**Supplemental Table 1.** Emergency Department critically ill patient boarding models broken into nine distinct classifications from literature review.

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| **Boarding Definition** | **Study** | **Year Published** | **Baseline Mean/Median ED LOS Times Reported** | **Frequency of Boarding** | **Findings** |
| Prolonged ED length of stay awaiting a critical care bed from ED arrival (time undefined) | Clark K et al(21) | 2007 | Mean 298 min | \* | 1536 enrolled; Mean overall ED LOS 298 minutes; from ICU order 93 minutes |
| Bhakta A et al(22) | 2013 | Mean 3.1 h (SD 2.1) to 4.2 h (SD 4.0) | \*\*  \* | Following policy of 24/7 open trauma bed protocol ED LOS decreased from 4.2+/-4.0 hrs to 3.1 +/- 2.1 hrs. |
| McCoy JV et al(23) | 2015 | Mean 324 to 375 min | \* | Using real time order entry at the time of consult ED LOS decreased 40 min (375 to 324 min) p= 0.006 |
| Fuentes E et al(24) | 2017 | Mean 82 to 311 min | \* | Using direct admit strategy ED LOS was 229 min shorter with intervention (82 vs. 311 min, *p* < 0.0001); There were no change in outcomes identified as a result of reduction of ED LOS |
| Ko A et al(25) | 2017 | Mean 2.4 to 3.0 h | \* | Using direct admit strategy, ED LOS was 2.4 v. 3.0 hours, p=0.005 |
| Prolonged ED length of stay following decision to admit (time undefined) | Mathews et al(26) | 2015 | Median 1.23 h (IQR 0.85-1.85) | \* | Simulation of reallocating all stepdown unit to ICU beds decreased overall wait times by 7.2% to 1.06 (SD, 1.39) hours |
| Mathews KS et al(18) | 2018 | Median 4.2 h (IQR 2.8-6.3) | \* | Longer ED boarding associated with increased odds of mortality and morbidity 1.77 [1.07-2.95]/log10 hour |
| Reznek MA(20) | 2018 | Median Boarding Time for ICU patients 2.9 h (IQR 1.7,5.3) | \* | Boarding times were not associated with mortality rates among ICU patients but affected non-ICU patients |
| Upper decile of total ED length of stay | McConnell KJ et al(28) | 2005 | 50%ile Median 202 min    90%ile Median 523 min | \* | 90th%ile met the study definition for boarding -mean wait was 523 minutes (8h) |
| More than 2 hours from decision to admit to leaving the ED | Singer AJ et al(16) | 2011 | \* | 87.6% | 15.9% had greater than 24 hour boarding |
| Pitts SR et al(29) | 2014 | Median 79 min (IQR 36,145) | 30% (95% CI 26%, 36%) |  |
| More than 4 hours from decision to admit to leaving the ED | Huynh TN et al(30) | 2014 | Median 339 min (IQR 284,495) | 5.8% |  |
| More than 6 hours from decision to admit to leaving the ED | Chalfin DB et al(31) | 2007 | \* | 2.1% | Study cites Lewin Group Report of Mean ED wait times of 5.8 h |
| More than 6 total hours from triage to leaving the ED | Pines JM et al (S1) | 2009 | Mean 301 min (95%CI 271,332) | 39.1% (95%CI 33.8, 44.4) |  |
| Hirschy R et al(S2) | 2018 | Mean Boarding Time 470.7 ± 333.9 min (range = 84-2,390 min) | 59% |  |
| Ventilator Hours in the ED | Bhat R et al(19) | 2015 | Mean 2.9 h | 65.5% | Subjects met criteria when greater than 2 ventilator hours observed.  Authors reported mean LOS for entire ED population including non-ICU |
| Angotti LB et al(32) | 2017 | Mean ventilator hours 4 h 28 min (SD 4 h 18 min) | 12% | Subjects met criteria when greater than 7 ventilator hours observed. |
| No ICU Bed Available at Time of Admission | Elliott DJ et al(27) | 2015 | Mean 6.24 h to 8.83 h | 85% |  |
| \* Not Reported | | | | | |

min, minutes; h, hours; SD, standard deviation; ED, emergency department; LOS, length of stay; ICU, intensive care unit; IQR, interquartile range; %ile, percentile; 95%CI, 95% confidence interval.

