**** IPHMI Literature Review ****

Keeping You Up To Date with Current EMS Literature and Studies

Vol. 2.9

1. **Respiratory Support for Adult Patients with COVID‐19.** Whittle JS, Pavlov I, Sacchetti AD, Atwood C, Rosenbert MS. J Amer Coll Emerg Phys Open. Published on-line April 2020, https://doi.org/10.1002/emp2.12071.
2. **Identifying patients with time-sensitive injuries: Association of mortality with increasing prehospital time** Chen S. Guyette FX, Peitzman AB, Billiar TR, Sperry JL, Brown JB. J Trauma Acute Care Surg. 2019;86:1015-1022.
3. **Factors influencing medication errors in prehospital care. A retroactive observational study.** Ramadanov N, Klein R, Schumann U, Valdez ADA, Behringer W. Medicine. 2019; 98(49):e18200. doi: 10.1097/MD.0000000000018200. Published on-line, open access.
4. **Right hospital, right patients: Penetrating injury patients treated at high-volume penetrating trauma centers have lower mortality.** Fu CY, Bajani F, Tatebe L, et al. J Trauma Acute Care Surg 2019;86:961–966.
5. **Respiratory Support for Adult Patients with COVID‐19. Whittle JS, Pavlov I, Sacchetti AD, Atwood C, Rosenbert MS. J Amer Coll Emerg Phys Open** Published on-line April 2020, https://doi.org/10.1002/emp2.12071.

Care of patients with COVID-19 presents many challenges. As with any disease disseminated by airborne droplets, a focused treatment plan, particularly as it relates to the airway and patient ventilation, needs to be in place. A crucial component of this treatment plan involves the safety of the Health Care Providers (HCP) caring for the coronavirus-infected patient. The authors of this clinical review paper discuss strategies for the delivery of respiratory support for patients with COVID-19 infection and focus on commonly used airway and oxygenation treatments and the disbursement of infected droplet particles associated with those procedures using a high-fidelity mannequin.

Oxygen delivery is a primary treatment modality for the care of those in respiratory distress. The goal is to maintain an oxygen saturation greater than 90% and greater than 92% in the pregnant COVID-19 patient. The authors looked at available oxygen delivery devices and the relative disbursement distance of aerosolized particles generated by each. They conclude that the device that produces the least amount of spread at less than 10cm is the Non-rebreathing mask (NRBM) using an oxygen flow rate of 10L/minute. This is followed by high flow nasal oxygen (HFNO) at 17cm at the highest flow rate of 60L/minute, however it was noted that if the canula became dislodged the distance would increase. Nasal cannulas provide up to 45% FiO2 to patients in mild to moderate distress however particle dispersal with a nasal cannula can reach as far as 40cm at 5 lpm flow rate. Venturi masks can deliver precise oxygen concentrations but can produce a particle reach of 40cm at 10 lpm. A simple oxygen mask produces particle distances of 40 cm at 10 lpm. Nebulized medication treatments are a cornerstone of treating patients with bronchospasm; however, they are a high-risk procedure in the face of COVID-19 or any viral condition. Modeling shows a dispersion of particles up to 80 cm at flow rates needed for optimal medication delivery. Closed systems or the use of a facemask may decrease the distance. Finally, the use of non-invasive positive pressure ventilation (NIPPV), to include CPAP or BiPAP, demonstrates the highest dispersion of particles at up to 95 cm, depending on device settings and patient condition.

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| **TREATMENT MODALITY** | **POTENTIAL DISPERSION DISTANCE (in cm)** | |
| **Centimeters** | **Inches** |
| Non-Rebreather Mask | 5-10 | 2.5-4.5 |
| High-flow Nasal Oxygen Systems | 5-17 | 2.5-8 |
| Nasal Cannula | 30-40 | 15-18 |
| Simple Mask | 40 | 18 |
| Venturi Mask | 30-40 | 15-18 |
| Nebulizer treatment | >80 | >36 |
| NIPPV/CPAP/BiPAP | 60 - >95 | 27->43 |

EMS services currently respond to many patients with COVID-19 that require supplemental oxygen or airway management and may also be required to provide interfacility transport of patients receiving any of the treatment modalities discussed in this paper. There are several of these modalities that EMS providers commonly employ. The use of each of these for a particular patient should be evaluated using a risk vs. benefit decision, taking into consideration the patient’s need and the availability of a comparable treatment with a lower risk profile for aerosolization and dispersal of infected particles. The management of a hypoxic patient with known or suspected coronavirus infection should follow a standard progression of steps, beginning with a non-rebreather mask and progressing to more advanced interventions as necessary to maintain oxygen saturation above 90%. Traditionally, EMS providers administer aerosolized bronchodilator medications for wheezing, usually by oxygen powered jet nebulizer. An alternative therapy that should be considered in coronavirus patients is the use of metered dose inhalers (MDI). CPAP, often utilized by EMS providers, has the greatest distribution of particles; this, combined with the limited patient care space in the patient compartment of an ambulance, makes CPAP intervention a high-risk treatment modality. Some newer CPAP and NIPPV devices have an exhalation port that will accept a viral filter, thus decreasing particle dispersion and reducing any potential exposure.

