

# What Is The Predominant Source of Intravascular Catheter Infections?

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**The predominant source of intravascular catheter–related bloodstream infections has been a research and clinical question for more than 30 years. During that time, we’ve moved from the position of a single source predominating in all clinical scenarios to a more realistic appraisal that both skin at the insertion site and the catheter hub/connector (ie, an extraluminal and an intraluminal source of infection, respectively) are important and that maximally effective prevention programs must address both sources of infection.**

Debate has existed regarding the major route whereby microbes infect intravascular catheters, an extraluminal route arising from skin at the catheter insertion site or an intraluminal route emanating from the catheter hub, from the catheter tubing connection, or less frequently, from contaminated intravenous fluids. Most of the evidence suggests that, in general, an extraluminal source of infection predominates in catheters placed for a shorter duration of time, whereas an intraluminal source predominates with more prolonged dwell times. In a study of 25 short-term catheter-related bloodstream infections (CRBSIs) that used molecular fingerprinting to confirm the source of infection, 15 CRBSIs were from an extraluminal source, 3 CRBSIs were

from an intraluminal source, and 7 CRBSIs could have originated from either source [1]. In sharp contrast, a study of 24 long-term CRBSIs found 5 CRBSIs were from an extraluminal source, 16 CRBSIs were from an intraluminal source, 2 CRBSIs could have arisen from either source, and 1 case resulted from hematogenous seeding of the catheter [2]. In another study that used molecular fingerprinting, the median duration of catheterization was 14 d for CRBSIs with a confirmed extraluminal source, 24 d when the source was either extraluminal or intraluminal, and 64 d when the source was confirmed as intraluminal [3]. Intraluminal colonization with biofilm-producing microbes was more widespread after prolonged catheterization in a study that found >40% of the intraluminal surface of catheters in situ after >30 d was covered with biofilm compared with only 15% of the intraluminal surface of catheters in place for <10 d ( $P < .001$ ) [4]. Catheter-drawn blood cultures were performed weekly in a study of patients with hemodialysis catheters [5]. If a catheter-drawn blood culture revealed microbial growth, then weekly,

percutaneously drawn blood cultures were obtained. Of 31 patients, 21 developed positive catheter-drawn blood cultures at a mean dwell time of 27 d. Of these 21 patients, 12 went on to develop concordant microbial growth from percutaneously drawn blood cultures at a mean time of 32 d after the first positive catheter-drawn blood cultures were obtained. These findings suggest that intraluminal catheter colonization, as measured by positive blood cultures drawn through the catheter, occurs in long-term catheters, and if left unchecked, this can lead to true CRBSI.

CRBSIs arising from the insertion site are extraluminal, and adequate cutaneous antisepsis of the insertion site reduces risk of such infections [6]. CRBSIs arising from an intraluminal source reflects a breach in aseptic technique when manipulating catheter hubs, caps, connectors, or stopcocks, or contamination of the infusate itself. In 1 study, 31% of nurses did not disinfect needleless catheter connectors before accessing them and 17% of “discarded” blood samples from blood drawn through these needleless connectors had microbial growth

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[7]. This may reflect inadequate time to properly clean the connectors before accessing them, inadequate training, or both. Likewise, a low nurse-to-patient ratio independently increases the risk of catheter infection [8], likely reflecting lapses in aseptic technique. Similarly, insufficiently trained nurses working in an intensive care unit setting independently increases the risk of such infections [9].

Some needleless connectors are associated with an increased incidence of catheter infection, likely from an intraluminal source [7, 10]. This may be due to difficulty cleaning the surface of some currently marketed connectors, the inability to disinfect the internal connector components, or behavioral issues, as noted above, leading to suboptimal disinfection of connectors prior to their being accessed, or no disinfection at all. On the other hand, a decreased risk of catheter colonization with use of needleless connectors has been found in some studies [11, 12], suggesting that there are likely differences in the risk of intraluminal contamination and resultant bloodstream infection among the devices now in clinical use.

In conclusion, both extraluminal and intraluminal routes of infection are important in the pathogenesis of central venous catheter-related infections. Soon after insertion, the extraluminal route of infection predominates, whereas the intraluminal route does so after a more extended dwell time. Thus, a focus on catheter insertion will help prevent CRBSIs that occur within days of catheterization and a focus on catheter maintenance will help prevent later infections. Behavioral changes reflecting education, evidence-based catheter insertion, and maintenance bundle use [13–15], as well as the promise of novel catheter and connector advances [16, 17],

antimicrobial dressings [18], and catheter flush solutions [19] will further reduce risk of catheter infections.

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