State of the Science Review

Impact of certified infection preventionists in acute care settings: A systematic review

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ABSTRACT

Background: Health care-associated infection (HAI) is a common adverse event affecting patient safety. This review aims to (1) establish evidence for the impact of certified infection prevention and control (CIC) specialists on infection prevention and patient safety in acute care settings and (2) summarize study design and statistical modeling used for impact assessment to inform future studies.

Methods: We searched and reviewed full-text, quantitative studies assessing the impact of CIC. The studies used empirical data published in English between January 2000 and April 2021 in PubMed, PsycINFO, and EMBASE. We identified 9 articles for data extraction and analysis. All eight studies used a cross-sectional design and had a quality rating of good to high based on the Johns Hopkins Nursing Evidence-Based Practice rating scales.

Results: CIC infection preventionists (IPs) may have a stronger understanding than other practitioners of the evidence for certain infection prevention practices and are more likely to recommend implementing them in the hospitals where they work, especially when the lead IP is certified. The association between CIC and HAI rates was inconsistent in our results.

Discussion and Conclusions: Further studies are needed to explore the impact of CIC IPs on HAI rates.

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Key Words: Certification Infection prevention Review Quality improvement Hospital Patient safety

Over the last fifteen years, the US health care system and its patients have paid an increasingly high price for adverse events. The health care system needs safe and reliable delivery systems to prevent common causes of patient harm.1–4 Health care-associated infection (HAI) is among the most common adverse events affecting patient care. An estimated 648,000 patients in acute care hospitals across the United States develop HAI annually, with 75,000 related deaths.5

Infection preventionists (IPs) play a significant role in preventing HAI in US hospitals. Defined by the Association for Professionals in Infection Control and Epidemiology (APIC), IPs are “experts in identifying sources of infections and limiting their transmission in healthcare facilities.” The Centers for Medicare and Medicaid Services (CMS)

require that all hospitals designate at least one IP to conduct surveillance and develop and implement intervention strategies to prevent and control infections.6 IPs must be familiar with the guidelines and literature on infection prevention and control (IPC) and recommend evidence-based practices. They may also lead organizational efforts of IPC practice implementation and improvement.

IPs can obtain certification in infection prevention and control, a designation that requires passage of a comprehensive examination to demonstrate mastery of 8 core competencies. The core competencies are (1) identification of infectious disease process; (2) surveillance and epidemiologic investigation; (3) prevention and control of the transmission of infectious agents and health care-associated infection; (4) occupational health; (5) communication and management; (6) education and research; (7) management of the health care environment; and (8) cleaning, sterilization, disinfection, and asepsis.7 The Certification Board of Infection Control and Epidemiology (CBIC) is the sole organization offering certified infection prevention and control (CIC) specialist designation in the US. The CBIC provides standardized knowledge assessment for practicing IPC, encourages professional learning and growth, and recognizes individuals that

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achieve the certification requirements. According to the APIC's Meg-aSurvey administered in 2015, 43% of the APIC-member IPs were CIC certified, and another 38% planned to obtain the certification in the near future.8

Better insight into the work and impact of CIC IPs on IPC and patient safety within hospitals is needed to assist hospital leadership and payers with resource deployment and policy making. Therefore, we conducted a systematic review to establish evidence of the impact of CIC on IPC and patient safety. The review focused on empirical, quantitative studies that aimed to quantify the impact in acute care settings. Our secondary objective was to inform future studies by collecting information on study design, frameworks, and statistical modeling used for impact assessment.

METHODS

We conducted the review with pre-specified protocols per the preferred reporting items for systematic reviews and meta-analyses (PRISMA).9

Search strategy

We searched studies published in English between January 1, 2000, and April 30, 2021, in the following scientific databases: PubMed, PsycINFO, and EMBASE. We tailored search terms to be inclusive and cover studies related to certification in infection prevention and control (see Table 1). The lead author (YJH) also manually searched articles to test the search terms and used the snowball approach for relevant articles. We then scanned references and citations from the included articles to further identify eligible papers.

Study inclusion and exclusion criteria

To be included, a study had to meet the following criteria: (1) English-language; (2) full-text published in a peer-reviewed journal; (3) assessing the impact of the certification or CIC IPs using empirical data; and (4) including at least one outcome measure related to IPC or patient safety. We excluded qualitative studies.

