

Overview of Operating Room Procedures During Inpatient Stays in U.S. Hospitals, 2018

STATISTICAL BRIEF #281

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Introduction

More than one-quarter of inpatient stays in the United States involve at least one operating room (OR) procedure.¹ On average, these stays are more than twice as costly as stays without OR procedures.¹ With surgical care accounting for nearly one-third of healthcare spending in the United States,² identifying the volume, costs, and characteristics of OR procedures can help guide cost reduction efforts and provide baseline data for assessing the potential impact of changes in reimbursement policy and advances in medical technology.

This Healthcare Cost and Utilization Project (HCUP) Statistical Brief presents statistics on OR procedures performed during inpatient stays using the 2018 National Inpatient Sample (NIS).^a Inpatient stays with and without OR procedures are compared in terms of patient characteristics, utilization characteristics, and outcomes. Additionally, the most common *all-listed* and most costly *principal* OR procedures are presented overall and by patient sex-age group. Because of the large sample size of the NIS data, small differences can be statistically significant. Thus, only differences greater than or equal to 10 percent are discussed in the text.

^a This Statistical Brief represents an update to HCUP Statistical Brief #233, *Overview of Operating Room Procedures During Inpatient Stays in U.S. Hospitals, 2014*. However, Statistical Brief #233 applied earlier versions of HCUP software designed for use with International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes (i.e., HCUP Clinical Classifications Software [CCS] for ICD-9-CM and HCUP Procedure Classes for ICD-9-CM). The present Statistical Brief applies updated tools for International Classification of Diseases, Tenth Revision, Procedure Coding System (ICD-10-PCS) codes, which in many cases use distinct terminology and clinical concepts to classify procedures. Because of these distinctions, direct comparisons of the estimates provided in the two reports are not recommended.

Highlights

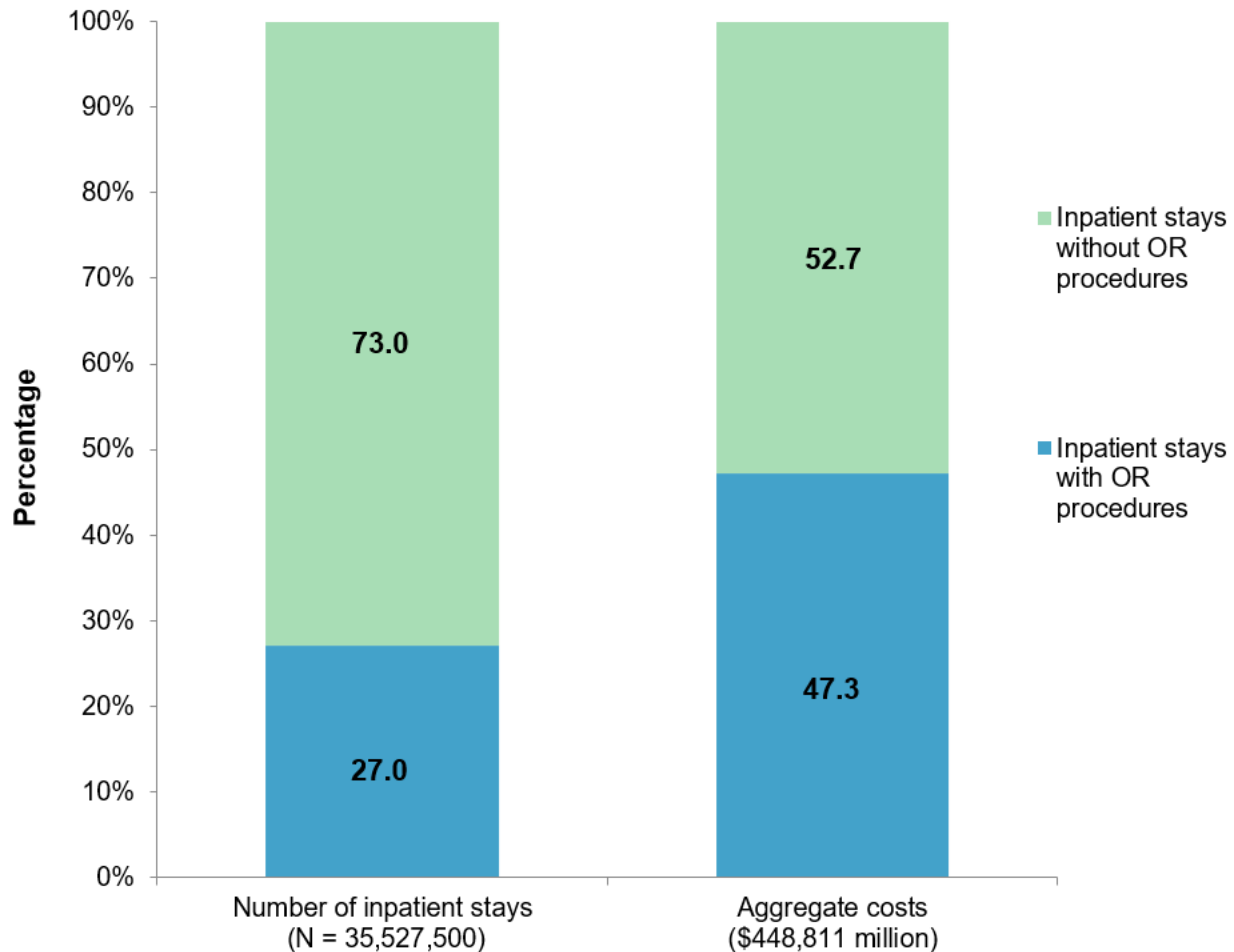
- In 2018, 9.6 million inpatient stays involved OR procedures, with a total of 14.4 million OR procedures. Stays involving OR procedures totaled \$210.3 billion in aggregate costs.
- Cesarean sections constituted 8.1 percent of all OR procedures, with a rate of 2,001.3 per 100,000 females aged 18–44 years.
- Appendectomy was the most common and one of the five most costly OR procedures for children, accounting for 4–5 percent of aggregate costs for stays with a principal OR procedure among males and females aged 0–17 years.
- Spine fusion was the most costly principal OR procedure in 2018, with stays for this procedure totaling \$14.1 billion in aggregate costs.
- Knee arthroplasty and hip arthroplasty were the second and third most costly principal OR procedures by aggregate cost in 2018. Each of these procedures accounted for 4–5 percent of all OR procedures by volume.
- Ranked by mean cost per stay, heart, lung, and liver transplants were among the five most expensive principal OR procedures in 2018.

