OPEN

Evidence-Based Practice Standard Care for Acute Pain Management in Adults With Sickle Cell Disease in an Urgent Care Center

Sunghee Kim, DNP, RN, ANP-BC, NP-C; Ron Brathwaite, MD; Ook Kim, MD

Background: Vaso-occlusive episodes (VOEs) with sickle cell disease (SCD) require opioid treatment. Despite evidence to support rapid pain management within 30 minutes, care for these patients does not consistently meet this benchmark. This quality improvement study sought to decrease the first analgesic administration time, increase patient satisfaction, and expedite patient flow. **Methods:** A prospective pre-/postevaluation design was used to evaluate outcomes with patients 18 years or older with VOEs in an urgent care (UC) center after implementation of evidence-based practice standard care (EBPSC). A pre- and postevaluation survey of SCD patients' satisfaction with care and analogous surveys of the UC team to assess awareness of EBPSC were used. A retrospective review of the electronic medical records of patients with VOEs compared mean waiting time from triage to the first analgesic administration and the mean length of stay (LOS) over 6 months. **Results:** Implementing EBPSC decreased the mean time of the first analgesic administration ($P = .001$), significantly increased patient satisfaction ($P = .002$), and decreased the mean LOS ($P = .010$). **Conclusion:** Implementing EBPSC is a crucial step for improving the management of VOEs and creating a positive patient experience. The intervention enhances the quality of care for the SCD population in a UC center.

Key words: acute pain management, guidelines, sickle cell disease

PURPOSE AND REVIEW OF LITERATURE

Despite improving survival rates for sickle cell disease (SCD),[1] vaso-occlusive episodes (VOEs) remain inadequately managed. As a result, patients suffer needlessly from uncontrolled acute pain.[2]

SCD is an inherited blood disorder that is characterized by acute pain episodes. Sickled red blood cells clump and attach to the walls of blood vessels, leading to vessel obstruction and ischemia, which, in turn, cause tissue hypoxia and intense pain. VOEs, the clinical hallmark of SCD, are the most common reason for emergency department (ED) visits and admissions for this population.[3]

Significance

SCD affects approximately 100 000 Americans,[4] and an additional 3 million carry the sickle cell trait.[5] From 1989 to 1993, an average of 75 000 hospitalizations occurred in the United States because of SCD, incurring approximately $475 million in medical costs.[4] Higher rates of resource utilization among SCD patients were found among those aged 18 to 30 years.[6] Rehospitalization rates at 30 days for SCD are 30% to 47%, and 14-day rates are 22.1%.[7]

Patient experience

Negative experiences in hospital

Patients with VOEs have reported significant negative hospital experiences, characterized by significant delays in pain control, mistrust, stigmatization, lack of autonomy over one's treatment, negligent care, poor monitoring of vital signs, and lack of psychosocial support.[2,8]

Barriers

Inadequate acute pain management for SCD stems partly from problems in the patient-provider relationship regarding this disease. Prejudice about drug abuse leads to disagreements between ED medical providers and SCD patients—53% of ED physicians and 23% of hematologists believed that more than 20% of SCD patients were addicted to narcotics and were disinclined to administer high-dose, parenteral opioids due to fears about the patient's narcotics addiction.[9,10] However, the prevalence of opioid addiction in SCD patients is 2%—lower compared with addiction in other chronic

Author Affiliations: *Department of Family Medicine, Loma Linda University Medical East Campus Hospital Urgent Care, Loma Linda, California (Drs S. Kim and Brathwaite); and Department of Internal Medicine, Loma Linda University Medical Center, Loma Linda, California (Dr O. Kim).*

Correspondence: *Sunghee Kim, DNP, RN, ANP-BC, NP-C, Loma Linda University Medical East Campus Hospital Urgent Care, 25333 Barton Rd, Loma Linda, CA 92354 (sgkim@llu.edu).*

The authors thank Mary Terhaar, DNSc, RN, FAAN, Associate Dean of Academic Affairs, Case Western Reserve University School of Nursing, for being an advisor. The authors also thank Ramon Issa, MD, Medical Director of the Urgent Care Center, Department of Family Medicine, Loma Linda University Medical East Campus Hospital and the Urgent Care, nursing staff.

