Preventing Catheter-Related Infections: Updating the Guidelines of 2002

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Outline

- Magnitude and scope of the problem
- Changing epidemiology of catheter related infections
- Highlights from 2002 Guideline
- What's new since 2002

From the Institute of Medicine: "Nosocomial Infections = Adverse Events"

• Preventable adverse events:	44 - 98,000 deaths
• Cost	$29 billion
• Nosocomial infections	5 - 15% in-patients
	25 - 50% ICU patients
• ICU Infections	Device-related

Institute of Medicine, 1999
Bates DW, 1999

Intravascular Catheters in the United States

- Purchased per year: 150 million
  - Peripheral catheters: 145 million
  - Central catheters 5 million
- Blood stream infections in hospitalized patients per year: 200,000
  - Related to catheters: 90%
  - Case fatality rate: 14%
  - Morbidity attributed to catheter related BSI: 19%
- Deaths per year due to catheter related BSI: 5000

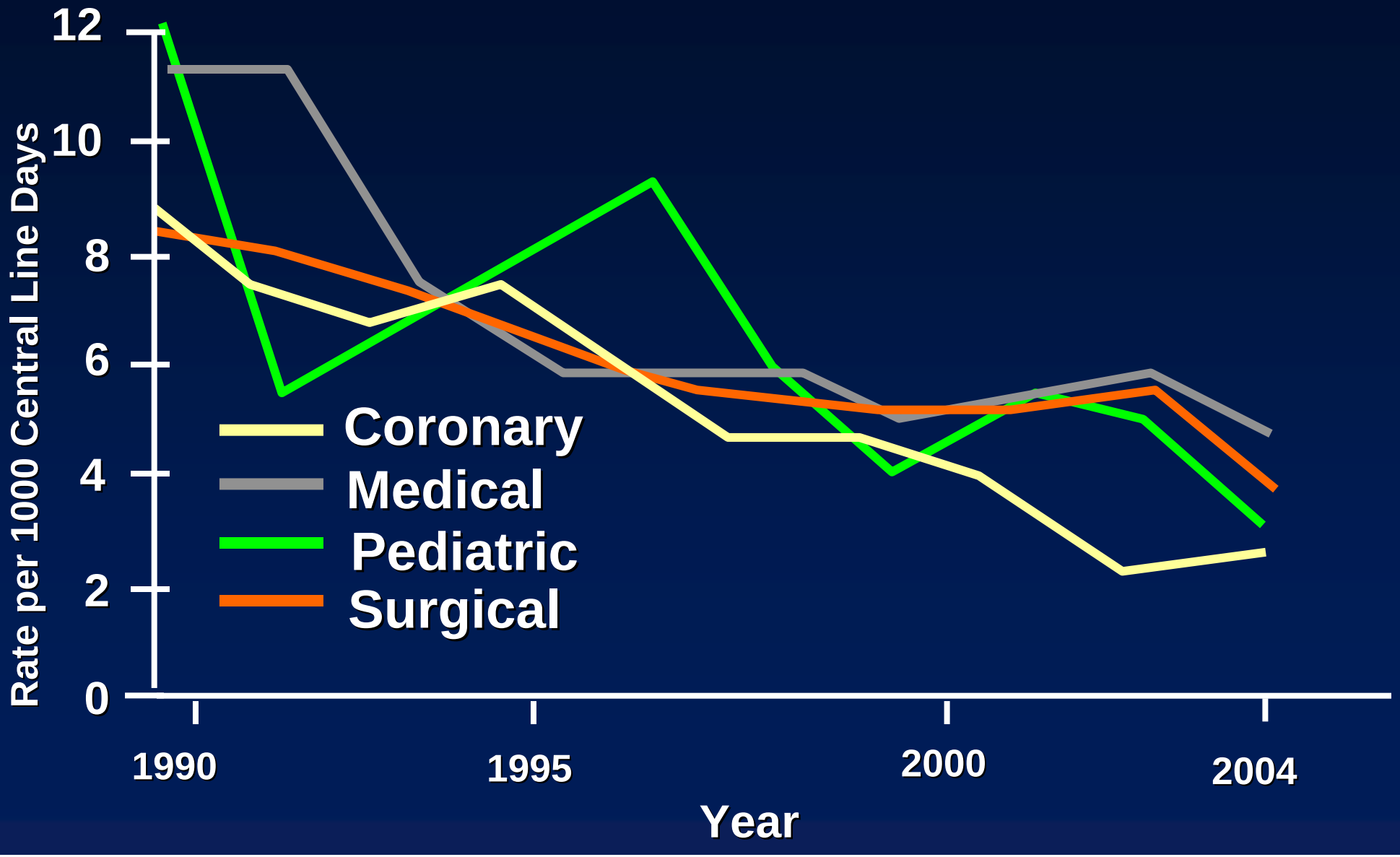
Maki and Mermel, 1998

Central Venous Catheter Related Blood Stream Infections in ICUs, United States

- Central catheter days per year — 15 million
- Blood stream infection rate — 5.3/1000 days
- Central catheter related BSI/year — 80,000
- Deaths/year — 10,000 - 20,000
- Cost/year — $0.296 - 2.3 billion

AJIC 1998; Mermel, Ann Int Med 2000

Bloodstream Infection Rates by ICU Type and Year --- NNIS, United States, 1990 -2004



Strategies to Reduce Catheter-Related Infections

Healthcare Worker Education and Training

Educate healthcare workers regarding indications, proper procedure and appropriate infection control measures to prevent catheter - related bloodstream infection.

Quality Assurance and Education

Education of Physicians-in-Training Can Decrease the Risk for Vascular Catheter Infection

