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## Practice Forum

## The master of public health graduate as infection preventionist: Navigating the changing landscape of infection prevention



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### Key Words:

Infection prevention  
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### A B S T R A C T

Infection prevention is a rapidly changing field with regulatory requirements and emerging global public health threats. Infection preventionists (IPs) must use advanced epidemiologic skills for health care–associated infection investigation and prevention. A potential talent pool for IPs is the Master of Public Health graduate. Those hiring IPs should consider master of public health graduates as candidates who can help drive the future of this profession.

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Infection prevention is a rapidly changing field with increasing regulatory requirements and emerging global public health threats, such as Ebola and Zika. The continual demand for infection prevention expertise should not diminish, and with approximately 40% of today's infection preventionists (IPs) likely to be retiring in the next 10–15 years, a threat can emerge to the maintenance and enhancement of realized infection prevention gains if IPs cannot be replaced. There is a need for IPs to use advanced epidemiologic skills for health care–associated infection (HAI) investigation and prevention.

According to the Infection Prevention and You campaign of the Association for Professionals in Infection Control and Epidemiology (APIC), “Infection Preventionists’ main responsibility is to prevent and control the spread of infections. IPs use their detective skills to find the bad germs and make sure that everyone is doing the right things to keep patients—as well as other healthcare professionals and visitors—safe.”<sup>1</sup>

Traditionally, IPs have been recruited from nursing and, less frequently, from the laboratory. One potential talent pool for IPs is

master of public health (MPH) graduates (which can also include a master of science in public health [MSPH] and doctor of public health [DrPH]). The MPH is a cross-disciplinary field, which covers epidemiology, health policy, health promotion, behavioral science, health care systems management, and occupational health. MPH graduates are trained in epidemiology, biostatistics, outbreak investigation, and health care research. They are comfortable with epidemiologic assessments and complicated data analysis. The skill sets that MPH graduates bring to the table are an asset to any infection prevention program and complement the strong nursing and education teams that are typically present in hospitals.

### DISCUSSION

Although the practice of infection prevention and control (IPC) has existed through the ages, the 1970s were a seminal decade for the profession of infection prevention in the United States.<sup>2</sup> In 1970, the Centers for Disease Control and Prevention held the First International Conference on Nosocomial Infections, which would later be known as the first organized training for IPs in the United States. Two years later, in 1972, the APIC, the professional association for IPs in the United States, was founded. Then in 1974, the Centers for Disease Control and Prevention conducted a project to study the efficacy of nosocomial infection control, which became known as SENIC (Study on the Efficacy of Nosocomial Infection Control). The project's aim was to determine whether infection control programs were successful in controlling nosocomial infections or

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HAIs in health care facilities.<sup>3</sup> The SENIC project led to the establishment of infection control programs in many health care facilities throughout the United States. “From a survey of all U.S. hospitals in 1976 and of a random sample in 1983, we found that the intensity of infection surveillance and control activities greatly increased, and the percentage of hospitals with an infection control nurse per 250 beds increased from 22% to 57%.”<sup>4</sup>

Despite this growing trend in infection control, staffing lagged until 2002, when the Delphi Project recommended a ratio of 0.8–1.0 full-time infection control professionals for every 100 occupied beds in acute care facilities.<sup>5</sup> This guideline helped many infection prevention departments to grow, because health care administration began to provide more funding to meet the bed size recommendations. The demands on and structure of many infection prevention departments began to change. Some IPs began to experience tension in this professional evolution,<sup>6</sup> but as Murphy et al<sup>7</sup> succinctly pointed out in 2002, “The choices to be made are clear: infection control practitioners (ICPs) can choose a leadership role, they can choose to be strong members of the team, or they can stay in their traditional role and hand over the data.” By 2007, Grant and Kim<sup>8</sup> highlighted that although IPs spent most of their time on surveillance activities, increased demands on IPs were driven by the changing nature of health care with more focus on quality and transparency.

