ORIGINAL ARTICLE

Changes in Prevalence of Health Care–Associated Infections in U.S. Hospitals

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ABSTRACT

BACKGROUND

A point-prevalence survey that was conducted in the United States in 2011 showed that 4% of hospitalized patients had a health care–associated infection. We repeated the survey in 2015 to assess changes in the prevalence of health care–associated infections during a period of national attention to the prevention of such infections.

METHODS

At Emerging Infections Program sites in 10 states, we recruited up to 25 hospitals in each site area, prioritizing hospitals that had participated in the 2011 survey. Each hospital selected 1 day on which a random sample of patients was identified for assessment. Trained staff reviewed medical records using the 2011 definitions of health care–associated infections. We compared the percentages of patients with health care–associated infections and performed multivariable log-binomial regression modeling to evaluate the association of survey year with the risk of health care–associated infections.

RESULTS

In 2015, a total of 12,299 patients in 199 hospitals were surveyed, as compared with 11,282 patients in 183 hospitals in 2011. Fewer patients had health care–associated infections in 2015 (394 patients [3.2%; 95% confidence interval {CI}, 2.9 to 3.5]) than in 2011 (452 [4.0%; 95% CI, 3.7 to 4.4]) (P<0.001), largely owing to reductions in the prevalence of surgical-site and urinary tract infections. Pneumonia, gastrointestinal infections (most of which were due to *Clostridium difficile* [now *Clostridioides difficile*]), and surgical-site infections were the most common health care–associated infections. Patients' risk of having a health care–associated infection was 16% lower in 2015 than in 2011 (risk ratio, 0.84; 95% CI, 0.74 to 0.95; P=0.005), after adjustment for age, presence of devices, days from admission to survey, and status of being in a large hospital.

CONCLUSIONS

The prevalence of health care–associated infections was lower in 2015 than in 2011. To continue to make progress in the prevention of such infections, prevention strategies against *C. difficile* infection and pneumonia should be augmented. (Funded by the Centers for Disease Control and Prevention.)

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Health care–associated infections are major threats to the safety of patients in the United States. Rates of selected health care–associated infections have become state and national metrics by which government agencies and consumers evaluate health care quality in hospitals. The National Healthcare Safety Network of the Centers for Disease Control and Prevention (CDC) tracks state and national progress regarding the prevention of health care–associated infections in thousands of U.S. health care facilities,[1] including approximately 3800 general, women's, and children's hospitals. When reporting data regarding health care–associated infections to the National Healthcare Safety Network, hospitals prioritize selected inpatient locations or infections that are included in federal, state, or local reporting mandates or quality-improvement programs.

Point-prevalence surveys of health care–associated infections in health care settings complement location- or infection-specific National Healthcare Safety Network data, allowing public health officials and health care leaders to conduct periodic assessments of these infections to be considered for tracking and prevention. In 2011, the CDC conducted a hospital prevalence survey of health care–associated infections and the use of antimicrobial agents with the Emerging Infections Program, a network of 10 state health departments and academic collaborators.[2] A total of 4% of patients had a health care–associated infection. We used these data to generate national estimates of 648,000 patients with 721,800 health care–associated infections in U.S. hospitals in 2011.[3]

Since 2011, efforts aimed at preventing health care–associated infections have continued to grow nationally, with a focus on antimicrobial-resistant pathogens.[4-8] Although data that have been reported by hospitals to the National Healthcare Safety Network indicate national progress in reducing the incidence of specific health care–associated infections that have been targeted by prevention initiatives or reporting requirements,[9] it is not clear whether reductions in the risk of health care–associated infection have occurred across hospital locations. We repeated the survey in 2015 to assess changes in the prevalence of health care–associated infections.

METHODS

HOSPITALS AND PATIENTS

At 10 sites in the Emerging Infections Program (in California, Colorado, Connecticut, Georgia, Maryland, Minnesota, New Mexico, New York, Oregon, and Tennessee), we recruited general, women's, and children's hospitals in their survey catchment areas (Tables S1 and S2 in the Supplementary Appendix, available with the full text of this article at NEJM.org). Sites preferentially recruited hospitals that had participated in the 2011 survey. Sites engaged additional hospitals, up to 25 per site, by recruiting from randomly sorted hospital lists stratified according to hospital size (small, <150 beds; medium, 150 to 399 beds; or large, ≥400 beds) (see the Supplementary Appendix).

Each hospital selected a survey date from May 1 through September 30, 2015. Random samples of patients in acute care locations were selected from hospitals' morning censuses on the survey date with the use of the method that had been used in the 2011 survey (see the Supplementary Appendix).

The CDC determined the survey to be a nonresearch activity. The Emerging Infections Program site and hospital review boards either considered the survey to be a nonresearch activity or approved the survey with a waiver of informed consent.

