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SCARES: A Clinician Guide to Spinal Cord Awareness, Response, and Emergency Support Creation and Implantation of SCARES Protocol Among Hospitalist Advanced Practice Providers

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Abstract

While they are more common in patients with oncological disease and trauma, SCE still exist among patients without these comorbidities. Less has been established regarding care protocols in this population. The absence of standardized procedures has been linked to preventable, adverse patient outcomes, including cases of permanent damage due to delayed treatment. This project employs Lean Six Sigma methodologies and Johns Hopkins Evidence-Based Practice to devise a robust SCE protocol, aimed at standardizing care and improving patient outcomes. A multidisciplinary team including general medicine, neurology, neurosurgery, and neuroradiology developed "Spinal Emergency Management Guidelines" protocol, which was implemented within the hospital's advanced practice settings with concurrent educational initiatives. The SCE protocol represents a significant advance in the management of spinal emergencies, underscoring the critical importance of standardized care pathways in acute medical settings.

Keywords: spinal cord emergencies, protocol, quality improvement, multidisciplinary, healthcare education, electronic health records

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Introduction

Spinal cord emergencies (SCE) encompass a range of critical conditions that necessitate immediate medical attention to prevent irreversible damage and preserve neurological function. The spinal cord, a vital component of the central nervous system, facilitates communication between the brain and the rest of the body (Galliker et al., 2020). Any compromise to its integrity through injury, compression, or disease can result in significant impairment or loss of motor, sensory, and autonomic functions. Common etiologies of SCEs include trauma, vertebral fractures, herniated discs, spinal infections, and vascular abnormalities. Clinicians encounter patients with spinal symptoms in various settings, including primary care, emergency departments, and inpatient where prompt evaluation and accurate diagnosis are crucial (Galliker et al., 2020).

The early recognition of SCEs is paramount, as delayed diagnosis and intervention can lead to permanent disability or even fatality (Fehlings et al., 2012). The spinal cord's limited regenerative capacity makes timely identification and management of these conditions imperative. Early intervention not only aims at stabilizing the patient but also at mitigating further damage to the spinal cord and surrounding structures. The early recognition of spinal cord emergencies has implications for resource allocation and healthcare costs. Prompt diagnosis can lead to more targeted and effective treatments, potentially reducing the need for extensive diagnostic testing and prolonged hospital stays (Fehlings et al., 2012).

Statement of the Problem:

Hospital X currently does not have an inpatient spinal cord emergency protocol thus prompting this quality improvement project. There is no available data for the annual encounters for non-oncological SCE at Hospital X. However there has been prior root cause analysis for the emergency department that led to permanent irreversible damage due to the lack of timely intervention and recognition of SCE. The need for this quality improvement project aimed at developing an in-patient SCE protocol arose from a patient event in which it was noted that there were multiple system failures and areas of improvement.

The patient that this protocol is based on is an adult male patient with hypertension and chronic back pain presented with difficulty urinating, admitted for pyelonephritis requiring insertion of Foley catheter. Upon removal of the Foley catheter, urinary retention was noted. Then, the patient had bilateral leg weakness and groin numbness, prompting concern for a spinal cord emergency. The provider discussed patient's presentation with neurology who together decided to "activate" a SCE response.

The neurologist consulting was familiar with the SCE Code given prior rotations; however, this emergency response bundle was not known to other providers. This contributed to a significant delay and deviation from the standard of care to appropriately diagnose a SCE: MRI of spine without contrast. It took over three hours to obtain an emergent MRI with delayed surgical invention. A knowledge deficit across providers and services contributed to an increased risk for poor outcomes. This case was reported within the Patient Safety Index quality reporting database and presented at an apparent cause analysis (ACA) thus highlighting a need for a more streamlined approach with a standardized protocol to ensure efficient delivery of care and reduce delays in diagnosis and treatment.

Current Knowledge:

Cauda Equina Syndrome (CES) manifests through a collection of vague symptoms and indicators, often leading to misdiagnosis and delayed treatment. The swift progression of acute CES categorizes it as a surgical crisis, predominantly caused by a lumbar disc prolapse. Failing to promptly identify and treat CES can result in severe, long-lasting damage to the patient, alongside substantial financial burdens on healthcare systems (Balasubramanian et al., 2010). This study conducted by the Department of Trauma and Orthopedics and the Department of Neurosurgery at James Cook University Hospital aimed to scrutinize the effectiveness of clinical evaluations in confirming CES diagnoses. Barriers such as lack of knowledge, prompt diagnostic imaging, and financial resources typically impede providers in accurately diagnosing SCE (Galliker et al., 2020).

The study incorporated 80 individuals suspected of CES, all of whom underwent immediate clinical examination and Magnetic Resonance Imaging (MRI) within a 12-month timeframe in 2008. Of these participants, 15 were diagnosed with CES and subsequently received lumbar discectomy and decompression treatments (Balasubramanian et al., 2010). A comprehensive review of medical records and MRI results for all participants was conducted. The collected data on presenting signs and symptoms were correlated with positive MRI findings. The Chi-square test, supplemented by Yates correction, confirmed correlation between clinical manifestations and positive MRI results indicative of CES.

The study’s findings revealed that 18.8% of the evaluated patients exhibited MRI evidence of CES-induced compression. Notably, the presence of saddle sensory deficits emerged as the sole clinical symptom significantly correlated with positive MRI findings of CES ($p = 0.03$). These results underscore the heightened diagnostic value of saddle sensory deficits over other clinical symptoms in identifying CES. Nevertheless, the study emphasizes that no single symptom or indicator can definitively predict CES. Consequently, any patient suspected of CES requires an expedited MRI to conclusively rule out or confirm the diagnosis, highlighting the critical nature of timely and thorough diagnostic procedures in managing potential CES cases (Balasubramanian et al., 2010).

