Specific Care Question

In pediatric oncology patients, does routine chlorhexidine (CHX) mouthwash versus no CHX, decrease central line-associated bloodstream infection (CLABSI) rates?

Recommendations Based on Current Literature (Best Evidence) Only

No recommendation can be made for or against routine CHX mouthwash versus no CHX mouthwash to decrease CLABSI rates in pediatric oncology patients based on expert review of current literature by the Department of EBP. However, this review does include oral care measures employed by other hospitals to decrease CLABSI rates. The certainty of the evidence is very low. One randomized control trial in adult ventilator patients showed CHX oral care was no different to standard oral care in the prevention of blood stream infections. The four quality improvement projects, included in this review, resulted in decreased rates of CLABSI per line days after implementing oral care bundles and employing comprehensive implementation strategies. We are not certain which element was responsible for the change or if the sum of all bundle parts produced the change. When there is a lack of scientific evidence, standard work should be developed, implemented, and monitored.

Literature Summary

Background. Central line-associated infections are a major source of Inpatient hospital patient morbidity and mortality (Center for Disease Control and Prevention, 2011). The estimated cost of a CLABSI in pediatric oncology patients is $70,000 (Wilson, Rafferty, Deeter, Comito, & Hollenbeak, 2014). It is believed that immunosuppression and impaired integrity of mucous membranes, increase risk for translocation of organisms from the oral mucosa into the bloodstream (Linder, Gerdy, Abouzelof, & Wilson, 2017). Children with cancer are at higher risk for oral mucositis due to the high doses of immunosuppressive medications (Linder et al., 2017).

Pediatric dentists recommend twice-daily toothbrushing for all immunocompromised patients unless they are actively bleeding from gums or mouth ulcerations with a soft-bristled toothbrush and fluoride toothpaste (American Academy of Pediatric Dentistry [AAPD], 2018). A systematic review of basic oral care for pediatric cancer patients determined that both sodium bicarbonate and saline were considered to be harmless, bland, effective for oral hygiene, and favorable for patient comfort (McGuire et al., 2013). Furthermore, chlorhexidine, a commonly used product, was not recommended for adult patients with head and neck tumors receiving radiation as it did not prevent moral mucositis (McGuire et al., 2013).

Study characteristics. The search for suitable studies was completed on November 12, 2019. J. Thompson, MD reviewed the 49 titles and/or abstracts found in the search and identified[a], eight single studies believed to answer the question. J. Thompson, MD reviewed the articles in December 2019 and March 2020 due to assure appropriate literature was selected. After an in-depth review of the remaining articles[b], five answered the question. The selected studies included one randomized control trial and two quality improvement project that used CHX mouthwash as one of its interventions (Best et al., 2016; Sarmiento, Beltran, & Borromeo, 2014; Wittekamp et al., 2018) and two quality improvement projects that focused on general oral care without CHX mouthwash (Kemp, Hallbourg, Altounji, & Secola, 2019; Linder et al., 2017) (see Figure 1).

Summary of Evidence Outcome

CLABSI rate with chlorhexidine mouth care. Three studies (Best et al., 2016; Sarmiento et al., 2014; Wittekamp et al., 2018) measured blood stream infections following interventions that included CHX oral care. A randomized control trial by Wittekamp et al. (2018) (*n* = 8,665) compared CHX oral care versus three other treatments of standard care oral care, antimicrobial mouth paste, and oropharyngeal application of a paste containing colistin. Absolute risk reductions for blood stream infection was 0.3%, 95% CI [−0.6, 1.1], 0.6%, 95% CI [−0.2, 1.4], and 0.8%, 95% CI [0.1, 1.6] for CHX, antimicrobial mouth paste, and colistin, respectively, compared with baseline standard oral care. CHX was not significantly different to the comparators. Sarmiento et al. (2014) conducted a quality improvement project (total number of participants was not disclosed) with interventions that included (a) daily 2% CHX baths, (b) CHX oral care performed every 12 hours, and (c) emphasis on proper hand hygiene and the use of a maximum barrier kit. CLABSI rate decreased from 4.8% per 1000 central catheter days, to 0 per 1000 central catheter days. It cannot be determined if CHX was responsible for the change or if it was the effect of all bundle parts. Best et al. (2016) implemented care bundles for pediatric bone marrow transplant patients (total number of participants was not disclosed) that included daily bathing, twice-daily oral care, and out-of-bed activity. The oral care consisted of: (a) brushing teeth and (b) nystatin mouth rinse, and/ or CHX mouth rinse 3 times daily (Best et al., 2016). CLABSI rates decreased from 2.01 per 1000-line days to 0.6 per 1000-line days. It cannot be determined if CHX was responsible for the change or if it was the sum of the bundle parts.