DATA COLLECTION AND MANAGEMENT

Staff at the hospitals or the Emerging Infections Program sites reviewed medical records on the survey date or retrospectively (see the Supplementary Appendix) to collect basic demographic and clinical data, including information on whether devices were present on the survey date, and to identify patients who received or were scheduled to receive antimicrobial agents on the survey date or the day before the survey. Trained staff of the Emerging Infections Program retrospectively reviewed records of patients who were receiving or were scheduled to receive antimicrobial agents, in order to collect data regarding the use of antimicrobial agents on the survey date and the day before the survey.

Program staff also reviewed medical records for health care–associated infections if patients were receiving antimicrobial agents for the treatment of an infection or for no documented rationale on the survey date or day before the survey. They identified and reported health care–associated infections for which signs and symptoms were present or for which antimicrobial treatment was given on the survey date. Two different National Healthcare Safety Network sets of definitions of health care–associated infections were used: the definitions used in the 2011 survey[10] and the definitions in place in 2015[11] (see the Supplementary Appendix). For comparisons of the prevalence of health care–associated infections in the two surveys, we included only the infections that were detected according to the 2011 definitions.

Program staff entered data into a Web-based data system developed at the CDC. Staff at the CDC reviewed the data from each site for errors and inconsistencies, and staff from the Emerging Infections Program re-reviewed medical records when necessary to verify data or make corrections.

Statistical Analysis

Extracts of patient data that were generated on November 16, 2017, were analyzed with the use of SAS software, versions 9.3 and 9.4 (SAS Institute), and OpenEpi software, version 3.01.[12] We compared the characteristics of the patients using chi-square or mid-P exact tests for categorical variables and median tests for continuous variables. We compared the percentages of patients who had health care–associated infections using mid-P exact tests. To account for characteristics of the patients and hospitals that might explain differences in the prevalence of health care–associated infections, we performed multivariable log-binomial regression modeling with survey year included as a covariate (see the Supplementary Appendix). A two-sided P value of 0.05 or less was considered to indicate statistical significance. National burden estimates for 2015 were developed with the use of a process that was similar to the method used in 2011,[3] with the 2014 National Inpatient Sample data (Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality)[13] and the formula of Rhame and Sudderth[14] (see the Supplementary Appendix).

Results

Patients

A total of 12,299 patients in 199 hospitals were surveyed in 2015 (Table 1, and Table S3 in the Supplementary Appendix), as compared with 11,282 patients in 183 hospitals in 2011. Hospital survey dates tended to be later in the survey period in 2015 than in 2011 (Table 2, and Fig. S1 in the Supplementary Appendix). The distribution of patients according to age and sex was similar in the 2011 and 2015 surveys (Table S4 in the Supplementary Appendix). In both surveys, approximately 15% of the patients were in critical care units, the median time from admission to the survey date was 3 days, and approximately 11% of patients with a health care–associated infection died during their hospitalization (Table 2). The percentages of patients with a urinary catheter or central catheter (known as a central line in surveillance of the National Healthcare Safety Network) on the survey date were lower in 2015 (urinary catheter, 18.7%; central catheter, 16.9%) than in 2011 (urinary catheter, 23.6%; central catheter, 18.8%) (P<0.001 for both comparisons).

In the 2015 survey, 4614 patients (37.5%) met the criterion for review of health care–associated infection by receiving antimicrobial agents for the treatment of an infection or receiving antimicrobial agents for which the rationale was not documented. This percentage was lower than that of patients who met the same review criterion in the 2011 survey (39.9%, P<0.001).

Prevalence of Health Care–Associated Infections

Applying the same definitions of health care–associated infections that had been used in 2011, we found that 394 of 12,299 patients in the 2015 survey had one or more health care–associated infections (3.2%; 95% confidence interval [CI], 2.9 to 3.5), as compared with 452 of 11,282 patients (4.0%; 95% CI, 3.7 to 4.4) in the 2011 survey (P<0.001). A comparison of the prevalence and distribution of health care–associated infections according to the 2011 and 2015 definitions among patients in the 2015 survey is presented in the Supplementary Appendix (Results section and Table S5 in the Supplementary Appendix).

