Procedural sedation and analgesia for treatment of adults with fractures and dislocations in the emergency department.

(Protocol for the PAINEX study)

Primary Investigator

Sophie Sværke, M.D.

Registrar and PhD-fellow in Emergency Medicine

Department of Emergency Medicine

Holbæk Hospital, Smedelundsgade 60, 4300 Holbæk

Odense University Hospital, J.B. Winsløws Vej 4, 5000 Odense

Administrative details

Primary investigator

Sophie Sværke, M.D, PhD-student
Department of Emergency Medicine, Holbæk Hospital
Department of Emergency Medicine, Odense University Hospital

Research team

Co-investigators:
Mikkel Brabrand, Clinical Professor, PhD, M.D, Consultant
Department of Emergency Medicine, Odense University Hospital
Department of Clinical Medicine, University of Southern Denmark

Ole Mathiesen, Clinical Professor, PhD, M.D, Consultant
Department of Anesthesiology, Zealand University Hospital, Køge
Department of Clinical Medicine, University of Copenhagen

Anders Krusenstjerna-Hafstrøm, Associate Professor, M.D, Consultant
Department of Emergency Medicine, Holbæk Hospital

Bjarke Viberg, Professor, PhD, M.D, Consultant
Department of Orthopaedic Surgery and Traumatology, Odense University Hospital
Department of Clinical Medicine, University of Southern Denmark

Local site investigator Zealand University Hospital Køge:
Marie-Laure Bouchy Jacobsson, Clinical Assistant Professor, M.D, Consultant
Emergency Department, Zealand University Hospital – Køge, Denmark
Department of Clinical Medicine, Faculty of Health and Medical Sciences, Copenhagen University, Denmark

Local site investigator Holbæk Hospital:
Martin Schou M.D, PhD, Consultant
Department of Emergency Medicine, Holbæk Hospital

Summary

Background

Each year, around 80,000 patients in Denmark suffer from painful fractures where 60% involves the hip, ancle, foot, upper arm, forearm, or fingers [1]. A substantial part of these injuries requires reduction treatment – a necessary painful stabilizing treatment in the emergency department. Physicians are trying to ease this pain with different types of medications for procedural sedation and analgesia. Systemic procedural sedation and/or analgesia or treatment with nerve or hematoma blocks depends on the injury but faces different challenges tied to choice of medication and administration route. These challenges include patient satisfaction and sufficient analgesic effect since several patients still experience considerably pain regardless of strong opioids. With focus on patient satisfaction and pain reduction, the best method for procedural sedation and analgesia for these types of injuries, remain unclear – but are very important aspects for both patients and physicians.

Aim

To describe patient satisfaction, pain-relieving effect, clinicians' satisfaction and adverse events of different procedural sedative and analgesic treatment options for adults with upper and lower extremity injuries in the emergency department at Odense University Hospital, Holbæk Hospital, and Zealand University Hospital, Køge.

Methods

This prospective observational cohort study will be reported following "The Strengthening the Reporting of Observational Studies in Epidemiology Statement: Guidelines for reporting observational studies" (STROBE guidelines) to evaluate the effectiveness of different procedural sedative and analgesic treatment options in three emergency departments.

The study will assess: Patient- and clinicians' satisfaction with procedural sedation and analgesia, pain levels before, under and after treatment, incidence of selected adverse events and usage of antidotes.

Eligible patients are: Adult patients with upper or lower extremity injuries that require painful stabilizing treatment. Data will be collected over a selected period of six months.

Detailed description

Background

Each year around 80,000 patients in Denmark suffer from painful fractures where 60% involves the hip, ancle, foot, upper arm, forearm, or fingers [1]. A substantial part of these injuries require stabilizing reduction treatment – a necessary but painful procedure performed in the emergency department [2]. To alleviate pain and discomfort, physicians use various types and combinations of medications for procedural sedation and analgesia [3, 4].