Certainty of the evidence. The certainty of the body of evidence was very low based on four factors: *within-study risk of bias*, *consistency among studies, directness of evidence*, and *precision of effect estimates*. The body of evidence was assessed to have very serious risk of bias, serious inconsistency, very serious indirectness and not serious imprecision, . Risk of bias was very serious due to two of the studies were a quality improvement project. Inconsistency was serious due to the studies using different interventions. Indirectness was serious as two of the studies (Sarmiento et al., 2014; Wittekamp et al., 2018) tested only adult ventilator patients.

CLABSI rate with general oral care. Two quality improvement studies (Kemp et al., 2019; Linder et al., 2017) measured CLABSI rates per line days. A meta-analysis was not completed due to total number of participants was not provided. Kemp et al. (2019) implemented an oral care bundle as well as a hygiene bundle. The oral care bundle included (a) soft-bristled toothbrush, (b) fluoride toothpaste, (c) twice-daily brushing with sodium bicarbonate rinses, (d) lip balm, and (e) oral moisturizer. Over a four-year timeframe, confirmed bloodstream infection rates decreased from 1.05 to 0.54 per 1,000-line days. The results were not statistically significant. Linder et al. (2017) implemented care bundles that included daily bathing, twice-daily oral care, and out-of-bed activity. The oral care included (a) brushing twice daily with soft bristle toothbrush for children with teeth, (b) gauze or sponges for infants without teeth, (c) daily flossing, (d) rinse mouth with saline or water after brushing, (e) lip balm or water-soluble gel, and (f) hydration. Over a five-year timeframe, CLABSI rates per 1000-line days significantly decreased from a pre-bundle 4.84, 95% CI [4.08, 4.93] to a post-bundle of 2.16, 95% CI [1.48, 2.84], *p*-value = 0.01.

Certainty of the evidence for oral care CLABSI rates. The certainty of the body of evidence was very low based on four factors: *within-study risk of bias, consistency among studies, directness of evidence,* and *precision of effect estimates*. The body of evidence was assessed to have very serious risk of bias, very serious indirectness, very serious inconsistency, and serious imprecision. Risk of bias was very serious due to the reported literature were quality improvement projects. Inconsistency was very serious as both studies implemented different oral hygiene care. Indirectness was serious due to both articles included other general hygiene activities in the bundle. The other activities could have influenced the effect size of the results. Imprecision was serious due to the low number of events.

Identification of Studies
Search Strategy and Results (see Figure 1)
Pubmed
Search: ("bloodstream infection"[All Fields] CLABSI[All Fields] OR "Catheter-Related Infections"[Mesh] OR "Bacteremia"[Mesh]) AND (("Chlorhexidine"[Mesh] OR chlorhexidine[tiab]) AND ("mouth rinse"[All Fields] OR "Oral Hygiene"[Mesh] OR "oral care"[All Fields] OR mouthwash[tiab]))

CINAHL

#	Query	Results
S5	S1 AND S4	28
S4	S2 AND S3	337
S3	(MH "Chlorhexidine") OR "Chlorhexidine"	1,697
S2	(MH "Mouth+") OR (MH "Mouth Mucosa") OR "mouthwash" OR "mouth rinse" OR (MH "Mouth Care+") OR (MH "Oral Hygiene+") OR "oral care" OR (MH "Mouthwashes+")	9,268
S1	"bloodstream infection" OR (MH "Catheter-Related Bloodstream Infections") OR (MH "Bacteremia") OR "alpha-hemolytic strep*" OR "CLABSI" OR (MH "Viridans Streptococci+")	

