



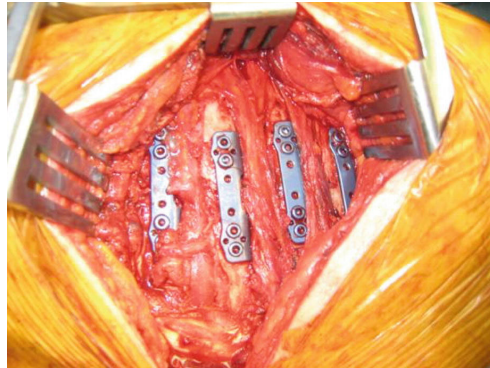
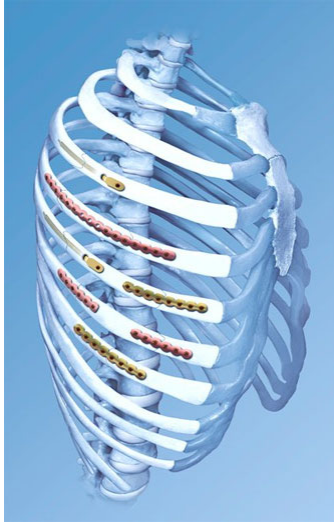
# Hot Topics in Trauma!

Sharmila Dissanaik MD FACS  
Peter C. Canizaro Chair and University Distinguished Professor  
Department of Surgery

## Selected Topics

- Rib Plating/ SSRF
- CAB versus ABC
- Whipstitch versus Abthera for Temporary Abdominal Closure
- Disclosure: These are snapshots, not in-depth analyses!
- No financial or other conflicts of interest with any of the content presented here.

## Rib Plating



## Brief History

- Tanaka 2002: 37 patients >5 ribs flail ↓ICU LOS, tracheostomy
- Grantzeny 2009: 40 pts flail ↓chest infections
- Marasco 2013: 46 pts ↓ ICU LOS, tracheostomy
- “It is recommended that one should consider fixation for those with five or more ribs fractured with a flail, particularly those requiring invasive or non-invasive positive pressure ventilation.”

De Moya, Nirula, Biffl 2017 JTACSO

## A multicenter, prospective, controlled clinical trial of surgical stabilization of rib fractures in patients with severe, nonflail fracture patterns (Chest Wall Injury Society NONFLAIL)

Pieracci, Fredric M. MD, MPH; Leasia, Kiara MD; Bauman, Zach DO; Eriksson, Evert A. MD; Lottenberg, Lawrence MD; Majercik, Sarah MD; Powell, Ledford MD; Sarani, Babak MD; Semon, Gregory DO; Thomas, Bradley MD; Zhao, Frank MD; Dyke, Cornelius MD; Doben, Andrew R. MD

Multicenter, prospective, controlled, clinical trial (12 centers) comparing SSRF within 72 hours to medical management. Inclusion criteria were three or more ipsilateral, severely displaced rib fractures without flail chest. The trial involved both randomized and observational arms at patient discretion. The primary outcome was the numeric pain score (NPS) at 2-week follow-up. Narcotic consumption, spirometry, pulmonary function tests, pleural space complications (tube thoracostomy or surgery for retained hemothorax or empyema >24 hours from admission) and both overall and respiratory disability-related quality of life (RD-QoL) were also compared.

### RESULTS

One hundred ten subjects were enrolled. There were no significant differences between subjects who selected randomization ( $n = 23$ ) versus observation ( $n = 87$ ); these groups were combined for all analyses. Of the 110 subjects, 51 (46.4%) underwent SSRF. There were no significant baseline differences between the operative and nonoperative groups. At 2-week follow-up, the NPS was significantly lower in the operative, as compared with the nonoperative group (2.9 vs. 4.5,  $p < 0.01$ ), and RD-QoL was significantly improved (disability score, 21 vs. 25,  $p = 0.03$ ). Narcotic consumption also tended toward being lower in the operative, as compared with the nonoperative group (0.5 vs. 1.2 narcotic equivalents,  $p = 0.05$ ). During the index admission, pleural space complications were significantly lower in the operative, as compared with the nonoperative group (0% vs. 10.2%,  $p = 0.02$ ).

