AHRQ National Scorecard on Hospital-Acquired Conditions Final Results for 2014 Through 2017

Summary

Final patient safety data for 2014 through 2017 showed a downward trend in the annual number of hospital-acquired conditions (HACs). Data previously reported in 2016, covering 2010 through 2014, showed the rate of HACs decreasing by 17 percent. The decrease in HACs from 2014 to 2017 based on a slightly different method showed a 13 percent reduction. From 2010 through 2017, the average observed annual reduction in the overall rate of HACs was approximately 4.5 percent.

For 2014 through 2017, methods were updated and a larger portion of hospital inpatients was included in the HAC calculations. The rate started at 99 HACs per 1,000 hospital discharges in 2014 and ended at 86 HACs per 1,000 discharges in 2017. In the method previously used, the 2010 rate was calculated as 145 HACs per 1,000 discharges and the 2014 rate was 121 HACs per 1,000 discharges. Both methods use the same 28 measures of patient safety events, including many types of hospital-acquired infections, adverse drug events, and injuries due to procedures, as well as pressure ulcers/pressure injuries and falls.

The 2014 baseline of 99 HACs per 1,000 discharges equates to approximately 2,940,000 HACs among all hospital inpatients 18 years old and over. The final rate for 2017 equates to approximately 2,550,000 HACs. Based on the HAC reductions seen in 2015, 2016, and 2017 compared with 2014, AHRQ estimates a total of 910,000 fewer HACs occurred than if the 2014 rates had persisted through 2017. These HAC reductions lead to estimates of approximately $7.7 billion in costs saved and approximately 20,700 HAC-related inpatient deaths averted from 2015 through 2017. Data reported in 2016 estimated that from 2011 through 2014, HAC reductions totaled 2.1 million, and these reductions resulted in approximately $19.9 billion in cost savings and 87,000 fewer HAC-related inpatient deaths.[1]

From 2014 to 2017, not all types of HACs showed similar trends. For example, measured adverse drug events continued to drop from 2014 to 2017, while measured pressure ulcers/pressure injuries increased from 2014 to 2015 and then decreased somewhat from 2015 to 2016 and 2017. A similar trend was seen for physician-diagnosed catheter-associated urinary tract infections.

[1] See the AHRQ HAC report at https://www.ahrq.gov/professionals/quality-patient-safety/pfp/2014-final.html.

Of special interest may be the apparent reduction in the rate of antibiotic-associated *Clostridioides difficile*[2] infections. Comparing these data with other sources of information, such as the Centers for Disease Control and Prevention (CDC) and the AHRQ Healthcare Cost and Utilization Project (HCUP), may help us determine if efforts to reduce the occurrence of this important HAC are effective at the national level.

Detailed Results

The 2014 baseline for the national HAC rate (NHR) is 99 HACs per 1,000 discharges. Exhibit 1 shows the details. *Clostridioides difficile* Infections is italicized because it was added as a "focus" HAC for reduction efforts and tracking the data for 2014 to 2017. In the 2010-2014 data, *Clostridioides difficile* infections were previously tracked in the "All Other HACs" measure, a collection of 13 other types of HACs. Methods used to calculate the NHR are provided in Appendix 1, and all the measures used in the NHR are shown in Appendix 2, Exhibit A2c.

Exhibit 1. 2014 national HAC rate baseline (rounded)

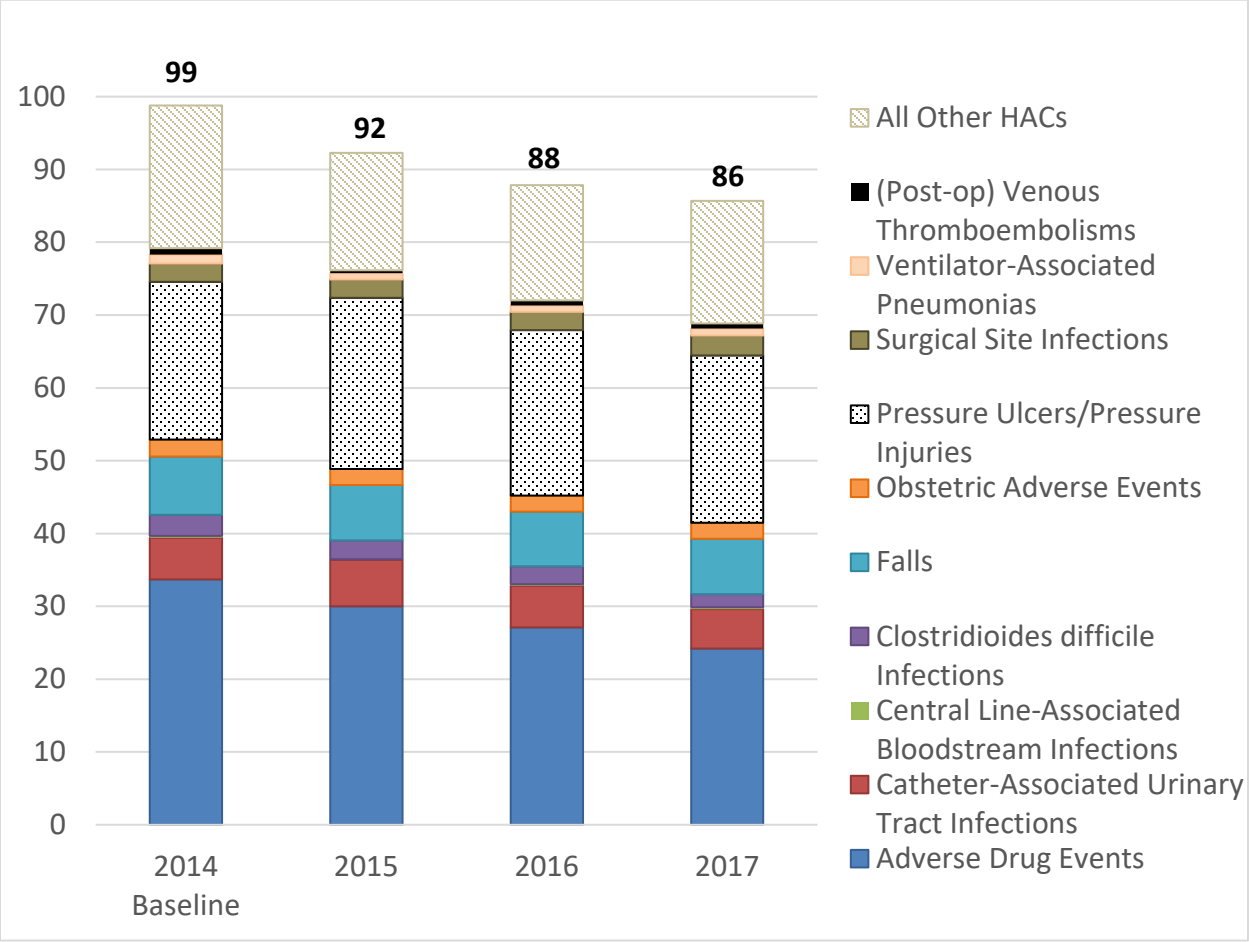
Hospital-Acquired Condition	2014 Measured Baseline for HACs	2014 Total HACs per 1,000 Discharges
Adverse Drug Events	1,001,000	33.7
Catheter-Associated Urinary Tract Infections	170,000	5.7
Central Line-Associated Bloodstream Infections	8,500	0.3
Clostridioides difficile Infections	86,000	2.9
Falls	239,000	8.0
Obstetric Adverse Events	67,000	2.3
Pressure Ulcers/Pressure Injuries	647,000	21.8
Surgical Site Infections	73,000	2.5
Ventilator-Associated Pneumonias	36,000	1.2
(Post-op) Venous Thromboembolisms	25,000	0.9
All Other HACs	584,000	19.6
Total	2,940,000	99