Two researchers (YJH and EN, or YJH and ZZ) independently assessed the eligibility of the retrieved articles. We based the first assessment on title and abstract. We retrieved and reviewed the full text of an article if the title and abstract provided insufficient information to determine eligibility. A full-text review then helped determine whether an article fulfilled all the inclusion criteria for the final selection.

Data extraction and synthesis

We developed a standardized form for data extraction for the studies included in our review. The pre-specified elements extracted included study design, study sample (unit and size), measurement of the certification variable, outcome measure(s), and principal findings regarding the impact of the certification. To gather information to inform future studies, we also extracted covariates adjusted in the regression models, if any, and whether the study examined any mediating or moderating effects. One researcher (EN or ZZ) extracted the data from each included study, and a second researcher (YJH) examined the extracted data. We described and organized study characteristics (eg, study design) and outcome measures for all included studies. We also analyzed and grouped covariates included in the statistical analysis, if any. The categorization of covariates included respondent characteristics, facility structure, facility process, and external facility characteristics. We based the definition of structure and process on Donabedian’s structure-process-outcome (SPO) categorization.10 Structure refers to the physical, organizational, and human capacity of a health care facility (eg, equipment, personnel). Process refers to providing care (ie, practitioner activities) and receiving care (ie, patient activities). Outcomes are the effects of care described at a patient or population level.

We did not expect that studies examining the impact of CIC would adjust for outcomes as covariates. The external facility characteristics are covariates representing broad policy, regulations, and the community or patients a facility serves.

Rating of selected studies

We used the Johns Hopkins Nursing Evidence-Based Practice (JHNEBP) evidence rating scales11 to appraise the level of evidence in this literature review. The JHNEBP tool assesses each study’s study design, results, and conclusions and then assigns a quality grade of ‘high quality,’ ‘good quality,’ or ‘low quality or major flaws’ to help determine the strength of evidence.

RESULTS

Search results

The scientific database search yielded 2,141 articles (Fig 1). After excluding duplicates, the title and abstract review resulted in 12 articles for full-text review. Five articles met all inclusion criteria. We then identified 3 additional articles through citations in the included articles and hand search. Ultimately, we used 8 articles for data extraction and analysis.

Study characteristics

We summarized study characteristics and primary findings regarding the impact of CIC based on the included studies in Table 2.

Study design and measures

All 8 articles used a cross-sectional design to examine the association of certification with outcome measures. Based on the JHNEBP evidence rating scales, all articles had a strength of evidence rating of level II out of 5 and a quality rating of A/high or B/good. Two of the studies, both survey studies, were conducted at the individual IP level. One compared the perceived strength of evidence supporting infection prevention practices between certified and non-certified IPs;12 the other compared a vaccine program score developed to measure self-reported adherence to the CDC’s and ACIP’s recommendations regarding vaccine handling and management.13

The other 6 studies were conducted at the hospital level. The certification-related independent variable was defined as whether the supervisory or lead IP was certified or whether there was a CIC IP in the hospital. Three studies examined self-reported adoption or use of specific infection prevention practices.14–16 The remainder

| Table 1 |
| --- | --- |
| **List of search terms** | **Search term** |
| 1 | Certification Board of Infection Control and Epidemiology |
| 2 | Certified infection preventionist(s) |
| 3 | Certified infection prevention and control professional(s) |
| 4 | Infection prevention certificate |
| 5 | CIC-certified |
| 6 | CIC certification |
| 7 | CIC credential |
| 8 | Certified in infection control |
| 9 | Certification examination AND infection control |
used HAI-related outcome measures, such as infection rates or CMS hospital-acquired condition domain scores.\textsuperscript{17–19}

\textbf{Covariate adjustment and analysis}

None of the included studies examined mediating or modifying effects. One study (individual level) did not include any adjustments.\textsuperscript{13} One study (hospital level) was a data brief, and it was unclear what covariates were included in the regression analysis.\textsuperscript{18} The other individual-level study adjusted for IP individual characteristics (eg, length of time in current position) and hospital characteristics (eg, bed size, whether the hospital participates in a collaborative to reduce HAI).\textsuperscript{12} In the hospital-level studies, 3 types of covariates were included:

1) \textit{Hospital-level or unit-level structural variables}: Examples included bed size, teaching status, and academic affiliation. Most of the studies also included staffing, nurse staffing, and infection prevention staffing (eg, whether a hospital had a hospital epidemiologist, total infection control staffing hours).

