



# Preventing Hospital-Acquired Infections: A National Survey of Practices Reported by U.S. Hospitals in 2005 and 2009

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**BACKGROUND:** Hospital-acquired infection (HAI) is common, costly, and potentially lethal. Whether initiatives to reduce HAI—such as the Centers for Medicare and Medicaid Services (CMS) no payment rule—have increased the use of preventive practices is not known.

**OBJECTIVE:** To examine the use of infection prevention practices by U.S. hospitals and trends in use between 2005 and 2009.

**DESIGN, SETTING, AND PARTICIPANTS:** Surveys of infection preventionists at non-federal general medical/surgical hospitals and Department of Veterans Affairs (VA) hospitals, which are not subject to the CMS no payment rule, in 2005 and 2009.

**MAIN MEASURES:** Percent of hospitals using practices to prevent central line-associated bloodstream infection (CLABSI), ventilator-associated pneumonia (VAP), and catheter-associated urinary tract infection (CAUTI).

**KEY RESULTS:** Survey response was approximately 70%. More than 1/2 of non-federal hospitals reported a moderate or large increase in CLABSI, VAP and CAUTI prevention as a facility priority due to the non-payment rule; over 60% of VA hospitals reported no change in priority. However, both non-federal and VA hospitals reported significant increases in use of most practices to prevent CLABSI, VAP and CAUTI from 2005 to 2009, with 90% or more using certain practices to prevent CLABSI and VAP in 2009. In contrast, only one CAUTI prevention practice was used by at least 50% of hospitals.

**CONCLUSIONS:** Since 2005, use of key practices to prevent CLABSI, VAP and CAUTI has increased in non-federal and VA hospitals, suggesting that despite its perceived importance, the non-payment rule may not be the primary driver. Moreover, while 65% of non-federal hospitals reported a moderate or large increase in preventing CAUTI as a facility priority, prevention practice use remains low.

**KEY WORDS:** infection prevention; hospitals; patient safety.

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## INTRODUCTION

Hospital-acquired infections (HAIs) are a common, costly, and potentially lethal patient safety problem in United States hospitals and world-wide.<sup>1–4</sup> HAIs affect between 5 and 10 percent of hospitalized patients in the U.S. annually, resulted in approximately 99,000 deaths in 2002, and may account for nearly \$45 billion in direct annual hospital costs.<sup>1,5</sup> While perhaps unavoidable in some patients, at least 20% of all HAIs can be prevented,<sup>6</sup> and approximately 70% of central line-associated bloodstream infections (CLABSIs) appear preventable.<sup>7</sup>

Despite published guidelines and evidence-based recommendations supporting several practices to prevent HAI,<sup>8–11</sup> research conducted in 2005 identified substantial variability in the use of these recommendations by U.S. hospitals.<sup>12–14</sup> For example, to prevent CLABSI about 70% of non-federal U.S. hospitals and 80% of Department of Veterans Affairs (VA) hospitals reported regular use of maximum barrier precautions and chlorhexidine gluconate during catheter insertion.<sup>12</sup> To prevent ventilator-associated pneumonia (VAP), over 80% of hospitals regularly used semi-recumbent positioning but only 21% used subglottic secretion drainage.<sup>13</sup> Finally, catheter-associated urinary tract infection (CAUTI) prevention practices were regularly used only by a minority of hospitals.<sup>14</sup>

Since 2005 there have been several initiatives related to infection prevention. Most notable, perhaps, is the change in the Centers for Medicare and Medicaid Services (CMS) payment system, which no longer pays hospitals for the additional costs incurred for certain hospital-acquired infections, including CAUTI and CLABSI, as of 1 October 2008.<sup>15,16</sup> Other initiatives include the rising number of hospitals participating in infection prevention collaboratives, the use of practice bundles, and the increase in

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mandated reporting of hospital infection rates by individual states.<sup>7,17,18</sup> Whether there has been any increase in the use of practices to prevent HAI by U.S. hospitals, however, is not known. Therefore, we examined the use of infection prevention practices by non-federal U.S. acute care hospitals and VA Medical Centers, and assessed trends in practice use between 2005 and 2009. Because CMS does not pay for services provided in VA hospitals, they are not subject to the non-payment rule and serve as a comparison group to provide insights about temporal changes as well as the impact of the CMS payment policy.

