Outcomes of an Emergency Department Observation Unit–Based Pathway for the Treatment of Uncomplicated Vaso-occlusive Events in Sickle Cell Disease

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Study objective: This was a prospective, pre-post, 13-year observational study documenting the multiyear implementation of an observation unit sickle cell pathway for patients with uncomplicated vaso-occlusive events.

Methods: The sickle cell pathway begins with rapid triage to identify patients with uncomplicated vaso-occlusive events for immediate transfer to the observation unit and initiation of patient-controlled analgesia followed by repeated evaluations of pain and identification of other complications. Data were abstracted from the electronic medical record or observation unit database. The sickle cell pathway was initiated in April 2006. Major revisions of it were carried out in June 2009 (physician evaluation occurs in sickle cell pathway and only patient-controlled analgesia administration of medications) and October 2010 (multidisciplinary management and individual dosing).

Results: Annual ED visits ranged between 287 and 528. The preimplementation hospital admission rate was 33% (123/368), 3-day return rate 16% (60/368), and 30-day return rate 67% (248/368). Refinements to the sickle cell pathway have resulted in a decrease in admission rate to 20% (258/1276); 3-day return rate, to 3.6% (46/1,276); and 30-day return rate, to 41% (525/1,276) for the past 3 years.

Conclusion: The use of a sickle cell pathway for the treatment of uncomplicated vaso-occlusive events has been effective in providing rapid treatment and reducing hospital admissions. However, it was not only the intervention and its refinement that made the sickle cell pathway successful. With the Consolidated Framework for Implementation Research, it was discerned that outer setting factors of organizational commitment to the care of patients with SCD, inner setting factors of learning climate and leadership engagement, individuals, and process contributed to the success of the sickle cell pathway. [Ann Emerg Med. 2020;76:S12-S20.]

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INTRODUCTION

Emergency departments (EDs) are frequently tasked with the treatment of painful acute vaso-occlusive events.[1] Acute vaso-occlusive events are considered the hallmark of sickle cell disease (SCD) and the leading cause of hospitalization.[2,3] Vaso-occlusive events are unpredictable and precipitated by known and unknown risk factors.[2,4] Since 1999, guidelines for emergency care of SCD and vaso-occlusive events have been proposed.[3,5,6] The 4 essential features of these guidelines are rapid initiation of opioid therapy within 60 minutes of arrival in the ED, use of adequate opioid starting dose, frequent repeated doses of opioids (every 15 to 30 minutes) until pain is significantly improved, and selection of treatment regimens based on an individual's opioid-response history. However, these features have been difficult to operationalize in an ED setting.

Vaso-occlusive events treated in the ED are one of many conditions vying for medical attention. Triage priority assignment and caseload affect the speed with which care is provided. Additionally, pain is a subjective experience and patients' responses to pain are variable. Complicating the provision of care is the variability of individual providers' approach to pain treatment and reports of negative bias in the provision of care to individuals with SCD.[7-10]

Before 2006, these challenges, as well as an inconsistent approach to treatment, medication doses, and admission decisions, and physician and patient dissatisfaction with care were present in the ED. To address these problems, we implemented a solution that had been successful in improving ED care of other diseases by decreasing the variability of care, managing costs, and increasing patient

satisfaction.[11] We determined that a clinical pathway[12] consisting of management plans that defined goals for patient care and provided the sequence and timing of interventions necessary to achieve these goals while optimizing diagnosis and treatment would be an effective strategy. Previous studies had demonstrated that the combination of a clinical pathway in an ED observation unit had been successful in achieving these goals for chest pain and acute asthma exacerbation.[13-15] We hypothesized that the combination of a sickle cell pathway and observation unit treatment for patients experiencing vaso-occlusive events would provide the necessary rapid access to treatment, reduce the variability in pain treatment, and increase patient and provider satisfaction with care.

Herein we present the development and outcomes of the sickle cell pathway for the treatment of uncomplicated vaso-occlusive events at a major academic medical center during the past 13 years. We discuss aspects of the development of the program that made it successful through the lens of the Consolidated Framework for Implementation Research.[16]

MATERIALS AND METHODS

Study Design

This study used a pre- and postimplementation observational design using retrospective and prospective chart review and real-time quality assurance data to evaluate the efficacy of a sickle cell pathway. The institutional review board approved this study with a waiver of consent and Health Insurance Portability and Accountability Act authorization.