In their 2018 study Bartles et al<sup>9</sup> make a strong case for improved infection prevention staffing owing to the changing nature of health care. “It is necessary to conduct a comprehensive assessment of the composition of a health care organization prior to determining the IPC staffing needs for that specific organization. Hospital size, scope, services offered, populations cared for, and type of care settings all impact the actual need for infection prevention coverage.”<sup>9</sup> Their study assessed infection prevention staffing needs at 1 IP per 69 licensed inpatient beds, rendering previous survey benchmarks in the literature invalid.<sup>9</sup>

### *Infection prevention in 2018*

The goal of infection prevention today is to decrease the burden of HAIs by implementing interventions that help clinicians to optimize performance and drive practice change to improve patient safety outcomes. However, this was not always the case. History has shown us that infection control was initially a profession of reaction, in which IPs spent a majority of their time on surveillance to “control” the spread of HAIs.<sup>10</sup> This change meant the field experienced a shift in focus from “controlling” infections after they spread to “preventing” them before they could occur.<sup>11</sup> The change of terminology from infection control to infection prevention, coupled with increased staffing levels, has changed the way the profession is viewed both internally and externally.

Today, the APIC has more than 15,000 members across the globe. According to the APIC, “Most APIC members are nurses, physicians, public health professionals, epidemiologists, microbiologists, or medical technologists who:

- Collect, analyze, and interpret health data in order to track infection trends, plan appropriate interventions, measure success, and report relevant data to public health agencies.
- Establish scientifically based infection prevention practices and collaborate with the healthcare team to assure implementation.
- Work to prevent HAIs in health care facilities by isolating sources of infections and limiting their transmission.
- Educate health care personnel and the public about infectious diseases and how to limit their spread.”<sup>12</sup>

The professional and practice standards established by APIC “provide direction and a framework for professional practice and define the scope, role, and minimal level of competency required of an infection Preventionist.”<sup>13</sup> As the field of infection prevention has evolved from a focus on surveillance, reporting, and education,<sup>14</sup> the function of the IP has expanded to include a much broader scope of responsibility, including program and financial management and regulatory and accreditation compliance. This expanded role of infection prevention in today’s complex health care environment requires rapidly evolving knowledge and skill sets to adapt to changing job needs.

We have a critical need to recruit talented new IPs who will drive our field forward in the coming decades. The APIC MegaSurvey found that 42% of IPs are 56 years of age or older, which means that many are likely to be retiring in the next 10–15 years (roughly from 2028–2033). More than one-third of APIC MegaSurvey respondents (38%) had 5 or fewer years of experience and may not yet be ready to replace the loss of expertise and experience that will come in the next decade.<sup>15</sup>

### **CHARACTERISTICS OF A STRONG IP**

What are the characteristics of a strong IP and how can an MPH graduate fill that role? There are several ways we can identify strong IPs. The first is through the use of APIC’s competency model. APIC’s Professional Competency Model for IPs has 4 distinct domains with patient safety at the center: leadership and program management, technical, IPC, and performance improvement and implementation science.<sup>16,17</sup>

The first benchmark of infection prevention competency is certification. The Certification Board for Infection Control (CBIC) examination for infection prevention consists of 7 core competencies: professional development, identification of infectious disease processes, surveillance and epidemiologic investigation, preventing/controlling the transmission of infectious agents, employee/occupational health, management and communication (leadership), and education and research. For IPs to be certified in infection prevention with the CMIC Certified in Infection Control “CIC” designation, IPs are expected to achieve competency in each of these 7 core areas.

Beyond CIC certification, APIC launched a fellows program in 2016. Those who qualify as an APIC fellow have the distinction of FAPIC. “The APIC Fellows program recognizes exemplary APIC members with status as a Fellow of the Association for Professionals in Infection Control and Epidemiology (FAPIC). Fellow of APIC status is a distinction of honor for infection preventionists who are not only advanced practitioners of infection prevention practice, but also leaders within the field.”<sup>18</sup> There are 307 IPs who qualified for the status of APIC fellow in 2016–2017 with a FAPIC designation. To qualify as an APIC fellow, the IP must have at least 7 years of infection prevention experience. She or he must provide activities that have occurred within the 10 years before applying for fellow status that demonstrate achievement in 3 of the 4 future-oriented domains of the APIC competency model. Starting in 2018, APIC fellows must have a master’s degree or higher.

### **MPH GRADUATES’ STRENGTHS**

Attaining an MPH requires candidates to develop a breadth of knowledge on epidemiology, population health, and interventions designed to improve health care and health outcomes. MPH functional and core knowledge areas complement the clinical skill sets already present in the hospital and in the infection prevention field. A professional with an MPH is a strong candidate for the field of infection prevention.