## METHODS

### Study Design and Data Collection

We conducted a longitudinal survey study to compare the use of infection prevention practices by U.S. hospitals in 2005 and 2009. Specifically, we surveyed infection preventionists at a national random sample of non-federal U.S. hospitals and all VA hospitals in both 2005 and 2009 and asked about the use of practices to prevent CLABSI, VAP, and CAUTI. The study sample was selected by identifying all non-federal, general medical and surgical hospitals with 50 or more hospital beds and with medical/surgical or cardiac intensive care beds using the 2005 American Hospital Association (AHA) Database™. We then stratified by bed size: 50–250 beds or 251 or more beds, and selected a random sample of 300 hospitals from each group for a study sample of 600 hospitals. The VA sample consisted of all VA medical centers with primarily general medical and surgical acute care operating beds in 2005 (n=119). The study survey was sent to this same sample of hospitals in March 2005 and in March 2009, with only a few exceptions due to the closure or merger of some hospitals during the study timeframe.

Following a modified Dillman approach,<sup>19</sup> we sent an initial mailing, a reminder letter, and a second mailing of the survey after four weeks to those who had not yet responded. A third survey mailing was added in 2009 due to a lower response to the first two mailings, which had occurred contemporaneous with H1N1 preparations. Institutional review board approval was provided by the University of Michigan and VA Ann Arbor Healthcare System.

### Study Measures

Main outcomes are dichotomous variables indicating regular use of practices for preventing CLABSI, VAP and CAUTI. The survey asked about the use of practices for adult acute care patients to prevent these three device-related infections, with a specific focus on practices identified in published guidelines or recommendations from

the Centers for Disease Control and Prevention (CDC) or professional associations.<sup>8–10,20–23</sup> Respondents were asked to rate the frequency of use for each practice on a scale from 1 to 5 (1 being never and 5 always). For our analysis, regular use is defined as receiving a rating of 4 or 5 indicating the practice is used always or almost always and we focused on practices that are generally recommended and were included in both the 2005 and 2009 surveys (see [Appendix](#)).

In the survey we asked respondents to indicate the effect of the CMS rule changes on the priority of preventing CLABSI, VAP and CAUTI at their facility by asking, for example: “What effect, if any, has the Centers for Medicare and Medicaid Services (CMS) rule changes regarding nonpayment for certain hospital-acquired infections had on the priority of preventing catheter-associated urinary tract infection at your facility?”. The response choices included no change, a small increase, moderate increase, or large increase. Information about general hospital characteristics and the infection control program were also collected, including whether the facility is affiliated with a medical school, use of hospitalists, and participation in an infection prevention-related collaborative. Participation in a collaborative is measured as a “yes” response to the question “Is your facility involved in a collaborative effort to reduce healthcare-associated infections?” We also collected data on the number of full-time equivalent infection preventionists and whether the lead infection preventionist is certified in infection control. The number of hospital beds was obtained from the AHA Database™ for fiscal years 2003 and 2007.

### Statistical analysis

Given our stratified sampling approach, survey data for the non-federal sample of hospitals were analyzed using sample weights based on the original probability of selection within each stratum resulting in estimates that represent the full population of non-federal acute care hospitals with 50 or more hospital beds and an ICU. Results are reported as weighted proportions with 95% confidence intervals. To take into account the differential probability of selection, and the clustering by hospital across the two waves of the survey, results were estimated as a weighted longitudinal panel design. We compared percentages across years within samples (non-federal or VA) and the change in percentages between samples using generalized estimating equations (GEE) with a logit link and robust standard errors with probability weights, accounting for the inherent clustering by hospital and non-independence of the residuals and the heterogeneous weights. As a form of sensitivity analysis, we also analyzed the data after excluding 24 critical access hospitals, which are exempt from the CMS non-payment rule. However, since there were no significant changes in the results we chose to report the results for the entire non-

federal sample. Reported P-values are two-tailed and all analyses were conducted using Stata version 11.0 (Stata-Corp, College Station, TX). Statistical significance is defined as a P-value  $\leq 0.05$ .