Records identified through database searching *n* = 49
Additional records identified through other sources *n* = 2

Studies Included in this Review

Citation	Study Type
Best et al. (2016)	Quality Improvement
Kemp et al. (2019)	Quality Improvement
Linder et al. (2017)	Quality Improvement
Sarminto et al. (2014)	Quality Improvement
Wittekamp et al. (2018)	RCT

Studies Not Included in this Review with Exclusion Rationale

Citation	Reason for exclusion
da Fonseca (1998)	Narrative review
Lecomte, Begot, Barraud, Matt, and François (2017)	Case study
Holcomb (2014)	Oral care not described

Methods Used for Appraisal and Synthesis

[a]Rayyan is a web-based software used for the initial screening of titles and / or abstracts for this analysis (Ouzzani, Hammady, Fedorowicz & Elmagarmid, 2017).

[b]Review Manager (Higgins & Green, 2011) is a Cochrane Collaborative computer program used to assess the study characteristics as well as the risk of bias and create the forest plots found in this analysis.

[c]The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram depicts the process in which literature is searched, screened, and eligibility criteria is applied (Moher, Liberati, Tetzlaff, & Altman, 2009).

[a]Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan-a web and mobile app for systematic reviews. *Systematic Reviews, 5*(1), 210. doi:10.1186/s13643-016-0384-4

[b]Higgins, J. P. T., & Green, S. e. (2011). *Cochrane Handbook for Systematic Reviews of Interventions [updated March 2011]* (Version 5.1.0 ed.): The Cochrane Collaboration, 2011.

[c]Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *Preferred Reporting Items for Systematic Reviews and Meta-Analyses*: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097 **For more information, visit www.prisma-statement.org.**

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Acronyms Used in this Document

Acronym	Explanation
AAPD	American Academy of Pediatric Dentistry
EBP	Evidence Based Practice
CAT	Critically Appraised Topic