**Table 1**  
IP competencies and domains compared with MPH knowledge and training

2013 APIC competency self-assessment <sup>22</sup> IP competency categories, integrating both the APIC and CBIC domains	IP practice areas as identified in CBIC practice analysis	Addressed by MPH core knowledge area or foundational competency?			Council on Education for Public Health 2016 accreditation requirements <sup>20</sup> MPH foundational area
		Yes	Partially addressed	No	
Identification of infectious disease processes (CBIC)	1. Differentiate among colonization, infection, and contamination		X		Epidemiology core knowledge area
	2. Identify occurrences, reservoirs, incubation periods, periods of communicability, modes of transmission, signs and symptoms, and susceptibility associated with the disease process		X		Epidemiology core knowledge area
	3. Interpret results of diagnostic/lab reports			X	Not covered
	4. Recognize limitations and advantages of types of tests used to diagnose infectious processes		X		Biostatistics core knowledge area
	5. Recognize epidemiologically significant organisms for immediate review and investigation		X		Epidemiology core knowledge area
	6. Differentiate among prophylactic, empiric, and therapeutic uses of antimicrobials			X	Not covered
	7. Identify indications for microbiologic monitoring			X	Not covered
Surveillance and epidemiologic investigation (CBIC)	1. Design of surveillance systems	X			Epidemiology foundational competencies
	2. Collection and compilation of surveillance data		X		Biostatistics core knowledge area
	3. Outbreak investigation		X		Epidemiology core knowledge area
Future-oriented domain (APIC): technical	Example: electronic surveillance systems, access to/use of electronic databases/electronic data warehouse, other related applications, algorithmic detection and reporting processes, clinical decision support, infection prevention within the electronic health record	X			Biostatistics, health services administration foundational competencies
Preventing/controlling the transmission of infectious agents (CBIC)	1. Develop and review IPC policies and procedures	X			Foundational competencies
	2. Collaborate with public health agencies in planning community responses to biologic agents		X		Epidemiology core knowledge area and foundational public health knowledge
	3. Identify and implement IPC strategies according to specific topics:	X			Foundational public health knowledge
	• Hand hygiene		X		Social and behavioral sciences core knowledge area
	• Cleaning, disinfection, and sterilization		X		Environmental health sciences core knowledge area
	• Specific direct and indirect care settings			X	Not covered
	• Therapeutic and diagnostic procedures and devices			X	Not covered
	• Product/equipment recall procedures			X	Not covered
	• Use of isolation/barrier precautions when indicated			X	Social and behavioral sciences core knowledge area
	• Patient placement, transfer, discharge			X	Health services administration core knowledge area
	• Environmental hazards	X			Environmental health sciences foundational public health knowledge
	• Use of patient care products and medical equipment			X	Not covered
	• Patient immunization programs			X	Epidemiology core knowledge area and foundational public health knowledge
	• Construction and renovation	X			Environmental health sciences foundational public health knowledge
• Influx of patients with communicable diseases			X	Epidemiology core knowledge area	

(continued)

Table 1 (Continued)

2013 APIC competency self-assessment <sup>22</sup> IP competency categories, integrating both the APIC and CBIC domains	IP practice areas as identified in CBIC practice analysis	Addressed by MPH core knowledge area or foundational competency?			Council on Education for Public Health 2016 accreditation requirements <sup>20</sup> MPH foundational area
		Yes	Partially addressed	No	
Future-oriented domain (APIC): IPC	Examples: ability to apply and use surveillance data and reports, advanced statistical methods and tools, including application of the standard infection ratio, risk assessment, hazard vulnerability analysis, use and evaluation of emerging prevention practices for patient care, diagnostic methods, participation in antimicrobial stewardship programs	X			Biostatistics, epidemiology foundational competencies
Management and communication (leadership) (CBIC)	1. Planning	X			Health services administration foundational competencies Foundational competencies Social and behavioral sciences core knowledge area
	2. Communication and feedback	X			
	3. Quality/performance improvement and patient safety		X		
Future-oriented domain (APIC): leadership and program management	Examples: leads integration of prevention activities within and across departments, high-level negotiation skills, financial/value analysis of programs and related projects, relationship management, ability to influence and persuade up to and including executive level, team and consensus building within and across stakeholder groups	X			Health services administration foundational competencies
Education and research (CBIC)	1. Education		X		Foundational competencies Epidemiology foundational public health knowledge
	2. Research	X			
Future-oriented domain (APIC): performance improvement and implementation science	Examples: leads performance improvement teams for institution/system, develops extraprofessional competencies, applies translational research methods, uses advanced performance improvement tools/methods, focus on reliability and sustainability	X			Foundational competencies
Employee/occupational health (CBIC)	1. Review and/or develop screening and immunization programs		X		Epidemiology core knowledge area and foundational public health knowledge Not covered
	2. Provide counseling, follow-up, work restriction recommendations related to communicable diseases or after exposures			X	
	3. Assist with analysis and trending of occupational exposure incidents and information exchange between occupational health and IPC departments			X	