The authors declare no conflict of interest.

Q Manage Health Care
Vol. 26, No. 2, pp. 108–115

DOI: 10.1097/QMH.0000000000000135

pain syndromes.[11] Negative attitudes from providers and lack of knowledge have been identified as critical barriers to effective pain management in SCD and have led to poor adherence to current analgesic protocols.[12]

Rapid pain management within 30 minutes from triage for VOEs is a well-supported evidence-based guideline for treating this population.[13] Yet, despite the literature in support of this standard of care, health care teams remain nonadherent, leading to inadequate pain management of SCD patients. Although this quality improvement (QI) study was conducted in the United States, it is applicable to practices worldwide because inadequate management of VOEs in patients with SCD is a global issue.[14,15]

Current guidelines and recommendations

A plethora of clinical guidelines exist regarding VOEs in patients with SCD. The clear and consistent message of these guidelines is that VOEs in patients with SCD require rapid assessment, evaluation, administration of analgesics, and initial pain control to be performed within 30 minutes of triage.[3,14-23]

Current evidence has demonstrated statistically significant outcomes for SCD patients with triage guidelines, fast-track algorithms, ED-based pain protocols, standardized ED analgesic protocols, and use of clinical pathways. The success of these interventions depends on the education of patients, nurses, and health care providers. The outcomes of these interventions include improved pain management, hospital revenue, utilization of primary care clinics, and compliance with standard practice patterns and reduced admissions, length of stay (LOS), repeat ED visits, and 30-day readmission rates.[6,17,24-30] Consequently, developing a set of quality measures and implementing evidence-based practice (EBP) clinical guidelines have the potential to improve health outcomes of SCD.[31,32]

The purpose of this QI study was to improve the timeliness of pain management for adult patients with SCD who are experiencing VOEs by translating EBP guidelines and recommended best practices into action-oriented standard care. The aims of the project were to decrease the time from triage until the first analgesic administration, increase patient satisfaction regarding acute pain control, and expedite patient flow by implementing an evidence-based practice standard care (EBPSC)—a visual algorithm flowchart for patients with VOEs.

METHODS

Setting and participants

The implementation site was an urban academic tertiary medical center urgent care (UC) unit. The inclusion criteria were as follows: age 18 years or greater with a final diagnosis of SCD crisis (ICD-10 code D57.00, D57.219, or ICD-9 code 282.62) and treatment with analgesics of patients while in the UC center without regard to their final disposition (admitted or discharged). The exclusion criteria were age less than 18 years or chief complaint unrelated to VOEs in patients with SCD. The patient sample size was estimated by data abstraction from a prior study[27] using the following assumptions: μ (0) = 293 "known" mean value for SCD population; μ (1) = 236 "expected" mean" value from sample; σ (standard deviation) = 154 for the population; 2-sided test; $\alpha = .05$; and $\beta = .8$. A sample of 58 patients per group was required to estimate a difference in time to initial administration of analgesic of 30 minutes and in LOS from triage to disposition in the UC center.

This QI study was reviewed by the institutional review board at the implementation site and granted a waiver from informed consent on June 25, 2015.

Intervention

The EBPSC (Figure 1), including computerized triage order sets, was developed and implemented on July 31, 2015. The 6-month period from July 31, 2014, to January 31, 2015, served as the historical control ("pre"), and another 6-month period, July 31, 2015, through January 31, 2016, was defined as the intervention period ("post"). The study used the same 6-month period in 2 consecutive years (2014 and 2015) to account for any seasonal confounding variables. Staff members attended 7 formal education workshops and informal meetings to facilitate their understanding of the action-oriented EBPSC before and during implementation of the EBPSC. S. K. conducted 10- to 15-minute educational lectures during the monthly staff meeting with PowerPoint presentations, storyboards, academic handouts, and posters from March 2015 to March 2016. S. K. provided 3 formal education sessions with a 30- to 60-minute PowerPoint presentation during provider meetings before and after the EBPSC implementation and several informal face-to-face educational sessions during the S. K.'s working hours.