**Supplemental Table 2.** Literature review of the outcomes of Emergency Department critically ill patient boarding.

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| **Author/ Year** | **Study Design** | **ED Boarding Definition** | **Endpoints** | **Major Findings** |
| Chalfin DB, et.al./ 2007(31) | R, MC  (n=50322) | ED boarding time ≥ 6 hours after decision to admit to ICU | ICU and hospital mortality  ICU and hospital length of stay | 1. ED boarding time ≥ 6 hours increased odds of both ICU mortality (10.7% vs 8.4%, p < 0.01) and hospital mortality (17.4% vs. 12.9%, p<0.001; risk-adjusted OR for survival 0.709, 95% CI 0.561-0.895).  2. For hospital survivors, ED boarding ≥ 6 hours was associated with longer hospital length of stay (7 vs 6 days, p<0.001). |
| Singer AJ, et.al./ 2011(16) | R, SS  (n=41256, 12.1% admitted to ICU) | ED boarding time ≥ 2 hours after the decision to admit | Hospital mortality | 1. Boarding time 12 hours or more was associated with increased hospital mortality (4.5% vs 2.5%, p<0.001)and hospital length of stay (8.7 vs 5.6 days, p<0.001)  2. Increased duration of ED boarding associated with increased ICU admissions. |
| Reznek, et.al/ 2018(20) | P, MC  (n=39781, 21.3% admitted to ICU) | Inpatient admission, but boarding in ED | Hospital mortality | 1. ICU patients who died in the hospital were not more likely to have had longer ED boarding times (adjusted HR 0.96, 95% CI 0.92-1.01).  2. Non-ICU patients who died in the hospital were more likely to have had longer ED boarding times (adjusted HR 1.19, 95% CI 1.03-1.36).  3. Authors hypothesize mitigation strategies may have contributed to findings: ICU patients had clear delineation of responsibility between ED and admitting teams whereas non-ICU patients cared for under mixed-responsibility model. |
| Mathews KS, et.al./ 2018(18) | R, SS  (n=854) | ED boarding after ICU consultation | Persistent organ dysfunction and/or death (POD-D) | 1. Length of ED boarding time post-consultation for ICU admission was associated with an increased odds of POD-D (OR 1.77, 95% CI 1.07-29.5) |
| Angotti LB, et.al./ 2017(32) | P, MC  (n=525) | Duration of MV > 7 hours | Hospital mortality | 1. Duration of MV > 7 hours in ED was associated with longer overall duration of MV (4.8 days vs 2.5 days, p=0.011) and increased hospital mortality (45.9% vs 29.4%, p=0.018; HR 1.31, 95% CI 1.03-1.7, 2. ICU or hospital LOS were not affected by duration of MV > 7 hours in the ED.  2. Fewer than 25% of patients had ventilator adjustments made while in the ED. |
| Cardoso LTQ, et.al./ 2011(39) | R, SS  (n=401) | Delayed ICU admission = Admitted to ICU, but bed not immediately available | ICU mortality | 1. Delayed ICU admission associated with higher ICU mortality rate (adjusted HR 1.015, 95% CI 1.006-1.023)  2. Each boarded hour in the ED was associated with a 1.5% increased risk of ICU mortality and a 1% increased risk of hospital mortality.  3. Delayed ICU admission had no effect on duration of MV, ICU or hospital LOS. |
| Agustin M, et.al./ 2017(S3) | R, SS  (n=287) | ED boarding time ≥ 6 hours after decision to admit to ICU | Hospital mortality  Sepsis protocol compliance  Resuscitation | 1. ED boarding time ≥ 6 hours was not associated with any difference in hospital mortality (22.6% vs 24.7%, p=0.68, adjusted OR 1.226, 95% CI 0.669-2.247).  2. Sepsis protocol compliance and achievement of resuscitation goals were not different for ED boarders. |
| Bhat R, et.al./ 2014(19) | R, SS  (n=169) | Boarded in the ED > 2 hours post-intubation | Process variables – post-intubation care | 1. Performance of all 6 post-intubation cares achieved in only 2.4% of patients. These cares included ventilator management, sedation, gastric decompression, ABG, chest x-ray and quantitative capnography.  2. None of the 6 post-intubation interventions were associated with differences in ventilator-associated pneumonia, duration of MV or ICU length of stay. |
| Rincon F, et.al./ 2010(38) | R, SS  (n=75) | ED boarding time ≥ 5 hours after decision to admit to ICU | Poor outcome, defined as a modified Rankin score of ≥ 4 | 1. In critically ill stroke patients, an ED boarding time ≥ 5 hours was an independent predictor of poor outcome (adjusted OR 3.94, 95% CI 1.69-9.14)  2. An ED boarding time ≥ 5 hours did not have effect on discharge NIHSS or hospital length of stay. |

