Published in final edited form as:

Infect Control Hosp Epidemiol. 2010 November ; 31(Suppl 1): S14–S17. doi:10.1086/655991.

Implementation Science: How To Jumpstart Infection Prevention

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“And let it be noted that there is no more delicate matter to take in hand, nor more dangerous to conduct, nor more doubtful in its success, that to set up as a leader in the introduction of changes. For he who innovates will have for his enemies all those who are well off under the existing order of things, and only lukewarm supporters in those who might be better off under the new.”

- Niccolo Machiavelli, *The Prince* (1513)

A few centuries after Machiavelli offered his advice about how to effect change, a young, smart – and admittedly brash – physician took a new position in a famous European hospital. He quickly became dismayed at the unacceptably high mortality rate. After carefully considering many possible causes for the deaths, he proposed a relatively simple solution. By implementing his idea he demonstrated a dramatic decrease in mortality. He then attempted to spread his ideas and implement his simple solution elsewhere but was (mostly) ignored, ridiculed, and rejected. Defenders of the *status quo* forced him from his job. He confirmed his findings in a different hospital in a different European city, but practice elsewhere continued as before. His behavior became increasingly erratic, and he died at 47 in an insane asylum.

Thus ended the life of the famous Hungarian obstetrician, Ignaz Semmelweis (1818 – 1865). Semmelweis found that when medical personnel washed their hands with a chlorinated lime solution before examining women during childbirth, the incidence of puerperal sepsis and maternal death fell dramatically. Given the importance of the problem, the simplicity of his innovation, and the empiric findings demonstrating its efficacy, it is instructive to briefly consider possible causes for the non-adoption of findings.^{1, 2}

First, he did not publish his data in a timely manner. Some 13 years elapsed between his initial observations and his publication of a monograph containing those same findings. The implications for us are obvious – disseminated research in the peer-reviewed literature is today the coin of the realm. Second, his approach to those who disagreed with him was rather offensive. He wrote to one “you, Herr professor, have been a partner in this massacre” and to another that if he did not agree with Semmelweis, “I declare before God and the

world that you are a murderer.” This mode of interaction was notably unsuccessful in bringing others around to his way of seeing the world. Finally, Semmelweis did not have a conceptual model to explain his striking findings. Contemporaries made the logical observation that “it seems improbable that enough infective material of vapor could be secluded around the fingernails to kill a patient.” Semmelweis simply could not explain *why* an invisible amount of material under the fingernail could cause the death of a previously healthy young woman. Today we would appeal to the germ theory of disease, but when Semmelweis was trying to effect change, the germ theory was still decades away from being successfully articulated. Semmelweis had solid empirical data, but he lacked a conceptual model. As discussed below, a conceptual model is often critical if one wants successfully to implement change.

Consistently implementing evidence-based practices in everyday clinical encounters remains a challenge. Adults in the United States receive recommended practices only 54% of the time.³ Within infection prevention, recommended practices are also used variably. During central line insertion U.S. hospitals regularly use chlorhexidine gluconate site disinfectant or maximum sterile barriers (MSB) – two practices highly recommended to prevent catheter-related bloodstream infection – less than 75% of the time.⁴ The use of a urinary catheter reminder (or stop-order) to prevent catheter-related urinary tract infection – another highly-recommended practice – is used in less than 1 in 10 U.S. hospitals.⁵ Finally only about 40% of healthcare workers comply with recommended hand hygiene.⁶

Given this gap between what should be done and what is now being done, how can we better implement evidence-based practices in infection prevention? Perhaps we can learn from “implementation science,” which is defined as “the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice...”⁷ The term implementation science, as used in this paper, is synonymous with “T3” translation, theory-practice gap, knowledge transfer, and knowledge utilization. Although Semmelweis lacked a conceptual model, Everett Rogers’ work over the past 6 decades on “Diffusion of Innovation” has provided implementation researchers with a strong conceptual foundation.⁸ While “diffusion” (or spread) of an “innovation” (a new practice or idea) was originally applied to the study of agriculture, it has been helpful in describing what occurs in other areas, including healthcare. For example, Krein et al have modified the Rogers’ model for use in infection prevention (Figure 1).⁹ The decision to adopt and implement an infection prevention practice is influenced by practice characteristics (e.g., cost, evidence, usability), the organization (e.g., leadership, personnel, resources), and the environmental context (e.g., public reporting, pay-for-performance). The decision to adopt – for example, to codify the use of MSB during central line insertion into the hospital’s formal infection prevention policies – is distinct from the decision to implement, in which the hospital somehow ensures that central lines are consistently inserted using MSB. Only by effectively *implementing* evidence-based infection prevention practices can we reduce healthcare-associated infection.⁹