### CONCLUSION

In this clinical trial, SSRF performed within 72 hours improved the primary outcome of NPS at 2-week follow-up among patients with three or more displaced fractures in the absence of flail chest. These data support the role of SSRF in patients without flail chest.

January 2022

# Rib fixation in non-ventilator dependent chest wall injuries

## A prospective randomized trial

Marasco, Silvana F. MBBS, MSurg, FRACS<sup>1,2</sup>; Balogh, Zsolt J. MD, PhD, FRACS, FACS<sup>4,5</sup>; Wullschleger, Martin E. MD, PhD, FRACS, FACS<sup>8,9</sup>; Hsu, Jeremy MBBS, DCl Surg, FRACS, FACS<sup>10,11</sup>; Patel, Bhavik MBBS, MS, M.Phil, FRACS<sup>8</sup>; Fitzgerald, Mark MBBS, MD, FACEM<sup>2,6,7</sup>; Martin, Kate MBBS, FRACS<sup>2,7</sup>; Summerhayes, Robyn BSc, Hons<sup>1</sup>; Bailey, Michael PhD<sup>3</sup>

A prospective multi-centre randomised controlled trial comparing rib fixation to non-operative management of non-ventilated patients with at least three consecutive rib fractures. Inclusion criteria were rib fracture displacement and/or ongoing pain. Pain (McGill Questionnaire) and QoL (Short Form 12) at 3 and 6 months post injury were assessed. Surgeons enrolled patients in whom they felt there was clinical equipoise. Patients who were deemed to need surgical fixation, or who were deemed to be too well to be randomized to rib fixation were not enrolled.

## Results

124 patients were enrolled at four sites between 2017 and 2020. 61 patients were randomised to operative management and 63 to non-operative management. No differences were seen in the primary endpoint of Pain Rating Index at 3 months, nor in the QoL measures. Return-to-work rates improved between 3 and 6 months, favouring the operative group.

## Conclusions

In this study no improvements in pain or QoL at 3 and 6 months in patients undergoing rib fixation for non-flail, non-ventilator dependent rib fractures have been demonstrated.

# Journal of Thoracic Disease

[J Thorac Dis](#). 2019 May; 11(Suppl 8): S1103–S1105.

doi: [10.21037/jtd.2018.12.51](#)

PMCID: PMC6545516

PMID: [31205769](#)

## Chest wall stabilization with rib plating after cardiopulmonary resuscitation

[Andrew Drahos](#), [Michael Fitzgerald](#), [Dennis Ashley](#), and [D. Benjamin Christie, III<sup>✉</sup>](#)

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## The Journal of Cardiothoracic Trauma

Official Publication of World Society for Cardiothoracic Trauma

Year : 2019 | Volume : 4 | Issue : 1 | Page : 28-34

### A multi-institution case series of intercostal nerve cryoablation for pain control when used in conjunction with surgical stabilization of rib fractures

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<sup>3</sup> Department of Trauma, Overland Park Regional Medical Center, Overland Park, KS, USA

**Methods:** Multi-institution retrospective review of 13 patients who underwent surgical stabilization of rib fractures (SSRFs) with video-assisted thoracoscopy-guided IC. Demographics included mechanism of injury, number of ribs fractured and plated, and number of intercostal nerves ablated. Outcomes include pre- and post-operative pain scores, completeness of nerve function return, and dysesthesias experienced during healing. Pre- and post-operative pain scores were compared by paired *t*-test. Statistical significance was attributed to  $P < 0.05$ .