Design

A prospective pre-/postevaluation design was used to compare postimplementation outcomes with a preimplementation convenience sample of patients 18 years or older who presented with VOEs in the UC center. A retrospective review of the electronic medical records (EMRs) of patients with VOEs compared mean waiting time from triage to the first analgesic administration and the mean LOS in the UC center during 6 months preimplementation versus 6 months postimplementation of the EBPSC. Data were collected through a pre- and postevaluation survey of SCD patients to assess their satisfaction with the level of pain control and through analogous surveys of staff and providers to assess attitude and awareness of EBPSC.

A 16-item preevaluation provider survey and a 13-item preevaluation staff survey were developed by the S. K. and adapted from existing evidence.[19] The surveys included questions regarding demographics, practice patterns, awareness of EBP guidelines, and attitudes toward the population with SCD. To measure providers' and staff members' attitudes, the

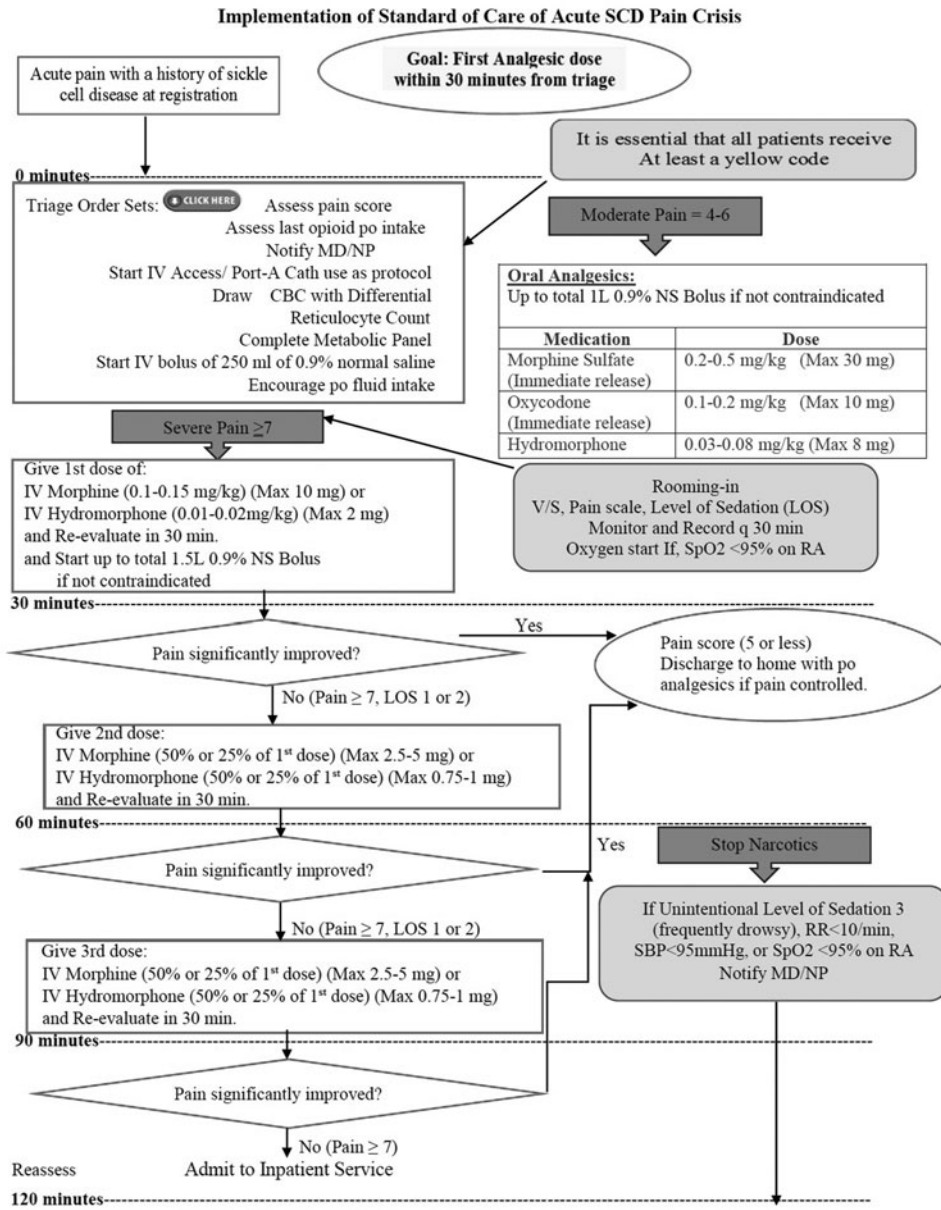

Figure 1. Evidence-based practice standard of care algorithm for vaso-occlusive episodes in patients with SCD. SCD indicates sickle cell disease; CBC, complete blood cell count; LOS, length of stay.

