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State of the Science Review

A narrative review of how infection preventionist (IP) staffing and outcome metrics are assessed by health care organizations and factors to consider

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Key Words:
IP staffing ratios
Health care–associated infections
IP staffing metrics

Background: Infection Preventionist to date are experiencing staffing shortages, the purpose of this narrative review is to understand how heath care organizations track staffing and outcome metrics in relation to Infection Preventionists.

Methods: Databases utilized included MEDLINE, PubMed, EMBASE, Web of Science, and Google Scholar.

Results: The initial search included 668 studies. After excluding duplicates, the title and abstract review yielded 50 articles. After screening full texts, 37 studies met the inclusion criteria. Significant variability exists within infection prevention staffing metrics. Common metrics to account for IP staffing levels include the ratio of IPs per facility and IPs per inpatient bed. Frequently tracked outcomes in relation to infection preventionists include Catheter-associated urinary tract infections and central line bloodstream infection incidence rates and standardized infection ratios, as well as *Clostridioides difficile* incidence rates. Metrics and outcomes from included studies are available in our supporting tables.

Conclusions: This review highlights the need for a new IP staffing model that focuses on a granular assessment of each program and care setting. Additional studies can then be conducted to examine how ideal staffing impacts outcome metrics.

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BACKGROUND

Infection preventionists (IPs) are multifaceted professionals with the primary mission of preventing infections. Despite their critical role, there is limited knowledge regarding how health care–organizations assess these professionals. Ongoing challenges of pandemics, epidemics, health care–staff shortages, and increases in patient safety and regulatory requirements directly expand the need for IPs, yet IP staffing shortages may lead to burnout and the inability for IPs to practice at the full scope of their professional expertise. Given the complex nature of our health care system and the changing disposition and needs of infection prevention and control (IPC) in various settings—an appropriate and granular system of measuring IP staffing needs to be established. However, before that can be done it is important to understand current IP staffing metrics and the influence that IP staffing may have on safety outcomes.

In this systematic search and narrative review our focus was to describe current IP staffing levels and IPC department resources in United States acute-care hospitals. Specifically, this review explores IP staffing metrics that health care organizations use, such as the number of IPs per hospital, IPs per the number of hospital beds, IPs per the number of patients, and the cumulative IP staffing hours per week/month/year. We also examine what health care outcomes are tracked in relation to IP professionals. IP outcome metrics that health care organizations could track include, but are not limited to,

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the number and/or severity of hospital-acquired infections, hospital readmissions due to infection, and morbidity or mortality events related to hospital-acquired infections. For this study, the term infection preventionist encompasses other closely related job titles, such as infection prevention and control technician, infection control practitioner, and infection practitioner.

METHODS

Search methodology

Systematic search and narrative review. Four electronic databases were searched using MEDLINE, PubMed, EMBASE, and Cochrane. Screening, data extraction, and reporting were performed in accordance with the preferred reporting items for systematic reviews and meta-analyses guidelines.

The title contained one of the following terms: "infection preventionist," "infection prevention technician," "infection control technician," "infection control practitioner," "infection practitioner," "manager of infection control," "director of infection control," "nurse of infection control," or ("infection prevention" plus "staffing"). The abstract also contain one of the search terms in our abstract table (Table 1). "(s)" indicates that both the singular and plural forms of the term were searched. "OR" indicates that both words in parenthesis were searched independently in combination with the word that comes after the words in parenthesis.

Study selection and inclusion/exclusion criteria

A dual-researcher team made all inclusion and exclusion decisions. This process was overseen by an experienced IP with research experience. Our inclusion criteria were (1) any study that outlines IP staffing metrics listed in previous sections of this protocol, and (2) any study that chronicles or assesses the metrics health care organizations use to evaluate infection preventionists, either individually or as a group. Presentations were permitted if and only if methods and quantitative results were clearly reported. Our exclusion criteria for all studies were any of the following study types: abstracts that did not clearly report results, case reports involving only 1 patient, and/or letters/opinion letters. Other exclusion criteria as determined by reviewing the title and abstract was if the study conclusions were outside of the scope of this investigation. The PROSPERO registration number is CRD42022382785.

Data extraction and synthesis

Publications that were selected for inclusion were stored in Rayyan and/or Excel Spreadsheets. Extracted and recorded data included study characteristics (eg, the name of the first author, publication year, country, and other study identifying features), patient characteristics (eg, sample number, sex, comorbidities if reported), and metrics or outcomes.

RESULTS

Our initial search included 668 studies. After excluding duplicates, the title and abstract review yielded 50 articles. After screening full texts, 37 studies met our inclusion criteria. Our preferred reporting items for systematic reviews and meta-analyses flow chart outlines this process (see Fig 1).

Thirteen studies reported IP staffing metrics that health care–organizations track.[1–13] Table 2 has a summary of the included studies that investigated IP staffing metrics, with the associated outcomes. Ten studies were cross-sectional, 2 were prospective, and 1 was a case-control study. Countries and or territories represented included the United States, Canada, Germany, Australia, Europe, and the Middle East. Ten studies studied invention preventionists solely in hospital settings, 1 study studied IPs in nursing homes, 1 study examined both hospital settings and nursing homes, and in 1 study the type of health care institution was unclear. The staffing metrics tracked were IP full-time equivalent, which is the number of hours IP spend on infection prevention and control activities per week divided by 40, IPs per bed, IPs per hospital, IPs per intensive care unit (ICU), average working hours per week, the median IP staffing per 100 inpatient/IPs per 100 beds, the ratio of IPs to beds, and percent of hospitals without IPs.