Findings

Inpatient stays with and without OR procedures, 2018

Figure 1 shows the percentage of all inpatient stays with OR procedures and the percentage of aggregate costs attributed to stays involving OR procedures in 2018.

Figure 1. Percentage of inpatient stays and aggregate costs for stays with and without OR procedures, 2018



Abbreviation: OR, operating room

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2018

- **Inpatient stays involving OR procedures constituted only about one-fourth of all stays but nearly half of all aggregate hospital costs.**

In 2018, 27.0 percent of inpatient stays involved at least one OR procedure. The costs associated with these stays accounted for 47.3 percent of aggregate costs for all inpatient stays.

Table 1 presents select utilization characteristics and outcomes for 2018 inpatient stays involving OR procedures compared with stays that did not involve OR procedures. Stays with OR procedures may include either those with a *principal* OR procedure (i.e., where the OR procedure is performed for definitive treatment, for example, appendectomy) or stays with a non-OR principal procedure where an OR procedure is secondary (e.g., principal non-OR procedure of mechanical ventilation with secondary OR procedure of tracheostomy). Table 1 separately presents stays with any OR procedure (principal or secondary) and the subset of stays with a principal OR procedure.

Table 1. Utilization and outcomes for inpatient stays with and without OR procedures, 2018

Characteristic or outcome	Stays with OR procedures		Stays without OR procedures
	Any OR procedure	Principal OR procedure	
Number of stays, N	9,605,500	8,425,900	25,922,000
All hospital stays, %	27.0	23.7	73.0
Rate of stays per 100,000 population	2,941.7	2,580.4	7,938.6
Aggregate costs, \$ millions	210,312	188,512	234,498
Aggregate costs, %	47.3	42.4	52.7
Mean cost per stay, \$	21,900	22,400	9,000
Mean length of stay, days	5.1	5.1	4.5
Admitted from emergency department, %	33.1	33.5	63.3
Discharge status, %			
Routine (to home) or to home healthcare	82.8	81.9	79.7
Transfer to another short-term hospital	0.7	0.7	2.4
Transfer to other type of facility	14.8	15.8	13.8
Died in the hospital	1.3	1.2	2.2
Other*	0.3	0.3	1.8

Abbreviation: OR, operating room

Notes: Number of stays and mean cost per stay are rounded to the nearest hundred. Discharge status was missing for less than 1 percent of stays.

* Other discharges include alive/destination unknown and against medical advice.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2018

- **In 2018, 9.6 million inpatient stays involved OR procedures, totaling \$210.3 billion in aggregate costs.**

Of the 9,605,500 stays with at least one OR procedure, the vast majority (8,425,900) had an OR procedure as the principal procedure. This subset of stays accounted for \$188.5 billion in aggregate costs.

