Coated catheters: a cost analysis

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* Consequences of CRBSI

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* What else can be done?

* What do we suggest?

Consequences of CVC-BSI

* The average cost of a CVC related BSI is $10.000 according to the meta-analysis

Hockenhull JC, et al. Health Technol Assess 2008;12:1-154.

However costs between $40.000 and $71.000 have been reported due to hospital length of stay increase of 22-24 days

Pittet D, et al. JAMA 1994, 271:1598-1601.

Dimick JB, et al. Arch Surg 2001, 136:229-234.

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

We conducted a collaborative cohort study predominantly in ICUs in Michigan. An evidence-based intervention was used to reduce the incidence of catheter-related bloodstream infections. Multilevel Poisson regression modeling was used to compare infection rates before, during, and up to 18 months after implementation of the study intervention. Rates of infection per 1000 catheter-days were measured at 3-month intervals, according to the guidelines of the National Nosocomial Infections Surveillance System.

RESULTS

A total of 108 ICUs agreed to participate in the study, and 103 reported data. The analysis included 1981 ICU-months of data and 375,757 catheter-days. The median rate of catheter-related bloodstream infection per 1000 catheter-days decreased from 2.7 infections at baseline to 0 at 3 months after implementation of the study intervention ($P \leq 0.002$), and the mean rate per 1000 catheter-days decreased from 7.7 at baseline to 1.4 at 16 to 18 months of follow-up ($P < 0.002$). The regression model showed a significant decrease in infection rates from baseline, with incidence-rate ratios continuously decreasing from 0.62 (95% confidence interval [CI], 0.47 to 0.81) at 0 to 3 months after implementation of the intervention to 0.34 (95% CI, 0.23 to 0.50) at 16 to 18 months.

CONCLUSIONS

An evidence-based intervention resulted in a large and sustained reduction (up to 66%) in rates of catheter-related bloodstream infection that was maintained throughout the 18-month study period.

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, Baltimore; and the University of Michigan, Ann Arbor (R.H.); William Beaumont Hospital, Royal Oak (R.W.); Ingham Regional Medical Center, Lansing (G.R.); Harper University Hospital, Detroit (J.B.); Sparrow Health System, Lansing (J.K.); and the Michigan Health and Hospital Association Keystone Center for Patient Safety and Quality, Lansing (C.G.) — all in Michigan.

N Engl J Med 2006;355:2725-32.

What else can be done? 2006

Which measures?

- **Impregnated dressing**
- **Impregnated CVC**

Which patients?

- **Higher risk of CRBSI**

All insertion sites, same CRBSI risk?

* Higher CRBSI in FV (n=288) > JV (n=1.390) > SV (

In FV (8.34) than JV (2.99) (OR=2.8; 95% CI=1.46-5.22; p=0.002)

In FV (8.34) than SV (0.97) (OR=2.9; 95% CI=1.90-4.75; p<0.001)

In JV (2.99) than SV (0.97) (OR=3.1; 95% CI=1.34-7.90; p=0.005)

Lorente L, et al. Critical Care 2005; 9(6): 631-635.

* Higher CRBSI in JV central access (n=515) than posterior (n=169)

4.8 vs 1.2/1000 d; OR=3.9; 95% CI=1.1- ∞; p=0.03

Lorente L, et al. Intensive Care Med 2007; 33: 1071-1075.

* Higher CRBSI with 141 JV-SV tracheostomy than in 1251 JV-SV w/o tracheostomy

(11.25 vs 1.43/1000 d; OR=7.99; 95% CI=4.38- ∞; *P* <0.001)

And higher CRBSI in 52 JV than in 89 SV with tracheostomy

(21.64 vs 5.11/1000 d; OR=4.23; 95% CI=1.44- ∞; *P* <0.001)

Lorente L, et al. Eur J Clin Microbiol Infect Dis 2009; 28:1141-5.

BSI According to Vascular Access Site

Our Experience Summary

* 0,97 in subclavian vein without tracheostomy
* 1,20 in jugular vein through posterior access without tracheostomy
* 4,80 in jugular vein through central access without tracheostomy
* 5,10 in subclavian vein with tracheostomy
* 9,50 in femoral vein
* 13,24 in jugular vein through posterior access with tracheostomy
* 21,64 in jugular vein through central access with tracheostomy

Lorente L. Prevención de la bacteriemia relacionada con catéter intravascular. Medicina Intensiva 2010; 34(9):577-580.

