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COMMENTARY

Zero: What Is It, and How Do We Get There?

Victoria Fraser, MD

This article is one of three in this issue (see also the articles by Richards and by Edmond) adapted from a joint plenary address entitled "Can We Really Get to Zero?" given at the 18th Annual Meeting of the Society for Healthcare Epidemiology of America (Orlando, Florida; April 5–8, 2008). The plenary session was structured as a formal debate, and each speaker was assigned a point of view to represent. The positions presented may or may not represent the actual opinions of the authors.—*The Editor*

Why would the 2008 Society for Healthcare Epidemiology of America (SHEA) Annual Meeting planning committee choose the topic "getting to zero"? As the open session speaker, I can presume that they picked this topic because it was timely, and of interest to many, but also controversial. It is timely, because of the significant advances in infection prevention over the past few years that have demonstrated that many healthcare-acquired infections (HAIs) may be preventable and that successfully implemented interventions can significantly reduce HAI rates in diverse settings. Dramatic reductions in reported rates of catheter-related bloodstream infection (BSI) and ventilator-associated pneumonia in intensive care units (ICUs), through targeted efforts, have inspired healthcare epidemiologists, infection prevention specialists, intensivists, patient safety professionals, hospitals, and private, governmental, and community-based organizations to set more aggressive goals and targets to reduce the risk of HAIs.

"Elimination of HAIs," "zero tolerance for HAIs," "targeting zero HAIs," and other catch phrases became calls to action, sound bites for marketing campaigns, and slogans to martial enthusiasm for the cause. The passion and emotion surrounding these specific choices of words have engendered considerable controversy. "Zero tolerance" has been interpreted by some to be punitive or intolerant toward healthcare workers and those people trying to prevent infections. I, personally, have never been a fan of the "zero tolerance" concept in healthcare epidemiology or as an approach to dealing with other complex public health challenges, such as underage drinking, sexually transmitted infections, HIV transmission risk, or tobacco and substance abuse. Perhaps this is because I have been working in healthcare epidemiology and taking care of patients for 20 years, or perhaps it is because I have 3 teenaged children. Although I am very passionate about and committed to trying to reduce the risk of HAIs and setting aggressive goals for the reduction of HAIs, I do not think the zero tolerance approach helps as much as it hurts our cause.

The concept of "targeting zero HAIs" is controversial, because many people believe it sets unrealistic or impossible expectations that all HAIs are preventable and that any HAI that may occur was due to an error or a broken process. To me, "targeting zero" is problematic, because it does not address the variation in the risk of HAIs in different patient populations or settings, it does not address the denominator or time frame that is necessary to understand rates of infection, and it inherently seems scientifically unrealistic. Although I believe now that many more HAIs are preventable than I thought even a few years ago, I do not believe our science is yet robust enough to prevent all HAIs. When taken as a "big, hairy, audacious goal," trying to eliminate HAIs seems quite laudable, however.

Some of the controversy has arisen because of the way different people think about using marketing campaigns and slogans to drive change or set agendas. It is actually very difficult to prevent HAIs. Hospitals, healthcare workers, patients, and healthcare delivery are all complex and ever-changing systems. Resources for healthcare epidemiology and infection prevention research and operations are actually quite limited, given the scope of the problem. It has taken decades of research, operational improvements, multidisciplinary collaborations, and policy changes to realize the dramatic reductions in HAIs reported in the past several years. To some, the slogans seem like unrealistic, unfunded mandates that demand perfect outcomes without providing the resources, the infrastructure, or the science to do the work or move the field forward. In some instances, it has been perceived that the slogans have fueled the fire, by setting expectations that all HAIs are preventable. Thus, patients and the public might think that any HAI is the result of an error

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or suboptimal process; the Centers for Medicare and Medicaid Services (CMS) and insurers could refuse payment for "never events."