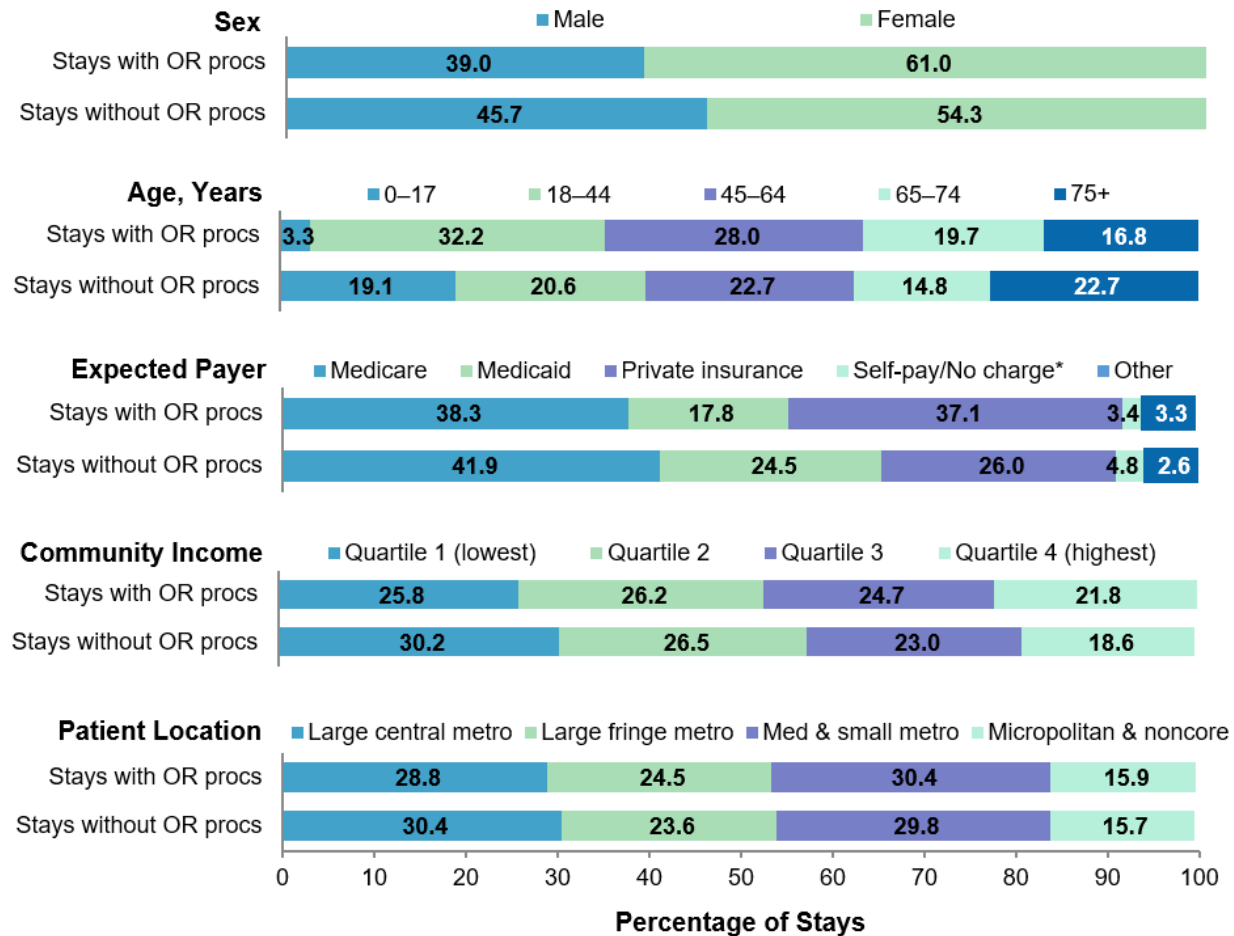
- **On average, inpatient stays with OR procedures were longer and more than twice as expensive as stays without OR procedures.**

In 2018, stays involving OR procedures averaged 5.1 days, with an average cost of \$21,900. In contrast, stays without OR procedures averaged 4.5 days, with an average cost of \$9,000.

Compared with inpatient stays without OR procedures, a lower percentage of stays involving OR procedures were admitted from the emergency department (33.1 vs. 63.3 percent). Additionally, the percentage of stays that resulted in in-hospital death was lower among stays that involved OR procedures than among stays that did not (1.3 vs. 2.2 percent). Similarly, the percentage of stays transferred to another short-term hospital was lower among stays with OR procedures than among those without OR procedures (0.7 vs. 2.4 percent).

Figure 2 displays the distribution of inpatient stays with and without OR procedures by patient sex, age group, primary expected payer, community-level income quartile, and location of patients' residence in 2018.

Figure 2. Inpatient stays with and without OR procedures, by patient characteristic, 2018



Abbreviations: Med, medium; metro, metropolitan; OR, operating room; procs, procedures

Note: Community-level income quartile was missing for less than 2 percent of stays and patient location was missing for less than 1 percent of stays.

*Self-pay/No charge: includes self-pay, no charge, charity, and no expected payment.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2018

- **Female patients, patients aged 18–74 years, patients with stays billed to private insurance, and patients living in the wealthiest communities represented a higher percentage of stays involving OR procedures than of stays without OR procedures.**

In 2018, the distribution of inpatient stays with and without OR procedures varied by patient sex, patient age, primary expected payer for the stay, and patients' community-level income but not by patient location. Females accounted for a larger percentage of stays with OR procedures than of stays without OR procedures (61.0 vs. 54.3 percent). The percentage was also higher for stays with versus without OR procedures for patients aged 18–44 years (32.2 vs. 20.6 percent), 45–64 years (28.0 vs. 22.7 percent), and 65–74 years (19.7 vs. 14.8 percent). Stays with a primary expected payer of private insurance represented 37.1 percent of stays with OR procedures but only 26.0 percent of stays without OR procedures. Patients living in the wealthiest communities (quartile 4) constituted 21.8 percent of stays involving OR procedures but only 18.6 percent of stays without OR procedures.