Table 1. Selected Characteristics of Surveyed Patients, 2015.*

Characteristic	All Patients (N=12,299)	Patients without Health Care–Associated Infection (N=11,905)	Patients with Health Care–Associated Infection (N=394)	P Value†
Hospital size — no. (%)‡				<0.001
Small	3,975 (32.3)	3,889 (32.7)	86 (21.8)	
Medium	5,629 (45.8)	5,459 (45.9)	170 (43.1)	
Large	2,695 (21.9)	2,557 (21.5)	138 (35.0)	
Location of patient in hospital on survey date — no. (%)				<0.001
Critical care unit	1,834 (14.9)	1,719 (14.4)	115 (29.2)	
Unit housing patients receiving different levels of acute care	228 (1.9)	220 (1.8)	8 (2.0)	
Newborn or special care nursery	456 (3.7)	455 (3.8)	1 (0.3)	
Specialty care area	60 (0.5)	58 (0.5)	2 (0.5)	
Step-down unit	547 (4.4)	525 (4.4)	22 (5.6)	
Ward, excluding nursery	9,174 (74.6)	8,928 (75.0)	246 (62.4)	
Central catheter in place on survey date — no. (%)				<0.001
Any	2,081 (16.9)	1,868 (15.7)	213 (54.1)	
One catheter	1,716 (14.0)	1,542 (13.0)	174 (44.2)	
More than one catheter	217 (1.8)	188 (1.6)	29 (7.4)	
Unknown number of catheters	148 (1.2)	138 (1.2)	10 (2.5)	
None	10,175 (82.7)	9,995 (84.0)	180 (45.7)	
Missing data	43 (0.3)	42 (0.4)	1 (0.3)	
Urinary catheter in place on survey date — no. (%)				<0.001
Yes	2,299 (18.7)	2,164 (18.2)	135 (34.3)	
No	9,959 (81.0)	9,703 (81.5)	256 (65.0)	
Missing data	41 (0.3)	38 (0.3)	3 (0.8)	
Ventilator in place on survey date — no. (%)				<0.001
Yes	586 (4.8)	505 (4.2)	81 (20.6)	
No	11,683 (95.0)	11,371 (95.5)	312 (79.2)	
Missing data	30 (0.2)	29 (0.2)	1 (0.3)	
Receiving or scheduled to receive antimicrobial therapy on the survey date or day before the survey, or information not available — no. (%)	6,223 (50.6)	5,829 (49.0)	NA§	—
Median no. of days from admission to survey (IQR)	3 (1–6)	2 (1–6)	13 (7–21)	<0.001¶
Median hospital length of stay (IQR) — days	5 (3–11)	5 (3–10)‖	20 (11–37)**	<0.001¶

* Percentages may not total 100 because of rounding. NA denotes not applicable, and IQR interquartile range.
† The chi-square test was used for calculating the P value, unless otherwise indicated. The comparison excluded patients with missing data, unless otherwise indicated.
‡ Hospital size was determined according to the number of beds: fewer than 150 beds indicated small size, 150 to 399 beds indicated medium size, and 400 beds or more indicated large size.
§ By definition, all patients with a health care–associated infection were receiving antimicrobial agents at the time of the survey.
¶ The P value was calculated by a median two-sample test. The number of days from admission to survey was calculated by subtracting the admission date from the survey date; the length of stay in the hospital was calculated by subtracting the admission date from the discharge date.
‖ The analysis excluded seven patients who were still in the hospital 6 months after the survey date and one patient for whom the hospital discharge date was unknown.
** The analysis excluded one patient who was still in the hospital 6 months after the survey date.

Table 2. Comparison of Selected Characteristics of the Patients, 2011 vs. 2015 Survey.*

Characteristic	2011 Survey Patients (N=11,282)	2015 Survey Patients (N=12,299)	P Value†
Survey month — no. (%)			<0.001
May or June	5863 (52.0)	3008 (24.5)	
July, August, or September	5419 (48.0)	9291 (75.5)	
Hospital size — no. (%)			<0.001
Small	4073 (36.1)	3975 (32.3)	
Medium	4995 (44.3)	5629 (45.8)	
Large	2214 (19.6)	2695 (21.9)	
Location of patient in hospital on survey date — no. (%)‡			<0.001
Critical care unit	1707 (15.1)	1834 (14.9)	
Unit housing patients receiving different levels of acute care	119 (1.1)	228 (1.9)	
Newborn or special care nursery	485 (4.3)	456 (3.7)	
Specialty care area	49 (0.4)	60 (0.5)	
Step-down unit	466 (4.1)	547 (4.4)	
Ward, excluding nursery	8456 (75.0)	9174 (74.6)	
Central catheter in place on survey date — no. (%)			<0.001
Yes	2121 (18.8)	2081 (16.9)	
No	9140 (81.0)	10,175 (82.7)	
Missing data	21 (0.2)	43 (0.3)	
Urinary catheter in place on survey date — no. (%)			<0.001
Yes	2659 (23.6)	2299 (18.7)	
No	8594 (76.2)	9959 (81.0)	
Missing data	29 (0.3)	41 (0.3)	
Received or were scheduled to receive antimicrobial therapy on the survey date or day before the survey, or information not available — no. (%)	5849 (51.8)§	6223 (50.6)	0.06
Received antimicrobial therapy for infection treatment or no documented rationale at time of survey — no. (%)	4504 (39.9)¶	4614 (37.5)	<0.001
Median no. of days from admission to survey (IQR)	3 (1–6)	3 (1–6)	0.40‖
Outcome among patients with health care–associated infection only — no./total no. (%)			0.99**
Survived	386/452 (85.4)	348/394 (88.3)	
Died	50/452 (11.1)	45/394 (11.4)	
Still in hospital or data were missing	16/452 (3.5)	1/394 (0.3)	

