

Injection Rhymes with Infection?

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IN this issue of *ANESTHESIOLOGY*,¹ we have a clear demonstration of a potential problem: bacterial contamination of IV injectates can happen (and frequently does, as demonstrated by the 6% rate of contamination found in this study and others²⁻⁴). The authors demonstrated that in real practice, bacteria and fungi can be recovered from the internal fluid path—intended to be sterile—of 6% of items (syringes and IV tubing) used in actual patient care. The authors combined two approaches to estimate the incidence of injectate microbial contamination: culturing the syringes prepared by providers and used to administer drugs and recovering for culture everything caught by a 0.2- μ m filter placed in the fluid path downstream of all access points. This latter technique is ingenious because it allows capture (as well as identifies a potentially therapeutic interception) of all culturable microbes* injected intravenously during the course of the case. This approach allows cumulative measurement of the total contamination risk throughout the case. Combined analysis from the two sources demonstrates a high contamination rate in the injectates actually delivered to patients.

This study nicely illustrates the potential for lapses in basic infection control practices in the setting of a busy clinical practice. Strikingly, this 6% incidence may be lower than what occurs in usual practice, given that the participants were aware of the study aims and goals regarding culturing and investigating for contamination and may have been extra careful to follow good infection control practice. In other settings, anesthesia providers' contaminated hands have been shown to be a significant source of intraoperative bacterial transmission to patients.⁵ In the spirit of fairness,



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breakdowns in infection control practices related to IV access and medication delivery are not unique to anesthesia professionals.

Clearly, this level of contamination raises a red flag. We do not know whether incidental injection of microbes is a major clinical source of infections, as the source of postoperative infections such as bacteremia is very challenging if not impossible to identify, and these infections may not be systematically tracked in healthcare settings. Most of the organisms identified are commensals found on skin and often have low pathogenic potential. In addition, the pathogenesis of surgical site infections (from direct wound inoculation as opposed to hematogenous seeding) calls into question the authors' claim of injectate contamination as an important source of surgical site infections. That said, we do not have any evidence that it is safe to inject microorganisms either (and in fact have clear evidence of harm from other settings).

Neatly, we have in the same issue of *ANESTHESIOLOGY* a report that describes a partial (but compelling due to its own workflow advantages) solution to the contamination problem: adoption of single-use, prefilled syringes.⁶ Reflecting on the typical drawer-to-arm workflow starting from a single-use drug vial and ending at the tip of a vascular catheter, professionally prepared, prefilled syringes eliminate about half of the potential opportunities to contaminate an IV solution: those occurring during the solution prep phase of the “prep → access IV → inject” process. Of course, prefilled syringes cannot prevent contamination due to poor IV access practices. Here, the 0.2- μ m filter likely helps by reducing (though not eliminating) distal passage of bacteria and fungi (but not viruses).

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*There may be more microbial contaminants that cannot be cultured *in vitro*.

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From the purist's perspective, some may argue that it is scientifically important to prove that accidental contamination of approximately 6% of all injectates with microorganisms is clinically meaningful. Prior work has demonstrated that the anesthesia work environment (patient, provider, and environs) becomes contaminated very quickly⁷ and that in some cases the bacterial type in subsequent infections matches that found in the work environment.²

It is easy to understand that contamination of injectates occurs because of imperfect aseptic technique by providers. During patient care, IV injection ports inevitably contact the patient's skin and other contaminated surfaces. Consequently, it is recommended to decontaminate IV injection ports before access because they must be assumed to be contaminated.

One of us (W.S.S.) actually uses this construct when educating trainees in aseptic technique: Unless one is working with sterile gloves in a sterile field, any sterile surface that is surrounded by an unsterile environment must be considered contaminated if the operator loses continuous visual confirmation that it has not contacted an unsterile object. Thus, it seems simple to educate clinicians to be careful to consistently use aseptic technique when preparing syringes and especially injecting into the IV, with the expectation that injectate contamination would cease to be a problem. (Cue: mild sarcasm.) As an optimistic example, hand hygiene success is associated with reduced anesthesia work environment contamination⁸ and reduced hospital infection rates.⁹ However, perfect hand hygiene performance is difficult to achieve and sometimes infeasible.⁸ Others may note that with the increasing turnover of healthcare providers and the growing burden of protocols, standards, and medical knowledge that clinicians must learn, we may not be able to reliably ensure adherence to basic practices 100% of the time. For instance, training of basic infection control practices is now relegated to instruction on the wards or clinics by clinical mentors/supervisors. With such diffusion of training, variability of practices invariably creeps in.

An alternative approach to the problem of injectate contamination may be *via* engineering controls: elements of the system that are inherently safer or more reliable because consistency or safeguards have been engineered in. Engineering controls such as disinfectable needleless injection ports can reduce contamination in IV injectates if the provider actually disinfects before injection.⁴ Replacing the provider as syringe preparer by a professional (or, increasingly, a computer-controlled robot) assigned only one task, operating in an optimal environment⁶ for microbial reduction is a strong engineering control. Adding the filter¹ is also an engineering control that can reduce the microbial burden reaching the patient. To a specialty focused on reliability, safety, and engineered systems, such controls are appealing. However, these three elements likely add cost.

Given the almost negligible cost of both interventions (prefilled syringes and filters) relative to the cost of

postoperative infections, should not we just implement? Such a proposal sets up a conflict between the drive for experimental rigor (the evidence-based medicine position: the cost of the infections should outweigh the cost of their prevention) *versus* the drive for sound, incremental improvement in the name of improving safety (the patient safety movement).¹⁰

In patient care, the access points to IV systems are constantly out of sight. But beyond the theoretical likelihood of out of sight equals contaminated, we know IV access points really do become contaminated. We compensate by attempting to resterilize them before access. However, once we begin to access the IV system, even for routine activities such as induction of anesthesia, the rule of "out of sight implies contaminated" is difficult to operate by. It is even more difficult to live by in an emergency or under the drapes. Laboratories long ago resolved the problem of maintaining sterility in locally prepared items by buying prepackaged sterile supplies and introducing engineering controls at every possible step of the process. Is it time for the same in anesthesia?

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Competing Interests

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