[2] The scientific name for the bacteria species *Clostridium difficile* has been changed to *Clostridioides difficile*. More information is available at https://www.ncbi.nlm.nih.gov/pubmed/27370902 and https://www.cdc.gov/hai/organisms/cdiff/cdiff_infect.html

The baseline established with the 2014 data was developed using a new method that was based on the method previously used to calculate the 2010-2014 NHR.[3] The major difference between the new method and the previous method is that the new method includes patient charts for most conditions treated in acute care hospitals. Previously, the Medicare Patient Safety Monitoring System (MPSMS) used patient charts from only four groups of patients. Three were represented by the principal diagnosis (acute myocardial infarction [AMI], congestive heart failure [CHF], and pneumonia [PN]). The other comprised major surgery patients, as described by the Surgical Care Improvement Project (SCIP). These groups were used to calculate the 2010–2014 NHR.

With the new method, charts for conditions other than AMI, CHF, PN, and SCIP were sampled as a single group, starting with 2014, thus producing five sets of inpatient charts. Data from MPSMS make up approximately 90 percent of the HACs represented in the NHR. The 2015 NHR rate is 92 HACs per 1,000 discharges, and 2016 and 2017 rates are 88 and 86 HACs per 1,000 discharges, respectively (Exhibit 2). Detailed information on the number of HACs from 2015 to 2017 is shown in Appendix 2, Exhibit A2c.

Exhibit 2. 2014-2017 National HAC Rate data



[3] See the report at https://www.ahrq.gov/sites/default/files/wysiwyg/professionals/quality-patient-safety/pfp/pfphac.pdf.

Exhibit A2e shows how the current NHR, which starts in 2014, compares with the NHR trended for 2010 to 2014. Appendix 3 describes changes in the samples used for the 2014–2017 analyses, compared with the 2010–2014 analyses. Exhibit 3 provides the same information as Exhibit 2, but in table form that provides more details on the combined results to date, based on 2015, 2016, and 2017 data, compared with the 2014 baseline.

Exhibit 3. Re-baselined 2014 data, with 2015, 2016, and 2017 national HAC rate data, and percent change through 2017data

Hospital-Acquired Condition	2014 Measured Baseline for HACs	2015 Normalized Count of HACs	2016 Normalized Count of HACs	2017 Normalized Count of HACs	Percent Change in HACs, 2014 vs. 2017
Adverse Drug Events	33.7	30.0	27.1	24.2	-28%
Catheter-Associated Urinary Tract Infections	5.7	6.4	5.7	5.4	-5%
Central Line-Associated Bloodstream Infections	0.29	0.07	0.22	0.27	-6%
Clostridioides difficile Infections	2.9	2.6	2.5	1.8	-37%
Falls	8.0	7.6	7.5	7.6	-5%
Obstetric Adverse Events	2.3	2.2	2.2	2.2	-3%
Pressure Ulcers/ Pressure Injuries	21.7	23.5	22.7	23.0	6%
Surgical Site Infections	2.5	2.5	2.5	2.7	8%
Ventilator-Associated Pneumonias	1.2	0.9	0.9	1.0	-13%
(Post-op) Venous Thromboembolisms	0.9	0.4	0.7	0.7	-17%
All Other HACs	19.6	16.1	15.8	16.8	-14%
Totals (rounded)	99	92	88	86	-13%

With the overall HAC reductions described above, and based on new per-HAC cost and mortality estimates that were updated in 2017, we project that over 2015–2017, there were approximately $7.7 billion in cost savings and 20,700 fewer deaths associated with HACs. These projections are tabulated in Exhibit 4. Appendix 4 shows the summary cost and mortality associated with each of the 10 types of focus HACs, and the full report from which this table is excerpted is available on the AHRQ website. The cost and mortality for “all other HACs” was estimated based on a weighted average of the 10 focus HACs, with the weighting based on the proportion of each of the 10 focus HACs in the 2014 baseline data.

Exhibit 4. Projected cost savings and deaths averted due to HAC changes to date from 2015 through 2017, compared with 2014 baseline

	Total Change in HACs, 2015, 2016, and 2017 Data Compared With 2014	Estimate of Total Change in HAC-Related Costs	Estimate of Total Change in HAC-Related Deaths
Adverse Drug Events	-585,000	-3,361,400,000	-7,020
Catheter-Associated Urinary Tract Infections	12,000	165,500,000	430
Central Line-Associated Bloodstream Infections	-9,000	-433,000,000	-1,350
Clostridioides difficile Infections	-54,000	-932,000,000	-2,380
Falls	-43,000	-287,800,000	-2,150
Obstetric Adverse Events	-8,000	-4,800,000	-40
Pressure Ulcers/Pressure Injuries	119,000	1,726,200,000	4,880
Surgical Site Infections	6,000	169,300,000	160
Ventilator-Associated Pneumonias	-23,000	-1,086,500,000	-3,220
Venous Thromboembolisms	-22,000	-382,100,000	-950
All Other HACs (not including *Clostridioides difficile* Infections)	-304,000	-3,256,800,000	-9,040
Totals From Annual Changes in HACs, HAC-Related Costs, and Deaths	-910,000	-7,683,000,000	-20,700

Note: Totals are rounded and thus may not reflect the total obtained by adding the individual cells

Looking Ahead

In spite of the volume and velocity of data flowing into and through healthcare, providers, health system leaders, and other stakeholders lack sufficient information to guide their efforts as they work to prevent HACs. Similarly, patients' choices often occur without the robust information they need, and this limitation constrains their efforts to be engaged in their own care.

In addition, numerous other unmet needs must be addressed to continue preventing HACs and sustain the improvements documented in this report. In particular, we must continue to advance patient safety measurement, expand the evidence base for patient safety improvement strategies, and create resources to help providers and the healthcare workforce improve patient safety at the point of care.

