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With diversion, lower blood culture contamination rates

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July 2017—To stage magicians, diversion is a trick—a way to direct the audience's attention to something irrelevant so they don't notice what they shouldn't see.

To those who perform blood cultures, diversion is also a trick, though there's nothing deceptive about it—and the way it helps avoid contamination can seem like magic.

"The diversion method, simply stated, is a way to re-route potentially contaminated blood into a separate tube or pouch before filling the sterile blood culture bottles. It is a way to 'flush the line,' " says Janis Atkinson, MD, laboratory medical director at Presence Saint Francis Hospital in Evanston, Ill. "Studies done in platelet procurement using the diversion method have shown that contamination rates can be reduced by as much as 50 percent, with an 85 percent reduction of contamination by skin flora. For that reason, diversion is standard operating procedure in blood bank protocols."

Dr. Atkinson and colleagues recently implemented a protocol they designed in their lab that uses diversion to reduce blood culture contamination. "The protocol uses no special equipment," Dr. Atkinson says, "and the design is simple: Change the order of the blood draw tubes so the culture bottles are not 'up first in line.' "

Dr. Atkinson

Now, a new product from Magnolia Medical Technologies, the SteriPath initial specimen diversion device, makes it possible to reduce contamination of blood cultures by diverting, sequestering, and discarding the first 1.5 to 2 mL of blood.

Invented by Magnolia Medical Technologies founder and medical director Richard G. Patton, MD, the SteriPath device was the subject of a study published in April and conducted by Mark E. Rupp, MD, and others (Rupp ME, et al. *Clin Infect Dis.* April 3, 2017 Epub ahead of print. doi:1093/cid/cix304). Dr. Rupp is a professor and chief of the University of Nebraska Medical Center Division of Infectious Diseases and medical director of the Department of Infection Control and Epidemiology at Nebraska Medicine, Omaha.

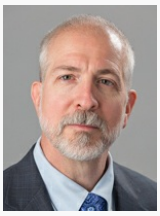
Dr. Patton, former chief of pathology and medical director of clinical laboratories at Northwest Hospital, Seattle, gives a quick description of the device: "A venipuncture wheel allows flow of blood into the reservoir where the sequestered fragments of skin are captured, and once that reservoir is filled, there's a trigger device that shunts the flow of blood into another channel where the blood culture bottle is present."

In the study, which examined 1,808 blood cultures, trained phlebotomists drew two samples from each patient—one using a standard syringe and the other the SteriPath device. If coagulase-negative staphylococci, *Propionibacterium* sp., *Micrococcus* sp., viridans group streptococci, *Corynebacterium* sp., or *Bacillus* sp. were recovered from one of the paired cultures, the culture was considered contaminated. Slightly more than one percent of the blood cultures proved to be contaminated. The standard draw yielded a contamination rate of 1.78 percent, while the SteriPath device yielded a contamination rate of 0.22 percent. (The American Society for Microbiology sets the target rate for

acceptable blood culture contamination at three percent.)

“When you’re talking about less than two percent contamination, most folks feel like that’s a pretty low number, and it doesn’t seem to be very significant,” Dr. Rupp says. “But when you understand that about 30 million blood cultures are done throughout the United States every year, two percent would be about 600,000 contamination events. There are a number of studies that show the amount of money that’s associated with a contamination event is thousands of dollars.”

One limitation to the study, he cautions, is that the researchers were required to obtain informed patient consent. “So, for instance, it excluded all the patients who had to have emergent procedures. It excludes everybody who was obtunded or couldn’t grant consent. Because you’re under a lot of time pressure in the emergency department, pretty much everybody who didn’t speak English was excluded because of the time it would take to get a translator and do the informed consent procedure,” he says. “So the phlebotomists had to bypass a lot of patients, and we had potentially a biased patient population.” In addition, the phlebotomists indicated they purposely avoided using the SteriPath device on combative patients or patients with small, fragile, or otherwise difficult-to-access veins.



Dr. Rupp

One limitation of the device itself is that “you may not want to use it in somebody with a very low blood volume,” Dr. Rupp says. For instance, “in our neonatal ICU where they have very low blood volumes, every milliliter is precious, and so you wouldn’t want to draw off a couple of milliliters that you discard.”

There is also the environmental effect to consider, given that the SteriPath is a single-use device. “The packaging we have is as minimal as possible,” Dr. Patton says, “and we have the device set up so that it can be disposed of in a safe fashion, and I think that’s all we can do, environment-wise and safety-wise.” He adds that since blood culture contamination has been shown to result in unnecessary laboratory tests, imaging studies, and antibiotic use, as well as increased length of stay, “given the fact that contamination is near zero with SteriPath, there may be a big environmental improvement.”