Setting

The sickle cell pathway is situated in a large, urban, tertiary care facility. The ED has an annual volume of 95,000 visits and is certified as a regional Level I trauma center. The observation unit is adjacent to the ED and has been managed at various times by emergency physicians or hospitalists. The hospital system has a comprehensive sickle cell center with a history of greater than 40 years of patient services and research. The center treats approximately 1,000 adult patients across Georgia and South Carolina, of whom 450 are considered local. Specialized treatment for SCD is provided on an emergency, inpatient, and outpatient basis.

The sickle cell pathway was initiated in 2006 during 4 months. After initial success, we began to observe deviations from the sickle cell pathway protocol, which negatively affected the outcomes. This led to a multiyear iterative process to refine the sickle cell pathway through monitoring and training of all staff involved in the process (Figure 1). It was determined in 2008 that the appropriate triage level was not being consistently applied to patients eligible for the sickle cell pathway. Although nurse-initiated protocols for analgesia in vaso-occlusive events have been shown to decrease delay in receiving medication,[17] many of the ED nurses were relying on vital signs and patient appearance to gauge the level of pain instead of the patient-reported pain value. This led to delays in initiating the sickle cell pathway. The triage process was altered so that after initial screening by the triage nurse, the eligible patients were immediately transferred to the observation unit. Moving directly from triage to the observation unit had several advantages, including bypassing the general ED. Rapid transfer of the patient from triage helped to initiate opioid therapy within 30 minutes of triage.[3] Rapid transfer also meant that the sickle cell pathway exclusion criteria were applied twice: once by the triage nurse and once by the sickle cell pathway nurse. This redundancy was thought to be a safer approach to identifying life-threatening conditions. It also became clear as other revisions to the pathway were implemented that the small and consistent nursing staff who worked in the observation unit allowed for focused training, as well as increased nurse accountability for the quality of care.

Direct admission to the sickle cell pathway allowed the observation unit nurse to initiate ultrasonographically guided vascular access and therapy immediately on patient arrival in the observation unit. This process located the emergency physician's evaluation in the observation unit. The physician's evaluation of the patient is a key step in the pathway because pain can be the sole manifestation of a vaso-occlusive event or may be a part of and even mask other complications, some of which are life threatening.[2,18] This process allowed rapid initiation of treatment without delays related to the physician evaluation.

The current iteration of the program (Figure 1) now includes a rapid ED SCD evaluation consisting of review of exclusion and inclusion criteria for the sickle cell pathway, as well as identification of life-threatening complications such as acute chest syndrome, followed by immediate treatment using patient-controlled analgesia and oral opioid medications, oral nonsteroidal anti-inflammatory medications, if not contraindicated, and hourly evaluations of pain and complications. The observation unit allows up to 24 hours of therapeutic management, using a protocol that has been tailored to vaso-occlusive event treatment guidelines and allows patient control of opioid delivery through a patient-controlled analgesia pump.

Throughout the operation of the sickle cell pathway, prospectively obtained quality assurance data (eg, length of stay, opioid used, disposition) were collected and used to evaluate compliance with protocols and to monitor patient