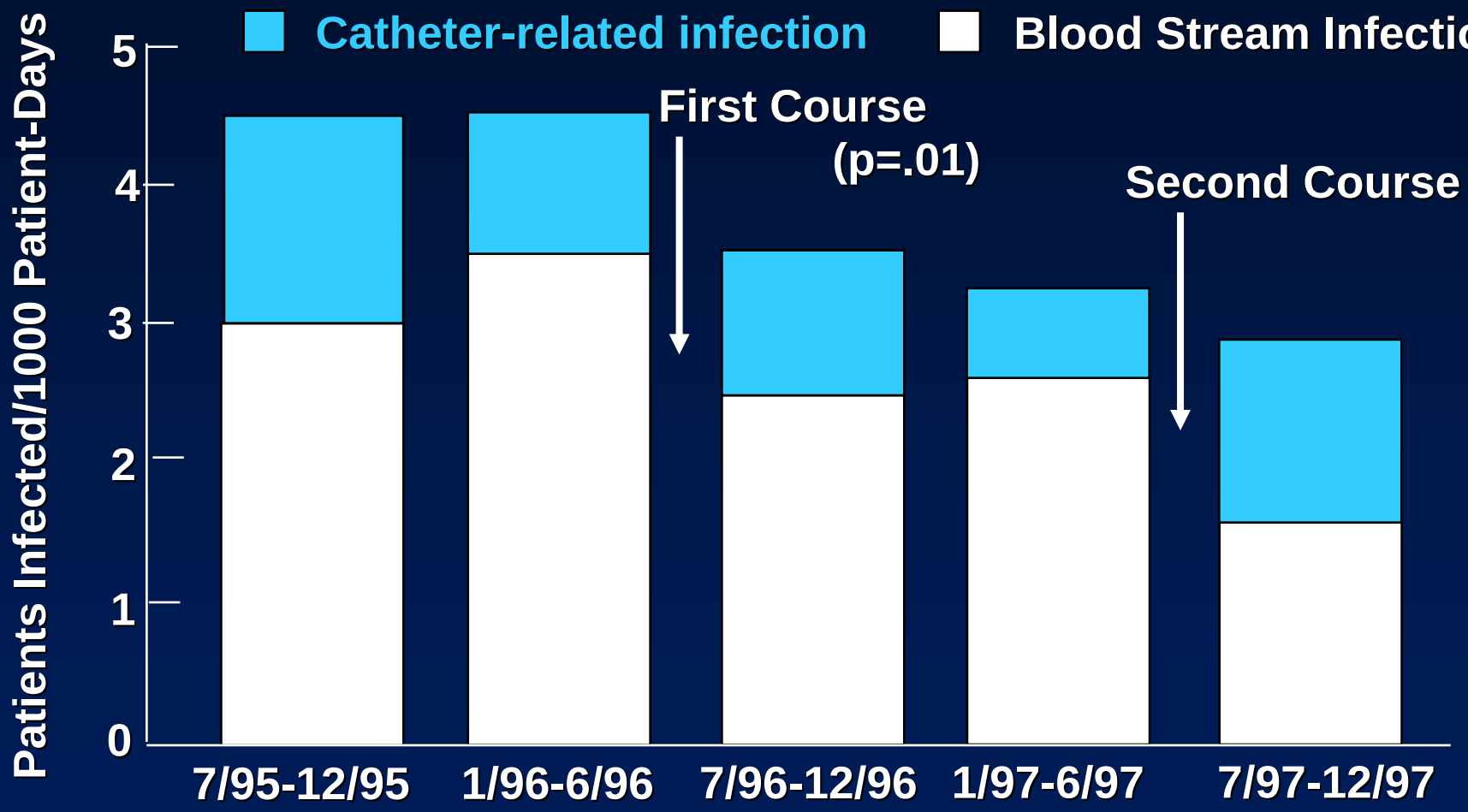
Robert J. Sherertz, MD; E. Wesley Ely, MD, MPH; Debi M. Westbrook, RN; Kate S. Gledhill, RN; Stephen A. Streed, MS; Betty Kiger, RN; Lenora Flynn, MT; Stewart Hayes, RRT; Sallie Strong, RN; Julia Cruz, MD; David L. Bowton, MD; Todd Hulgan, MD; and Edward F. Haponik, MD

Background: Procedure instruction for physicians-in-training is usually nonstandardized. The authors observed that during insertion of central venous catheters (CVCs), few physicians used full-size sterile drapes (an intervention proven to reduce the risk for CVC-related infection).

Vascular catheter infection is a substantial cause of morbidity and death in hospitalized patients. It has been estimated that 50 000 to 100 000 blood-stream infections related to vascular devices occur yearly in the United States; 90% of these infections

Sherertz et al. Ann Intern Med 2000;132:645

Effect of “Procedure Course” on Risk for BSI



Sherertz et al. Ann Intern Med 2000;132:645

Quality Assurance and Education

Impact of Formal Continuing Medical Education

Do Conferences, Workshops, Rounds, and Other Traditional Continuing Education Activities Change Physician Behavior or Health Care Outcomes?

Dave Davis, MD
Mary Ann Thomson O'Brien, MSc
Nick Freemantle, PhD
Fredric M. Wolf, PhD
Paul Mazmanian, PhD
Anne Taylor-Vaisey, MLS

Context Although physicians report spending a considerable amount of time in continuing medical education (CME) activities, studies have shown a sizable difference between real and ideal performance, suggesting a lack of effect of formal CME.

Objective To review, collate, and interpret the effect of formal CME interventions on physician performance and health care outcomes.

Data Sources Sources included searches of the complete Research and Development Resource Base in Continuing Medical Education and the Specialised Register of the Cochrane Effective Practice and Organisation of Care Group, supplemented by searches of MEDLINE from 1993 to January 1999.

Study Selection Studies were included in the analyses if they were randomized con-

TWO APPARENTLY CONFLICTING pieces of evidence exist about

Davis et al. JAMA 1999;282:870

Interactive CME Effect Change in Professional Practice and Outcomes

Source	Intervention	Effect Size (95% CI)
Boissel et al, 1995	Didactic session	0.07(-0.17 to 0.30)
Browner et al, 1994	Seminar	-0.31 (-0.71 to 0.11)
Dietrich et al, 1992	Small group didactic	0.36 (-0.36 to 0.77)
Levinson, 1993	4.5h didactic presentation	0.17 (-0.54 to 0.88)
Kottke et al, 1989	3h interactive session	0.88 (0.46 to 1.29)*
White et al, 1985	2h workshop	0.83 (0.19 to 1.45)*
Wilson et al, 1992	2h workshop	1.59 (0.60 to 2.54)*

Davis et al. JAMA 1999;282:870

Education and Implementation

ARTICLES

Impact of a prevention strategy targeted at vascular-access care on incidence of infections acquired in intensive care

Philippe Eggimann, Stephan Harbarth, Marie-Noëlle Constantin, Sylvie Touveneau, Jean-Claude Chevrolet, Didier Pittet

Summary

Background Intravascular devices are a leading cause of nosocomial infection. Specific prevention strategies and improved guidelines for the use of intravascular devices can decrease the rate of infection; however, the impact of a combination of these strategies on rates of vascular-access infection in intensive-care units (ICUs) is not known. We implemented a multiple-approach prevention programme to decrease the occurrence of vascular-access infection in an 18-bed medical ICU at a tertiary centre.