Most frequent all-listed OR procedures, 2018

Table 2 presents the 20 most common all-listed OR procedures during inpatient stays in 2018. Specifically, the total number of procedures and the population rate are provided, as well as the percentage of all OR procedures and the percentage of stays with an OR procedure that the procedures represent. Because more than one OR procedure can be performed during an inpatient stay, the denominators for these two percentage calculations are distinct.

Table 2. Most frequent all-listed OR procedures, 2018

Rank	All-listed OR procedure	Number of procedures	Rate per 100,000 population	Percent of all OR procedures	Percent of stays with an OR procedure
1	Cesarean section	1,167,700	357.6	8.1	12.2
2	Knee arthroplasty	715,200	219.0	5.0	7.4
3	Perineal muscle laceration repair (second-degree or greater obstetrical and other)	688,400	210.8	4.8	7.2
4	Hip arthroplasty	599,500	183.6	4.2	6.2
5	Percutaneous coronary intervention	481,800	147.5	3.4	5.0
6	Spine fusion	455,500	139.5	3.2	4.7
7	Cholecystectomy	335,200	102.7	2.3	3.5
8	Femur fixation	307,300	94.1	2.1	3.2
9	Colectomy	298,600	91.5	2.1	3.1
10	Vertebral discectomy	285,600	87.5	2.0	3.0
11	Subcutaneous tissue and fascia excision	241,100	73.8	1.7	2.5
12	Gastrointestinal system lysis of adhesions	238,000	72.9	1.7	2.5
13	Bone excision	227,700	69.7	1.6	2.4
14	Saphenous vein harvest and other therapeutic vessel removal	223,900	68.6	1.6	2.3
15	Fallopian tube ligation and excision	223,000	68.3	1.6	2.3
16	Angioplasty and related vessel procedures (endovascular; excluding carotid)	201,800	61.8	1.4	2.1
17	Coronary artery bypass graft	201,600	61.7	1.4	2.1
18	Salpingectomy	191,200	58.6	1.3	2.0
19	Appendectomy	190,000	58.2	1.3	2.0
20	Musculoskeletal procedures, not elsewhere classified	184,800	56.6	1.3	1.9
Top 20 OR procedures (6,501,000 stays)		7,457,900	2,284.0	51.9	67.7
All OR procedures (9,605,500 stays)		14,365,200	4,399.3	100.0	100.0

Abbreviations: ICD-10-PCS, International Classification of Diseases, Tenth Revision, Procedure Coding System; OR, operating room

Notes: Number of procedures is rounded to the nearest hundred. Percentage is based on unrounded data values. Procedures were identified using the Clinical Classifications Software Refined (CCSR) for ICD-10-PCS Procedures. Procedure totals include only one occurrence of a CCSR category per inpatient stay because multiple codes may be used for related procedures performed during a single operation. The overall number of procedures represents the sum of all CCSR category totals. Although some procedures are specific to the female population (e.g., cesarean section and perineal muscle laceration repair), the population denominator used to calculate the rate includes both sexes.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2018

- **The 20 most frequent OR procedures accounted for more than half of OR procedures in 2018.**

In 2018, there were 14,365,200 total OR procedures (4,399.3 per 100,000 population) performed during 9,605,500 total inpatient stays. The 20 most frequent OR procedures represented 7,457,900 of these procedures (51.9 percent)—a rate of 2,284.0 per 100,000 population. Inpatient stays involving 1 or more of the 20 most frequent OR procedures accounted for 6,501,000 stays, or 67.7 percent of the 9,605,500 stays with at least one OR procedure.

- **Cesarean sections constituted 8.1 percent of all OR procedures. Knee arthroplasty, perineal muscle laceration repair, and hip arthroplasty each accounted for 4–5 percent.**

Along with cesarean section, which represented 8.1 percent of all procedures, three other obstetric/gynecological procedures were among the top 20 procedures in 2018: perineal muscle laceration repair (second-degree or greater obstetrical tear/laceration or other), fallopian tube ligation (i.e., closing off) and excision (i.e., partial removal), and salpingectomy (i.e., removal or resection of fallopian tubes). Combined, these four procedures accounted for 15.8 percent of all OR procedures.

Eight musculoskeletal procedures constituted 21.0 percent of all OR procedures: knee arthroplasty (i.e., reconstruction or replacement), hip arthroplasty, spine fusion, femur fixation (i.e., stabilization of broken bone), vertebral discectomy (i.e., removal of all or part of the damaged disc), excision of subcutaneous tissue and fascia (i.e., connective tissue covering muscle, bone, and other organs), bone excision, and musculoskeletal procedures not elsewhere classified.