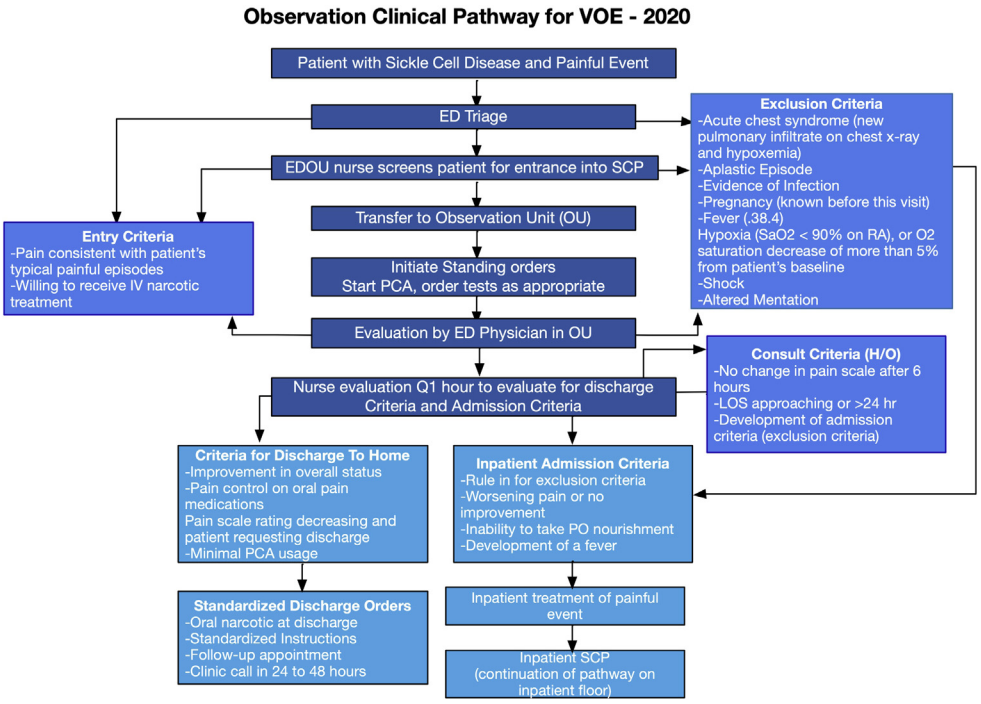

Figure 1. Observation clinical pathway for vaso-occlusive events, 2020. *SCP*, Sickle cell pathway.

outcomes. This information, combined with the experience of clinical staff, contributed to an iterative process of pathway revision to better adhere to the goals outlined in the guidelines for the ED management of vaso-occlusive event. Each revision was in response to observed variability in adherence to the sickle cell pathway. Major revisions of the pathway included removing bolus opioid medications and allowing only patient-controlled analgesia for opioid delivery (2009), having the initial emergency physician screening occur in the observation unit instead of the ED (2009), and creating and using a database to individualize the patient-controlled dosage of opioids (2010) (Figure 2).

Starting in 2009, we evaluated the outcomes of the sickle cell pathway by prospectively following a cohort of patients who received follow-up care at the comprehensive sickle cell center. The primary objective was to determine the effectiveness of the sickle cell pathway by examining ED utilization, admission rates, and 3-day return rates of patients experiencing uncomplicated vaso-occlusive events.

Data Collection and Processing

Data from 2 patient samples are presented. The quality assurance data are derived from all patients with SCD who were admitted to the sickle cell pathway for treatment of uncomplicated vaso-occlusive events. With the commencement of the sickle cell pathway, mechanisms were put into place to obtain quality assurance data. These data were collected as patients were evaluated in the ED and reported in the aggregate monthly without identifiers beginning in 2006. It was expected that patients in this group would vary over time. In 2009, the retrospective and ongoing chart review for the cohort was initiated. The chart data extraction occurred with a standardized template. Data from the patient cohort from the comprehensive sickle cell center were composed of all active adult patients in treatment in 2009 who meet inclusion criteria (diagnosis of SCD, all phenotypes, received regular care from the comprehensive sickle cell center, and $\geq$18 years).

The preimplementation phase of the study consisted of ED data from 2005. The postimplementation data began in 2006 and are ongoing. Although individual patients in the cohort were followed, the actual data used in this analysis were information from individual visits. Visits included in the analysis met the following criteria: they were for uncomplicated vaso-occlusive event, and treatment was provided in the observation unit. Excluded were visits in which patients presented with abnormal vital signs (blood pressure $<$90/60 mm Hg, respiratory rate $>$20 breaths/min, or pulse rate $>$120 beats/min), fever, known pregnancy, or signs of a complicated crisis (eg, acute chest, symptomatic anemia). These patients were not admitted to the sickle cell pathway and were treated in the ED and, if needed, admitted to inpatient care.