Conflict of Interest Statement: Two of the authors disclosed working relationships with companies that produce HFNO delivery systems.

1. **Identifying patients with time-sensitive injuries: Association of mortality with increasing prehospital time.** Chen S. Guyette FX, Peitzman AB, Billiar TR, Sperry JL, Brown JB. J Trauma Acute Care Surg. 2019;86:1015-1022.

It is well recognized that survival from trauma is time sensitive. The sooner a critical trauma patient reaches the operating suite or definitive care, the better the patient’s chance of recovery to a full and productive life. For the last 30 years EMS work has worked under the premise of the “Golden Hour” principle, where rapid extrication and transport techniques were utilized, limiting the time spent on the scene The performance of treatments in the back of the ambulance while in route to the trauma center was and is commonplace, although challenging and in some cases difficult at best to perform in a moving ambulance.

The authors of this retrospective observational study attempt to determine what existing prehospital trauma triage criteria can identify patients that are likely to have increased mortality associated with increased prehospital time, while correcting for potential survival bias.

The study reviewed all patients 16 years old and older from the National Trauma Databank (NTDB) from 2007-2015. Patients that were excluded included burn patients, patients with missing total prehospital times, and prehospital times greater than three (3) hours. For the purpose of this study, the authors defined total prehospital time as the time from dispatch of EMS to the arrival of the patient to the hospital. After taking the above factors into account and correcting for survival bias, a study population of 517,863 patients with a prehospital time of less than 30 minutes was analyzed. Twenty five percent (23%) presented with penetrating injuries.

The authors found that patients with a systolic BP (SBP) of less than 90mmHg, a GCS score of eight (8) or less or non-extremity penetrating trauma had an increased odds of mortality associated with increasing prehospital times. Of interest, patients with a GCS score ≤8 who were intubated by ground ambulance responders compared to those patients who were not intubated; however this finding was not found in those individuals transported by helicopter EMS. While an exact reason for this difference cannot be explained by this study, the authors speculate that the difference in training and the availability of medication assisted intubation may be factors.

Limitations of this study relate to the retrospective observational design and the NTDB for availability of full data. For example, 9% of potential study patients were missing prehospital time and not included in the analysis. In addition, trauma patients with prehospital times greater than 30 minutes were not included and may represent a group that could benefit by shorter prehospital times.

This study does not change the practice of modern prehospital trauma care. It does, however, reaffirm that in the subset of patients with a SBP less than 90 mmHg, a GCS of eight (8) or less, or penetrating trauma to the head, neck or torso, incremental increases in prehospital time can directly impact overall survivability of these patients. This study also reaffirms that, although it is commonly referred to as the “Golden Hour”, many patients do not have 60 minutes in which definitive care can be provided but rather it is a “Golden Period” which in some patients may exceed 60 minutes and in some patients be much shorter.

1. **Factors influencing medication errors in prehospital care. A retroactive observational study.** Ramadanov N, Klein R, Schumann U, Valdez ADA, Behringer W. Medicine. 2019; 98(49):e18200. doi: 10.1097/MD.0000000000018200. Published on-line, open access.

Errors of medication administration in the prehospital, emergency medical setting are thought to be common, however supporting data is lacking. Literature shows a range of errors from 9.1% to 77.5% in the hospital and emergency department. Medication errors are preventable and cause patient harm. Factors that contribute to the errors are medication knowledge deficiencies, patient knowledge deficiencies, wrong calculations, nomenclature issues, and others. Additionally, factors that contribute to medication errors in the urgent or emergent prehospital environment are misuse (incorrect dose, route, or contraindicated medication), underuse (omission of a beneficial medication), and overuse (administration of an unnecessary medication).

This retrospective observational study was conducted in the EMS Center in Bad Belzig, Germany. The German institution for medications and medicine products (BfArM) estimates that annually 500,000 preventable errors lead to emergency department (ED) admission. The aim of this study is to determine the frequency and factors influencing medication errors in the prehospital environment. The German EMS system is an emergency physician led system. The physician and a paramedic rendezvous with an ambulance staffed by two additional paramedics at the scene respond only to select critical patients during their 24-hour shifts. All other responses are managed by paramedics. Prehospital emergency physicians are trained in traditional medical specialties and then have special education, considered a “supra-specialty”, in emergency medicine.