Four cardiovascular procedures constituted 7.7 percent of all OR procedures: percutaneous coronary intervention (PCI), saphenous vein (i.e., large leg vein) harvest and other therapeutic vessel removal, angioplasty and related vessel procedures, and coronary artery bypass graft (CABG).

Four procedures related to diseases of the gastrointestinal (GI) system accounted for 7.4 percent of all OR procedures: cholecystectomy (i.e., removal of the gallbladder), colectomy (i.e., removal of all or part of the colon), GI system lysis of adhesions (i.e., cutting of fibrous bands of scar tissue), and appendectomy.

Table 3 presents the five most common all-listed OR procedures during inpatient stays by sex-age group in 2018.

Table 3. Most frequent all-listed OR procedures by sex-age group, 2018

Males				Females			
Rank	All-listed OR procedure	Number of OR procedures	Rate per 100,000 population	Rank	All-listed OR procedure	Number of OR procedures	Rate per 100,000 population
Ages 0–17 years		270,100	717.3	Ages 0–17 years		228,500	633.3
1	Appendectomy	26,000	69.1	1	Appendectomy	17,400	48.1
2	Bone fixation excluding extremities	8,800	23.4	2	Perineal muscle laceration repair*	9,700	26.8
3	Musculoskeletal procedures, not elsewhere classified	8,500	22.6	3	Spine fusion	8,800	24.4
4	Upper GI therapeutic procedures, not elsewhere classified	8,500	22.6	4	Bone fixation, excluding extremities	8,100	22.3
5	Femur fixation	8,300	22.0	5	Cesarean section	7,700	21.4
Ages 18–44 years		818,500	1,386.4	Ages 18–44 years		3,328,700	5,769.3
1	Fixation of leg and foot bones	34,100	57.7	1	Cesarean section	1,154,700	2,001.3
2	Appendectomy	33,300	56.4	2	Perineal muscle laceration repair*	676,500	1,172.5
3	Subcutaneous tissue and fascia excision	29,500	50.0	3	Fallopian tube ligation, excision	216,600	375.4
4	Bone excision	28,900	48.9	4	Salpingectomy	84,100	145.8
5	Spine fusion	27,900	47.2	5	Cholecystectomy	77,300	134.0
Ages 45–64 years		2,233,000	5,432.3	Ages 45–64 years		2,202,400	5,102.5
1	PCI	146,400	356.2	1	Knee arthroplasty	164,200	380.5
2	Knee arthroplasty	110,500	268.8	2	Spine fusion	103,100	238.9
3	Hip arthroplasty	99,400	241.9	3	Hip arthroplasty	99,200	229.7
4	Spine fusion	96,000	233.6	4	Hysterectomy	77,200	178.8
5	Vertebral discectomy	65,000	158.1	5	Salpingectomy	76,000	176.1
Ages 65–74 years		1,512,800	10,568.3	Ages 65–74 years		1,454,300	8,930.9
1	Knee arthroplasty	107,100	748.3	1	Knee arthroplasty	170,200	1,045.0
2	PCI	90,800	634.2	2	Hip arthroplasty	112,100	688.3
3	Hip arthroplasty	77,800	543.8	3	Spine fusion	66,800	410.4
4	Spine fusion	61,400	428.6	4	PCI	46,600	286.0
5	Saphenous vein harvest†	60,000	418.9	5	Colectomy	42,600	261.5
Age 75+ years		1,065,500	12,330.6	Age 75+ years		1,248,400	9,958.1
1	PCI	69,500	804.2	1	Hip arthroplasty	127,000	1,012.8
2	Hip arthroplasty	65,000	752.7	2	Femur fixation	122,100	974.0
3	Knee arthroplasty	57,000	659.2	3	Knee arthroplasty	96,300	768.0
4	Femur fixation	42,900	496.8	4	PCI	51,400	410.0
5	Saphenous vein harvest†	32,900	380.8	5	Colectomy	38,700	308.5

Abbreviations: GI, gastrointestinal; ICD-10-PCS, International Classification of Diseases, Tenth Revision, Procedure Coding System; OR, operating room; PCI, percutaneous coronary intervention

Notes: Number of procedures is rounded to the nearest hundred. Procedures were identified using the Clinical Classifications Software Refined (CCSR) for ICD-10-PCS Procedures. Procedure totals include only one occurrence of a CCSR category per inpatient stay because multiple codes may be used for related procedures performed during a single operation. The overall number of procedures represents the sum of all CCSR category totals. The population denominators used to calculate rates are sex and age-group specific.

* Includes second-degree obstetrical and other repair.

† Includes other therapeutic vessel removal, such as destruction of superior vena cava and excision of coronary vein.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2018

- **Procedures related to diseases of the GI system were among the most common OR procedures for males and females in the two youngest age groups (0–17 and 18–44 years).**

Appendectomy ranked in the top five procedures for both males and females aged 17 years and younger (69.1 per 100,000 males and 48.1 per 100,000 females), as well as for males aged 18–44 years (56.4 per 100,000). Another procedure group related to GI diseases—upper GI therapeutic procedures, not elsewhere classified—was among the five most common procedures for males aged 0–17 years (22.6 per 100,000). Cholecystectomy was among the top five procedures for females aged 18–44 years (134.0 per 100,000).