For example, it is critically important that we continue to drive innovation that efficiently harnesses the full potential of data and measurement. AHRQ's patient safety measurement projects, including the Quality and Safety Review System (QSRS), are making progress by moving information closer to points of care where it can support providers and the safer care that all stakeholders want to achieve.

A powerful foundation of knowledge about how to improve patient safety has been established over more than two decades of AHRQ-funded research and implementation projects. If we want to use this knowledge to address persistent patient safety challenges, it is crucial to pair it with capabilities that help clinicians and other healthcare workers reliably measure patient safety. When providers trust information they receive about patient safety, they are in better positions to understand these ongoing problems and to effectively prioritize and target them with safer practices. QSRS is being developed in part to serve this purpose by providing information that clinicians and other healthcare workers will trust and use to improve safety.

AHRQ and other HHS agencies recognize that improving the safety and quality of healthcare is the ultimate purpose of measurement systems, and the ability to support this improvement effectively and efficiently is a desirable characteristic of these systems. AHRQ and CMS have used the MPSMS as the primary system to measure the NHR, but AHRQ has been working with CMS and other Federal partners, contractors, and other experts to develop the QSRS, an improved system to succeed MPSMS.

The QSRS has been developed and is undergoing use in the Clinical Data Abstraction Center, pilot testing at non-Federal settings,[4] and refinement pursuant to the goal of supporting safe, high-quality care. QSRS has been designed as a robust measurement platform that will serve the shared needs of different healthcare stakeholders.

[4] See https://www.ahrq.gov/professionals/quality-patient-safety/qsrs/index.html and https://www.ahrq.gov/sites/default/files/wysiwyg/research/findings/factsheets/translating/action3/actioniii-2016-summaries.pdf.

QSRS is designed to provide up-to-date national HAC rates, including rates of some additional types of HACs not currently measured with MPSMS, the AHRQ Patient Safety Indicators (PSIs), the Centers for Disease Control and Prevention National Healthcare Safety Network (NHSN), or other sources of information concerning patient safety in hospitals. It has been developed so that non-Federal entities, including hospitals and healthcare systems, will be able to use it to measure patient safety.

QSRS will allow assessment of safety for new patient populations not currently captured by MPSMS, which was originally designed to focus on adverse events experienced by Medicare patients. In addition, QSRS will allow organizations to consider aligning their local patient safety measurements with the same methods and measures used at the national level. Standard methods for measurement, such as those in QSRS, have been a valuable component of other healthcare improvement initiatives, including some that have addressed more specific safety challenges.

The AHRQ Common Formats for Surveillance,[5] a subset of the AHRQ Common Formats, serve as the underlying content that provides the foundation of QSRS measures and cover a broad range of common and uncommon threats to patient safety. Development and revision of the Common Formats for Surveillance and QSRS are ongoing processes that include structured review and public feedback facilitated by the National Quality Forum. After release of QSRS, AHRQ will rely on feedback, especially from users, to inform the development of new versions of the Common Formats for Surveillance and for QSRS. This process will enable the Common Formats and QSRS to keep pace with users' needs and the emerging scientific evidence base for patient safety and quality improvement.

Some data needed for patient safety measurement may be increasingly available from electronic health records; therefore, AHRQ is studying the feasibility of automated approaches to data abstraction.[6] This work includes specific efforts related to QSRS and the AHRQ Common Formats for Surveillance and aims to improve efficiency and ease of use, while reducing burden and maintaining accuracy.[7]

[5] More information is available at https://www.psoppc.org/psoppc_web/publicpages/surveillancecommonformats.
[6] See publication in the Journal of Patient Safety online at: https://www.ncbi.nlm.nih.gov/pubmed/28671914.
[7] More information is available at www.pso.ahrq.gov/common/development and https://www.ahrq.gov/sites/default/files/wysiwyg/professionals/quality-patient-safety/qsrs/qsrs-final-report-feasibility-508.pdf

Appendix 1. Method To Estimate the Baseline 2014 National Hospital-Acquired Condition Rate

This document describes the methods AHRQ developed to estimate the national rate of HACs for 2014 to 2017. The estimate includes a wide variety of adverse events, including the 10 HACs selected for special focus by CMS as part of the programs to achieve the 20 percent reduction, as well as several other HACs.

Collectively, 28 specific measures are used (Exhibit A1a): 15 measures to generate rates for the 10 specific focus HACs and 13 measures to generate a summary rate for "all other" HACs. Of the 28 measures, 21 are from the MPSMS, 6 are from the PSIs, and 1 is based on NHSN data.

Exhibit A1a. Measures used to estimate the national HAC rate

HAC Type	Source	Measure
Adverse Drug Event	MPSMS	ADE Associated With Digoxin
	MPSMS	ADE Associated With Hypoglycemic Agents
	MPSMS	ADE Associated With IV Heparin
	MPSMS	ADE Associated With LMWH and Factor Xa Inhibitor
	MPSMS	ADE Associated With Warfarin
CAUTI	MPSMS	Catheter-Associated Urinary Tract Infections
CDI	MPSMS	*Clostridioides difficile* Infections
CLABSI	MPSMS	Blood Stream Infections Associated With Central Venous Catheters
Falls	MPSMS	In-Hospital Patient Falls
Obstetric Adverse Events	PSI	OB Trauma in Vaginal Delivery With (PSI 18) and Without Instrument (PSI 19)
Pressure Ulcer	MPSMS	Hospital-Acquired Pressure Ulcers/Pressure Injuries
Surgical Site Infection	NHSN	SSIs for 17 procedures w/CDC SCIP+5 data
VAP	MPSMS	Ventilator-Associated Pneumonia
VTE	MPSMS	Postoperative Venous Thromboembolic Events
All Other Hospital-Acquired Conditions	MPSMS	Femoral Artery Puncture for Catheter Angiographic Procedures
	MPSMS	Adverse Event Associated With Hip Joint Replacements
	MPSMS	Adverse Event Associated With Knee Joint Replacements
	MPSMS	Contrast Nephropathy Associated With Catheter Angiography
	MPSMS	Hospital-Acquired MRSA
	MPSMS	Hospital-Acquired Vancomycin-Resistant *Enterococcus* (VRE)
	MPSMS	Mechanical Complications Associated With Central Venous Catheters
	MPSMS	Postoperative Cardiac Events for Cardiac and Noncardiac Surgeries
	MPSMS	Postoperative Pneumonia
	PSI	Iatrogenic Pneumothorax (PSI 6)
	PSI	Post-Op Hemorrhage or Hematoma (PSI 9)
	PSI	Post-Op Respiratory Failure (PSI 11)
	PSI	Accidental Puncture or Laceration (PSI 15)

Data from these 28 measures are combined to generate a summary national HAC rate (NHR) that has been calculated annually since 2010.[3] The current method is built on the 2010–2014 methods but includes some changes. The current method removes the use of reference data from 2005–2006 and includes a fifth set or sample of charts to augment the four samples used in the 2010–2014 method.