* Percentages may not total 100 because of rounding.
† The chi-square test was used for calculating the P value, unless otherwise indicated. The comparison excluded patients with missing data, unless otherwise indicated.
‡ The locations of the patients were defined according to the 2015 National Healthcare Safety Network categories. Solid-organ transplantation and dialysis units were classified as specialty care areas, and bone marrow transplantation and hematology–oncology units were classified as non–nursery ward locations.
§ The analysis excluded 11 patients in the 2011 survey who were screen-positive based on a special criterion for dialysis patients. This criterion was not implemented in the 2015 survey.
¶ The analysis included 7 patients who underwent medical record review for health care–associated infection because they met the antimicrobial use screening criterion for patients undergoing dialysis. This criterion was not implemented in the 2015 survey.
‖ The P value was calculated by a median two-sample test. The number of days from admission to survey was calculated by subtracting the admission date from the survey date.
** The comparison included only patients for whom the outcome was known (died vs. survived).

Table 3. Multivariable Log-Binomial Regression Model to Identify Variables Associated with Health Care–Associated Infections, Combined 2011 and 2015 Survey Populations.*

Variable	Total No. of Patients	No. of Patients with Infection	Adjusted Risk Ratio (95% CI)	P Value
Survey year 2015†	12,299	394	0.84 (0.74–0.95)	0.005
Ventilator on the survey date‡	1,113	176	1.63 (1.38–1.92)	<0.001
Central catheter on the survey date§	4,202	472	1.84 (1.59–2.13)	<0.001
Urinary catheter on the survey date¶	4,958	312	1.24 (1.07–1.44)	0.004
Large hospital‖	4,909	280	1.20 (1.05–1.37)	0.007
Time from admission to survey				
≤1 day	7,022	27	Reference	—
2–4 days	9,013	81	2.15 (1.41–3.38)	<0.001
5–6 days	2,154	76	7.14 (4.67–11.26)	<0.001
7–9 days	1,834	127	12.97 (8.71–20.05)	<0.001
≥10 days	3,557	535	25.45 (17.54–38.58)	<0.001
Age**				
<40 yr	7,217	172	Reference	—
40–50 yr	2,185	88	1.50 (1.17–1.89)	<0.001
51–57 yr	2,277	114	1.67 (1.33–2.08)	<0.001
58–65 yr	3,048	140	1.45 (1.17–1.78)	<0.001
66–72 yr	2,703	104	1.39 (1.10–1.75)	0.005
73–80 yr	2,815	113	1.56 (1.24–1.95)	<0.001
≥81 yr	3,335	115	1.65 (1.31–2.07)	<0.001

* The total number of patients who were included in either survey was 23,581. One patient from the 2011 survey for whom age was unknown was excluded from the model. Other variables that were tested but found not to be significant predictors of the risk of health care–associated infection were survey month (May or June vs. July through September) and location of the patient in a critical care unit (yes vs. no).

† The comparator group for the risk ratio was the group of patients in the 2011 survey.

‡ The comparator group for the risk ratio was the group of patients without a ventilator or for whom the presence of a ventilator was unknown. The presence of a ventilator was unknown for 36 patients without a health care–associated infection and for 1 with a health care–associated infection.

§ The comparator group for the risk ratio was the group of patients without a central catheter or for whom the presence of a central catheter was unknown. The presence of a central catheter was unknown for 62 patients without a health care–associated infection and for 2 with a health care–associated infection.

¶ The comparator group for the risk ratio was the group of patients without a urinary catheter or for whom the presence of a urinary catheter was unknown. The presence of a urinary catheter was unknown for 65 patients without a health care–associated infection and for 5 with a health care–associated infection.

‖ The comparator group for the risk ratio was the group of patients in small or medium hospitals.

** The model excluded 1 patient without a health care–associated infection for whom age was unknown.

Because the percentage of patients who met the criterion for review of health care–associated infection was lower in 2015 than in 2011, we also determined the prevalence of these infections in the subgroup of patients for whom review occurred. A total of 394 of 4614 patients (8.5%) who met the review criterion in 2015 had a health care–associated infection, as compared with 452 of 4504 patients (10.0%) in 2011 (P=0.01).

After adjustment for age, time from admission to survey, presence of devices, and status of being in a large hospital, patients in the 2015 survey were 16% less likely to have a health care–associated infection than patients in the 2011 survey (risk ratio, 0.84; 95% CI, 0.74 to 0.95; P=0.005) (Table 3). We repeated the analysis in the subgroup of patients who met the review criterion. After adjustment for similar factors, patients in the 2015 survey remained less likely than those in the 2011 survey to have a health care–associated infection (risk ratio, 0.84; 95% CI, 0.75 to 0.94; P=0.003) (Table S6 in the Supplementary Appendix).