R, retrospective; MC, multicenter; ED, emergency department; ICU, intensive care unit; OR, odds ratio; SS, single center; P, prospective; POD-D, persistent organ dysfunction or death; MV, mechanical ventilation; HR, hazard ratio; 95%CI, 95% confidence interval; NIHSS, National Institutes of Health stroke scale.

**Supplemental Table 3.** Literature review of potential Emergency Department boarding mitigation strategies for care of the critically ill patient.

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| Category | Rationale | Mitigation Strategies |
| **Sedation Practices** | Early deep sedation is associated with longer ventilator duration and higher need for tracheostomy. Excessive sedation of intubated adult patients in the ED was associated with increased patient morbidity and in-hospital mortality. The Richmond Agitation-Sedation Scale (RASS) and Sedation-Agitation Scale (SAS) are the most valid and reliable sedation assessment tools for measuring quality and depth of sedation in adult ICU patients.(S4-S8) | P[[1]](#endnote-1)ain should be routinely assessed for all intubated patients using a validated scoring tool (eg. Numeric Rating Scale, Critical Care Pain Observation Tool or Behavioral Pain Scale)  Agitation should be routinely assessed for all intubated patients using Richmond Agitation Sedation Scale (RASS) or Riker Sedation Agitation Scale (SAS)  Per consensus guidelines, light levels of sedation should be targeted. Sedation intensity within the first 48 hours is associated with worse outcomes.  Pain management should be optimized with opioid analgesia. Non-benzodiazepine sedation is suggested.  Institutions should individually define frequency of these assessments, goals and medication titrations. |
| **Mechanical Ventilation Practices** | Evidence suggests that ventilated patients often receive suboptimal management settings in emergency departments and that those ventilation parameters often impact their initial inpatient management. It has been shown that lung-protective mechanical ventilation with a low tidal volume can improve the prognosis of patients with acute lung injury (ALI) or acute respiratory distress syndrome (ARDS). Newer research suggests that ventilation parameters that target optimal tidal volume and pulmonary pressures offer benefits to critically ill patients even without ARDS. Implementing a mechanical ventilator protocol in the ED targeting a lung protective approach is feasible and is associated with significant improvements in the delivery of safe mechanical ventilation and clinical outcome. It influences ventilator settings in the ICU and reduces pulmonary complications.(S9-S15)  Exposure to severe hyperoxia during critical illness has been associated with increased ICU and hospital mortality and associated with fewer ventilator-free days. ED exposure to hyperoxia is common and associated with increased mortality and suggests that hyperoxia in the immediate post-intubation period could be particularly injurious. Targeting normoxia (PaO2 60–120 mm Hg) from initiation of mechanical ventilation may improve outcome.(S16-S19)  End Tidal CO2 Monitoring via continuous-waveform capnography is recommended, in addition to clinical assessment to confirm and monitor correct placement of an endotracheal tube and to provide feedback on patient cardiopulmonary function. If waveform capnography is not available, a non-waveform exhaled CO2 monitor, in addition to clinical assessment, is suggested as the initial method for confirming correct tube placement in a patient in cardiac arrest.(S20, S21) | 1. Get an accurate height to use for predicted body weight ([PBW](http://www.ardsnet.org/files/pbwtables_2005-02-02.pdf)) for optimizing tidal volume (6–8 mL/kg using patient’s PBW 2. Start supplemental O2 at lower targets to generate minimal FiO2 to meet an O2 saturation greater than 90%, and/or PaO2 between 55–80 mmHg; avoid hyperoxia. 