Methods 3154 critically ill patients, admitted between October, 1995, and November, 1997, were included in a

Introduction

Insertion of intravascular devices is among the main causes of nosocomial infections,[1] which exacerbate morbidity and hospital costs in intensive-care units (ICUs).[2,3] Various strategies have been used to decrease the risk of vascular-access infections, including prevention efforts targeted at the materials from which catheters are made, and catheter care.[4–7] So far, only a few studies have used a multiple-strategy approach to decrease infection rates and to explore the possible benefits of the combined measures on rates of vascular-access infections.[8,9] Hitherto, no large-scale study has assessed the impact of an overall management approach in the adult critical-care setting.

Eggimann et al. Lancet 2000; 355:1864-68

Comparison of Guidelines Used During Control and Intervention Periods

Guideline	Control period	Intervention period
Positioning of patient	Various	Nurse mandatory
Skin prep	Povidone iodine	Chlorhexidine
Barrier precaution	Sterile gloves, small fenestrated drape	Full barrier precautions
Technique	No specific training required	Didactic session bedside teaching

Eggimann et al. Lancet 2000; 355:1864-68

Incidence of Nosocomial Infections Before and After Interventions

Nosocomial Infection	Control Number/Density	Intervention Number/Density	RR	p
Respiratory	121 / 13.5	54 / 12.7	.93 (.68-1.29)	.75
Bloodstream	101 / 11.3	16 / 3.8	.33 (.20-.56)	.0001
Exit site	82 / 9.2	14 / 3.3	.03 (.20-.63)	.0001
UTI	47 / 5.3	22 / 5.2	.98 (059-1.63)	1.0

Eggimann et al. Lancet 2000; 355:1864-68

Cutaneous Antisepsis Before Catheter Insertion

Disinfect clean skin with an appropriate antiseptic. A 2% chlorhexidine-based preparation is preferred. Alternatively, tincture of iodine, an iodophor, or 70% alcohol could be used.

Efficacy of Aqueous Chlorhexidine for Cutaneous Antisepsis

Reference	Disinfectant	RR Catheter Colonization	RR BSI
Maki, 1991	Chlorhexidine (2%) Pov Iod (10%) or Alc	0.3 (0.1-0.8)	0.2 (0.0-1.9)
Sheehan, 1993	Chlorhexidine (2%) Povidone Iodine (10%)	0.3 (0.1-0.9)	---
Mimoz, 1996	Chlorhex 0.25/Benz 0.25 Povidone Iodine	0.4 (0.2-0.8)	0.9 (0.2-4.2)
Humar, 2000	Chlorhexidine (0.5%) Povidone iodine	1.2 (0.8-1.9)	---

Barrier Precautions During Catheter Insertion

Use maximal barrier precautions, including a mask, cap, sterile gown, sterile gloves and a large sterile drape for the insertion of central venous catheters and guidewire exchanges.

Reduced Risk of CR-BSI Using Full Barrier Precautions

- 297 pulmonary artery catheters studied
- 91 catheters inserted in the ICU using full barrier precautions
- 206 catheters inserted in OR without large sterile sheet or sterile gown
- Analysis of risk by logistic regression

Mermel et al. Am J Med 1991; 201-4

Risk Factors for CR-BSI

Factor	Relative Risk	95% CI	p Value
Site colonization > 100 CFU	5.5	2.9-10.5	< 0.001
IJ placement	4.3	1.1-16.9	< 0.01
Duration > 3 days	3.1	1.6-6.0	< 0.01
Placement in OR	2.1	1.1-5.2	< 0.03

Mermel et al. Am J Med 1991; 201-4

Comparability of Catheters Inserted in the ICU vs Operating Room

	ICU n = 86	Operating Room n = 211
Location of Catheters (%)		
•Internal Jugular	44	93*
•Subclavian	32	6
•Femoral	13	1
Use of catheter for TPN (%)	55*	3
Duration catheter in place (hrs)	92*	70
Infection of catheter	13 (15.1%)	52 (24.6%)

*p < 0.01

Mermel et al. Am J Med 1991; 201-4

Routine Replacement of Central Venous Catheters

Do not routinely replace central venous catheters as a method of preventing catheter related infections

Routine Replacement Strategies

Special Article

Central venous catheter replacement strategies: A systematic review of the literature

Deborah Cook, MD, FRCPC, MSc(Epid); Adrienne Randolph, MD, MSc; Phillip Kernerman, MD; Cynthia Cupido, MD; Derek King, BMath; Clara Soukup, MD; Christian Brun-Buisson, MD

Objective: To evaluate the effect of guidewire exchange and new-site replacement strategies on the frequency of catheter colonization and infection, catheter-related bacteremia, and mechanical complications in critically ill patients.

Data Sources: We searched for published and unpublished research by means of MEDLINE and Science Citation Index, manual searching of *Index Medicus*, citation review of relevant primary and review articles, review of personal files, and contact with primary investigators.

Study Selection: From a pool of 151 randomized, controlled

infection. Guidewire exchange is also associated with trends toward a higher rate of catheter exit-site infection (relative risk 1.52, 95% confidence interval 0.34 to 6.73) and catheter-related bacteremia (relative risk 1.72, 95% confidence interval 0.89 to 3.33). However, guidewire exchange is associated with fewer mechanical complications (relative risk 0.48, 95% confidence interval 0.12 to 1.91) relative to new-site replacement. Exchanging catheters over guidewires or at new sites every 3 days is not beneficial in reducing infections, compared with catheter replacement on an as-needed basis.

Cook et al. Crit Care Med 1997; 25:1417-24

Summary of Randomized Trials

Author	# Catheters	Intervention
Pettigrew et al. 1985	38	NSR vs GWX
Michel et al. 1988	54	NSR vs GWX
Snyder et al. 1988	303	NSR vs GWX q 3d
Eyer et al. 1990	294	NSR vs GWX q 7d vs prn
Kowalewska et al. 1991	31	NSR q 7d vs GWX q 3d
Cobb et al. 1992	523	NSR q3d vs GWX q3d vs prn
Senegore et al. 1987	25	NSR vs GWX
Bach et al. 1992	148	NSR vs GWX
Kealey et al. 1995	264	NSR q 2d vs GWX q 2d
Powell et al. 1988	126	GWX q 3 d vs GWX prn
Bock et al. 1990	107	NSR q 3d vs NSR prn
Uldall et al. 1981	NR	GWX q 7 d vs NSR prn