**Results:** The median age was 58 (35–77) and all injuries were caused by blunt mechanism. Median number of ribs fractured was 7 (4–11). Mean time to operation was  $2.1 \pm 1.2$  days. Median number of ribs plated was 4 (range 3–6), and the median number of intercostal nerves ablated was 6 (3–7). Eleven patients with complete pain scores were found to have mean preoperative pain of  $6.9 \pm 2.3$  and mean postoperative pain of  $4.9 \pm 2.9$  ( $P = 0.026$ ). The mean length of stay was  $8.1 \pm 2.9$  days after admission and  $5.9 \pm 2.7$  days after surgery. At an average follow-up of  $21.3 \pm 6.2$  weeks, all patients had regained some sensation. Sensation regained ranged from 10% at 16.1 weeks to 100% as early as 15.9 weeks. One patient (7.6%) developed transient severe, lifestyle limiting, hyperesthesia present at 3 months and resolved at 6 months. 8 of 13 (61.5%) patients developed transient mild-to-moderate, nonlifestyle limiting, dysesthesias. These symptoms resolved by 6 months.

**Conclusion:** In our patients with severe rib fractures, cryoneurolysis with SSRF resulted in significantly decreased postoperative pain and approximately 70% of patients reporting some transient dysesthesias in the recovery process. While these results are encouraging, larger, prospective studies are needed to fully characterize the indications for IC.

Hot Off The Press..





Original Research Article

The where, when, and why of surgical rib fixation: Utilization patterns, outcomes, and readmissions

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ARTICLE INFO

Keywords:

Surgical stabilization of rib fractures

Rib fixation

Flail chest

Non-flail multiple rib fractures

ABSTRACT

**Introduction:** There has been increasing use of surgical stabilization of rib fractures (SSRF), but most literature demonstrate outcomes of single centers during the index hospitalization. We sought to analyze statewide patterns and longer-term outcomes after SSRF.

**Methods:** Adult patients with >1 rib fracture in the 2016–2018 California Office of Statewide Health Planning Database were identified. SSRF and non-operatively managed (NO) patients were matched on clinical and demographic variables. Patterns and outcomes of SSRF were assessed with multivariate modeling.

**Results:** 599 SSRF patients were matched to 1191 NO patients. Readmission and readmission complication rates were similar between the groups. In a competing risks regression, admission to a high-volume SSRF center (SHR 4.6, CI95 4.0–5.4,  $p = 0.01$ ) was the primary predictor of SSRF. 30-day mortality adjusted risk was lower for the SSRF vs. NO group (HR 0.47, CI 0.25–0.88,  $p = 0.02$ ).

**Discussion:** Statewide utilization of SSRF varied widely and appears to be driven by center or surgeon characteristics rather than clinical factors. Efforts to expand access to SSRF based on clinical factors may be warranted.

Fig. 2. Cumulative incidence of SSRF based on admission to hospital volume of SSRF

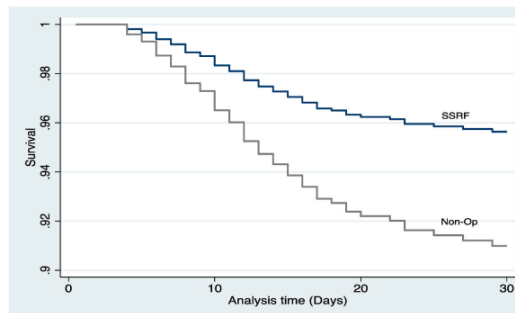


Fig. 3. 30-Day Mortality of SSRF Patients vs Non-Op Patients.

ventilation modes and settings, narcotic medication use, etc. The OSHPD database also does not include cause of death data; therefore, it is unknown whether the patient's mortality is related to their rib fractures or other factors of their traumatic injuries. Although SSRF utilization has been increasing, its use is still relatively rare compared to non-operative management. A matched analysis allowed for controlling for confounding variables, but it did exclude a significant number of NO patients from analysis.

5. Conclusions

Readmission rates for patients with rib fractures are similar for those

managed with SSRF and nonoperatively. Hospital lengths of stay were found to be longer in those patients undergoing SSRF vs NO management approaches. However, there was an independently associated and relatively robust survival benefit associated with surgical management and stabilization of rib fractures in this cohort. Currently, and of most concern, there is a widely disparate utilization of SSRF statewide that does not appear to be primarily related to any patient demographic, clinical, or injury-specific factors. Efforts to expand access to SSRF based on clinical factors rather than hospital or surgeon SSRF volume may be warranted to further clarify optimal timing and patient selection criteria.

