Brief Report

Critical Care Explorations

OPEN

Relocating IV Pumps for Critically Ill Isolated Coronavirus Disease 2019 Patients From Bedside to Outside the Patient Room

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Objectives: Discuss advantages and disadvantages of relocating IV pumps for coronavirus disease 2019 patients from bedside to outside the patient room and characterize reproducible details of an external infusion pump model.

Design: Brief report.

Setting: ICUs at a single-center teaching hospital.

Patients: Critically ill coronavirus disease 2019 patients under contact and special droplet precautions.

Interventions: Relocation of IV pumps for coronavirus disease 2019 patients from bedside to outside the patient room using extension tubing.

Measurements and Main Results: Infusion pumps secured to a rolling IV pole are moved immediately outside the patient room with extension tubing, reaching the patient through a closed door. It is anticipated that this practice may reduce unnecessary coronavirus disease 2019 exposure for healthcare professionals, reduce the consumption of personal protective equipment, and promote patient safety by limiting delays of donning personal protective equipment to initiate or adjust medications.

Conclusions: Risks of situating IV pumps outside the patient room must be carefully weighed against the benefits. Relocation of IV pumps outside the patient room may be considered given shortages of personal protective equipment and high risk of healthcare professional exposure. Institutional review-approved studies investigating the measured impact on decreased exposure, personal protective equipment usage, and patient safety are required.

Key Words: coronavirus; coronavirus disease 2019; infusion; personal protective equipment; pumps; relocation

The coronavirus disease 2019 (COVID-19) outbreak has caused substantial strain on healthcare systems. As the pandemic escalates, healthcare professionals (HCPs) are continuously exposed to patients requiring contact and special droplet precautions. This has caused a rapid increase in consumption of personal protective equipment (PPE), demand for which is quickly exceeding supply (1). Relocation of IV infusion pumps typically located at the bedside to a novel position outside the patient room might reduce requirements for room entry, and, in turn, reduce staff exposure to COVID-19 and PPE consumption. Furthermore, IV pump relocation is anticipated to promote patient safety by limiting delays of donning PPE to initiate or adjust medications and limiting muffled alarm sounds caused by portable filtration system in negative pressure rooms.

MATERIALS AND METHODS

Infusion pumps secured to a rolling IV pole were moved immediately outside the patient room with six feet of tubing extending to the patient through a closed door. Given the pandemic crisis situation, approval for this procedural change in practice was granted by the institution's Critical Care Committee. All COVID-19

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Crit Care Expl 2020; 2:e0168

DOI: 10.1097/CCE.0000000000000168

positive patients or patients under investigation admitted to any of the ICUs within our institution were included. The setup was trialed prior to utilization, and emergency methodology was then implemented immediately.

Transducer extension tubing was used since regular IV tubing, although more pliable, is unavailable in extended lengths. Two 210-cm microbore transducer extensions per line were determined to be necessary to allow for adequate distance and leeway to the IV site from outside the patient room (**Fig. 1**). Tubing was passed between the double doors as a gap between the doors allowed for tubing to be affixed and easily visualized without kinking. This method was preferred over channeling tubing underneath the doors from an infection prevention standpoint. Nursing staff routinely ensured that negative pressure room doors did not damage or mechanically impede tubing and that tubing was maintained off the floor. Nurses also ascertained that all open ports have disinfection caps placed to prevent contamination and infection.

Transducer extension tubing adds approximately 20 mL of circuitry. Administration of a continuous runner/carrier infusion is necessary to prevent medication delays through the circuitry to the patient's IV site. A carrier line was attached to the end of the manifold, with a rate of 50 mL/hr to aid infusion delivery. Depending on the patient's clinical volume status, the rate of the carrier line/maintenance fluid was adjusted and individualized to a minimum of 10 mL/hr. Lines were flushed with a priming volume equivalent to the extension tubing, estimated to be approximately 30 mL, prior to connecting the patient's IV line to minimize delay in infusion initiation. A self-contained and needleless 16-inch extension set with a removable ULTRAPORT zer0 Stopcock quadruple manifold (B. Braun Medical Inc., Bethlehem, PA) was used (**Fig. 2**). Additional infusions were added to the manifold and were administered through the same line, except for noncompatible and lipid-based medications (**Table 1**). The line setup was codified for uniformity. The manifold was placed in line with the continuous runner and extension tubing was added distally to the manifold in order to reach the patient's IV access (Fig. 2). This setup can be simplified by adding extension sets to the traditional pump tubing. The manifold is anchored externally using a Foley anchor (Fig. 2) or IV tube anchor (**Fig. 3**) to facilitate access and prevent contamination. This model is reproducible with peripheral line placement, although a central line should be considered in patients requiring multiple infusions to facilitate medication administration (Fig. 1). If a central line is not available, a 20 gauge or larger bore angiocatheter is preferred.