APIC, Association for Professionals in Infection Control and Epidemiology; CBIC, Certification Board for Infection Control; IP, infection preventionist; IPC, infection prevention and control; MPH, master of public health.

The Association of Schools and Programs of Public Health lists the following core competencies for MPH programs: biostatistics, environmental health sciences, epidemiology, health policy and management, social and behavioral sciences, communication and informatics, diversity and culture, leadership, public health biology, professionalism, program planning, and systems thinking.<sup>19</sup> Competencies from an MPH program that are relevant to infection prevention include the following:

- Identify key sources of data for epidemiologic purposes,
- Calculate basic epidemiologic measures,
- Communicate epidemiologic information to lay and professional audiences,
- Draw appropriate inferences from epidemiologic data, and
- Evaluate the strengths and limitations of epidemiologic reports.

Schools of public health and public health programs are accredited by the Council on Education for Public Health, which sets educational requirements and conducts peer-reviewed program evaluations.<sup>10</sup> The Council on Education for Public Health has established a set of foundational competencies that include public health core knowledge areas and foundational public health knowledge

**Table 2**Outbreak investigation skills from the Association for Professionals in Infection Control and Epidemiology roadmap for the novice infection preventionist<sup>23</sup>

Stage 1: days 1–60	Stage 2: days 61–120	Stage 3: day 121 to end of year 1	Stage 4: beginning of year 2 to passing the certification in infection control examination
<b>Begin to learn the steps to investigate a cluster/outbreak:</b> <ul style="list-style-type: none"> <li>• <b>Verify diagnosis of reported cases</b></li> </ul>	<b>Learn the steps to investigate a cluster/outbreak:</b> <ul style="list-style-type: none"> <li>• <b>Collaborate with appropriate persons to establish the case definition, period of investigations, and case-finding methods</b></li> <li>• <b>Define the problem using time, place, person, and risk factors</b></li> <li>• <b>Confirm that an outbreak exists</b></li> <li>• <b>Formulate hypothesis on source and mode of transmission</b></li> <li>• Implement and evaluate control measures, including ongoing surveillance</li> <li>• Summarize findings and present to key stakeholders</li> </ul>	<b>Learn the appropriate use of culturing during an outbreak:</b> <ul style="list-style-type: none"> <li>• Health care worker culturing</li> <li>• <b>Collection on environmental samples that may be linked epidemiologically to outbreaks</b></li> </ul> <b>Understanding the role of pulse field gel electrophoresis and whole genome sequencing in outbreak investigation</b>	<b>Prepare reports for dissemination, evaluate strategies implemented for control</b>

NOTE. Skills in bold represent areas where the MPH prepared early career IP may already have academic training or experience from their MPH program. Those skills not in bold are skills that the new MPH IP is not likely to have when beginning the role.

and skills competencies that must be demonstrated by MPH candidates before graduation.<sup>20</sup>

These core knowledge areas and skills<sup>21</sup> align well with the knowledge and skills required for infection prevention practice<sup>22</sup> (Table 1). Seventy-eight percent of infection prevention practice areas (29/37) in the 2013 APIC/CBIC competency self-assessment are covered by MPH foundational competencies.<sup>21</sup> Thirty-two percent of infection prevention practice areas defined in the CBIC practice analysis are fully covered by the minimum foundational competencies required by accredited MPH programs (12/37).<sup>21</sup> Forty-six percent of infection prevention practice areas are partially covered by either foundational competencies or core knowledge areas (17/37).<sup>13</sup> However, an individual's skills in these areas may vary significantly, depending on their area of concentration and research in their course of study. Only 8 of the practice areas covered in the practice analysis are not addressed by the typical MPH program.<sup>20,21</sup>

MPH graduates are particularly strong in the future-oriented domains of the APIC competency model: leadership and program management, IPC, technology, and performance improvement/implementation science.<sup>16</sup> Although most MPH students focus on larger scale community health, the focus areas of the MPH program translate well to the smaller population of the health care environment. An MPH graduate's training in epidemiology provides a strong foundation to infection prevention programs, because infection prevention departments are essentially practicing hospital epidemiology; they are charged with looking at the distribution and determinants of health care–associated diseases every day.