In the 2010–2014 method, *Clostridioides difficile* Infection data were included in "All Other HACs" rather than as a focus HAC, which is the case with the new method. As before, the new method uses HCUP data on the annual number of hospital inpatient discharges as the denominator for the rate calculations. The details of how the current NHR is calculated are summarized below.

1. The NHR is calculated using the following variables:

    a. **Rate of 21 MPSMS adverse events** in the MPSMS sample provided by CMS, including those in the SCIP (major surgery) sample, those with a principal diagnosis of AMI, CHF, or pneumonia, and a "global" sample intended to complement these four groups of patients. The sample is limited to patients 18 years old and over.

    For the NHR calculation, the rates of the 21 MPSMS adverse events are expressed as a rate for the whole sample population, rather than as a rate for the subpopulation that has the opportunity to experience the adverse event. For example, the CLABSI rate, like all rates in the sample, uses all patients in the denominator, not just the patients who had a central line inserted during their hospital stay.

    For each of the 21 MPSMS HACs, the estimate is a weighted average of the HAC rate for each group, where each group is given a weight that approximates the fraction of patients the group represents in the hospital discharge population age 18 and over. This approach ensures that the estimated rate will not be affected by variation across years in the percentage of patients in the samples of charts representing each of the five groups (SCIP, AMI, CHF, pneumonia, and global). It also uses the data from each sample in a way that best represents the conditions treated in the actual hospital inpatient population.

    The weights follow, based on their percentage[8] of the inpatient population:

    - AMI: 2.15%,
    - CHF: 3.24%,
    - Pneumonia: 4.41%,
    - SCIP plus 5 other major surgeries: 19.17%,
    - Global: 71.03%.

[8] These weights (percentages) are slightly different than in the report released in June 2018 (see https://www.ahrq.gov/sites/default/files/wysiwyg/professionals/quality-patient-safety/pfp/natlhacratereport-rebaselining2014-2016_0.pdf). The change in weights to incorporate newer information is the reason that the HAC rate calculated in the June 2018 report for 2014 was 98 HACs per 1,000 discharges, while the rate for 2014 in this report is 99.

These AMI, CHF, and pneumonia patient data percentages were based on data from 2014 from the AHRQ National Inpatient Sample. The percentage of SCIP+5 patients was calculated based on the number of surgeries in the SCIP+5 sample from CDC, which was 5,704,493 among 29,751,955 discharges in 2014. The weighting for the global sample was 100 percent minus the contribution from the other four samples.

b. **National number of adverse events captured by PSIs 18 and 19 on obstetric injury** and national number of four other PSIs (6, 9, 11, and 15) included among "all other" HACs.[9]
c. **National number of selected surgical site infections computed in a special calculation for CDC.** This calculation is based on NHSN data for 17 specific operations: the 12 SCIP operations and 5 other major surgical procedures not included in the SCIP.[10]
d. To estimate the rate of adverse events for each of the 21 HACs for all patients for which the MPSMS data are used, we follow these steps:

    - Multiply the adverse event rate for each of the 21 HACs for patients with one of the five conditions included in the 2014–2017 MPSMS samples by the number of hospital inpatients represented by the sample, as calculated by the weight of each sample and the overall total annual national discharges listed above.
    - Sum the estimates for each of the five samples for each measure to produce an estimate for each of the 21 measures.

2. The estimated **total count of annual HACs** in the national HAC rate is calculated as the sum of the total number of HACs for the 21 MPSMS HACs in (d) above, plus the estimated number of PSI HACs in (b), plus the number of NHSN-estimated HACs in (c).
3. The **national HAC rate** is the total HAC count in (2) above divided by the number of annual hospital inpatient discharges of patients at least 18 years old, as provided by HCUP.
4. This method established for 2014 has been repeated for 2015, 2016, and 2017.Thus, for each year to date (2015, 2016, and 2017), we normalized the data to generate national estimates of HACs based on 29,751,955 discharges, which was the total number of discharges in 2014 for inpatients 18 years old and over.
5. Due to changes in how some conditions and adverse events are described in ICD-9 and ICD-10, the data for the 7 of 28 measures that depend entirely or partly on administrative data cannot be compared directly across the period of 2014-2017. These seven measures are the six PSI-based measures and the SSI data, which constitutes approximately 8 to 10 percent of the overall NHR for 2014 through 2017. In 2014 and the first three quarters of 2015, ICD-9-based data were used, and ICD-10 was used in 2016 and 2017.

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[9] Due to the transition from ICD-9 to ICD-10 that occurred with the start of the fourth quarter of 2015 and the effect of this change on the PSI data, only data from the first three quarters of 2015 were used to calculate the number of PSI events for 2015. The number of PSI events for January through September 2015 was multiplied by 4/3 to estimate the number of events (HACs) for the full year of 2015.

[10] Due to the ICD-9 to ICD-10 transition that occurred with the start of the fourth quarter of 2015, only data from the first three quarters of 2015 were used to calculate the number of CDC NHSN SSI events for 2015. The CDC estimate provided for 2015 was based on 12 months of data, from October 2014 through September 2015.

To best address the interest in trending the data, we have reused the data from 2015 in the 2016 results for these measures, and then used the 2016 data for comparison to the 2017 data. This approach means that for these seven measures, we have estimated the trends from 2014 to 2015, and 2016 to 2017, but not the trend for 2015 to 2016. For these measures in 2017, we have adjusted the total numbers of events proportionately to be able to be trended with the 2014-2016 data.

The observed data for 2016 and 2017 that we have received from the AHRQ HCUP team and the CDC NHSN statistician, and used in the detailed data in Exhibit A2c and elsewhere in this report are tabulated below in Exhibit A1b. For the reasons described above, the 2016 data below were only used to establish a basis for comparison for the 2017 estimates.

Exhibit A1b. Data from AHRQ HCUP and CDC NHSN on total numbers of HACs associated with each ICD-9 dependent measure for 2015[11] (9 months), and each ICD-10-dependent measure for 2016,[12] and 2017[13]

Measure Name	2015 Number of Cases of Adverse Events	2015 Number of Patients Included in Sample for This Measure	2016 Number of Cases of Adverse Events	2016 Number of Patients Included in Sample for This Measure	2017 Number of Cases of Adverse Events	2017 Number of Patients Included in Sample for This Measure
PSI 6, Iatrogenic Pneumothorax	7,372	18,948,556	5,472	25,363,956	4,852	25,536,803
PSI 9, Perioperative Hemorrhage or Hematoma	12,285	5,368,607	16,264	7,087,787	15,709	7,044,598
PSI 11, Postoperative Respiratory Failure	35,971	2,384,676	18,547	3,346,770	14,822	3,301,020
PSI 15, Unrecognized Abdominopelvic Accidental Puncture/Laceration	32,396	19,811,918	5,220	4,824,816	5,095	4,806,878
PSI 18, Obstetric Trauma - Vaginal Delivery with Instrument	14,663	121,323	17,925	165,125	17,891	156,244
PSI 19, Obstetric Trauma - Vaginal Delivery without Instrument	34,066	1,874,410	40,544	2,352,854	42,063	2,372,403
Surgical Site Infections (special calculation performed by CDC NHSN to include SSIs in a consistent set of major surgeries since 2010)	74,236	5,708,856 (estimate)	80,157	5,999,045 (estimate)	79,916	5,999,970 (estimate)

[11] AHRQ HCUP estimates based on a modified version 4.1 of Patient Safety Indicators, modified to not use present on admission or procedure day. Weighting is to community, nonrehabilitation hospitals in the United States.
[12] AHRQ, HCUP, State Inpatient Databases (SID), 2016, 34 States weighted to provide national estimates; and the AHRQ Patient Safety Indicators, version 8.0.1.
[13] AHRQ, HCUP, SID, 2017, 36 States weighted to provide national estimates; and the AHRQ Patient Safety Indicators, version 2019.01 using indicators that events were not present on admission.

