# Pushing for IV Push Medications: Cost-Effectiveness Model of Switching from IV Piggyback to IV Push for Frequently Used Emergency Department Medications

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**ABSTRACT**

In considering the potential to reduce the carbon footprint of our emergency department (ED) via decreasing plastic waste, we aimed to evaluate the effects of changing certain common emergency department medications from an intravenous (IV) piggyback administration route to IV push. Our team queried hospital pharmacy data to determine the number of doses of several frequently utilized antibiotics administered over a six-month time period, then calculated the resultant cost savings of a switch to IV push. Based upon our modeling calculations, switching certain medication administration routes to IVP can have significant impacts on cost, with an estimated cost savings of about $47,000 every six months. Maximizing the use of push administration could result in even more dramatic cost savings. In some scenarios, using IVP administration results in less than half the amount of plastic waste generated. Future research including a full life-cycle analysis is needed in order to precisely determine the impact on carbon footprint created by making this change.

**KEYWORDS:** IV piggyback; IV push; cost; antibiotics; sustainability

## BACKGROUND

Waste reduction in healthcare is critically important for two reasons: it is beneficial for the environment, and it can result in significant cost savings. According to a report on waste in the United States healthcare system, an estimated $75.7 to $101.2 billion is spent annually in the U.S. on "overtreatment or low-value care."[1]

One way to curb costs associated with waste is through addressing excess use of premixed bags or "piggybacks" (IVPB) for medication administration, rather than using vials of medications which can be reconstituted and pushed via syringe. Several frequently used emergency department medications, including common antibiotics, are often "piggybacked" when they could be administered via intravenous push (IVP), saving time and money, and potentially, reducing the amount of plastic waste.

Giving medications via the "piggyback" route requires resources, including a primary and a secondary set of tubing, a plastic bag of IV fluid for the primary line, a plastic bag of medications "piggybacked" onto the primary line, and often, an infusion pump to control the flow rate. IV push administration involves injecting the medication directly into the IV line, utilizing only a needle and syringe to withdraw and inject the diluent for reconstitution and subsequently withdraw the required dose of medication. Full life-cycle analysis research to determine the precise quantity of carbon savings has not been published; however, comparing the weights of all the materials involved in each process, IVP administration involves a much smaller weight of plastic waste, and less waste by weight overall compared to IVPB when considering the need for two separate sets of tubing and bags. The IVP route has been shown to decrease time to administration of critical medications – for example, patients are more likely to receive broad-spectrum antibiotics for sepsis within 60 minutes of arrival to the ED when administered IVP versus IVPB.[2] This benefit of decreased time to administration has been shown in multiple studies across settings from the ED to the OR and ICU.[3,4,5] Switching to IVP has also been associated with cost savings and is reportedly preferred by nursing staff in sites that have made the change.[6] Additionally, prior studies have demonstrated that the IV tubing is often not flushed after administering a medication as IVPB, resulting in up to 20% of the medication remaining in the tubing instead of reaching the patient.[7] The steps involved in the processes of IVPB administration versus IVP are outlined in **Table 1**. **Images 1** and **2** illustrate the waste utilized in each approach, and **Table 2** details the weights of the materials for comparison.

Levetiracetam has been highlighted in recent studies as a drug frequently given by IVPB but that can also be safely administered by IVP.[8] In the authors' hospital system in Rhode Island, a recent change to IVP administration of levetiracetam has resulted in significant realized cost savings.

In order to pursue a goal of reductions in medical waste and CO2 equivalents, as well as cost savings, the research team created a proposal and plan to implement the use of IV push medications as a standard for administration of several other commonly used medications and modeled potential results.

**Table 1.** Comparison of Processes for IVP Administration Versus IV Push

| IV Push Administration | IV Piggyback Administration |
|---|---|
| Collect vial and saline flush | Collect premixed bag, secondary tubing, and saline flush |
| Reconstitute medication: inject diluent into vial and shake until dissolved | Optional: locate and collect infusion pump |
| Draw up reconstituted medication into syringe | Spike premixed bag on secondary tubing |
| Scrub the end of the IV line port with alcohol pad | Scrub the end of the IV line port with alcohol pad |
| Saline flush IV line | Saline flush IV line |
| Attach the antibiotic syringe and push the IV medication over 3 to 5 minutes, or as directed | Attach secondary tubing to primary IV line and hang bag |
| After push is complete, disconnect syringe | Optional: set up infusion pump for desired rate, attach to line |
| Saline flush IV line | When infusion is complete, disconnect tubing/pump |
| | Saline flush IV line |