**Table 3**

How infection preventionists spend their time

	Association for Professionals in Infection Control and Epidemiology MegaSurvey Methodology <sup>15</sup>
Surveillance/investigation	25.4
Prevention/control transmission	15.6
Identification of infection	14.2
Management/communication	12.2
Education/research	10.3
Environment	9.5
Cleaning/sterilization	8.7
Employee/occupational health	8.0

## WHAT TO DO WHEN THE MPH DOES NOT HAVE CLINICAL TRAINING

### Training and clinical skill development

The APIC MegaSurvey explored “the expansion of the IP workforce to include professionals from non-clinical backgrounds” and the benefit to health care organizations to have IPs from diverse educational and professional backgrounds.<sup>15</sup> Many health care facilities may have concerns that an IP with an MPH background may be missing clinical skills that clinicians (eg, physicians, registered or licensed vocational nurses, or medical technologists) bring to the position. Effective infection prevention practice requires a strong understanding of the clinical provision of care and the workflow and barriers faced by hands-on care providers. However, the duties and responsibilities of the IPs are not clinical in nature. Bedside care and treatment of patients are not provided by IPs. Instead, IPs must be trained to identify lapses in the practice of bedside caregivers so that improvements can be made to reduce HAIs.

Only 8 of the 37 infection prevention competencies outlined in the APIC competency self-assessment are not addressed by typical MPH programs<sup>20,21</sup>:

- Identification of infectious disease processes: interpret results of diagnostic/laboratory reports; differentiate among prophylactic, empiric, and therapeutic uses of antimicrobials; identify indications for microbiologic monitoring.
- Preventing/controlling the transmission of infectious agents (CBIC): identify and implement IPC strategies for specific direct and indirect care settings; therapeutic and diagnostic procedures and devices; product/equipment recall procedures; use of patient care products and medical equipment.
- Employee/occupational health: provide counseling, follow-up, and work restriction recommendations related to communicable diseases or after exposures.

APIC's Roadmap for the Novice Infection Preventionist can provide the groundwork for training new IPs from various backgrounds.<sup>23</sup> The roadmap is a training guide broken down by CBIC examination content and professional stages. Each step in the roadmap provides examples of training needed to master competencies and reading assignments from the APIC text for both clinical and nonclinically trained IPs. The roadmap takes IPs from day 1 on the job through the

passing of the CIC examination, regardless of background before starting the IP role.

Each new IP will come to the role with a unique background, skills, and experiences. The tasks and skills contained in the APIC roadmap can be used to guide the training and initial skill development of the early career IP. An initial knowledge and skills and assessment should be performed to determine where the IP has academic training or prior experience and, what additional competencies and skills needed so that a training and development plan can be developed that is tailored to the individual's needs (Table 1).

For example, an MPH entering the field of infection prevention may already have very strong skills in the category of "surveillance and epidemiologic investigation." To use the cluster/outbreak investigation skills as a model, the novice MPH IP will have academic training and experience in the items in bold in Table 2 and should need job-specific training in the application of those skills within their facility or program. For the other, nonbolded items, the novice MPH IP will need training and skill development.

#### Core work processes

Several studies have categorized the time IPs report spending on routine duties and core work processes,<sup>9,14,15,24,25</sup> the most recent of which is the APIC MegaSurvey.<sup>15</sup> Surveillance/infection, prevention/control transmission, and identification of infections take up a majority of an IP's time (Table 3.) Of these domains, occupational/employee health requires the highest level of clinical skill and may require clinical licensure, depending on the duties or job role within the organization. Many MPH graduates will not have this training if they do not have other clinical education/training such as in nursing or medicine. However, IPs report spending only 8% of their time on employee/occupational health activities.<sup>15</sup> The MPH-prepared IP will likely need exposure assessment and postexposure management training as a part of their orientation and on-the-job training to advise the employee/occupational health departments in exposure assessments. In most health care facilities, infection prevention partners with employee/occupational health nurses who oversee postexposure follow-up and prophylaxis, if required. Infection prevention's role is best spent advising employee/occupational health and not actually providing clinical care to exposed employees or managing the post-exposure follow-up process.