Appendix 2. 2014–2017 NHR Data Tabulated (HACs and HAC Rate) and Compared With Summary 2010–2014 Data

Information on the HACs for 2014, 2015, 2016, and 2017 is provided below. Exhibit A2a shows the calculated number of HACs (rounded), and Exhibit A2b shows the calculated HAC rates per 1,000 discharges. Exhibit A2c shows all the measures, including those used in the calculation of "All Other HACs."

These data have been normalized to account for the changes in annual discharges, i.e., the number of HACs shown in 2015–2017 is based on the number of HACs that would have occurred if the number of hospital discharges in 2015 (30,167,977), 2016 (30,188,612), and 2017 (30,420,919) were unchanged from that in 2014 (29,751,955). Hospital discharge data are from HCUP, and the exact numbers are based on a special analysis performed for this study to limit hospital discharges to those 18 years old and over.

Exhibit A2a. HAC count estimates (rounded), 2014-2017

Hospital-Acquired Condition	2014 Measured Baseline for HACs	2015 Normalized Count of HACs	2016 Normalized Count of HACs	2017 Normalized Count of HACs	Change in HACs, 2014 vs. 2017	Percent Change in HACs, 2014 vs. 2017[14]
Adverse Drug Events	1,001,000	894,000	805,000	721,000	-280,000	-28%
Catheter-Associated Urinary Tract Infections	170,000	191,000	170,000	161,000	-9,000	-5%
Central Line-Associated Bloodstream Infections	8,500	2,200	6,500	8,000	-500	-6%
Clostridioides difficile Infections	86,000	77,000	73,000	54,000	-32,000	-37%
Falls	239,000	225,000	223,000	227,000	-13,000	-5%
Obstetric Adverse Events	67,000	64,000	64,000	65,000	-2,000	-3%
Pressure Ulcers/Pressure Injuries	647,000	700,000	677,000	683,000	36,000	6%
Surgical Site Infections	73,000	73,000	73,000	79,000	6,000	8%
Ventilator-Associated Pneumonias	36,000	28,000	26,000	31,000	-5,000	-13%
(Post-op) Venous Thromboembolisms	25,000	12,000	20,000	21,000	-4,000	-17%
All Other HACs	584,000	479,000	468,000	499,000	-84,000	-14%
Totals	2,940,000	2,740,000	2,610,000	2,550,000	-390,000	-13%

[14] Due to use of the unrounded numbers in the calculations of the percent changes, some percent changes shown are different from the change that would result from using the rounded numbers.

Exhibit A2b. HAC rates for 2014, 2015, 2016, and 2017

Hospital-Acquired Condition	2014 Baseline, Updated	2015	2016	2017
Adverse Drug Events	33.7	30.0	27.1	24.2
Catheter-Associated Urinary Tract Infections	5.7	6.4	5.7	5.4
Central Line-Associated Bloodstream Infections	0.29	0.07	0.22	0.27
Clostridioides difficile Infections	2.9	2.6	2.5	1.8
Falls	8.0	7.6	7.5	7.6
Obstetric Adverse Events	2.3	2.2	2.2	2.2
Pressure Ulcers/Pressure Injuries	21.7	23.5	22.7	23.0
Surgical Site Infections	2.5	2.5	2.5	2.7
Ventilator-Associated Pneumonias	1.2	0.9	0.9	1.0
Venous Thromboembolisms	0.9	0.4	0.7	0.7
All Other HACs	19.6	16.1	15.7	16.8
Totals	98.7	92.3	87.6	85.7

Note: Data in cells may not add to the total due to rounding.

Exhibit A2c. All 2014, 2015, 2016, and 2017 HACs (not rounded)

HAC Type	Source	Measure	Total 2014 HACs	Total 2014 HAC Rate per 1,000 Discharges	Total 2015 HACs Normalized to 2014 Baseline	Total 2015 HAC Rate Normalized to 2014 Baseline	Total 2016 HACs Normalized to 2014 Baseline	Total 2016 HAC Rate Normalized to 2014 Baseline	Total 2017 HACs Normalized to 2014 Baseline	Total 2017 HAC Rate Normalized to 2014 Baseline
Adverse Drug Event	MPSMS	ADE Associated With Digoxin	6,204	0.21	795	0.03	169	0.01	2,671	0.09
	MPSMS	ADE Associated With Hypoglycemic Agents	517,177	17.38	549,638	18.47	471,536	15.85	446,134	15.00
	MPSMS	ADE Associated With IV Heparin	141,711	4.76	81,362	2.73	83,677	2.81	71,713	2.41
	MPSMS	ADE Associated With LMWH and Factor Xa Inhibitor	247,441	8.32	159,633	5.37	170,041	5.72	146,266	4.92
	MPSMS	ADE Associated With Warfarin	88,814	2.99	102,338	3.44	79,773	2.68	53,819	1.81
	MPSMS	**Total ADE (sum of 5 above)**	1,001,348	33.66	893,766	30.04	805,196	27.06	720,604	24.22
CAUTI	MPSMS	Catheter-Associated Urinary Tract Infections	169,961	5.71	190,797	6.41	170,282	5.72	160,833	5.41
CDI	MPSMS	*Clostridium difficile* Infections	85,753	2.88	76,650	2.58	73,114	2.46	53,943	1.81
CLABSI	MPSMS	Blood Stream Infections Associated With Central Venous Catheters	8,493	0.29	2,182	0.07	6,519	0.22	7,991	0.27
Falls	MPSMS	In-Hospital Patient Falls	239,286	8.04	225,199	7.57	223,106	7.50	226,642	7.62
Obstetric Adverse Events	PSI	OB Trauma in Vaginal Delivery With (PSI 18) and Without Instrument (PSI 19)	67,482	2.27	64,077	2.15	64,033	2.15	65,157	2.19

