Communication

Use of a Unique Mobile Medical Asset in COVID Monoclonal Antibody Treatment

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Abstract: The COVID-19 pandemic and the subsequent surge of patients presented to emergency departments has forever changed the paradigm of delivering emergency care. The highly infectious nature of the 2019 Novel Coronavirus, or COVID-19, mandated strict environmental changes, novel patient care, and flexible strategies to continue to deliver efficient emergency care while maintaining appropriate physical distancing between suspect and non-suspect COVID-19 patients. The engagement of a unique rapidly deployable Mobile Satellite Emergency Department (MSED) with scalable capability from prompt care to resuscitation level allowed the emergency care team to optimize patient care and throughput. The MSED was strategically located adjacent to the ambulance entrance. While initially deployed to increase Emergency Department surge capacity, the MSED was repurposed to cohort and treat COVID patients with the monoclonal antibody, Bamlanivimab, who were expected to be discharged after treatment. This allowed for more efficient use of Emergency Department resources, including physical space and staffing.

Keywords: COVID-19; Mobile Satellite Emergency Department; COVID monoclonal antibody treatment; Bamlanivimab; COVID-19 patient isolation; COVID-19 patient treatment area

1. Introduction

This communication describes the use of a unique mobile medical asset to improve patient care and optimize the use of Emergency Department (ED) resources during the COVID-19 pandemic.

The location of use is the Hackensack Meridian Health—Jersey Shore University Medical Center in Neptune, New Jersey. The Jersey Shore University Medical Center is a 630-bed academic medical center in the Eastern Central part of the state. The Emergency Department volume is approximately 88,300 patients per year, with 20,000 being pediatric (2019 pre-COVID).

The specific innovation addressed in this communication is the treatment of patients diagnosed with COVID-19 with the monoclonal antibody Bamlanivimab in a unique alternate care area. These are generally patients who are scheduled to present for treatment and whose discharge is anticipated after treatment. The process can take several hours, since it involves evaluation, intravenous infusion, and re-evaluation post-treatment. Coupled with the required isolation, a significant amount of Emergency Department resources can be consumed.

The availability of a unique trailer based mobile medical asset, coupled with patients being scheduled well in advance, has allowed the implementation of a specialized patient flow pathway to optimize care and throughput.

Patients receiving the antibody were treated in a dedicated Mobile Satellite Emergency Department (MSED) located outside the ambulance entrance of the normal Emergency Department.
This communication will discuss details and considerations of staffing, supply, patient flow, and the unique Mobile Satellite Emergency Department.

2. Materials and Methods

The Mobile Satellite Emergency Department (MSED) is part of a unique fleet of mobile medical assets originally developed by Hackensack University Medical Center, Hackensack, New Jersey, with federal government funding, circa 2010. The intent of the program was to provide a capability for an individual hospital to deploy mobile rapid response hospital-level medical care. Three prototype medical units and support vehicles were designed and built collaborating with vehicle manufacturers. There were also various research efforts related to the fleet development [1,2].

The prototype program and associated research projects were successful. When federal government funding ended a non-profit consortium of multiple hospitals and health care organizations were formed to continue the program. The program is known as the Advanced Mobile Emergency Resource Coalition (AMERCO); http://www.amercousa.org/, accessed on 26 May 2020.

Five categories of missions were anticipated, including disaster response where local resources were overwhelmed or transport to them impaired, providing surge capacity during times of high patient volume, community outreach to the underserved, providing alternate clinical space during hospital repairs or construction and a clinical treatment area for patients requiring special isolation precautions. Over the years, the units have been deployed for all of these missions, including, in 2018, to St Croix, USVI, post-hurricane.

The units are nominally 50 foot trailers with expandable sides that are compatible with commercial tractors. They are highly mobile and are driven as standard tractor trailers. When open, the nominal footprint is $25 \times 50$ feet. Two are configured to function as well-equipped Emergency Departments or Intensive Care units. One is configured as a formal operating suite, complete with a hospital grade sterilizer. Units can function individually or be connected with enclosed climate controlled connectors.

If necessary, all three units can function alone, with no external utilities required. Each has an on-board electrical power generator, heating-ventilation-air conditioning (HVAC) systems, water tank, wastewater tank, oxygen supply, satellite and cellular communications links. During extended deployments, the units can be connected to external sources; detailed requirements for this are listed in Appendix A.