RESULTS

The cohort identified by the comprehensive sickle cell center included 422 individuals. Removing duplicate

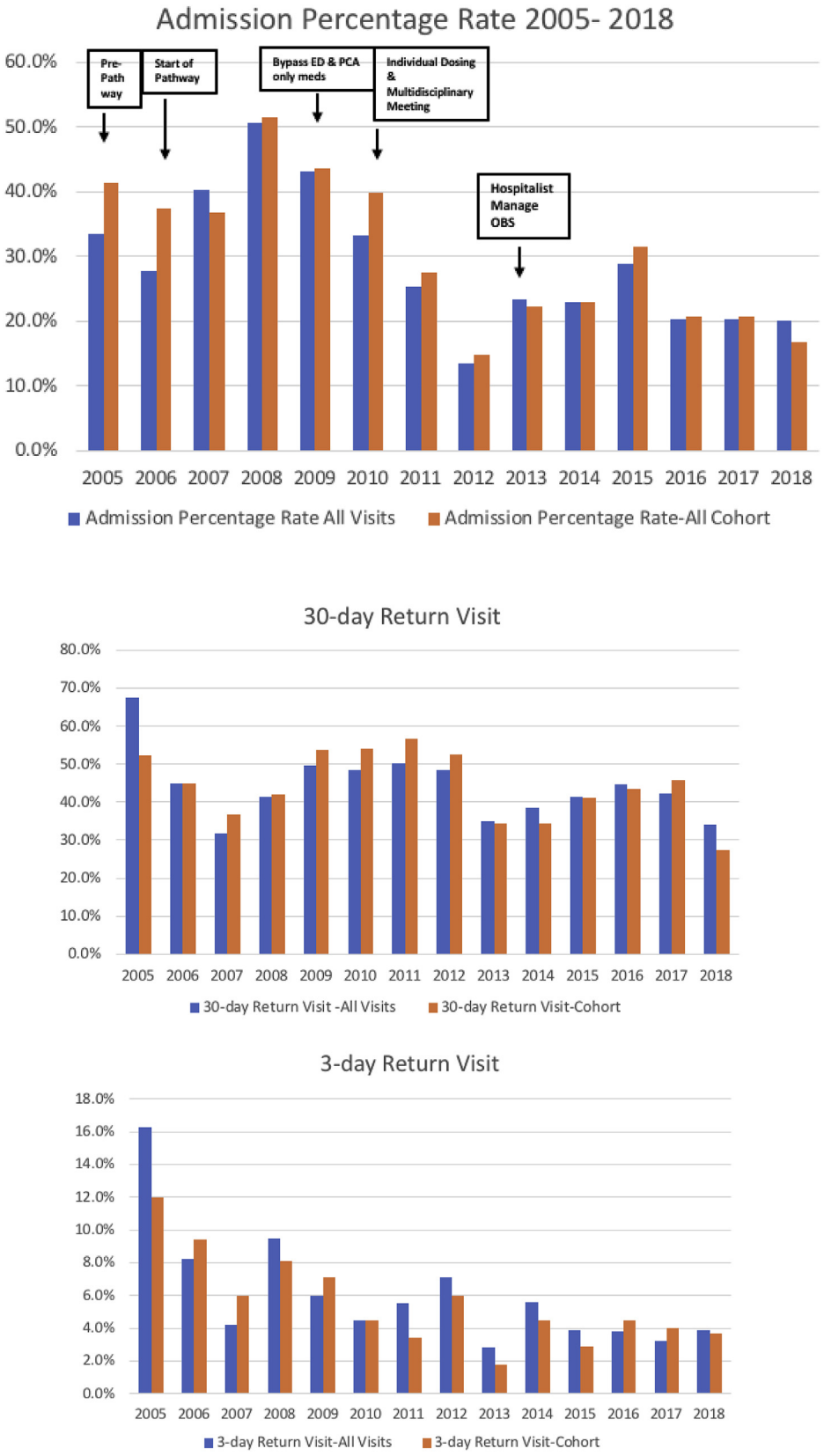

Figure 2. Admission and visit percentages, 2005 to 2018. *PCA*, Patient-controlled analgesia.

Table. SCD Visit and Admission Data.

All SCD Observed Visits

Year	Total Visits	3-Day Revisits	30-Day Revisits	Admissions	Not Admitted	3-Day Revisit Rate, %	30-Day Revisit Rate, %	Admission Rate, %	Available Data Number of Months	Missing Data
2005	368	60	248	123	245	16.3	67.4	33.42	12	
2006	331	27	149	92	239	8.2	45.0	27.79	12	
2007	287	12	91	116	171	4.2	31.7	40.42	12	
2008	336	32	139	170	166	9.5	41.4	50.60	12	
2009	399	24	198	172	227	6.0	49.6	43.11	12	
2010	421	19	204	140	281	4.5	48.5	33.25	12	
2011	528	29	265	134	394	5.5	50.2	25.38	12	
2012	462	33	224	62	400	7.1	48.5	13.42	12	
2013	354	10	124	83	271	2.8	35.0	23.45	10	May, June
2014	319	18	123	73	246	5.6	38.6	22.88	10	May, June
2015	431	17	179	124	307	3.9	41.5	28.77	11	September
2016	500	19	223	101	399	3.8	44.6	20.20	12	
2017	443	14	188	90	353	3.2	42.4	20.32	12	
2018	333	13	114	67	266	3.9	34.2	20.12	12	