So, why was I asked to give this talk? I am the past president of SHEA and a member of the Association of Professionals in Infection Control and Epidemiology (APIC). I work at Washington University and Barnes-Jewish Hospital, part of the BJC HealthCare system. These institutions, along with my infectious diseases and infection prevention specialist colleagues in the BJC Infection Control Consortium, have a long track record of reducing the rate of HAIs and of doing research studies on the risk factors, outcomes, and prevention of HAIs, with funds from the Centers for Disease Control and Prevention (CDC) Epicenters Program. I work at an institution that targets "zero." We still have HAIs, but we never stop trying to prevent them. Philosophically, I prefer to set aggressive targets, even though they may not be attainable, rather than set the bar low enough to ensure success. Last but not least, I am an incurable optimist, and I suspect they asked me to speak to help motivate everyone to believe in their ability to significantly reduce HAIs.

So, how did we get to the point that people are actually talking about eliminating HAIs? Ten years ago, the very thought was inconceivable, and now it's front and center. The history of modern healthcare epidemiology and infection prevention is relatively short. Let me review some of the major landmarks in the history of modern hospital infection prevention. In the 1950s, hospital outbreaks of *Staphylococcus aureus* infection were reported that raised awareness about the risks of infection transmission in hospitalized patients. In the 1970s, the CDC developed infection control expertise by performing research and outbreak investigations, training a cadre of physicians and nurses in healthcare epidemiology, performing and supervising concurrent surveillance activities in hospitals, and standardizing surveillance definitions for HAIs. The Joint Commission prioritized systems and guidelines for infection prevention in hospitals to be used with hospital accreditation procedures. The National Nosocomial Infection Surveillance System began in 1970, with 62 hospitals in 31 states. In 1972, APIC was established, and SHEA began in 1981. The CDC and the Healthcare Infection Control Advisory Committee developed the first major guidelines for prevention of HAIs in the 1980s. In 1985, the Study on the Efficacy of Nosocomial Infection Control reported specific structures and processes linked to reduced infection rates. In this landmark study, it was suggested that as many as 30% of HAIs might be preventable.[1,2]

Healthcare delivery expanded rapidly over the next 2 decades, with shorter lengths of hospital stay and increasingly complicated surgical techniques, invasive procedures, and immunosuppressive therapy for cancer, transplants, rheumatologic conditions, and other diseases. The severity of illness and the age of inpatients increased, as did the prevalence of immunosuppression, implants, hardware, and invasive devices. Reported HAI rates remained relatively steady from 1975 through 1990, although we do not have an accurate surveillance system to track actual HAI rates from all hospitals in the United States.

In the 1990s, the Joint Commission increased regulation of hospital infection control activities, and quality improvement, quality assurance, and performance improvement programs expanded in hospitals. HAI rates reported to the National Nosocomial Infection Surveillance System declined throughout the decade, although there were significant increases in the rates of infections caused by antimicrobial-resistant organisms.[3] Alcohol-based hand hygiene products were introduced and became widely disseminated in hospitals to reduce the rate of infections. The CDC Epicenters Program began, in 1997, to fund research in the prevention and control of HAIs. In 1998, the Institute of Medicine report "To Err is Human" was published, and it ignited the patient safety movement, by focusing renewed attention on preventing adverse events and errors in health care.[4] By 1999, the National Nosocomial Infection Surveillance System had expanded to 285 hospitals in 42 states. The patient safety movement helped infection prevention and healthcare epidemiology, by broadening the approaches to include root cause analysis, failure modes and effects analysis, and sentinel event analysis.