Limitations of the study include an accounting for potential errors arising from inter- and intra-observer variability. Additionally, the structure of subject presentation did not readily facilitate the collection of meaningful data to assess these potential discrepancies. Another limitation is the absence of a standardized proforma for recording clinical presentation data, which might have led to incomplete observations for certain patients. This oversight potentially reduced the number of patients for whom comprehensive data was available. It's important to note that the data was collected from a single center, a tertiary center for spinal surgery, which serves as the primary point of care for all patients within the subregion. However, this study specifically targets units within the secondary care sector, suggesting that the findings are applicable and transferable to the intended audience.

MRI as a diagnostic tool for CES has also been evaluated by Ahad et al. (2015) in a retrospective analysis. In this study, 79 patients who required urgent MRI were evaluated. Of these, 62 underwent MRI, and 32.9% within 24 hours of admission. Nine patients were subsequently referred for an urgent neurosurgical review, and 6.3% were confirmed to have CES via MRI. One patient who had an MRI 15 days post-hospital presentation was diagnosed with CES and immediately referred for spinal surgery. Statistical analysis using Kendall's tau test revealed that no clinical features reliably predicted the presence of CES on MRI. Specific findings such as decreased anal tone, fecal incontinence, urinary retention, bladder incontinence, constipation, and saddle anesthesia were all analyzed, but none showed significant predictive value. The study found a correlation between a previous abnormal MRI for back pain and a new diagnosis of CES on MRI, suggesting a potential area for further research and investigation.

While the study aimed to identify clinical signs that could predict CES on MRI, no definitive indicators were found. The correlation between previous abnormal MRIs and new CES diagnoses may warrant additional exploration to enhance the assessment and management of acute lower back pain.

The limitations of this study primarily stem from its small sample size, which restricts the ability to conduct a comprehensive analysis of individual or combined symptoms. This significant constraint affects the depth and reliability of the results presented. Additionally, the study's retrospective design introduces potential weaknesses, particularly in data collection and study methodology. In addition, there is a possibility that the data were not recorded as meticulously as they might have been in a prospective study, leading to the potential omission of crucial findings. Moreover, the involvement of multiple radiologists in interpreting the images raises concerns about consistency, as it could lead to inter-observer variability.

Dugas et al. (2011) investigates the challenges and risks associated with the diagnosis of acute spinal cord and cauda equina compression (SCC) in the emergency department (ED), emphasizing the critical need for timely and accurate diagnosis to prevent lasting neurological impairment. The study points out that existing literature primarily focuses on specific causes of SCC, offering limited practical insights for emergency physicians. To address this gap, the study presents a retrospective case series design, evaluating ED presentations of nontraumatic SCC at a tertiary care center. The study population includes patients aged 18 and older, discharged from inpatient stays with an ICD-9 code indicating spinal disease, and who visited the ED with a related complaint within the previous 30 days. Patients with acute traumatic injuries and existing diagnoses of SCC were excluded. The data analysis contrasts correctly diagnosed and misdiagnosed cases, highlighting the presentation complexities and potential pitfalls in the diagnostic process in the ED.

The study delves into the complexity of diagnosing nontraumatic Spinal Cord Compression (SCC) in the Emergency Department (ED), emphasizing the variability in symptoms and the high misdiagnosis rate of 29%. The authors highlight the variance in etiology and patient demographics, with disk disease being predominant in their population, contrasting with other regions and diseases like metastasis. The cervical spine was the most common SCC site, challenging the conventional focus on cauda equina compression. A significant portion of the cohort showed minimal physical symptoms, underscoring the critical role of patient history and clinical suspicion in diagnosis. Misdiagnosis was attributed to mild SCC presentations, multiple comorbidities, or nonspecific symptoms leading to diagnostic anchoring. The misdiagnosed group had less severe disease and similar outcomes to the correctly diagnosed group, despite delayed intervention. The paper calls for more research to enhance diagnostic accuracy and understand SCC's ED presentation.

The results indicate that SCC misdiagnosis occurred in 29% of the cases, with misdiagnosed patients experiencing a longer median time to diagnosis compared to those correctly diagnosed. The misdiagnosed group also exhibited a higher likelihood of normal motor and sensory functions during examination, while more likely presenting isolated gait deficits. The study concludes that SCC can manifest subtly, with potential absent or unilateral motor and sensory deficits, and that ED misdiagnosis of SCC in non-trauma patients is common. It underscores the importance of vigilant and thorough diagnostic practices in the ED to ensure timely intervention and mitigate the risks of lasting neurological damage.

Limitations include that this study was exclusively based on medical record documentation, leading to potential inaccuracies and biases typical of retrospective chart reviews. There is uncertainty whether unrecorded information was not elicited or simply not documented, and this might have disproportionately affected patients with more severe symptoms, as physicians could have been more meticulous in documenting these cases. This could also skew the outcome analysis towards more severe presentations. The study's criteria for distinguishing between correct and incorrect diagnoses could have led to misclassification bias. Additionally, the study might not have captured all cases of spinal cord compression (SCC), especially those misdiagnosed in the emergency department (ED) but treated elsewhere, or those not identified due to incorrect or incomplete ICD-9 coding. The broad scope of ICD-9 codes used might have led to an exhaustive review process, reviewing 1,231 patients to identify 63 SCC cases. The single-center nature of the study could limit the generalizability of the results and the small study population might have influenced the results.

Chau et al. (2014) addresses the ambiguity surrounding the optimal timing for surgical intervention in CES, a critical and time-sensitive neurosurgical condition. Despite being identified and studied since 1934, the literature still presents conflicting views, particularly concerning the advocated 48-hour window for safe surgical delay. This ambiguity holds significant implications, affecting both patient outcomes in the early stages of the condition and influencing legal proceedings in cases of delayed treatment. The study is predominantly qualitative systematic review, delving into both animal studies and clinical trials involving humans, to critically assess the available evidence on the urgency required for surgical decompression in CES and to evaluate the validity of the commonly cited 48-hour rule.

