

The way forward for prehospital transfusion

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December 2022—Ask Leonard Weiss, MD, what his favorite part of his schedule is, and he's quick to answer that it's the fieldwork: the helicopter and ambulance dispatches he accompanies once or twice a month as associate medical director of emergency medical services at the University of Pittsburgh Medical Center.

Dr. Weiss, who is also assistant professor of emergency medicine and assistant medical director of Pittsburgh's Stat Medevac service, says one of the UPMC emergency services he strongly supports is the prehospital transfusion of blood products. "Until recently, there wasn't a lot of evidence to deploy its use on the ground as it is in the air, but thanks to extensive use by the military and scientific evidence of the value of prehospital transfusion," he says, it is more likely to become part of some hospitals' emergency medicine programs. The 911 ground-based transfusion program at UPMC and city of Pittsburgh EMS began in 2020.

As Dr. Weiss and his UPMC colleagues acknowledge, however, myriad complexities come into play. "There is so much variability in what is allowed by state regulation for different providers to use in the field, what level of training they're at, what the tolerance is for different therapies. So as a whole, prehospital transfusion in modern-day 911 systems is far lacking compared to where it needs to be," Dr. Weiss says.

It's also not the standard of care, says Mark Yazer, MD, professor of pathology at the University of Pittsburgh and associate medical director of UPMC's centralized transfusion service. Hoping to change that, Dr. Yazer and Dr. Weiss support efforts to encourage prehospital blood product transfusion programs and provide advice on how to launch and operate them, many of which would rely on a hospital blood bank.

More than half of potentially preventable civilian prehospital deaths are due to hemorrhage, and about 85 percent of the 30,000 potentially preventable deaths per year in the U.S. happen before the patient arrives at the hospital. A multicenter trial that compared the administration of plasma with standard-care resuscitation (in many cases, crystalloid fluid only) during air medical transport of trauma patients found that the use of plasma resulted in lower 30-day mortality (Sperry JL, et al. *N Engl J Med*. 2018;379[4]:315-326). In a secondary analysis of the same trial, patients who received prehospital packed RBCs plus plasma had the greatest mortality benefit (Guyette FX, et al. *Ann Surg*. 2021;273[2]:358-364).

Those and other findings were cited in the Trauma, Hemostasis and Oxygenation Research (THOR)-AABB (Association for the Advancement of Blood and Biotherapies) working party recommendations for a prehospital blood product transfusion program, coauthored by Dr. Yazer (Yazer MH, et al. *Prehosp Emerg Care*. 2022;26[6]:863-875). Representatives of transfusion medicine, trauma surgery, emergency and critical care medicine, and EMS physician medical directors wrote the recommendations as a framework for implementing a program for patients who require prehospital transfusion or a transfusion during an inter-facility transfer.

Saline use still prevails, though, and logistics are an important reason. "Saline is the current standard because it's cheap, doesn't transmit diseases, and if you spill it, it evaporates. And there's no cold storage; there's no need to link the specific unit to the patient who receives it," Dr. Yazer says.

Prehospital transfusion, by contrast, "is a logistical pain with paperwork and regulations," he says. "Anyone who offers a blood program is subject to audit, and therefore there has to be a record of the temperature of each unit for every second it's on the shelf or in transport. So there is an enormous compliance program that goes along with blood products. It's one of the obstacles people cite as to why their EMS doesn't offer a prehospital blood product program."

In many states—Pennsylvania is one—the law requires a physician to be onsite, standing next to the patient, observing the blood pressure, observing the scene, "and then they can say okay, this patient needs a transfusion and I authorize that. It's an antiquated law that is getting in the way of good practice," Dr. Yazer says. Studies have

shown that “crystalloids just make everything worse.

“The medical community has been reluctant to adopt prehospital transfusion because of the logistical hurdles of transfusing blood and the lack of evidence indicating that transfusion is superior to saline. But increasingly that’s becoming less of an excuse, as the evidence indicates transfusion is better than saline for the patient’s initial resuscitation of life-threatening bleeding.”



