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Dissemination and implementation science for infection prevention: A primer

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Dissemination and implementation science (D&I) is a rapidly growing area of investigation. Although many evidence-based guidelines for infection prevention are available, not all are systematically implemented into clinical practice. This evidence-to-practice gap has been linked to poor health outcomes. D&I science bridges the gap between research and everyday practice by providing a knowledge base about how health information, interventions, and new clinical practices and policies are translated for use in specific settings. D&I science can expedite and sustain the successful integration of evidence into practice to improve care delivery, population health, and health outcomes. This article offers an introductory overview of D&I and addresses issues such as variation in terminology, finding and appraising evidence, theories and models, implementation strategies, and the future of D&I. Examples from the infection prevention literature are presented throughout.

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The field of dissemination and implementation science (D&I) bridges the gap between public health, clinical research, and everyday practice by providing a knowledge base about how health information, interventions, and new clinical practices and policies are translated for public health and health care service in specific settings.[1] The field explores new and innovative approaches, such as behavior change, engaging leaders, and adapting culture. D&I focuses on the social and behavioral aspects of moving discoveries from an experimental environment into widespread everyday practice. Implementation science focuses on what helps and what hinders the uptake, effective implementation, and sustainability of evidence-based programs in clinical practice.[2]

Implementation scientists have attempted to answer such questions as, How do we get the flu vaccine to the people who would benefit the most,[3] and how do we get clinicians to fully implement all steps of a clinical guideline?[4,5] Implementation science methodology can help infection preventionists (IPs) promote the adoption of effective interventions to reduce health care–associated infections (HAIs) in their diverse clinical settings. IP competency in this core domain is essential for patient safety.[6] This competency is predicated on an understanding of the knowledge discovery and implementation cycle. This article offers an introductory overview of D&I and addresses issues such as variation in terminology, finding the evidence in the literature, theories and models, implementation strategies, and the future of D&I. Examples from the infection prevention literature are presented.

TERMINOLOGY

Since D&I is a young field with national and international roots, terminology has not been fully standardized. D&I, as used in this article, is synonymous with knowledge translation and integration, a

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Table 1
Terminology for D&I science*

Term	Definition
Dissemination	The targeted distribution of information and intervention materials to a specific public health or clinical practice audience; the intent is to spread (scale up) and sustain knowledge and the associated evidence-based practice.
Implementation	The use of strategies to adopt and integrate evidence-based health interventions and change practice patterns within specific settings.
Evidence-based intervention	Interventions with proven efficacy and effectiveness; may include program, practices, processes, policies, and guidelines.
Adoption	The decision by an organization or community to commit to and initiate an evidence-based intervention.
Sustainability	The extent to which an intervention can deliver its intended benefits over an extended period after external support is terminated.
Reinvention/ adaptation	The degree to which an intervention is changed by a user during adoption and implementation to suit the needs of the setting or to improve the fit to local conditions.

D&I, dissemination and implementation science.
*Adapted from reference 7.

term used by the Canadian Institutes of Health Research. The terms commonly found in US literature are summarized in Table 1 and discussed extensively by Rabin and Brownson.[2]

EVIDENCE-BASED PRACTICE

Evidence-based practice is essential because our knowledge about health and illness is incomplete, the amount of health care information is ever-expanding and impossible to master completely, knowledge is constantly updated, and there is a constant need for innovation and improvement.[3] The importance of evidence-based practice in infection prevention is particularly relevant given the burden of HAIs. Questions have been raised regarding the evidence to prevent infections. These include questions about the existence of evidence that is generalizable to all settings and populations, the application of evidence in practice, and the quality and relevance of the evidence for current health care systems. A key to advancing evidence-based practice is formulating discrete and searchable questions. Typically, these are very specific and include a population, intervention, control or comparison, and outcome—also called a "PICO" question.

Bridging this gap between research and action to prevent HAIs requires an understanding of sources of scientific evidence and appraisal methods. Finding the evidence requires knowing how to search the literature, being familiar with the sources available, and having access to a computer and library resources. Selecting the appropriate database is essential to ensuring a thorough search of the most relevant literature. Librarians and informationists are resources that can assist in developing the question and navigating available data sources. Evidence is often categorized into primary and secondary sources. Primary sources are defined as journal articles, dissertations/theses, conference proceedings, and book chapters written by the individuals involved in the original research.[3] Secondary sources are written by those not involved in the original research. These include commentaries, summaries, reviews, and interpretations of primary sources, such as textbooks, newspapers, and magazine articles.