MPH-prepared IPs are also likely to need significant training with clinical process owners to understand nursing and medical care practices, such as appropriate Foley catheter or central line insertion and maintenance practices. Although the IP does not perform those tasks, they should understand the associates processes, risk points, and evidence-based practice recommendations.

#### Health care experience

Informal networking reveals that MPH graduates often enter infection prevention early in their careers, either directly from masters programs with little professional experience, or after experience in other related fields, such as public health epidemiology or health education. This is a different pattern of entry into the field than has been seen in the past. Many current IPs transitioned into the field from other health care roles, with nearly one-half (5,122/3,170 [48%]) having more than 15 years of health care experience before becoming an IP.<sup>15</sup> In reviewing responses for IPs in the role of infection prevention coordinator or practitioner (61% of respondents), rather than leadership roles, currently 16% (298/928) have 5 years or less of health care experience before becoming an IP.<sup>15</sup>

Infection prevention is a very different role than others in the health care field and requires significant development and training to reach competency for all new practitioners.<sup>16,26</sup> Based on

the APIC MegaSurvey results, 41% of IPs (1,297/3,152) have 5 or fewer years in the field.<sup>15</sup> Most health care organizations have support and career development opportunities for new hires. However, this is difficult for health care organizations to provide if their IP is a sole practitioner or part of a very small department. Many health care organizations do not have a deep understanding of the training and development needs of an IP. Thus, use of the APIC roadmap, competency self-assessment tools, and educational resources can help to structure the new IP's baseline training to competency and certification and can help to guide early career development.

#### Cross-functionality

A registered nurse or other clinician can be cross-functional and serve other roles within a health care organization, such as employee health nurse, thereby adding additional "value" to their hire. Although there are few data on program effectiveness and outcomes when IPs fill multiple roles rather than specializing in infection prevention, in our experience, when an IP covers infection prevention and other responsibilities such as employee/occupational health, the demands of a role such as employee/occupational health dominates their time and attention and the infection prevention program can suffer.

An IP is a valued team member in the effort to improve patient safety. IPs can play a key role in value-based purchasing within health care organizations for reimbursement of inpatient and outpatient core measures. The MPH-prepared IP can also be cross-functional in areas such as performance improvement, program management, regulatory compliance, education, and data analysis. Many MPH graduates come with backgrounds in health care policy or management. They can support health care organizations in navigating changes in reimbursement and payment structures, as well as assessment of financial and operational impact to local and national health care policy. MPH graduates can strengthen the infection prevention department's expertise to help change the culture of the health care environment to improve patient outcomes through decreased HAIs.

#### CONCLUSIONS

Approximately 25% (76/307) of the 2016-2017 APIC fellows are MPH, MSPH, or DrPH graduates.<sup>18</sup> Thirteen percent (40/307) of APIC fellows who have public health training with an MPH, MSPH, or DrPH do not have nursing or medical degrees, whereas 11% (34/307) of MPH, MSPH, or DrPH graduates have either nursing or medical degrees.<sup>18</sup> Consequently, 33% of IPs (100/307) who received the APIC fellow designation in 2016-2017 do not have nursing or medical degrees.<sup>18</sup> They have either public health and/or laboratory training.

As demands for IPs grow and as the field faces a potential future loss of expertise because approximately 40% of today's IPs will be retiring in the next 10-15 years, more IPs are needed.<sup>15</sup> The skill sets that MPH graduates bring to the table are an asset to any infection prevention program to sustain realized patient safety gains with decreased HAIs and can complement the strong nursing and education teams that are typically present in hospitals. A professional with an MPH degree is a strong candidate for infection prevention, either as a member of a team or as a solo practitioner. Those who are in the position to hire IPs should consider MPH graduates as strong candidates who can help to drive the future of this profession to decrease HAIs and promote overall patient safety efforts with their epidemiologic skills.

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