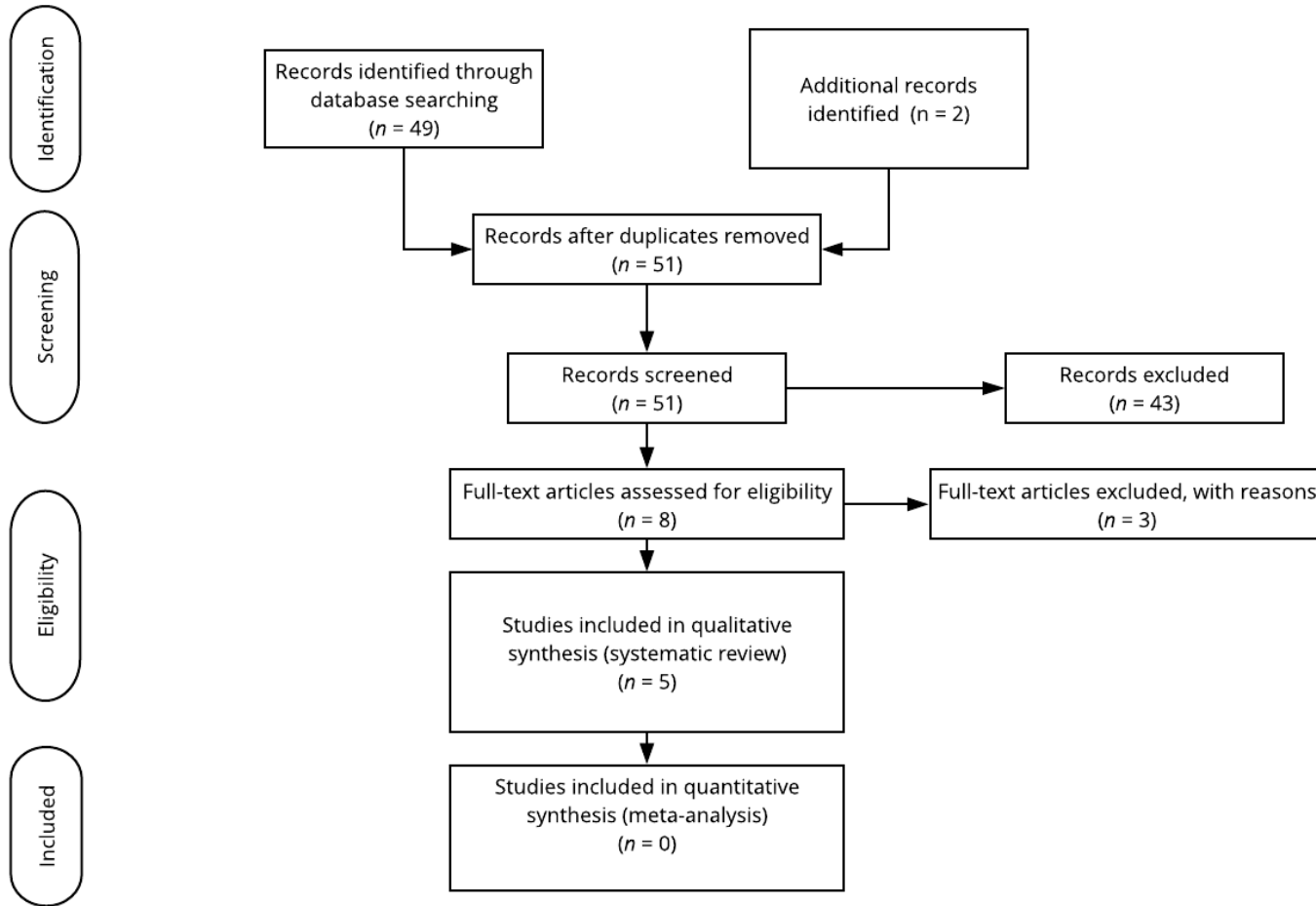| CDC | Center for Disease Control and Prevention |
| CLABSI | Central line-associated bloodstream infection |
| PRISMA | Preferred Reporting Items for Systematic Reviews and Meta-Analyses |

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRIMSA)[c]

Characteristics of Intervention Studies

Best et al., 2016

Characteristics of Study	
Methods	Quality Improvement
Participants	**Participants**: Pediatric Bone Marrow Transplant Patients **Setting:** Cancer Center at Pediatric Hospital in Cincinnati April 2014 through May 2015. **Number enrolled into study:** • Not reported **Gender, males: (as defined by researchers)** • Not reported **Race / ethnicity or nationality (as defined by researchers):** • Not reported **Age, years, standard deviation** • Not reported **Inclusion criteria:** • Not reported **Exclusion criteria:** • Not reported

Interventions	Activities of Daily Living (ADL) Bundle was implemented and included:
	• Once daily chlorhexidine (CHX) bath with impregnated cloths and daily linen change
	• Activity at least 2 times per day
	• Oral care at least 3 times per day
	    o Oral care consisted of brushing teeth,
	    o Nystatin mouth rinse, and/ or CHX mouth rinse 3 times daily.
	Interventions:
	• Improved documentation
	• Automated reminders of ADLs
	• Personal responsible for baths and linin change
	• Family center rounds included oral care compliance and activity specific interventions.

Outcomes	**Primary outcome(s):** • To create and implement a standardized process for ADL compliance.
Notes	**Results:** • Baseline data showed a CLABSI rate of 2.01 CLABSIs/1000-line days. After initiation there was a decrease in the CLABSI rate to 0.6 CLABSIs/1000-line days. • Median compliance with the all-or-none ADL 1-2-3 initiative increased from 25% to 66% in 90 days. With a sustained median compliance of 75% sixteen months after implementation. **Limitations:** • Quality improvement study.

