Impact of a Clinical Decision Support Tool on Cancer Pain Management in Opioid-Tolerant Inpatients

Hospital Pharmacy
2018, Vol. 53(4) 256–262
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sagepub.com/journalsPermissions.nav
DOI: 10.1177/0018578717746369
journals.sagepub.com/home/hpx

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Abstract

Background: Pain is both common and undertreated in the hematology/oncology population despite national guidelines and a focus from The Joint Commission. **Objective:** Herein, we describe the features of a pain clinical decision support tool (PCDST) embedded into the electronic medical record (EMR) and report its impact on oncology inpatients at risk for uncontrolled pain. **Methods:** The PCDST was developed to identify patients with potentially uncontrolled pain, defined as a pain score ≥ 4 . Clinical pharmacists were encouraged to use the tool to determine whether interventions were needed to better control pain. Pain and safety outcomes between 2 cohorts of opioid-tolerant adult inpatients presenting with severe pain were compared prior to and following the implementation of the PCDST. **Results:** The primary endpoint, attainment of analgesia at 24 hours from admission, was met in 10 of 30 (33.3%) patients in the preimplementation group and in 14 of 32 (43.8%) of patients in the postimplementation group ($P = .78$). Secondary endpoints including time to analgesia, mean pain score, frequency of pharmacy intervention, and National Comprehensive Cancer Network (NCCN) guideline-adherent pain regimens were not found to be statistically significantly different between the 2 groups. The number of mean nursing pain assessments in the first 24 hours from admission was found to be significantly higher in the postimplementation group compared with the preimplementation group (12 vs 7.4, $P < .001$). Safety events were rare and not statistically different between groups. **Conclusion:** Overall, a modest, but statistically nonsignificant, improvement in pain outcomes was associated with patients admitted after the implementation of a pharmacist-managed electronic pain scoring tool.

Keywords

pain management, analgesics, drug/medical use evaluation, monitoring drug therapy, oncology

Introduction

Pain is a common complication of cancer and is experienced by an estimated 55% to 66% of patients undergoing active chemotherapy treatment and 39% of patients after curative treatment.¹ Pain negatively impacts cancer patients' comfort, social well-being, and quality of life and is one of the most feared symptoms identified by patients.² In addition, it has been suggested that pain control is associated with improved survival via early incorporation of palliative care services.³ National practice guidelines published by the National Comprehensive Cancer Network (NCCN) and the World Health Organization are well-recognized standard-of-care approaches to the management of cancer pain.^{4,5} These guidelines focus on the importance of high-quality patient pain assessment (type, location, intensity) and proper pharmacologic and nonpharmacologic treatments. Despite the availability of these practice guidelines and regulatory pressure, 1 in 3 cancer patients still struggle to achieve adequate pain control.^{6,7}

Previous research at our institution identified opioid-tolerance as a risk factor for worse pain control 24 hours after admission and a higher likelihood for inadequate therapy, defined as nonadherent to NCCN guideline recommendations.⁸ Two major gaps were identified from the pharmacist's perspective: (1) methods for identification of patients with potentially uncontrolled pain (2) relevant pain assessment data were located in multiple areas of the electronic medical record (EMR). Therefore, the authors of this study developed a pain clinical decision support tool (PCDST) designed to identify patients for potentially uncontrolled pain, defined as a pain score of greater than or equal to 4. In addition, a summary report was developed to include information on analgesic

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administration, vital signs, pain assessment information, and laboratory data. The PCDST was designed to aid the pharmacist in identifying patients who require assessment and display patient-specific information to assist clinical decision making.

Pharmacists have been shown to improve pain outcomes in both cancer and noncancer patients in both the inpatient and outpatient settings.⁹⁻¹¹ Furthermore, clinical decision support tools (CDSTs) have demonstrated improvement in guideline adherence, pain relief, and safety, but studies supporting CDSTs have generally been methodologically weak with no focus on the impact of pharmacist-managed CDSTs.¹²⁻¹⁵ Therefore, we set out to assess the impact of a pharmacist-managed PCDST on opioid-tolerant inpatient oncology patients at risk for uncontrolled pain.

Methods

This study was a single-center, retrospective, cohort study, conducted at the University of Chicago Medicine and approved by the Biological Sciences Division Institutional Review Board. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. All adult patients admitted to the inpatient hematology/oncology service who received at least 1 dose of long-acting opioid were included in the analysis. Patient selection included patients with solid tumors and hematologic malignancies and/or history of stem cell transplant. A historical cohort of patients from 2011 was used from a previous study at our institution.⁸ The postimplementation group was evaluated between November 1, 2013, and January 15, 2014. Patients were excluded if any of the following applied: initial pain score was less than 4, length of stay was less than 24 hours, patient-controlled analgesia (PCA) or continuous infusion opioids were used, initial admission was to a nononcology service, or if there was incomplete information.