Meta-analysis 2006
Chlorhexidine vs Standard Dressing

- 5 RCT: 2396 CVC and AC
  Colonization: 174/1149 (15.1%) vs 342/1247 (27.4%);
  R=0.47 (0.34-0.65)
  CRBSI: 26/1149 (2.3%) vs 46/1247 (3.7%);
  RR=0.61 (0.30-1.26)
  Ho KM, Litton E. J Antimicrob Chemother 2006;58:281-7

- 7 RCT: 10481 CVC and AC
  Colonization: 361/5281 (6.8%) vs 743/5200 (14.3%);
  RR=0.52 (0.43-0.64)
  9 RCT: 11247 CVC y CA
  CRBSI: 64/5639 (1.1%) vs 120/5608 (2.1%)
  RR=0.60 (0.41-0.88)
  Safdar N, et al. Crit Care Med 2014;42:1703-1713

2006

CHSS-CVC
First generation (external)

*** Meta-analysis with 12 RCT and 2.611 CVC**

Lower CRBSI (OR=0.56; 95% CI=0.37-0.84; p =0.005)

Veenstra DL, et al. JAMA 1999;281(3):261-7.

2006

CHSS-CVC 2nd. Generation (external e internal)

* RCT with 188 impregnated catheters and 175 non-impregnated

Lower tip colonization (11.0 vs 3.6/1000 d; p=0.01)

No different CRBSI (5.2 vs 2.0/1000 d; p=0.10)

Brun-Buisson C, et al. Intensive Care Med 2004;30(5):837-43.

* RCT with 90 impregnated and 94 non-impregnated

Lower tip colonization (33% vs 12%; p<0.05)

No different CRBSI (7% vs 3%; NS)

Ostendorf T, et al. Support Care Cancer 2005;13(12):993-1000.

* RCT with 780 CVC

Lower tip colonization (24.1 vs 13.3/1000 d; p=0.01)

No different CRBSI (1.24 vs 0.42/1000 d; p=0.60)

Rupp ME, et al. Ann Intern Med 2005;143(8):570-80.

There is no meta-analysis including all 3 RTCs in 2006

* Meta-analysis including 1176 patients from the 3 RCTs

CRBSI: OR=0.34 (95% CI=0.14-0.81)

Hockenhull JC, et al. Health Technol Asses 2008;12:1-154

2006

Rifampicin-Minocycline CVC

* RCT 738p: OR=0.08 (95% CI=0.01-0.61)
  Darouiche RO, et al.N Engl J Med 1999;340:1-8.

* RCT 356p: OR=0.19 (95% CI=0.05-0.68)
  Hanna H, et al. J Clin Oncol 2004;22:3163-71.

* RCT 312p: OR=0.16 (95% CI=0.04-0.76)
  Darouiche RO, et al. Ann Surg 2005;242:193-200.

* Meta-analysis with 8 RCT and 3.452 CVC
  (rifampicin-minocycline in 7 RCT and rifampicin-miconazole in 1 RCT)
  Lower CRBSI (OR=0.23; 95% CI=0.14-0.40)
  Falagas ME, et al. J Antimicrob Chemother 2007; 59(3):359-369

* RCT: Lower CRBSI with rifampicin-minocycline than with CHSS 1st. Generation (external surface) (1/356 (0.3%) vs 13/382 (3.4%); p<0.002)
  Darouiche RO, et al. N Engl J Med 1999;340(1):1-8.

What have we tested in 2006?

Which measures?

- **Meta-analysis CHG dressings reduce colonization (2006)**
  Afterwards in 2014 meta-analysis reduce CRBSI

- **Studies CHSS-CVC 2nd. Generation reduce colonization**
  Afterwards in 2008 meta-analysis reduce CRBSI

- **Studies rifampicin-CVC reduce CRBSI**
- **In a RCT lower CRBSI with rifampicin-CVC than CHSS 1st. generation**

Which patients?