![Children's Mercy Kansas City logo]

Office of Evidence Based Practice (EBP) – Critically Appraised Topic (CAT):
Mouthwash for The Prevention of CLABSI in Oncology Patients

Kemp et al., 2019

Characteristics of Study	
Methods	Quality Improvement Study

Participants	**Participants:** Pediatric Oncology Patients
	Setting: Inpatient Pediatric Oncology Unit
	Number enrolled into study: *N* = Not reported
	Gender, males: (as defined by researchers)
	   • Not reported
	Race / ethnicity or nationality (as defined by researchers):
	   • Not reported
	Age, mean/median in months/years, range/IQR (if not reported, delete this parenthetical note)
	   • Not reported
	Inclusion criteria:
	   • NA
	Exclusion criteria:
	   • NA

Interventions	All patients received:
	Bundle:
	   • The hospital's purchased oral care bundles packets:
	      o Clear plastic zipper pouch
	      o Pediatric-sized soft-bristled toothbrush
	      o Fluoride toothpaste
	      o Sodium bicarbonate–treated oral swab
	      o Petroleum-free lip balm
	      o Applicator cotton swabs
	      o Small packets of a water-based oral moisturizing
	Bundle Instructions:
	   • Oral care bundle was given to each patient upon admission to brush teeth and rinse twice a day
	   • Lip balm and oral moisturizer could be used as needed
	   • Additional swabs and moisturizer would be given to the patients each day during their stay, and the toothbrushes would be replaced as needed for patients with extended length of stay
	Education
	   • Education on the oral care and hygiene bundle was provided to all direct care staff.
	   • The education methods included:
	      o Review at daily shift huddles
	      o Visual educational materials posted on unit education boards
	      o E-mail reinforcements
	   • Automatic prompts in the electronic medical record to remind direct care staff to document oral care and hygiene bundle tasks
	   • Families were educated that toothbrushing is safe and recommended for patients regardless of their platelet count
	   • Laminated posters were created and placed in each patient room to visually remind staff, patients, and families of the oral care and hygiene bundle elements

	Hygiene Bundle • Recommended daily bath or shower • Daily linen changes
Outcomes	**Primary outcome(s):** • Reduce CLABSI rates per 1000 line days • Reduce mucosal barrier injury rate per 1000 line days
Notes	**Results:** • Oral and hygiene bundle was implemented in January 2015 • CLABSI rate compared over similar time periods, the rates of the first 6 months of 2014 were compared to the first 6 months of 2018. • Laboratory-confirmed bloodstream infection rates decreased from 1.05 to 0.54 per 1,000 line days • Mucosal barrier injury rates decreased from 2.98 to 1.27 per 1,000 line days. • While reporting minimal statistical significance, the study did report clinical significance reduction. Only one unit was found to have a decrease that was statistically significant, $p < .05$ Notes: • Patient/family resistance was a barrier to achieving compliance. • To address these barriers, patient/family education materials were modified to enhance understanding of the importance of hygiene.

Linder et al. 2017

Characteristics of Study	
Methods	Quality Improvement Study
Participants	**Participants:** Pediatric Oncology Patients **Setting: Inpatient** Pediatric Oncology Unit **Number enrolled into study:** *N* = Not reported **Gender, males: (as defined by researchers)** • Not reported **Race / ethnicity or nationality (as defined by researchers):** • Not reported **Age** • Not reported **Inclusion criteria:** • NA **Exclusion criteria:** NA
Interventions	• Bundles were started in 2011-2012 and the protocol was initiated in 2013 • Bundles initiated in 2011-2012 • 1-2-3 Protocol initiated in 2013 o Daily bathing, twice daily oral care, out-of-bed three times daily Oral Care Protocol • Brush teeth at least twice daily using a soft toothbrush and fluoride toothpaste • Use moistened sponges or gauze for babies • Daily flossing, discontinue if flossing results in pain or bleeding • Rinse mouth with saline or water after brushing and flossing • Lip balm or water-soluble gel to keep lips moist • Ensure adequate hydration. For patients with mucositis, continue the above along with the following: • Substitute moistened sponges for tooth brushing if pain or bleeding occurs • Administer analgesics as needed to promote comfort with oral care and relieve pain associated with mucositis Supportive Care Protocol • Daily bath or shower with a mild, nondrying soap • Daily linen change • Initiate barrier creams on admission for diapered patients receiving chemotherapy • Promote regular bowel movements • Out of bed activity at least 3 times daily Staff Implementation • Unit-based bulletin boards and education via the monthly staff newsletter • Education emphasized the scientific rationale driving the interventions • Staff were coached on strategies to foster more active patient/family engagement • Audits addressing adherence to best practice bundles also incorporated discussion of the 1-2-3 supportive cares to support staff engagement and address barriers to implementation