Procedural sedation and analgesia are described in the literature as the use of sedative, analgesic or dissociative drugs to relieve anxiety and pain associated with diagnostic or therapeutic procedures [5]. It is practiced daily in the emergency department for various types of procedures [6]. Recently, data on local practices and available medication used for procedural sedation and analgesia was collected from 21 different Danish emergency departments. Most departments used analgesics like morphine, fentanyl, and paracetamol as monotherapy or combined with sedatives such as midazolam or diazepam. Other medications available for procedural sedation and analgesia included alfentanil, intravenous ketamine, intranasal sufentanil combined with ketamine, N^2O, remimazolam, or intravenous ketorolac. While some departments facilitated a broad range of analgosedatives, while others favored a more limited selection. The study did not specify the choice of medications for particular procedures or types of injuries.

Nationally and internationally, hematoma blocks are also a commonly used treatment method for managing pain in distal radius fractures and in certain countries no analgesia is administrated during treatment of distal radius fractures despite pain [7-9]. Other nerve blocks such as interscalene- or infraclavicular blocks may be used for reduction treatment of shoulder or elbow dislocations e.g. [10] [11].

Usage of procedural sedation and analgesia in the emergency department faces different challenges depending on the choice of medication and administration route. Patient satisfaction is a very important factor which can rely on these factors. A 2023 meta-analysis of 52 randomized controlled trials with adult patients undergoing procedural analgosedation for different procedures, found ketamine-propofol to increase patient satisfaction compared to midazolam-opioid [12], which is widely used. Other challenges include the fact that patients still may experience significant pain despite the use of strong opioids. A Danish review evaluating 2,348 patients treated with intravenous fentanyl by paramedics, found that while fentanyl reduced pain levels >2 points on the numerical rating scale for 79.3% of patients, 60% of patients still reported moderate to severe pain at hospital arrival [13, 14]. Patients

undergoing closed reduction treatment for distal forearm fractures are often treated with hematoma blocks alone, but research points in different directions and some available studies suggest only mild pain relief [15] while others find hematoma blocks comparable to intravenous procedural sedation and analgesia [8].

Another potential challenge with procedural sedation and analgesia is safety. A 2024 meta-analysis [16] reviewed 32 randomized controlled trials involving a total of 6,377 procedural sedations, identifying hypoxia as the most common adverse effect, occurring at a rate of 78.5 per 1,000 sedations [16]. Other frequent adverse events included apnea (31 per 1,000 sedations) and hypotension (28.1 per 1,000 sedations). Severe adverse events were rare: bradycardia occurred in 16.7 per 1,000, laryngospasm in 2.9 per 1,000, intubation in 10.8 per 1,000, and aspiration in 2.7 per 1,000 [16]. One of the most frequently employed regimens, the combination of midazolam and opioids, was specifically associated with hypotension (1.7%), bradycardia (3.2%), apnea (1.7%), hypoxia (5.3%), agitation (1.3%), and vomiting (1.3%) [16]. The same review identified ketamine as the safest option for minimizing respiratory adverse events, showing the lowest rates of apnea and hypoxia compared to other sedatives, including midazolam, diazepam, ketofol, etomidate, propofol, alfentanil, and combinations such as ketamine with propofol or midazolam with opioids [16].

The optimal method for procedural sedation and/or analgesia of some of the most frequent upper and lower extremity injuries treated in the emergency department - remains unclear when it comes to patient satisfaction, pain relief and safety, which are essential factors for both patients and physicians. This prospective cohort study therefore aims to evaluate patient satisfaction, pain-relieving effect, clinicians' satisfaction, and adverse events associated with different standard procedural sedative and/or analgesic methods used for adults with upper and lower extremity injuries in the emergency departments of Odense University Hospital, Holbæk Hospital and Zealand University Hospital, Køge.

Objective and aim

To investigate patient satisfaction, pain-relieving effect, clinicians' satisfaction and adverse events of different standard treatment options used in clinical practice for routine procedural sedation and/or analgesia in adults at the emergency departments of Odense University Hospital, Holbæk Hospital and Zealand University Hospital, Køge.

Methods

Study design

This study is a prospective observational cohort study. It will be reported following "The Strengthening the Reporting of Observational Studies in Epidemiology Statement: Guidelines for reporting observational studies (STROBE guidelines)" [17].