Antibiotic/Antiseptic Catheters

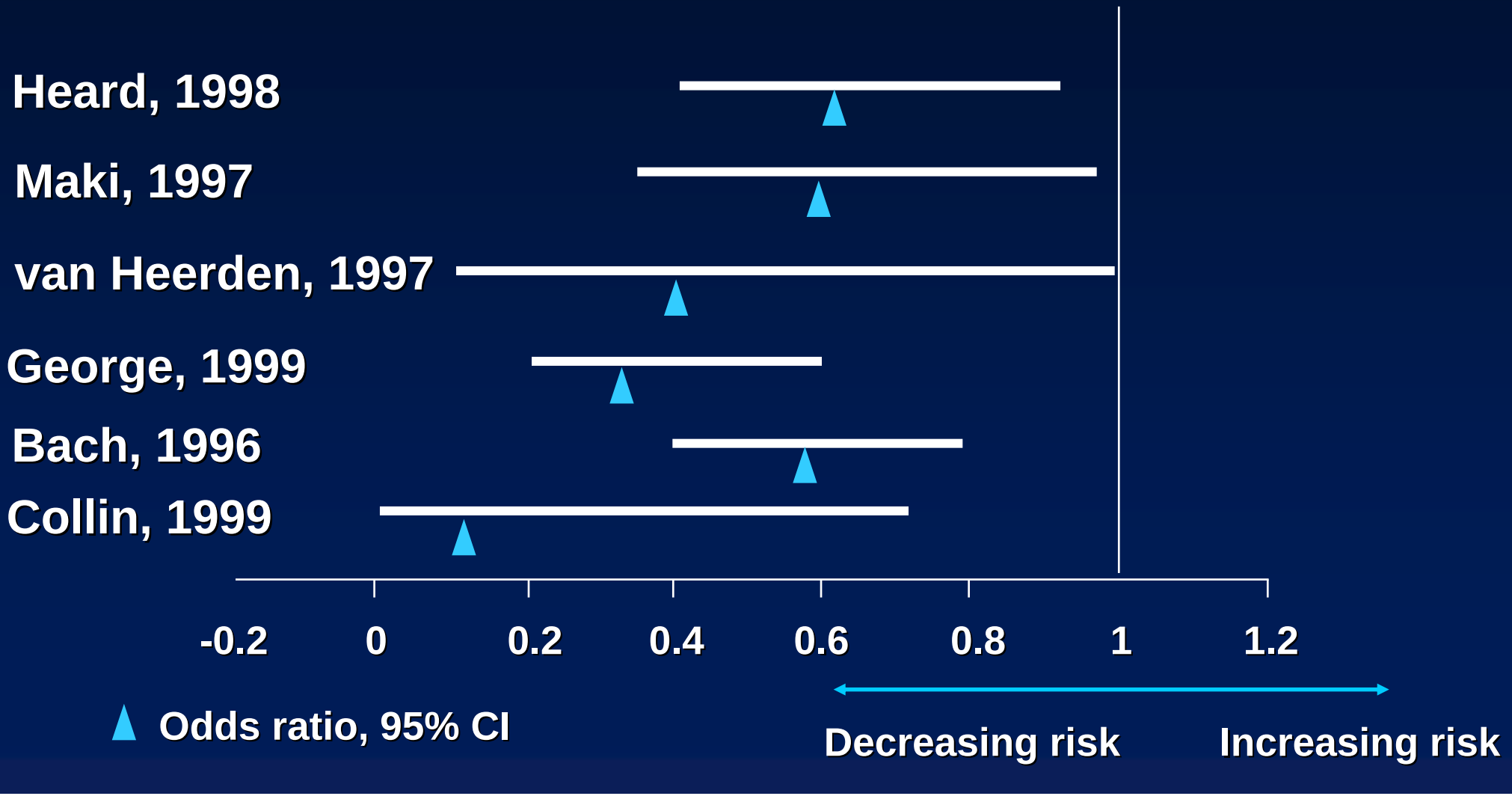
Use an antimicrobial or antiseptic-impregnated CVC in adults whose catheter is expected to remain in place >5 days if, after implementing a comprehensive strategy to reduce rates of CR-BSI, the rate has not sufficiently decreased. The comprehensive strategy should include the following 3 components: educating persons who insert and maintain catheters, use of maximal barrier precautions, and a 2% chlorhexidine preparation for skin antisepsis during central venous catheter insertion.