Due to the smaller caliber and rigid nature of transducer extension tubing, increased pressures related to resistance were noted. Occlusion limits on IV pumps were raised from 300 to 500 mm Hg to overcome resistance to flow rates/fluid viscosity and prevent occlusion alarms which may potentially interfere with the continuous infusion of vital medications. Infusion pump accuracy was expected to remain consistent despite increased resistance. In order to prevent occlusion alarms related to agents with increased viscosity,

Figure 1. Full set up with pump, infusions, and manifold outside patient room. A, Pressure transducer cable.

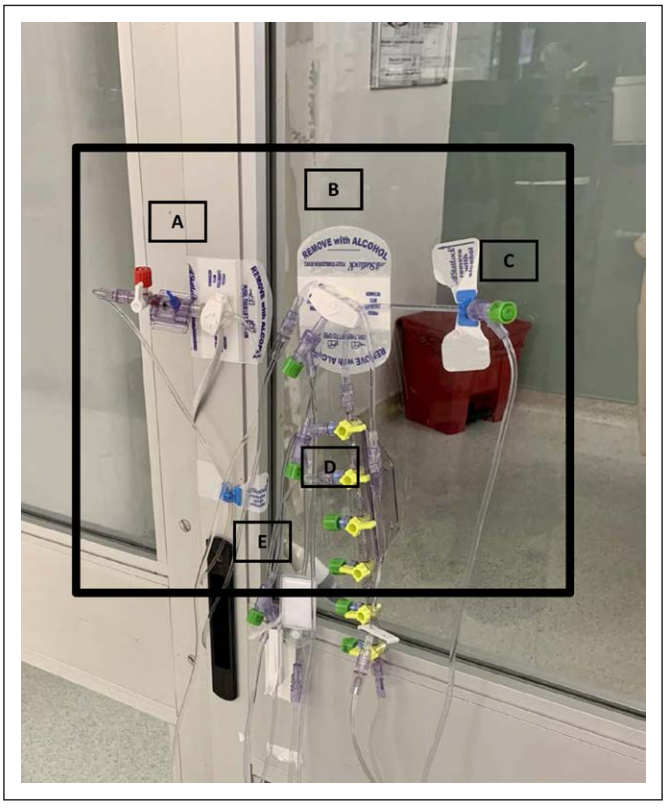

Figure 2. Manifold secured externally by foley anchor. A, Arterial line; B, Foley anchor; C, Stat-lock; D, Manifold with needleless ports with infusions; and E, Infection control caps.

TABLE 1. Medication Incompatibilities

Antibiotics
Cefepime-argatroban
Cefepime-diltiazem
Cefepime-mannitol
Cefepime-midazolam
Cefepime-vancomycin 1 g in 100 mL
Cefepime-vecuronium
Meropenem-amiodarone
Meropenem-ketamine
Meropenem-nicardipine
Vancomycin-valproate sodium
Anticoagulants
Alteplase-dobutamine
Alteplase-dopamine
Alteplase-heparin
Alteplase-nitroglycerin
Argatroban-cefepime
Heparin-amiodarone
Heparin-ketamine
Incompatible with sodium and potassium phosphate
Amiodarone
Ketamine
Lorazepam
Incompatible with sodium bicarbonate
Amiodarone
Dopamine
Dobutamine
Epinephrine
Ketamine
Midazolam
Nicardipine
Norepinephrine
Incompatible with furosemide
Diltiazem
Esmolol
Ketamine
Milrinone
Nicardipine
Vancomycin
Vecuronium
Miscellaneous incompatible
Insulin-phenylephrine