Cohort Data

Year	Total Visits	3-Day Revisits	30-Day Revisits	Admissions	Not Admitted	3-Day Revisit Rate, %	30-Day Revisit Rate, %	Admission Rate, %	Available Data Number of Months	Missing Data
2005	292	35	153	121	171	12	52.4	41.44	12	
2006	171	16	77	64	107	9.4	45.0	37.43	12	
2007	201	12	74	74	127	6.0	36.8	36.82	12	
2008	236	19	99	122	114	8.1	41.9	51.69	12	
2009	322	23	173	141	181	7.1	53.7	43.79	12	
2010	356	16	192	142	214	4.5	53.9	39.89	12	
2011	435	15	246	116	319	3.4	56.6	26.67	12	
2012	352	21	185	52	300	6.0	52.6	14.77	12	
2013	221	4	76	49	172	1.8	34.4	22.17	10	May, June
2014	178	8	61	41	137	4.5	34.3	23.03	10	May, June
2015	245	7	101	77	168	2.9	41.2	31.43	11	September
2016	269	12	117	56	213	4.5	43.5	20.82	12	
2017	251	10	115	52	199	4.0	45.8	20.72	12	
2018	161	6	44	27	134	3.7	27.3	16.77	12	

patients (2), those not eligible for the observation unit (8), and those with an absence of a SCD diagnosis (30) left 382 individuals who were followed. Of these individuals, 182 did not have a visit to the Augusta University ED at initiation of retrospective data collection. The remaining 200 individuals were responsible for the visits from 2005 to 2009 and constituted the principal cohort users of the sickle cell pathway through 2018. The mean age of the cohort in 2009 was 31.95 years, with a range from 18.19 to 65.33 years. Men (n=189) and women (n=193) and phenotype (SS=255, SC=82, $S\beta^0$=16, $S\beta^+$=24) were distributed evenly across the groups that did and did not visit the ED. There are no demographics to report for the quality assurance data because of the deidentified manner in which the data were collected. A problem with the ED First Net program affected the ability to retrieve 5 months of data during the 13 years of data collection.

The average length of stay in the observation unit during the study period was 18.5 hours. The Table and Figure 2 highlight the effect of the sickle cell pathway on the admission rate, which decreased from a range of 27.79% to 51.69% in the first 4 years of the pathway to 16.77% to 20.82% for both groups during the last 4 years. An equally significant decline can also be observed in the 3-day revisit

rate. The 30-day revisit rate for patients treated only in the observation unit was not affected by implementation of the sickle cell pathway. The decline in admissions was not linear. Explanations for the variability in admission rate are found in the "Discussion."

DISCUSSION

Clinical pathways to treat sickle cell vaso-occlusive events have been shown to decrease hospital resource use, as demonstrated by decreased length of stay, decreased admission, and decrease in 30-day readmission.[17,19-22] However, there are significant barriers to implementation of clinical pathways in the ED,[19] which include health care worker attitudes toward patients with SCD, lack of knowledge of clinical guidelines, lack of clinical or diagnostic tests to substantiate the presence or severity of a vaso-occlusive event, lack of hematology specialists working with patients with SCD, ED crowding, and fear of creating drug dependence or addiction.[6,22-25] As such, many patients with SCD face unpredictable, intermittent pain that is poorly managed in the outpatient setting, as well as in the ED.[20] The burden of unrelieved pain can lead to negative influences on a patient's quality of life and the pathophysiology of the disease, leading to earlier onset of complications, as well as premature death.[20]