Results were similar in an analysis that was restricted to 148 hospitals that participated in both surveys. In these hospitals, the percentage of patients with a health care–associated infection was 3.2% (95% CI, 2.9 to 3.6) in 2015 (297 of 9169 patients), as compared with 4.1% (95% CI, 3.7 to 4.6) in 2011 (383 of 9283 patients) (P=0.001). After adjustment for age, presence of devices, time from admission to survey, and status of being in a large hospital, patients in the 2015 survey had a 22% lower risk of health care–associated infections than patients in the 2011 survey (risk ratio, 0.78; 95% CI, 0.68 to 0.90; P<0.001) (Table S7 in the Supplementary Appendix).

Because the inclusion of the presence of a ventilator, central catheter, or urinary catheter in the model neutralizes the effect of reducing device use as a strategy for preventing health care–associated infections, we also evaluated the association of survey year with health care–associated infections in a model that did not adjust for the presence of a device. In this model, patients in the 2015 survey had a 24% lower risk of health care–associated infection than patients in the 2011 survey (risk ratio, 0.76; 95% CI, 0.66 to 0.87; P<0.001) (Table S8 in the Supplementary Appendix).

Types of Health Care–Associated Infection

There were 427 health care–associated infections in 394 patients in the 2015 survey. Pneumonia was the most common infection, followed by gastrointestinal infections (most of which were due to *Clostridium difficile* [now *Clostridioides difficile*]), and surgical-site infections (Table 4). Although the percentages of patients with pneumonia, gastrointestinal infection (including *C. difficile* infection), or bloodstream infection did not differ significantly between 2015 and 2011, the percentages of patients with a surgical-site infection or urinary tract infection were lower in 2015 than in 2011 (Table 4). The percentage of patients with other health care–associated infections was also lower in 2015 than in 2011.

Of 69 surgical-site infections in the 2015 survey, 54 (78%) were deep incisional or organ-space infections. Surgical-site infections were attributed to 25 different categories of National Healthcare Safety Network operative procedures, most commonly classified as "other" procedures (11 infections [16%]), followed by colon procedures (7 [10%]), hip replacements (7 [10%]), and spinal fusions (5 [7%]).

Among the 358 health care–associated infections that were not surgical-site infections, the inpatient location to which the infection was attributed was reported for 346 infections. Of these, 126 infections (36.4%) were attributed to critical care locations, 199 (57.5%) to ward or nursery locations, and 21 (6.1%) to step-down or specialty care units or to units that house patients receiving different levels of acute care (known as mixed acuity locations in surveillance of the National Healthcare Safety Network).

Pathogens Causing Health Care–Associated Infection

At least 1 pathogen was reported for 300 of 427 health care–associated infections (70.3%). Of 392 total pathogens, *C. difficile*, *Staphylococcus aureus*, and *Escherichia coli* were the most common, with each being reported for 10% or more of all health care–associated infections (Table 5). Among 47 *S. aureus* isolates with antimicrobial susceptibility results, 21 (45%) were methicillin resistant (MRSA). Among 66 *E. coli*, klebsiella, and enterobacter isolates with susceptibility results that were reported for at least one carbapenem, 3 (5%) were resistant.

National Estimates of Health Care–Associated Infections in Hospitals in 2015

The age of the patients, the presence of a ventilator or central catheter, the length of stay in the hospital, the number of beds for which the hospital was licensed, and hospital location (rural vs. urban) were independently associated with the prevalence of health care–associated infections in the final log-binomial regression model (Table S9 in the Supplementary Appendix). A reduced model included factors that were present in both the 2015 prevalence survey and the National Inpatient Sample data sets: the age of the patient, length of stay, and hospital location. Hospital location was removed because statistical significance was not sustained after bootstrap validation. The final model that was used to obtain parameter estimates for the estimation of burden included the age of the patient and length

Table 4. Percentages of All Surveyed Patients with Specific Types of Health Care–Associated Infection, 2011 vs. 2015 Survey.*