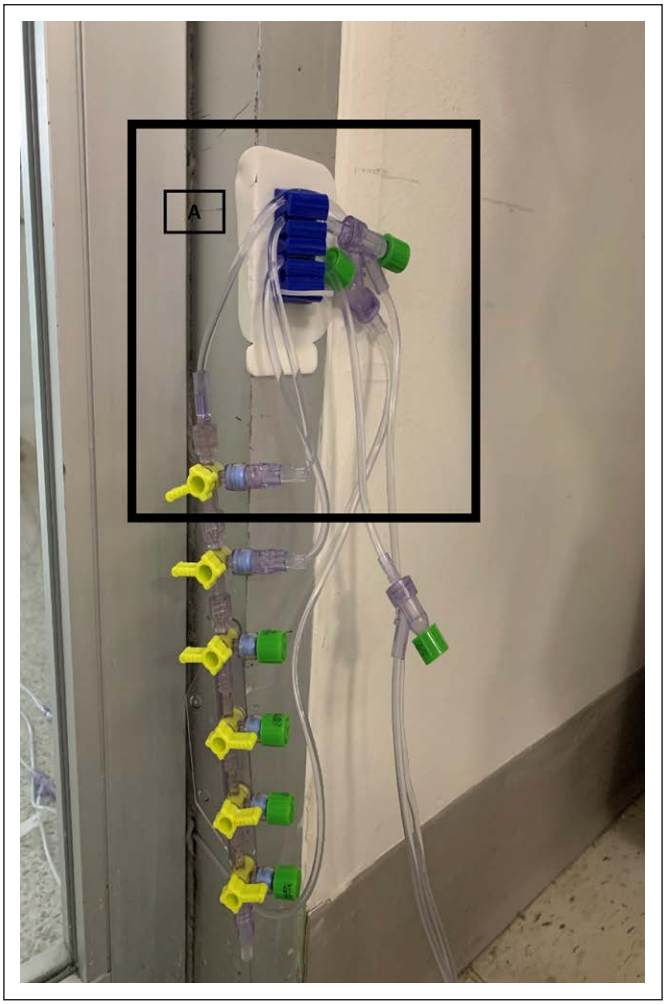

Figure 3. Manifold secured externally by IV tubing anchor. A, IV tubing anchor.

the line was flushed with normal saline 20 mL post-administration of dextrose-containing medications. All alarms were immediately assessed and addressed. Due to inherent IV pump limitations, system alarms could only identify potential occlusion and did not identify tubing disconnection. All connection sites were checked consistently to ensure that lines did not dissociate. In addition to routine bihourly assessments, nurses inspected IV insertion sites, connections, and manifold junctures to ensure integrity and uninterrupted medication delivery with any change in patient clinical condition as part of standard clinical assessment.

Upon patient arrival and initiation of the external pump configuration, two sets of patient identification bracelets were dispensed. Two independent nurses were responsible for ensuring accurate identification bands and verifying that the patient identification bracelet matches patient demographics. One band was placed on the patient's wrist as standard procedure, and the other band was immediately taped to the inside of the glass door to facilitate scanning. All medications were then scanned in addition to the patient identification bracelet as standard process with a two-nurse independent check with initiation or dose adjustments of high-alert medications. To limit exposure and facilitate patient care, patient care activities including laboratory draws, medication administration, suctioning, patient cleaning, dressing changes, routine

airway management, tubing changes, blood draws, and continuing assessment/verification of patient identification bracelets were completed in bundled tasks when possible.

DISCUSSION

Supplies are known to be scarce and institutions have gone to great lengths to preserve PPE (1, 2). The Centers for Disease Control and Prevention has provided guidance on preserving supplies, recommending the reuse of respirators, facemasks, and eye protection beyond single patient contact (1). Repeated entry to the patient's bedside each time there is a need to change IV pump programming results in staff exposure and excessive use of PPE during a time of restricted availability (3, 4). Furthermore, it can be argued that it is unethical to repeatedly expose frontline HCPs to COVID-19 when not clinically necessary (5). With the rising number of patients and uncertain supply of PPE associated with the progression of the pandemic, it is vital to ensure that an adequate number of healthy HCPs are available to handle the demand. Situating IV pumps outside of the patient room may be an optimal strategy to minimize exposure and tactically conserve PPE. Furthermore, delays in donning PPE or muffled alarm sounds due to the portable filtration system in negative pressure rooms may hinder patient safety. The accessible location of IV pumps can facilitate access to respond to alarms, program pumps, and change infusions (6).

ECRI, an organization affiliated with The Institute for Safe Medication Practices, has recently published a report highlighting extension set considerations. ECRI notes that either microbore or macrobore extension sets may be used, multiple extension sets may be connected in series, and access ports should be protected with caps. ECRI has tested major large-volume infusion pumps with 20 feet of microbore tubing, concluding that pump performance is acceptable with extended tubing at commonly used flow rates (5–300 mL/hr) (5). Several healthcare facilities have positioned IV pumps outside the patient room for COVID-19 patients to reduce HCP exposure and conserve PPE, although connectivity and tubing considerations have been vague and variable, and there has been no peer-reviewed publication detailing the format of this methodology (4). These facilities reported no major concerns with this innovative practice (5).