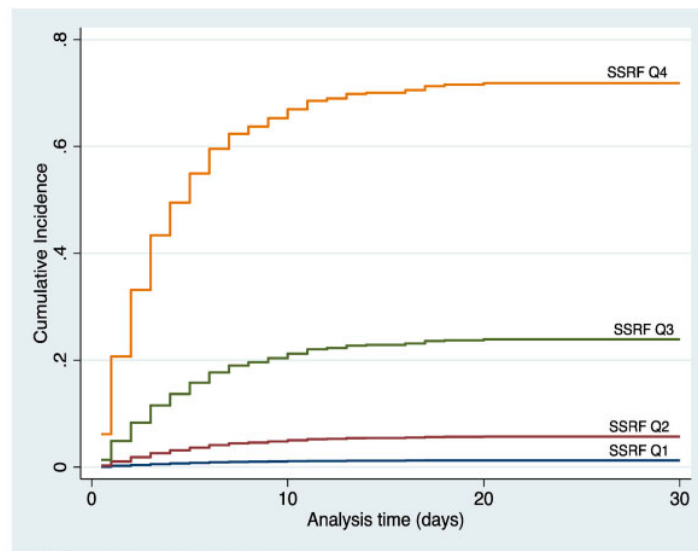


Fig. 2. Cumulative incidence of SSRF based on admission to hospital volume of SSRF

## JAMA Surgery

### RCT: Operative vs Nonoperative Treatment of Acute Unstable Chest Wall Injuries

#### POPULATION

156 Male participants,  
51 female participants



Individuals aged 16-85 y with a flail chest or severe chest wall deformity  
Mean age, 53 y

#### INTERVENTION

211 Patients randomized



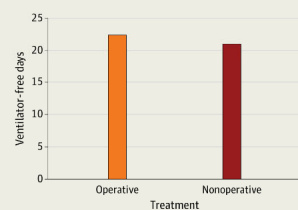
**108 Operative treatment**  
Surgical fixation of rib fractures to stabilize chest wall



**99 Nonoperative treatment**  
Nonoperative treatment of rib fractures

#### FINDINGS

There was no statistically significant difference in VFDs between the operative and nonoperative treatment groups



#### SETTINGS / LOCATIONS



15 Hospitals in  
Canada and US

#### PRIMARY OUTCOME

Ventilator-free days (VFDs) in the first 28 d following injury

Mean (SD) VFD, 22.7 (7.5)  
Mean (SD) VFD, 20.6 (9.7)  
Mean difference, 2.1 d; 95% CI, -0.3 to 4.5;  $P = .09$

Dehghan N, Nauth A, Schemitsch E, et al; Canadian Orthopaedic Trauma Society and the Unstable Chest Wall RCT Study Investigators. Operative vs nonoperative treatment of acute unstable chest wall injuries: a randomized clinical trial. *JAMA Surg*. Published online September 21, 2022. doi:10.1001/jamasurg.2022.4299

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**Main Outcomes and Measures** The primary outcome was ventilator-free days (VFDs) in the first 28 days after injury. Secondary outcomes included mortality, length of hospital stay, intensive care unit stay, and rates of complications (pneumonia, ventilator-associated pneumonia, sepsis, tracheostomy).

**Results** A total of 207 patients were included in the analysis (operative group: 108 patients [52.2%]; mean [SD] age, 52.9 [13.5] years; 81 male [75%]; nonoperative group: 99 patients [47.8%]; mean [SD] age, 53.2 [14.3] years; 75 male [76%]). Mean (SD) VFDs were 22.7 (7.5) days for the operative group and 20.6 (9.7) days for the nonoperative group (mean difference, 2.1 days; 95% CI, -0.3 to 4.5 days;  $P = .09$ ). Mortality was significantly higher in the nonoperative group (6 [6%]) than in the operative group (0%;  $P = .01$ ). Rates of complications and length of stay were similar between groups. Subgroup analysis of patients who were mechanically ventilated at the time of randomization demonstrated a mean difference of 2.8 (95% CI, 0.1-5.5) VFDs in favor of operative treatment.