Data Collection

Baseline characteristics including age, sex, presence of metastatic disease, opioid allergy, serum creatinine, alanine aminotransferase (ALT), aspartate transaminase (AST), and total bilirubin were recorded. Renal dysfunction was defined as a calculated creatinine clearance less than 50 mL/min, and hepatic dysfunction was defined as total bilirubin, AST, or ALT greater than 3 times the upper limit of normal. Pain scores were recorded from admission through hour 28, as this was the time point data collected in the published preimplementation data.⁸ Opioid medications prior to admission were obtained as recorded in the electronic medical record to assess for opioid tolerance. Pharmacist intervention was measured through i-Vents, an electronic tool to document specified interventions, in the EPIC EMR. Safety data including respiratory rate, oxygen saturation, and naloxone use were recorded.

Table 1. Long-Acting Opioids for Screening in Drug Utilization Review.

Opioid	Strength	Dosage form
Fentanyl	12 mcg/h	Transdermal patch
Fentanyl	25 mcg/h	Transdermal patch
Fentanyl	50 mcg/h	Transdermal patch
Fentanyl	100 mcg/h	Transdermal patch
Methadone	5 mg	Tablet
Methadone	10 mg	Tablet
Methadone	10 mg/mL	Oral liquid
Morphine	15 mg	SR tablet
Oxycodone	10 mg	SR tablet
Oxycodone	20 mg	CR tablet
Oxycodone	40 mg	CR tablet

Note. SR = sustained release; CR = controlled release.

Definitions and Endpoints

Opioid tolerance was defined as the patient receiving at least 60-mg oral morphine/day or equivalent, including 25-mcg transdermal fentanyl/hour, 30-mg oral oxycodone/day, 8-mg oral hydromorphone/day, 25-mg oral oxymorphone/day, or an equianalgesic dose of another opioid for 1 week or longer. Identification of inpatient long-acting opioid use was used by an electronic drug utilization review (Table 1). Note that due to hospital formulary, multiple oral or transdermal dosage forms are combined to obtain the prescribed dose. Attainment of analgesia was defined as a pain score ≤ 4 or a 50% reduction in pain from baseline (baseline pain scores of 9 required a pain score of 4 in order for analgesia to be considered attained). A pain score of 4 was used based on institutional policy recommending more frequent pain assessment in patients reporting a pain score of 4 or greater. Adherence to NCCN guidelines for opioid-tolerant patients was defined as patients receiving 10% to 20% oral morphine equivalent of short-acting opioid with respect to their total daily dose. The primary endpoint was attainment of analgesia at 24 hours from admission. Secondary endpoints included time to analgesia (in patients achieving analgesia in ≤ 28 hours), mean pain score, number of pain score nursing assessments in the first 24 hours, frequency of pharmacy intervention, and percent of patients with NCCN guideline-adherent pain regimens. Safety endpoints included opioid-induced adverse events including respiratory rate less than 10 breaths per minute, oxygen saturation less than 90%, and naloxone use.

Pharmacist Training

All clinical pharmacists, including pharmacy residents, received training on use of the PCDST prior to the implementation in November 2013. The hematology/oncology clinical specialists had access to the tool prior to expanding

its use to the entire pharmacy staff to identify clinical and technology issues before dissemination to the entire staff. An electronic communication emphasizing the importance of pharmacy interventions being documented in the electronic medical record was also sent to the clinical pharmacy group. After PCDST implementation, regular feedback was sought from clinical pharmacists regarding their experience with the tool and areas for improvement.

Statistical Analysis

Chi-square analysis was used for nominal data including the primary endpoint, NCCN guideline adherence, and baseline characteristics. An unpaired 2-sided *t* test was used for continuous data. *Z* tests were used for safety data. The Mann-Whitney *U* test was used for ordinal data. Microsoft Excel 2010 was used for statistical analysis. We anticipated requiring a total of 70 patients, or 35 in each group, to detect an estimated difference of 30% between groups with a β of 0.80 and 2-sided α of 0.05 based on 33% attainment of analgesia in the baseline preimplementation group.⁸

Results

Development of PCDST

The PCDST, a clinical decision support tool, was designed as an application within the University of Chicago Medicine information system (Epic Systems Corporation, Verona, Wisconsin). The tool enables a systematic and transparent approach to patient prioritization based on the display of the most recent and maximum pain score, which can be seen in Figure 1. Patients with a most recent pain score of 8 or greater are displayed as a red colored box in the column; those with a pain score of 4 to 7 are displayed as blue. Patients with a most recent pain score of 5 or greater are displayed in the box as well. Those with a pain score of greater than or equal to 4 in the past 24 hours are displayed with a red down arrow signifying that while the patient's pain has recently improved, review of the patient's pain regimen by a pharmacist may be beneficial. The pharmacist may document that the pain management of a patient has been reviewed by placing a "check mark" to keep track of patient pain review status within the EMR. A screenshot of the patient list and PCDST is displayed in Figure 1.