Scholarly works are written by and for professionals and traditionally published in peer-reviewed journals. This means that prior to publication, manuscripts are reviewed by a minimum of two peers familiar with the content and methodology and critiqued using a set quality criterion. Trade journals have a wider range of topics, including issues, trends, and developments within the profession. Popular literature is written to inform the public.[3] IP practice should be based on and guided by primary sources.

Once evidence is located, the IP must appraise its strength. Strength, sometimes referred to as the level of evidence, is often depicted in a hierarchy ordered by study design (Table 2). In this hierarchy, the highest strength (Level 1) of evidence is derived from systematic reviews that include randomized controlled trials. The lowest strength of evidence (Level 7) is derived from expert committees and opinion makers.[3] In between are single and combined systematic reviews of correlational and observational studies.[3] Much of the evidence that guides IP practice is derived from Levels 2 to 6 of the evidence hierarchy (Table 2).

It is important to recognize that the highest level of evidence for answering a specific question may not exist. Randomized controlled trials are quite rare in health services research in general, and infection prevention more specifically, because of the ethical risks and feasibility of conducting the study. Moreover, different types of clinical questions require different methodologic approaches. For example, qualitative approaches often uncover valuable insights into understanding new phenomena or barriers and facilitators to infection prevention practice. In the field of infection prevention, one of the most researched evidence-based practices is hand hygiene. An example of levels of evidence and sources of studies that have examined hand hygiene is presented in Table 2.

After locating the evidence and identifying where it fits in the evidence hierarchy, the scientific merit and clinical relevance of the research must be appraised. Studies should be evaluated by the methodologic design, rigor and quality, validity, and applicability.[3] Taken together, these characteristics can assist in evaluating the overall quality and strength of the evidence. Three overarching questions to guide an appraisal are (1) what are the results, (2) are the results of the study valid, and (3) how can I apply these results?

Many appraisal guides and tools are available to evaluate the quality of the study and the study design, such as the Critical Appraisal Skills Programme checklists (https://casp-uk.net/casp-tools-checklists/) and the Joanna Briggs Institute tools (http://joannabriggs.org/). For quality improvement projects, the SQUIRE guidelines are an excellent appraisal tool (http://www.squire-statement.org/). Common questions to consider when assessing the scientific merit and clinical relevance of research are listed in Table 3. Following the individual appraisal, key features of the study can be synthesized into an evidence table, typically including the study authors, title, reference, design, setting, findings, and level of evidence.

D&I MODELS AND FRAMEWORKS

Guidance, in the form of theoretical models and frameworks, is available to assist in the adoption and implementation of evidence-based practices. In 2012, 61 models were being used in D&I science.[8] Today, there are more than 100 models and frameworks available. The main reasons for using a model are to describe the process of translating research into practice, to explain what influences implementation, and to evaluate implementation. For example, models can help implementers identify key constructs that may serve as barriers or facilitators and inform data collection.[9] Of note, using a model throughout the research process will contribute to the study's success.

The most frequently used D&I models and frameworks are the Consolidated Framework for Implementation Research,[10] followed by the Reach, Effectiveness, Adoption, Implementation, Maintenance framework[11] and the diffusion of innovation model.[12] A brief summary of these 3 health care frameworks, the domains they cover, and an example of application of these models for infection prevention is presented in Table 4. For more information on selecting and adapting