The existing literature shows a lack of consensus on whether immediate surgery yields better patient outcomes. Nevertheless, there is a gradually forming agreement recognizing that biological systems degrade gradually rather than abruptly. The existing neurological function at the time of surgery—distinguished as either incomplete CES or CES with urinary retention—emerges as a crucial predictor of the patient's prognosis. Additionally, the initial presentation and the duration of symptoms appear to influence not just the final outcome, but also the time required for neurological recovery.

The study concludes that the 48-hour mark does not provide a universally safe threshold for delaying surgical intervention in CES cases. Both immediate and somewhat delayed surgical procedures can lead to enhanced neurological recovery. Nonetheless, initiating surgical intervention sooner, particularly in cases of acute neurological deterioration, is likely to yield more favorable outcomes for the affected nerve structures.

The study has a few potential limitations. The first is a predominantly qualitative approach; the study's major reliance on a qualitative systematic review could limit its ability to provide quantitative comparisons or meta-analysis of the existing research, potentially affecting the robustness of its conclusions. Given the discordance and conflicting views in the literature regarding CES, the variability in study designs, patient populations, and outcome measures could introduce heterogeneity, making it challenging to draw definitive conclusions. The methodology for selecting which animal studies and human clinical trials to include in the review is not specified, which might introduce selection bias and affect the generalizability of the findings. Lastly, the study critiques the 48-hour rule but does not propose a clear alternative timeframe or criteria for optimal surgical timing, which could leave practitioners with continued uncertainty.

In study by Fehlings et al. (2012) an international, multicenter, prospective cohort study named Surgical Timing in Acute Spinal Cord Injury Study (STASCIS) was conducted on adults aged 16-80 with cervical spinal cord injury (SCI), from 2002 to 2009 across six centers in North America. The main outcome measured was the change in the ASIA Impairment Scale (AIS) grade six months after the injury, alongside secondary outcomes like complication rates and mortality. Out of the 313 enrolled patients with acute cervical SCI, 182 received early surgery, averaging 14.2 (± 5.4) hours post-injury, while 131 received late surgery, averaging 48.3 (± 29.3) hours post-injury. At the 6-month follow-up (available for 222 patients), 19.8% of the early surgery group showed an improvement of 2 or more grades in AIS, in contrast to 8.8% in the late decompression group (Odds Ratio = 2.57, 95% Confidence Interval: 1.11-5.97). Adjusting for initial neurological status and steroid administration in a multivariate analysis, the early surgery group had 2.83 times higher odds of showing at least a 2 grade AIS improvement (Odds Ratio = 2.83, 95% CI: 1.10-7.28). Over the 30 days following the injury, both surgical groups had one mortality each. Complications occurred in 24.2% of the early surgery patients compared to 30.5% of the late surgery patients ($p = 0.21$). Thus, proving that performing decompression surgery within the first 24 hours of a spinal cord injury is a safe procedure and is linked to significantly better neurological outcomes, as evidenced by a 2 or more grade improvement in AIS six months after the injury.

Limitations of this study include patients in the early surgery group were generally younger and had more severe initial injuries than those in the late surgery group. This could be due to surgeons being more inclined to promptly treat younger patients with SCI or because younger patients typically have fewer health issues, facilitating quicker surgical intervention. Regardless of these discrepancies, after adjusting for initial differences, the multivariate analysis affirmed that early decompression within 24 hours of an acute cervical SCI is linked to better neurological outcomes.

The study's adjustment for confounding variables, such as initial neurological status and steroid administration, in the multivariate analysis strengthens the validity of its findings. However, as it is not a randomized controlled trial, there are inherent limitations and potential biases that prevent it from being classified as Level I evidence (Petrisor et al., 2006).

Rationale:

The necessity to establish a spinal cord emergency protocol arises from the urgency associated with spinal cord injuries (SCIs). Such injuries can lead to severe neurological complications, potentially resulting in paralysis or fatality (Karsy & Hawryluk, 2019). Rapid and correct responses can substantially determine a patient's future health trajectory. By introducing a standardized protocol, medical professionals can ensure immediate, efficient care, reducing the risk of secondary injuries which might compound the initial harm. This protocol would also foster consistency in treatment, guaranteeing that every patient, irrespective of the medical team on duty, receives uniform, evidence-driven care (Karsy & Hawryluk, 2019). Furthermore, with the involvement of multiple medical disciplines in treating SCIs—from neurology to surgery, radiology, and intensive care—a cohesive protocol becomes instrumental in optimizing communication and collaboration among them. In doing so, not only are medical delays diminished, but outcomes are also enhanced, leading to a better recovery trajectory and life quality for the affected individuals. Additionally, such a protocol serves as a foundational tool for training medical personnel, ensuring even those less versed with SCIs can deliver top-tier care. Additionally, with clear guidelines in place, the likelihood of medical oversights or errors—especially detrimental in the context of SCIs—is significantly reduced. In essence, a spinal cord emergency protocol isn't just a measure to enhance immediate responses, but a holistic strategy aimed at improving patient outcomes and refining healthcare delivery (Karsy & Hawryluk, 2019).

Specific Aims:

The specific aim of creating a spinal cord emergency protocol is to standardize and optimize the immediate response to spinal cord injuries, ensuring timely, efficient, and evidence-based care. This protocol aims to minimize the extent of secondary injuries, improve patient outcomes in terms of neurological and functional recovery, and reduce complications associated with spinal cord trauma, improving patient experience, and lowering the cost of care. Additionally, by providing clear guidelines, the protocol seeks to enhance the confidence and preparedness of medical professionals in handling such emergencies, streamline communication and coordination among interdisciplinary teams, and promote consistent, high-quality care across various clinical settings. "Spinal Emergency Management Guidelines" protocol will satisfy the components of the quadruple aim.

