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High and Low Dose Hydromorphone via Patient-Controlled Anesthesia (PCA) Pump and Intravenous Push (IVP) in the Control of Pain in Adult Patients with a Diagnosis of Sickle Cell Disease (SCD) with Pain Crisis

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Abstract

Patients with Sickle Cell Disease (SCD) are often treated with hydromorphone for sickle cell pain. These patients were treated with high dose hydromorphone intravenous and patient controlled analgesia (PCA). To evaluate if high dose hydromorphone controls pain as effective as low to moderate dose.

A retrospective chart review was conducted looking at the usage of hydromorphone intravenous push (IVP) and patient controlled analgesic (PCA). Data collection from Care Cast; electronic medical record (EMR) on pain scores, hydromorphone dosage, route, length of time used was completed. Variables monitored; pain scores, daily hydromorphone dose. Fifty percent decrease in pain scale in the first three days was considered as adequate pain control. The efficacy of the hydromorphone was measured by comparing the downward trending of the usage and pain scores documented.

The data highlights that there is no significant decrease in pain scores from day 2 to day 3 (p-value = 0.107) despite a large increase in hydromorphone dose. In addition, there was no statistically significant correlation between pain scores and hydromorphone dose on day 3 of admission (p-value = 0.064) while on days 1 and 2 there were significant correlations with p-values of 0.033 and 0.002 respectively. This suggests that the large increase of hydromorphone on day 3 did not yield a significant decrease in pain and therefore did not provide the additional care that would be expected with the increase in medication.

Keywords: Sickle Cell Disease, Hydromorphone, Pain, Opioids, Pain Control

Aim

To evaluate if high dose hydromorphone controls pain as effective as low to moderate dose.

Introduction

Patients with a diagnosis of SCD are often treated with hydromorphone for sickle cell crisis pain control. Treatment is usually based on presenting symptoms, medication history and acuity of pain. Patient-controlled analgesia and IVP are favored routes when the patients present to the hospital in pain crisis. Medication dosing is an issue because of adverse effects of opioids and concerns over pain relief. Although there are many criteria that can affect treatment one must consider some of the most important in this patient population; frequency of administration, the acuity of the crisis, patient history in relationship to opioid tolerance, opioid dependency length of time on the medication and the amount used in a 24-hour period. The dosing and the frequency of the hydromorphone played a significant role in this study. Clinician concerns were focused on the length of time to treat effectively in order to get pain relief that could also affect the dosing [1]. These patients were treated with high dose hydromorphone from 6 mg to 10 mg every 2 hours and every 3 hours. This created concerns that led to the study in this population of patients. Despite the initiation of the PCA hospital wide IVP dosing continued. Although most

physicians preferred the PCA because they believed there is less adverse effects the patients received high doses from both routes.

Background

Patient-controlled analgesia (PCA) is a method of administering opioid analgesia that enables a patient to self-administer a bolus ("rescue") dose of opioid when required to control their pain. A PCA pump is programmed to deliver an opioid dose at a predetermined frequency, with a maximum total dose during a set period. The PCA pump may be programmed to allow a continuous infusion of opioid in addition to the bolus (rescue) option. The PCA is used to provide analgesia in a variety of pain conditions. For example, Hydromorphone is a derivative of morphine that is used via a PCA pump to treat sickle cell disease pain crisis. Hydromorphone differs from its parent compound because of its' higher potency. It has been suggested that hydromorphone may have fewer systemic side effects in comparison to morphine [2].

A randomized controlled prospective comparison study between two commercially available PCA pumps and conventional therapy for postoperative pain was done by Hecker and Albert [3]. The two pumps and conventional therapy were compared for efficacy and cost. The pumps were set up with different drug delivery characteristic used for patient-controlled analgesia. Pump "A" emitted an audible signal only when the drug was successfully administered into the patient's vein and pump "B" produced a placebo effect by emitting an audible signal whenever the patient depressed the trigger button. Patients in both pump groups used less drugs and perceived less pain than those on conventional therapy. Greater pain relief, patient and nursing satisfaction were reported with pump "A". Daily cost including drug, pharmacy and nursing time, and pump rental cost was 33 %, for pump "A", versus 23% for "B" which was more than conventional therapy. The study concluded with the report that PCA provides superior pain management at minimal additional cost.