- **Obstetric/gynecological procedures were among the most frequent procedures for females in the groups aged 0–17, 18–44, and 45–64 years.**

Cesarean section was the top OR procedure for females aged 18–44 years, with the highest rate observed for any OR procedure across sex-age groups—2,001.3 per 100,000 females. Cesarean section was also among the five most common OR procedures for females aged 17 years or younger, but the rate among this group was relatively low (21.4 per 100,000).

Four other obstetric/gynecological procedures ranked in the top five OR procedures for specific female age groups: perineal muscle laceration repair for ages 0–17 years (26.8 per 100,000) and 18–44 years (1,172.5 per 100,000), fallopian tube ligation and excision for ages 18–44 years (375.4 per 100,000), hysterectomy for ages 45–64 years (178.8 per 100,000), and salpingectomy for ages 18–44 years (145.8 per 100,000) and 45–64 years (176.1 per 100,000).

- **For adults in the three older age groups (45–64, 65–74, and 75+ years), cardiovascular and musculoskeletal procedures were among the most common OR procedures.**

PCI was common among adults aged 45+ years and occurred in the top five OR procedures for both males and females in each of the three older age groups (except for females aged 45–64 years). PCI rates increased with age for both sexes, and population rates for males were roughly double the corresponding rates for females (634.2 vs. 286.0 per 100,000 population for ages 65–74 years and 804.2 vs. 410.0 per 100,000 for ages 75+ years).

Hip arthroplasty and knee arthroplasty also ranked among the top OR procedures for both females and males in the three older age groups. The population rate of both procedures was always higher for females than for males (except that hip arthroplasty for ages 45–64 years was similar for males and females). For knee arthroplasty, the difference between the sexes was greater among those aged 45–64 and 65–74 years (40–42 percent higher for females than for males) than among those aged 75+ years (16.5 percent higher for females).

Most costly principal OR procedures during inpatient stays, 2018

Because hospital costs represent an overall inpatient stay and are not specific to a single procedure, the following tables focus on OR procedures that are the principal procedure for the stay. Because a stay has only one principal procedure, the total number of stays with a principal procedure is equivalent to the total number of principal procedures.

Table 4 presents the 20 most costly principal OR procedures in 2018. For stays with each principal OR procedure, the aggregate cost, mean cost per stay, and total number of stays are presented. OR procedures are ranked by aggregate cost on the left side of the table and by mean cost per stay on the right side. Stays with a non-OR principal procedure, including those involving an OR procedure (e.g., principal procedure of spontaneous vaginal delivery with secondary procedure of perineal muscle laceration repair), are excluded.

Table 4. Most costly stays with a principal OR procedure, 2018

Ranked by aggregate cost					Ranked by mean cost per stay				
Rank	Principal OR procedure	Aggregate cost, \$ millions	Mean cost per stay, \$	Number of stays	Rank	Principal OR procedure	Aggregate cost, \$ millions	Mean cost per stay, \$	Number of stays
1	Spine fusion	14,145	33,800	418,700	1	Heart transplant	1,012	304,300	3,300
2	Knee arthroplasty	11,877	16,800	705,100	2	Lung transplant	476	220,700	2,200
3	Hip arthroplasty	10,468	17,700	591,700	3	Heart and great vessel bypass	738	159,100	4,600
4	PCI	9,391	23,500	399,000	4	Liver transplant	1,119	149,400	7,500
5	Cesarean section	8,598	7,500	1,150,200	5	Heart assist device procs	1,924	128,400	15,000
6	CABG	7,322	46,800	156,600	6	Tracheostomy	3,583	107,600	33,300
7	Colectomy	6,080	25,900	234,600	7	Ventriculostomy (percutaneous)	861	67,200	12,800
8	Heart valve replacement (non-endovascular)*	5,627	60,400	93,200	8	Kidney transplant	1,326	65,600	20,200
9	Femur fixation	5,455	20,000	272,500	9	Heart valve replacement (non-endovascular)*	5,627	60,400	93,200
10	Cholecystectomy	4,332	15,100	286,500	10	Septal repair†	971	60,300	16,100
11	Angioplasty‡	4,010	31,600	126,900	11	Vessel repair, replacement	1,523	58,900	25,800
12	Tracheostomy	3,583	107,600	33,300	12	Select CNS drainage procs§	758	54,800	13,800
13	Heart valve replacement (endovascular)*	3,440	48,100	71,600	13	Other coronary artery procs (not PCI or CABG)	165	50,600	3,300
14	Aneurysm repair	2,839	44,100	64,300	14	Esophagectomy	197	50,000	4,000
15	Subcutaneous tissue and fascia excision	2,789	19,700	141,800	15	Heart valve replacement (endovascular)*	3,440	48,100	71,600
16	Arthroplasty of joint other than knee or hip	2,768	19,300	143,100	16	CABG	7,322	46,800	156,600
17	Pacemaker, defibrillator procs	2,703	40,900	66,100	17	Decompressive craniectomy	437	46,700	9,400
18	Fixation of leg and foot bones	2,673	20,000	133,600	18	Ligation and embolization of vessels	2,133	46,500	45,900
19	CNS excision procs	2,587	36,600	70,700	19	Gastrostomy	193	44,300	4,400
20	Small bowel resection	2,322	29,600	78,400	20	Aneurysm repair	2,839	44,100	64,300
Top 20		113,009	21,600	5,237,900	Top 20		36,646	60,400	607,200
All principal OR procs		188,512	22,400	8,425,900	All principal OR procs		188,512	22,400	8,425,900