S. K. administered 2 previously validated items from the Positive Provider Attitudes Toward Sickle Cell Patients Scale. Haywood et al[28] reported good reliability (Cronbach α = 0.76-0.89) on attitude items. A 9-item postevaluation provider and staff survey consisted of items from the preevaluation survey to measure differences in practice patterns and attitudes toward SCD patients after implementing the EBPSC. Postevaluation surveys for providers and staff included questions regarding demographics (4 items), awareness of EBP guidelines (4 items), and attitudes toward the population with SCD (1 item). S. K. also developed a 9-item survey of SCD patients' UC center experiences, based on a literature review of acute pain management in the ED. The patient survey was a 9-item Likert-based scale (5 = very satisfactory; 4 = satisfactory; 3 = fair; 2 = low; 1 = very low), covering demographics (3 items) and experience with acute pain management in the UC center (6 items).

Data collection

Data collection began on July 31, 2014, and lasted through January 31, 2016. The list of patients with VOEs in the UC center was retrieved from the coding Department of Family Medicine. Pertinent data were abstracted from the patient's EMR. In addition, pre- and postevaluation surveys of SCD patients, nursing staff, and providers were collected. All surveys

were anonymous. Web-based survey software, Survey Monkey, and paper surveys were used for the providers and staff.

Patients' surveys were collected through a Web-based survey software, Survey Monkey, and paper surveys at community SCD support group meetings, the bedside, and the outpatient SCD clinic.

Statistical analysis

Data were analyzed using IBM Statistical Package for Social Sciences (Chicago, Illinois), version 22.0, for Windows. To assess the accuracy of data entry by the S. K., O. K. reviewed the charts independently. Descriptive statistics were generated for all categorical and continuous variables for the pre- and postimplementation groups. The independent *t* test and the χ^2 test were used to compare continuous and categorical data as appropriate. Pearson's *r* correlation test was used to compute the relationship between initial analgesic administration time (minutes) and LOS (minutes) in the UC center from triage to disposition. A *P* value of less than .05 was considered statistically significant.

RESULTS

Pre- and postimplementation group characteristics

A total of 124 (pre: 61; post: 63) adult patients with VOEs in the UC center were included in the QI study. Demographics and clinical characteristics are reported in Table 1. No statistically significant differences in group characteristics were found between the pre- and postimplementation groups. Subject demographics and sickle genotypes were similar between the 2 groups, including age, gender, race, pain score in triage, type of first analgesic, disposition, and whether patients were on hydroxyurea therapy. However, patients aged between 18 and 27 years with VOEs had the highest UC center utilization rates.

Primary outcomes

All primary outcome measures demonstrated statistically significant improvements (Table 2).

Aim 1: Mean time to first analgesic administration from triage decreased from 92 minutes (SD = 59) to 62 minutes (SD = 37) ($P = .001$).

Table 1. Demographics and Clinical Characteristics of Patient Groups

Characteristics	Pre (n = 61)	Post (n = 63)	*P*
Age, mean ± SD, y	27.48 ± 4.66	25.98 ± 5.63	.698
Gender, n (%)			.369
Female	53 (86.9)	51 (81)	
Male	8 (13.1)	12 (19)	
Race, n (%)			
African American	61 (100)	63 (100)	
Sickle genotype, n (%)			.108
HbSS	24 (39.3)	26 (41.3)	
HbSC	2 (3.3)	1 (1.6)	
HbSβ+		4 (6.3)	
HbSβ°			
Unspecified	35 (57.4)	32 (50.8)	
Pain score in triage, mean ± SD	8.4 ± 1.2	8.4 ± 1.4	.227
First analgesic, n (%)			.109
Opioid (intravenous)	59 (96.7)	55 (87.3)	
NSAID (intravenous)	2 (3.3)	7 (11.1)	
Other (oral)		1 (1.6)	
Hydroxyurea use, n (%)			.432
Yes	40 (65.6)	37 (58.7)	
No	21 (34.4)	26 (41.3)	
Disposition, n (%)			.714
Home	11 (18)	13 (20.6)	
Admission	50 (82)	50 (79.4)	

Abbreviations: HbSβ°, sickle β° thalassemia; HbSβ+, sickle β+ thalassemia; HbSC, sickle hemoglobin C disease; HbSS, sickle hemoglobin SS disease; NSAID, nonsteroidal anti-inflammatory drug.