Dr. Mark Yazer (left) and Dr. Leonard Weiss at the Pittsburgh emergency medical service training division. “We now have a real renaissance of prehospital transfusion and the use of whole blood. It’s all coming together,” says Dr. Yazer, coauthor of recommendations for a prehospital blood product transfusion program. [Photo by Alan Freed]

The THOR-AABB recommendations are an effort to show the way forward, Dr. Yazer says. “Prehospital transfusion is not something that is reserved for only the highest-volume users. By following these commonsense steps, a prehospital transfusion program could be established anywhere there are injured patients.” In his view, rural centers ought to be the ones to adopt prehospital transfusion most quickly because their patients are the farthest from definitive care at the hospital. Some statistics can be misleading in judging whether adopting a prehospital transfusion program makes sense, Dr. Yazer says. For example, the usual metric recorded is the transport time from whenever the emergency rescue vehicle arrives at the patient’s accident site until they get to the hospital. But the patient could have been injured long before the vehicle arrived at the scene, and this time is often not documented, he says. And sometimes even though the ambulance is on the scene, the patient might not be available for immediate treatment because they are still in a wrecked car or can’t be reached because of active gunfire.

“Transport time typically covers the last mile. The first few miles are how long does it take to find out about the bleeding patient? How long does it take to get to them? So having a short transport time is not necessarily a justification in my mind to not have a prehospital transfusion program because the patient could have been injured for a long time before the ambulance or helicopter got to them and started treatment,” Dr. Yazer says.

In the past, the AABB had standards that were restrictive about how to use whole blood. “You had to know the patient’s ABO group and give ABO-identical whole blood. But the problem is you won’t know the patient’s ABO type until you get them to the hospital and have had a chance for the blood bank to determine their ABO group, and many patients would benefit from transfusions before they get to the hospital.” However, in 2018, the AABB standards were changed to permit the use of low titer group O whole blood (LTOWB) for any patient, including those whose ABO group is not known at the time the transfusion is administered. With this change, the hospital can decide for which patients LTOWB is appropriate and how many units to administer.

That “opened the door” to the use of whole blood, Dr. Yazer says. “We showed in a survey in 2021 that use of whole blood has gone up significantly since 2018. Now any patient with severe bleeding can receive low titer O whole blood. So we now have a real renaissance of prehospital transfusion and the use of whole blood. It’s all coming together.”

Inertia prevails at hospitals that contemplate starting a prehospital transfusion program because of all the regulatory, cost, and cold chain issues, Dr. Yazer has found. But the evolving evidence points to prehospital transfusion being safe and effective in saving lives when transport and storage have been handled properly. “If the EMS can’t get whole blood, but they can get red cells and plasma, don’t hesitate to set up that prehospital transfusion program while waiting for the whole blood. Any blood product is better than saline when transfusion is appropriate,” he says.

EMS systems vary in structure. Some are hospital-owned, hospital-based, or health care system-owned or -based. Some are independent private companies; others are government entities funded and operated by a city or county. Pittsburgh operates its EMS as a third service alongside fire and police. Philip Spinella, MD, professor of critical care and surgery, co-director of the Trauma and Transfusion Medicine Research Center at UPMC, and a coauthor of the THOR-AABB recommendations, has seen better coordination of prehospital transfusion programs when the EMS is part of the same health care or hospital system and they work together. When he was with another university in another city, the EMS companies were not at all related and would not work together to share blood products. That makes the logistics of transporting the blood, where to keep it when it comes off the helicopter, and so on, harder to settle on.

The cost itself of prehospital transfusion blood can present problems because reimbursement for all care provided is typically bundled, by the Centers for Medicare and Medicaid Services, into a package amount for EMS. “They get one amount of reimbursement no matter what they provide on the ambulance or helicopter,” Dr. Spinella says.

“So if they try to add blood to their inventory, with the cost of a whole blood unit in the \$600 range—red cells and plasma individually are less—they want to do their best by their patients and they’ve figured out a way to do it without additional reimbursement. But it’s very difficult for many helicopter or ambulance services to add that cost without reimbursement.”

Since the CMS does not allow separate billing for blood, it has hindered the ability to have blood on helicopters as part of a prehospital transfusion program, and the coverage outlook for privately insured patients is not much better, Dr. Spinella says. “An EMS company could try to bill your private insurer, but I’ve been told they have to fight, they have to argue, they have to appeal two or three times before even a private company will reimburse. It’s a lot of work and it’s almost not worth it.”

Indeed, the financial impact of starting a prehospital transfusion program can dissuade some EMS systems from doing so, Dr. Spinella says, noting that some EMS agencies in the Midwest found they could not afford it. “So it’s dependent on the solvency of the EMS program and its total volume, what it can absorb financially, how forward-looking the EMS CEO is. But reimbursement has been a big barrier to implementing prehospital transfusion, and there are multiple efforts to get CMS to change regulations to allow EMS programs to bill for blood.”