In Table 3, 14 studies reported how IPs divide their time among their duties 5,12.[14–25] Four studies reported the time by percentage breakdown. Marrs et al found IPs spent the highest percentage of their time on administrative duties (24%).[14] Pearson et al found IPs spent the highest percentage of their time directly on infection control (44.6%).[15] Vassallo et al and O'Boyle et al both found that IPs spent most of their time on surveillance and investigation (25.4% and 27% respectively).[16,17] Other metrics reported included surveying IPs on the percent of time they spend directly on infection control activities, full-time versus part-time IPs divided by hospital bed count, hours per week on infection surveillance, percent of time spent on antibiotic stewardship, hours per week spent in specific settings, and hours per year spent on various activities and a frequency-important tasks index.[25]

Four studies investigated the percentage of infection preventionists that work in a given type of location (Table 4). All studies were conducted on United States health care–infection prevention staff. Two out of the 4 studies also investigated Canadian infection prevention staff. All studies had a cross-sectional study design. Pogorzelska-Maziarz et al found the location types were varied, with ambulatory surgical centers being the highest-ranking health care site type, followed by long-term acute-care facilities.[18] Bjerke et al found that IPs often worked in more than one location, with general inpatient medical-surgical centers being the highest-ranking health care location type. Critical care and burn units were the second and third-highest-ranking health care location types, respectively, from this study.[19] O'Boyle et al found that acute-care settings were the most common IP employment location.[17] Pugliese et al only studied infection preventionists that worked in hospitals but gave a breakdown of

Table 1
Search terms

Search field	Terms
Title	"infection preventionist", "infection prevention technician", "infection control technician", "infection control practitioner", "infection practitioner", "manager of infection control", "director of infection control", "nurse of infection control", ("infection prevention" plus "staffing"), or ("infection control" plus "staffing").
Title or abstract	"number of", "ratio", "percent", "percentage", "metric(s)", "bed(s)", "amount of", "staff shortage", "staffing shortage", "hospital acquired infection(s)", "surgical site infection(s)", "readmission(s)", "site(s)", "per patient", "hours", "outcomes", "assessment", "evaluation", "evaluating", "analysis", "analyzing", "appraising", "appraisal", "(per) OR (for every) hospital", "(per) OR (for every) health care", "(per) OR (for every) clinic", "(per) OR (for every) surgical", "(per) OR (for every) medical", "(per) OR (for every) practice", "(per) OR (for every) nursing", "(per) OR (for every) assisted living facility", "(per) OR (for every) assisted living center", "(per) OR (for every) acute rehabilitation", "(per) OR (for every) subacute rehabilitation".

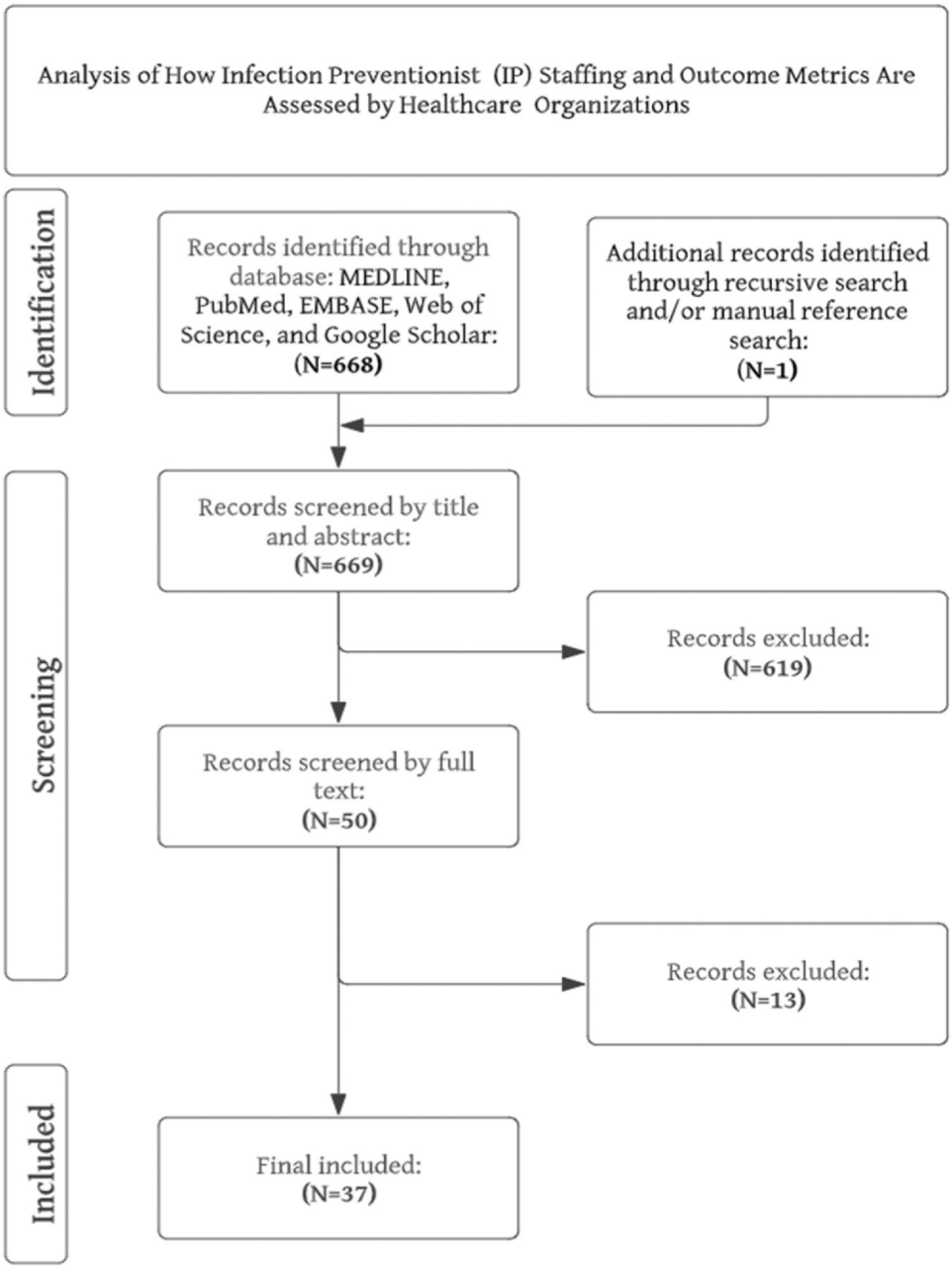


Fig. 1. Systematic review flow diagram for Infection Preventionists staffing metrics and outcomes based on preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines.

hospital types. The 2 largest hospital types were community hospitals and community-teaching hospitals, at 43% and 35%, respectively.[20]