Efficacy of Chlorhexidine-Silver Sulfadiazine Catheters for Prevention of CR-BSI

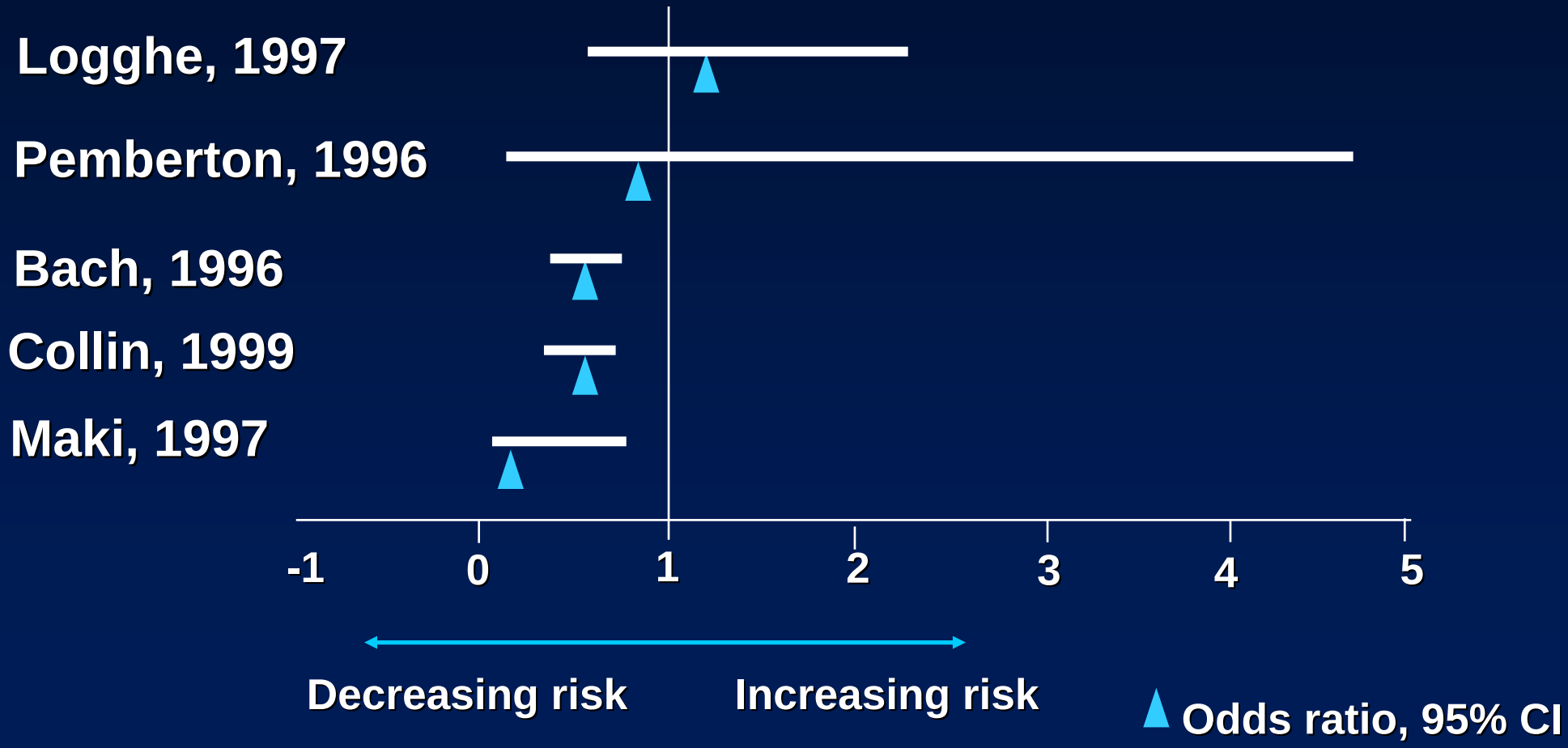
Reference	Colonization RR	Blood Stream Infection RR
Maki, 1997	0.56 (0.36-0.89)*	0.2 (0.03-0.95)*
van Heerden, 1997	0.4 (0.1-1.0)*	--
Heard, 1998	0.59 (0.34-0.97)*	--
Bach,1996	0.6 (0.4-0.9)*	0.5 (0.4-0.7)*
Collin, 1999	0.1 (0.0-0.7)*	0.5 (0.4-0.7)*
George, 1999	0.3 (0.2-0.6)*	--
Pemberton, 1996	--	0.8 (0.2-4.7)
Logghe, 1997	--	1.2 (0.6-2.3)

Mermel, Ann Intern Med 2000; 132:391-402
Eggimann and Pittet, Advances in Sepsis, 2000

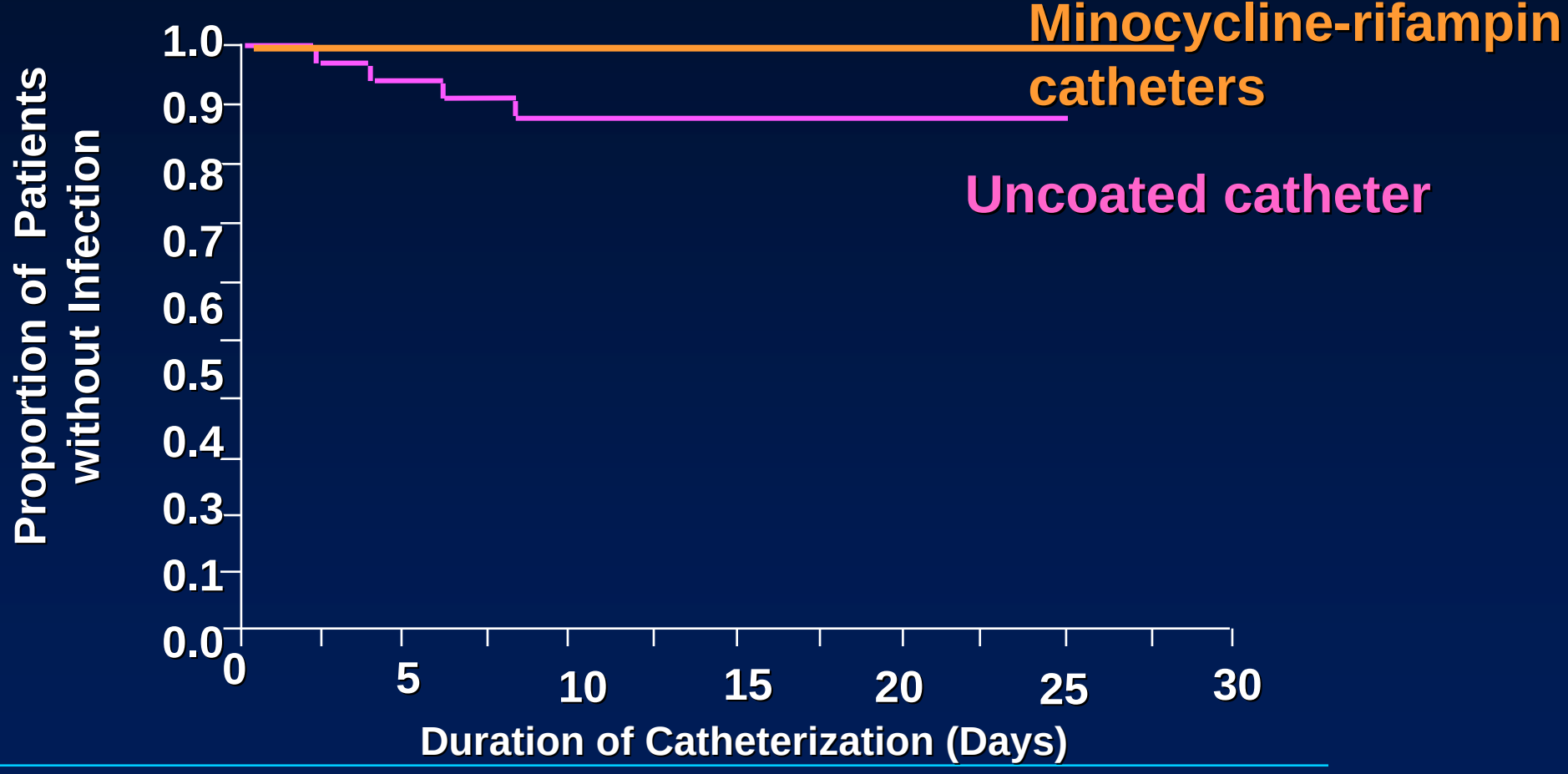
Efficacy of Chlorhexidine-Silver Sulfadiazine Catheters for Prevention of Catheter Colonization