HAC Type	Source	Measure	Total 2014 HACs	Total 2014 HAC Rate per 1,000 Discharges	Total 2015 HACs Normalized to 2014 Baseline	Total 2015 HAC Rate Normalized to 2014 Baseline	Total 2016 HACs Normalized to 2014 Baseline	Total 2016 HAC Rate Normalized to 2014 Baseline	Total 2017 HACs Normalized to 2014 Baseline	Total 2017 HAC Rate Normalized to 2014 Baseline
Pressure Ulcer	MPSMS	Hospital-Acquired Pressure Ulcers/Pressure Injuries	647,096	21.75	699,790	23.52	676,834	22.75	682,984	22.96
Surgical Site Infection	NHSN	SSIs for 17 procedures w/CDC SCIP+5 data	73,158	2.46	73,212	2.46	73,162	2.46	79,305	2.67
VAP	MPSMS	Ventilator-Associated Pneumonia	35,894	1.21	27,548	0.93	25,695	0.86	31,213	1.05
VTE	MPSMS	Postoperative Venous Thromboembolic Events	25,400	0.85	12,307	0.41	20,127	0.68	21,080	0.71
All Other Hospital-Acquired Conditions	MPSMS	Femoral Artery Puncture for Catheter Angiographic Procedures	22,075	0.74	15,907	0.53	9,118	0.31	15,176	0.51
	MPSMS	Adverse Event Associated With Hip Joint Replacements	48,925	1.64	49,141	1.65	61,670	2.07	49,988	1.68
	MPSMS	Adverse Event Associated With Knee Joint Replacements	41,639	1.40	40,500	1.36	42,398	1.43	48,518	1.63
	MPSMS	Contrast Nephropathy Associated With Catheter Angiography	128,012	4.30	85,072	2.86	78,686	2.64	97,561	3.28
	MPSMS	Hospital-Acquired MRSA	19,526	0.66	6,840	0.23	3,095	0.10	15,272	0.51

HAC Type	Source	Measure	Total 2014 HACs	Total 2014 HAC Rate per 1,000 Discharges	Total 2015 HACs Normalized to 2014 Baseline	Total 2015 HAC Rate Normalized to 2014 Baseline	Total 2016 HACs Normalized to 2014 Baseline	Total 2016 HAC Rate Normalized to 2014 Baseline	Total 2017 HACs Normalized to 2014 Baseline	Total 2017 HAC Rate Normalized to 2014 Baseline
	MPSMS	Hospital-Acquired Vancomycin-Resistant *Enterococcus* (VRE)	15,501	0.52	4,590	0.15	3,934	0.13	2,125	0.07
	MPSMS	Mechanical Complications Associated With Central Venous Catheters	59,610	2.00	53,033	1.78	67,004	2.25	59,924	2.01
	MPSMS	Postoperative Cardiac Events for Cardiac and Noncardiac Surgeries	32,773	1.10	28,768	0.97	22,103	0.74	45,886	1.54
	MPSMS	Postoperative Pneumonia	88,156	2.96	79,687	2.68	64,621	2.17	62,233	2.09
	PSI	Iatrogenic Pneumothorax (PSI 6)	10,674	0.36	9,694	0.33	9,688	0.33	8,525	0.29
	PSI	Post-Op Hemorrhage or Hematoma (PSI 9)	17,670	0.59	16,154	0.54	16,143	0.54	15,474	0.52
	PSI	Post-Op Respiratory Failure (PSI 11)	48,087	1.62	47,300	1.59	47,268	1.59	37,486	1.26
	PSI	Accidental Puncture or Laceration (PSI 15)	51,249	1.72	42,599	1.43	42,570	1.43	41,239	1.39
	MPSMS & PSI	**Total All Other HACs (sum of 13 above)**	583,897	19.63	479,286	16.11	468,299	15.74	499,405	16.79

HAC Type	Source	Measure	Total 2014 HACs	Total 2014 HAC Rate per 1,000 Discharges	Total 2015 HACs Normalized to 2014 Baseline	Total 2015 HAC Rate Normalized to 2014 Baseline	Total 2016 HACs Normalized to 2014 Baseline	Total 2016 HAC Rate Normalized to 2014 Baseline	Total 2017 HACs Normalized to 2014 Baseline	Total 2017 HAC Rate Normalized to 2014 Baseline
		Total MPSMS-Based Measured HACs	2,669,447	89.7	2,491,779	83.8	2,353,504	79.1	2,301,973	77.4
		Total PSI-Based Measured HACs	195,162	6.6	179,824	6.0	179,701	6.0	167,879	5.6
		Total NHSN-Based Measured HACs	73,158	2.5	73,212	2.5	73,162	2.5	79,305	2.7
		Total HACs	2,937,767	98.7	2,744,815	92.3	2,606,367	87.6	2,549,157	85.7

Note: Data in cells may not add to the total due to rounding.

The estimates that were previously used in 2016 to trend 2010 to 2014 results and the estimates for 2014-2017 are shown below in Exhibit A2d. More details on the 2010-2014 results are available in the final data report for that period.[15]

Exhibit A2d. Historical and new estimates for 2014 (rounded)

New Data for Trending 2014–2017 Results			Historical Data for Trending 2010–2014 Results
Hospital-Acquired Condition	**2014 Updated Baseline for HACs**	**2014 Total HACs per 1,000 Discharges**	**HAC Rate for 2014 (Calculated for Comparison With 2010)**
Adverse Drug Events	1,001,000	33.7	41.4
Catheter-Associated Urinary Tract Infections	170,000	5.7	7.6
Central Line-Associated Bloodstream Infections	8,000	0.3	0.2
Clostridioides difficile Infections	86,000	2.9	(Included in All Other HACs)
Falls	239,000	8.0	7.9
Obstetric Adverse Events	67,000	2.3	2.3
Pressure Ulcers/Pressure Injuries	647,000	21.7	30.9
Surgical Site Infections	73,000	2.5	2.5
Ventilator-Associated Pneumonias	36,000	1.2	1.2
(Post-Op) Venous Thromboembolisms	25,000	0.9	0.5
All Other HACs	584,000	19.6	26.4
Total	2,940,000	99	121

Data in Exhibits A2e and A2f provide summary information on the trends from 2010 to 2014 based on historical data and methods as reported in 2016.[11] These exhibits also provide new summary information on the data from the 2014 to 2017 results that were computed using the new methods.