- **FV and JV => higher CRBSI rates**

RM-CVC in FV and JV

Do RM-CVC reduce CRBSI?
Answer: Yes

- Observational with RM in FV and JV central access

184 FV (73 RM and 111 non-coated) and 241 JV (114 RM and 117 non-coated)

Lower CRBSI in FV with RM (0 vs 8.62/1000d, OR=0.13, 95% CI=0.00-0.86; p=0.03)

Lower CRBSI in JV with RM (0 vs 4.93/1000d, OR=0.13, 95%CI=0.00-0.93; p=0.04)

Lorente L, et al. Clin Infect Dis 2008;47(9):1171-5.

Are RM-CVC efficient?
Answer: Yes

* Observational with RM in JV tracheostomy: 68 RMC y 79 non-coated.

Lower CRBSI with RM (0 vs 20.16/1000 d; OR=0.05; 95% CI=0.001-0.32; P<0.001)

Lower costs with RM (€11.46±6.25 vs 38.11±77.25 per day; p<0.001).

Lorente L, et al. Eur J Clin Microbiol Infect Dis 2012;31:1833-6.

* Observational with RM in FV: 184 RM-C and 190 non-coated.

Lower CRBSI with RM (8.61 vs 0/1000 d; OR=19.26; 95%CI=3.24-i∞; p<0.001)

Lower costs with RM (12.61±8.38 vs €18.22±53.13 per day; p<0.001)

Lorente L, et al. Am J Infect Control 2011;39(10):895-7.

What have we tested in 2012?

- **We have verified RM are efficient in JV-tracheostomy and FV**
- **Meta-analysis 2008 CHSS-CVC 2nd. generation reduce CRBSI**
  - **Meta-analysis including 1176 patients from 3 RCT**
  - **CRBSI: OR=0.34 (95% CI=0.14-0.81)**
  - **Hockenhull JC, et al. Health Technol Asses 2008;12:1-154**
- **CHSS-CVC are cheaper than RM-CVC**

CHSS-CVC

Do CHSS-CVC reduce CRBSI? Yes
Are CHSS-CVC efficient? Yes

* Observational w/ CHSS in FV: 64 CHSS and 190 non-coated
  Lower CRBSI with CHSS (0 vs 8.61/1000 d; p<0.001)
  Lower costs with CHSS (2.92±1.77 vs 18.22±53.13 €; p<0.001)
  Lorente L, et al. Am J Infect Control 2014;42:1130-2.

* Observational with CHSS in JV: 245 CHSS and 391 non-coated
  Lower CRBSI with CHSS (0 vs 5.04/1000 d; p<0.001)
  Lower costs with CHSS (3.78±4.45 vs 7.28±16.71 €; p<0.001)
  Lorente L, et al. Am J Infect Control 2014;42:321-4.

* Observational with CHSS in SV: 353 CHSS and 518 non-coated
  Lower CRBSI with CHSS (0 vs 2.12/1000 d; p=0.02)
  Lower costs with CHSS (3.35±3.75 vs. 3.94±9.95 €; p=0.002)
  Lorente L, et al. Am J Infect Control 2015; Epub ahead of print.

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Brief report

Cost/benefit analysis of chlorhexidine-silver sulfadiazine-impregnated venous catheters for femoral access

Leonardo Lorente MD, PhD [a,*], María Lecuona MD, PhD [b], Alejandro Jiménez PhD [c], Lisset Lorenzo MD [a], Sara Diosdado MD [a], Lucía Marca MD [a], María L. Mora MD, PhD [a]