The objectives of the sickle cell pathway included achieving the following: time to triage to observation unit less than 15 minutes, time to physician evaluation less than 30 minutes, length of stay less than 12 hours, and an admission rate less than 15%. The initial design of the pathway included the use of patient-controlled analgesia for the majority of patients; however, it became clear that many emergency physicians were resistant to ordering patient-controlled analgesia, preferring bolus administration of opioids, because they did not acknowledge the patient's expressed level of pain. The providers' resistance to using the sickle cell pathway was similar to that in other published pathway experiences.[19] As a result, the quality measures chosen to monitor the pathway such as the admission rate and the revisit rate began to increase above the preimplementation levels. Multiple studies have shown that the use of opioids delivered by patient-controlled analgesia decreased the overall dose, as well as the time to a reduction in severe pain.[25-27] The use of bolus opioids was eliminated from the pathway in 2009. By limiting medication delivery choice, we hoped to achieve the documented advantages of patient-controlled analgesia. Although decreasing the options for opioid delivery did simplify and make the pathway treatment more consistent, the admission rate returned only to the preimplementation level.

With the establishment of patient-controlled analgesia as the sole method of opioid delivery, there remained physician variability in the dosage regimen despite training on the recommended dosage for opioids delivered by patient-controlled analgesia.[24,25] Similar to what was observed by Solomon,[6] many patients were undertreated, whereas some were overtreated. The electronic medical record was rarely used to determine previous doses, and there were instances of oversedation and the use of naloxone for opioid reversal. Individualizing patient-controlled analgesia dosage was implemented to address these problems. To accomplish this, an accessible database with individualize patient dosages was created and stored on a secure hospital server. This database was used to monitor for adequate pain relief, as well as for complications. At each visit, the patient received the previous effective dose of opioids, thus eliminating dose variability. This dose was modified according to the response of the patient. This change to the sickle cell pathway in 2010 had a significant effect, markedly decreasing the admission rate, which has remained stable, at 20% (Figure 2). Since implementation of the individualized patient-dosing database, naloxone has not been used because of oversedation for any patient-controlled analgesia on the pathway.

Patient-controlled analgesia delivery of opioids had an additional benefit. Patients who had an opioid addiction were easily identified through opioid diversion behaviors such as tampering with or disabling the patient-controlled analgesia device. These patients were determined to be ineligible for future use of the sickle cell pathway (Figure 3) and advised about opioid treatment programs. Other patients, identified as having high pathway use but not with suspected opioid addiction, remained eligible for the pathway even if use was frequent as long as they were adherent with outpatient appointments and compliant with the current Georgia opioid laws.

To address patients who became behaviorally ineligible and determine when it was appropriate to allow them to again use the pathway, a multidisciplinary team was formed, including the observation unit director and nurse director, the comprehensive sickle cell center director and staff, and an addiction specialist (psychologist). This team also developed care plans for individuals with high ED utilization. The individual plans varied greatly but included increased long-acting opioids in the noncrisis period, identification of social support, reinstitution of maintenance therapy, and grief counseling (Figure 3).

Although major changes to the sickle cell pathway have not occurred since 2012, many external factors have occurred that have affected the ED and hospital care of