Abbreviations: CABG, coronary artery bypass graft; CNS, central nervous system; ICD-10-PCS, International Classification of Diseases, Tenth Revision, Procedure Coding System; OR, operating room; PCI, percutaneous coronary intervention; procs, procedures

Notes: A minimum volume threshold of 1,000 stays was applied for top procedures by mean cost. Mean cost per stay and number of stays are rounded to the nearest hundred. Procedures were identified using the Clinical Classifications Software Refined (CCSR) for ICD-10-PCS Procedures.

* Includes heart valve replacement and other valve procedures.

† Includes septal repair and other therapeutic heart procedures.

‡ Includes angioplasty and related vessel procedures (endovascular, excluding carotid).

§ Includes CNS drainage procedures other than minimally invasive CNS biopsy, lumbar puncture, spinal canal and spinal cord drainage, intracranial epidural and subdural space drainage, and percutaneous ventriculostomy.

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2018

- **Ranked by aggregate cost, the three most costly principal OR procedures in 2018 were spine fusion, knee arthroplasty, and hip arthroplasty.**

Three musculoskeletal procedures—spine fusion, knee arthroplasty, and hip arthroplasty—were the three most costly OR procedures in 2018, with stays for these procedures totaling \$14.1 billion, \$11.9 billion, and \$10.5 billion in aggregate costs, respectively. Four other musculoskeletal procedures also ranked in the top 20 OR procedures by highest aggregate cost: femur fixation (\$5.5 billion), subcutaneous tissue and fascia excision (\$2.8 billion), arthroplasty of joint other than knee and hip (\$2.8 billion), and fixation of leg and foot bones (\$2.7 billion). Together, stays for these seven musculoskeletal procedures accounted for more than one-fourth (26.6 percent) of aggregate costs for all stays with a principal OR procedure.

Seven cardiovascular procedures ranked among the 20 most costly principal OR procedures in 2018: PCI (\$9.4 billion), CABG (\$7.3 billion), non-endovascular heart valve replacement and other valve procedures (\$5.6 billion), angioplasty (\$4.0 billion), endovascular (i.e., performed through or inside of blood vessels) heart valve replacement and other valve procedures (\$3.4 billion), aneurysm repair (\$2.8 billion), and pacemaker and defibrillator procedures (\$2.7 billion). Combined, stays for these seven cardiovascular procedures represented 18.7 percent of aggregate costs for all stays with a principal OR procedure.

- **Ranked by mean cost per stay, heart, lung, and liver transplants were among the five most expensive principal OR procedures in 2018.**

With a mean cost per stay of \$304,300, heart transplant was the most expensive of all principal OR procedures associated with at least 1,000 inpatient stays in 2018. Lung, liver, and kidney transplants were also among the 20 most expensive principal OR procedures, with mean costs of \$220,700, \$149,400, and \$65,600 per stay, respectively.

In addition to heart transplants, 10 other cardiovascular procedures were among the 20 most expensive principal OR procedures in 2018. The mean cost per stay exceeded \$100,000 for two of these procedures: heart and great vessel bypass (\$159,100 per stay) and heart assist device procedures (\$128,400 per stay).

Table 5 presents by sex-age group the five most costly principal OR procedures during inpatient stays in 2018, based on aggregate cost. Aggregate cost, percentage of aggregate costs for all principal OR procedure stays, and number of stays are provided. Stays with a non-OR principal procedure are excluded.