Table 2. Comparison of Primary Outcomes Pre- and Postimplementation

	Pre (n = 61), Mean ± SD	Post (n = 63), Mean ± SD	*P*
Time to first analgesic from triage, min	92.44 ± 58.7	61.95 ± 36.7	.001[a]
	Pre (n = 26), n (%)	**Post (n = 25), n (%)**	***P***
Patient satisfaction with acute pain management			.002[b]
Unsatisfactory	20 (76.9)	8 (32.0)	
Satisfactory	6 (23.1)	17 (68.0)	
	Pre (n = 61), Mean ± SD	**Post (n = 63), Mean ± SD**	***P***
Time to disposition from triage, min	283.31 ± 168.7	255.56 ± 96.5	.010[a]

[a]Statistically significant independent *t* test ($P < .05$).
[b]Statistically significant χ^2 test ($P < .05$).

Aim 2: Patient satisfaction with acute pain management in the UC center increased from 23% to 68% who were satisfied before versus after implementation of the EBPSC (Fisher's exact test $P = .002$). A total of 26 preevaluation surveys and 25 postevaluation surveys were collected.

Aim 3: Mean time to disposition from triage declined significantly from 283 minutes (SD = 169) to 256 minutes (SD = 97) ($P = .010$).

Secondary outcomes

Initial analgesic administration time (minutes) was directly related to LOS (minutes) in the UC facility from triage to disposition: the briefer the time between triage and administration, the shorter the time until disposition ($r = 0.223$; total N = 124; $P = .013$) (Figure 2). Pain reassessment within 30 minutes after initial analgesic administration increased from 24.6% preintervention to 42.9% postintervention ($P = .032$). Patients' perception of receiving empathy increased from 23.1% preintervention to 64% postintervention (Fisher's exact test, $P = .005$) and shared decision making of acute pain management increased from 26.9% to 68%, respectively (Fisher's exact test, $P = .005$). Administration of the second dose of analgesic within 30 minutes after initial analgesic dose was unchanged ($P = .375$) as were 30-day readmission rate (pre: 31%; post: 19%; $P = .120$) and discharged home from the UC center (pre: 18%; post: 20.6%; $P = .714$) (Tables 3 and 4).

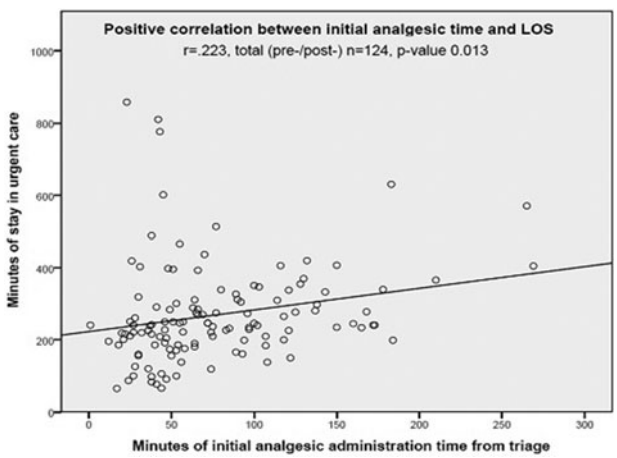

Figure 2. Correlation between time to initial analgesic dose and LOS. Minutes of initial analgesic administration time was related to minutes of LOS in the urgent care center from triage ($r = 0.223$; total N = 124 [pre: 61/post: 63]; $P = .013$). LOS indicates length of stay.

