COMMENTARY

When Counting Central Line Infections Counts

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(See the article by Wise et al, on pages 547–554.)

In this issue of the journal, Wise et al[1] report encouraging news of significant declines in reported rates of central venous catheter (CVC) bloodstream infections (BSIs) in critical care units over the past 2 decades. Using data from the US Centers for Disease Control and Prevention's (CDC's) National Nosocomial Infections Surveillance system for the years 1990–2004 and the National Healthcare Safety Network (NHSN) for the years 2006–2010, the authors carefully adjusted for changes in definitions, changes in hospital facility characteristics, and potential bias arising from the transition to the NHSN. They estimated that between 100,000 and 200,000 fewer infections have occurred compared with what might have been expected if infection rates had remained stable at 1990 levels.

Much of the improvement can be attributed to increased utilization of evidence-based procedures for line insertion,[2] along with such technical innovations as antimicrobial catheters[3] and chlorhexidine insertion-site patches.[4] More broadly, these declines are likely due to sweeping cultural change. The 2006 Michigan Keystone project in particular may be said to have disrupted the prevailing norm that hospital-acquired infections (HAIs) were simply the price of doing business in critical care.[5] With its report of a reduction from a mean 7.7 to 1.4 central line BSIs per 1,000 catheter-days in more than 100 intensive care units (ICUs), the Keystone project demonstrated that many—though not all—central line infections are preventable.[6]

The findings of Wise and colleagues will be welcomed by patients, practitioners, and payers. But there is some room for caution, on 3 counts. The first relates to the appropriation of definitions intended for surveillance for purposes for which they were not originally designed. The second is linked and relates to the elasticity of notions of preventability. The third is that we may be reaching the limit of preventability, and we may have to confront the possibility that zero infections may not be an achievable goal in all circumstances.

A small but important body of work points to considerable variability in how definitions of central line infections are applied and interpreted. One study, using 2004–2007 data from 20 ICUs at 4 large academic medical centers, found limited correlation between CVC BSI rates determined by infection preventionists and a computer algorithm–generated standard rate.[7] A retrospective survey in 6 Australian hospitals found "unacceptably low" agreement between reported CVC BSIs and gold standard application of definitions.[8] A recent ethnographic study of English ICUs points to some of the reasons why variability occurs in what gets counted as a CVC BSI: mundane challenges (setting up and operating data collection systems), clinical practices in dispatching samples for microbiological analysis, and differences in clinical judgement all play a part.[9]

Much of the variability has its roots in the CDC definitions themselves, which were designed for surveillance. Maximizing sensitivity—the detection rate—has traditionally been a goal of surveillance systems for HAIs because ensuring that all candidate infections are identified and that appropriate action is taken likely serves the best interests of patients. High specificity—indicating a low false-positive rate—is clearly a benefit too, mainly to avoid overtreatment and unwarranted costs. The CDC catheter-associated (not catheter-related) definition, used by many US hospitals, is known to maximize sensitivity[10] and thus may overcount CVC BSIs. But recent policy developments, by appropriating HAI surveillance rates as a form of performance management, are changing the rules of the game.

In October 2008, the US Centers for Medicare and Medicaid Services (CMS) eliminated additional payments for certain hospital-acquired conditions, including CVC BSI, and since January 2011 the CMS has required all hospitals participating in the Inpatient Prospective Payment System to report CVC BSI rates using the CDC's NHSN. Currently, 32 states and the District of Columbia have policies requiring the reporting of CVC BSIs.[11] Public report cards and rankings compiled by the media and advocacy groups now draw on

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these HAI data in judging quality of care and comparing hospitals. Yet the accuracy of reported rates is in question, and it is unclear what proportion of NHSN CVC BSI data is currently well validated. One recent study in Oregon ICUs found that external validation and adjudication raised publicly reported rates by 27%.[12]

The risk is that policy moves have converted a locally useful surveillance measure into what social scientists call a "reactive" measure: the kind of measure that modifies the phenomenon under study and in the process changes the thing being measured.[13] Put bluntly, the more that organizations are incentivized by the prospect of shaming or financial penalties to decrease sensitivity—and thus not to find cases—the less certain it is that they are reporting a valid assessment of their infection rate. As a consequence, some are now arguing that infection rates may say more about willingness to report than underlying harm.[14] This is a classic demonstration of Goodhart's law: "any observed statistical regularity will tend to collapse once pressure is placed on it for control purposes."[15] Or stated another way, "when a measure becomes a target, it ceases to be a good measure."[16] Ironically, there is little evidence to support positive impacts from the new policies. Two recent studies[17,18] looking at the impact of the 2008 CMS nonpayment policy found that it had no measurable effect on CVC BSIs or other HAI rates, and another[19] found no difference between CVC BSIs in facilities located in mandatory versus voluntary reporting states.

Uncertainty about the true rate of CVC BSI suggests that there is considerable elasticity regarding what "preventable" really means. Implementation of technical best practices does not spare all patients from CVC BSIs, particularly if they have more severe illness and repeat abdominal operations[20] or if they acquire CVC BSI through a secondary infection that cannot be addressed by interventions focused on CVC insertion.[10] To date, no study has demonstrated complete elimination of CVC BSIs in critical care, including a recent large-scale program in England involving more than 200 ICUs that reported an overall impressive reduction in rates of infection.[21] Thus, although Wise and colleagues argue that the 15,000 CVC BSIs that manifested in 2010 are targets for improvement, how many would truly be preventable is far from clear. Striving for zero may be an important goal, but whether it is really achievable always and everywhere for everyone is another matter. What is clear is that science rather than rhetoric should provide the answer.