Type of Infection	2011 Survey			2015 Survey			P Value†
	No. of Patients with Infection	No. of Infections	Percentage of Patients with Infection (95% CI)	No. of Patients with Infection	No. of Infections	Percentage of Patients with Infection (95% CI)	
Pneumonia	110	110	0.98 (0.81–1.20)	110	110	0.89 (0.74–1.10)	0.52
Ventilator-associated pneumonia	43	43	0.38 (0.28–0.51)	39	39	0.32 (0.23–0.43)	0.41
Other pneumonia	67	67	0.59 (0.47–0.75)	71	71	0.58 (0.46–0.73)	0.87
Gastrointestinal infection	86	86	0.76 (0.62–0.94)	91	91	0.74 (0.60–0.91)	0.84
Clostridium difficile infection‡	61	61	0.54 (0.42–0.69)	66	66	0.54 (0.42–0.68)	0.97
Other gastrointestinal infection	25	25	0.22 (0.15–0.33)	25	25	0.20 (0.14–0.30)	0.76
Surgical-site infection	109	110	0.97 (0.80–1.20)	69	69	0.56 (0.44–0.71)	<0.001
Deep incisional or organ-space infection	77	77	0.68 (0.55–0.85)	54	54	0.44 (0.34–0.57)	0.01
Superficial incisional infection	33	33	0.29 (0.21–0.41)	15	15	0.12 (0.07–0.20)	0.004
Bloodstream infection	50	50	0.44 (0.34–0.58)	51	52	0.41 (0.31–0.55)	0.74
Central catheter–associated bloodstream infection	42	42	0.37 (0.27–0.50)	37	38	0.30 (0.22–0.42)	0.35
Other primary bloodstream infection	8	8	0.07 (0.03–0.14)	14	14	0.11 (0.07–0.19)	0.29
Urinary tract infection	65	65	0.58 (0.45–0.73)	39	39	0.32 (0.23–0.43)	0.003
Catheter-associated urinary tract infection	44	44	0.39 (0.29–0.52)	24	24	0.20 (0.13–0.29)	0.005
Other urinary tract infection	21	21	0.19 (0.12–0.29)	15	15	0.12 (0.07–0.20)	0.21
Other infection§	78	83	0.69 (0.55–0.86)	61	66	0.50 (0.39–0.64)	0.05
Any infection	452	504	4.0 (3.7–4.4)	394	427	3.2 (2.9–3.5)	<0.001

* A total of 11,282 patients were included in the 2011 survey, and 12,299 in the 2015 survey; these values are the denominators for the percentages of patients with infection. Patients could have more than one health care–associated infection.
† P values were calculated by a mid-P exact test.
‡ *Clostridium difficile* is now known as *Clostridioides difficile*.
§ Other infections in the 2011 survey included the following: ear, eye, nose, and throat infections (28 infections); lower respiratory tract infection (20); skin and soft-tissue infections (16); cardiovascular infection (6); bone and joint infections (5); central nervous system infection (4); reproductive tract infection (3); and systemic infection (1). Other infections in the 2015 survey included the following: skin and soft-tissue infections (22 infections); ear, eye, nose, and throat infections (21); lower respiratory tract infection (18); bone and joint infections (2); central nervous system infection (1); cardiovascular infection (1); and reproductive tract infection (1).

Table 5. Pathogens Reported for Health Care–Associated Infections, 2015.*

Pathogen	All Infections (N=427)	Pneumonia (N=110)†	Gastrointestinal Infection (N=91)‡	Surgical-Site Infection (N=69)§	Bloodstream Infection (N=52)¶	Urinary Tract Infection (N=39)‖	Other Infection (N=66)**
	number of infections (percent)						
C. difficile	66 (15)	0	66 (73)	0	0	0	0
Staphylococcus aureus	48 (11)	13 (12)	2 (2)	12 (17)	12 (23)	0	9 (14)
Escherichia coli	44 (10)	2 (2)	1 (1)	13 (19)	4 (8)	18 (46)	6 (9)
Candida species	26 (6)	7 (6)	3 (3)	1 (1)	7 (13)	3 (8)	5 (8)
Enterococcus species	23 (5)	1 (1)	2 (2)	8 (12)	6 (12)	4 (10)	2 (3)
Enterobacter species††	22 (5)	3 (3)	1 (1)	10 (14)	0	3 (8)	5 (8)
Pseudomonas aeruginosa	22 (5)	8 (7)	2 (2)	3 (4)	0	5 (13)	4 (6)
Klebsiella pneumoniae or *K. oxytoca*	21 (5)	6 (5)	1 (1)	3 (4)	3 (6)	7 (18)	1 (2)
Streptococcus species‡‡	21 (5)	4 (4)	1 (1)	9 (13)	6 (12)	0	1 (2)
Coagulase-negative staphylococcus	16 (4)	1 (1)	2 (2)	6 (9)	6 (12)	0	1 (2)
Other gram-negative bacterium§§	11 (3)	2 (2)	0	4 (6)	1 (2)	1 (3)	3 (5)
Proteus mirabilis	8 (2)	0	0	3 (4)	1 (2)	3 (8)	1 (2)
Other gram-positive bacterium¶¶	8 (2)	0	0	6 (9)	1 (2)	0	1 (2)
Stenotrophomonas species	6 (1)	1 (1)	1 (1)	0	2 (4)	0	2 (3)
Acinetobacter baumannii	6 (1)	1 (1)	0	0	2 (4)	0	3 (5)
Bacteroides species‖‖	5 (1)	0	0	2 (3)	3 (6)	0	0
Virus***	5 (1)	1 (1)	0	0	0	0	4 (6)
Citrobacter freundii	4 (1)	0	0	1 (1)	1 (2)	1 (3)	1 (2)
Prevotella species	4 (1)	0	0	3 (4)	1 (2)	0	0
Serratia species	4 (1)	3 (3)	0	1 (1)	0	0	0
Mold	4 (1)	1 (1)	0	1 (1)	0	0	2 (3)
Yeast, not otherwise specified	4 (1)	3 (3)	0	0	1 (2)	0	0
Haemophilus influenzae, type not specified	3 (1)	3 (3)	0	0	0	0	0
Lactobacillus species	3 (1)	1 (1)	0	1 (1)	0	0	1 (2)
Other pathogen†††	2 (<1)	1 (1)	1 (1)	0	0	0	0
No pathogen reported	127 (30)	64 (58)	16 (18)	19 (28)	0	0	28 (42)