The Food and Drug Administration regulations applied to prehospital transfusions give considerable scope for EMS to offer such transfusions because they allow for all blood products to be given prehospital. FDA regulations also cover the cold chain of blood products and storage containers that keep products refrigerated and have monitors

to determine variance from temperature range.

Progress has been made in the cooler technology and the methods to keep the blood stored and mobile, Dr. Weiss says. "Cooperation between the trauma services, our EMS and public safety service, our department of emergency medicine, and the blood specialists and the blood bank pathologist is where we're beginning to make this program excel and exponentially grow."



Dr. Philip Spinella, coauthor of the THOR-AABB recommendations. "Reimbursement has been a big barrier to implementing prehospital transfusion," Dr. Spinella says, and efforts to change that are underway.

The Stat Medevac helicopter service has two units on board at all times, and each helicopter base has its own approved onsite blood storage, he says. "When a dispatch is made, our operating procedures set the quantity of units it needs. But there are times when we've needed more and don't have it. The program has to ask how much it can carry. How much weight can we fly with? How much should we have to make sure we're not wasting units?"

Avoiding waste would be a concern for ground-based 911 operations, Dr. Weiss says. "We pick it up directly from the blood services at our trauma centers, they're transferred to a cooler that we've had validated for up to 12 hours of carrying on ice, and then we return the product if it's not used so it can go right back into the pool."

"I also have a low threshold to treat a patient with the blood and don't even think of that as waste," he continues. "If a patient has any sign of instability after a trauma event, blood is a given. Our training is to use blood appropriately, but if there's even an inkling of instability after a trauma event, we give blood without a second thought."

The usual expectation to avoid waste has to be reconsidered for an intervention where the blood product provides a lot of benefit but is used in an unpredictable, episodic manner, Dr. Yazer says. "In Pittsburgh, we waste about 19 percent of the whole blood units we collect—about two units per day—because we were unable to transfuse it to an injured patient or we couldn't manufacture a red cell from it and use that red cell."

"If we wasted that many platelets per day, the transfusion service would have to really reflect on why that was happening," he continues. "But a higher percentage of wastage in this setting translates to a fairly small number of units overall. The way the evidence is pointing, it's better to over-provide blood to the resuscitation than to leave the patient without. We don't want to be without blood products in the prehospital setting, so we tolerate a higher

degree of wastage there, although we are also looking at ways to reduce the wastage.”

Decisions about resuscitation using prehospital transfusion expose the institution to minimal liability, he says, “as long as we’re following the standard of care according to the scope of practice, and as long as we have a trained individual give the blood in an appropriate fashion.”

The different standard of care is central to the liability question, however. “Right now, if I was in a hospital and someone needed blood and I didn’t give them blood, I would be liable because I’m able to do it and I should do it.” In the field, Dr. Yazer says, the EMS program is working on developing the same expectation, at least in the traditional 911 ground ambulance programs. “And eventually I hope prehospital administration of blood products will be the standard of care, and then that pendulum will swing.”

Transfusion reactions, in Dr. Weiss’ experience with prehospital transfusion, have been rare and mild when they do occur. “In the immediate trauma patient, we will give untyped, or type O, uncrossmatched blood, and I’ve very rarely seen a major reaction. You can have a mild fever or allergic reaction in a small percent of the population. And some of the more serious hemolytic reactions are exceedingly rare.”

Even in the instance of a severe response like anaphylactic or hemolytic reactions, “it’s difficult to tell if the hypotension is caused because the patient has just started to bleed even worse, or because of the blood product unit.”

“If a patient in a prehospital setting is injured and needs a transfusion, they may die without intervention, so the balance shifts toward just going with the transfusion,” Dr. Weiss says.

Some might question the release of O-negative blood for potential use in the field when there is a likely real need in the hospital, particularly when blood products are in short supply. Says Dr. Yazer: “I think that producing whole blood for the prehospital setting ought to be a priority. The faster we get blood products to patients, the faster the bleeding is going to stop, so we may not need as many blood products [later] in the hospital.”