Patients

Eligible patients with upper and lower extremity injuries that require painful stabilizing treatment in the emergency department.

Inclusion criteria

1. Age ≥18.
2. Patients with the following injuries are eligible:
   a) Reduction treatment of shoulder dislocation
   b) Reduction treatment of elbow dislocation
   c) Reduction treatment of distal radius fractures, application of cast
   d) Reduction treatment of finger fractures/dislocation
   e) Casting treatment of upper extremity fractures
      - Proximal humerus fracture, application of fixed sling
      - Humeral shaft fracture, application of Sarmiento brace
      - Supracondylar fracture, application of angled cast
   f) Reduction treatment of hip dislocation
   g) Reduction treatment of patella dislocation
   h) Reduction of tibial shaft fracture, application of cast
   i) Reduction treatment of ancle fractures including distal tibia fracture
   j) Reduction treatment for toe fractures/dislocation
   k) Casting treatment of lower extremity fractures
      - Distal femur fracture, application of cast/traction
      - Proximal tibia fracture, application of cast or hinged brace
      - Ancle fracture, application of walker

Exclusion criteria

1. Unable to give informed consent (e.g. unconscious, psychotic or dementia)
2. Unwilling to participate in the study
3. Prior inclusion in the study
4. Already included in another clinical study at the same day/hospital visit
5. Pregnant or breastfeeding

Procedural sedation

Each department will collect data on the treatment patients with the upper and lower extremity injuries receive during reduction or stabilizing treatment (procedural sedation and/or analgesia, or no treatment).

Outcomes

Primary outcome

Patient satisfaction with procedural sedation regime measured using numerical rating scale [18] when awake and alert before discharge from the emergency department.

Secondary outcomes

1. Re-call of maximal pain score during treatment procedure using the Numerical Rating Scale [18], asked when awake and alert before discharge from the emergency department.
2. Patient satisfaction with the sedation regime and treatment measured with the Short Assessment of Patient Satisfaction (SAPS) [19].
3. Clinician's satisfaction with the analgosedation using the Numerical Rating Scale [18], after completed procedure.
4. Incidence of following adverse events: Hypoxia, hypotension, treatment requiring bradycardia, nausea, vomiting, or hallucinations, and need of reversal agents (antidote medication)

Explorative outcomes

1. Patient satisfaction with sedation regime and treatment via a 5-point Likert Scale [20], asked when awake and alert before discharge from the emergency department.
2. The incidence of procedural amnesia (patient reported outcome).
3. Dissociative experience during treatment (patient and physician reported outcome).

Description of outcome measures

Numerical rating scale (NRS)

We will use the numerical rating scale to evaluate the primary outcome (patient satisfaction with procedural sedation regime) and secondary outcome – clinician satisfaction. The numerical rating scale is an 11-point scale ranging from 0 to 10 and can be used to measure patient satisfaction and clinician satisfaction where 0 = totally dissatisfied and 10 = totally satisfied. Patient and clinicians will be asked for the number corresponding to their level of satisfaction with the procedural sedation. Patients will be asked when awake and alert before discharge from the emergency department and clinicians after completed procedure.

We will also use the numerical rating scale to measure the intensity of pain. It is simple and allows patients to self-report their pain level using a numeric value, providing a straightforward and standardized way to evaluate and monitor pain in clinical settings [18, 21, 22]. The numerical rating scale used to measure pain level ranges from 0 to 10 where: 0 represents "no pain" and 10 represents "the worst imaginable pain" [18, 21, 22]. Before discharge, and when the patient is awake and relevant, we will ask patients about their level

of experienced pain on the numerical rating scale (0-10 scale): 1) Before administration of procedural sedation (recall), 2) pain level during the procedure (recall) and 3) after procedure at discharge (post-procedure). These scores will be used to evaluate the effectiveness of different analgesics in reducing patients' pain intensity**.**

Short assessment of patient satisfaction (SAPS)

The short assessment of patient satisfaction is a brief, validated questionnaire designed to measure patients' satisfaction in a quick and efficient manner. It evaluates key aspects of healthcare experiences, making it suitable for assessing overall patient satisfaction [19]. It will consist of 7–10 short items and uses the rating system from the 5-point Likert scale that patients are already introduced into with "Very Dissatisfied" to "Very Satisfied".