Methods

Context:

Hospital X is a highly ranked, academic medical center. It is a private, not-for-profit organization in Manhattan, NY. A significant value is placed on the quality of the delivery of care and reimbursement practices. Therefore, assessing these domains for areas of improvement is essential to improve quality and reduce financial penalties. Medicine Unit A is a 67 bed, closed unit that provides acute care for patients, as well as serving as a teaching unit for nursing, physician assistant, and nurse practitioner students. The staff on the unit includes daytime hospital attendings, advanced practice providers, nurses, and patient care technicians. On

Medicine Unit A one will find a wide range of patient populations including, but not limited to: heart failure, pneumonia, chronic comorbidities, chronic obstructive pulmonary disorders, skin integrity disorders, and, most recently, coronavirus 2 (SARS-CoV-2), COVID-19.

A significant value is placed on the quality of the delivery of care and reimbursement practices. Therefore, assessing these domains for areas of improvement is essential to improve quality and reduce financial penalties. The staff's nursing experience varies from new graduates, with under a year experience, to seasoned nurses with over 15 years of expertise.

Hospital X lacks an inpatient spinal cord emergency protocol, prompting this quality improvement project. There's no data on annual SCE encounters. Prior cases in the emergency department highlighted the need for timely SCE intervention. The need for this protocol arose from a specific patient case and the process of multiple providers unfamiliar with activating an impatient SCE that caused significant delays in diagnosis and treatment. This case was reported in the Patient Safety Index (Tokareva & Romano, 2023) with an increased score of six, meaning causing temporary harm to a patient, emphasizing the need for a standardized protocol to ensure efficient care delivery and reduce delays in treating spinal cord emergencies.

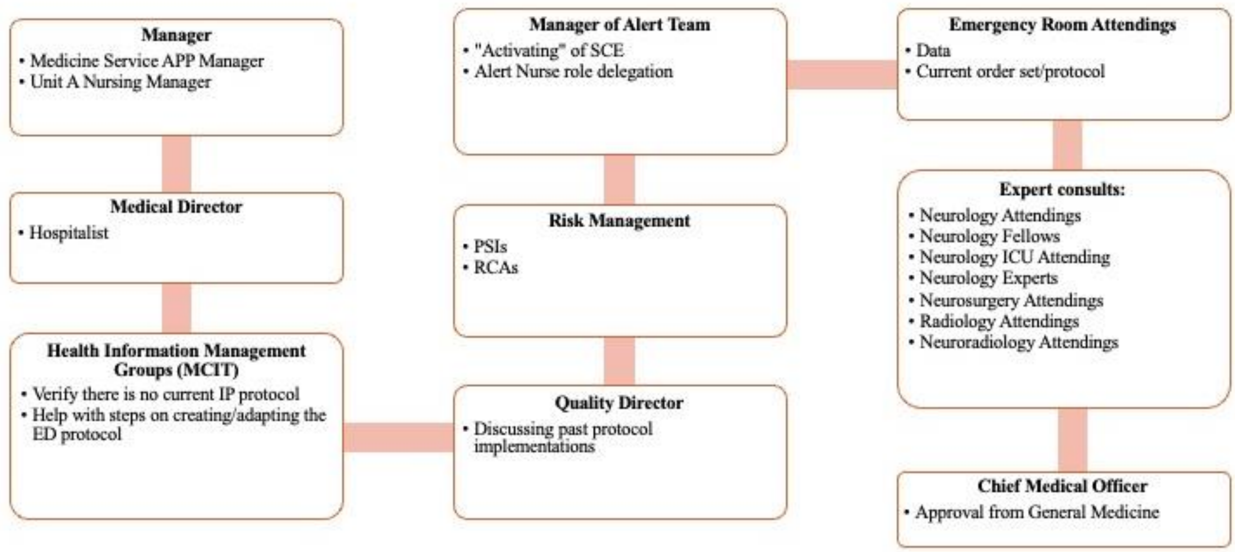
Interventions:

Over the course of five months, August 2023-December 2023, meetings were held with key stakeholders (Figure 1) to discuss spinal cord management and create an adapted version inclusive of multiple inpatient settings. A pre-survey was completed by APP staff (n=20) to assess staff knowledge and support the work towards adapting "Traumatic Spinal Cord Emergencies". In December 2023, the adapted version went live on the hospital's policy and protocol site. Before educational intervention implementation, the project was proposed to the

Hospital X DNP council and approved. Immediately following the publication of the adapted protocol, a presentation was given at the APP staff meeting in January 2024.

Figure 1

Meetings Across Hospital X



Meetings consisted of various providers even within the specialties as, initially, there was push-back to creating an inpatient protocol because the neurology intensive care unit (ICU) attendings knew the steps of a SCE emergency due to their expertise. Additional notable meetings were with the emergency department as they utilize the “Traumatic Spinal Cord Emergencies” protocol. The basis of the new SCE inpatient protocol was adapted from the previously established emergency room policy.

This project employed Lean Six Sigma as its quality improvement conceptual framework. Lean aims to minimize cost, inefficiency, and waste in any given process, while Six Sigma focuses on decreasing defects and variations on processes (Black, 2009). Combined, Lean Six Sigma is a process and quality improvement methodology focused on eliminating waste (from the Lean philosophy) and reducing variation (from the Six Sigma philosophy) in processes, leading to better efficiency and quality.

The Johns Hopkins Evidence-Based Practice (JHEBP) model (see Appendix D) was used to lead this quality improvement project to utilize concepts of Lean Six Sigma to adapt Hospital X's Emergency Department's Traumatic Spinal Cord Emergency to a more inclusive protocol that could be implemented across healthcare systems (Dang et al., 2022). Initially, an inquiry was made when the DNP student cared for a patient with signs of an SCE an no inpatient protocol at Hospital X. This led to a significant amount of triaging phone calls and potential for delay in patient care. Next, a practice question was formulated "Does the lack of an inpatient protocol at Hospital X lead to impaired quality of patient care and ineffective provider workflow?".

This was answered by a pre-survey needs assessment conducted by the DNP student to the APPs on Medicine A. By completing a systemic search and collection of relevant medical evidence, a literature review was completed. Literature review revealed that more often policies were focused on oncology or trauma than non-traumatic SCE.