## RESULTS

The overall survey response rate in both 2005 and 2009 was approximately 70% (72% in 2005 and 68% in 2009). Selected hospital characteristics for both years are shown in Table 1. Within groups, the respondent samples in 2005 and 2009 were generally similar with respect to size and academic affiliation, although there are clear differences across groups given the high proportion of VA hospitals that are affiliated with a medical school. There was a significant increase in both groups in the percent of hospitals reporting they had hospitalists (non-federal 57% vs. 75%,  $P < 0.001$ ; VA 64% to 79%,  $P = 0.016$ ) and that they participated in a collaborative effort to reduce HAI (non-federal 42% vs. 68%,  $P < 0.001$ ; VA 31% to 85%,  $P < 0.001$ ).

Among non-federal hospitals, 58% reported a moderate or large increase in priority for preventing CLABSI related to the CMS non-payment rule, 54% reported a moderate or large increase in importance for preventing VAP, and 65% of hospitals indicated the payment policy had a moderate or large increase in preventing CAUTI as a facility priority. For VA hospitals, over 60% reported no change in facility priority for preventing CLABSI, VAP or CAUTI related to the CMS payment change.

### Practices to Prevent Central Line-Associated Bloodstream Infections (CLABSI)

Between 2005 and 2009, the reported use of several practices to prevent CLABSI increased significantly

(Fig. 1), with at least 90% of both non-federal and VA hospitals using two of the key recommended practices in 2009. Specifically, there was an increase in the percent of both non-federal and VA hospitals reporting use of maximum barrier precautions (non-federal 71% to 90%,  $P < 0.001$ ; VA 84% to 96%,  $P = 0.025$ ) and chlorhexidine gluconate (non-federal 69% to 95%,  $P < 0.001$ ; VA 91% to 100%,  $P = 0.011$ ) during central venous catheter insertions, and in the use of an antimicrobial dressing with chlorhexidine (non-federal 25% to 54%,  $P < 0.001$ ; VA 29% to 75%,  $P < 0.001$ ). The use of antimicrobial central venous catheters remained about the same in both groups with approximately 30% of hospitals reporting regular use in 2005 and 2009. The only difference between non-federal and VA hospitals was in the use of an antimicrobial dressing, with the increase in use being significantly greater among VA hospitals.

### Practices to Prevent Ventilator-Associated Pneumonia (VAP)

The percent of hospitals reporting regular use of several key practices to prevent VAP also increased between 2005 and 2009 (Fig. 2), with a majority of hospitals in both groups using two key prevention practices in 2009. The percentage of hospitals using semi-recumbent positioning (non-federal 82% to 95%,  $P < 0.001$ ; VA 89% to 98%,  $P = .049$ ) and an antimicrobial mouth rinse (non-federal 41% to 58%,  $P < 0.001$ ; VA 33% to 60%,  $P < 0.001$ ) increased significantly in both groups. Use of subglottic secretion drainage (non-federal 21% to 42%,  $P < 0.001$ ; VA 23% to 37%,  $P = 0.053$ ) and selective digestive tract decontamination (non-federal 13% to 24%,  $P < 0.001$ ; VA 9% to 14%,  $P = 0.330$ ) also increased, but less so among VA hospitals. There were no significant differences in changes in use between non-federal and VA hospitals for any of the practices examined.