5-point Likert scale

The 5-point Likert scale is a commonly used survey tool to measure levels of satisfaction with different treatments or outcomes [20, 23]. We will use it besides the numerical rating scale to measure patient satisfaction with the procedural sedation treatment. It provides the patients with five response options that reflect varying degrees of satisfaction. The scale includes both positive and negative endpoints, allowing patients to express their experiences in a structured manner [23].

The 5-point Likert Scale is divided into the following answers:

1. Very dissatisfied
2. Dissatisfied
3. Neutral (or neither satisfied nor dissatisfied)
4. Satisfied
5. Very satisfied

We will use the 5-point Likert scale in collaboration with the numerical rating scale to determine the minimal important difference of patient satisfaction with procedural sedation. Patients will be asked when awake and alert before discharge from the emergency department.

Sample size

The sample size will be a non-consecutive convenience sample with inclusion of eligible patients over a six-month period beginning from July 2025.

Statistical analysis

The study is an observational cohort study. We will use R version 4.1.0. to analyze data when necessary. The analysis will include patient satisfaction, type of injury, type of analgetic, and a description of patients' baseline characteristics. They will be summarized using appropriate descriptive statistics. If any data is missing, we will describe this.

Continuous variables will be presented as either mean and standard deviation (SD) for normally distributed data or median and interquartile range (IQR) for non-normally distributed data. Categorical variables will be reported as frequencies and percentages.

We will use the results from the 5-point Likert Scale as an anchor to evaluate Minimal Important Difference (MID) for patient satisfaction, defined as the difference in pain (on the NRS scale) between patients who reported no pain, versus patients who reported mild pain as well as in patients with mild pain, moderate pain or severe pain. This will help us evaluate the clinical relevance of the findings.

Ethical considerations and protection of data

The study will assess the procedural sedative and/or analgesic methods currently used in emergency departments, which poses no additional risk to patients. No changes to current treatments will be employed because of the study, as patients are treated as usual. The study will be registered at Clinicaltrials.gov and patients will be asked for informed oral and written consent accordant to Danish law.

This protocol has obtained permission according to Danish legalization. It is registered and approved in PRVACY in the Region Zealand and Research Registry for Health Science in the Region of Southern Denmark. The head of department of each participating department has approved the study can be conducted in their departments. This research group has agreed on a shared data responsibility and a legal contract was made by SDU Rio to cover all aspects of data protection and sharing between the two regions. The research group has also signed a contract of collaborative research. All data is collected electronically and stored safely. The data is stored regarding to General Data Protection Regulation (GDPR) in an electronic password protected database in REDCap. The REDCap database is anchored in the Region of Zealand.

Data management

Data collection

A local site investigator and the research team will be responsible for inclusion at each site, and a selection of local staff will take part in inclusion of patients and collection of data after training by the primary investigator. The data will be collected and typed directly into REDCap.

The following data will be collected at inclusion:

1) Date of arrival.
2) Primary diagnosis.
3) Treatment/procedure.

The following data will be collected post procedure, when patient is awake and alert (before discharge from the emergency department):

1) Patient characteristics:
    a) Age
    b) Sex
    c) Weight
    d) American Society of Anesthesiologists classification (ASA class)
2) Type of any analgesics before arrival (including no medication taken)
3) Number of strategies used for procedural sedation and/or analgesic (including no medication used) (if shifting medication or administration route during procedure to accomplish e.g. reduction treatment)

    Following data will be collected for each strategy:

    a) Medication and dosage
    b) Administration route (oral, intravenous, intranasal, local (block) or intramuscular)
    c) Requirement for supplemental analgesics
    d) Usage of antidotes: Naloxone or flumazenil
    e) Number of reduction attempts, success with reduction (yes/know)
    f) Need of general anesthesia to accomplish desired procedure