Data were collected through a pre- and postevaluation survey of UC providers (pre: 15/post: 21) and staff (pre: 14/post: 15) to assess attitudes and awareness of the EBPSC. The results demonstrated improved provider awareness of rapid pain management within 30 minutes from triage, from 80% preintervention to 95% postintervention ($P = .254$). Inadequate pain assessment tools were identified by 42% of 36 providers (pre: 15/post: 21) as the greatest barrier to rapid pain management. Staff awareness of guidelines that required rapid pain management within 30 minutes from triage increased from 28.6% preintervention to 100% postintervention (χ^2 test, $P = .000$). Among the staff, 45% (n = 29; pre: 14/post: 15) identified lack of time or overcrowding in the UC center as the greatest barrier in the management of VOEs in patients with SCD. The percentage of staff who believed that SCD patients were drug-addicted declined from 57.1% preintervention to 33% postintervention (likelihood ratio $\chi^2 = 6.723$, df = 5, $P = .242$).

DISCUSSION

The implementation of EBPSC, including computerized triage order sets and education for the UC team, was associated with improvements in VOE pain management in patients with SCD during the implementation period. However, multiple confounding variables were identified and potentially affected project outcomes.

System factors

Overcrowding and unpredictable surges in volume in this UC setting, where the average daily census is 90,

Table 3. Secondary Outcomes From Pre- and Postimplementation of Evidence-Based Practice Standard Care

	Pre (n = 61), n (%)	Post (n = 63), n (%)	*P*
Time to second analgesic after initial analgesic, min			.375
Not given	19 (31.1)	10 (15.9)	
0-30	5 (8.2)	4 (6.3)	
31-60	11 (18.0)	17 (27.0)	
61-90	12 (19.7)	11 (17.5)	
91-120	5 (8.2)	12 (19.0)	
121-150	5 (8.2)	4 (6.3)	
151-180	2 (3.3)	2 (3.2)	
≥181	2 (3.2)	3 (4.8)	
Pain reassessment within 30 min after initial analgesic			.032[a]
Yes	15 (24.6)	27 (42.9)	
No	46 (75.4)	36 (57.1)	
30-d readmission			.120
Yes	19 (31.1)	12 (19.0)	
No	42 (68.9)	51 (81.0)	
Disposition to home			.714
Yes	11 (18.0)	13 (20.6)	
No	50 (82.0)	50 (79.4)	

[a]Statistically significant χ^2 test ($P < .05$).

were challenging throughout the study. Both aspects had the potential to interfere with adoption among providers and staff. Another challenge was competing priority issues in this setting. In addition, this UC center prioritizes patients with trauma, stroke, heart disease, and sepsis. As a result, staff and providers cannot give priority to hemodynamically stable SCD patients: when UC center beds were occupied by patients with high-priority conditions, the waiting times for SCD patients lengthened significantly.

Table 4. Secondary Outcomes of Patients' Urgent Care Experiences Pre- and Postimplementation of the Evidence-Based Practice Standard Care

	Pre (n = 26), n (%)	Post (n = 25), n (%)	*P*
Receiving respect from urgent care team			.050
No	16 (61.5)	8 (32.0)	
Yes	10 (38.5)	17 (68.0)	
Receiving empathy from urgent care team			.005[a]
No	20 (76.9)	9 (36.0)	
Yes	6 (23.1)	16 (64.0)	
Sharing decision making			.005[a]
No	19 (73.1)	8 (32.0)	
Yes	7 (26.9)	17 (68.0)	

[a]Statistically significant $P < .05$.

Barriers

Resistance to change, lack of knowledge of EBP guidelines, nonacceptance of the evidence, and nonadherence by the UC team were barriers to be overcome. Some providers and staff did not grasp the importance of EBPSC for VOEs in patients with SCD. As a result, reinforcing communication channels was critical, as were anticipating and troubleshooting challenges during implementation. This QI study also involved establishing a new culture of quality within the work environment, requiring that team members follow quality guidelines themselves and consistently observe others taking quality-focused actions. Creating an environment in which quality-focused behavior is the norm can be a crucial first step in changing negative perceptions and stereotypes about the SCD population in the UC team. Furthermore, improving health care teams' knowledge of current EBP guidelines and rigorously evaluating outcomes allow the UC team to effectively meet population needs and understand the impact of practices that are grounded in strong evidence.

