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Brief Report

Microorganisms present on peripheral intravenous needleless connectors in the clinical environment

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The aim of this study was to quantify culturable microorganisms on needleless connectors (NCs) attached to peripheral intravenous catheters in hospitalized adult medical patients. Half (50%) of 40 NCs were contaminated with microorganisms commonly found on the skin or mouth. *Staphylococcus capitis* and *Staphylococcus epidermidis* were most commonly isolated. Emergency department insertion and higher patient dependency were statistically associated with positive NC microorganism growth. These results reaffirm the need for NC decontamination prior to access.

BACKGROUND

Almost all vascular access devices require a needleless connector (NC) to access the intravascular system.[1] NCs were introduced to reduce the risk of health care worker needlestick injury.[2] There are a wide variety of connector types and manufacturers. There is debate about the role NCs play in bloodstream infection risk.[3] It is thought that before NCs were developed, clinicians intuitively knew to decontaminate the access port with antiseptic prior to accessing it with a needle.[1] A recent study found that 31% of clinicians did not disinfect the NC prior to access.[4]

The Centers for Disease Control and Prevention[5] and Infusion Nurses Society[6] state that the optimal time frame and technique for NC decontamination has not been empirically established. The evidence for successful NC decontamination varies between 5 and 60 seconds,[1] with 15 seconds being a frequently identified and recommended disinfection time.[7-9] Laboratory studies have inoculated NCs with *Staphylococcus epidermidis* or common skin contaminants, and then used varied disinfection times to establish whether microbes have been eliminated.[8-11] However, these may not reflect true clinical settings. Few studies have looked at which microorganisms, and in what numbers, are present on the NCs of patients with peripheral intravascular cannulas (PIVCs).

AIM

The aim of the study was to identify culturable microorganisms present on the external surface area of NCs used on PIVCs in a clinical environment.

METHODS

There were 37 adult patients, recruited from medical and cardiology units, who had 40 NCs (Smartsite Needlefree Valve; BD-Care Fusion, Franklin Lakes, NJ) on PIVCs. Inclusion criteria were the PIVC had been in situ for >24 hours, patient verbal consent, and the NC was free of an infusion. Data were collected on patient location, age, sex, level of care, room capacity, dominant hand, insertion site and side (right or left), dwell time, insertion location, number of NC accesses, and indication for PIVC.

Samples were collected adhering to hospital hand hygiene and aseptic nontouch technique policies. A sterile cotton-tip stick (Transystem culture swab transport system; COPAN, Brescia, Italy)

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Table 1
Culture results from 40 NCs

Organism*	No. of NCs (%)	Injectable site (wet), any growth	Injectable site (dry), any growth	NC side, any growth
No growth	20 (50)	✓	✓	✓
Staphylococcus capitis	8 (20)	✓	✓	✓
Staphylococcus epidermidis	7 (17.5)	✓	✓	✓
Staphylococcus hominis†	4 (10)	✓	✓	✓
Staphylococcus haemolyticus†	3 (7.5)	✓	x	✓
Streptococcus gordonii	1 (2.5)	✓	x	x
Streptococcus salivarius subsp *thermophilus*†	1 (2.5)	✓	x	x
Staphylococcus warneri	1 (2.5)	✓	x	x
Kocuria kristinae	1 (2.5)	✓	x	x
Micrococcus luteus (yellow) or *Micrococcus lylae*	1 (2.5)	✓	x	x
Kytococcus sedentarius	1 (2.5)	x	✓	x
Staphylococcus aureus	1 (2.5)	x	x	✓
Corynebacterium sp (GPB coryneform, Cat+)	3 (7.5)	✓	x	✓
Corynebacterium xerosis or *Corynebacterium amycolatum*	1 (2.5)	✓	x	x
Corynebacterium coyleae	1 (2.5)	x	x	✓

✓, positive; *x*, negative; *NC*, needleless connector.
*Eight NCs were contaminated with 2 different microorganisms, 3 NCs grew 3 microorganisms, and 1 NC had 4 different microorganisms.
†Samples marked grew >10 colony forming units for ≥1 patient, and all other results were ≤10 colony forming units.

was used to swab the connector (no decontamination was performed). Two samples were collected from the injectable surface of the NC: the first was moistened with sterile sodium chloride 0.9%, and the second was a dry swab from the same site. With the exception of the first 5 patients, a third swab, moistened with sterile sodium chloride 0.9%, was used to swab the side of the NCs. A qualified clinical microbiologist plated the specimens onto a prepackaged Horse Blood Agar plate (horse blood agar plate (bioMérieux, Marcy l'Etoite, France). The plates were incubated at 35°C for 2 days, and 28°C for a further 3 days. Plate analysis was undertaken by the microbiologist at days 3, 4, and 5. Growth rate was determined by counting the number of colonies on the plate. The VITEK MS MALDI-TOF (bioMérieux) was used to identify the organisms.