Efficacy of Chlorhexidine-Silver Sulfadiazine Catheters for Prevention of CR-BSI



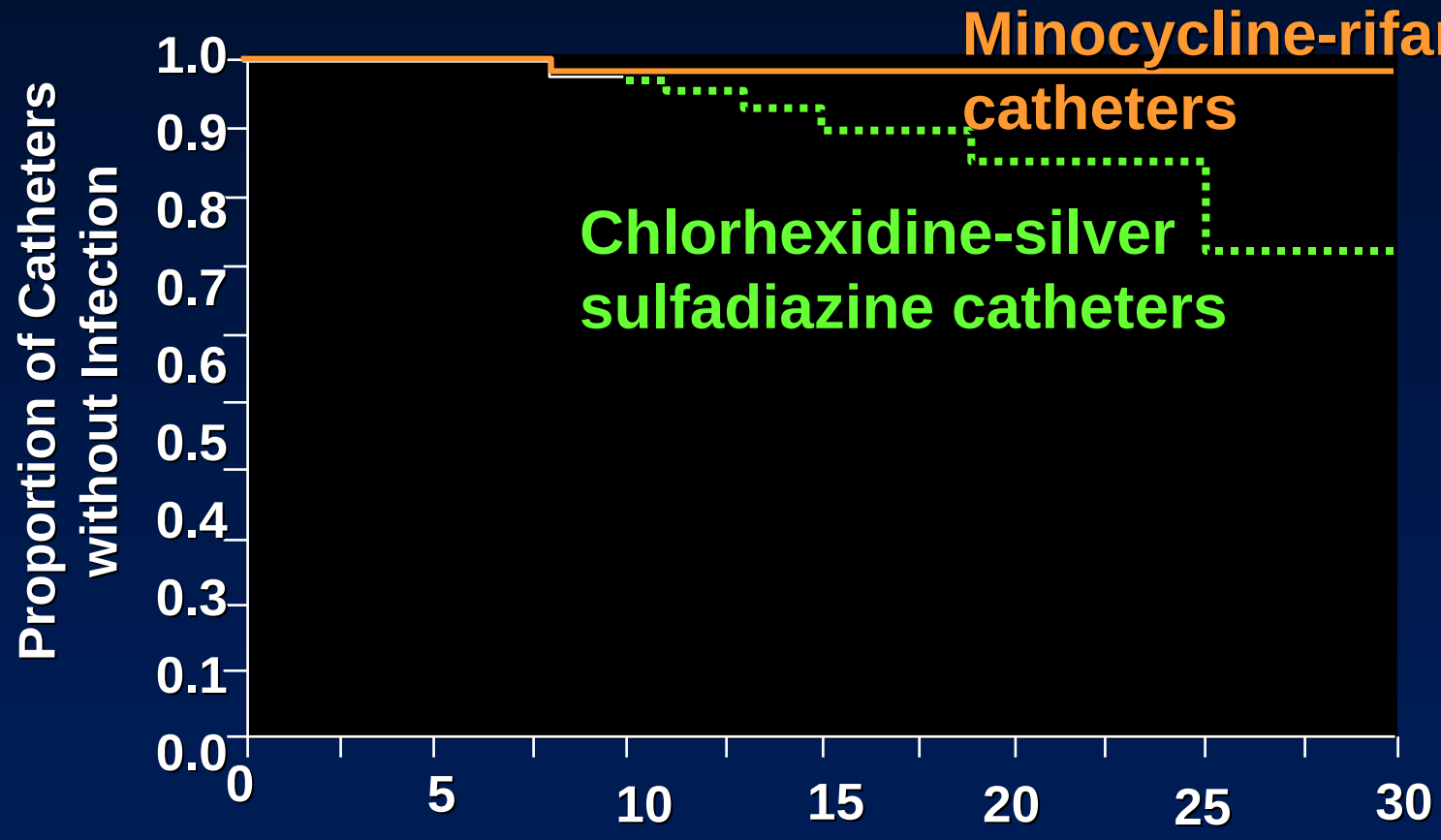
Time to Occurrence of CR-BSI with Minocyline-Rifampin Catheter



Catheters (n)	266	170	50	11	6	1	0

Raad, Annals Intern Med 1997

Risk of Bloodstream Infections Using Two Types of Impregnated Catheters



Catheter	No. at Risk	Duration of Catheterization (Days)					
M/R	365	214	93	48	20	9	4
C/SS	382	246	96	39	18	5	2

Darouiche NEJM 1999

What’s New?

Catheter Site Dressing Regimens

Use a chlorhexidine sponge dressing in adult patients with short-term catheters to reduce the incidence of infection catheter-related infection.

CARING FOR THE
CRITICALLY ILL PATIENT

Chlorhexidine-Impregnated Sponges and Less Frequent Dressing Changes for Prevention of Catheter-Related Infections in Critically Ill Adults

A Randomized Controlled Trial

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Carole Schwebel, MD, PhD
Lila Bouadma, MD
Arnaud Geffroy, MD
Maïté Garrouste-Orgeas, MD
Sebastian Pease, MD
Marie-Christine Herault, MD
Hakim Haouache, MD
Silvia Calvino-Gunther, RN
Brieuc Gestin, PhD
Laurence Armand-Lefevre, PharmD
Véronique Leflon, PharmD
Chantal Chaplain, PharmD

Context Use of a chlorhexidine gluconate–impregnated sponge (CHGIS) in intravascular catheter dressings may reduce catheter-related infections (CRIs). Changing catheter dressings every 3 days may be more frequent than necessary.

Objective To assess superiority of CHGIS dressings regarding the rate of major CRIs (clinical sepsis with or without bloodstream infection) and noninferiority (less than 3% colonization-rate increase) of 7-day vs 3-day dressing changes.

Design, Setting, and Patients Assessor-blind, 2×2 factorial, randomized controlled trial conducted from December 2006 through June 2008 and recruiting patients from 7 intensive care units in 3 university and 2 general hospitals in France. Patients were adults (>18 years) expected to require an arterial catheter, central-vein catheter, or both inserted for 48 hours or longer.

Interventions Use of CHGIS vs standard dressings (controls). Scheduled change of unsoiled adherent dressings every 3 vs every 7 days, with immediate change of any soiled or leaking dressings.

Main Outcome Measures Major CRIs for comparison of CHGIS vs control dressings; colonization rate for comparison of 3- vs 7-day dressing changes.