3. To achieve this goal early monitoring of an arterial blood gas (within 30mins) of intubation/mechanical ventilation. 4. Match PEEP to the FiO2 according to the [ARDSNet protocol](http://www.ardsnet.org/files/ventilator_protocol_2008-07.pdf), 5. Keep the plateau pressure < 30 mm Hg, and 6. Keep the head of the bed at 30 degrees. 7. End-tidal CO2 (PETCO2) is suggested to guide ventilator management. 8. Capnography is suggested to identify abnormalities of exhaled air flow. 9. Volumetric capnography is suggested to assess CO2 elimination and the ratio of dead-space volume to tidal volume (VD/VT) to optimize mechanical ventilation. |
| **Infection Prevention Practices** | VAP: Care of mechanically ventilated patients is wrought with potential complications, including ventilator-associated events/ infections/pneumonia (VAEs/VAP). Ventilator associated events/infections (VAEs) account for significant patient co-morbidities and health care costs. Prevention of these events has been pivotal to hospital based quality initiatives over the past years and care bundle implementation has been one strategy used to reduce VAE. Certain bundle practices are important in the early stages of care and should be instituted in the emergency department (ED).(S22-S26) | 1. Maintain continuous head of bed elevation to 30–45 degrees, unless medically contraindicated. 2. Suction subglottic secretions above the endotracheal tube. 3. Use closed endotracheal suctioning versus open endotracheal suctioning when possible. 4. Implement oral hygiene within 1 hour of intubation and continued every 4 hours. 5. Implement application of chlorhexidine solution to the oral cavity after intubation and every 12h thereafter, orotracheal intubation with a tube that enables continuous subglottic suctioning. 6. Assess endotracheal cuff pressure after intubation and every 4h thereafter to maintain pressure between 20 and 30cm H2O. |
| CLABSI: Central-line-associated bloodstream infection (CLABSI) is associated with increased morbidity, mortality, length of stay, and cost. Implementation of a central line bundle has been shown to reduce CLABSI rates.(16, S27-S30) | 1. Implement a standardized hand hygiene; maximal barrier precautions upon insertion of central lines; chlorhexidine skin antisepsis; optimal catheter site selection, with avoidance of femoral vein for central venous access in adult patients. 2. Standardize use of aseptic technique for accessing and changing needleless connectors and the use of a disinfectant cap on intravenous line hubs is recommended; when disinfectant caps are not available, ensure the hub is disinfected with an alcohol or chlorhexidine-based disinfectant using friction for 30 seconds prior to accessing. |
| CAUTI: Catheter-associated urinary tract infections (CAUTI) are common and lead to increased hospital costs, as well as increased morbidity and mortality. | 1. If a patient requires placement of an indwelling catheter, ensure that all Centers for Disease Control and Prevention (CDC) guidelines are adhered to in order to prevent catheter-associated urinary tract infections (CAUTI). 2. Catheters should remain in place only as long as needed. |
| **Hemodynamic Management** | Effective management of the critically ill patient often requires assessment of cardiovascular performance and determining correct therapeutic interventions.(S31) | 1. Consider other assessment variables such as right ventricular function, intrathoracic pressure, vena cava filling, and venous compliance when considering fluid responsiveness and titrating fluids and vasopressors. 2. Bedside monitoring using point of care ultrasonography and various invasive and noninvasive monitoring can provide a multi-modal approach to basic hemodynamic monitoring and aid in selecting an optimal resuscitation strategy. |