Eleven studies investigated the association between IP staffing metrics and patient outcomes.[26–36] Table 5 has a summary of each study and its outcome. Dependent variables were as follows: 4 studies tracked catheter-associated urinary tract infections (CAUTI) and 6 studies tracked central line-associated bloodstream infections (CLABSI). Two of the studies that tracked both CLABSI and CAUTI metrics reported results in the unit of standardized infection ratios. Four studies tracked *Clostridioides difficile* infections, 4 studies tracked hospital-acquired Methicillin-resistant *Staphylococcus aureus* infections, 2 studies tracked surgical site infections, 1 study tracked pressure ulcers, 1 study tracked influenza vaccination rates, 1 study tracked carbapenem-resistant *Enterobacteriaceae* infections, and 1 study tracked incidences of ventilator-associated pneumonia. Ten of 11 studies found a positive association with having infection preventionists on staff and an improvement in the tracked health care metrics. Additionally, Mori et al found that, compared to facilities that had no full-time or full-time equivalent infection control practitioners, those facilities with these practitioners had consultations for prevention and control of health care–associated infections, a reporting system for antibiotics, cleaning more than 5 days per week in general wards, and patient and family education regarding *C difficile*.[30]

DISCUSSION

This literature review investigated the staffing and outcome metrics that health care–organizations track in relation to infection

Table 2
Infection preventionist (IP) staffing metrics

First author (Publication Year)	Country	Sample size	Study design	Units	Details
Taylor[1] (2021)	USA	12 acute-care hospitals, including 2 critical access hospitals, and one acute psychiatric hospital	Prospective	IPs per bed	1 IP for every 171 licensed beds. This includes 8.0 full-time IPs and 1 IP director.
Shang[2] (2020)	USA	433 nursing homes (NHs)	Cross-sectional	IP full-time equivalent (FTE), which is the number of hours IP spend on infection prevention control activities per week divided by 40.	IP FTE has generally increased from 0.29 in 2014-0.32 in 2018. Yet, IP FTE was significantly higher in profit than nonprofit NH (0.32 vs 0.30, *P*-value .007). Furthermore, there was a positive correlation between bed size or occupancy level and FTE.
Campbell[3] (1986)	Canada	205 acute-care facilities with a capacity of more than 200 beds each.	Cross-sectional	IP per hospital	More than 90% of the hospitals encompassing 200-250 and 501-750 beds have 1 IP and the rest had 2 IPs. Almost all hospitals with 251-500 beds had 1 IP. For hospitals containing 751-1,000 beds, about 50% of these hospitals had 1 IP; about 40% had 2 IPs, and nearly 10% had 3 IPs. Of 1,001-1,250 bed hospitals, 70% of these hospitals had 1 IP and the rest had 3 IPs. Finally, nearly half of the hospitals of more than 1,250 bed-capacity had 1 IP and the other half had 3 IPs. IPs were full-time, full-time+ other tasks or part-time.
Losos[4] (1984)	Canada	1084 hospitals responded, of which 57.7% (625 hospitals) had an ICP, a total of 656 ICPs.	Cross-sectional	IP per hospital and the job title of IPs.	The majority of hospitals had only 1 ICP. Even in large teaching hospitals (≥300 beds), only 18.9% of these hospitals had more than 1 ICP. Full-time infection control position was occupied by 18.6 ICPs and part-time position by 81.4%. Ninety-two percent of the ICPs were nurses, 3.5% were lab technicians, and 4.5% were physicians, pharmacists, etc.
Rock[5] (2016)	USA	16 hospitals (80 ICUs)	Prospective cohort	The average IP number per hospital, the average IP number per ICU, and the average working hours per week.	The average IP number per hospital was 5.1, the average IP number per ICU was 1.1, and the average working hours per week was 16.6 h on the study's surveillance and 2.9 h on the ICU.
Pogorzelska-Maziarz[6] (2018)	USA	1623 IPs from acute-care settings in the USA	Cross-sectional (survey data)	The median IP staffing per 100 inpatient and the portion of time per each task category.	The median IP staffing per 100 inpatient census was 1.25 (mean 3.47; IQR 1.81). 72% of the participating IPs worked in a single facility, whereas 28% worked in multiple facilities. 56% of the study's IPs had certification in infection prevention and control. Regarding background/ job title, 82% had a nursing background, 1% had a med tech background, 4% had a lab science background, 5% had a microbiology background, and 5% had a public health background. IPs, according to this analysis, generally spent the majority of their time on surveillance and epidemiology (mean 28%), followed by identifying infections, infection prevention and control, management & communication, education and research, and the least time on occupational health and sterilization/ disinfection. In small hospitals, IPs spent significantly less time on infection prevention and control and more time on occupational health and education and research compared to large hospitals.

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Table 2 (*continued*)

First author (Publication Year)	Country	Sample size	Study design	Units	Details
Stone[7] (2009)	USA	289 hospitals in the US National Health Care Safety Network. 617 IPs were surveyed.	Cross-sectional	IP per bed & how the working hours are spent	46.7% of the participating (N = 288) IPs were certified in infection control. Median staffing was one IP per 167 beds. There was an inverse relationship between the hospital size and the number of IPs; higher staffing hours were detected in small than in large hospitals (*P*-value ˂.001). Regarding how IPs spent time, an average/mean of 44.5% of the work time was spent on the collection, analysis, and interpretation of data on infection incidences. 15% of the time went to staff meetings and policy development; 12.9% to isolation issues, 13% to infection prevention and control education; and 8.8% of the time to occupational health education, product evaluation, and emergency measures. Finally, 6.1% of the work time was specified for outbreaks-related activities.
Tannous[8] (2022)	GCC (Gulf Cooperation countries) and other Middle Eastern countries.	269 infection prevention and control (IPC) personnel	Cross-sectoinal	IPC per 100 beds, IPCs' qualifications, and how the working hours are spent.	About 60.9% of the health care settings had at least 1 IPC personnel per 100 beds. The GCC had more personnel compared to other countries (*P*-value = .047). About 32.2% of these IPC personnel attained the CBIC (Certification Board of Infection Control), 5.2% attained an infection control diploma, and 28.8% attained any other infection control certificate. While 63.7% of the IPs were nurses, 22.8% were medical doctors. The most time-consuming task was surveillance (26.6%). This was followed by isolation, investigation of outbreaks, identification of infection, management and communication, education and research, environment cleaning, and occupational health (12.4%, 12.1%, 11.4%, 10.8%, 10.4%, 8.2%, and 8.1%, respectively).
Mitchell[9] (2015)	Australia	152 hospitals (67% were public hospitals)	Cross-sectional	ICPs per 100 beds	The mean number of ICPs (infection prevention and control professionals) was 0.66 per 100 overnight beds (one FTE per 152 beds). The number was significantly lower in private hospitals as opposed to public hospitals (*P*-value ˂ .01).
Dickstein[10] (2016)	Europe	560 hospital responses (from 61 countries)	Cross-sectional	Ratio of infection control nurses to beds	The median ratio of infection control nurses is 0.8 (1 nurse per 125 beds)
Kramer[11] (2013)	Germany	229 responses from hospitals, 14 0ut patient centers, and 16 nursing homes.	Cross-sectional	Perent of hospitals that did not employ ICNs (in-house infection control nurses)	13% and 32% of the hospitals with 400-999 beds did not employ ICNs or ICLNs (infection control link nurses), respectively. The average number of the placed jobs was 2.1 and 11.8, respectively. For hospitals with more than 1,000 beds, 22.2% and 33.3% did not employ ICNs or ICLNs, respectively.
Li[12] (1996)	USA	629 Nursing Homes	Cohort Case-Control	hours per week per IP, IPs per nursing home.	The mean hours per week of infection control practitioners working on infection control in case and cohort sample homes were 28.3 and 29.3, respectively. The mean number of infection control practitioners in case and cohort sample nursing homes were 1.12 and 1.05.