Limitations

This report was a single-site study that was conducted with small, convenience samples. Imperfections in EMR could have led to inaccurate recordings. Other potential sources of bias included the limitations that are

inherent to using a pre- versus postevaluation design and the Hawthorne effect from having providers and staff members collect UC center experience surveys in real time from patients in their care. The identified confounding variables might have masked an actual association. Furthermore, because this UC unit effectively functions as a sub-ED and thus differs from other UC settings, the effectiveness and sustainability of the EBP change of this project might be unsuitable for other ED or UC settings because patient flow patterns and severity of disease differ between sites.

Implications for future research

Implementing standard care is an effective means of translating strong evidence and experience into best practices to optimize care. However, health care teams and team members who harbor negative biases toward SCD patients might show low adherence to new EBPSC for acute VOE pain management. The barriers between EBPSC and day-to-day practice by health care team members deserve further research to improve care for acute SCD pain in multiple settings. The highest UC utilization group from this study echoes that in previous research,[6] indicating that patients with SCD rely more heavily on acute care settings for SCD care posttransition from pediatric to adult care.[33] These findings emphasize the need for more research to improve transition care in this population.

CONCLUSION

Health care teams should not ignore or underestimate SCD patients' pain. Implementing EBPSC and educating staff and providers about its function and need are crucial steps for improving the pain management of VOEs, creating a more positive patient experience, and routinizing the standard and quality care for the SCD population in the UC center. Even allowing for overcrowding in acute care settings, delays in acute SCD pain management can be overcome and the quality of care can be improved.