Table 1. Selected Characteristics of Hospitals in 2005 and 2009

Characteristic	Percent Yes or Mean (with 95% CI)*			
	Non-federal Hospitals 2005	Non-federal Hospitals 2009	VA Hospitals 2005	VA Hospitals 2009
Number of hospital beds	229 (216–242)	226 (212–239)	297 (255 – 339)	280 (232 – 329)
Have hospitalists	57%	75% <sup>†</sup>	64%	79%
Affiliated with a medical school	23%	24%	81%	76%
Number of full-time equivalent infection preventionists (IPs)/100 hospital beds	0.67 (0.63 – 0.71)	0.80 <sup>†</sup> (0.75 – 0.85)	0.70 (0.62 – 0.78)	0.88 <sup>†</sup> (0.76 – 0.99)
Infection control professional certified in infection control	57%	59%	75%	64%
Participate in a collaborative effort to reduce HAI	42%	68% <sup>†</sup>	31%	85% <sup>†</sup>

\*Estimates derived using sample weights to reflect the total population hospitals represented by the respondent sample

<sup>†</sup>  $P \leq 0.001$  between years

VA=Department of Veterans Affairs

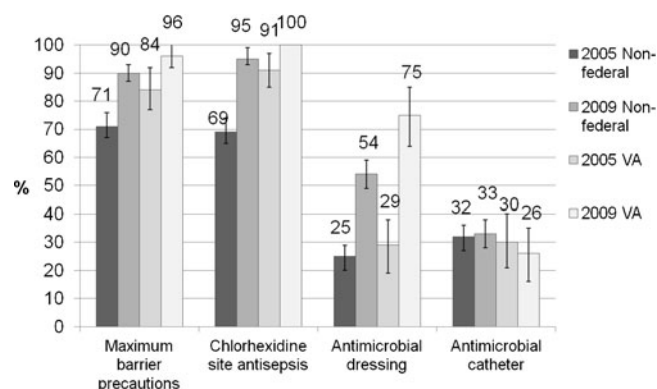


Figure 1. Use of Practices to Prevent Central Line-Associated Bloodstream Infection (CLABSI) in 2005 and 2009.

### Practices to Prevent Catheter-Associated Urinary Tract Infection (CAUTI)

As with CLABSI and VAP, there was an increase in the use of many of the CAUTI prevention practices (Fig. 3), although the only practice used by 50% or more of hospitals in either group was bladder ultrasound. Among non-federal hospitals, the percent using portable bladder ultrasound scanners increased from 29% to 39% ( $P=0.001$ ); the percent using a urinary catheter reminder or stop-order increased from 9% to 20% ( $P<0.001$ ); and the percent of hospitals using antimicrobial urinary catheters rose from 30% in 2005 to 45% in 2009 ( $P<0.001$ ). The use of condom catheters for men as an alternative to an indwelling catheter, on the other hand, did not change significantly with only 12% of non-federal hospitals reporting regular use in 2005 and 10% in 2009 ( $P=0.25$ ). Among VA hospitals the only statistically significant increase was in the use of portable bladder ultrasound, with 50% of VA hospitals reporting use of this technology in

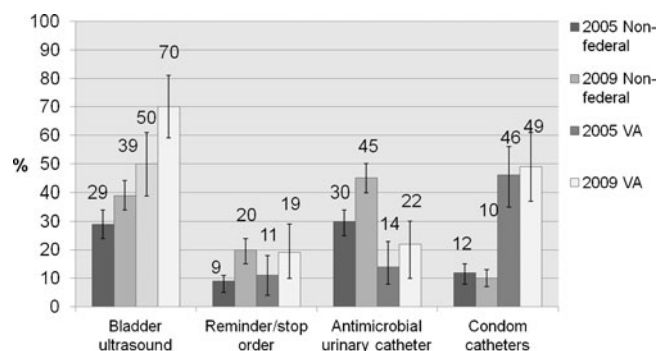


Figure 3. Use of Practices to Prevent Catheter-Associated Urinary Tract Infection (CAUTI) in 2005 and 2009.