Baseline Characteristics

The study population included 39 patients in the preimplementation group and 32 patients in the postimplementation group. The demographic information for the 2 groups were similar, with the exception of a higher incidence of metastatic disease and a statistically nonsignificant higher median opioid dose in the preimplementation group (Table 2).

Study Endpoints

All study endpoints are summarized in Table 3. The primary endpoint, attainment of analgesia at 24 hours from admission, was met in 10 of 30 (33.3%) in the preimplementation group and 14 of 32 (43.8%) in the postimplementation group. While a 10.5% absolute difference was found between groups, statistical significance was not reached ($P = .78$). The secondary endpoint of mean frequency of nursing pain assessments was higher in the postimplementation group compared with the preimplementation group (12 vs 7.4, $P < .001$).

Safety Endpoints

Safety endpoints (summarized in Table 4) included respiratory rate less than 10 breaths per minute, oxygen saturation $<90\%$, and use of naloxone during the entire admission. Overall, rates of adverse events were rare and not different between groups.

Influence of Time of Admission

When time of patient admission was analyzed with respect to pain outcomes, fewer patients who were admitted in the 1501-2300 timeframe (5 of 15) achieved analgesia at 24 hours when compared with those admitted during 0701-1500 and 2301-0700 (7 of 12 and 4 of 5, respectively) (Figure 2).

Discussion

Pain and safety outcomes were assessed in opioid-tolerant adult hematology/oncology inpatients presenting with severe pain prior to and following the implementation of a pharmacist-managed PCDST. A nonsignificant 10% difference in achievement of analgesia was found ($P = .78$); however, the study was initially powered to detect a 30% difference based on a previous study at our institution and trials documenting the influence of a clinical pharmacist on improving guideline adherence. The feasibility of conducting a study to detect this level of difference was determined not to be feasible based on resources available, as an estimated 776 patients would need to detect the 10% difference that was found. For this reason, further expansion of the study populations was not pursued.

Factors such as lack of pharmacist familiarity with and use of the pain scoring tool may play a role in the outcomes. Although the clinical pharmacy staff was trained on the use of the tool, the study inclusion date in the postimplementation group was immediately after training due to the timeline of the project. This may not have allowed enough time for the pharmacy staff to become familiar with the tool. It is also difficult to assess pharmacist adherence with the tool and whether pharmacists are using it consistently.

Figure 1. The PCDST report includes a chart of laboratory values and vital signs relevant to pain and pain medication assessment including liver function tests, respiratory rate, heart rate, and blood pressure as a function of time.
 Note. A line graph was used to visually display the pain score on a scale of 0 to 10 on the y-axis and time on the x-axis allowing the provider to correlate pain scores with analgesic administration. A list of the current ordered analgesic medications, doses, routes, and frequency is listed at the bottom of the PCDST as well as the analgesic history of ordered medication throughout the admission. © 2017 Epic Systems Corporation. Used with permission. PCDST = pain clinical decision support tool.

Table 2. Baseline Characteristics in Preimplementation and Postimplementation Groups.

Characteristics	Preimplementation group, n (%) (n = 30)	Postimplementation, n (%) (n = 32)	P value ^a
Mean age, y (SD)	56.1 (10.3)	56.0 (12.9)	.97 ^b
Age greater than 65 y	6 (20%)	6 (18.8%)	.9 ^c
Sex, percent male	12 (40%)	14 (43.8%)	.77 ^c
Renal dysfunction	4 (13.3%)	7 (21.9%)	.39 ^c
Hepatic dysfunction	2 (6.7%)	3 (10.3%)	.62 ^c
Metastatic disease	21 (70%)	12 (37.5%)	<.001 ^c
Allergy to opioids, percent allergic	7 (23.3%)	3 (10.3%)	.14 ^c
Median home opioid dose, milligram oral morphine equivalent (interquartile range)	184 (212)	130 (107.5)	.32 ^b

^aP value <.05 indicates statistical significance.^bt test.^cChi-square.**Table 3.** Study Endpoints: Comparison of Preimplementation and Postimplementation of a Pain Clinical Decision Support Tool.