**Image 1.** Supplies for IVP Medication Administration

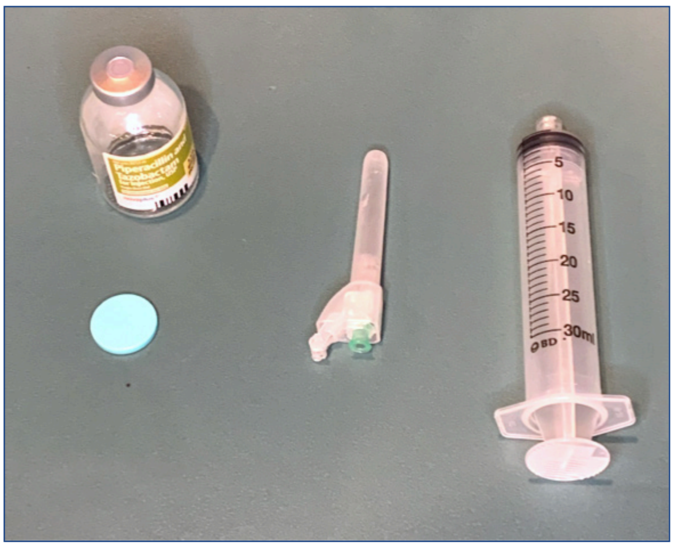


**Image 2.** Supplies for IVPB Medication Administration

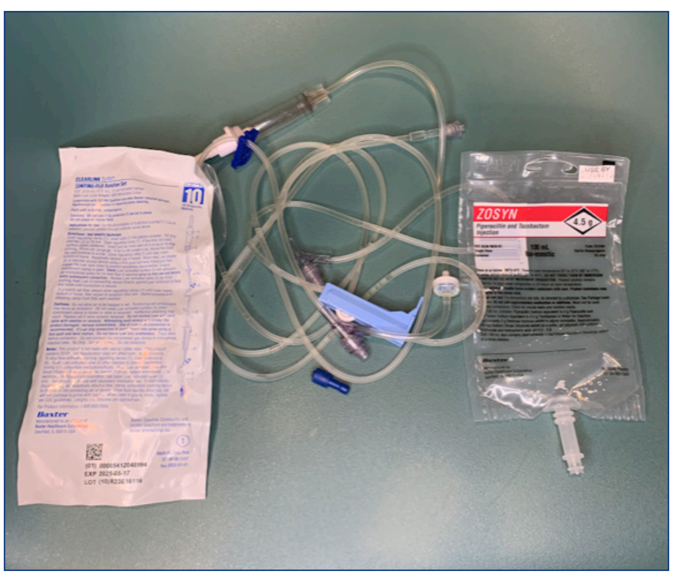


**Table 2.** Weight of Waste for Unique Products Used in IVP Versus IVPB Routes

| | |
|---|---|
| All unique products used in IVP route | 63 grams |
| Uncapped, empty glass vial weight | 37 grams |
| Weight of plastic waste used in IVP route | 26 grams |
| All unique products used in IVPB route | 60 grams |
| IV tubing and accessories for primary line, plus liter bag to run primary line | 52 grams |
| Weight of plastic waste used in IVPB route, total including primary line | 112 grams |

## METHODS

We began by researching the logistics of changing over to primary use of vials for targeted medication, including costs, and creating educational materials such as electronic presentation slides, letters and flyers to promote awareness about the project. The data from the ED medication orders were queried for number of doses given over the six months from January 1, 2023 to June 30, 2023, of a number of commonly used medications that are administered by IVPB but could be given by IVP (**Table 3**).

### Cost Analysis

Reviewing this list of medications which could be administered by the IVP route, we decided to further evaluate the administration of antibiotics commonly used in the ED and model the potential results of switching routes from IVPB to IVP with regards to the potential cost savings of the change. Further expansion of the program to maximize the usage of the IVP route whenever feasible would potentially result in significantly greater cost savings of almost $50,000 in a six-month period as seen in **Table 4**.

**Table 3.** Medications Amenable to IVP Administration Used in the RIH AED (Six-month Time Period)

| Medication Name | Doses (6 mo) | IV Piggyback (IVPB) Details | IV Push (IVP) Details |
|---|---|---|---|
| Ceftriaxone | 1935 | 1 Gram/50 Ml In Dextrose (Iso-Osmotic) | 1 Gram Vial |
| Cefazolin | 983 | 2 Gram/50 Ml In D5W IV Wrapper | 1 Gram Vial |
| Cefepime | 725 | 2 Gram/100 Ml In Dextrose (Iso-Osmotic) | 2 Gram Vial |
| Ceftriaxone | 682 | 2 Gram/50 Ml In Dextrose (Iso-Osmotic) | 1 Gram Vial |
| Cefepime | 320 | 1 Gram/50 Ml In Dextrose (Iso-Osmotic) | 1 Gram Vial |
| Cefazolin | 168 | 1 Gram/50 Ml In Dextrose (Iso-Osmotic) | 1 Gram Vial |
| Meropenem | 139 | 1 Gram/50 Ml In 0.9% Sodium Chloride | 1 Gram Vial |