2005 and 70% in 2009 ( $P=0.003$ ). The use of other practices also increased but these changes were not statistically significant. Likewise, no significant differences in changes in use between non-federal and VA hospitals were identified.

### DISCUSSION

Preventing HAI is a patient safety priority in the U.S. and world-wide.<sup>24,25</sup> Along with a continuing need to develop new practices to reduce infection, we must also understand the extent to which recommended practices are being used to identify potential gaps and opportunities for enhancing infection prevention activities to protect hospitalized patients.<sup>26</sup> This study shows a significant increase in the percentage of U.S. hospitals, both non-federal and VA, reporting use of several key practices to prevent CLABSI, VAP, and CAUTI between 2005 and 2009. The majority of non-federal hospitals report that the CMS policy to no longer pay for the additional cost of some HAIs had a moderate to large increase on the priority of preventing CLABSI, VAP and CAUTI at their facility. Not surprisingly, a majority of VA hospitals report no change in priority related to the CMS rule since they are not directly subject to the payment change. Despite the increased use of many practices, however, there is much variability and the use of practices to prevent CAUTI remains relatively low compared to those for CLABSI and VAP among both groups of hospitals.

Of the 12 practices included in this analysis, reported use increased for 11 of the practices among non-federal hospitals and for 11 of the practices among VA hospitals. Although not all increases were statistically significant, the patterns observed for many of the practices appeared to be similar between the non-federal and VA hospitals particularly those for preventing CLABSI and VAP. Reported use of all of the practices for preventing

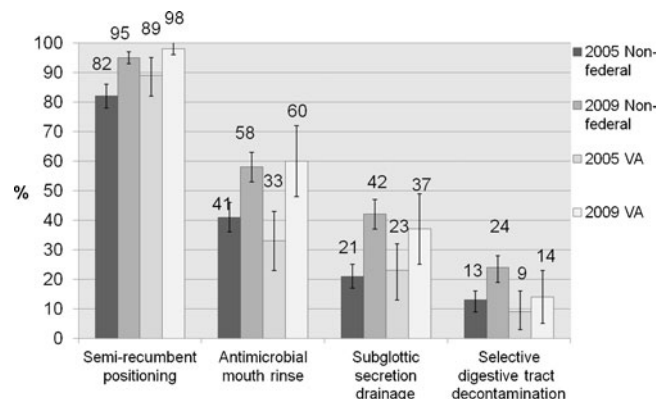


Figure 2. Use of Practices to Prevent Ventilator-Associated Pneumonia (VAP) in 2005 and 2009.



CLABSI, except antimicrobial central venous catheters, and all of the practices for preventing VAP increased among both non-federal and VA hospitals. Interestingly, more than half of the non-federal hospitals identified a moderate or large increase in the importance of preventing VAP as a result of the CMS payment change. Yet, while VAP was one of the conditions considered when the initial list was established and remains among the conditions discussed for subsequent inclusion, it is not currently affected by the CMS payment rule.<sup>27</sup> Perceived importance notwithstanding, the actual direct impact of the reimbursement rule on prevention efforts to date appears to be limited.

Despite 65% of non-federal hospitals indicating a moderate or large increase in CAUTI as a facility priority due to the CMS payment rule and a significant increase in the use of several practices to prevent CAUTI, no practice was used by more than 50% of non-federal hospitals in 2009. Likewise, bladder ultrasound was the only practice used by a majority of VA hospitals. Although the use of urinary catheter reminders or stop-orders doubled since 2005, this relatively simple approach is only used by 1 in 5 U.S. hospitals despite evidence and recommendations supporting this practice.<sup>10,20,28,29</sup> Therefore, a nationwide gap in translating evidence-based practices to prevent CAUTI seems to exist. In contrast, over 90% of hospitals report using at least one practice for preventing CLABSI and VAP. Notably, the practices now used by 90% or more of U.S. hospitals, which includes use of maximum barrier precautions and chlorhexidine as a site antisepsis for prevention of CLABSI and semi-recumbent positioning to prevent VAP, are practices that have been promoted as part of practice bundles and through collaboratives, including the Institute for Healthcare Improvement breakthrough collaboratives and the Keystone ICU initiative in Michigan.<sup>7,17</sup> Until recently, however, there were no practice bundles or large-scale collaboratives that focused on preventing CAUTI.<sup>16</sup>