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Table 2 (*continued*)

First author (Publication Year)	Country	Sample size	Study design	Units	Details
Friedman[13] (1998)	USA	45 University HealthSystem Consortium Institutions	Cross-sectional (survey)	Various metrics per FTE (see results).	The number of occupied beds per infection control FTE ranged from 29 to 257 beds/FTE, with a median of 137 beds/FTE and a 75th percentile of 176 beds/FT. The number of staff per infection control FTE ranged from 477 to 2965 staff members/FTE, with a median of 1,118 staff members/FTE and 75th percentile of 1,461 staff members/FTE. The number of ambulatory care visits per infection control FTE ranged from 5,991 to 244,546 visits/FTE, with a median of 104,426 visits/FTE and a 75th percentile of 132,525 visits/FTE. The number of admissions or discharges per infection control FTE ranged from 2771 to 13,255 admissions-discharges/FTE, with a median of 6,686 admissions-discharges/FTE and 75th percentile of 8,744 admissions-discharges/FTE. The number of ICU beds per infection control FTE ranged from 6 to 72 ICU beds/FTE, with a median of 28 ICU beds/FTE and a 75th percentile of 37 ICU beds/FTE.

preventionist staff. The analysis demonstrated significant variability in staffing metrics overall. However, the most common metrics reported to account for IP staffing levels were the ratio of IPs per facility and the ratio of IPs per inpatient beds.

The ratio of 1 infection prevention resource for a 250 acute-care bed facility was considered the historical standard for hospital settings following the 1970's Centers for Disease Control and Prevention initiated study on the efficacy of nosocomial infection control project.[37] Since this time, the role and scope of Infection Prevention has changed significantly, particularly regarding increased requirements for regulatory reporting and response. More recently reported ratios vary from a high of one IP per 152 beds[9] to a low of one IP per 69 beds.[22] This metric is limited in several ways. First, there is variability in the type of inpatient bed referenced (licensed bed versus staffed bed), which adds nuance to the application of the ratio. It also does not account for the complexity that may exist within a facility in both the size and scope of services provided. Facilities with extraordinarily complex or high-risk programs may require more robust infection prevention staffing than facilities without these programs. Given the "one-size-fits-all" nature of this metric, it falls short of providing the granular viewpoint needed to effectively staff an IP program.

The ratio of IPs per facility metric was more likely to be utilized in nonhospital-based care settings (ex: ambulatory clinics), due to the inpatient bed ratio not being a feasible metric in these settings. This reflects the changing nature of the infection prevention role as higher volumes of services and services with greater complexity and risk are offered outside hospital settings. Similar to the ratio of IPs per inpatient bed metric, this metric also falls short of recognizing the risks associated with different care settings and services as well as the overall size of the facility and the number of patients seen. Therefore, a ratio of this type cannot accurately predict individualized infection prevention needs in a comprehensive and meaningful way.

A more granular viewpoint of how IP working hours are spent has not yet been quantified into a formal metric, but there is a large degree of heterogeneity reported in the literature. Administrative tasks and infection surveillance consistently ranked highest and account for between one-quarter and one-half of work hours. In settings where an individual has infection prevention responsibilities as part of a larger role, this may leave little time for other, more staff-centered and beneficial IP tasks (like rounding and education). Nonetheless, quantification of a metric that reflects the day-to-day tasks of an infection preventionist specific to the care setting within which they work will provide the most accurate assessment of staffing needs.

As expected, the largest number of IPs are reported to work in inpatient hospital settings. Less frequently reported settings included ambulatory clinics, ambulatory surgery centers, long-term care, mental health facilities, and home health. As the scope of the IP role continues to expand, a greater need for staffing assessment tools can be expected in these less traditional care settings.

As aforementioned, of the historical inpatient focus of the IP profession, the most common outcomes tracked in relation to IP program efficacy were the incidence of CAUTI, CLABSI, and *C difficile*. Nearly all studies assessing efficacy demonstrated a positive relationship between the use of IP professionals and associated outcome metrics (10/11 studies that tracked outcome metrics). Because of the multifactorial nature of infection, it can be difficult to conclude a cause/effect relationship in relation to IP staffing. Additional studies should be performed to better understand how outcomes may change with minimal IP staffing versus more robust staffing.