While Rogers’ model has been an effective basis for implementation science,⁸ it is a descriptive – not an action-oriented – model. It nicely describes what is occurring, but does not necessarily help hospital epidemiologists figure out what to do to implement change in their hospital.¹⁰ As recently reviewed by Damschroder and colleagues, several descriptive and action-oriented models have been published, many of which share similar features.¹⁰ For example, Greenhalgh and colleagues published a complex descriptive model based on their synthesis of research from numerous disciplines.¹¹ Additionally, Figure 2 shows the “4 E’s” model used in a successful infection prevention project;^{12,13} this action-oriented model incorporates several key elements from other models and would be a reasonable model to consider.

Despite recent advances in implementation science, several challenges remain. The first is determining how to sustain meaningful change. Ideally, any successful initiative should be institutionalized. Too often, healthcare organizations fail to consolidate gains made during one change process before proceeding to the next problem. Second, understanding context is incredibly important,¹¹ but not straightforward. Implementation within healthcare is often highly dependent on the setting, hospital personnel – both leadership and followership – and organizational culture (and micro-culture). Healthcare settings are unpredictable and non-linear. Implementation science is a clinical and a social discipline that has both “technical” components and “adaptive” ones.¹⁴ Therefore, using the tools from social science – such as qualitative research – may be necessary to better understand context.^{15, 16} Finally, while much attention has focused on underuse, given the rise in healthcare costs – in part driven by the use of new technologies – tackling overuse (or over-diffusion) of an innovation will be vital.¹⁷ In short, we need models to help us focus on “appropriate” use.

How should infection prevention advocates prepare for the next decade, one in which the national research agenda is likely to focus on implementation science? We offer several suggestions:

- Continue to define the technical components (what should be the key items in the toolkits or part of the bundle) while focusing also on the adaptive ones (how to adapt or tailor the intervention given the context).
- Collaborate with organizational behavioralists, other social scientists, and each other to develop approaches to address the dynamic role of context.
- Establish a research network to find out not only what works, but how it works and in what settings.
- Determine how to “institutionalize” change while avoiding the over-adoption of fads.
- Identify funders (e.g., National Institutes of Health, Agency for Healthcare Research and Quality (AHRQ), Centers for Disease Control and Prevention) that are willing to make large investments in understanding implementation science using infection prevention as an appropriate clinical model.

About a decade ago, the Institute of Medicine (IOM) released “To Err is Human: Building a Safer Health System”,¹⁸ a landmark publication that galvanized the public's attention on the issue of patient safety. Curiously, the only attention to infection prevention and hospital epidemiology was contained in just 5 paragraphs spanning two pages in Appendix E, representing about 0.5% of the total pages of the IOM report.¹⁹ The situation today is quite different. Through the work of infection prevention leaders throughout the world,²⁰⁻²² infection prevention is a major component of national and international efforts to enhance patient safety. For example, AHRQ's Critical Analysis of Patient Safety Practices²³ devoted about 16% of its chapters to infection prevention and hospital epidemiology. The Centers for Medicare and Medicaid Services (CMS), which recently decided that certain hospital-acquired complications are no longer reimbursable,²⁴ devotes 30% of the complications to infection prevention. Finally, roughly half of the initiatives in the “100,000 Lives” Campaign are related to infection prevention.²⁵ Thus, just as healthcare epidemiology has become the dominant paradigm for patient safety over the past decade,¹⁹ we hope that at the 6th Decennial, infection prevention will have emerged as a useful paradigm for implementation science.

Acknowledgments

Dr. Saint is currently supported by award R21-DK078717 from the National Institute of Diabetes and Digestive and Kidney Diseases and Drs. Saint and Krein are currently supported by award R01-NR010700 from the National Institute of Nursing Research. The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the National Institutes of Health or the Department of Veterans Affairs. Dr. Saint has received honoraria from the Institute for Healthcare Improvement (IHI) as an affiliated faculty member. None of the other authors have any relevant conflicts of interest related to the content of this manuscript. We thank Christine Kowalski, MPH, and Laura Damschroder, MS, MPH for their assistance in preparing this manuscript.

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Figure 1.
Conceptual framework for translating infection prevention evidence into practice.⁸

Figure 2.
The 4 E's: An action-oriented implementation model¹²