Timsit JF et al. JAMA 2009

Eliminating Catheter Related Infections

Annals of Internal Medicine | ARTICLE

Effect of a Second-Generation Venous Catheter Impregnated with Chlorhexidine and Silver Sulfadiazine on Central Catheter–Related Infections

A Randomized, Controlled Trial

Mark E. Rupp, MD; Steven J. Lisco, MD; Pamela A. Lipsett, MD; Trish M. Perl, MD, MSc; Kevin Keating, MD; Joseph M. Civetta, MD; Leonard A. Mermel, DO, ScM; David Lee, MD; E. Patchen Dellinger, MD; Michael Donahoe, MD; David Giles, MD; Michael A. Pfaller, MD; Dennis G. Maki, MD; and Robert Sherertz, MD

Background: Central venous catheter–related infections are a significant medical problem. Improved preventive measures are needed.

colonized at the time of removal compared with control catheters (13.3 vs. 24.1 colonized catheters per 1000 catheter-days; $P <$ 0.01). The center-stratified Cox regression hazard ratio for coloni-

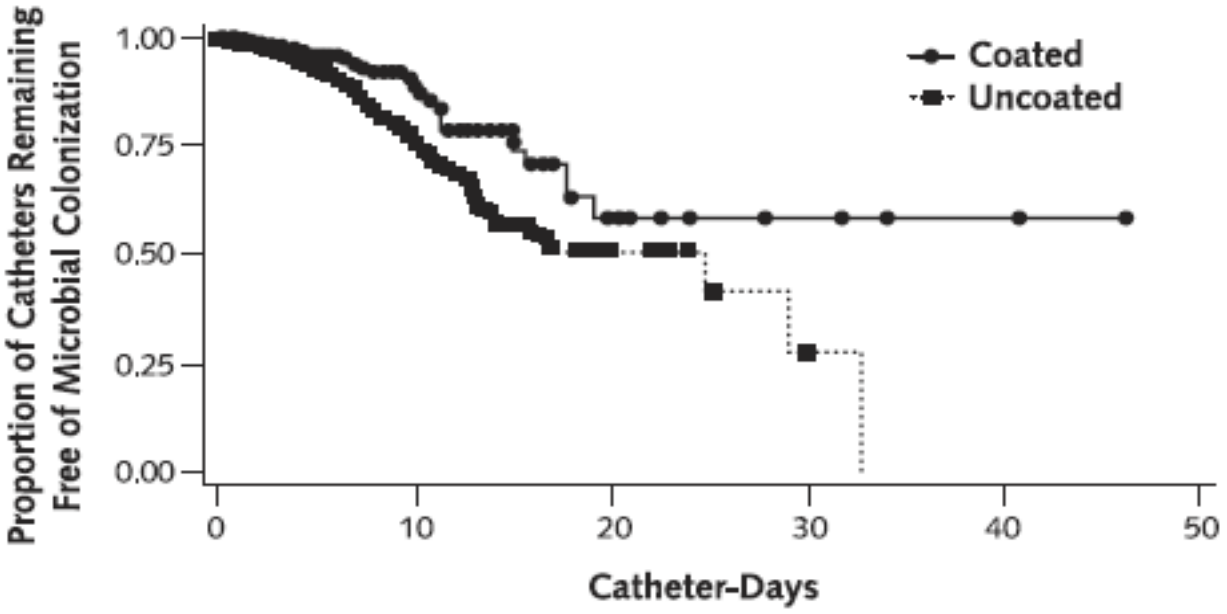
Annals of Internal Med 2005

Eliminating Catheter Related Infections

- 777 Catheters
- 393 Control catheters and 384 antiseptic catheters
- Funding source: Arrow
- Sponsor collected and analyzed the data
- Difference in BSI not significant (0.42/1000 catheter days vs 1.24/1000 catheter days)

Eliminating Catheter Related Infections

Figure 2. Kaplan–Meier curve demonstrating initial study catheters free of microbial colonization versus time.



Catheters remaining, *n*	Day 0	Day 10	Day 20	Day 30
Antiseptic CVC	345	68	13	3
Control CVC	362	68	16	1

Eliminating Catheter Related Infections

Feature Article—Continuing Medical Education

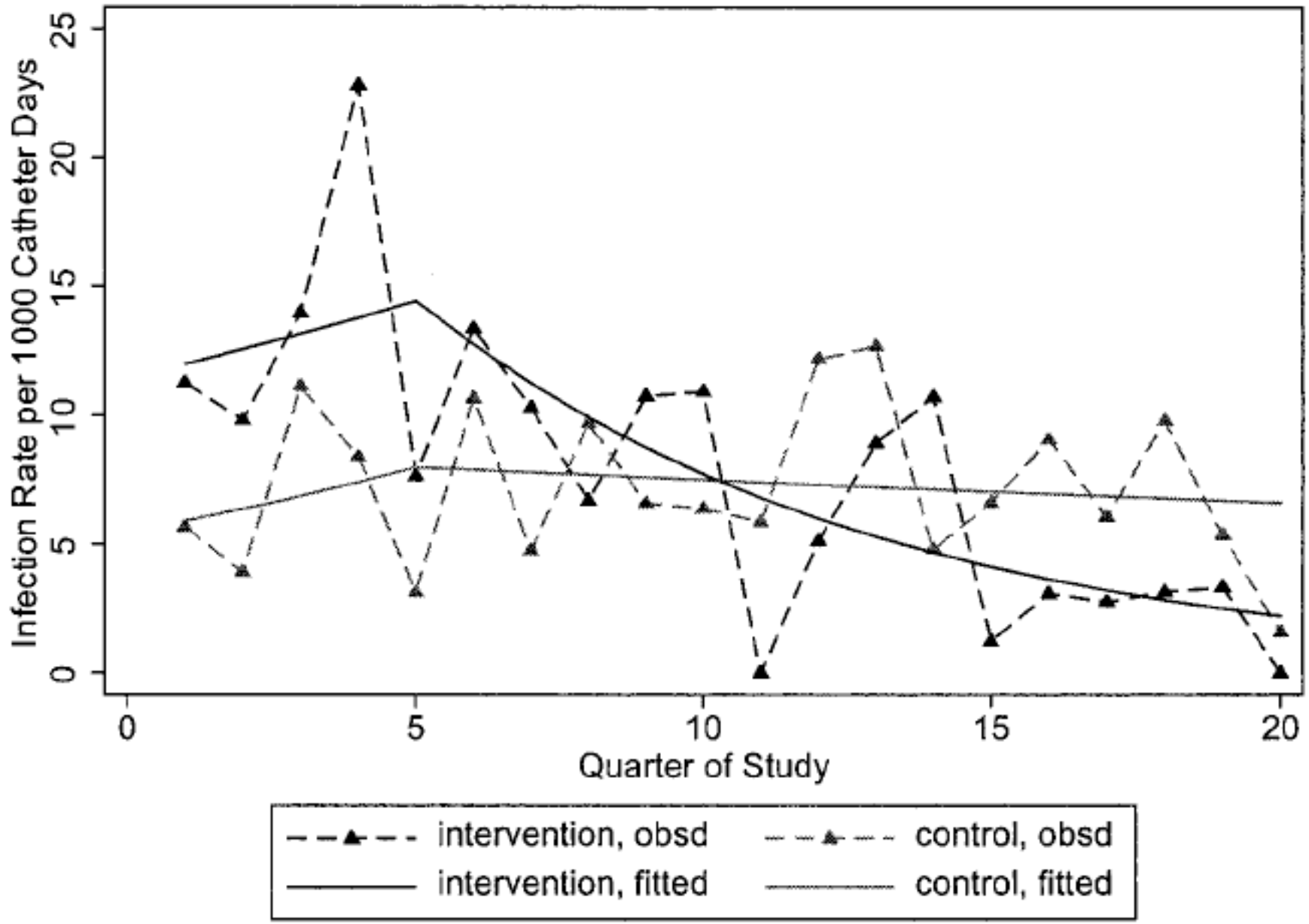
Eliminating catheter-related bloodstream infections in the intensive care unit*