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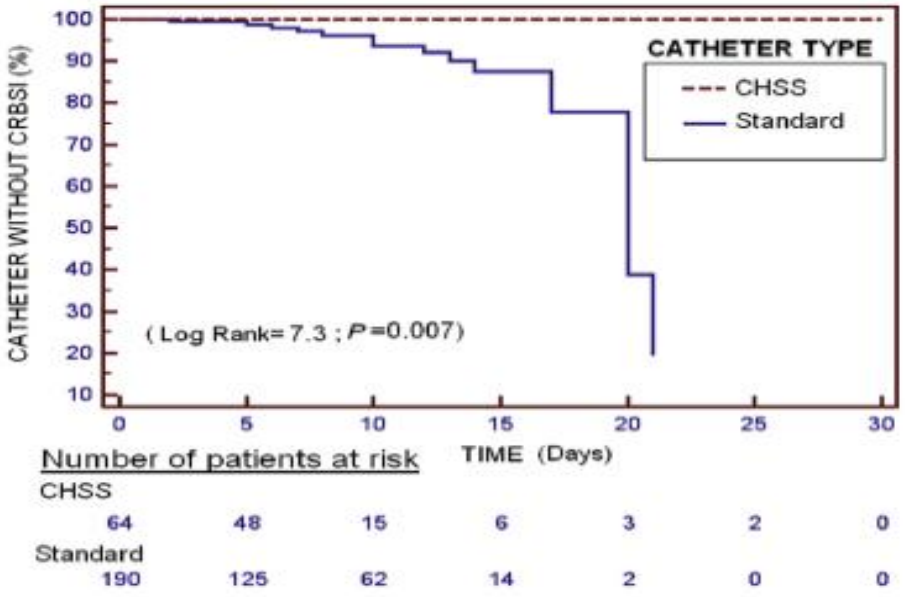
Characteristic	Standard catheter (n = 190) (1,626 d)	CHSS-impregnated catheter (n = 64) (569 d)	P
Age, y	59.07 ± 16.62	60.02 ± 17.36	.70
Male sex	129 (67.9)	46 (71.9)	.64
APACHE-II score	17.36 ± 6.01	17.50 ± 5.41	.91
Admission diagnosis			.50
Cardiac surgery	34 (17.9)	10 (15.6)	
Cardiology	26 (13.7)	11 (17.2)	
Respiratory	40 (21.1)	9 (14.1)	
Digestive	30 (15.8)	9 (14.1)	
Neurologic	26 (13.7)	13 (20.3)	
Trauma	31 (16.3)	9 (14.1)	
Intoxication	3 (1.6)	3 (4.7)	
Chronic obstructive pulmonary disease	22 (11.6)	6 (9.4)	.82
Diabetes mellitus	36 (18.9)	11 (17.2)	.85
Chemotherapeutic agents	7 (3.7)	3 (4.7)	.72
Steroid agents	24 (12.6)	7 (10.9)	.83
Hematologic tumor	6 (3.2)	3 (4.7)	.70
Solid tumor	15 (7.9)	6 (9.4)	.79
Use of antimicrobial agents	151 (79.5)	56 (87.5)	.19
Use of mechanical ventilation	173 (91.1)	54 (84.4)	.16
Use of tracheostomy	63 (32.6)	15 (23.4)	.21
Use of paralytic agents	22 (11.6)	9 (14.1)	.66
Duration of catheter use, d	8.56 ± 4.70	8.90 ± 5.49	.64
CRBSI	14 (7.4)	0	.02
No. of CRBSIs/1,000 catheter days	8.61	0	<.001
CVC-related cost per day, €	18.22 ± 53.13	2.92 ± 1.77	<.001

Analysis	Odds ratio	95% confidence interval	P
Exact logistic regression analysis			
CHSS-impregnated catheter (reference category: standard catheter)	0.12	0-0.739	.009
Duration of catheter insertion, d	1.16	1.053-∞	.005
Exact Poisson regression analysis			
CVC-related cost per day, €	0.18	0-0.197	<.001



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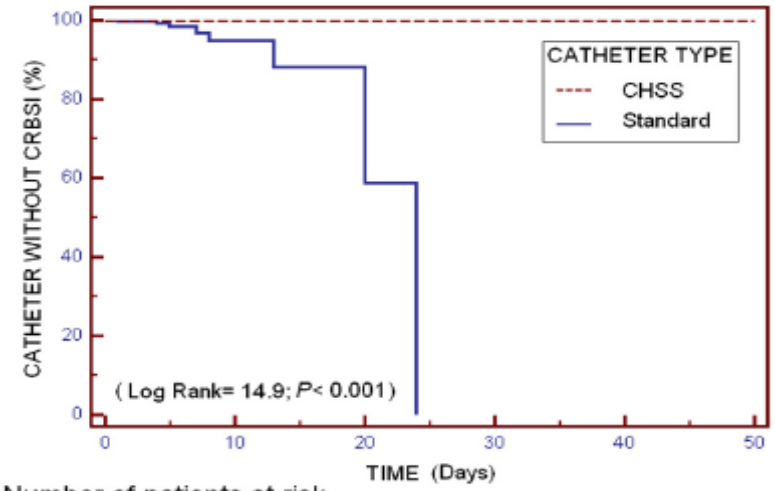
Major article