Since 2000, the rate of change and the challenges to healthcare epidemiology and infection prevention have moved at the speed of light, compared with the prior 2 decades. The Agency for Healthcare Research and Quality funded patient safety research, and the National Nosocomial Infection Surveillance System evolved into the National Healthcare Safety Network, with an ever expanding number of participating hospitals.[5] There was enhanced public awareness of the importance of HAIs; and the CMS, the Joint Commission, the National Quality Foundation, the National Patient Safety Foundation, the Institute for Health Care Improvement, community-based organizations, and patient advocacy groups all became more active and collaborated to help prevent HAIs. Hospital epidemiology and infection control made a noticeable directional change from surveillance to interventions, first at single centers and then in multicenter initiatives. Successful interventions to reduce catheter-related BSI rates and ventilator-associated pneumonia rates in ICUs were reported, along with increasingly successful interventions using care "bundles," collaboratives, and regional initiatives.[6-13] Public reporting of HAIs increased, and the World Health Organization began the "Clean Care is Safer Care" Campaign to reduce HAIs on a global scale. Infection control measures became law in some states, along with laws requiring that rates of methicillin-resistant *S. aureus* (MRSA) infection be reported and that active surveillance for MRSA be performed. Chlorhexidine body washing has been reported to reduce infection rates in some settings,[14] and some centers reported dramatic reductions in the rate of MRSA infection with "search and destroy" approaches, including active surveillance, contact isolation, and decolonization therapy.[11] The CMS developed the value-based purchasing plan that is in-

tended to reduce payments to hospitals for HAIs and "never events." The continued reports of success in reducing the rate of HAIs, in some cases, to zero spurred interest in the "elimination of HAIs," "getting to zero," and "zero tolerance" slogans.

But what is zero? Although zero actually has several definitions, most of us think of zero as an arithmetical symbol denoting the absence of all magnitude or quantity. Usually, epidemiologists don't deal well with zero, because it lacks a denominator and a time frame for exposure risk. What about trying to eradicate HAIs? The CDC defines eradication as a permanent reduction to zero of the worldwide incidence of infection caused by a specific agent. Eradication occurs with deliberate efforts and creates an environment in which intervention measures are no longer needed.

There are specific criteria for infectious disease eradication initiatives: biologic feasibility (are humans the only reservoir?); the burden of disease, disability, and death; and the availability of an effective practical intervention (eg, drugs or vaccine). Ideally, interventions should be safe, inexpensive, long-lasting, and easily deployed. One must also assess the cost effectiveness of eradication, compared with the ongoing control measures, and understand the operational and technical feasibility of implementing eradication strategies.

Last, but not least, there has to be a global capacity for the political, financial, managerial, and technical support needed for worldwide initiatives. These considerations were all addressed when diseases like smallpox, polio, measles, dracunculiasis, lymphatic filariasis, onchocerciasis, Chagas disease, and Hansen disease were targeted for eradication. This model doesn't exactly work for HAIs, because we deal with many different organisms and types of infections, humans are not the only reservoir, many of the organisms are normal flora, and relatively limited scientific and operational resources have actually been dedicated to preventing HAIs. Elimination of infectious disease is defined as the reduction to zero of the incidence of infection in a defined geographic area. This requires ongoing intervention measures, because the agent still exists elsewhere and could be imported. This doesn't exactly fit HAIs, but it is an interesting model.

On the other hand, is the big, hairy, audacious goal a good model?[15] A big, hairy, audacious goal is a tangible, energizing, and highly focused goal that requires little or no explanation. It reaches out and grabs you in the gut. Ideally, a big, hairy, audacious goal preserves a business' core value and ideology, but some people think that a consistent pattern of making bold, risky investments in audacious projects stimulates forward progress. So, I can understand trying to eliminate ventilator-associated pneumonia, catheter-related BSI, and other HAIs as big, hairy, audacious goals. Why? Because we have been making progress in reducing the rate of HAIs. The National Nosocomial Infection Surveillance System reported that ventilator-associated pneumonia and BSI rates declined, from 2001 to 2004, in multiple types of ICUs.[3,5] The Pittsburgh Regional Health Initiative reported a 68% reduction in catheter-related BSI rates, in 32 hospitals in southwestern Pennsylvania, from 2001 through 2005.[11] Johns Hopkins Hospital reported dramatic reductions in rates of catheter-related BSI from 2001 through 2005 (Pat Rosenbaum, personal communication). Pronovost et al.[12] reported significant reductions in catheter-related BSI rates in Michigan hospitals that participated in the Keystone Center for Patient Safety Project. The Institute for Health Care Improvement's 100,000 Lives Campaign reported significant decreases in rates of HAIs, with several hospitals reporting reductions in rates of ventilator-associated pneumonia and of catheter-related BSI to zero.[10,16] At BJC hospitals, aggressive, targeted interventions reduced ventilator-associated pneumonia rates and catheter-related BSI rates, dramatically, over the past 8 years.[6,8,9,12]

The important point is understanding how and why HAI rates have been reduced. I think that, in hospitals that have successfully reduced HAI rates, there has been an increased focus on the specific mechanics of HAI prevention. There has been a culture change in many institutions. HAI prevention has become more multidisciplinary and team based; there is more administrative support and accountability.