**Conclusions and Relevance** The findings of this randomized clinical trial suggest that operative treatment of patients with unstable chest wall injuries has modest benefit compared with nonoperative treatment. However, the potential advantage was primarily noted in the subgroup of patients who were ventilated at the time of randomization. No benefit to operative treatment was found in patients who were not ventilated.

Original Investigation

September 21, 2022

ONLINE FIRST

**Operative vs Nonoperative Treatment of Acute Unstable Chest Wall Injuries**  
A Randomized Clinical Trial

Niloofar Dehghan, MD<sup>1,2</sup>, Aaron Nauth, MD<sup>3</sup>, Emil Schemitsch, MD<sup>4</sup>, et al

> Author Affiliations | Article Information

JAMA Surg. Published online September 21, 2022. doi:10.1001/jamasurg.2022.4299

## Complications and Death

With the exception of tracheostomy (9 [8%] operative group vs 16 [16%] nonoperative group; 95% CI, 0.83-5.73;  $P = .13$ ), the rates of complications were similar between the 2 groups (Table 3). There were 6 in-hospital deaths during the initial hospitalization: zero in the operative group and 6 (6.0%) in the nonoperative group ( $P = .01$ ). Details are available in the eResults, eTable 2, and eTable 3 in Supplement 8. All but 1 of these patients was ventilated at the time of randomization.

## Surgical Complications and Reoperation

Surgical complications are detailed in the eResults in Supplement 8 but were generally infrequent. Four patients in total from the operative group required repeat surgery: 1 for irrigation and debridement of empyema, 1 for irrigation and debridement of empyema plus removal of loose hardware, 1 for video-assisted thoracic surgery evacuation of retained hemothorax, and 1 for loose hardware removal.

In the nonoperative group, 4 patients underwent an unplanned surgery: 2 for empyema evacuation, and 2 were treated with surgical fixation of their rib fractures owing to further deterioration despite maximal nonoperative management.

Original Investigation

September 21, 2022

ONLINE FIRST

**Operative vs Nonoperative Treatment of Acute Unstable Chest Wall Injuries**  
A Randomized Clinical Trial

Niloofar Dehghan, MD<sup>1,2</sup>, Aaron Nauth, MD<sup>3</sup>, Emil Schemitsch, MD<sup>4</sup>, et al

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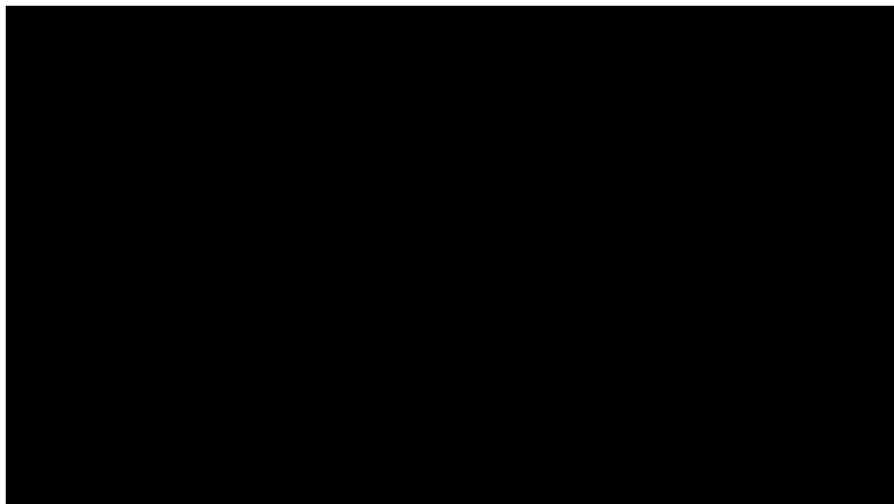
## Summary: SSRF