In addition to literature reviews, meetings with key stakeholders were conducted to advise on the need of an adapted inpatient protocol. Through continued meetings throughout multiple disciplines (Figure 1), a need was seen at the mesosystem, thus the revision/rewriting process of the old SCE protocol began. The re-rewriting process used evidence-based practice informed by evidence-based guidelines, including multiple drafts amongst the key stakeholders and the DNP student over the span of two months.

To alert and disseminate staff for the utilization of the adapted protocol, an oral presentation was held session during a staff meeting, an 11"x13" poster was displayed in the APP workroom (see Appendix A), and a follow up e-mail was sent with the adapted protocol and poster. The effectiveness of the education of this protocol was evaluated by a quantitative post survey (see Appendix B).

Study of the Interventions:

Pre- and post- intervention data was collected to evaluate the quality improvement (QI) project. A pre-survey (see Appendix B) was distributed among nurse practitioners and physician assistants comprising the Advanced Practice Provider (APPs) Medicine Service to obtain quantitative data assessing both objective knowledge and participants perceived knowledge of SCE management (see Appendix B). Invited participants included 20 advanced practice providers on Medicine Unit A. No patients were included, as this is a quality improvement project for advanced practice providers (APPs). The only inclusion criterion is being an advanced practice provider on Medicine Unit A; exclusion criteria included float providers and support staff.

The DNP student presented the adapted protocol “Spinal Emergency Management Guidelines” during a staff meeting in January 2024. This presentation informed APPs of the project and its purpose. Emails provided links to the text of the adapted “Spinal Emergency Management Guidelines” protocol. A poster (see Appendix A) was displayed in the APP’s workroom’s bulletin board specific to clinical updates with a goal to reinforce staff knowledge. These activities were aimed to obtain 100% staff participation. The effect of this multifaceted approach was assessed through a post-survey (see Appendix B).

Measures:

A preliminary assessment via an electronic seven question pre-survey was distributed to evaluate education and perceived comfort regarding spinal cord emergencies (see Appendix B). Additionally, the DNP student evaluated the educational needs via discussions with APP staff. Following the educational interventions, a subsequent online survey was distributed to the APP staff to evaluate the effectiveness of the educational interventions and perceived confidence with SCE.

Analysis:

Data analysis included the data collected via a pre- and post- intervention survey (see Appendix B) that measured APP comfort and basic information regarding what an SCE entails. A p-chart was the method of analysis in the setting of statistical process control. Additional analysis of APP attendance in January 2024 was performed to capture all participants (n=20).

Ethical Considerations:

Staff at Hospital X and the DNP student maintained and protected survey data and its security in accordance with the Health Insurance Portability and Accountability Act (HIPPA). Although one member of the quality improvement project is affiliated with the institution, no potential conflict of interest is identified as they are employed on a different unit.

Results

The adapted and subsequent implementation of the SCE protocol that was approved in December 2023 (see Appendix C) is anticipated to shift the management of acute spinal injuries within Hospital X. Quantitative post-survey assessments have recorded a significant improvement in the knowledge base and comfort level of advance practice providers regarding the identification and management of spinal cord emergencies.

The first question was “What is your title”, with 90% NP response and 10% PA (pre- and post- results the same, n=20). Additional questions regarding SCE at Hospital X include: “Have you ever had a patient with a spinal cord emergency?” with yes for 20% response, 10% maybe, and 70% pre and post survey (n=20), “Do you know what the current practice is for spinal cord emergency is at Hospital X" with 10% yes and 90% no pre survey (n=20) and 100% yes post-survey (n=20).

Pre-survey findings of "How confident are you in 'activating' a spinal cord emergency?" were 40% not at all confident, 15% not so confident, 40% somewhat confident, 5% very confident (n=20). Post-survey findings of "How confident are you in 'activating' a spinal cord emergency?" were 75% extremely confident and 25% very confident (n=20).

The other noteworthy finding was the improvement in SCE knowledge. The question "Do you know what a spinal cord emergency is?" had yes for 100% response pre and post survey (n=20). In addition, the question of "The symptoms of cauda equina syndrome are varied and, if left untreated, can lead to complete paralysis of the lower extremities, so it is best to determine if a patient has cauda equina syndrome in order to provide immediate treatment. Which of the following symptoms, if present, suggests cauda equina rather than spinal cord injury due to trauma?" initially saw 15% of participants (n=20) get the correct answer of "decreased deep tendon reflexes in the legs" pre-survey, whereas, post-survey, 75% of participants (n=20) got the answer correct. Another question was "Cauda equina syndrome occurs when nerve roots at the caudal end of the spinal cord are compressed or damaged. Of the several causes of this disorder, which of the following is most common?" with 20% herniated disk, 80% herniated disk, 10% spinal stenosis, and 10% spinal cord infection pre survey (n=20).

There has not been a PSI or RCA post ""Spinal Emergency Management Guidelines" protocol intervention.

Discussion

Summary:

Informed by a clinical issue, this quality improvement project evolved from the clinical question: "Does the lack of an inpatient protocol at Hospital X lead to impaired quality of patient care and ineffective provider workflow?". This question was answered through the assessment of advanced practice providers' knowledge and comfort level in managing SCEs with resulting data supporting a lack of knowledge and confidence. Thus, an interdisciplinary workgroup was formed, yielding an adapted "Spinal Emergency Management Guidelines" to meet the project's quadruple aim of enhanced confidence and preparedness of medical professionals in handling such emergencies, streamlined communication and coordination among interdisciplinary teams, and consistent, high-quality care across various clinical settings. To ensure APPs were aware of this protocol change, its publication was accompanied by multifaceted educational interventions: presentations, workroom poster, and electronic communication.