2) \textit{Process variables}: One study adjusted for infection control screening, contact precautions, and surveillance practices in health care facilities when examining the association between infection control department characteristics and multidrug-resistant infection rates.\textsuperscript{19}

3) \textit{External characteristics}: Region or geographic location.

\textbf{Impact of certification}

In the 2 individual-level studies that examined self-reported measures, CIC status was associated with higher self-assessed competency and greater perception of evidence strength for several IPC practices. These practices included antimicrobial stewardship programs, nurse-initiated urinary catheter discontinuation protocols, and sedation vacations.\textsuperscript{12} CIC status was associated with better self-reported vaccine management and handling.\textsuperscript{13} However, CIC status was negatively correlated with perceived strength of evidence for other practices, such as routine changes of central venous catheter, oscillating/kinetic beds, and antimicrobial mouth-rinse.

All 3 hospital-level studies that examined the use or adoption of infection prevention practices reported a positive impact on CIC status.\textsuperscript{14–16} Hospitals with a lead certified IP or a greater proportion of certified IPs were more likely to implement certain practices, including subglottic secretion drainage to prevent ventilator-associated pneumonia (VAP), use of antimicrobial central venous catheters and avoidance of routine central catheter changes to prevent central-line associated bloodstream infections (CLABSIs) and screening new admissions.

One of 3 studies of the association between CIC status and HAI rates reported positive findings. Hospitals with a certified infection control director had lower rates of Methicillin-Resistant Staphylococcus Aureus (MRSA) infection after controlling for structure and process variables.\textsuperscript{19} The other 2 studies did not find an association between CIC status and surgical site infection (SSI) or Clostridium difficile infection (CDI) rates at the hospital level.\textsuperscript{17,18}

\textbf{DISCUSSION}

We systematically reviewed the literature for the impact of certification in infection prevention and control on HAI prevention and patient safety in the US. Our review suggested that CIC IPs may have a stronger understanding than other practitioners of the evidence for certain infection prevention practices. CIC IPs were also more likely to recommend implementing these practices in the hospitals where they worked, especially as the lead IP. The finding is consistent with core competencies that certification aims to build among CIC IPs. However, the association between CIC status and HAI rates was inconsistent. The 3 studies on the association between CIC status and HAI rates examined different types of infections, used different measures for the CIC status of acute care facilities (eg, whether any of the IPs were CIC versus whether a hospital’s infection control director...
Table 2  
Summary of included studies