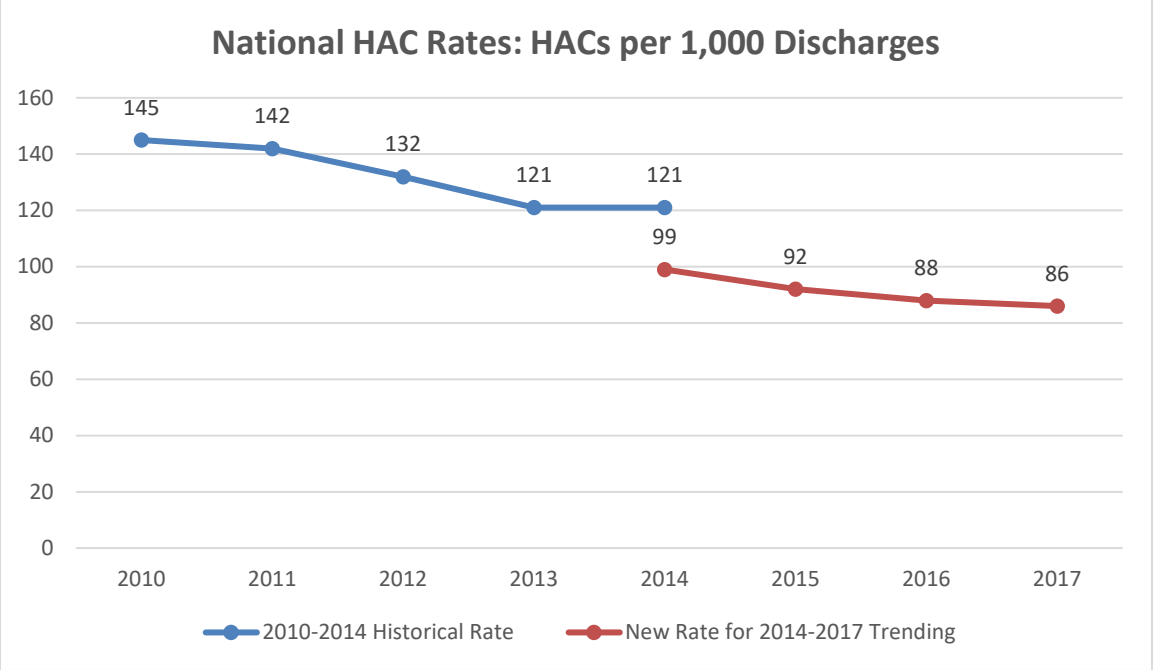
[15] See the AHRQ HAC report at https://www.ahrq.gov/professionals/quality-patient-safety/pfp/2014-final.html.

Exhibit A2e. Summary data trended from 2010–2014 (historical) and 2014–2017* (new)

	2010–2014 Historical Rate	Annual Change From Previous Year	Annual Reduction From Baseline Year (2010)	New Rate for 2014–2017 Trending	Annual Change From Previous Year	Annual Reduction From Baseline Year (2014)
2010	145					
2011	142	-2.1%	-2.1%			
2012	132	-6.9%	-8.8%			
2013	121	-8.8%	-16.8%			
2014	121	0.0%	-16.8%	99		
2015				92	-6.6%	-6.6%
2016				88	-5.0%	-11.2%
2017				86	-2.3%	-13.2%
Average Annual Percent Change		-4.4%			-4.6%	

*Unrounded values for rates are used in calculation of annual reduction percentages and may vary due to rounding.

Exhibit A2f. Summary data trended from 2010–2014 (historical) and 2014–2017 data (new)



Appendix 3. Changes in the Samples Used for the MPSMS 2014–2017 Compared With 2010–2014 Previous Analyses

The Medicare Patient Safety Monitoring System (MPSMS) methodology to identify adverse events within each chart from 2014 to 2017 is the same as in prior years. However, the methodology by which charts are identified, sampled, and included for review with the MPSMS has changed significantly during the period. The most significant changes are the result of changes to the requirements for the Hospital Inpatient Quality Reporting (IQR) Program and changes from International Classification of Diseases, 9th Revision (ICD-9) to 10th Revision (ICD-10) coding. The Hospital IQR Program is mandated by law.

Changes to the Hospital IQR Program and Its Impact on the MPSMS Four-Condition Sample

When the original method for calculating a national HAC rate (NHR) was developed,[3] CMS and AHRQ monitored patient safety for the NHR using charts from patients treated for four conditions:

- Acute myocardial infarction (AMI),
- Congestive heart failure (CHF),
- Pneumonia (PN), and
- Major surgeries associated with the Surgical Care Improvement Project (SCIP).[16]

CMS reduced burden and costs by reusing charts for these conditions already obtained to support validation of the Hospital IQR Program as described in the *Federal Register*.[17]

Briefly, all acute care hospitals subject to the inpatient prospective payment system (IPPS) receive payment incentives for meeting Hospital IQR Program reporting requirements. Therefore, from 2010 through 2014, nearly all IPPS hospitals submitted data to CMS on random samples of all inpatient stays that met the definitions for the four noted conditions.

To validate the reported data on AMI, CHF, PN, and SCIP, CMS contractors randomly sampled between 400 and 800 hospitals (depending on the year) and requested 12 medical records (3 from each category) from each sampled hospital. CMS's Hospital IQR Program requirements for AMI, CHF, PN, and SCIP remained similar for several consecutive years such that we obtained a stable consistent sample of medical charts from these four conditions from 2010 through 2014.

From 2015 onward, the MPSMS four-condition sample (AMI, CHF, PN, and SCIP) has been an approximation of the previous four-condition samples used from 2010 through 2014. It had to be reconstructed by sampling hospitals reimbursed under IPPS and requesting charts from available all-payer data submitted to the Hospital IQR Program.

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[16] See https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier4&cid=1228773989482.

[17] See "7. Chart Validation Requirements for Chart-Abstracted Measures" at 75 FR 50225-50229, August 16, 2010, at https://www.gpo.gov/fdsys/pkg/FR-2010-08-16/pdf/2010-19092.pdf.

As the hospital care environment changed, the Hospital IQR Program discontinued chart-based reporting requirements for these four conditions in 2015 (CHF, PN, and SCIP) and 2016 (AMI).[18] Thus, from 2015 onward, after randomly sampling hospitals to provide data for MPSMS, CMS contractors identified medical records submitted to the Hospital IQR Program under global population specifications[19] that also met the formally defined criteria for AMI, CHF, PN, or SCIP.

The samples for 2015–2017 only approximate the data from 2014, so it is possible that the four-condition sample for 2015–2017 had a different risk profile than the sample data from 2014. This potential issue may be addressed by risk adjusting the data, which has been done in previous studies using MPSMS data. In general, the risk-adjusted results have shown trends similar to the results before risk adjustment.[20]

Changes From ICD-9 to ICD-10 Coding and Their Impact on the MPSMS Four-Condition Sample

In quarter 4, 2015, hospitals began using ICD-10 coded data in place of ICD-9 coded data. It is notable that because MPSMS is based on chart-abstraction, results do not depend on this coding system. However, the specifications that CMS's contractors used to identify charts for the four conditions (AMI, CHF, PN, and SCIP) did depend on these specifications. Therefore, this coding change introduced an inherent uncertainty regarding the nature of the comparability of the four-condition sample before and after quarter 4, 2015.