Then, too, “In a paradigm shift, SteriPath is expected to obviate the need for a second venipuncture in the blood culture process.

“The advantage of diversion in the first venipuncture enables an even lower contamination rate in the second culture without a second venipuncture,” Dr. Patton says, pointing out that environmental improvement accrues as the second venipuncture, “with it’s paraphernalia and inconvenience, becomes redundant.”

The Medical University of South Carolina’s emergency department began using SteriPath last year in an attempt to lower its contamination rate, which, despite many efforts, had for several years never dropped below four percent. Director of diagnostic microbiology Lisa Steed, PhD, calls the pre-2016 rate “unacceptably high.”

“No matter what kind of intervention we did, the ED never got below four percent,” she recalls. “One year they met four percent, but they never went below four percent. But once we started using SteriPath, the rate dropped precipitously.” For 2015, the ED’s blood culture contamination rate was 4.6 percent; for 2016, it was 2.3 percent.

Dr. Patton

At MUSC, two types of nurses work in the emergency department: nurses who always work in the ED, and nurses who float from department to department. Only the former use the SteriPath device. In the ED, about twice as many blood cultures are drawn with SteriPath than are drawn without it.

During the 18 months since MUSC has been using SteriPath, the average contamination rate for blood cultures drawn with the device is 0.78 percent, with three months showing zero percent contamination. In contrast, the average contamination rate for the blood cultures drawn without the device is 3.63 percent, with no months showing

zero percent contamination.

“Some of the nurses really didn’t want to use the SteriPath, but once they developed the hand muscle memory to use the device, they liked it,” Dr. Steed says. “Part of the reason they liked it was that they didn’t have so many contaminated cultures, and the nurse manager didn’t jump all over them.”


Dr. Steed

Dr. Steed praises the training Magnolia provided. “The SteriPath people came to teach the nursing staff how to use the device,” she says. “The other thing they did that I really appreciated was they took our internal institutional blood culture collection policy, which many of our nurses didn’t even know existed, and taught the nurses according to that policy. They stressed not just how to use the SteriPath device and perform better aseptic technique, but also that the nurses are supposed to put more blood in those bottles than they’d been doing. Which is important to me, because if the organism doesn’t get into my blood culture bottle, then I can’t get it back out, and the physicians don’t know how to manage the patients optimally if they don’t have a pathogen. If I don’t get enough blood in that bottle, I’ve got a false-negative blood culture, and it doesn’t help anybody.”

As for the blood that is wasted through diversion with SteriPath, she says, “In the big scheme of things, I am less concerned about the blood wasted if it avoids having a false-positive blood culture. For some of our immunocompromised patients, anything that grows the clinicians are going to want to kill. It’s very hard for the clinicians of those patients to just say, ‘Okay, I’m going to blow this off, it’s a contaminant,’ and not worry about it.”

For Dr. Atkinson, the move to the diversion method was prompted by her unwelcome realization in 2015 that the blood culture contamination rate in Presence Saint Francis’ emergency department was exceeding three percent about once every three months (and sometimes rising to as high as five percent). This in contrast to the rate of less than two percent yielded by the phlebotomy draws on the hospital’s floors.

“In our hospital, it’s the emergency department nurses who draw the blood cultures. As in many EDs, we have high nurse turnover, and they’re not directly under lab, either,” Dr. Atkinson says. “In addition, the skin-cleansing process is arduous, it’s multiple steps, you have to wait for the iodine to dry. Nurses want to draw the blood and get on to the next thing they have to do. As a result, sometimes the bacteria aren’t completely eliminated from the draw site.”

Dr. Atkinson points to recent literature estimating the cost of a single contaminated blood culture at “everything from $3,000 to $10,000, depending on how you evaluate it.” She was determined to avoid those costs, as well as the accompanying hits to patient care. And so, diversion.

In July 2015, Dr. Atkinson began an 18-month study into a new protocol around blood culture contamination. The protocol designated a 7-mL blood collection tube destined for chemistry analysis as the diversion tube. “It was really elegant,” Dr. Atkinson says. “We just changed the order of the tubes that are drawn. The standard protocol is to do the blood culture bottles first, but we just switched the order. We altered nothing about the standard blood culture protocol—for example, with regard to the need for careful sterilization of the skin—other than adding the extra draw-off tube, carefully cleaned, before drawing the culture bottle.”

But what if a patient doesn’t need chemistry testing? “Then the 7 mL of blood would just be wasted,” Dr. Atkinson admits. “But that would happen for only a minority of patients, because the majority of our blood cultures are done on emergency department patients, and 100 percent of them have additional testing done. And if you think about it, a lot more blood is wasted if the cultures have to be redrawn because they weren’t drawn correctly the first time. So there is a downside, but it’s more than offset by the advantages.”