	Preimplementation group, n (%) (n = 30)	Postimplementation group, n (%) (n = 32)	P value ^a
Attainment of analgesia at 24 h	10 (33.3%)	14 (43.8%)	.78 ^b
Time to analgesia, h (SD)	14 (8.5)	15.9 (7.9)	.59 ^c
Mean pain score at admission (SD)	6.3 (2.8)	7.4 (1.9)	.063 ^c
Mean pain score over first 28 h (SD)	4.9 (2.0)	4.2 (1.6)	.11 ^d
Frequency of pharmacy intervention			
Within first 24 h	5 (17.2%)	4 (12.5%)	.65 ^c
During entire admission	9 (31.0%)	18 (56.3%)	.32 ^c
Mean frequency of pain assessment in first 24 h (IQR)	7.4 (3.75)	12.0 (4.25)	<.001 ^c
NCCN guideline–adherent pain regimen, n (%)	12 (40.0%)	15 (46.9%)	.97 ^b

Note. IQR = interquartile range; NCCN = National Comprehensive Cancer Network.

^aP value <.05 indicates statistical significance.^bChi-square.^ct test.^dMann-Whitney U test.**Table 4.** Safety Endpoints.

	Preimplementation group, n (%) (n = 28)	Postimplementation group, n (%) (n = 32)	P value ^a
Respiratory rate <10 breaths per minute	3 (10.7%)	1 (3.1%)	.24 ^b
Oxygen saturation <90%	3 (10.7%)	3 (9.4%)	.87 ^b
Naloxone use during admission	1 (3.4%)	0 (0.0%)	.29 ^b

^aP value <.05 indicates statistical significance.^bZ test.

Another consideration is the effect of the timing of patient admissions with pain outcomes and use of the pain scoring tool. It was found that fewer patients achieved analgesia if they were admitted between 1501-2300 compared with those admitted between 0701-1500 and 2301-0700. While many factors may contribute to this outcome, we also predict that the pain scoring tool is being used less within these hours as our pharmacy services shift to a higher emphasis on operation functions overnight. While it was

found that there was not a statistically significant increase in NCCN guideline–adherent pain regimens between the preimplementation and postimplementation groups, an interesting correlation in the rate of improvement with respect to the primary endpoint was observed. Guideline-adherent pain regimens increased 6.9% after the addition of the pain scoring tool, and attainment of analgesia increased 10.5%, suggesting guideline adherence may positively influence analgesia attainment (Figure 3).

Figure 2. Attainment of analgesia as a function of the time period patients were admitted is represented. The total number of patients admitted is plotted where the black area on the bar graph indicates the patients in which analgesia was attained at 24 hours.

Figure 3. Percent of patients meeting the specified endpoint, NCCN guideline–adherent therapy, and attainment of analgesia is displayed. A similar improvement was observed between groups suggesting a positive relationship between guideline adherence and pain outcomes.

Note. NCCN = National Comprehensive Cancer Network.

The majority of the secondary endpoints including time to analgesia, mean pain score, frequency of pharmacy intervention, and NCCN guideline–adherent pain regimens were not found to be statistically significantly different between the 2 groups. While the study was not powered to address these endpoints, we anticipate that being underpowered to detect a difference in the primary endpoint resulted in these endpoints being underpowered as well. Time to analgesia was approximately 2 hours earlier in the preimplementation group which is surprising given the trend toward improved analgesia in the postimplementation group at 24 hours and increased frequency of nursing pain assessment which has been associated with improved pain outcomes.⁸ Mean pain score during the study period was found to be slightly lower in the postimplementation group, but this endpoint failed to reach significance. Pain score at admission was found to be higher in

the postimplementation group, which trended toward significance ($P = .085$), signifying a further improvement in baseline pain score was required to achieve analgesia in this group. Pharmacy intervention associated with opioid therapy was essentially equal within the first 24 hours of admission but trended toward an increased number of pharmacist intervention per patient when assessed over the entire admission. This may be due to electronic communication sent to the clinical pharmacy staff encouraging documentation of interventions. However, we also suspect that pharmacy intervention was underdocumented in both patient groups based on department feedback. Adherence to NCCN guidelines was found to increase by about 7% following implementation of the pain scoring tool, which indicated that approximately half of the patients were receiving guideline-adherent therapy. While we anticipated higher rates of NCCN guideline

adherence, it may be that patients' opioid regimens move toward being guideline-adherent after the initial 24-hour period, which was not assessed during the study period. Interestingly, the median number of nursing pain assessment within the first 24 hours of admission was 3.5 assessments higher in the postimplementation group compared with the preimplementation group. This is certainly a positive finding as increased pain assessments have been associated with improvement in analgesia rates, but the pain scoring tool did not have a direct effect on this endpoint.⁸

Safety endpoints of bradypnea, hypoxia, and naloxone use were infrequent, similar among groups, and likely not affected by the pain score tool. Upon chart review, it was found that several of the hypoxic events were not opioid-related but the result of the removal of a patient's nasal cannula either accidentally or through a planned breathing trial.

Attainment of analgesia was compared in opioid-tolerant adult hematology/oncology inpatients presenting with severe pain. A modest, but statistically nonsignificant, improvement in pain outcomes was associated with the group exposed to the pain scoring tool; however, the study was found to be underpowered to detect this difference.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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