* Pathogens were reported for 300 of 427 health care–associated infections. Up to 3 pathogens could be reported for each infection.
† A total of 62 pathogens were reported for 46 of 110 pneumonias (42%).
‡ A total of 83 pathogens were reported for 75 of 91 gastrointestinal infections (82%).
§ A total of 89 pathogens were reported for 50 of 69 surgical-site infections (72%). Two organisms in the same genus or pathogen group were reported for each of 2 surgical-site infections.
¶ A total of 59 pathogens were reported for 52 of 52 bloodstream infections (100%). The definition of a bloodstream infection required pathogen reporting. Two organisms in the same genus were reported for each of 2 bloodstream infections (2 streptococcus species were reported for 1 bloodstream infection, and 2 bacteroides species were reported for another bloodstream infection).
‖ A total of 45 pathogens were reported for 39 of 39 urinary tract infections (100%). The definition of a urinary tract infection required pathogen reporting.
** A total of 54 pathogens were reported for 38 of 66 other infections (58%). Two organisms in the same genus were reported for each of 2 other infections.
†† A total of 23 enterobacter were reported for 22 health care–associated infections (*E. cloacae* and *E. aerogenes* [now *Klebsiella aerogenes*] were each reported for 1 infection).
‡‡ A total of 24 streptococci were reported for 21 health care–associated infections (2 different streptococci were reported for each of 3 infections).
§§ Pathogens included gram-negative rod (not otherwise specified; for 2 infections), *Morganella morganii* (for 2), *Burkholderia cepacia* (for 1), capnocytophaga species (for 1), *Chryseomonas luteola* (now *Pseudomonas luteola*; for 1), *Eikenella corrodens* (for 1), gram-negative coccus (not otherwise specified; for 1), *Legionella pneumophila* (for 1), and neisseria species (for 1).
¶¶ Pathogens included 9 other gram-positive bacteria for 8 health care–associated infections: gram-positive coccus (not otherwise specified; for 3 infections), corynebacterium species (for 2), gram-positive rod (not otherwise specified; for 2), *Clostridium perfringens* (for 1), and *Rothia mucilaginosa* (for 1).
‖‖ A total of 6 bacteroides were reported for 5 health care–associated infections (both *B. fragilis* and *B. thetaiotaomicron* were reported for 1 infection).
*** Pathogens included rhinovirus (for 3 infections), cytomegalovirus (for 1), and herpes simplex virus type 2 (for 1).
††† Pathogens included *Pneumocystis jirovecii* (for 1 infection) and other unspecified pathogen (for 1).

of stay (Table S9 in the Supplementary Appendix). Using National Inpatient Sample data stratified according to the categories of age and length of stay, we estimated that there were 633,300 patients with a health care–associated infection (95% CI, 216,000 to 1,912,700) and 687,200 health care–associated infections (95% CI, 181,400 to 2,691,200) in U.S. hospitals in 2015 (Table S10 in the Supplementary Appendix).

DISCUSSION

In this point-prevalence survey conducted in multiple states, we found that health care–associated infections affected 3.2% of hospitalized patients — a significantly lower percentage than we observed in a survey that had been conducted in 2011. These results provide evidence of national success in preventing health care–associated infections, particularly surgical-site and urinary tract infections. In contrast, there was no significant reduction in the prevalence of pneumonia or *C. difficile* infection, nor in the percentage of patients with health care–associated infection who died during their hospitalization, which suggests that more work is needed to prevent these infection types and reduce mortality among patients with health care–associated infections.