One limitation of this study was that a non-trivial number of supporting references were in the form of presentation text

Table 3
Breakdown of how infection preventionists (IP) spend time on duties

First author (Publication Year)	Study description	Country	Study design	Sample size	Time unit	Details of time breakdown
Rock[5] (2016)	Measures hospital-onset bacteremia association with CLABSI rates as a proxy for evaluating health care–associated infection related outcomes.	USA & Canada		80 ICUs from 16 hospitals	Hours per week on surveillance	average of 16.6 h/wk on CLABSI surveillance average of 2.9 h/ICU/wk.
Li[12] (1996)	To determine institutional risk factors that may increase or decrease the risk of catching nosocomial infections. In the data, the authors reported the mean hours the infection control practitioners work per week in the case and control nursing homes.	USA	Case-control	Case: one nursing home that reported 2 or more respiratory or GIT outbreaks. Control: another nursing home reporting no outbreaks	the infection control practitioners' mean working hours per week to control outbreaks	The mean working hours were 28.3 and 29.3 for cases and controls, respectively.
Marrs[14] (2017)	6 IPs in a 700-bed academic medical center tracked how they divided their time among 10 key areas. The top 3 activities ranked by time spent were administrative tasks, surveillance, and communication/ external meetings.	USA	Prospective	6 IPs from 1 hospital	Percent of time IPs spent on 10 key areas	Percent of time spent on 10 key areas Administrative: 24% Surveillance: 17% On call/Exposures: 13% Communication/External Meetings: 12% Disinfection and Sterilization: 10% Career Development/Training: 8% PI Projects (HH, C Diff, CLABSI, SSI): 8% Education/Teaching: 4% Outbreak/Investigations: 2% Construction: 2%
Pearson[15] (1990)	A survey of ICPs in all skilled nursing facilities in Connecticut revealed that ICPs in Connecticut have increased in number and devote more time to infection control than in previous years.	USA	Cross-sectional	143 facilities	Percentage of time ICP spent on various activities	Infection control: 44.6% In-service education: 13.8% Employee health: 5.0% Administrative nursing: 29.4% Direct patient care: 23.4%
Vassallo[16] (2019)	Posits master of public health graduates as a promising pool to recruit IPs from because they have been trained with many of the requisite core competencies.	USA		4079 IP survey responses from APIC MegaSurvey	Percentage of time that IPs spent on tasks.	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%
O'Boyle[17] (2002)	Survey of Delphi panel on IP staffing metrics, and their recommendations for ideal staffing metrics.	USA	Cross-sectional	Delphi panel members (n = 32) from 20 states	Percentage of time ICP spent on various activities	The activity with the greatest amount of mean estimated time was surveillance at 27% followed by education (16%), prevention (14%), and communication activities (14%). The least amount of estimated mean allotment of time was for control activities (8%) (seeFig. 2). For surveillance, the greatest proportion of time (mean percent) was spent on case finding (32%), followed by analysis of data (20%). Tasks within the education function were evenly distributed in the following activities: developing education materials (35%), presenting educational information (35%), and assessing educational needs (25%).

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Table 3 (*continued*)

First author (Publication Year)	Study description	Country	Study design	Sample size	Time unit	Details of time breakdown
Pogorzelska-Maziarz[18] (2017)	Survey of APIC members practicing in acute-care facilities to determine the degree of involvement in antimicrobial stewardship programs.	USA	Cross-sectional	252 IPs	Percent of time dedicated to infection surveillance, prevention and control activities (ISPC) and percent of time dedicated to antimicrobial stewardship programs (ASP)	62% of IPs said > 75% of time dedicated to ISPC
Bjerke[19] (1993)	The study identifies the professional responsibilities of infection control practitioners.	USA & Canada	Cross-sectional	577 ICPs in US and Canada	Number of hours spent on infection control activities.	Most infection control practitioners (40.2%) spent 40-49 h per week on infection prevention activities. 11.4% spent < 10 h/wk on infection control activities 8.5% spent 10-19 h/wk on infection control activities 16.3% spend 20-29 h/wk on infection control activities 16.1% spent 30-39 h/wk on infection control activities 40/2% spent 40-49 h/wk on infection control activities 7.4% spent ≥50 h/wk on infection control activities
Pugliese[20] (1984)	The study found a relationship between hospital size and tasks performed by IPC.	USA	Cross-sectional	473 ICPs from a randomized stratified sample across the US	Time spent working by ICPs by hospital bed size	In hospitals with ≤100 beds, 73% ICPs worked < 20 h/wk, 21% worked > 20 h/wk, 6% worked full time In hospitals with > 100 beds, 10% ICPs worked < 20 h/wk, 15% worked > 20 h/wk, 70% worked full time
Weir et al.[21] (2022)	Assessed the needs for IPs in the pediatric ambulatory setting of Boston Children's Hospital.	USA		Measured the complexity of 238 unique locations/services to determine IP need across all.	IP hours/week dedicated to these locations	178 IP hours/week estimated for pediatric ambulatory setting.
Bartles[22] (2018)	Quantifies the number of IPs required to sustain effective infection prevention programs.	USA	Cross-sectional	643 locations of Providence Health & Services	IP hours per week in various settings	Rehab facility: 65.70 h/wk long-term care facility: 50.63 h/wk ambulatory clinics: 57.65 h/wkhome care: 5.11 h/wkadult day center: 0.77 h/wk
Wundavalli et al.[23] (2020)	Determine adequate staffing based on actual workload and involvement in New Delhi, India.	India	Prospective cohort	Not a survey, quantitative estimate of IP need in acute-care hospitals in New Delhi.	Standard workload = volume of work per year per employee. Standard workload calculated for each IPC activity calculated in minutes	Environmental sampling: 1,555 Transporting samples: 766.5 Distribution of reports: 1,022 Collecting patient reports: 1,022 Data management: 6,132 Daily reporting: 6,132 Rounds in the hospital: 766.5 CLABSI surveillance: 18,396 VAP surveillance: 9,189 SSI surveillance: 18,396

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Table 3 (*continued*)