Sean M. Berenholtz, MD, MHS; Peter J. Pronovost, MD, PhD; Pamela A. Lipsett, MD; Deborah Hobson, BSN; Karen Earsing, RN, MS; Jason E. Farley, MSN, MPH, CRNP; Shelley Milanovich, RN, MSN, ACNP; Elizabeth Garrett-Mayer, PhD; Bradford D. Winters, MD, PhD; Haya R. Rubin, MD, PhD; Todd Dorman, MD; Trish M. Perl, MD, MSc

Crit Care Med; October 2004

Eliminating Catheter Related Infections

- Educational intervention to increase provider awareness
- Created CVC insertion cart
- Asking providers daily if the CVC is needed
- Checklist at bedside for nurses
- Empowering nurses to stop the procedure
- Did not include tunneled of PA catheters


Infection Rate per 1000 Catheter Days
0
5
10
15
20
25
0
5
10
15
20
Quarter of Study
intervention, obsd
control, obsd
intervention, fitted
control, fitted

Eliminating Catheter Related Infections

- Implemented simple strategies
- No impregnated catheters
- Reduced infection rate from 11.3/1000 catheter days to 0/1000 catheter days during study period
- Performance sustained
- Jan-April 2003 only 2 infections (0.54/1000 catheter days)

Eliminating Catheter Related Infections

The NEW ENGLAND JOURNAL of MEDICINE

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An Intervention to Decrease Catheter-Related Bloodstream Infections in the ICU

Peter Pronovost, M.D., Ph.D., Dale Needham, M.D., Ph.D., Sean Berenholtz, M.D., David Sinopoli, M.P.H., M.B.A., Haitao Chu, M.D., Ph.D., Sara Cosgrove, M.D., Bryan Sexton, Ph.D., Robert Hyzy, M.D., Robert Welsh, M.D., Gary Roth, M.D., Joseph Bander, M.D., John Kepros, M.D., and Christine Goeschel, R.N., M.P.A.

ABSTRACT

BACKGROUND

Catheter-related bloodstream infections occurring in the intensive care unit (ICU) are common, costly, and potentially lethal.

METHODS

From the School of Medicine (P.P., D.N., S.B., S.C., B.S.), the School of Professional Studies in Business and Education (D.S.), and the Bloomberg School of Public Health (H.C.), Johns Hopkins University, Balti-

Eliminating Catheter Related Infections

- Excluded PICCS
- Implemented teaching program
- CVC carts
- Checklist for compliance with handwashing and barrier precautions

Eliminating Catheter Related Infections

The NEW ENGLAND JOURNAL of MEDICINE

Table 3. Rates of Catheter-Related Bloodstream Infection from Baseline (before Implementation of the Study Intervention) to 18 Months of Follow-up.*

Study Period	No. of ICUs	No. of Bloodstream Infections per 1000 Catheter-Days				
		Overall	Teaching Hospital	Nonteaching Hospital	<200 Beds	≥200 Beds
		median (interquartile range)				
Baseline	55	2.7 (0.6–4.8)	2.7 (1.3–4.7)	2.6 (0–4.9)	2.1 (0–3.0)	2.7 (1.3–4.8)
During implementation	96	1.6 (0–4.4)†	1.7 (0–4.5)	0 (0–3.5)	0 (0–5.8)	1.7 (0–4.3)†
After implementation						
0– 3 mo	96	0 (0–3.0)†	1.3 (0–3.1)†	0 (0–1.6)†	0 (0–2.7)	1.1 (0–3.1)†
4–6 mo	96	0 (0–2.7)†	1.1 (0–3.6)†	0 (0–0)†	0 (0–0)†	0 (0–3.2)†
7–9 mo	95	0 (0–2.1)†	0.8 (0–2.4)†	0 (0–0)†	0 (0–0)†	0 (0–2.2)†
10–12 mo	90	0 (0–1.9)†	0 (0–2.3)†	0 (0–1.5)†	0 (0–0)†	0.2 (0–2.3)†
13–15 mo	85	0 (0–1.6)†	0 (0–2.2)†	0 (0–0)†	0 (0–0)†	0 (0–2.0)†
16–18 mo	70	0 (0–2.4)†	0 (0–2.7)†	0 (0–1.2)†	0 (0–0)†	0 (0–2.6)†

* Because the ICUs implemented the study intervention at different times, the total number of ICUs contributing data for each period varies. Of the 103 participating ICUs, 48 did not contribute baseline data. P values were calculated by the two-sample Wilcoxon rank-sum test.
† P≤0.05 for the comparison with the baseline (preimplementation) period.
† P≤0.002 for the comparison with the baseline (preimplementation) period.

Summary

- Educate healthcare workers and provide training for the insertion and maintenance of catheters
- Use chlorhexidine preferentially for skin antisepsis
- Use maximal barrier precautions
- Use a chlorhexidine sponge dressing in adults with short-term catheters
- Use an antibiotic/antiseptic catheters if CRI rates remain above the institutional goal after implementing other measures.
- Use a bundled strategy for simplicity

Conclusions

- Prevention strategies have measurable impact
- Multiple interventions may be needed
- Performance improvement programs will be focused on moving toward elimination of CA-BSIs rather than “benchmark goals”

Thank you.