The MSED deployed for COVID-19 monoclonal antibody treatment was one of the Emergency Department/Intensive Care Units. The unit is configured with seven stretchers with bedside cardiorespiratory monitors connected to a central monitoring/alarm station, portable digital X-Ray, medical gas and suction, surgical procedure lighting, intravenous administration pumps and controllers, point of care blood gas and general laboratory analysis units, monitor/defibrillator/pacers, Omnicell medication distribution unit [3], code carts, supply carts, privacy curtains, multifunction stretchers, and a hydraulic platform lift for stretchers, wheelchairs, personnel, or supplies. It also includes a bathroom, sinks, refrigerator, macerator for disposable bedpans, and separate room for storage. Not all of these features were needed for the COVID monoclonal antibody treatment deployment.

Figure 1 is an external photograph and Figure 2 is an internal photograph of the MSED.
Figure 1. External view MSED outside the Emergency Department. Jersey Shore University Medical Center. Neptune, NJ, USA.

Figure 2. Internal view MSED set up for COVID treatment.
For this COVID-related deployment, the on-board HVAC systems were supplemented with two standalone HEPA recirculating filter units, one from Abatement Technologies (model HC800FD), and one from Dri-Eaz Defendair (model HEPA 500).

The MSED was located in close proximity to the Emergency Department ambulance entrance, which facilitated movement of patients, staff, and supplies and also allowed for rapid transfer of patients into the main Emergency Department if required. A parking deck is attached to the hospital building at that location, providing shelter from inclement weather.

Since this was an extended deployment, connections for power, water, wastewater, and computer network were made to the hospital building. The computer network connection allowed the host hospital to utilize their own VoIP telephones, Electronic Medical Record, and computer applications as if they were in the building [4].

Because the MSED emulated the in-house Emergency Department, only minimal staff training was required. This consisted of a walk-through orientation of the space, a review of the patient selection process for the MSED, as well as discussion regarding managing and communicating should a patient deteriorate or change clinical status. All key hospital stakeholders were provided with frequent updates on the daily hospital safety conference call.

3. Discussion and Results

Starting in December 2020, the mobile satellite emergency department treated adult pre-selected patients to receive the intravenous infusion Bamlanivimab, a monoclonal antibody provided to known positive COVID-19 patients. Patients meeting eligibility criteria for this emergency use authorization of medication were scheduled for outpatient infusion times one day in advance of their treatment dates. Selection criteria was the same as for patients treated in the in-building Emergency Department, as described in Appendix B.

Patients scheduled for Bamlanivimab infusions present to the emergency department, receive a quick patient registration, are examined by ED clinical staff (Physician, Physician Assistant, or Nurse Practitioner) for medical stability, and are expeditiously escorted to the mobile satellite emergency department adjacent to the main emergency department building. Patients are physically distanced while maintaining appropriate face masking and grouped with similar patients. Although the MSED has the capability to treat seven patients simultaneously, being mindful of physical distancing requirements, the determination was made to treat no more than four Bamlanivimab infusion patients at one time. The assignment of four patients in the MSED also met the needs of the nursing team; the MSED was staffed with one registered nurse and one patient care technician. Two ‘rounds’ of patient schedules were maintained in the MSED; patients arriving at 07:00 for 08:00 infusions and patients arriving at 12:00 for 13:00 infusions. The rationale for having patients arrive 1 hour prior to their scheduled infusion time was to allow for the required pharmacy preparation time for the infusion. To ensure that Bamlanivimab infusions were not wasted the facility did not begin medication preparation until the patient had arrived on-site.

Treatment with Bamlanivimab requires approximately 1 hour of pharmacy preparation time in addition to 1 hour of intravenous infusion time. This is in addition to time required for registration, evaluations, and discharge.

The MSED proved to be a reliable, efficient, safe, and flexible treatment area that team members found to be a comfortable work environment. Although formal data had not been collected to verify team member satisfaction in the MSED, we believe that the absence of scheduling issues (inability to schedule team members, call-outs), as well as real-time feedback from the nursing and physician teams demonstrated team member satisfaction. Additionally, and importantly, team member scheduling for the MSED was on a voluntary basis. The emergency department leadership team had minimal if any challenges, staffing this ancillary care area.
During the first four complete months of 2021, 250 Bamlanivimab infusions were administered in the MSED. Patients triaged to the MSED had a completed nursing assessment and triage in 10 minutes (median). An evaluation by a physician/licensed independent provider was completed within 6 minutes. There were no safety issues identified during this period. Three patients were admitted to the main hospital from the MSED due to COVID-19 complications and worsening of their condition. The three patients requiring hospitalization were managed in the MSED until an inpatient bed became available. There were no issues or concerns with the MSED facility in caring for them.