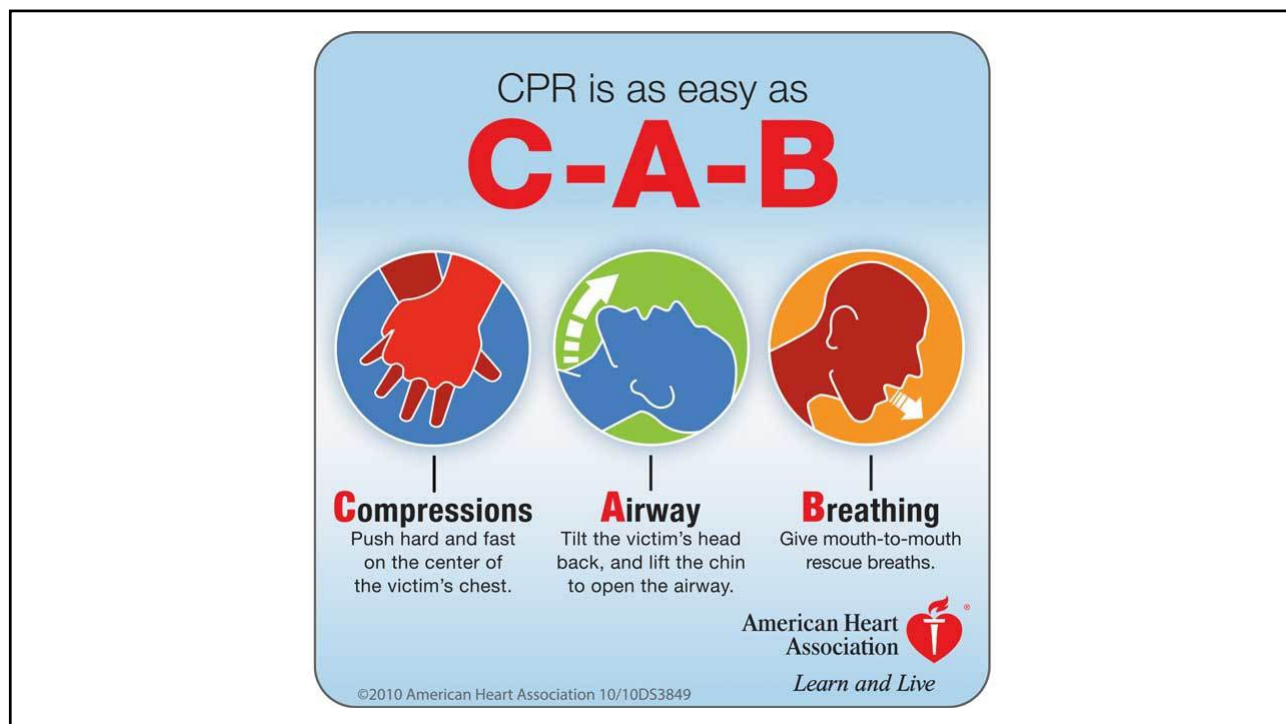
- Use is expanding rapidly in some centers, while being slow to catch on in others
- Evidence remains equivocal for short and long term outcomes, especially for non-ventilated patients
- What is the best method: Intra-thoracic versus extra-thoracic, VATS versus Open?



Should we do CAB instead of ABC?

What big change in resuscitation happened in 2010?





And yet,  
over here in  
Trauma  
world...