Another issue distinguishing CAUTI prevention from CLABSI and VAP prevention is that the majority of patients with short-term central venous catheters and those on ventilators are in an ICU. Thus, instituting the use of specific prevention practices may be achieved through a focused effort within a relatively defined area. Whereas indwelling urinary catheters, while prevalent in ICUs, are also used in patients located throughout the hospital and the strategies needed to implement key CAUTI prevention practices may not only vary by type of practice but also by unit. For example, implementing a urinary catheter reminder or stop-order on a medical-surgical floor may differ from that of a rehabilitation unit or even from one medical-surgical floor to another depending on how the units are staffed and how care is delivered.

Our findings should be interpreted in the context of some possible limitations. First, non-response bias is a potential issue. Although the overall response rate was approximately 70% in both years, the response among VA hospitals in 2009 was only 62%. Nonetheless, given a nearly 70% response in the non-federal sample in both years we believe these results provide a reasonable estimate of the use of infection prevention practices by U.S. non-federal hospitals with 50 or more beds and an ICU in both 2005 and 2009. In addition, we found no significant differences in academic affiliation or size (i.e., number of hospital beds) between the hospitals that responded versus those that did not for the VA sample. For the non-federal sample there was also no difference in academic status, but larger hospitals were somewhat less likely to respond in 2009. Second, the 2009 survey was conducted only six months after the CMS payment rule went into effect and it may have been too early to capture some of the prevention activities by non-federal hospitals. However, since the non-payment rule was publicized well in advance of the date when it actually took effect, we expect that the time factor did not substantially impact our study results. Lastly, although we have a considerable amount of information about the use of infection prevention practices, we do not have data on actual infection rates. Nonetheless, we focused primarily on practices that have been shown through research to reduce infections and are generally included in published guidelines or recommendations from the CDC and other professional associations. Also, in line with our finding of significantly higher use of practices to prevent CLABSI and VAP compared to CAUTI, data collected by the CDC through the National Healthcare Safety Network (NHSN) and its predecessor the National Nosocomial Infections Surveillance (NNIS) system suggest a sizeable decline in rates of CLABSI and VAP (comparing data from 2002–2004 vs. 2006–2008) but little change in CAUTI rates.<sup>1,30,31</sup> Likewise, although information about CAUTI is not currently available, data collected by the VA also show significant decreases in CLABSI and VAP from fiscal year 2005 to fiscal year 2010.<sup>32</sup>

In conclusion, our findings reveal that the majority of non-federal hospitals report that the CMS payment rule had a moderate to large increase on their priority in preventing CLABSI, VAP and CAUTI compared to no reported change in priority by the majority of their VA counterparts. However, both non-federal and VA hospitals reported significant increases since 2005 in the use of several key practices to prevent CLABSI, VAP, and CAUTI. These findings suggest that while it is perceived as important and may contribute to changes in practice, the CMS payment rule is likely not the primary driver of the increased use of infection prevention practices among US hospitals over the past several years. Additionally, there is

still variability in the types of practices used to prevent certain infections and the percent of hospitals using specific practices to prevent CAUTI remains low compared to CLABSI and VAP. This gap indicates that additional strategies may be required to encourage the use of key CAUTI prevention practices to decrease infection risk and enhance patient safety.

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Dr. Saint has received numerous honoraria and speaking fees from academic medical centers, hospitals, specialty societies, state-based hospital associations and non-profit foundations (including the Institute for Healthcare Improvement) for lectures about patient safety, implementation science, and urinary tract infection. None of the other authors report relevant conflicts of interest related to the content of this manuscript.