Patients generally appeared to be fascinated and accepting of the MSED’s novel treatment environment.

Relative to patient throughput, for COVID-19 patients treated in the MSED with Bamlanivimab, the overall hospital arrival to departure length of stay for these patients was 199 minutes (median). This is illustrated in Figure 3 and Table 1.

![Figure 3. MSED patients arrival to departure time, first quarter, 2021.](image)

**Table 1.** MSED patients count and arrival to departure time.

| Arrival Month 2021 | MSED Patients (Count) | MSED Patient Arrival to Departure Time (Median Minutes) |
|-------------------|-----------------------|------------------------------------------------------|
| January           | 55                    | 219                                                  |
| February          | 72                    | 203                                                  |
| March             | 77                    | 188                                                  |
| April             | 46                    | 181                                                  |
| Total             | 250                   | 199                                                  |

This is in comparison to a hospital length of stay of 195 minutes (median) for patients of similar complexity patients being treated in the Emergency Department, as illustrated in Figure 4 and Table 2.
4. Conclusions

Although the primary function and purpose of the MSED during wave two of the pandemic was for outpatient monoclonal antibody infusions, the Emergency Department and hospital administration remained cognizant that at any time the function of the MSED may change, dependent on the catchment area’s healthcare needs. At any given moment, the ED team was prepared to utilize the MSED as a Fast Track area, a COVID-19 isolation area, or, for more critical patients, COVID or non-COVID. Although it was not necessary, discussion had taken place with the team so that the MSED was prepared to be utilized to house admitted patients. The ED team was also prepared to utilize the MSED to manage cardiac and other critical care patients, and we were confident that the MSED had the capabilities to do so. This flexibility allowed for strategic planning and preparation for whatever COVID-19 brought to the front doors of the Emergency Department.

The overall admission to discharge time for patients treated in the MSED with Bamlanivimab and Emergency Department patients of similar complexity treated in the hospital building was essentially the same, 199 minutes vs. 195 minutes, respectively, illustrating that alternate use care areas are an effective valued strategy when managing emergency department surge and/or pandemic occurrences.

Utilizing the MSED for the purpose of Bamlanivimab infusion resulted in making 829 hours of Emergency Department stretcher time available for patient use. However, we would like to mention that, in this ED patient processing, quality improvement activity hereby communicated that the authors are aware that the separate location for the 250 patients seen in the MSED vs. the 6290 seen in the main ED might have been influenced by several variables, including how busy the main ED was, the time of day, and staffing numbers, etc. We report on a retrospective, observational quality improvement activity.
The pandemic presented emergency departments with new and concerning challenges. The infectious nature and unknowns associated with the coronavirus demanded that ED’s function under new guidelines. The MSED offered an opportunity to flex the delivery of patient care services in an ever-changing environment. COVID-19 presented unique opportunities to improve patient care services and reinforced the continuing need for EDs to look to ancillary care areas for flexibility during time of patient care surge when Emergency Departments are stretched to capacity.

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**Informed Consent Statement:** Informed consent was not required as the data was gathered retrospectively without using, recording or disclosing any patient identifiers.

**Data Availability Statement:** The volume and length of stay data is maintained in a secure Hackensack Meridian Health system-wide volume, quality, and financial database to health care institution standards. Data can be, and is, collected and accessed real time or retrospectively. Length of stay data is interfaced to this database directly from the secure patient medical record.

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**Conflicts of Interest:** The authors declare no conflict of interest.

**Appendix A**

Mobile Satellite Emergency Department External Connections (if not in stand-alone mode).

Electric Power is 208-volt 3 phase on a 200-amp circuit breaker. Ground is required, while neutral is not required. Separate earth ground is required for vehicle chassis. MSED provides 50 feet of welding type cable with open stranded copper ends for connection to source.

The on-board backup diesel electric generator with automatic start/switchover can be disabled if the power source is already backed up. Care must be taken to assure no hazards from the generator exhaust if used.

The water is standard hose bib at standard city pressure must be protected from freezing.

Wastewater is a standard 3-inch RV connection, gravity feed and must be protected from freezing. An external pump is required if there is an uphill flow. Generator exhaust and waste vents on the roof of the trailer must be distanced from building windows/openings, HVAC intakes, etc.

The fire alarm is a standard commercial system. External contacts are available in the lower compartment.
For the computer network, the vehicle is prewired with Ethernet cables. Patch panels are in lower and upper compartments. The host hospital installs their own equipment, e.g., routers, switches, terminals, wireless nodes, printers, etc. Typically, the host hospital runs fiber to the MSED.