First author (Publication Year)	Study description	Country	Study design	Sample size	Time unit	Details of time breakdown
Hessels et al.[24] (2019)	To assess the workload increase perceived by nurses and IPs at the time of outbreaks and compare the two groups. Also, the study reported the most time-consuming activities.	USA	Cross-sectional	378 (150 nurses and 228 Ips)	The increase in daily workload.	A workload of >60 min per day was detected in the nurse group when dealing with *Clostridium difficile* (76%), lice or scabies (46%), and influenza (45%). A workload of >60 min per day was detected in the IP group when dealing with mumps or measles (66%), tuberculosis (64%), and *C difficile* (50%). Furthermore, according to nurses, the most time-consuming activities were isolation precautions (according to 92% of nurses, N = 138), followed by patient and family education on the outbreak (63%), staffing changes due to absent colleagues or patient cohorting (56%), electronic health recording and its related documentation (29%), and visits to health and safety workforces (20%). For IPs, the most time-consuming activities at the time of outbreaks in descending manner were chart review (65%), completing exposure lists (61%), taking preventive measures (43%), notifying staff and visitors (35%), case detection (29%), and ward rounding (19%).
McArthur et al.[25] (1984)	Survey of ICP conducted to define the scope of practice of infection control as the basis for the development of certification examination.	US	Cross-sectional	473 ICPs	Frequency-importance task index. Key tasks were identified by a frequency-importance task index of ≥ 6.5	Develop policies for patient care departments: 7.74 Develop policies and procedures for nonpatient care departments: 7.12 Develop policies and procedures for diagnostic invasive procedures: 7.02 Develop policies and procedures for therapeutic procedures: 8.02 Independently initiate isolation/precaution techniques: 8.91 Develop policies and procedures on isolation techniques for communicable diseases: 7.46 Teach patient care personnel strategies for the prevention of nosocomial infections: 10.09 Assess patient histories for possible exposure to communicable diseases by chart review or interview: 9.00 Identify infections by correlating laboratory results and clinical information: 11.68 Develop policies and procedures for the immunocompromised patient: 6.73 Perform epidemiologic surveillance: 11.60 Use written criteria for defining infections: 11.50 Collect data on high-risk hospital procedures: 8.30 Define a problem by using a descriptive study: 8.00 Determine the incidence of nosocomial infections: 8.13 Determine the prevalence of nosocomial

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Table 3 (*continued*)

First author (Publication Year)	Study description	Country	Study design	Sample size	Time unit	Details of time breakdown
						infections: 6.61 Conduct an investigation of outbreaks by using epidemiologic methods: 8.32 Design a study to investigate a problem: 6.98 Use tables, graphs, charts to present reports of epidemiologic investigations or surveillance: 7.09 Calculate rates and rations: 7.97 Interpret results of culture reports: 11.63 Evaluate and select products to be used for handwashing: 6.67 Develop policies and procedures for nonpatient care departments: 7.12 Teach infection control practices related to food sanitation: 6.89 Teach infection control practices specific to patient care departments: 7.11 Present for education programs: 9.14 Assess educational needs of patient care and nonpatient care personnel: 8.33 Assess educational needs of patients: 7.04 Use audiovisual aids for teaching: 8.18 Develop policies for excluding personnel with communicable diseases from word or patient care areas: 7.10 Develop policies and procedures for immunization, prophylaxis, and treatment of hospital personnel: 6.87 Develop screening programs for employees for certain communicable diseases: 6.86 Investigate and follow-up personnel exposed to communicable diseases: 7.12 Obtain information by interviewing personnel: 10.27 Discuss the hospital infection control needs with patient care and nonpatient care personnel: 8.31 Develop and revise written goals, action plans, objectives for the infection control program: 7.17 Evaluate the infection control program in relation to the completion of goals, objectives, action plans, outcome: 7.01

Table 4
Percentage of infection preventionists (IPs) that work at a given site

First author (Publication Year)	Study description	Country	Study design	Sample size	Details of time breakdown
Pogorzelska-Maziarz[18] (2017)	Uses the APIC MegaSurvey to find that staffing in infection prevention and control is lacking.	USA & Canada	Cross-sectional	861 IPs	The number of respondents in coordinator or practitioner positions that worked in: Ambulatory surgical centers = 123 Long term care = 85 Long-term acute-care = 100 Mental health = 57 Clinic or outpatient 51 Home health = 12 Overall # respondents that were coordinators or practitioners = 428
Bjerke[19] (1993)	Evaluation of infection prevention and control professionals conducted to validate that they have the knowledge and skills needed in their day-to-day work.	USA & Canada	Cross-sectional	577 IP respondents	Distribution of sample services provided (n (%)) (respondents were asked to check all that apply) Medical-surgical: 480 (83.2%) Pediatrics: 357 (61.9%) Critical Care: 441 (76.4%) Neonatology: 230 (39.9%) Obstetrics: 345 (59.8%) Psychiatry: 350 (60.7%) Rehabilitation: 336 (58.2%) Burn: 381 (66.0%) Oncology: 76 (13.2%) Gerontology: 362 (62.7%)
Pugliese G[20] 1984	A survey of infection prevention and control professionals conducted to define the scope of practice of infection control as the basis for the development of certification examination.	USA	Cross-sectional	473 ICPs	Hospital type: Community 43%, community-teaching 35%, municipal 12%, university 5%, and federal 5%.
O'Boyle[17] (2002)	Survey of Delphi panel on IP staffing metrics, and their recommendations for ideal staffing metrics.	USA	Cross-sectional	Delphi panel members (n = 32) from 20 states	22 (68%) members were employed in acute-care settings. Other work settings included long-term care and mental health and home care. Most 26 (81.3%) worked in a single setting, but some (6; 18.7%) reported having responsibility for infection control in multiple settings.