To encourage staff to follow the new protocol, Dr. Atkinson had instruction sheets made and put into bags containing everything necessary to draw a successful sample: a 7-mL gold-top tube, blood culture bottle, alcohol wipe, and so forth. “We made hundreds of these kits and distributed them all around the hospital during the first month of the study,” she says. Staff continued to be required to initial tubes so that contaminants could be traced.

Staff also continued to be reminded regularly of proper draw technique, which includes never drawing from lines and never re-palpating a draw site after it's been cleansed. One advantage of the diversion method, Dr. Atkinson points out, is that if the nurse or phlebotomist does re-palpate, bacteria are going to flush into the chemistry tube, so "it doesn't matter as much," she says. (Still, she says with a smile, "We don't tell them that.")

Over the following 18 months, through the end of 2016, Dr. Atkinson and her team gathered contamination data on 27,396 cases, finding 568 contaminants such as *Staphylococcus epidermidis*, *Staphylococcus hominis*, *Staphylococcus capitis*, and *Streptococcus viridans*. At the end of that time, they compared the data with data from the 18 consecutive months prior to the study.

They found that after the diversion protocol was introduced, the contamination rate in the emergency department dropped from 2.92 percent to 1.95 percent, while the inpatient contamination rate dropped from 1.82 percent to 1.31 percent. For ED and inpatient cultures combined, the rate dropped from 2.46 percent to 1.70 percent. "We were able to meet our monthly goal of less than three percent contamination rate for the hospital 100 percent of the time during the study period," Dr. Atkinson says. For two glorious consecutive months early in the study, the inpatient contamination rate dropped to 0.2 percent.

The new protocol resulted in an overall average length-of-stay reduction of two to three days for sepsis patients. "If we had gotten even half a day's reduction, I would have considered the project a success," Dr. Atkinson says. "Two to three days is really significant for both the hospital and the patient."

"If we take a very conservative estimate of $3,000 per blood culture bottle, we were able to save our hospital somewhere between $300,000 and $400,000 during this 18-month period with no added cost and a better quality patient experience."

The sticking point (so to speak) has been maintaining compliance. "After we completed the study, we had a new batch of nurses come through and our contamination rate shot up during that month," she says. "We realized we needed something more than just training. We needed a monthly reminder."

That's why she recently began publicly posting the initials of the individuals each month who have turned in contaminated blood cultures. If that doesn't work, she may re-introduce the kits, perhaps even fastening the gold-top tube to the blood culture bottle with a rubber band, "so people will think, 'Why is this attached? Oh yeah, I have to draw it first.' " In the meantime, the diversion protocol has been rolled out to other sites in the hospital's system, "and we are getting preliminary very positive results from them," she reports.

"The protocol I use costs nothing extra for the patient or hospital," she adds, "which is the beauty of it."

Dr. Patton has experimented with changing blood draw protocol in an attempt to reduce contamination, and he says "it didn't work as well, not nearly as well as the way we have now set up with the SteriPath device." He says, too, "Using a non-sterile tube for collection prior to the culture is contraindicated. Also, two studies which measured contamination improvement using a sterile 3-mL diversion vessel showed only 50 percent or less improvement, while SteriPath improvement is greater than 95 percent."

Dr. Rupp adds that when following the diversion protocol Dr. Atkinson has laid out, "you'd have to be really careful to make sure you're not contaminating the needle with that chemistry device. In other words, that's probably not a sterile test tube; you would have to carefully disinfect the stopper." The more the system is manipulated, he says, "the more likely it is that some sort of contamination occurs." Still, he praises the fact that Dr. Atkinson's technique, unlike the SteriPath method, does not result in discarded sample: "It does make sense that you don't want to waste that blood."
Drs. Atkinson, Rupp, and Patton agree that even institutions that don't exceed the ASM's target contamination rate of three percent should work on reducing their rates.

"Even if you are making your three percent goals month after month, the [diversion] protocol will still reduce your

blood culture contamination rate, and that can still translate to saved dollars," Dr. Atkinson says. "Even if you only have a modest improvement to make in your hospital, or even if you're meeting the goal, this will still reduce your rates, and it will still translate to big savings."

Beyond cost, Dr. Patton says, blood culture contamination is about patient safety. Each year about 1 million contaminations are associated with increased length of stay, "with the low end of length of stay being two days," he says. That adds up to about 2 million additional hospital days per year in which patients are exposed to the morbidity and mortality of health-care-associated infections. "So the goal should be to minimize contamination," Dr. Patton says, "and not just improve it."

Anne Ford is a writer in Evanston, Ill.