Interpretation:

The increase in perceived knowledge and comfort managing with SCEs, as reported by the post-intervention survey, suggests improved management on non-oncological SCE among this pilot group on Medicine A. The increase in staff comfort has been particularly notable, as the comprehensive nature of the protocol offers a clear and concise roadmap for intervention, relieving the hesitation that often accompanies complex medical emergencies.

Limitations:

The adapted SCE protocol bridged previous gaps in expertise, forging a more informed and quick response by specialty providers, including neurology and neurosurgery. Barriers related to the project included an early resistance to change and adaptation of the protocol by

Hospital X's Neurocritical Care Division Director. This was likely a result as the existing protocol already alerted the Neurocritical Care Team. Additionally, the director did not feel an additional protocol or adaptation was necessary since a stroke code would garner the same clinical response and services. This was overcome by the continued evidence-based research and meetings with other key stakeholders, who agreed with the need for an inpatient protocol. These key stakeholders and the DNP student reached out to the neurocritical care director and urged for the need of a newly adapted protocol as there was no clear delineation of tasks for the primary provider and the neurocritical care attending did succumb to these findings.

This resistance represents a bias in a tertiary facility that has immediate services, specifically neurosurgery, available to intervene within the recommended 24-hour period. In smaller medical centers, and community and critical access hospitals, resources may be more limited, necessitating a SCE protocol that easily identifies risk for spinal cord emergency, confirmatory diagnosis, and coordination of intervention and management. This is a pilot project in the flagship hospital of a large medical system inclusive of satellite facilities. Additional training for these facilities is warranted, as well as continued education and integration into APP orientation.

Additional barriers include an inability to effectively track the incidences of spinal cord emergencies outside of one department or service: emergency department and oncology, both reported through institutional root cause analysis (RCA) and associated cause analysis (ACA). Therefore, it is unclear if this issue was preexisting and if any significant delays in care and associated poor outcomes occurred. Therefore, one cannot effectively assess improvements from the implementation of an adapted protocol using objective data.

The associated/accompanied educational interventions demonstrated an improved level of knowledge and perceived comfort in spinal cord emergency management among Hospital X Medicine Service's APPs. Most notably, there was a decrease from 95% to 0% of survey participants being somewhat or less confident in activating a spinal cord emergency, with three quarters of post-survey participants feeling "extremely confident". This includes improved recognition of SCE, utilization of a streamlined approach, and ultimately favorable outcomes for the patient.

Conclusion

The implementation and education of SCE at Hospital X has advanced the management of acute spinal emergencies which is demonstrated through a marked improvement in knowledge and confidence among advanced practice providers. This quality improvement project bridged potential gaps in care through the creation of an adapted protocol, as well as associated knowledge gaps and responsiveness to SCEs through comprehensive educational interventions, including pre and post survey assessments, flow-sheet diagrams, and targeted educational sessions.

Ongoing rigorous review of the latest evidence-based practice will need to be continued and the protocol updated as warranted. As a pilot project in the flagship hospital of a large medical system inclusive of satellite facilities, additional training for these satellite facilities is needed, as well as continued education and integration into APP orientation.

Sustainability of the project is evident in ongoing efforts, including the development of an integrated order set within the electronic medical record (EMR) and associated analytics. The protocol's integration into the electronic medical record as an order set is poised to further streamline the workflow, reducing the time to definitive care, and minimizing human error. This initiative not only optimizes the use of hospital resources but also ensures that patient care is efficient and meets best practice standards. This order set will include key components of the adapted protocol, including MRI of total spine without contrast and urgent consults to neurology and neurosurgery. This order set aims to create a more seamless and efficient process, particularly among coordination of interdisciplinary care. Additionally, utilization of the order set will also be tracked can be tracked through future improvements efforts through a dashboard analysis tool. Components of the analysis will include time to surgical intervention when using the SCE protocol versus ordering the individual components imaging and neurology and neurosurgery consults separately.

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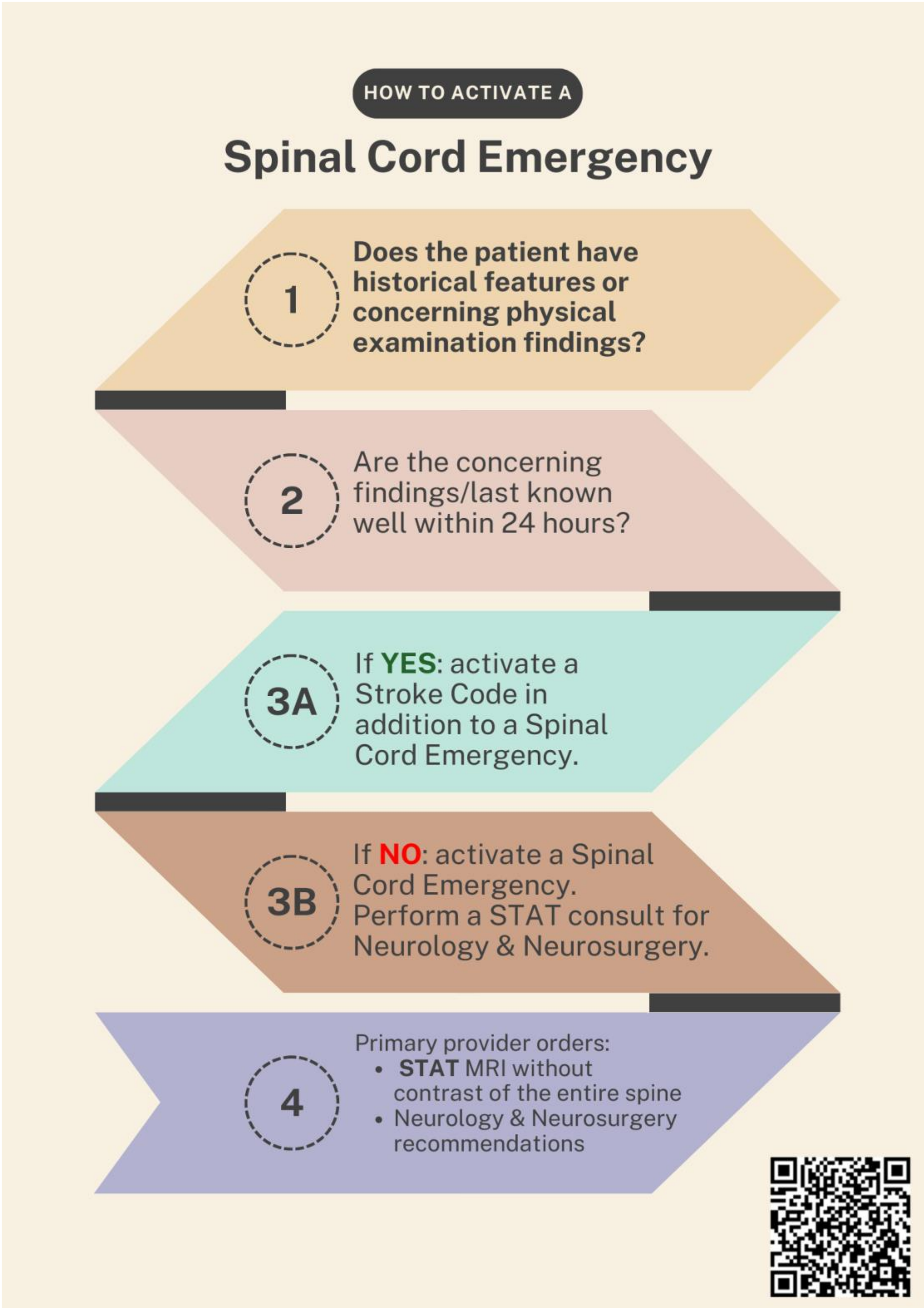
Appendix A