The MSED is prewired for the standard POTS telephone service. Most users employ a VoIP telephone service through their computer network. External connections are available for oxygen, medical air, and suction if on-board sources are not used. Military grade oxygen concentrator units (POG-33’s) are also available as a source of medical gas.

The units can operate alone (without connection to external utilities) indefinitely, as long as they are periodically resupplied with diesel fuel and water and have their waste tank pumped out. The MSED carries 500 gallons of diesel fuel, which can typically supply the on-board generator for several days. There is variability of course, depending on the outside temperature (HVAC energy requirement) and clinical use pattern, etc. If it must fully stand alone for extended periods, the on-board water and wastewater tanks are supplemented with external tanks to reduce re-supply and pump out requirements.

Appendix B

Bamlanivimab (BAM) is a neutralizing monoclonal antibody that targets the S protein of SARS-CoV-2. Bamlanivimab was started during our “second wave” of COVID-19 at JSUMC. Bamlanivimab received Emergency Use Authorization as a course of treatment for high risk COVID-19 positive patients to prevent hospitalization and worsening symptoms. It was thought that, if these patients received these antibodies within the first 10 days of symptoms, there may be improved outcomes post-Covid-19. During our experience of infusing Bamlanivimab in the MSED, the infusion (Bamlanivimab) was changed to Bamlanivimab 700 mg plus etesevimab 1400 mg; this change in medication did not alter any function or established process within the MSED; however, the infusion change was accompanied by a decrease in medication infusion time from 60 min to 30 min [5,6].

Criteria to receive Bamlanivimab in our institution was as follows:

- Confirmed coronavirus at high risk for hospitalization,
- BMI > or =35,
- Chronic kidney disease, diabetes, immunocompromised,
- Age greater than 65,
- Older or equal to 55 with cardiovascular disease, hypertension, or COPD.

Prospective Bamlanivimab patients were reviewed for inclusion criteria to receive the intravenous infusion by an infectious disease physician and infectious disease-trained pharmacist. Strict adherence to written emergency use authorization guidelines were followed [7]. Patients were referred to the facility through primary care physicians, emergency department physicians, or hospital attending physicians. Prior to receiving the Bamlanivimab infusions, patients were re-evaluated by the Emergency Department nursing and emergency department physicians for continued inclusion and or exclusion criteria.

References

1. Ogedegbe, C.; Morchel, H.; Hazelwood, V.; Hassler, C.; Feldman, J. Demonstration of novel, secure, real-time, portable ultrasound transmission from an austere international location. In Proceedings of the 2012 Annual International Conference of the IEEE Engineering in Medicine and Biology Society, San Diego, CA, USA, 28 August–1 September 2012; pp. 5794–5797. [CrossRef]
2. Morchel, H.; Ogedegbe, C.; Chaplin, W.; Cheney, B.; Zakharchenko, S.; Misch, D.; Schwartz, M.; Feldman, J.; Kaul, S. Evaluation of a Novel Wireless Transmission System for Trauma Ultrasound Examinations From Moving Ambulances. Mil. Med. 2018, 183 (Suppl. 1), 111–118. [CrossRef]
3. Morchel, H.; Ogedegbe, C.; Desai, N.; Faley, B.; Mahmood, N.; Moro, G.D.; Feldman, J. Use of an automated drug distribution cabinet system in a disaster response mobile emergency department. Am. J. Disaster Med. 2015, 10, 75–78. [CrossRef] [PubMed]
4. Horahan, K.; Morchel, H.; Raheem, M.; Stevens, L. Electronic health records access during a disaster. Online J. Public Health Inform. 2014, 5, 232. [CrossRef] [PubMed]
5. NIH. Anti-SARS-CoV-2 Monoclonal Antibodies—COVID 19 Treatment. 2020. Available online: https://www.covid19treatmentguidelines.nih.gov/anti-sars-cov-2-antibody-products/anti-sars-cov-2-monoclonal-antibodies/ (accessed on 4 April 2021).

6. Centers for Disease Control and Prevention. SARS-CoV-2 Variant Classifications and Definitions. 2021. Available online: https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/variant-surveillance/variant-info.html (accessed on 14 April 2021).

7. Food and Drug Administration. Fact Sheet for Healthcare Providers: Emergency Use Authorization (EUA) of REGEN-COV (Casirivimab and Imdevimab). 2020. Available online: https://www.fda.gov/media/145611/download (accessed on 21 April 2021).