In 2005, a randomized controlled study by Evans, Turley, Robinson and Clancy compared effectiveness, safety and patient satisfaction of PCA with titrated IV opioid injections for the management of acute pain in the emergency department (ED) [4]. The study groups were given morphine via PCA system and the control groups were given Morphine via the conventional route nurse titration. The study concluded that there was no significant difference between the groups in terms of pain relief.

In 2009, a randomized double-blind clinical trial by Chang, Bijur, Baccelieri, & Gallagher measured the efficacy and safety of a single dose of hydromorphone in older adults with acute severe pain [5]. The data suggested that a single dose of hydromorphone 0.0075 mg/ kg and morphine 0.05 mg/kg for treatment of acute and severe pain in the doses given had similar efficacy and safety profiles in that patient population. A PCA study by Grass reviewed PCA paradigm [6]. He focused on the effects of PCA on pain. He wrote the smallest concentration at which pain is relieved is termed the "minimum effective analgesic concentration" (MEAC). Minimal analgesia is achieved with titration of opioid until the MEAC is achieved, which marks the difference between severe pain and analgesia. Two prerequisites for effective opioid analgesia were established; 1. Individualized dosing and titrating to pain relief response to achieve the MEAC and establish analgesia, 2. Maintain constant plasma opioid concentrations and avoid peaks and troughs. After titration to achieve the MEAC and establish analgesia, patients used the PCA to maintain opioid concentrations at or just above their individual MEAC.

Research Question

Given the amount of hydromorphone used for pain crisis through both routes this question was asked: How effective is high dose hydromorphone administered via PCA and intravenous push (IVP) in the control of pain in adult patients with sickle cell disease painful crisis vs low to moderate dose?

Methodology

A retrospective chart review was done. Records were reviewed for patients with a diagnosis of SCD who were admitted for a painful crisis and was treated with hydromorphone. The electronic medical record (EMR) reviewed charts for patient who were hospitalized for 1 year; from January 1, to December 31. The data was divided into 2 groups. The first group used more than 75 mg of hydromorphone in 24 hours. The second group used less than 75 mg of hydromorphone in 24 hours. The records of the patients who were admitted for sickle cell crisis and were in the inclusive criteria were reviewed.

We collected data for the first 3 days the patients were treated (target date). That date was chosen as the target date because patients with pain crisis average length of hospital stay is about 3-5 days and average length of pain crisis is 4 days. Pain scores were monitored over the three-day period; every 4 hours in a 24-hour period. The pain scores were compared from day # 1 to day # 3, assessing a downward trend and were also compared to the sustained dose or decreased dose of hydromorphone. The following variables were used in the study; pain scores (Pain scores showing medication effectiveness; scores dropped from 10/10 to 5/10. The number 5/10 correlated to pain relief. The number of days when pain relief was reported (length of time) and daily maximum amount of the hydromorphone used in three days.

Study Design

The study was a retrospective design looking at the existing data on the dosing of the hydromorphone in both groups and the length of time to get relief. Is pain relief reported in both groups about the same time, if not were there any exceptions or what was an identified criterion that worked in one group better than the other.

Study Population

Eligible subjects were adult patients with a diagnosis of SCD who were admitted with painful crisis and were treated with Hydromorphone intravenous or PCA for their pain. These subjects had a documented diagnosis of crisis pain with a primary diagnosis of SCD. The diagnosis of acute pain or exacerbation of chronic pain was identified. Morphine and Fentanyl are used in this population, but Hydromorphone is used about 70 percent more. Efficacy of both Morphine and Fentanyl are sometimes challenged by the patients as a result, Hydromorphone is used instead.

The Variables

1. Dose and amount of hydromorphone IVP/PCA order in 24 hours.
2. Time in reference to admission when treatment was initiated and completed
3. Pain scores for day # 1 to day # 3.
4. The number of days treated with Hydromorphone

Exclusion Criteria

1. Subjects unable to tolerate PCA.
2. Subjects who are narcotic naïve
3. Subjects who used very low dose IV narcotic and oral opioids to achieve pain control

4. Subjects who after the first 24 hours of treatment achieved 50 percent of better pain control.

Dosing

Group one; PCA and IVP dosing are equal to or more than 75 mg daily in divided doses of PCA 0.4 mg to 1 mg in frequency of every 6 to 15 minutes locked out intervals and IVP dosing of 6-8 mg every 2-4 hrs.