HOW TO ACTIVATE A
Spinal Cord Emergency
1
Does the patient have historical features or concerning physical examination findings?
2
Are the concerning findings/last known well within 24 hours?
3A
If YES: activate a Stroke Code in addition to a Spinal Cord Emergency.
3B
If NO: activate a Spinal Cord Emergency. Perform a STAT consult for Neurology & Neurosurgery.
4
Primary provider orders:
• STAT MRI without contrast of the entire spine
• Neurology & Neurosurgery recommendations

Appendix B

What is your title?

NP

PA

MD

RN

Do you know what a spinal cord emergency is?

Yes

No

Have you ever had a patient with a spinal cord emergency?

Yes

Maybe

No

Do you know what the current practice is for spinal cord emergency per NYU Langone?

Yes

Maybe

No

How confident are you in "activating" a spinal cord emergency?

Not at all confident

Not so confident

Somewhat confident

Very confident

Extremely confident

Cauda equina syndrome occurs when nerve roots at the caudal end of the spinal cord are compressed or damaged. Of the several causes of this disorder, which of the following is most common?

Congenital neurologic anomalies

Herniated disk

Spinal stenosis

Spinal cord infection

The symptoms of cauda equina syndrome are varied and, if left untreated, can lead to complete paralysis of the lower extremities, so it is best to determine if a patient has cauda equina syndrome in order to provide immediate treatment. Which of the following symptoms, if present, suggests cauda equina rather than spinal cord injury due to trauma?

Bladder and bowel dysfunction

Decreased deep tendon reflexes in the legs

Paresthesia

Sensory loss

Appendix C

Effective Date:	*12/2017*
Reissue Date:	*12/2023*
Reviewed Date:	*02/2022; 12/2023*

Issuing Department: ***Emergency Department, Neurology, Neurosurgery, Radiology***

Policy: ***Spinal Emergency Management Guidelines*** *Page **1** of **8***

I. CLINICAL CONTENT:

In patients with spinal cord or cauda equina compression, diagnosis is often delayed. "Classic" presentations are frequently variable or absent, leading to a lower clinician index of suspicion. In patients with spinal cord or cauda equina compression 75% have focal weakness, 50% have bowel or bladder dysfunction, and 40-90% with sensory abnormalities. Many patients with compressive lesions do not have rectal or urinary sphincter dysfunction or saddle anesthesia on presentation. Signs and symptoms may also evolve over the course of an emergency department encounter

II. SCOPE:

A. The "Spinal Emergency" guidelines apply to all inpatients at [redacted] Hospital – [redacted]

B. Patients presenting to the [redacted] Emergency Department should be emergently transferred to either the [redacted] Emergency Departments for evaluation and guideline activation. The [redacted] Emergency Department should contact Neurosurgery at the accepting site and remind the accepting Emergency Department team to activate a Spinal Emergency upon arrival.

C. Patients at [redacted] Orthopedic Hospital should follow the rapid response protocol currently in place.

III. GUIDELINE RECOMMENDATIONS:

A. Triggers

1. It is recommended to activate a Spinal Emergency in presence of one of the following "**hard**" neurological findings (see below).
2. Clinicians may consider activation in presence of concerning findings in history or exam.
3. Clinicians should be mindful that a Spinal Emergency may be indicative of spinal cord ischemia and activate a stroke alert in addition to a Spinal Emergency as indicated with a last known well/last known normal of less than 24 hours.
4. **Consider alternative diagnoses in patients presenting with signs of cranial nerve dysfunction, altered mental status, cognitive changes, or seizures.**
5. In unclear cases, it is recommended to consult neurology and/or neurosurgery to determine whether

to activate a Spinal Emergency.