REFERENCES

1. Hamideh D, Alvarez O. Sickle cell disease related mortality in the United States (1999-2009). *Pediatr Blood Cancer*. 2013; 60(9):1482-1486.
2. Haywood C Jr, Tanabe P, Naik R, Beach MC, Lanzkron S. The impact of race and disease on sickle cell patient wait times in the emergency department. *Am J Emerg Med*. 2013;31(4):651-656.
3. Lovett PB, Sule HP, Lopez BL. Sickle cell disease in the emergency department. *Emerg Med Clin North Am*. 2014;32(3):629-647.
4. Centers for Disease Control and Prevention. Sickle cell disease: data & statistics. http://www.cdc.gov/ncbddd/sicklecell/data.html. Accessed April 3, 2016.
5. Sickle Cell Disease Association of America, Inc. About SCD & SCT. www.sicklecelldisease.org/. Accessed April 3, 2016.
6. Blinder MA. ED-based protocols speed care to sickle cell patients, reduce repeat ED visits, and discharge admitted patients earlier. *ED Manag*. 2013;25(4):37-40.
7. Leschke J, Panepinto JA, Nimmer M, Hoffmann RG, Yan K, Brousseau DC. Outpatient follow-up and rehospitalizations for sickle cell disease patients. *Pediatr Blood Cancer*. 2012;58(3): 406-409.
8. Weisberg D, Balf-Soran G, Becker W, Brown SE, Sledge W. "I'm talking about pain": sickle cell disease patients with extremely high hospital use. *J Hosp Med*. 2013;8(1):42-46.
9. Brown SE, Weisberg DF, Balf-Soran G, Sledge WH. Sickle cell disease patients with and without extremely high hospital use: pain, opioids, and coping. *J Pain Symptom Manage*. 2015;49(3): 539-547.
10. Tanabe P, Thornton VL, Martinovich Z, Todd KH, Wun T, Lyons JS. The Emergency Department Sickle Cell Assessment of Needs and Strengths (ED-SCANS): reliability and validity. *Adv Emerg Nurs J*. 2013;35(2):143-153.
11. Treadwell MJ, Hassell K, Levine R, Keller S. Adult sickle cell quality-of-life measurement information system (ASCQ-Me): conceptual model based on review of the literature and formative research. *Clin J Pain*. 2014;30(10):902-914.
12. Haywood C Jr, Diener-West M, Strouse J, et al. Perceived discrimination in health care is associated with a greater burden of pain in sickle cell disease. *J Pain Symptom Manage*. 2014;48(5): 934-943.
13. Yawn BP, John-Sowah J. Management of sickle cell disease: recommendations from the 2014 expert panel report. *Am Fam Physician*. 2015;92(12):1069-1076.
14. Po' C, Colombatti R, Cirigliano A, et al. The management of sickle cell pain in the emergency department: a priority for health systems. *Clin J Pain*. 2013;29(1):60-63.
15. Telfer P, Bahal N, Lo A, Challands J. Management of the acute painful crisis in sickle cell disease—a re-evaluation of the use of opioids in adult patients. *Br J Haematol*. 2014;166(2): 157-164.
16. Agency for Healthcare Research and Quality. Sickle cell acute painful episode: management of an acute painful sickle cell episode in hospital. http://www.guideline.gov/content.aspx?id=37865. Accessed April 3, 2016.
17. Forni GL, Finco G, Graziadei G, et al. Development of interactive algorithm for clinical management of acute events related to sickle cell disease in emergency department. *Orphanet J Rare Dis*. 2014;23(9):91.
18. Gillis VL, Senthinathan A, Dzingina M, et al. Management of an acute painful sickle cell episode in hospital: summary of NICE guidance. *BMJ*. 2012;344:e4063.
19. Glassberg JA, Tanabe P, Chow A, et al. Emergency provider analgesic practices and attitudes toward patients with sickle cell disease. *Ann Emerg Med*. 2013;62(4):293-302.e10.
20. Patrick PA, Rosenthal BM, Iezzi CA, Brand DA. Timely pain management in the emergency department. *J Emerg Med*. 2015;48(3):267-273.
21. Thornton VL, Holl JL, Cline DM, Freiermuth CE, Sullivan DT, Tanabe P. Application of a proactive risk analysis to emergency department sickle cell care. *West J Emerg Med*. 2014;15(4): 446-458.
22. Whiteman LN, Lanzkron S, Stewart RW, Haywood C Jr, Strouse JJ, Feldman L. Quality improvement process in a sickle cell infusion center. *Am J Med*. 2015;128(5):541-544.
23. Yawn BP, Buchanan GR, Afenyi-Annan AN, et al. Management of sickle cell disease: summary of the 2014 evidence-based report by expert panel members. *JAMA*. 2014;312(10): 1033-1048.
24. Andemariam B, Odesina V, Owarish-Gross J, et al. A fast-track emergency department acute sickle cell pain management algorithm results in fewer hospital admissions, decreased length of stay and increased hospital revenue. *J Pain*. 2014; 15(4)(suppl):S39. DOI: http://dx.doi.org/10.1016/j.jpain.2014.01.162.
25. Baker M, Hafner JW. What is the best pharmacologic treatment for sickle cell disease pain crises? *Ann Emerg Med*. 2012;59(6):515-516.
26. Brown M. Managing the acutely ill adult with sickle cell disease. *Br J Nurs*. 2012;21(2):90-92, 95-96.
27. Ender KL, Krajewski JA, Babineau J, et al. Use of a clinical pathway to improve the acute management of vaso-occlusive crisis pain in pediatric sickle cell disease. *Pediatr Blood Cancer*. 2014;61(4): 693-696.
28. Haywood C Jr, Lanzkron S, Hughes MT, et al. A video-intervention to improve clinician attitudes toward patients with sickle cell

disease: the results of a randomized experiment. *J Gen Intern Med*. 2011;26(5):518-523.
29. Kavanagh PL, Sprinz PG, Wolfgang TL, et al. Improving the management of vaso-occlusive episodes in the pediatric emergency department. *Pediatrics*. 2015;136(4):e1016-e1025.
30. Tanabe P, Martinovich Z, Buckley B, Schmelzer A, Paice JA. Safety of an ED high-dose opioid protocol for sickle cell disease pain. *J Emerg Nurs*. 2015;41(3):227-235.
31. Mathias MD, McCavit TL. Timing of opioid administration as a quality indicator for pain crises in sickle cell disease. *Pediatrics*. 2015;135(3):475-482.
32. Tanabe P, Hasnain-Wynia R. Promoting equity: developing quality measures for sickle cell disease. *Am J Med Qual*. 2012;27(1):80-82.
33. Blinder MA, Duh MS, Sasane M, Trahey A, Paley C, Vekeman F. Age-related emergency department reliance in patients with sickle cell disease. *J Emerg Med*. 2015;49(4):513-522.e1.