## ATLS – The Primary Survey

- Simple ABC's Approach
  - Airway with cervical protection
  - Breathing
  - Circulation
  - Disability
  - Exposure and environmental control

## Why might CAB be better?

- The vasodilatory response from anesthetic drugs administered for intubation, may result in hypotension→ cardiac arrest
- Positive pressure ventilation further impedes venous return, and is particularly detrimental at higher respiratory rates
- Analysis of National Trauma Data Bank showing pre-hospital intubations resulted in further hypotension in hypovolemic patients
- A 2019 meta-analysis confirms ↑mortality in patients who suffer post-intubation hypotension

Pepe PE, Raedler C, Lurie KG, Wigginton JG. Emergency ventilatory management in hemorrhagic states: elemental or detrimental? J Trauma. 2003

Shafi S, Gentilello L. Pre-hospital endotracheal intubation and positive pressure ventilation is associated with hypotension and decreased survival in hypovolemic trauma patients: an analysis of the National Trauma Data Bank. J Trauma. 2005

Ferrada P, Manzano-Nunez R, Lopez-Castilla V, Orlas C, García AF, Ordonez CA, Dubose JJ Meta-Analysis of Post-Intubation Hypotension: A Plea to Consider Circulation First in Hypovolemic Patients. Am Surg. 2019



## Circulation first – the time has come to question the sequencing of care in the ABCs of trauma; an American Association for the Surgery of Trauma multicenter trial

Paula Ferrada<sup>1†</sup>, Rachael A. Calcutt<sup>2†</sup>, David J. Skarupa<sup>3</sup>, Therese M. Duane<sup>4</sup>, Alberto Garcia<sup>5</sup>, Kenji Inaba<sup>6</sup>, Desmond Khor<sup>6</sup>, Vincent Anto<sup>7</sup>, Jason Sperry<sup>7</sup>, David Turay<sup>8</sup>, Rachel M. Nygaard<sup>9</sup>, Martin A. Schreiber<sup>10</sup>, Toby Enniss<sup>11</sup>, Michelle McNutt<sup>12</sup>, Herb Phelan<sup>13</sup>, Kira Smith<sup>13</sup>, Forrest O. Moore<sup>14</sup>, Irene Tabas<sup>15</sup>, Joseph Dubose<sup>16</sup> and AAST Multi-Institutional Trials Committee

In this study of 12 major Level 1 trauma centers, over 50% started resuscitation before intubation, in trauma patients in shock anyway!

### Abstract

**Background:** The traditional sequence of trauma care: Airway, Breathing, Circulation (ABC) has been practiced for many years. It became the standard of care despite the lack of scientific evidence. We hypothesized that patients in hypovolemic shock would have comparable outcomes with initiation of bleeding treatment (transfusion) prior to intubation (CAB), compared to those patients treated with the traditional ABC sequence.

**Methods:** This study was sponsored by the American Association for the Surgery of Trauma multicenter trials committee. We performed a retrospective analysis of all patients that presented to trauma centers with presumptive hypovolemic shock indicated by pre-hospital or emergency department hypotension and need for intubation from January 1, 2014 to July 1, 2016. Data collected included demographics, timing of intubation, vital signs before and after intubation, timing of the blood transfusion initiation related to intubation, and outcomes.

**Results:** From 440 patients that met inclusion criteria, 245 (55.7%) received intravenous blood product resuscitation first (CAB), and 195 (44.3%) were intubated before any resuscitation was started (ABC). There was no difference in ISS, mechanism, or comorbidities. Those intubated prior to receiving transfusion had a lower GCS than those with transfusion initiation prior to intubation (ABC: 4, CAB: 9,  $p = 0.005$ ). Although mortality was high in both groups, there was no statistically significant difference (CAB 47% and ABC 50%). In multivariate analysis, initial SBP and initial GCS were the only independent predictors of death.

**Conclusion:** The current study highlights that many trauma centers are already initiating circulation first prior to intubation when treating hypovolemic shock (CAB), even in patients with a low GCS. This practice was not associated with an increased mortality. Further prospective investigation is warranted.

