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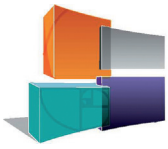

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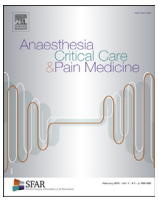

Original Article

Bundle of care for blunt chest trauma patients improves analgesia but increases rates of intensive care unit admission: A retrospective case-control study

Cédric Carrie [a,*], Laurent Stecken [b], Elsa Cayrol [a], Vincent Cottenceau [a], Laurent Petit [a], Philippe Revel [b], Matthieu Biais [c,d], François Sztark [a,d]

[a] Anaesthesiology and Critical Care Department I, CHU de Bordeaux, 33000 Bordeaux, France
[b] Emergency Department, CHU de Bordeaux, 33000 Bordeaux, France
[c] Anaesthesiology and Critical Care Department III, CHU de Bordeaux, 33000 Bordeaux, France
[d] Université de Bordeaux Segalen, 33000 Bordeaux, France

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ABSTRACT

Introduction: This single-centre retrospective case-control study aimed to assess the effectiveness of a multidisciplinary clinical pathway for blunt chest trauma patients admitted in emergency department (ED).

Patients and methods: All consecutive blunt chest trauma patients with more than 3 rib fractures and no indication of mechanical ventilation were compared to a retrospective cohort over two 24-month periods, before and after the introduction of the bundle of care. Improvement of analgesia was the main outcome investigated in this study. The secondary outcomes were the occurrence of secondary respiratory complications (pneumonia, indication for mechanical ventilation, secondary ICU admission for respiratory failure or death), the intensive care unit (ICU) and hospital length of stay (LOS).

Results: Sixty-nine pairs of patients were matched using a 1:1 nearest neighbour algorithm adjusted on age and indices of severity. Between the two periods, there was a significant reduction of the rate of uncontrolled analgesia (55 vs. 17%, $P < 0.001$). A significant increase in the rate of primary ICU transfer during the post-protocol period (23 vs. 52%, $P < 0.001$) was not associated with a reduction of secondary respiratory complications or a reduction of ICU or hospital LOS. Only the use of non-steroidal anti-inflammatory drugs appeared to be associated with a significant reduction of secondary respiratory complications (OR = 0.3 [0.1–0.9], $P = 0.03$).

Conclusion: Implementation of a multidisciplinary clinical pathway significantly improves pain control after ED management, but increases the rate of primary ICU admission without significant reduction of secondary respiratory complications.

1. Introduction

Blunt chest trauma frequently involves multiple rib fractures that result in a painful limitation of thoracic amplitude and reduction of coughing. The parietal restrictive syndrome is exacerbated by the reduction in functional residual capacity due to pleural effusion or alveolar contusion, which triggers a vicious circle with bronchial congestion, alveolar consolidation and atelectasis, leading to secondary respiratory complications as pneumonia, respiratory failure, need for prolonged ventilation and possible death [1].

In blunt chest trauma patients without immediate life-threatening injuries, multidisciplinary interventions such as effective analgesia, respiratory care and surgical fixation may reduce the rate of secondary respiratory complications and improve patient outcomes [2–5]. Moreover, an early management through appropriate orientation seems paramount in order to prevent secondary transfers in intensive care unit (ICU), associated with increased use of health-care resources and long-term

* Corresponding author. Surgical and Trauma Intensive Care Unit, Anaesthesiology and Critical Care Department I, Hôpital Pellegrin, CHU de Bordeaux, place Amélie-Raba-Léon, 33076 Bordeaux cedex, France.
E-mail address: cedric.carrie@chu-bordeaux.fr (C. Carrie).

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functional impairment [6]. In this context, the role of emergency physician is thus to provide an optimal pain control and organise the more appropriate orientation to prevent under-triage of patients at risk for secondary respiratory complications.

On the other hand, the implementation of a multidisciplinary clinical pathway may be difficult in the emergency settings, and evaluation of this prophylactic resource-consuming strategy is still lacking [7]. We thus hypothesised that implementation of a bundle of care including regional analgesia was associated with a significant improvement of pain control after emergency management. The main objective of this retrospective study was thus to assess the effectiveness of the bundle of care on reducing the rate of uncontrolled analgesia. The secondary outcome was to assess the effectiveness of the bundle of care on reducing the rate of under-triage and secondary respiratory complications.

2. Methods

2.1. Study design, population and settings

In our emergency department (ED), an 8-bed emergency intensive care unit (ICU) receives directly from scene all trauma patients suspected to be severely injured during pre-hospital assessment according to French guidelines [2]. This Level 1 trauma centre is under the responsibility of intensivist doctors with experience in non-invasive ventilation (NIV) and regional analgesia. In March 2015, a bundle of care was developed to manage every blunt chest trauma patient in accordance with the up-to-date recommendations [2]. Clinical pathways depended on several prognostic scores and therapeutic interventions performed in the ED [8–12]. Briefly, high-risk trauma patients were defined by at least one of the following factors: age $\geq$ 45 years, chronic pulmonary or cardiovascular disease, congenital or acquired coagulation disorders, multiple trauma, multiple rib fractures $\geq$ 3, pulmonary contusion or pleural effusion, hypoxemia or hypercapnia, respiratory rate $\geq$ 20/min or a forced vital capacity (FVC) $\leq$ 50% despite an optimised intravenous analgesia [8–10]. This protocol is described in Table 1.