	Family Implementation • Unit-based bulletin boards in public areas • Dry erase communication boards placed in patient rooms to with check boxes to serve as a visual reminder of daily expectations • Teaching the 1-2-3 supportive cares as part of routine education for families whose children are newly diagnosed with cancer • Unit-based rounds involving clinical leadership also serve to reinforce this teaching as well as the rationale for the 1-2-3 care
Outcomes	Primary Outcome • Reduce CLABSI rate
Notes	Results: • Significant differences were present between the preintervention baseline and implementation of the supportive care protocols, p = 0.01.

All CLABSIs	2006-2010 Preintervention	2011-2012 Bundles Initiated	2013-2015 Bundles + 1-2-3s
Total CLABSI Events	156	44	39
Overall CLABSI rate/1000-line days (95% CI)	4.84 (4.08, 4.93)	3.29 (2.23, 4.26)	2.16 (1.48, 2.84)

Notes
- Limitation of this project is that it was conducted at a single institution in the context of a quality improvement project rather than a controlled experiment
- Multiple factors contribute to CLABSIs, and the analyses did not attempt to control for these factors. For example, in July 2013, the hospital implemented the use of alcohol-impregnated caps for all patients with central lines

Sarmiento et al., 2014

Methods	Quality Improvement
Participants	**Participants**: Adult ICU Patients **Setting:** University Hospital in Maryland 2011 **Number enrolled into study:** • Not reported **Gender, males: (as defined by researchers)** • Not reported **Race / ethnicity or nationality (as defined by researchers):** • Not reported **Age, years, standard deviation** • Not reported **Inclusion criteria:** • Not reported **Exclusion criteria:** • Not reported
Interventions	• Mandatory education tools were distributed, including a safety video. • A unit-based guideline to prevent CLABSIs was developed. • Daily 2% CHX baths on all ICU patients. • CHX oral care was performed every 12 hours on all ventilator as well as unconscious nonventilator patients with poor oral hygiene. • The central catheter insertion checklist was revised with emphasis on proper hand hygiene and the use of a maximum barrier kit. • Swab caps were used to disinfect central catheter ports before each use and all unused ports were covered with swab caps. • Central catheter daily maintenance care bundle was implemented.
Outcomes	**Primary outcome(s):** • To eradicate Hospital acquired infections-CLABSIs in the ICU and expand this project throughout the hospital.
Notes	**Results:** • CLABSI rate decreased from 4.8% per 1000 central catheter days, to 0 per 1000 central catheter days. • CLABSI rate was 0 for more than 2 years.