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**Conflicts of Interest:** None disclosed.

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## APPENDIX

Table 2 shows infection prevention practices included in survey.

Table 2. Infection Prevention Practices Included in Survey

Practices to Prevent Central Line-Associated Bloodstream Infection <sup>1</sup>	Healthcare Infection Control Practices Advisory Committee (HICPAC) Guideline Level of Evidence/Recommendation*	Part of the Institute for Healthcare Improvement (IHI) Central Line Bundle <sup>4</sup>
Maximum barrier precautions (full gown, sterile gloves, full body sterile drape) during central catheter insertion	1B <sup>†</sup>	Yes
Chlorhexidine gluconate for antisepsis of the insertion site	1A	Yes
Antimicrobial central venous catheter	1A <sup>††</sup>	No
Antimicrobial dressing with chlorhexidine	1B	No
Practices to Prevent Ventilator-Associated Pneumonia <sup>2</sup>		Part of the Institute for Healthcare Improvement (IHI) Ventilator Bundle <sup>5</sup>
Semi-recumbent positioning of the patient (head of bed elevated 30 degrees or more)	II	Yes
Subglottic secretion drainage (via a special endotracheal tube)	II	No
Antimicrobial mouth rinse	II	Yes
Topical and/or systemic antibiotics for selective digestive tract decontamination	Unresolved	No
Practices to Prevent Catheter-Associated Urinary Tract Infection <sup>3</sup>		Part of the Keystone Bladder Bundle <sup>6</sup>
Portable bladder ultrasound scanner for determining post-void residual	II	Yes
Urinary catheter reminder or stop-order	1B	Yes
Antimicrobial urinary catheter	1B	No
Condom catheters in men	II	Yes

\*HICPAC Level of Evidence/Recommendation:

**Category IA.** Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiologic studies.

**Category IB.** Strongly recommended for implementation and supported by some experimental, clinical, or epidemiologic studies and a strong theoretical rationale; or an accepted practice (e.g., aseptic technique) supported by limited evidence.

**Category IC.** Required by state or federal regulations, rules, or standards.

**Category II.** Suggested for implementation and supported by suggestive clinical or epidemiologic studies or a theoretical rationale.

**Unresolved issue.** Represents an unresolved issue for which evidence is insufficient or no consensus regarding efficacy exists.

<sup>†</sup>The recommendation for maximum sterile barriers changed from 1A in the 2002 recommendations to 1B in the 2011 recommendations.

<sup>††</sup>The recommendation for antimicrobial catheters changed from 1B in 2002 to 1A in 2011: Category IA

<sup>1</sup>O'Grady NP, Alexander M, Dellinger EP, et al. Guidelines for the prevention of intravascular catheter-related infections. 2011. Available at: <http://www.cdc.gov/HAI/bsi/bsi.html>. Accessed October 13, 2011.

<sup>2</sup>Tablan OC, Anderson LJ, Besser R, Bridges C, Hajjeh R. Guidelines for preventing health-care-associated pneumonia, 2003: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. MMWR Recomm Rep. 2004;53(RR-3):1-36.

<sup>3</sup>Gould CV, Umscheid CA, Agarwal RK, Kuntz G, Pegues DA. Guideline for prevention of catheter-associated urinary tract infections 2009. Infect Control Hosp Epidemiol. 2010;31(4):319-26.

<sup>4</sup>Available at: <http://www.ihl.org/explore/CentralLineInfection/Pages/default.aspx>. Accessed October 13, 2011.

<sup>5</sup>Available at: <http://www.ihl.org/knowledge/Pages/Changes/ImplementtheVentilatorBundle.aspx>. Accessed October 13, 2011.

<sup>6</sup>Saint S, Olmsted RN, Fakh MG, et al. Translating Hospital-Associated Urinary Tract Infection Prevention Research into Practice via the Bladder Bundle. Joint Commission Journal on Quality and Patient Safety 2009; 25:449-455