Table 2
Hierarchy of evidence for hand hygiene compliance

Level of evidence	Description	Example article
Level 1	Evidence from a systematic review of all relevant RCTs or evidence-based clinical practice guidelines based on systematic reviews of RCTs	Priyanka Pamaiahgari BD. Evidence summary. Hand hygiene in hospitals: alcohol-based solutions. The Joanna Briggs Institute Evidence-Based Practice Database, JBI@Ovid. 2018; JBI671. Kingston L, O'Connell NH, Dunne CP. Hand hygiene-related clinical trials reported since 2010: a systematic review. J Hosp Infect 2016;92:309-20.
Level 2	Evidence obtained from at least one well-designed RCT	Ho HJ, Poh BF, Choudhury S, Krishnan P, Ang B, Chow A. Alcohol hand rubbing and chlorhexidine handwashing are equally effective in removing methicillin-resistant *Staphylococcus aureus* from health care workers' hands: a randomized controlled trial. Am J Infect Control 2015;43:1246-8. Reilly JS, Price L, Lang S, Robertson C, Cheater F, Skinner K, et al. A pragmatic randomized controlled trial of 6-step vs 3-step hand hygiene technique in acute hospital care in the United Kingdom. Infect Control Hosp Epidemiol 2016;37:661-6.
Level 3	Evidence obtained from well-designed controlled trials without randomization (ie, quasi-experimental)	Chun HK, Kim KM, Park HR. Effects of hand hygiene education and individual feedback on hand hygiene behavior, MRSA acquisition rate and MRSA colonization pressure among intensive care unit nurses. Int J Nurs Pract 2015;21:709-15.
Level 4	Evidence from well-designed case-control and cohort studies	Fakhry M, Hanna GB, Anderson O, Holmes A, Nathwani D. Effectiveness of an audible reminder on hand hygiene adherence. Am J Infect Control 2012;40:320-3. Al-Hussami M, Daraward M, Almhairait II. Predictors of compliance handwashing practice among healthcare professionals. Healthc Infect 2011;16:79-84.
Level 5	Evidence from systematic reviews of descriptive and qualitative studies	Smiddy MP, O'Connell R, Creedon SA. Systematic qualitative literature review of health care workers' compliance with hand hygiene guidelines. Am J Infect Control 2015;43:269-74. Picheansathian W. Effectiveness of alcohol-based solutions for hand hygiene: a systematic review. JBI Libr Syst Rev 2004;2:1-27.
Level 6	Evidence from a single descriptive or qualitative study	Salmon S, McLaws M. Qualitative findings from focus group discussion on hand hygiene compliance among health care workers in Vietnam. Am J Infect Control 2015;43:1086-91. Jackson C, Lowton K, Griffiths P. Infection prevention as "a show": a qualitative study of nurses' infection prevention behaviors. Int J Nurs Stud 2014;51:400-8.
Level 7	Evidence from the opinions of authorities or reports of expert committees	Centers for Disease Control and Prevention. Guideline for hand hygiene in health-care settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. MMWR 2002;51:(No. RR-16). Association for Professionals in Infection Control and Epidemiology. Guide to hand hygiene programs for infection prevention. Available from: https://apic.org/Professional-Practice/Implementation-guides#HandHygiene. Accessed November 10, 2018.

RCT, randomized controlled trial.

Table 3
Common article critique questions by section

Article section/ heading	Questions to consider
Abstract	• Is there a clear statement of the purpose of the article? • Is the methodology stated and are setting and sample briefly described? • Is the conclusion supported by results?
Introduction/ background	• Is comprehensive and current background provided to introduce the topic? • Is a gap in knowledge defined and how this study differs from other published studies stated? • Is the purpose of what is to follow clearly stated?
Methods and materials	• Are methods clearly described or referenced so the study can be replicated? • Is rationale for sample and setting size and selection stated? • Are all measures and instruments clearly defined and reliability and validity presented? • Are steps to minimize threats to internal and external validity described? • Are all clinically important outcomes and potential confounders considered?
Results	• What are the results? • Are they clearly presented with supporting statistical analyses or charts, graphs, and discussion? • How strong and precise are the results? • Are all statistical analyses appropriate given methods and accurately performed?
Discussion/ conclusion	• Are all results compared with current knowledge? • Are all conclusions based on the results presented in the study (not beyond)? • Are potential and actual biases and limitations acknowledged? • Will the results help locally? • Can they be applied to your context?

D&I models, we recommend www.dissemination-implementation.org.

IMPLEMENTATION STRATEGIES

Implementation strategies are the "how to" component of D&I science. They are defined as methods or techniques used to enhance the adoption, implementation, and sustainability of a clinical program or practice.[16] Implementation strategies focus on overcoming barriers and increasing the pace and effectiveness of implementation. These can be top down/bottom up, push/pull, and carrot/stick tactics and typically involve a bundled approach.[17] Implementation strategies include training and decision support; intervention-specific toolkits, checklists, and algorithms; formal practice protocols and guidelines; and learning collaboratives. Two well-known infection prevention studies that used these implementation strategies include the Michigan Keystone[18] and STOP CAUTI[19] projects. Business and organizational-based implementation strategies have been borrowed from the field of management science. These include plan-do-study-act cycles[20] and lean thinking,[21] both taught through the Institute for Healthcare Improvement programs (www.ihi.org).

