Short Communication

Role of Antimicrobial Solutions in Preventing Catheter-Associated Bloodstream Infections

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ABSTRACT

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Vascular access devices are essential to modern care, yet catheter-associated bloodstream infections remain a persistent,high-mortality, and costly challenge. These infections arise through two primary pathways: extraluminal skin flora migration and intraluminal entry via contaminated connectors. Traditional manual protocols, such as scrubbing needleless connectors, suffer from low clinician compliance (10%–27%) and variable execution, exacerbated by severe nurse staffing shortages. A dual-pathway approach addresses these vulnerabilities by replacing technique-dependent manual tasks with passive antimicrobial protection. Intraluminal protection using 3M™ Curos™ Disinfecting Port Protectors provides passive hub disinfection and a physical barrier for up to 7 days, achieving a 99.99% microbial reduction.Complementing this, extraluminal protection using 3M™ Tegaderm™ CHG Securement Dressing continuously suppresses insertion-site flora, reducing catheter-related bloodstream infections by 60%. Passive, standardized dual-pathway technologies systematically eliminate technique variability, improve compliance, ease nursing workload, and optimize patient outcomes, presenting a strong case for bundled facility-level adoption.

Keywords:

Vascular access devices (VADs), Catheter-related bloodstream infections (Crbsi/Clabsi), Dual-pathway protection, Passive disinfection caps, Chlorhexidine gluconate (CHG) dressing.

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Introduction

Vascular access devices (VADs) are indispensable to modern hospital care, yet they remain one of the most significant preventable sources of healthcare-associated infection. In the US alone, the annual cost of treating central line-associated bloodstream infections (CLABSIs) exceeds $2.3 billion, and catheter-related bloodstream infections (CRBSIs) are associated with a 1.57-times higher risk of mortality in critically ill adults.[1] Up to 1 in 4 patients who contract a CLABSI die as a result of the infection, and the average cost to treat a single CLABSI episode is approximately $45,000.[2] Despite more than two decades of infection-prevention initiatives, catheter-associated bloodstream infections (CABSIs) continue to represent a persistent and costly patient safety problem.

Clinical Context

Vascular catheters provide prolonged access but inherently breach the skin's natural barrier, creating two distinct pathways for microbial entry:

- Extraluminal contamination occurs when skin flora migrate along the external catheter surface and enter at the insertion site.
- Intraluminal contamination occurs when organisms are introduced into the catheter lumen, typically via contamination of the needleless connector or hub during access.

Approximately 60% of all hospital-acquired bloodstream infections originate from some form of vascular access,[3] and short-term peripheral intravenous catheters (PIVCs) alone account for 22% of hospital-acquired catheter-related bloodstream infections.[4] Compounding this risk, health-

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care staffing pressures have been associated with reduced infection-control compliance. Significant increases in healthcare-associated infection rates were observed nationally in 2020, with central line-associated bloodstream infections (CLABSIs) showing the largest rise.[5] With an average medical-surgical nurse-to-patient ratio of 6.3:1 and the World Health Organization projecting a shortage of 4.5 million nurses by 2030, [6] manual, technique-dependent disinfection protocols are increasingly difficult to sustain reliably at the bedside.

The long-standing standard of care for intraluminal protection—manual "scrub the hub" disinfection using 70% isopropyl alcohol (IPA) for 15–30 seconds plus drying time—is compromised by low intuitiveness, inconsistent technique, and poor compliance. Reported compliance rates with scrub-the-hub protocols are as low as **10%–27%**, and in one study, **31% of clinicians did not attempt to disinfect needleless connectors at all,** even under direct observation.[7] Disinfection effectiveness has also been shown to vary significantly with scrubbing technique, applied force, and duration.[8, 9]

Innovation: A Dual-Pathway Approach to CABSI Prevention

Addressing both contamination pathways requires complementary technologies rather than a single intervention.

- **Intraluminal protection—3M™ Curos™ Disinfecting Port Protectors:** Curos caps provide passive disinfection of needleless connectors, male luer connectors, stopcocks, and catheter hubs. The alcohol-impregnated cap bathes the access point surface for one minute, achieving a 99.99% (≥4-log) reduction across six clinically relevant organisms, including S. aureus, S. epidermidis, E. coli, P. aeruginosa, C. albicans, and C. glabrata, while maintaining a physical contamination barrier for up to 7 days.[10, 11] Independent peer-reviewed studies have demonstrated consistent benefit:

Study	Outcome
ClinicoEconomics and Outcomes Research, 2023[12]	73% fewer CLABSI incidences; ½-day shorter hospital stay; $6,703 lower cost per stay
Journal of the Association for Vascular Access, 2018[13]	~90% compliance protecting needleless connectors and disconnected male ends
Burns, 2017[14]	68% reduction in CLABSI rates in a burn ICU
American Journal of Infection Control, 2012[15]	Significant CLABSI reduction once cap-use compliance reached 85%

Extraluminal protection—3M™ Tegaderm™ CHG Chlorhexidine Gluconate I.V. Securement:

Dressing Tegaderm CHG is the only transparent dressing cleared by the FDA to reduce vascular catheter colonization and CRBSI.[16] Its integrated chlorhexidine gluconate (CHG) gel pad provides continuous antimicrobial action for up to 7 days while allowing visual site inspection. In a multicenter RCT of 1,879 patients and 4,163 catheters, Tegaderm CHG was associated with a 60% reduction in CRBSI rates compared with non-chlorhexidine dressings.[17] An 11-year real-world study of over 18,000 ICU patients demonstrated sustained CRBSI reduction with continued use.[18] Comparative data also show superior placement accuracy (100% vs. 31% for a chlorhexidine disk requiring separate application) and greater securement pull-force versus disk-plus-separate-dressing combinations.[19, 20]

Across both technologies, the recurring finding—replicated by independent research teams, patient populations, and care settings—is that **passive, standardized antimicrobial protection consistently outperforms manual, technique-dependent protocols,** both in infection reduction and in compliance achieved.

Key Learning

While the cumulative global evidence base is substantial (Curos: 35+ published articles; Tegaderm CHG: 22+ studies encompassing over 30,000 patients), [21,22] there remains a notable gap in **combined-bundle evidence**—specifically, prospective data quantifying the incremental benefit of pairing intraluminal (cap) and extraluminal (dressing) antimicrobial protection simultaneously, as opposed to evaluating each technology in isolation. Most published outcome studies evaluate one intervention against historical "scrub the hub" or standard-dressing controls, rather than a fully bundled dual-protection strategy. This represents an opportunity for future prospective, facility-level surveillance.

Implications for Practice

- **For the healthcare worker:** Passive disinfection removes user-technique variability, reduces time burden per shift, and provides immediate visual confirmation of protection status—supporting compliance even under staffing pressure.
- **For the patient:** Dual-pathway protection reduces risk of a potentially fatal, costly complication and supports continuous site monitoring through transparent, intact dressings.
- **For the hospital:** Standardized, bundled antimicrobial protocols align with INS, CDC, APIC, ONS, and SHEA guidelines, support auditable compliance tracking, and are associated with measurable reductions in length of stay and cost of care.

Toolkit: Protocol for Successful CABSI Prevention

Recommendations
Apply passive intraluminal disinfection using antiseptic barrier caps to all needleless connectors, male luer connectors, and stopcocks between accesses.
Apply a chlorhexidine gluconate (CHG)-impregnated transparent securement dressing to all eligible central and peripheral intravascular catheters.

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Declaration

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Conflict of interest

The available study record did not report any competing interests.

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