Table 5
Outcomes studies in relation to infection preventionist staffing

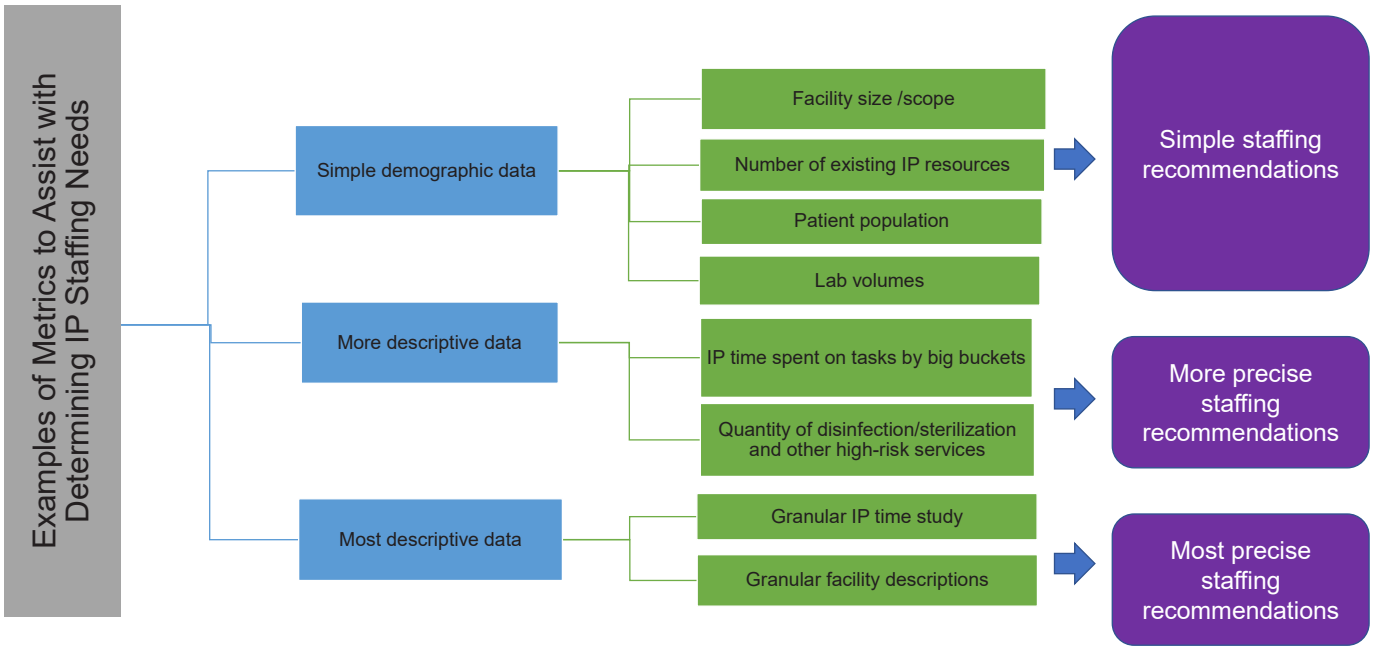
First author (Publication Year)	Study description	Study type	Sample size	Country	Independent variable (s)	Dependent variables (outcomes studied)	Findings
Clifford[25] (2022)	Evaluate relationships between infection preventionists (IPs) staffing levels, nursing hours, and rates of 10 types of health care–associated infections (HAIs).	Cohort - Prospective	528-bed teaching hospital	USA	IP FTEs	10 HAIs inclusive of CAUTI SIRs, *Clostridioides difficile* and carbapenem-resistant *Enterobacteriaceae* infection rates, along with 4 of 5 types of surgical site SIRs.	HAIs infections increased during the periods of lowest IP staffing levels and the absence of certified Ips.
Christie[26] (2020)	Examine differences in CLABSI and CAUTI standardized infection ratios (SIR) between director-led IP programs and manager-led programs	Cross-Sectional	27-facility US acute-care hospitals	USA	Infection prevention programs led by IP directors	CLABSI and CAUTI standardized infection ratios (SIR)	Programs led by IP directors had statistically significant lower CLABSI ($P = .00$) and CAUTI ($P = .026$) SIRs than manager-led programs. There was no significant difference in years of IP experience ($P = .31$), CIC status ($P = .38$) or the number of FTEs ($P = .24$) between each group.
Wagner[27] (2014)	Impact of Maryland NH infection preventionists (IPs) on NH quality measures.	Cross-Sectional	234 nursing homes	USA	Number of IPs	Influenza vaccination and pressure ulcer rates	Influenza vaccination and pressure ulcer rates were significantly associated with the number of IPs
Spencer[28] (2013)	Effect of Corporate Infection Preventionist Consultant (CIPC) on outcome metrics in a large hospital system.	Cohort - Prospective	"Large hospital system"	USA	Corporate Consultant Infection Preventionists	CAUTI, CLABSI, VAP, surgical site infections, *C diff* infections, MRSA infections	(1) ICU-CAUTI (0.6)—57% reduction, (2) ICU-CLABSI (0.6)—54% reduction, (3) ICU-VAP (1.1)—11% reduction, (4) CABG (0.2)—71% reduction, (5) Total Hip (0.6)—15% reduction, (6) Total Knee (0.4)—50% reduction, (7) *C diff* (2.4/10,000 pt days)—12%, and (8) MRSA (0.13)—62% reduction
Mori[29] (2016)	How the full-time or part-time status of IPs affects outcome metrics and quality measures.	Cross-Sectional	47 "National Hospital Organizations"	Japan	Presence of full-time or full-time equivalent infection control practitioners.	Infection prevention actions (see findings)	Compared to facilities that had no full-time or full-time equivalent infection control practitioners, the facilities with these practitioners had consultations for prevention and control of HAIs, a reporting system for antibiotics, cleaning more than 5 days per week in general wards, and patient and family education regarding CDI.
Valencia[30] (2009)	How IP and ICU nursing floor collaboration impact incidences of CAUTI	Cohort-Retrospective	ICU of Dallas Hospital	USA	IP Teaching in medical units	CAUTI incidence	A decrease of 10% in the rate of CAUTI infections hospital wide
Wright[31] (2017)	Study to investigate the relationship of IP staffing ratios and CIC certification with HACs	Cohort-Retrospective	120 hospitals, 259 beds, 208 IPS, 126 (61%) were CIC	USA	IP staffing ratios, CIC certifications	HAC Domain 2 scores	Cross-sectional study, we did not find a positive correlation between HAC Domain 2 scores or state-reported SSIs and IP staffing ratios, regardless of board certification

(*continued on next page*)

Table 5 (*continued*)