*Pricing current as of September 2023

**Table 4.** Estimated Cost Savings of Transition from IVPB to IVPB Administration (Six-month Time Period)

| Medication Name | IVPB Per Dose Cost | IVPB Total Cost | IVP Per Dose Cost | IVP Total Cost | Savings Per Unit (IVPB → IVP) | Total Savings Per Medication |
|---|---|---|---|---|---|---|
| Ceftriaxone | $10.04 | $19,427.40 | $1.20 | $4,644.00 | -$7.64 | -$14,783.40 |
| Cefazolin | $9.64 | $9,476.12 | $0.66 | $1,297.56 | -$8.32 | -$8,178.56 |
| Cefepime | $15.43 | $11,186.75 | $4.31 | $3,124.75 | -$11.12 | -$8,062.00 |
| Ceftriaxone | $19.43 | $13,251.26 | $1.20 | $1,636.80 | -$17.03 | -$11,614.46 |
| Cefepime | $9.91 | $3,171.20 | $2.30 | $736.00 | -$7.61 | -$2,435.20 |
| Cefazolin | $3.80 | $638.40 | $0.66 | $110.88 | -$3.14 | -$527.52 |
| Meropenem | $14.53 | $2,019.67 | $4.18 | $581.02 | -$10.35 | -$1,438.65 |
| | | **Average Savings Per Unit** | | | **-$9.32** | |
| | | **Total Savings** | | | | **-$47,039.79** |

## DISCUSSION

In conducting this analysis of two potential administration routes for certain IV medications, our main goal was to clarify the effects that shifts between these routes in clinical practice might have on the generation of plastic waste and overall carbon footprint. A full life-cycle analysis would include evaluation of the materials used in each administration route, from materials extraction to manufacture and distribution, through use, and disposal. Further study will be needed to conduct these holistic studies of the impacts of these processes; however, in simply comparing the weight of plastic waste generated through each process, IVPB generates four times as much plastic weight when accounting for the fact that a primary line running a bag of IV fluids is obligatory with this process. It should be noted that the glass vial used in IVP is not recyclable currently as it is treated as hazardous waste, and that its weight means that shipping these products has a larger carbon footprint. If solely considering the unique materials used for each process in total, both plastic and glass, the materials for IVP weighed 63 grams to IVPB's 60 grams.

While the environmental effects are more complicated to consider, our modeling calculations did predict a significant cost savings by adoption of the use of IVP route administration for certain antibiotics that are commonly used in the ED, and prior studies cited above have described potential benefits of pushing certain medications or in certain scenarios with regard to patient outcomes. However, logistical challenges are inevitable for any program aiming to make a process change, such as gaining widespread support from staff for the change and buy-in from all members of the team. To help promote the benefits of IVP route use, we planned an educational campaign to share potential improvements that could affect patients, such as faster time to administration of antibiotics for patients with sepsis, ensuring medication doses are fully administered, and elimination of the need to find a medication pump to use.

As the cost savings is realized only by the institution and not by staff members themselves, we hoped to incentivize making the change by creating a campaign in which successful implementation of the process change would result in tangible rewards to staff members, such as by providing new amenities in the staff break room, ordering out food for staff on each shift, or providing small gift certificates to the cafeteria. We met with the departmental nurse educator and other members of nursing staff to discuss the project. Potential barriers to the transition to IVP presented by our nursing colleagues included concern that the process of preparing a dose for IVP administration may take longer than the process of preparation for IVPB, as well as concern that medications requiring a prolonged IVP administration time (five minutes or longer) may remove the nurse from their other patient care responsibilities for too long. Nursing staff did agree that searching for a pump to use with IVPB use can be frustrating and time consuming and would be a potential benefit of transitioning to IVP administration. Our team aims to continue to address these potential barriers as we work to develop our IVP medication administration process. Prior studies involving similar projects in other EDs suggested nursing had a positive reaction to the changes after the implementation was complete.[3]

While researching the process for adopting this change, we learned of several other issues that could arise. For example, our automated dispensing cabinets for the ED are currently stocked with premixed preparations of these medications for IVPB administration. In order for the automated dispensing cabinet to know to dispense a vial preparation for IVP, the order placed in the electronic medical record (EMR) would need to reflect the vial preparation. Currently, our institution's standardized electronic orders for these antibiotics default to the premixed bag preparations; therefore, changes will need to be made to the standardized orders prior to transitioning to IVP administration. The information technology (IT) specialists we consulted regarding making the change recommended making IVP administration the exclusive order available for ED use in order to ensure the correct product is dispensed from the automated dispensing cabinets for IVP administration. Other institutions could choose to approach this differently; however, at our institution, this was recommended due to the above outlined constraints in our electronic ordering process. IT recommendations also included ensuring the order was changed in all ED quicklists and preference lists in order to allow seamless transition to the new route of administration, which would be done via a service request for the EMR.

## CONCLUSION

Reduction of waste is an important goal for environmental and cost efficiency reasons. Switching the route of administration of commonly used medication can save money, decrease time to administration, and potentially reduce the plastic waste created by the department. Future studies are planned to clarify the full impact of the use of common ED materials on the department's carbon footprint. Promoting the simple use of IVP medication administration, when appropriate, for certain antibiotics, based on our modeling calculations could result in a significant projected resultant cost savings for our department of close to $100,000 annually.

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