ANALYSIS

Data were imported into Stata 14.1 (StataCorp, College Station, TX) for analysis. The outcome (microorganism growth) was setup as a dichotomous variable (yes or no), whereas the exposures (eg, insertion location) were either categorical or ordinal variables. The null hypothesis of no difference in growth between the various levels of exposure was assessed with the Fisher exact test. Considering the family-wise error rate of <0.05 and the number of comparisons (5), *P* values ≤.01 were considered statistically significant (Bonferroni correction for multiple comparisons).

RESULTS

Results of the 115 swabs are presented in Table 1. Half of the NCs (50%) yielded growth of microorganisms on at least 1 of the 3 swabs taken. Most grew normal skin flora, with 2 patients culturing oral flora. The most common organisms were coagulase-negative staphylococci, *Staphylococcus capitis*, and *S epidermidis*. *Corynebacterium* sp was the most common gram-positive bacillus. One NC (2.5%) cultured *Staphylococcus aureus* (coagulase-positive *Staphylococcus*).

Three NCs were contaminated with >10 colony forming units of the isolated organism, with 29 colony forming units being the highest level of contamination. The first wet swab taken from the injectable surface yielded the greatest microorganism growth (16/40, 40%), with the wet swab taken from the side of the NC yielding the next highest growth (10/35, 29%). Ten NCs were contaminated on both their side and injection surface.

Table 2
Participant characteristics and study outcome for 40 NCs

Characteristic	Descriptive statistic	Outcome		*P* value
		No growth	Growth	
Group size	40 (100)	20 (50)	20 (50)	
Patient level of dependence				.041
Independent	27 (68)	17 (85)	10 (50)	
Dependent	13 (32)	3 (15)	10 (50)	
Insertion location				.009
Ward, ICU, or CCU	27 (68)	17 (85)	10 (50)	
Emergency department	7 (18)	0 (0)	7 (35)	
Ambulance or other hospital	6 (15)	3 (15)	3 (15)	
IV location				.485
Forearm	17 (42)	8 (40)	9 (45)	
Antecubital fossa	12 (30)	7 (35)	5 (25)	
Hand	7 (18)	2 (10)	5 (25)	
Wrist	4 (10)	3 (15)	1 (5)	
No. of times accessed				.170
1-4 times	5 (12)	2 (10)	3 (15)	
5-8 times	10 (25)	8 (40)	2 (10)	
9-12 times	3 (8)	1 (5)	2 (10)	
>12 times	22 (55)	9 (45)	13 (65)	
IV dwell time				.525
≤48 h	12 (30)	6 (30)	6 (30)	
49-72 h	17 (42)	10 (50)	7 (35)	
≥73 h	11 (28)	4 (20)	7 (35)	

NOTE. Values are n (%) unless otherwise noted. Proportions (%) were calculated with the number of nonmissing values in the denominator. Proportions may not add up to 100% because of rounding. *P* values were calculated using Fisher exact test.
CCU, coronary care unit; *ICU*, intensive care unit; *IV*, intravenous; *NC*, needleless connector.

There were statistically significant associations between NC colonization and both the insertion department and patient dependency variables (Table 2). Seven PIVCs were inserted in the emergency department, with all 7 NCs (100%) having microorganisms present at day 3 of incubation, compared to 50%-63% in other areas ($P = .04$). Dependent patients (requiring assistance with mobilization and hygiene) were more likely to culture microorganisms than independent patients (77% vs 37%, $P = .009$). Although not statistically significant, insertion site was also of interest, with 5 of 7 (71%) NCs attached to cannulas inserted in the hand culturing microorganisms.

DISCUSSION

Using standard culture-based environmental sampling techniques, half of the NCs on PIVCs were contaminated with

microorganisms. A large U.S. study identified that 35% of bloodstream infections were attributed to PIVCs,[12] with inconsistent or neglected NC decontamination a likely reason for these infections; however, there is a dearth of clinical studies reporting microorganism load on NCs before or after decontamination. Our results reinforce the need for effective decontamination of injection surfaces prior to NC access, and we suggest replication in other hospitals may provide compelling feedback data to bedside staff to motivate consistent best practice. Our results bring more urgency to the unresolved question of the most effective method of NC decontamination, with various solutions, durations, and techniques recommended in multiple guidelines.[1,2,6]

Our finding that emergency department PIVC insertion was statistically associated with colonized NCs implies contamination may occur at the time of insertion, in addition to ineffective decontamination subsequently on the ward. Dependent patients also appear to be at higher risk of NC contamination, and hand-inserted PIVCs may harbor more risk. Future quality improvement and research is needed to further investigate these associations.

CONCLUSIONS

NCs in the clinical environment are frequently contaminated, which reaffirms the importance of effective decontamination prior to access. Further research is required to definitively determine the shortest time and optimal solution for decontamination.

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