Group two; PCA and IVP dosing of equal to or less than 75 mg daily in divided dosage of less than 0.4 mg every 6 to 15 min locked out intervals and IVP dosing of 2-4 mg every 2-4 hours.

Pain Relief

Measurement of numerical pain score (NSR) was identified according to documented pain scores on the electronic medical record (EMR). The NRS measures pain from zero (0) to 10. It is the NSR that is used in the EMR the hospital documenting program. Ten being severe pain and zero being no pain. A significant trending in reduction in pain in the first 48 to 60 hours was identified as achieving pain control depending on the severity of the crisis. A numerical number trending downward daily was identified as pain relief or effectiveness of treatment.

Adverse Effects Affecting the Study

Addiction, tolerance and dependency are all common conditions that can have some effects on treatment of pain in all settings and populations. Tolerance interferes with the dosing while dependency affects the need for continued use. While those conditions are seriously assessed and are concerns, addiction can affect the treatment process for both the clinician and the patient if honesty is not exercised.

Discussion

In this patient population there is concern about patients who are hospitalized for 20 or more days, discharged and is readmitted within 24 to 48 hours of discharged. The most common complaint by the patients is pain that is not controlled and relief that is not sustained. The treatment course is significant for the controlling of pain, but the type of pain must be identified before the treatment course is initiated. The standard treatment for SCD crisis is opiates and non-opiates with, opiates use being more frequently. There are major differences between opiates and non-opiates in the treatment of these painful crises. Non-opioids have a ceiling effect, a dose above that which has no additive analgesic effect, and are associated with serious systematic side effects. On the other hand, the serious complications of opioids that need consideration are hyperalgesia, tolerance, physical dependency, withdrawal, pseudo addiction and addiction [7,8].

Results

The data highlights that there is no significant decrease in pain scores from day 2 to day 3 (p-value = 0.107) despite a large increase in hydromorphone dose. In addition, there was no statistically significant correlation between pain scores and hydromorphone dose on day 3 of admission (p-value = 0.064) while on days 1 and 2 there were significant correlations with p-values of 0.033 and 0.002 respectively. This suggests that the large increase of hydromorphone on day 3 did not yield a significant decrease in pain and therefore did not provide the additional care that would be expected with the increase in medication [9-11].

Figure 1: Baseline Demographics (Mean ± SD)

Age	27±9.6
Length of Admission (Days)	8±6.3
Initial ED Pain Score (1-10)	9±1.1
Sex (Male: Female)	18:22

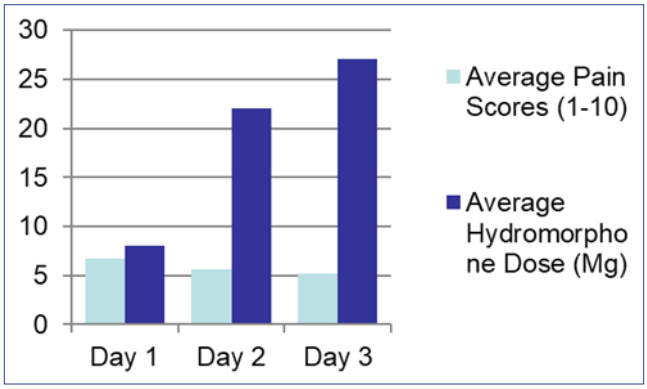

Table 2: Average Pain score vs. average hydromorphone dose daily

	Hydromorphone	Dose (Mg)	NRS Pain Score	(0-10)
	Average Dose	Standard Deviation	Average Score	Standard Deviation
Day # 1	7.8	18.62	6.7	1.9
Day # 2	22.30	28.68	5.7	1.9
Day # 3	27.59	34.20	5.2	2.1

Conclusion

The data suggests that increasing the dose of hydromorphone does not lead to a significant decrease in pain scores. Rather, the disparities between average pain scores in the first three days remains minimal despite the increasing average daily dose of hydromorphone. This is significant because it suggests that lower doses of hydromorphone may be adequate to treat painful episodes in SCD patients, thereby potentially exposing patients to fewer side effects. Risks of prescribed opioids include vomiting, dizziness, drowsiness, nausea and constipation. The data therefore suggests that further studies are warranted to verify our findings and also to establish the lowest possible dose of opioids that can control pain in SCD patients [12,13].

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