A menu of 68 implementation strategies has been published.[22] This is split into 6 key processes: planning (eg, conducting a needs assessment), educating (eg, hosting educational sessions), financing (eg, offering incentives), restructuring (eg, revising professional roles), managing quality (eg, audit and feedback), and attending to policy context (eg, changing licensure requirements). Some may involve only a single component, such as dissemination of implementation guidelines, with the goal of changing clinical behavior. Examples include the Association for Professionals in Infection Control and Epidemiology implementation guidelines (www.apic.org/Professional-Practice/Implementation-guides). Others are combined to

Table 4
D&I models and frameworks

Model	Use	Domains	Infection prevention study
CFIR	Studying and planning implementation and analysis	• Intervention • Outer setting • Inner setting • Individuals • Process	PROHIBIT project[13]
RE-AIM	Guiding comprehensive evaluation of interventions	• Reach • Effectiveness • Adoption • Implementation • Maintenance/sustainability	Implementation of universal rapid HIV screening on labor and delivery[14]
Diffusion of innovation	Describing factors that could influence spread of a new practice	• Innovation • Communication channel • Time • Social system	TRIP study[15]

CFIR, Consolidated Framework for Implementation Research; *D&I*, dissemination and implementation science; *PROHIBIT*, Prevention of Hospital Infections by Intervention and Training; *RE-AIM*, reach effectiveness adoption implementation maintenance; *TRIP*, Translating Infection Prevention into Practice.

form a multifaceted strategy, such as training, consultation, and audit and feedback. There are also a number of branded multifaceted implementation strategies, such as the Institute of Healthcare Improvement's learning collaborative.[23] Examples of frequently applied implementation strategies used in infection prevention programs and their definitions[24] are outlined in Table 5.

IPs should approach the selection of implementation strategies in a similar fashion as evidence-based practices. IPs should evaluate if an implementation strategy has been scientifically tested, communicated clearly in the literature, accurately employed in a health care setting, and conceptually and operationally defined.[25] If these issues are considered up front, the measurement, testing, and effective deployment of select implementation strategies will result in generalizable knowledge that will move the field of infection prevention forward.

FUTURE OF D&I IN INFECTION PREVENTION

The overarching contribution and promise of D&I is to contribute to the nation's health care improvement goals to improve care and the health of populations, reduce health care costs, and improve the experience of providing care.[26] D&I fosters a systematic approach to the implementation, adoption, evaluation, and effectiveness of strategies within unique contexts. The promise of D&I for IPs emanates from D&I sensitivities to overarching health care improvement priorities in concert with local contextual factors.

Guidelines and evidence-based recommendations generally focus on the technical aspects of infection prevention but provide little guidance regarding how to deal with the social, cultural, and contextual considerations that are likely to influence implementation. D&I, as evidenced in the Association for Professionals in Infection Control and Epidemiology implementation guides, addresses these factors specifically. These include (1) intervention characteristics, such as the complexity, design quality, packaging, and cost; (2) patient needs and resources; (3) external policies and activities, such as mandatory reporting; (4) structural characteristics, such as networks and communication; (5) organizational culture and implementation climate; (6) readiness for implementation; and (7) availability of resources, including access to information and knowledge. D&I also incorporates characteristics of the individuals involved, such as knowledge and beliefs about the intervention and self-efficacy.

IPs have great potential to improve patient outcomes, as well as the health of populations, and reduce health care costs related to HAIs when guided by D&I terminology, models, and frameworks and applying skills of identifying and appraising evidence and implementation science. IPs may also find job satisfaction if they are given the tools and support to function to the best of their abilities. This includes competency in the rapid translation of evidence into practice. It is essential that infection prevention projects are evaluated, shared internally, and disseminated broadly through presentations and publications. This will build the body of evidence that supports the safest and highest quality infection prevention care for all.

Table 5
Implementation strategies frequently applied in infection prevention programs

Implementation strategy	Definition	Example
Audit and feedback	Collection and summarization of clinical performance data over a specified period and provision to clinicians and administrators for monitoring, evaluating, and modifying provider behavior	HAI benchmark report cards Public reporting
Facilitation	A process of interactive problem-solving and support that occurs in a context of recognized need for improvement and supportive interpersonal relationships	HAI-specific performance improvement projects
Strategy tailoring	Tailoring of implementation strategies to address barriers and leverage facilitators identified through earlier data collection	Preprocedure checklists
Champion identification and preparation	Identification and preparation of individuals who dedicate themselves to supporting, marketing, and implementing, overcoming indifference or resistance the intervention may provoke in an organization	Clinical champions
Educational material distribution	Distribution of educational materials (including guidelines, manuals, toolkits) in person, by mail, or electronically	APIC implementation guides

APIC, Association for Professionals in Infection Control and Epidemiology; *HAI*, health care–associated infection.

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