4) Patient satisfaction with sedation measured using the “Numerical Rating Scale” (0-10) [18] measured before discharge.
5) Patient satisfaction via the “Short Assessment of Patient Satisfaction” [19] measured before discharge.
6) Clinician satisfaction with the analgosedation using the numerical rating scale [18], after completed procedure.
7) Selected adverse events and serious adverse events (reported by clinician in patient journal in relation to procedural sedation): Hypoxia (drop of saturation SpO2 of >5% from baseline measured on peripheral saturation monitoring), hypotension (Mean Arterial Pressure <65), treatment requiring bradycardia, vomiting or hallucinations (objective assessment by treating physician).
8) Experience of pain level on the numerical rating scale (0-10 scale): a) Before administration of procedural sedation (recall), b) max pain level during the procedure (recall) and c) after procedure before discharge (post-procedure pain level). [18]
9) Incidence of procedural amnesia (yes/no), measured before discharge
10) Dissociative experience during treatment (good dreams or bad dreams)

11) Patient satisfaction via a “5-point Likert Scale” [20] measured before discharge.
12) Patient contact information if interested in study results or to become part of the patient steering committee for future studies.

Handling
All information will be treated confidentially according to GDPR, and patients will be anonymized in the reporting of the study.

Study organization
This organization is a collaboration between emergency medicine, orthopedics and anesthesiology researchers. All researchers have experience with procedural sedation for emergency department injuries, and at all participating sites, emergency medicine physicians are in charge of both emergency department injury treatment and procedural sedation.

Conflicts of Interest
The investigators have no conflict of interest.

Financing
The study is fully funded and has received funding from:
Brødrene Hartmanns Fond.
Danmarks Frie Forskningsfond.
Emergency Department, Holbæk Hospital.
Else og Mogens Wedell-Weddelsborgs Fund.
Kong Christian den tiendes Fond.
L.F Foghts Fond.
Ingeniør K.A Rhode og Hustrus Legat.
Odense University Hospital PhD Fund.
Region of Zealand.
Region of Southern Denmark.
Region of Southern Denmark and Region of Zealand Common Fund.

Timeline
This study is expected to begin in July 2025 and last six months after required approvals and registrations.

Perspectives
This study aims to evaluate patient satisfaction, analgesic efficacy, clinician satisfaction and adverse events with existing procedural sedative and/or analgesics treatments in the emergency department for patients with upper and lower extremity injuries. Annually 80,000

patients in Denmark suffer from painful fractures where 60% involves the hip, ancle, foot, upper arm, forearm, or fingers, yet few studies have focused on patient satisfaction in acute care settings [1]. Currently, no research has examined patient satisfaction with different approaches to procedural sedation and/or analgesia in the emergency department. By assessing these factors, the study will contribute to highlight key issues concerning the quality and safety of treatment practices, ensuring that patients receive the most effective and patient-centered care.

Disseminations of results

Expected results, implementation and publication

The results are expected to generate at least one publication in a national or international peer-reviewed journal, preferably as open access publications. Results will be presented at relevant national conferences or meetings. All results (positive, negative or inconclusive) will be published. Included patients will be informed if they wish to.

Authorship

Authorship will be granted according to the Vancouver rules for authorship and will occur in the following order:

1. Sophie Sværke
2. Martin Schou
3. Marie-Laure Bouchy Jacobsson
4. Camilla Hedegaard Riis
5. Anders Krusenstjerna-Hafstrøm
6. Bjarke Løvbjerg Viberg
7. Mikkel Brabrand
8. Ole Mathiesen

N.B. Changes might appear, and further authors might be added but Sophie Sværke will remain 1st author and Ole Mathiesen last author.