Notwithstanding ambiguities around measurement, there is little doubt that CVC BSI rates are declining. Anyone who has spent the past 10–20 years as an infection preventionist or hospital epidemiologist can attest to how evidence-based methods and cultural change have had a real and lasting impact on infection rates. But the financial and reputational consequences of new policies mean that the sensitivity and specificity of the CDC CVC BSI definitions now matter in ways not anticipated when they were designed for surveillance purposes. The time may have arrived to redefine "zero" as "zero *preventable* infections" and to update surveillance definitions accordingly. Punishing hospitals that do not achieve zero using current definitions not only is unfair but also is likely to be fateful for the whole enterprise of infection control. Undermining our surveillance system to serve ill-designed demands for accountability means that it may no longer be useful for monitoring and driving patient-safety improvements. That would truly be a shame.

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REFERENCES

1. Wise ME, Scott RD II, Baggs JM, et al. National estimates of central line–associated bloodstream infections in critical care patients. *Infect Control Hosp Epidemiol* 2013;34(6):547–554 (in this issue).
2. Furuya EY, Dick A, Perencevich EN, Pogorzelska M, Goldmann D, Stone PW. Central line bundle implementation in US intensive care units and impact on bloodstream infections. *PLoS ONE* 2011;6(1):e15452.
3. Casey AL, Mermel LA, Nightingale P, Elliott TS. Antimicrobial central venous catheters in adults: a systematic review and meta-analysis. *Lancet Infect Dis* 2008;8(12):763–776.
4. Timsit JF, Schwebel C, Bouadma L, et al. Chlorhexidine-impregnated sponges and less frequent dressing changes for prevention of catheter-related infections in critically ill adults: a randomized controlled trial. *JAMA* 2009;301(12):1231–1241.
5. Dixon-Woods M, Bosk CL, Aveling EL, Goeschel CA, Pronovost PJ. Explaining Michigan: developing an ex post theory of a quality improvement program. *Milbank Q* 2011;89(2):167–205.
6. Pronovost P, Needham D, Berenholtz S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. *N Engl J Med* 2006;355(26):2725–2732.
7. Lin MY, Hota B, Khan YM, et al. Quality of traditional surveillance for public reporting of nosocomial bloodstream infection rates. *JAMA* 2010;304(18):2035–2041.
8. McBryde ES, Brett J, Russo PL, Worth LJ, Bull AL, Richards

https://doi.org/10.1086/670630 Published online by Cambridge University Press

MJ. Validation of statewide surveillance system data on central line–associated bloodstream infection in intensive care units in Australia. *Infect Control Hosp Epidemiol* 2009;30(11):1045–1049.
9. Dixon-Woods M, Leslie M, Bion J, Tarrant C. What counts? an ethnographic study of infection data reported to a patient safety program. *Milbank Q* 2012;90(3):548–591.
10. Sihler KC, Chenoweth C, Zalewski C, Wahl W, Hyzy R, Napolitano LM. Catheter-related vs. catheter-associated blood stream infections in the intensive care unit: incidence, microbiology, and implications. *Surg Infect* 2010;11(6):529–534.
11. State-based HAI prevention. Centers for Disease Control and Prevention website. http://www.cdc.gov/hai/stateplans/required-to-report-hai-NHSN.html. Accessed February 28, 2013.
12. Oh JY, Cunningham MC, Beldavs ZG, et al. Statewide validation of hospital-reported central line–associated bloodstream infections: Oregon, 2009. *Infect Control Hosp Epidemiol* 2012;33(5):439–445.
13. Espeland WN, Sauder M. Rankings and reactivity: how public measures recreate social worlds. *Am J Sociol* 2007;113(1):1–40.
14. Chopra V, Shojania KG. Recipes for checklists and bundles: one part active ingredient, two parts measurement. *BMJ Qual Saf* 2013;22(2):93–96.
15. Bevan G, Hood C. What's measured is what matters: targets and gaming in the English public health care system. *Public Adm* 2006;84(3):517–538.
16. Strathern M. "Improving ratings": audit in the British university system. *Eur Rev* 1997;5:305–321.
17. Krein SL, Kowalski CP, Hofer TP, Saint S. Preventing hospital-acquired infections: a national survey of practices reported by U.S. hospitals in 2005 and 2009. *J Gen Intern Med* 2012;27(7):773–779.
18. Lee GM, Kleinman K, Soumerai SB, et al. Effect of nonpayment for preventable infections in U.S. hospitals. *N Engl J Med* 2012;367(15):1428–1437.
19. Ellingson K, McCormick K, Jernigan JA, Edwards J, Fridkin S. A comparison of central line–associated bloodstream infections in states with mandatory versus voluntary reporting through the National Healthcare Safety Network. Abstract 1227 presented at: IDWeek 2012, San Diego, October 2012. https://idsa.confex.com/idsa/2012/webprogram/Paper37309.html. Accessed April 3, 2013.
20. Lissauer ME, Leekha S, Preas MA, Thom KA, Johnson SB. Risk factors for central line–associated bloodstream infections in the era of best practice. *J Trauma Acute Care Surg* 2012;72(5):1174–1180.
21. Bion J, Richardson A, Hibbert P, et al. "Matching Michigan": a 2-year stepped interventional programme to minimise central venous catheter–blood stream infections in intensive care units in England. *BMJ Qual Saf* 2013;22(2):110–123.

https://doi.org/10.1086/670630 Published online by Cambridge University Press