Chlorhexidine–silver sulfadiazine–impregnated venous catheters save costs

Leonardo Lorente MD, PhD [a,*], María Lecuona MD, PhD [b], Alejandro Jiménez PhD [c], Ruth Santacreu MD [a], Lorena Raja MD [a], Oswaldo Gonzalez MD [a], María L. Mora MD, PhD [a]

Data	Standard (n = 391) (1,586 days)	CHSS (n = 245) (1,685 days)	*P* value
Age, y (mean ± SD)	65.72 ± 13.86	60.15 ± 15.91	<.001
Male sex, n (%)	253 (64.7)	151 (61.6)	.45
APACHE II, score (mean ± SD)	12.42 ± 7.07	16.82 ± 9.01	<.001
Admission diagnostic, n (%)			<.001
Cardiac surgery	318 (81.3)	17 (6.9)	
Cardiology	13 (3.3)	40 (16.3)	
Respiratory	10 (2.6)	78 (31.8)	
Digestive	40 (10.2)	31 (12.7)	
Neurologic	3 (0.8)	38 (15.5)	
Traumatology	1 (0.3)	26 (10.6)	
Others	6 (1.5)	15 (6.2)	
Chronic obstructive pulmonary disease, n (%)	34 (8.7)	36 (14.7)	.03
Diabetes mellitus, n (%)	158 (40.4)	78 (31.8)	.03
Chemotherapeutic agents, n (%)	9 (2.3)	11 (4.5)	.20
Steroid agents, n (%)	6 (1.5)	15 (6.1)	.002
Hematologic tumor, n (%)	6 (1.5)	11 (4.5)	.04
Solid tumor, n (%)	40 (10.2)	27 (11.0)	.79
Use of antimicrobials, n (%)	382 (97.7)	225 (91.8)	.001
Use of mechanical ventilation, n (%)	379 (96.9)	202 (82.4)	<.001
Use of tracheostomy, n (%)	14 (3.6)	36 (14.7)	<.001
Use of paralitic agents, n (%)	8 (2.0)	36 (14.7)	<.001
Duration of the catheter, days (mean ± SD)	8.64 ± 4.75	8.56 ± 4.70	.86
CRBSI, n (%)	8 (2.0)	0	.03
Number CRBSI/1,000 catheter-days	5.04	0	<.001
CVC-related cost, €/day (mean ± SD)	7.28 ± 16.71	3.78 ± 4.45	<.001

	OR	95% CI	*P* value
Exact logistic regression analysis			
CHSS catheter (reference category: standard catheter)	0.02	Infinite to 0.276	.001
Duration of catheter insertion (days)	1.25	1.114-1.405	<.001
Exact Poisson regression analysis			
CVC-related/day cost (euros)	0.52	0.504-0.535	<.001



Number of patients at risk

CHSS	245	47	8	1	1	0
Standard	391	27	2	0	0	0

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Major article

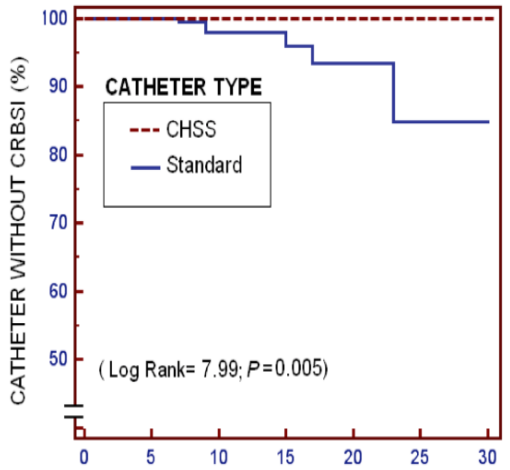
Efficiency of chlorhexidine—silver sulfadiazine-impregnated venous catheters at subclavian sites