Introduction of the Four-Condition Complement ("Global") Sample

To improve the number of conditions represented by MPSMS, we introduced the four-condition complement ("global") sample designed to include most types of patients not included in the four-condition sample. All charts abstracted as part of MPSMS's four-condition complement were originally submitted to the Clinical Data Abstraction Center for validation of Hospital IQR Program measures.

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[18] See "CY 2015 reporting period" and "CY 2016 reporting period" at https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier4&cid=1228775411587.

[19] See Section 2.9, "Global Initial Patient Population," at https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier4&cid=1228773989482.

[20] See, for example, risk-adjusted data on ventilator-associated pneumonia rates in https://jamanetwork.com/journals/jama/fullarticle/2583369 or risk-adjusted physician-diagnosed catheter-associated urinary tract infection rates in https://www.ncbi.nlm.nih.gov/pubmed/28625702 and data without risk adjustment in https://www.ahrq.gov/sites/default/files/wysiwyg/professionals/quality-patient-safety/pfp/2014finalhacreport-cx.pdf and earlier reports.

The MPSMS-abstracted sample is representative of hospitals submitting cases to the Hospital IQR Program as specified for the "global" population.[21] At first, we excluded cases younger than 18 years of age to increase consistency with the four-condition sample and cases meeting the definitions for AMI, CHF, PN, and SCIP, because these charts were monitored in the four-condition sample. Later, we excluded cases involving any major surgery to increase consistency in the observed sample from year to year.

From 2014 to 2017, the overall number of charts used in the analyses to calculate the NHR and other information included in this document changed somewhat from year to year. Only the sample size of the global[22] or four-condition complement group increased every year. Detailed information is provided in Exhibit A3.

Exhibit A3. Number of charts used in the 2014, 2015, 2016, and 2017 MPSMS analyses for the NHR

Year and Sample	2014	2015	2016	2017
AMI	4,234	4,076	3,797	2,651
CHF	4,820	2,423	5,330	3,779
Pneumonia	4,941	2,427	5,737	4,004
SCIP (CMS-defined major surgery cases)	5,480	2,817	5,920	3,880
"Global" (four-condition complement)	4,308	6,072	7,114	7,912
Total	23,783	17,815	27,898	22,226

Because the four-condition complement is defined by excluding cases with AMI, CHF, PN, and SCIP, the complement is also potentially affected by the introduction of ICD-10 in quarter 4, 2015. However, because this sample reflects a much broader spectrum of conditions treated in acute care hospitals, we anticipate that the influence of this change would be smaller when applied to the four-condition "complement" than to the four conditions themselves.

Results for Individual Measures

Depending on the year, the sample size varied from approximately 18,000 to 28,000 charts, reflecting care delivered in approximately 800 to 1,600 hospitals. Data are more precise for the overall harm rates than for individual metrics. MPSMS is also sensitive to changes in documentation practices, which in turn may be sensitive to changes in other measurement practices. For example, changes to the technical specifications used to define hospital-acquired infections or other adverse events might influence the way that harms get documented in the medical record over time. These changes to documentation in turn might influence some of the

[21] See "Section 2.9, "Global Initial Patient Population," at https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier4&cid=1228773989482.

[22] The number of charts presented in Exhibit A3 for the global sample in 2015 and 2016 is 4.3% and 11.2% less, respectively, than indicated in the June 2018 report (see https://www.ahrq.gov/sites/default/files/wysiwyg/professionals/quality-patient-safety/pfp/natlhacratereport-rebaselining2014-2016_0.pdf). The total charts in the samples were reduced due to the removal of AMI, CHF, and pneumonia charts that had been erroneously included in these samples previously. Removing these charts from the 2015 and 2016 global samples resulted in lower HAC rates. Due to these changes, the 2015 rate was reduced from 94 to 92 HACs per 1,000 discharges, and the 2016 rate was reduced from 90 to 88.

observed chart-abstracted HAC rates derived from the MPSMS. Changes in documentation and definitions also can influence the rates of other (PSI and NHSN-based) data used in this analysis.

Possible Overrepresentation of Care Delivered in Small Hospitals

The design of the MPSMS sample is closely linked to the current and historical designs of the Hospital IQR Program validation sample. Therefore, hospitals in any given quarter generally contributed approximately the same number of records of each type each quarter regardless of hospital size and volume. For example, a hospital that discharges 10 patients per day and one that discharges 100 patients per day would both have contributed approximately the same number of SCIP charts.

Because of this strategy, the MPSMS sample overrepresents care delivered in smaller hospitals. We anticipate this overrepresentation to be consistent over time. However, because larger hospitals generally tend to treat more complex cases, it is conceivable that the overrepresentation of patients from smaller hospitals may have a greater impact on cases from the four-condition complement ("global") sample, which is younger and has fewer comorbidities than the four-condition samples. A paper based on risk-adjusted MPSMS data covering the period of 2010 to 2017 is in preparation and is intended to follow up on results previously published based on MPSMS data for 2005–2011. [23]

[23] See https://www.ncbi.nlm.nih.gov/pubmed/24450892.

Appendix 4. Estimates for HAC Costs and Mortality

These data are based on the report *Estimating the Additional Hospital Inpatient Cost and Mortality Associated With Selected Hospital-Acquired Conditions*.[24] These data update and replace the data available in Exhibit 1 in the 2013 Annual Hospital-Acquired Condition Rate and Estimates document.

Exhibit A4. New estimates and comparisons with historical estimates used to calculate projections based on 2010–2014 data

NORC (2017)	Additional Cost per HAC		Excess Mortality per HAC	
	Current (New) Study Estimate (95% CI)	2010 AHRQ Estimate	Current (New) Study Estimate (95% CI)	2010 AHRQ Estimate
ADE	$5,746 (-$3,950–$15,441)	$5,452	0.012 (0.003–0.025)	0.02
CAUTI	$13,793 ($5,019–$22,568)	$1,090	0.036 (0.004–0.079)	0.023
CLABSI	$48,108 ($27,232–$68,983)	$18,537	0.150 (0.070–0.270)	0.185
Falls	$6,694 (-$1,277–$14,665)	$7,888	0.050 (0.035–0.070)	0.055
OB Adverse Events	$602 (-$578–$1,782)	$3,271	0.005 (0.003–0.013)	0.0015
Pressure Ulcers/Pressure Injuries	$14,506 (-$12,313–$41,326)	$18,537	0.041 (0.013–0.093)	0.072
SSI	$28,219 ($18,237–$38,202)	$22,898	0.026 (0.009–0.059)	0.028
VAP	$47,238 ($21,890–$72,587)	$22,898	0.140 (-0.110–0.730)	0.144
VTE	$17,367 ($11,837–$22,898)	$8,723	0.043 (0.040–0.078)	0.104
Clostridioides difficile Infection	$17,260 ($9,341–$25,180)	None	0.044 (0.028–0.064)	None

[24] This report is available at https://www.ahrq.gov/sites/default/files/wysiwyg/professionals/quality-patient-safety/pfp/hac-cost-report2017.pdf.