Although there are advantages of IV pump relocation outside the patient room, there are also inherent challenges, including risks to patient care. Extended tubing requires increased volume of drug or carrier fluid, which may delay medication delivery and affect patient response (6). Increased medication volume may also produce waste, which is of distinct concern as medication shortages are noted with increased use during the pandemic surge. Preventing unnecessary looping in the tubing and minimizing the number of extension sets is expected to reduce line resistance and ensure rate accuracy (1). Furthermore, priming extension sets prior to connecting the patient's IV line can minimize delay in infusion initiation. To ensure optimal and complete drug delivery, HCPs should flush with a priming volume equivalent to the extension tubing (7). Extended tubing may also hinder pump safety mechanisms and patient assessment (6, 8). High-rate infusions (> 300 mL/hr) through long, narrow tubing may increase rates of false occlusion alarms, leading to "alert fatigue." Contrarily, low-rate infusions (< 5 mL/hr) may delay time needed to build pressure and trigger occlusion alarms, resulting in delayed response to patient complications (5, 7). Furthermore, infection risk may be increased if tubing rests on the floor or an extension set disconnects and is exposed to air. This can be minimized by utilizing IV tubing or Foley anchor securement devices and affixing loose tubing. Chlorhexidine-impregnated sponges, or any other institution-approved infection control mechanism, may be applied circumferentially around central catheter insertion sites to reduce the risk of catheter-related bloodstream infections (9). Additionally, exposed ports may be covered with chlorhexidine disinfection protectors and prevalon pads may be used to prevent tubing contamination. Checklists for prevention of central line-associated bloodstream infections should be followed as standard practice. Additionally, patient safety must also be taken into consideration given barriers to patient barcode scanning (4).

Impact on resources must also be considered. Pump manufacturers have reported shortages of extension sets and IV tubing resulting from increased demand. A few vendors have reported that their extension tubing is on backorder and have recently increased manufacturing (4). Alternative extension tubing, such as MRI tubing, may be used depending on institution-specific supply. Specific parameters of the tubing used should be taken into consideration, including length, caliber or compliance, volume, and diameter. Furthermore, extended tubing may pose a safety hazard for staff. In addition to utilizing IV tubing or Foley anchor securement devices, HCPs may consider securing disposable paper pads at each tubing connection site as a visual reminder to reduce the risk of tripping or potentially dislodging the extension sets (4). Institutions have described using an airtight hole in the wall if available to decrease the risk of tripping, disconnection, and power loss (4). IV pumps should be connected to emergency or generator back-up outlets when possible.

Critically ill patients typically require several concomitant IV continuous infusions. Placing the IV pump outside the patient room facilitates administration of multiple medications but may increase the risk of incompatible medications running simultaneously. A separate line should be designated for IV medications which are incompatible with other continuous infusions (Table 1). Medications formulated as lipid emulsions are also of concern because they are capable of supporting microorganism growth, posing an infection risk unless tubing is changed more frequently per manufacturer recommendations and infection prevention guidelines (10, 11). All other tubings should be changed routinely per institution protocols.

Although the relocation of IV pumps outside the patient room may have theoretical advantages, studies guided by the Institutional Review Board (IRB) are required to objectively evaluate benefits and risks for metrics such as staff exposure and patient safety outcomes (extravasation, hypotensive episodes, hyperglycemia, etc.).

CONCLUSIONS

The demands of the COVID-19 pandemic have caused HCPs to develop innovative methods to safely provide patient care while reducing exposure and PPE usage. Given the current situation, many healthcare facilities must carefully weigh the risks and benefits of situating IV pumps outside the patient room.

The practice of relocating IV pumps outside of the patient room is not ideal nor should it be recommended under typical non-COVID circumstances. However, given the current pandemic and limitations of resources, this practice should be given consideration. Additional IRB-approved studies investigating the measured impact on decreased exposure, PPE usage, and patient safety are required.

This report aims to discuss advantages and disadvantages of relocating IV pumps for coronavirus disease 2019 patients from bedside to outside the patient room and characterize reproducible details of an external infusion pump model. To the best of our knowledge, there has been no peer-reviewed publication to date detailing the format of this methodology, especially on this scale. This process was completed on an institution-wide scale among various ICUs.

The authors have disclosed that they do not have any potential conflicts of interest.

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