This single-centre retrospective case-control study aimed to compare two 24-month periods, before and after implementation of the bundle of care. A retrospective review of the institution's trauma registry was used to identify all patients with multiple rib fractures triaged to our Level 1 trauma centre from March 2013 to March 2015 (control group) and from March 2015 to March 2017 (protocol group). Non-inclusion criteria were patients < 18 years old, patients admitted under mechanical ventilation, patients admitted more than 24 h after trauma or from another hospital, patients with less than 3 ribs fractures or who did not receive CT-scan. Secondary exclusion criteria were patients who required an intubation during the emergency care for a life-threatening condition or emergency surgery, decision to limit life-support or loss of follow-up (discharge to home or transfer to another hospital) [8].

The observational character of this before-and-after retrospective study was approved by the Institutional Review Board (Comité de Protection des Personnes Sud-Ouest et Outre-Mer III, Bordeaux, France, protocol n° DC 2015/114).

2.2. Data collection and outcomes

For each patient, the following variables were retrospectively collected in the ED medical record: demographic data, mechanism of injury, history of heart failure or obstructive pulmonary disease, thoracic injuries, associated injuries, Injury Severity Score (ISS) and Simplified Acute Physiology Score II (SAPS II). A blinded physician calculated the Thoracic Trauma Severity (TTS) score a posteriori. Covariates included age, PaO_2/FiO_2 ratio, number of rib fractures, importance of pulmonary contusion and pleural effusion [11]. Type of pain control (thoracic paravertebral infusion [TPI], epidural analgesia [EA] or intravenous [IV] pain control), chest tube requirement and the use of NIV and/or high-flow nasal cannula oxygen therapy were also recorded during the emergency care. After ED management, the primary orientation of the patient was recorded (Intensive Care Unit [ICU], post-traumatic unit [PTU] or ward management). In our institution, PTU differs from ICU by the non-ability to manage high-risk patients under NIV, vasopressors and/or EA.

The first day after emergency management, the computerised paramedical records allowed to collect the visual analogue scale (VAS) pain scores at rest every 4 hours and the mean consumption of morphine (equi-analgesic doses). At the end of the primary hospitalisation, were noticed the occurrence of secondary respiratory complications, the ICU and hospital length of stay (LOS). Secondary respiratory complications were defined by one or more

Table 1
Bundle of care and clinical pathways for blunt chest trauma patients.

Multidisciplinary interventions in emergency ICU within 12 hours
Repeated assessment of pain score and functional respiratory status
Repeated assessment of visual analogue pain scale (VAS) at rest, coughing and deep breathing
Repeated assessment of forced vital capacity (FVC) by portable spirometer [8]
Intravenous analgesia
Morphine and/or ketamine titration until resting VAS < 3
Multimodal analgesia including non-steroid anti-inflammatory drugs (NSAIDs) unless contra-indicated
Addition of morphine intravenous patient-controlled analgesia if persistence of VAS > 3
Locoregional analgesia
If persistence of a VAS > 3 and/or FVC < 50% despite optimised intravenous analgesia, preferably in high-risk patients
Indication and technique (epidural and paravertebral catheters) left to the discretion of the attending physician unless specific contraindication
Chest tube insertion
In case of traumatic pleural effusion responsible for hemodynamic and/or respiratory failure or hemothorax estimated > 500 mL
Indication and technique left to the discretion of the attending physician. Pigtail catheters preferred in isolated pneumothorax with low risk of secondary hemothorax
Respiratory support
Non-invasive ventilation (NIV) indicated if persistent hypoxemia (PaO_2/FiO_2 ratio $\leq$ 200 mmHg) after CT-scan and chest tube insertion when indicated. Optimal dosing $\geq$ 6 h/day. Strict compliance with contraindications and monitoring procedures
High-flow nasal cannula oxygen therapy in association with NIV or if NIV contra-indicated
Surgical advice
Discuss indication of osteosynthesis for flail chest and/or complex costal fractures (multiple rib fractures with shift > 2 cm)
Clinical pathways within 24 hours
Primary ICU admission
If indication of NIV and/or high-flow nasal cannula oxygen therapy
If indication of epidural analgesia in high-risk selected patients
Post-traumatic unit admission
If indication of pleural drainage or pleural effusion requiring continuous monitoring
In high-risk selected patients without indication of specific intervention mentioned above (age $\geq$ 45 years, cardiorespiratory comorbidity, multiple trauma, rib fractures $\geq$ 3, pulmonary contusion or pleural effusion, moderate hypoxemia)
Ward admission
In moderate-risk selected patients requiring IV analgesia and/or oxygen therapy < 2 L/min without hypercapnia after a 24-hour supervision in the ED
Home discharge
In low-risk selected patients (age < 45 years, no cardiorespiratory comorbidity, isolated chest trauma, rib fractures < 3, no significant pulmonary contusion, no pleural effusion, no hypoxemia or hypercapnia)
Analgesia controlled at rest and coughing by oral medication and FVC > 65%
Oral and written instructions for specific surveillance and indication of emergency consultation, control imaging and written information to the attending physician

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