<table>
<thead>
<tr>
<th>First author &amp; publication year</th>
<th>Sample size</th>
<th>Study design</th>
<th>Outcome variable(s)</th>
<th>Primary independent variable(s)</th>
<th>Covariates</th>
<th>Summary of results</th>
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<tr>
<td>Saint, S et al. (2013)12</td>
<td>478 IPs</td>
<td>Cross-sectional design</td>
<td>Perceived strength of evidence for use of HAI* prevention practices</td>
<td>Whether the IP is CIC</td>
<td>Number of years the respondent has been in their current position, number of full-time equivalent IPs, hospital bed size, hospital participation in a collaborative focused on reducing HAI</td>
<td>CIC status was significantly associated with stronger perceived strength of evidence for several practices, including antimicrobial stewardship programs, nurse-initiated urinary catheter discontinuation protocols, and sedation vacation. CIC status was also significantly associated with decreased perceived strength of evidence for other practices, including routine central venous catheter changes, oscillating/kinetic beds, antimicrobial mouth-rinse.</td>
</tr>
<tr>
<td>Carrico, RM et al. (2013)13</td>
<td>1006 IPs</td>
<td>Cross-sectional design</td>
<td>Adherence to recommendations regarding vaccine selection and administration, vaccine handling and management, and training</td>
<td>Whether the IP is CIC</td>
<td>None</td>
<td>CIC IPs scored significantly higher in overall program performance than non-certified IPs.</td>
</tr>
<tr>
<td>Krein, SL et al. (2007)14</td>
<td>516 hospitals</td>
<td>Cross-sectional design</td>
<td>Regular use of specific practices for preventing catheter-related bloodstream infections</td>
<td>Whether a hospital’s supervisory ICP is a CIC IP</td>
<td>Hospital characteristics: hospital type (non-federal vs. Department of Veterans Affairs medical centers), number of intensive care unit beds, registered nurse staffing, level of facility support for evidence-based practices, county population, and metropolitan location</td>
<td>Hospitals with a supervisory ICP that was CIC were more likely to use antimicrobial central venous catheters and avoid routine central catheter changes.</td>
</tr>
<tr>
<td>Krein, SL et al. (2008)15</td>
<td>516 hospitals</td>
<td>Cross-sectional design</td>
<td>Use of following infection prevention practices: semirecumbent positioning, antimicrobial mouth rinse, subglottic secretion drainage, and oscillating or kinetic beds. Adoption of screening and infection control interventions for multi-drug-resistant organisms</td>
<td>Whether the lead ICP is CIC</td>
<td>Whether the facility had a hospital epidemiologist, whether the facility was participating in a collaborative effort to encourage the use of infection control practices, academic affiliation, nurse staffing</td>
<td>If the ICP was CIC, the facility was significantly more likely to report regular use of subglottic secretion drainage.</td>
</tr>
<tr>
<td>Pogorzelska, M et al. (2012)16</td>
<td>250 hospitals</td>
<td>Cross-sectional design</td>
<td>Proportion of CIC IPs</td>
<td>Screening practices, number of infection control staff, bed size, and region</td>
<td>Intensive care units in hospitals with a greater proportion of CIC IPs were less likely to report correct implementation of policy to screen new admissions after controlling for the number of infection control staff and region.</td>
<td></td>
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<tr>
<td>Musuza, JS et al. (2020)17</td>
<td>126 VA acute-care facilities</td>
<td>Cross-sectional design</td>
<td>Health care-associated Clostridioides difficile infection rates</td>
<td>Whether any of the IPs are CIC in a facility</td>
<td>Complexity of each facility (a surrogate measure of patient case mix)</td>
<td>Whether a facility’s Clostridioides difficile infection rates were above or below the national Clostridioides difficile infection rate was not influenced by the certification of IPs in infection control. Clostridioides difficile infection rates were not influenced by infection control training and infection control certification.</td>
</tr>
<tr>
<td>Wright, MO et al. (2017)18</td>
<td>120 hospitals</td>
<td>Cross-sectional design</td>
<td>Centers for Medicare and Medicaid Services hospital-acquired condition Domain 2 scores and surgical site infection rates for coronary artery bypass graft operations and knee prosthesis</td>
<td>IP staffing levels</td>
<td>Unknown</td>
<td>Board certification was not significantly associated with hospital-acquired condition Domain scores or surgical site infection rates.</td>
</tr>
<tr>
<td>Pogorzelska, M et al. (2012)19</td>
<td>180 hospitals</td>
<td>Cross-sectional design</td>
<td>Hospital-associated methicillin-resistant Staphylococcus aureus bloodstream infections rates, hospital-associated vancomycin-resistant Enterococcus bloodstream</td>
<td>Whether a hospital’s infection control director is a CIC IP</td>
<td>Structure variables: bed size, teaching status, setting (urban/suburban/rural), and participation in quality initiative. Structures of care (infection control department characteristics): IP staffing, presence of a full-time</td>
<td>Hospitals with a CIC director had significantly lower rates of methicillin-resistant Staphylococcus aureus bloodstream infections.</td>
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Table 2

<table>
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<th>Covariates</th>
<th>Summary of results</th>
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<td></td>
<td>Infection preventionist.</td>
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<td>The Society for Healthcare Epidemiology of America.</td>
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<td>Hospital-acquired infection.</td>
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<td>Infection control professional.</td>
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<td>The Association for Professionals in Infection Control and Epidemiology.</td>
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**Covariates**

- Independent variable(s)
- Outcomes variable(s)
- Study design
- Sample size
- Analysis and publication year

**Summary of results**

<table>
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<td>Infections rates, and Hospital-associated C difficile infection rates</td>
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**References**