First author (Publication Year)	Study description	Study type	Sample size	Country	Independent variable (s)	Dependent variables (outcomes studied)	Findings
Pogorzelska[32] (2012)	Assess the relationship of infection prevention policies and hospital staff structural characteristics to rates of methicillin-resistant *Staphylococcus aureus* (MRSA) or vancomycin-resistant *Enterococcus* (VRE) bloodstream infections and *C difficile* infections.	Cross-Sectional	203 Hospitals	USA	Presence of CIC director	MRSA or VRE bloodstream infections and *C difficile* infections.	Hospitals with a certified infection control director had significantly lower rates of MRSA bloodstream infections ($P < .05$).
Boken[33] (2008)	Impact of improved infection prevention staffing, a hand hygiene program, and other interventions on the rate of nosocomial MRSA infections in a community hospital	Interventional	350-bed community non-teaching acute-care hospital. 22 adult critical care beds	USA	Presence of ICP	Hospital-acquired MRSA infections	A second full-time ICP was hired, bringing the ratio to 0.6 MSRA infections per 100 occupied acute-care beds.
Eichelberger[34] (2019)	A Midwest health care system implemented a new position, the Infection Prevention Technician, to support the hospital's Infection Preventionist by performing environment-of-care (EOC) rounds	Cohort-Prospective	350-bed hospital	USA	Addition of infection control technician to aid infection preventionist	*C diff* SIR, MRSA bloodstream infections, MRSA transmission rate, and VRE	Findings decreased by an average of 46% over the 12-month period. *C diff* standardized infection ratio (SIR) was 0.670 down to 0.574. MRSA bloodstream infections continued to be sporadic with many months at zero. The MRSA transmission rate decreased from 0.48 (per 1,000 patient days) to 0.35 postintervention. During the same period, the VRE transmission rate decreased from 0.56 to 0.52 respectively.
Bren[35] (2020)	How the addition of an 0.8 FTE IP dialysis staff position affect positive bloodstream infections and compliance to infection prevention policies?	Cohort-Retrospective	4 outpatient hemodialysis centers, 1 inpatient hemodialysis center and a home peritoneal dialysis program	USA	0.8 FTE IP dialysis staff position	Positive blood culture events.	Positive blood culture events dropped 42%, from 12 in 2018-7 (as of December 2019).

a



b

Hospitals

WHAT ARE WE TRYING TO ASSESS?	WHAT METRICS ARE AVAILABLE?
Size of facility	• Licensed beds • Number of inpatient units • Number of intensive care units
Complexity of patients and services offered (risk)	• Case mix index • Presence of specific programs/ populations (Stem cell transplant, oncology, etc.)
Volume of patients	Adjusted occupied beds
Volume of surveillance work	Lab volumes State required reporting
Data and reporting needs	Existing clinical analytic resources (i.e., does this fall to the infection prevention team or to someone else, hence it doesn't need to be accounted for in the calculation)
Other areas of coverage	• Occupational Health • Antimicrobial Stewardship • Outpatient facilities on The Joint Commission's footprint • Associated long term care facilities
External programs	Additional state requirements Other quality programs (Magnet, Leapfrog, etc.)

Fig. 2. b Example of factors to be considered for staffing metrics based on care setting. 2b Example of factors to be considered for staffing metrics based on care setting. 2c example of factors to be considered for staffing metrics based on care setting. 2d Example of factors to be considered for staffing metrics based on care setting.

versus peer-reviewed, published articles. In these cases, the inclusion of all relevant information was verified. However, this indicates a need for infection prevention professionals to create published manuscripts for any research they conduct relevant to this topic. Another limitation of this study is that many supporting studies used surveys that rely on respondent memory. This was especially apparent with the studies that track how IP professionals spend their time. Utilization of a standardized method for time studies would increase the rigor of the evidence.

c

Long-term Care Facilities

WHAT ARE WE TRYING TO ASSESS?	WHAT METRICS ARE AVAILABLE?
Size of facility	• Licensed beds • Number of inpatient units • Number of ventilated beds (or some other measure of intensive care)
Complexity of patients and services offered (risk)	• Case mix index • Presence of specific programs/ populations (ventilators, etc.)
Volume of patients	Adjusted occupied beds
Volume of surveillance work	Lab volumes State required reporting
Data and reporting needs	Existing clinical analytic resources (i.e., does this fall to the infection prevention team or to someone else, hence it doesn't need to be accounted for in the calculation)
Other areas of coverage	• Occupational Health • Antimicrobial Stewardship
External programs	• Additional state requirements • Other quality programs or accreditation

d

Outpatient Clinics

WHAT ARE WE TRYING TO ASSESS?	WHAT METRICS ARE AVAILABLE?
Size of facility	• Number of exam and treatment rooms • Square footage
Complexity of patients and services offered (risk)	• Presence of high-level disinfection or sterilization • Use of aerosol generating procedures • Volume of patients with Tuberculosis (or other key infection types)
Volume of patients	Patient visits
Data and reporting needs	Existing clinical analytic resources (i.e., does this fall to the infection prevention team or to someone else, hence it doesn't need to be accounted for in the calculation)
External programs	• Additional state requirements • Other quality or accreditation programs

Fig. 2. (*continued*)

CONCLUSIONS

Overall, this analysis describes the various IP staffing and outcome metrics that are tracked. This work highlights the need for a new staffing model that focuses on a granular assessment of each individualized program and care setting and a model that can demonstrate the variability that exists when attempting to quantify staffing and responsibilities of IP professionals in various settings. An effective staffing model should also take into consideration all the various roles that could exist within an infection prevention and control program, including (but not limited to): infection preventionists, medical directors, health care epidemiologists, surveillance-focused infection preventionists, analysts, project or program managers, administrative support, etc. An ideal model would also utilize actual hours of work required within each setting requiring IP services as informed through time studies. This model would need to be replicated multiple times in various care settings to determine the ideal staffing ratios for each care setting type. This could then allow for the generation of a standard staffing tool that with appropriate inputs could assist an organization in producing a customized staffing plan. Figure 2 provides examples of metrics and factors for hospitals, long-term care facilities, and outpatient settings that can be considered in determining staffing levels and the complexity that can exist in determining appropriate staffing for specific care

settings. The limitation of the model is that it does not account for the staff mix and responsibilities in an infection prevention and control program; however, it does provide some common factors among facilities that can lead to a standard tool.

Following development of a standard staffing tool, additional studies should be conducted to better understand the relationship between ideal staffing and infection prevention outcomes. Ultimately the case for robust infection prevention staffing will be supported by drawing correlations between staffing metrics and improvements in patient and caregiver safety. The heterogeneity that exists for measuring IP staffing is demonstrative that no IPC programs are the same, thus tools that account for differences among these programs and IP staffing needs are essential to ensure patient safety and to avoid extensive burnout of IPs.[38,39]

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