Staff shortages too raise questions and barriers. The staff shortage that has become widespread in post-pandemic health care has had an impact at UPMC, but newer prehospital transfusion programs are more likely to be hurt by the shortage than those that are more established, Dr. Yazer says. “It might affect them if the blood centers did not have enough personnel to determine if a unit is a low-titer unit, so they opt to just make a red cell and plasma from it because that’s easier to do. So there might be fewer products available at the beginning” of a prehospital transfusion program.

“If a center has not yet implemented whole blood, they might not have the staffing to go about learning the regulations and buying refrigerators and monitoring. The center would have to prioritize what they want to do with the staff they have.”

Staffing shortages have affected the nurses and field paramedics more than the physicians at UPMC and the surrounding municipality, Dr. Weiss says. “We worry we’re not going to have enough responders to go on calls or they’re going to be on multiple shifts and could be fatigued.” Some EMS agencies have closed ambulance and helicopter bases nationwide owing to staff shortages, he says. Resource limitations and limited bandwidth mean specialized programs like prehospital transfusion will suffer because they involve more than maintaining the basic level of care. “And it’s a very scary situation in health care right now.”

The THOR-AABB recommendations are not to be considered standards for prehospital transfusion. They’re a road map for centers to think about when establishing a prehospital transfusion program. “They are not to be considered standards under which centers could be audited and inspected,” Dr. Yazer says, and in fact the AABB chose the label “recommendations” to steer clear of an implication that formal regulation of prehospital transfusion should be required.

“What needs to be regulated, the number one thing, is how to take care of the blood products and to make sure that, wherever they are, they are in compliance with proper storage conditions. And the EMS would already have to

be in compliance with those standards before they started transporting and administering blood products.”

Here is a sampling of the recommendations for prehospital transfusion programs:

- Medical oversight by an EMS physician medical director is a mandatory component. This medical director approves the training program, credentials the providers, and oversees the associated ongoing quality program.
- The transfusion should be initiated only by personnel trained to administer transfusions. Aspects of such training would include, in part, logistics of product management, types of blood products, administration guidelines, acute adverse event management guidelines, appropriate hand-off procedures, and documentation.
- Documentation of the prehospital transfusion should consist, at minimum, of product type (RBC, plasma, low titer O whole blood), ABO and Rh group as applicable, blood product unit numbers, volume transfused, and noted or suspected adverse events. The form containing this information should be forwarded to the blood bank at the receiving hospital.
- A segment from the RBC/LTOWB unit(s) that was or were transfused in the prehospital phase should be sent to the hospital blood bank for crossmatching.
- If an RhD-positive RBC or LTOWB unit has been administered to a female patient who appears to be of childbearing age, this information in particular should be communicated to the receiving team and the hospital blood bank.
- There must be a plan for the disposition of unused blood products. The ability to prove that the cold chain has been maintained while the products were outside a monitored refrigerator or long-term storage cooler is essential for the integrity of the returns process.

A list of the indications for transfusion can be developed locally, as can the transfusion threshold and rate of infusion, Dr. Yazer says, and having the flexibility to determine some things locally will help with uptake of this process. “I don’t think we should be imposing non-evidence-based things on programs. Let them evolve, let them read the literature, let them set their own practices based on their local needs,” he says.

Asked whether an EMS agency might want to consider partnering with a regional blood center for its products instead of a hospital, Dr. Yazer says it should do whatever makes it easiest to obtain blood. “But partnering with a hospital system that has experience in the remote storage of blood products can save the EMS time and effort by copying what has already been done and what works at a hospital,” he says. “Plus, a large trauma center likely has a dedicated transfusion physician who can be a great asset in developing the program.”

Any hospital administration that is considering launch of a prehospital transfusion program should engage with a team of academic and non-academic medical specialists working closely with trauma and emergency medicine and

the pathology and laboratory medicine department, in addition to the EMS agencies, to build its program, Dr. Weiss advises. (He says there are no published data on the number of programs in existence today but estimates organized 911 blood programs at fewer than 10.) He hopes hospitals with a prehospital transfusion program will advocate for scope-of-practice models that will allow a wider use of the blood in the field by paramedics.

“Working with the paramedics and nurses in the field is a unique experience, and helping patients at the point of injury is rewarding,” he says. He appreciates the access they now have, having gone from a hospital-laboratory-based treatment to a treatment that is deployable in the field. “It makes a difference,” Dr. Weiss says. “The quality measures that are enforced, the training, and the willingness to release blood products in unique ways save lives, and that should be commended on all sides.”□

Anne Paxton is a writer and attorney in Seattle.