Wittekamp et al., 2018

Characteristics of Study	
Methods	Randomized Control Trial (cluster randomization and crossover)
Participants	**Participants:** Adult ICU patients with anticipated mechanical ventilation of more than 24 hours **Setting:** 13 European ICUs December 2013 to May 2017 **Randomized into study:** *N* = 8665 (13 ICU clusters randomized) • **Group 1, Standard care:** *n* = 2251 • **Group 2, Chlorhexidine (CHX) mouthwash:** *n = 2108* • **Group 3, Selective oropharyngeal decontamination (SOD):** *n = 2224* • **Group 4, Selective digestive tract decontamination (SDD):** *n = 2082* **Completed Study:** *N = 8665* • **Group 1:** *n = 2251* • **Group 2:** *n = 2108* • **Group 3:** *n = 2224* • **Group 4:** *n = 2082* **Gender, males (as defined by researchers):** • **Group 1:** *n* = 1420 (63.1%) • **Group 2:** *n* = 1358 (64.4%) • **Group 3:** *n = 1439* (64.7%) • **Group 4:** *n = 1344* (64.6%) **Race / ethnicity or nationality (as defined by researchers):** • The study occurred in Belgium, Spain, Portugal, Italy, Slovenia, and the United Kingdom. The authors did not identify race or ethnicity of the participants **Age, mean years, (standard deviation)** • **Group 1:** 62.0 (±15.6) • **Group 2:** 61.4 (±15.7) • **Group 3:** 61.6 (±15.7) • **Group 4:** 62.8 (±15.5) **Inclusion Criteria:** • Only ICUs with an extended-spectrum β-lactamase prevalence of at least 5% among Enterobacteriacea-causing blood stream infections were eligible. • Patients with an expected duration of invasive mechanical ventilation of at least 24 hours were eligible **Exclusion Criteria:** • Age younger than 18 years • Pregnancy • Allergy to any study intervention component **Power Analysis:** • To demonstrate a 10% relative difference in 28-day mortality for each intervention compared with baseline, 10,800 patients were required (using a baseline 28-day mortality of 27.5%; α = .05; 80% power). An error in the calculation of variance between study groups was discovered after study completion, which led to lower patient numbers than required for the power of 80%

Interventions	**All Groups:** Each participating ICU started with the baseline period of 6 months in which standard care was implemented. Standard care consists of daily chlorhexidine body wash and oropharyngeal care. Each intervention lasted 6 months with one month washouts. • **Group 1:** Oral washing with sterile water (3-4 times daily) and toothbrush twice daily. • **Group 2:** Standard care and oropharyngeal application of 10 ml chlorhexidine in a 2% concentration every 6 hours. Chlorhexidine will be applied daily until extubation. • **Group 3:** Standard care and the application of an antimicrobial mouth paste every 6 hours. Topical antibiotics applied 4 times daily until extubation. • **Group 4:** Standard care and oropharyngeal application of a paste containing colistin, tobramycin and nystatin every 6 hours until extubation. Topical antibiotics applied 4 times daily until extubation.
Outcomes	**Primary outcome(s):** • *The occurrence of ICU-acquired bloodstream infection **Secondary outcome(s)** • Twenty eight-day mortality during each intervention period compared with the baseline period *Outcomes of interest to the CMH CPG or CAT development team
Notes	Results: • ICU-acquired bloodstream infection with MDRGNB occurred among 144 patients (154 episodes) in 2.1%, 1.8%, 1.5%, and 1.2% of included patients during the baseline, CHX, SOD, and SDD periods, respectively. • Absolute risk reductions were 0.3%, 95% CI, [−0.6, 1.1], 0.6%, 95% CI [−0.2, 1.4], and 0.8%, 95% CI [0.1, 1.6] for CHX, SOD, and SDD, respectively, compared with baseline • Adjusted odds ratios for 28-day mortality were 1.07, 95% CI [0.86, 1.32], 1.05, 95% CI [0.85, 1.29], and 1.03, 95% CI [0.80, 1.32] for CHX, SOD, and SDD, respectively, vs baseline. • The study was not powered for primary outcome.

Risk of bias table		
Bias	**Scholars' judgment**	**Support for judgment**
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Low risk	ICUs cluster randomization
Blinding of participants and personnel (performance bias)	Low risk	Unblinded but unlikely to affect outcomes
Blinding of outcome assessment (detection bias)	Unclear risk	Not reported by author
Incomplete outcome data (attrition bias)	High risk	Study did not meet power due to error.
Selective reporting (reporting bias)	Low risk	All outcomes reported.
Other bias	Unclear	not reported

Office of Evidence Based Practice (EBP) – Critically Appraised Topic (CAT): Mouthwash for The Prevention of CLABSI in Oncology Patients

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