implemented in January of 2016 and Trumbull

Memorial Hospital has no current local data to report on the success rate of this combination.

Summary

An open mind, quality research data, clear and measurable goals, and proper knowledge of pathophysiology and pharmacology can drastically change the effectiveness of our pain management protocols. Dose ranges should be considered for all patient weights, history, route of administration, and medications or combinations of medications. No one pain management experience can be assumed of the next. The prehospital, emergency, and inpatient environments are all different. Patients are all different. Account for these factors, use common sense, and apply your passion to your patient care to make a difference in every patient you encounter.

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