Leonardo Lorente MD, PhD [a,*], María Lecuona MD, PhD [b], Alejandro Jiménez PhD [c], Lisset Lorenzo MD [a], Ruth Santacreu MD [a], Silvia Ramos MD [a], Eva Hurtado MD [a], Manuel Buitrago MD [a], María L. Mora MD, PhD [a]

Table 1
Characteristics of patients receiving either a clorhexidine–silver sulfadiazine (CHSS)-impregnated or a standard catheter

	Standard (n = 518) (3,297 d)	CHSS (n = 353) (2,743 d)	*P* value
Age, y	59.50 ± 16.31	60.46 ± 15.23	.39
Male sex	323 (62.4)	236 (66.9)	.20
APACHE-II score	16.32 ± 8.86	17.35 ± 8.40	.14
Admission diagnostic			.50
Cardiac surgery	48 (9.3)	31 (8.8)	
Cardiology	55 (10.6)	40 (11.3)	
Respiratory	96 (18.5)	76 (21.5)	
Digestive	99 (19.1)	58 (16.4)	
Neurologic	103 (19.9)	74 (21.0)	
Traumatology	73 (14.1)	39 (11.0)	
Intoxication	12 (2.3)	15 (4.2)	
Others	32 (6.2)	20 (5.7)	
Chronic obstructive pulmonary disease	64 (12.4)	52 (14.7)	.31
Diabetes mellitus	147 (28.4)	100 (28.3)	.99
Chemotherapeutic agents	27 (5.2)	16 (4.5)	.75
Steroid agents	44 (8.5)	39 (11.0)	.24
Hematologic tumor	19 (3.7)	15 (4.2)	.72
Solid tumor	56 (10.8)	41 (11.6)	.74
Use of antimicrobial agents	489 (94.4)	326 (92.4)	.26
Use of mechanical ventilation	410 (79.2)	292 (82.7)	.22
Use of tracheostomy	86 (16.6)	103 (29.2)	<.001
Use of paralytic agents	56 (10.8)	45 (12.7)	.39
Duration of the catheter, d	6.36 ± 5.65	7.77 ± 6.40	.001
CRBSI	7 (1.4)	0	.03
Number of CRBSI/1,000 catheter-days	2.12	0	.02
CVC-related cost, €/d	3.94 ± 9.95	3.35 ± 3.75	.002

	Odds ratio	95% confidence interval	*P* value
Exact logistic regression analysis			
CHSS catheter (Reference category: standard catheter)	0.10	−∞ to 0.667	.008
Duration of catheter insertion, d	1.18	1.096-∞	<.001
Exact Poisson regression analysis			
CVC-related per-day cost, €	0.85	0.001-0.873	<.001



Number of patients at risk

CHSS	353	203	88	34	19	11	3
Standard	518	215	102	43	16	5	0

Guidelines Recommendations: Impregnated CVC

* CDC/IDSA-2008: Consider use in the following circumstances (A-I):
  1) Hospital units or patient populations have a CRBSI rate higher than the institutional goal, despite compliance with basic prevention practices
  2) Patients have limited venous access and a history of recurrent CRBSI
  3) Patients are at heightened risk for severe sequelae from a CRBSI (eg, patients with recently implanted intravascular devices, such as a prosthetic heart valve or aortic graft).

Marschall J, et al. ICHE 2008; 29 Suppl1:S22-30

* CDC/IDSA-2011: Use in the following circumstances (A-I): catheter is expected to remain in place >5 days, if, after successful implementation of a comprehensive strategy to reduce rates of CRBSI it is not decreasing. (educating, maximal sterile barrier precautions, and a >0.5% chlorhexidine preparation with alcohol for skin antisepsis)

O'Grady NP, et al. Clin Infect Dis 2011;52:e162–193

*American Society of Anesthesiologists-2012: patients selection according to infection risk and costs.

Rupp SM, et al. Anesthesiology 2012;116:539-73.

CONCLUSIONS

Our experience

CHSS-CVC to all patients

¡Muchas gracias!
Grazie!
Thank you!