References

1. Jes Bruun Lauritzen, K.S.O.R., Per-Henrik Randsborg, Jan Erik Madsen. *Knoglebrud*. Lex 2025 [cited 2025 05/09/2025]; Available from: https://lex.dk/knoglebrud.
2. Löw, S., M. Papay, and C. Eingartner, *Pain Perception following Initial Closed Reduction in the Preoperative Care of Unstable, Dorsally Displaced Distal Radius Fractures.* J Hand Microsurg, 2019. **11**(2): p. 111-116.
3. Wakai, A., R. O'Sullivan, and A. McCabe, *Intra-articular lignocaine versus intravenous analgesia with or without sedation for manual reduction of acute anterior shoulder dislocation in adults.* Cochrane Database Syst Rev, 2011. **2011**(4): p. Cd004919.
4. Funk, L., *A prospective trial to compare three anaesthetic techniques used for the reduction of fractures of the distal radius.* Injury, 1997. **28**(3): p. 209-12.
5. Krauss, B. and S.M. Green, *Procedural sedation and analgesia in children.* Lancet, 2006. **367**(9512): p. 766-80.
6. Bahn, E.L. and K.R. Holt, *Procedural sedation and analgesia: a review and new concepts.* Emerg Med Clin North Am, 2005. **23**(2): p. 503-17.
7. Sørensen, O.G. and T.B. Hansen, *[Systematic pain treatment following Colles' fracture].* Ugeskr Laeger, 2004. **166**(22): p. 2155-8.
8. Fathi, M., et al., *Ultrasound-guided hematoma block in distal radial fracture reduction: a randomised clinical trial.* Emerg Med J, 2015. **32**(6): p. 474-7.
9. Issin, A., H. Yurten, and S. Özcan, *No-anesthesia for Colles fracture.* Injury, 2024. **55**(7): p. 111614.
10. Raeyat Doost, E., et al., *Ultrasound-guided interscalene nerve block vs procedural sedation by propofol and fentanyl for anterior shoulder dislocations.* Am J Emerg Med, 2017. **35**(10): p. 1435-1439.
11. Akay, S., et al., *Case Report: Ultrasound-Guided Infraclavicular Brachial Plexus Block for a Case with Posterior Elbow Dislocation.* J Emerg Med, 2017. **53**(2): p. 232-235.
12. Sharif, S., et al., *Pharmacological agents for procedural sedation and analgesia in the emergency department and intensive care unit: a systematic review and network meta-analysis of randomised trials.* Br J Anaesth, 2024. **132**(3): p. 491-506.
13. Medicine, E.S.F.E. *Guidelines for the management of acute pain in emergency situations*. 2020 [cited 2024 July 11]; Available from: https://www.eusem.org/images/EUSEM_EPI_GUIDELINES_MARCH_2020.pdf.
14. Friesgaard, K.D., et al., *Efficacy and safety of intravenous fentanyl administered by ambulance personnel.* Acta Anaesthesiol Scand, 2016. **60**(4): p. 537-43.
15. Aniel-Quiroga, M., et al., *[Translated article] The haematoma block is not enough as method of anaesthesia in reduction of displaced distal radius fractures.* Rev Esp Cir Ortop Traumatol, 2023. **67**(5): p. T371-t377.
16. Khan, M.T., et al., *Safety of procedural sedation in emergency department settings among the adult population: a systematic review and meta-analysis of randomized controlled trials.* Intern Emerg Med, 2024. **19**(5): p. 1385-1403.
17. Vandenbroucke, J.P., et al., *Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration.* Ann Intern Med, 2007. **147**(8): p. W163-94.
18. Karcioglu, O., et al., *A systematic review of the pain scales in adults: Which to use?* Am J Emerg Med, 2018. **36**(4): p. 707-714.

19. Hawthorne, G., et al., *Measuring patient satisfaction with health care treatment using the Short Assessment of Patient Satisfaction measure delivered superior and robust satisfaction estimates.* J Clin Epidemiol, 2014. **67**(5): p. 527-37.
20. Voutilainen, A., et al., *How to ask about patient satisfaction? The visual analogue scale is less vulnerable to confounding factors and ceiling effect than a symmetric Likert scale.* J Adv Nurs, 2016. **72**(4): p. 946-57.
21. Hawker, G.A., et al., *Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP).* Arthritis Care Res (Hoboken), 2011. **63 Suppl 11**: p. S240-52.
22. Downie, W.W., et al., *Studies with pain rating scales.* Ann Rheum Dis, 1978. **37**(4): p. 378-81.
23. Bancsik, K., et al., *Comparative Analysis of Patient Satisfaction Surveys-A Crucial Role in Raising the Standard of Healthcare Services.* Healthcare (Basel), 2023. **11**(21).