Background

Methods

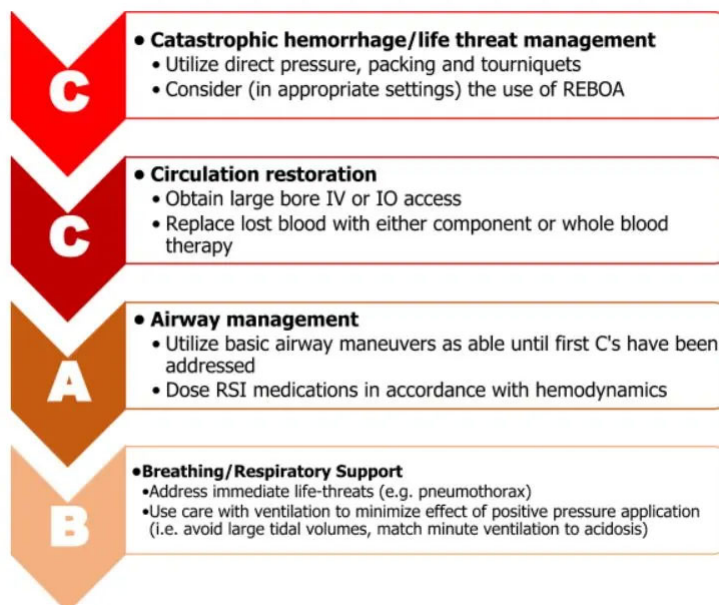
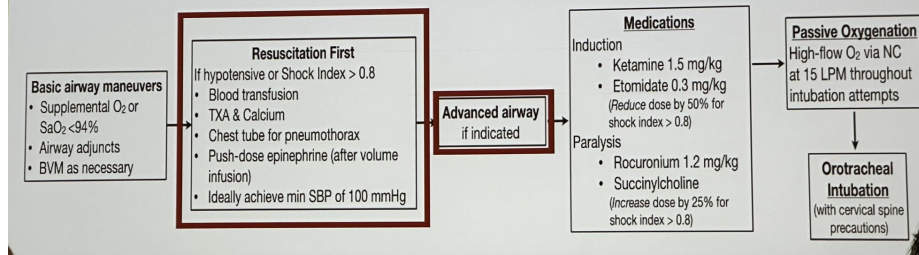
Results

Conclusions

***Intubation in the emergency department was significantly associated with increased in-hospital mortality in hypotensive NCTH patients even after controlling for injury type, injury severity, and markers of physiological derangement***



## CAB Algorithm for NCTH



## Summary

- If bleeding is the problem, fixing the problem should take precedence
- Intubating an already hypotensive patient can drop their preload →



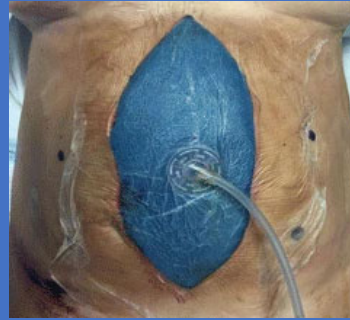
- Deferring airway concerns while prioritizing resuscitation is the default at many busy Level 1 trauma centers – simply not formalized yet.

And Finally – the Open Abdomen

## Temporary Closure Methods for Open Abdomen



Whipstitch closure  
\$1.71-\$3.91 per suture



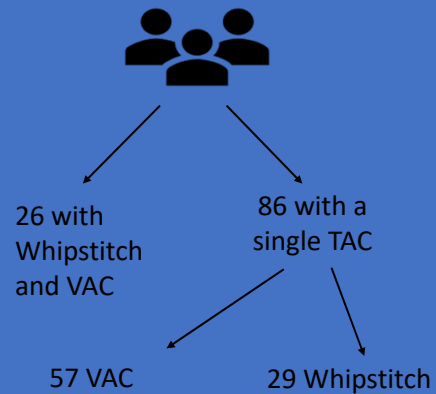
Vacuum assisted closure  
\$478.40 per dressing kit

## Methods



OA following blunt or penetrating trauma managed using either vacuum assisted closure (VAC) or whipstitch between 2015 and 2021

112 trauma patients



## Results



No significant difference in age, BMI, ISS, ASA, mechanism of Injury

### Whipstitch showed:



#### Overall Complications:

- Bleeding
- Evisceration
- SSI
- Organ Space Infection
- Wound Dehiscence



## Conclusions

- Limited by retrospective nature and selection bias for each TAC method
- Where feasible, whipstitch is an effective and cost-efficient option for TAC of OA