| **Transfusion Practices** | For all patient populations in which it has been studied, transfusing RBCs at a threshold of 7 mg/dl is associated with similar or improved survival, fewer complications, and reduced costs compared with higher transfusion triggers." It is possible that different thresholds may be appropriate in patients with acute coronary syndromes, although most observational studies suggest harms of aggressive transfusion even among such patients. A significant percentage of ED blood product transfusions are discordant with guideline recommendations, though it is unclear if ED transfusion practice relates to worse clinical outcomes. Adoption of standardized transfusion triggers/practices that align with inpatient recommendations seems prudent.(S32, S33) | 1. Do not transfuse RBCs in hemodynamically stable, nonbleeding ICU patients with an Hb concentration greater than 7 mg/dl. 2. Evidence-based transfusion guideline that recommends packed red blood cell transfusion for four distinct situations:   - acute bleeding (blood loss of >30%) with severity evidenced by tachycardia and low blood pressure;  - hemoglobin of <8 g/dL in high-risk patients  (e.g. cardiovascular and chronic pulmonary  disease; patients receiving chemotherapy);  - haemoglobin of <7 g/dL in patients with  symptomatic chronic anaemia;  - special circumstances (e.g. sickle cell  crisis and other causes of poor oxygen  delivery). |
| **Resource Management** | Palliative Care: Perceived value and quality rarely are associated with overly aggressive life-sustaining therapy and prolonged dependence on their support. Engaging patients at high risk of death and their surrogate decision makers in discussions about alternatives to life-sustaining therapies may promote value and improve the quality of dying, and reduce distress and bereavement.(S32,S34) | 1. Don’t delay engaging available palliative and hospice care services in the emergency department for patients likely to benefit. 2. Don’t continue life support for patients at high risk for death or severely impaired functional recovery without offering patients and their families the alternative of care focused entirely on comfort. |
| Staffing: Critical care patients boarding in the emergency department (ED) have significantly poorer outcomes.1-5 Patients waiting for critical care beds require a higher level of care and more nursing time. Staffing patterns and ED patient flow make it challenging for emergency nurses, respiratory therapists, pharmacists, patient care techs, etc to provide the same level of care that would be provided in a critical care unit.(S35, S36) | 1. Staffing patterns applicable to other specialized areas/units of the hospital should apply equally to the boarded ED patients to assure that there is a consistent standard of care within the organization. 2. These staffing patterns must not degrade the ability of the ED staff to provide emergency care and must be consistent with established guidelines, such as the Emergency Nurses Association (ENA) position statement Staffing and Productivity in the Emergency Department. |

RASS, Richmond Agitation-Sedation Scale; SAS, Sedation-Agitation Scale; ICU, intensive care unit; ALI, acute lung injury; ARDS, acute respiratory distress syndrome; ED, emergency department; PaO2, partial pressure of inspired oxygen; CO2, carbon dioxide; PBW, predicted body weight; FiO2, fraction of inspired oxygen; PEEP, positive end-expiratory pressure; PETCO2, end-tidal carbon dioxide; VD/VT, dead space fraction; VAE, ventilator-associated event; VAP, ventilator-associated pneumonia; CLABSI, central line associated bloodstream infection; CAUTI, catheter-associated urinary tract infections; CDC, Centers for Disease Control and Prevention; RBC, red blood cells; ENA, Emergency Nurses Association.

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