Data were collected from 1760 EMS calls from 2013-2015. Prehospital patient care reports and discharge summaries were reviewed from Bad Belzig or other select local hospitals. Patients were excluded for reasons of multiple discharge diagnoses, lack of admission to or ambulatory treatment in the ED, lack of recorded diagnosis, death of the patient during EMS deployment, or incorrect/unreadable patient data. This resulted in 708 patients being included in the study. Medication Appropriateness (MA) for medication administration was determined by the consensus of three experienced prehospital emergency physicians. MA was considered present when all guidelines were adhered to, and absent either when an obligatory medication was omitted or a contraindicated medication was administered. Dosing correctness was not considered. Influencing factors in the study were physician related factors (including Diagnostic Agreement), patient related factors, and deployment related factors.

Of the 708 patients, 337 (47.6%) were male, 371 (52.4%) were female. The mean age was 68. Two hundred and twenty patients (31.1%) took  4 medications per day, 488 (68.9%) took more than 4 medications per day on a regular basis. In total 1058 doses of 37 different medications were administered in the field. The inter-rater reliability for MA of the three reviewing physicians was 0.96. MA was absent in 220 of 708 patients, meaning that there was a medication error 31.1% of the time. There were four factors that were felt to have a significant influence on errors. The first was an incorrect diagnosis by the prehospital emergency physician. A second factor was physician experience. Resident physicians had fewer medication errors than their specialist counterparts, perhaps because resident physicians were deployed twice as often as the specialists and thus had more field experience. Another factor was patient age. Twenty-seven percent of errors occurred in patients ≤75 years, whereas the error rate was 36.0% in those greater than76 years of age. Polypharmacy, pharmacokinetics and pharmacodynamics of geriatric patients played roles. Finally, deployment times were noted as a factor. The majority of errors were seen between 3 am and 6 am and were attributed to a lack of sleep as ambulance shifts began at 07:30. An item of note, when Diagnostic Agreement (DA) between the prehospital and the hospital assessments was present, MA was absent in 20.9% of patients. When DA was absent, errors were made in 53.9% or patients.

While this study centers on medication errors performed by physicians in the prehospital environment in Germany, it is imperative to recognize that medication errors occur at all levels of prehospital providers in all countries. All possible measures should be taken to prevent them. Regardless of the urgency of the situation, adherence to “the six rights” must be employed each and every time (the right patient, the right medication, the right dose, the right time, the right route, and the right documentation). In this study, the majority of errors in medication administration take place in the early morning hours when fatigue from a 24 hour shift is at its maximum. Providers and agencies should strengthen awareness of this problem and identify solutions to mitigate these instances. Improving communication between all responders involved, considering the patients’ pre-existing conditions, and promoting a culture of patient safety is imperative. Additionally, further studies should be conducted across other agencies to explore additional possibilities for process improvement.

1. **Right hospital, right patients: Penetrating injury patients treated at high-volume penetrating trauma centers have lower mortality.** Fu CY, Bajani F, Tatebe L, et al. J Trauma Acute Care Surg 2019;86:961–966.

In the early days of EMS, patients were often transported to the closest hospital or the hospital of their choice, regardless of their illness or injury. As modern EMS systems developed, a shift took place and patients were preferentially transported to specialty hospitals that had the ability and expertise to care for specific patient presentations. Trauma centers and trauma systems were among the first to develop.

The authors of this retrospective cohort analysis investigate the differences, if any, in survival of patients with penetrating injury between Level I and II trauma centers that receive a high volume of penetrating trauma compared to those that do not.

The authors enrolled patients from the local Cook County Hospital (CCH) trauma registry along with those from the National Trauma Data Bank (NTDB). All patients from 2011 to 2015 with penetrating trauma from level I and II trauma centers were enrolled. Exclusions were patients who were dead on arrival at the hospital and those with missing records or key information. In terms of number of penetrating trauma patients treated, the top twenty-five (25) percent of trauma centers that treat over 167 penetrating injuries per year were compared to the bottom twenty-five (25) percent of trauma centers that treated less than 37 penetrating traumas per year. There are twenty (20) trauma centers that manage over 400 penetrating trauma patients per year.

Trauma centers in the high-volume group treated significantly more patients presenting with hypotension (9.0% vs. 7.6%) and patients that had a higher injury severity scale (ISS) at 8.9 vs. 7.7. Patients that required ventilatory support were also greater in the higher volume trauma center group (17.4% vs. 13.7%). The authors demonstrated that patients who presented with higher ISS (>25) had a survival advantage (71.7% vs. 66.8%) when treated at trauma centers in the high-volume group.

The study demonstrates that trauma centers that care for a greater number of penetrating trauma patients have better outcomes in those patients who have sustained severe injuries. This study has implications in terms of EMS destination policy and whether or not the choice of destination for penetrating trauma victims should be limited to specific trauma centers to maximize the volume and experience of that center’s staff and thus optimize patient outcome.