In many settings, principles of patient safety, quality improvement, performance improvement, lean production, and Six Sigma have been incorporated into HAI prevention. Surveillance and feedback measuring processes and outcomes have gotten better and more timely. Enhanced reporting of HAI rates and enhanced transparency of reporting have helped focus attention on the problem, along with implementing multiple, iterative interventions, including education, evidenced-based policies and procedures, checklists, standardized orders, competency assessments, and monitoring tools. Marketing campaigns, visual aids, rewards, and incentives have also helped in our program. Additional measures suggested for fostering success in reducing HAIs include critical event analysis of each infection, engaging leadership and recruiting champions, daily assessment of devices, rapid response teams, infection control liaisons, weekly executive reports, focusing on systems reliability and simplification, and persistence. Interestingly, multiple different, often bundled, approaches have been used. Zell et al.[16] suggest that it requires strong will, application of evidence-based practices, and robust execution to get to zero.

It has been beneficial for healthcare workers to learn from highly reliable organizations and to adopt applications from other industries (from General Electric, Six Sigma; and from Toyota, lean production). The Institute for Health Care Improvement has taught us a great deal about the science of implementation and the value of "campaigns." The rates of HAIs have been reduced, because multidisciplinary groups worked together and shared best practices and success stories across hospitals and regions, so that they could be replicated, and because the focus was personal—protecting patients and saving lives.

There are a number of caveats, however. There have been dramatic reductions in the rates of HAIs seen in many hos-

pitals, yet actual reported data on national rates of HAIs are limited. It is very hard to comprehensively measure actual HAI rates and numbers and "lives saved." Reductions in HAIs don't always correlate with reduced mortality. Most publicly quoted national HAI numbers are based on limited 2002 data[17] and older estimates created before the dramatic declines in HAI rates. Recent reports of lowered HAI rates necessitate more accurate measurements and not just estimates. Our current HAI surveillance methods remain somewhat variable and imperfect. Most of the reductions in HAIs are reported in ICUs, but most HAIs occur outside the ICU, and we know less about the epidemiology and prevention of non-ICU HAIs.

There are still a number of challenges and limitations to the existing infection control knowledge base. It is very difficult to do randomized, controlled trials of infection prevention strategies. Infection prevention research and data are often limited by lack of funding and suboptimal study designs (eg, before-and-after studies without adequate controls, small sample sizes, single-center studies, short-term follow-up, limited patient populations, and inability to control for comorbidities or to perform multivariable analysis). There are many unanswered questions about the best ways to prevent infections, the cost-effectiveness of different interventions, and which aspects of care "bundles" are the most important. Whether better risk prediction models can be developed to target prevention strategies to the patients at highest risk, whether better risk stratification can be used to more effectively predict which HAIs are preventable across populations and centers, and whether reductions in mortality can be demonstrated along with reduced HAI rates remain to be seen. Given the current scientific evidence in the field, it is unlikely that all HAIs are preventable. Currently, we can only guess what proportion is actually preventable. Even in error-free settings with perfect healthcare delivery and implementation of best practices, HAIs can still occur. If we want to move beyond this limitation, we need to advance the science in the field.

Currently, the amount of federal and state resources dedicated to HAI prevention and research is not proportional to the estimated public health burden of HAIs. If we want to "eliminate HAIs," then we must work together to garner the additional resources for research and infection control programs, so that we can more effectively try to "eliminate HAIs." Otherwise, as a good friend once told me, "a vision without resources is just a hallucination."

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