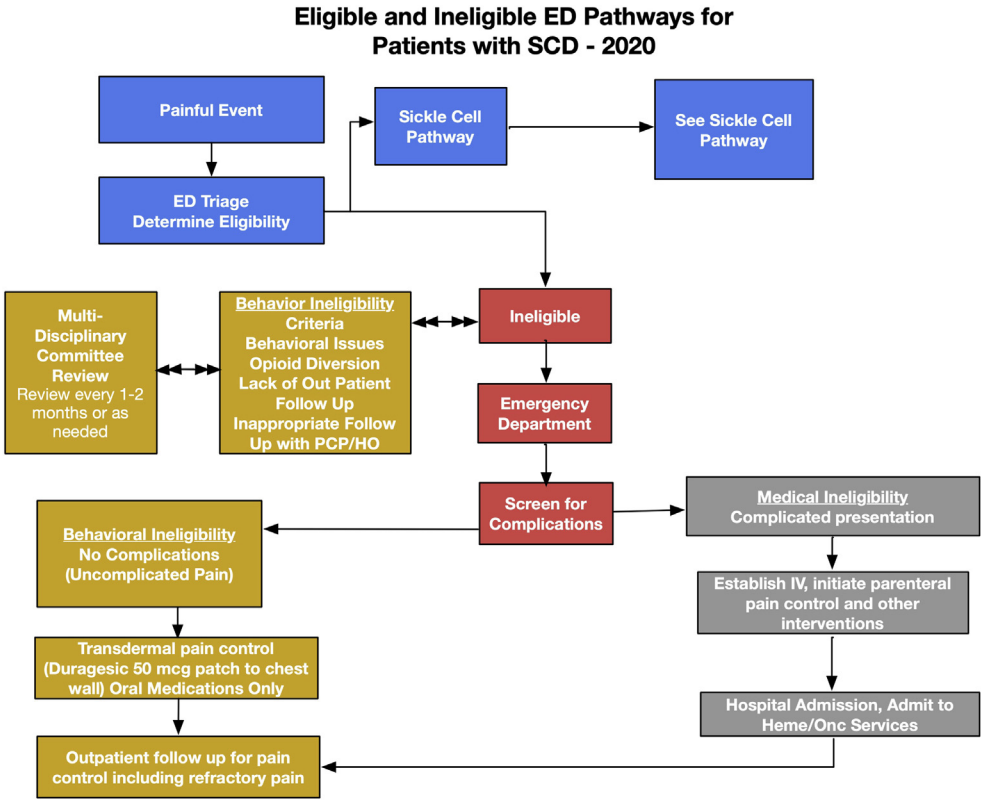

Figure 3. Eligible and ineligible ED pathways for patients with SCD, 2020.

vaso-occlusive events. Beginning in late 2013, the hospitalist service began managing patients in the ED observation unit. The effects on vaso-occlusive event metrics were minimal in most respects (Table). Also in 2013, Georgia state laws affecting opioid prescribing were enacted and revised during the following years. These laws, even with exceptions for patients with SCD, have affected outpatient opioid prescribing by the comprehensive sickle cell center. This required modifications to the eligibility of patients for the sickle cell pathway. Patients who were not eligible for outpatient opioid prescriptions became ineligible for the sickle cell pathway. This typically was due to positive urine drug screen results for illegal substances. When patients were eligible for outpatient opioids, they were again eligible for the sickle cell pathway (Figure 3).

The 13-year evolution of the sickle cell pathway made it necessary to consider multiple ways to evaluate both process and outcomes. Implementation science, a systematic method to evaluate the formative processes of interventions, was used to evaluate the sickle cell pathway process. Implementation science is most effective when initiated in a prospective manner allowing documentation of intervention revisions and adaptation. We were not aware of implementation science at the start of the sickle cell pathway; however, we were diligent in documenting the process of improving the pathway. Acknowledging the limitations of a retrospective approach, we explored aspects of the sickle cell pathway and its implementation through the Consolidated Framework for Implementation Research,[16] which posits 5 domains that influence the success of an intervention: characteristics of the intervention, inner setting, outer setting, individuals, and implementation process.

Characteristics of the intervention that supported the success of the sickle cell pathway included an evidence-based protocol-driven process with all steps clearly detailed in department policies and the sickle cell pathway's focus on one goal, the provision of rapid treatment for vaso-occlusive events. The inner setting describes the organization, location, and culture of the place of the intervention. Specifically, the observation unit was part of the ED infrastructure and had consistent knowledgeable staff familiar with protocolized medicine who placed value in the collection of quality assurance data. The space was underused, and the director of the observation unit was the sickle cell pathway champion. The outer setting describes the broader environment that can influence patient care. For

the sickle cell pathway, this was the increasing attention to the needs of individuals with SCD, awareness of patient dissatisfaction with current treatment practices, awareness of provider treatment bias, and collaboration with the comprehensive sickle cell center. *Individuals* refers to the people most responsible for carrying out the sickle cell pathway. These included the champion of the process, the director of the observation unit, the director of the comprehensive sickle cell center, and the observation unit staff, who all worked collaboratively with a singular focus to make the sickle cell pathway a success. The final element is the implementation process. Process aspects that contributed to the success of the sickle cell pathway were the iterative nature of ongoing problem solving and adaptation of the elements of the sickle cell pathway, the persistence of the leadership, the use of data to assess outcomes, and the inclusion of many stakeholders. Also important was that the sickle cell pathway was given time to succeed.

In summary, uncomplicated SCD vaso-occlusive events are well suited for an observation unit–based clinical pathway. In the observation unit setting, goals for treating vaso-occlusive event pain can be accomplished efficiently and rapidly. The sickle cell pathway provides for uniform treatment that leads to better outcomes for patients and improved use of hospital resources.

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