6. Concerning Historical Features
   a. History of malignancy
   b. Use of corticosteroids
   c. Use of anticoagulants
   d. Recent spinal anesthesia
   e. Fever
   f. Immunocompromised state
   g. Parenteral drug use
   h. History of bacteremia
   i. New or frequent falls
   j. Midline back pain
   k. Nocturnal back pain
   l. Sphincter incontinence or urinary urgency
   m. Bilateral leg symptoms
7. Concerning Physical Examination Findings
   a. Sensory level (Hard finding)
   b. Paraparesis (Hard finding)
   c. Quadraparesis (Hard finding)
   d. Saddle anesthesia
   e. Hyper-reflexia
   f. Absent reflexes in involved limbs in the setting of **Hard Finding** (7a, 7b, 7c)
   g. Babinski sign in the setting of back pain
   h. Lax rectal tone
   i. Post void residual of greater than 100 mL
   j. New ataxia or difficulty walking

B. Imaging Modality of Choice and Rationale

1. MRI *without* contrast of the entire spine and/or appropriate spinal segment in consultation with

neurology, neurosurgery, and neuroradiology services unless there is concern for malignancy, infection or acute demyelination in which case the MRI should be ordered *with* contrast.

2. If an MRI cannot be obtained in a timely manner, a CT of the total spine should be obtained.
3. Physical exam findings frequently do not localize a lesion to specific area of the spine
   a. In patients with malignant cord compression or cauda equine syndrome secondary to cancer, approximately 70% of lesions are in thoracic spine, 20% in lumbosacral spine, 10% in cervical spine
   b. Approximately 33% of patients with cord compression have multiple sites of epidural metastasis and compression
4. The imaging strategy for postoperative neurosurgery and orthopedic spinal surgery patients should be determined in consultation with the specific operative service as described below.

C. Management overview of patients determined to be at high risk for spinal emergency

1. Primary provider consults neurology (via activation of a Stroke Code if appropriate based on the timing described above) and neurosurgery and indicates they are activating a Spinal Emergency. In the ER, the provider also orders ‘Spinal Emergency Protocol’ from the Epic ED Quicklist.
2. Primary provider orders STAT MRI *without* contrast of the entire spine and/or appropriate spinal segment in consultation with neurology, neurosurgery, and neuroradiology services with comment in notes that it is for spinal cord emergency.
3. Neurosurgery responds to consult within 30 minutes.
4. Neurology responds to consult within 30 minutes or as per Stroke Activation protocol if a Stroke Code is activated.
5. Neurology calls Radiology to activate Spinal Emergency and discusses case directly with neuroradiologist.
6. Neurology alerts anesthesia of need for their assistance performing imaging, if indicated.
7. Radiology prioritizes MRI, with goal to initiate within 1-2 hours.
8. Nursing performs serial neuro checks, monitors I/Os, checks post void residual, prepares patient for MRI and communicate with MRI tech regarding transport to MRI.
9. MRI Radiology Tech notifies radiologist when MRI is completed to obtain an immediate read.
10. Radiology results will be communicated to the primary team as per hospital’s policy on reporting of significant radiology findings
11. Subsequent diagnostic and therapeutic strategies will be determined in consultation with neurology

and neurosurgery.

12. Neurosurgery will call anesthesia if plan is for surgery.

D. Management of Patients with Suspected Acute Cervical Spinal Ischemia
   1. Primary team activates Stroke Code as per above guidance
   2. Stroke team considers emergent Neuro IR consult for diagnostic angiography and/or intra-arterial therapies
   3. Stroke team consults Neurocritical Care to assist with management of blood pressure.
   4. Neurosurgery should be consulted as per spinal emergency pathway. Lumbar drain should be considered if appropriate.
   5. Stroke team considers IV thrombolytic therapy as an off-label therapy in the setting of acute spinal cord ischemia if hyperacute MRI images will be available in a reasonable time frame.
      a. Given the risk of confounding diagnoses, the following imaging should be obtained prior to IV thrombolytic therapy:
         i. Head CT to rule out intracranial hemorrhage
         ii. CT total spine to evaluate for cord compression and hemorrhage.
         iii. Hyperacute MRI of total spine (CT total spine is not sufficient to rule out hemorrhage).
      b. Documentation of risk/benefit discussion with the patient should be made in the electronic medical record (EMR) as this is an off-label indication
      c. Standard thrombolytic therapy exclusion criteria apply. All patients should be screened for thrombolytic therapy exlusion criteria as per existing protocol "Management of the Patient Receiving Intravenous Thrombolytic Therapy"[1]

E. Management of postoperative neurosurgery and orthopedic spinal surgery patients
   1. The specific diagnostic, imaging, and treatment strategy should be conducted in consultation with the specific operative service with input from neurology/neurocritical care as appropriate.

IV. RESPONSIBILITES

A. PRIMARY PROVIDER ACCOUNTABILITIES

1. Activation of spinal emergency protocol

[redacted]

   a. Activate in presence of one (1) new or worsening hard neurological finding.
   b. Consider activation in presence of concerning findings in history or exam.
   c. In unclear cases, consult neurology and/or neurosurgery to determine whether to activate a Spinal Emergency.
   d. If concern for spinal ischemia, activate Stroke Code.
2. Enter necessary orders including MRI imaging and consults to neurology and neurosurgery.

B. NEUROLOGY PROVIDER ACCOUNTABILITIES

1. Responds to spinal emergency consult within 30 minutes.
2. Calls Radiology to activate Spinal Emergency and discuss case directly with neuroradiologist.
3. Calls Anesthesia if sedation is needed for imaging.
4. Evaluates patient in conjunction with imaging findings and formulate further diagnostic and treatment strategy with the services.

C. NEUROSURGERY PROVIDER ACCOUNTABILITIES

1. Responds to spinal emergency consult within 30 minutes.
2. Evaluates patient in conjunction with imaging findings and formulate further diagnostic and treatment strategy with the services.

D. NEURORADIOLOGY TEAM ACCOUNTABILITIES

1. Prioritizes MRI.
2. Protocols MRI as appropriate for the clinical indication and discussion with the clinical team.
3. Communicates to primary team as per hospital’s policy on reporting of significant radiology findings.

V. OTHER CONSIDERATIONS

Not applicable.

VI. PERTINENT PERFORMANCE MEASURES

Number of activations per month.

VII. REFERENCES:

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IX. APPROVALS:

[redacted]

Appendix D

The Johns Hopkins Nursing Evidence-Based Practice Model (2017)