Although the prevalence of health care–associated infections was significantly lower in 2015 than in 2011, we did not directly compare the national burden estimates from the two surveys. Two barriers to such a comparison were present. First, there were differences in the variables that remained in the best-fitting multivariable regression models that were used in the 2011 and 2015 burden-estimation processes. For example, we lacked complete data regarding the length of stay in the hospital for patients in the 2011 survey and therefore used a proxy measure (the number of days from admission to the survey). In addition, the Nationwide Inpatient Sample underwent a redesign starting with 2012 data and was renamed the National Inpatient Sample.[15]

Despite differences in the methods used in the prevalence survey and in National Healthcare Safety Network surveillance, similar signals have emerged from these complementary systems, providing evidence of improvements in the safety of patients in U.S. hospitals. Analyses of National Healthcare Safety Network data through 2014, before the implementation of major changes in the definitions of health care–associated infections, showed reductions in the standardized infection ratios for central catheter–associated bloodstream infections between 2008 and 2014, selected surgical-site infections between 2008 and 2014, and MRSA bacteremia between 2011 and 2014.[9] There was no reduction in the standardized infection ratio for catheter-associated urinary tract infections in hospitals nationally from 2009 to 2014, but a significant decrease in the standardized infection ratio was evident from 2013 to 2014.[9]

We observed significant reductions in the prevalence of urinary tract infections and surgical-site infections. Experience has shown that health care–associated infections can be prevented by means of evidence-based interventions; for example, implementation of a Comprehensive Unit-based Safety Program that was focused on catheter-associated urinary tract infection in 603 U.S. hospitals between 2011 and 2013 led to a reduction in the rates of catheter-associated urinary tract infection and urinary-catheter use.[16] Reductions in urinary-catheter use, which we observed in the survey, may partially explain the lower prevalence of urinary tract infection. Although we did not collect data on urine-culturing practices, increased focus on improving the diagnosis and treatment of urinary tract infection in recent years may also have contributed.[17] The reduction in the prevalence of surgical-site infections may reflect the uptake of preoperative infection-prevention practices, such as the decolonization of patients with *S. aureus* colonization,[18-20] or the use of updated surgical prophylaxis guidelines.[21] A limitation of our survey is that we do not have data to evaluate practice changes, nor do we have information about changes in the volume or types of operative procedures that may have affected the overall prevalence of surgical-site infections.

Our survey showed that pneumonia was the most common health care–associated infection, with a stable prevalence between 2011 and 2015. Similarly, an analysis of Medicare Patient Safety Monitoring System data showed that, between 2005 and 2013, the percentage of patients with ventilator-associated pneumonia among eligible Medicare patients with selected diagnoses who were undergoing mechanical ventilation remained the same, at approximately 10%.[22] Although the prevention of ventilator-associated pneumonia remains an important goal, the majority of pneumonia events in hospitals in our survey were not ventilator-associated. The published literature contains relatively little regarding the prevention of non–ventilator-associated pneumonia in hospitalized patients, despite the association of this infection with poor outcomes in some reports.[23,24] Some investigators have called for increased attention and resources for this underappreciated health care–associated infection.[25-27]

We also found that the prevalence of *C. difficile* infection was stable between 2011 and 2015. However, we did not collect data on changes in the use of nucleic acid amplification tests for the diagnosis of *C. difficile* infection in participating hospitals from 2011 to 2015. Others have suggested that increasing the use of such tests may result in an increased incidence of *C. difficile* infection owing to overdiagnosis.[28,29] It is possible that an increased use of nucleic acid amplification tests in survey hospitals masked actual reductions in the prevalence of *C. difficile* infection. Analyses of National Healthcare Safety Network data have begun to show progress regarding the prevention of *C. difficile* infection with onset in the hospital.[9] Regardless of whether changes in testing have inflated our estimate of the burden of *C. difficile* infection in hospitals, there is room for improvement. Because the use of antibiotics is a major driver of *C. difficile* infections as well as antimicrobial resistance, continued focus on improving practices for the prescribing of antibiotics is critical, in addition to infection-control measures to prevent transmission in hospitals.

Our survey has other potential limitations. As in the 2011 survey, the 2015 survey included geographically diverse sites, but the results may not be generalizable to all U.S. hospitals. Owing to the types of data available in the National Inpatient Sample, we were unable to account for all the factors associated with the prevalence of health care–associated infections in the process of developing national burden estimates. In the 2015 survey, we used the same antimicrobial screening criterion that had been used in 2011 to identify patients for review of health care–associated infections.[3,30] In 2015, the proportion of patients who met the screening criterion was significantly lower than in 2011. This resulted in a lower proportion of medical records being reviewed for health care–associated infections and potentially could have resulted in the detection of fewer health care–associated infections. However, analyses of the prevalence of health care–associated infections among just those patients for whom review was performed confirmed that a smaller percentage of patients had a health care–associated infection in 2015 than in 2011, even after adjustment for other factors. Additional limitations are discussed in the Supplementary Appendix.

Prevalence surveys capture the range and relative frequencies of all health care–associated infections among hospitalized patients and complement ongoing tracking of these infections. The health care–associated infections that we identified in this survey are only one portion of the overall burden of such infections, which includes infections that occur in other settings, such as nursing homes. The CDC and the Emerging Infections Program sites are collaborating on a large-scale nursing home prevalence survey to address this gap.[31] Collaborations among health care facilities, public health agencies, and other partners, bolstered by recent increases in support for programs regarding health care–associated infections, will be critical to the continued progress toward the goal of eliminating health care–associated infections.

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention (CDC).

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APPENDIX

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