Table 5. Most costly stays with a principal OR procedure by sex-age group, 2018

Males					Females				
Rank	Principal OR procedure	Aggregate cost, \$ millions	Percent of all aggregate costs	Number of stays	Rank	Principal OR procedure	Aggregate cost, \$ millions	Percent of all aggregate costs	Number of stays
Ages 0–17 years					Ages 0–17 years				
		6,201	100.0	153,400			5,014	100.0	127,200
1	Heart and great vessel bypass	406	6.6	2,500	1	Spine fusion	472	9.4	8,300
2	Tracheostomy	338	5.5	1,000	2	Heart and great vessel bypass	302	6.0	1,700
3	Appendectomy	298	4.8	23,800	3	Septal repair*	295	5.9	3,700
4	Septal repair*	285	4.6	3,500	4	Tracheostomy	220	4.4	700
5	Spine fusion	252	4.1	4,100	5	Appendectomy	194	3.9	15,500
Ages 18–44 years					Ages 18–44 years				
		12,082	100.0	463,300			20,104	100.0	1,798,500
1	Spine fusion	851	7.0	24,400	1	Cesarean section	8,491	42.2	1,137,500
2	Fixation of leg and foot bones	567	4.7	25,500	2	Cholecystectomy	858	4.3	70,300
3	Bone fixation†	446	3.7	16,700	3	Spine fusion	742	3.7	23,900
4	Femur fixation	443	3.7	14,300	4	Gastrectomy	678	3.4	59,800
5	Colectomy	429	3.5	15,800	5	Hysterectomy	521	2.6	46,700
Ages 45–64 years					Ages 45–64 years				
		34,925	100.0	1,309,400			27,770	100.0	1,244,200
1	Spine fusion	2,852	8.2	87,600	1	Spine fusion	2,940	10.6	95,200
2	PCI	2,766	7.9	123,200	2	Knee arthroplasty	2,718	9.8	162,100
3	CABG	2,204	6.3	49,100	3	Hip arthroplasty	1,702	6.1	98,200
4	Knee arthroplasty	1,856	5.3	108,700	4	Colectomy	1,066	3.8	45,700
5	Hip arthroplasty	1,716	4.9	98,400	5	PCI	1,038	3.7	46,000
Ages 65–74 years					Ages 65–74 years				
		24,147	100.0	905,700			20,857	100.0	895,700
1	CABG	2,060	8.5	44,800	1	Knee arthroplasty	2,782	13.3	168,500
2	Spine fusion	1,990	8.2	56,800	2	Spine fusion	2,117	10.2	62,300
3	PCI	1,790	7.4	74,800	3	Hip arthroplasty	1,905	9.1	110,900
4	Knee arthroplasty	1,768	7.3	105,600	4	PCI	939	4.5	38,600
5	Hip arthroplasty	1,333	5.5	77,000	5	Colectomy	826	4.0	33,900
Age 75+ years					Age 75+ years				
		18,084	100.0	684,400			19,308	100.0	843,300
1	PCI	1,393	7.7	55,400	1	Hip arthroplasty	2,267	11.7	124,800
2	Heart valve replacement (endovascular)‡	1,274	7.0	26,800	2	Femur fixation	2,023	10.5	113,500
3	Hip arthroplasty	1,201	6.6	63,900	3	Knee arthroplasty	1,612	8.4	95,100
4	CABG	1,118	6.2	22,400	4	Heart valve replacement (endovascular)‡	1,147	5.9	24,500
5	Knee arthroplasty	949	5.2	56,100	5	PCI	1,041	5.4	41,400

Abbreviations: CABG, coronary artery bypass graft; ICD-10-PCS, International Classification of Diseases, Tenth Revision, Procedure Coding System; OR, operating room; PCI, percutaneous coronary intervention

Notes: Number of stays is rounded to the nearest hundred. Percentage is based on unrounded data values. Procedures were identified using the Clinical Classifications Software Refined (CCSR) for ICD-10-PCS Procedures.

* Includes septal repair and other therapeutic heart procedures.

† Excludes extremities.

‡ Includes heart valve replacement and other valve procedures (endovascular).

Source: Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project (HCUP), National Inpatient Sample (NIS), 2018

- **In 2018, spine fusion was one of the five most costly principal OR procedures for both males and females in all age groups younger than 75 years.**

Spine fusion was among the top five most costly principal OR procedures for all but the oldest age group (75+ years). Across sex-age groups, the aggregate cost of stays for spine fusion ranged from \$252 million among males aged 0–17 years to \$2.9 billion among females aged 45–64 years.

For males aged 18–44 years, three other musculoskeletal procedures ranked in the top five most costly principal OR procedures: fixation of leg and foot bones (\$567 million); bone fixation, excluding extremities (\$446 million); and femur fixation (\$443 million). Together with stays for spine fusion, stays for these musculoskeletal procedures accounted for 19.1 percent of costs for all stays with a principal OR procedure among this sex-age group.

Hip arthroplasty and knee arthroplasty were among the most costly principal OR procedures for both males and females in the three older age groups. For males aged 45–64, 65–74, and 75+ years, stays for hip and knee arthroplasty combined accounted for 10–13 percent of aggregate costs for all stays with a principal OR procedure. Hip and knee arthroplasty combined constituted an even higher percentage of aggregate costs for females in the three older age groups (16–22 percent).

- **For individuals in the two younger age groups (0–17 and 18–44 years), procedures related to GI diseases were among the most costly principal OR procedures.**

Among children (ages 0–17 years), appendectomy was one of the principal OR procedures with the highest aggregate costs. Stays for this procedure totaled \$298 million for males and \$194 million for females in the youngest age group (4–5 percent of aggregate costs for stays with a principal OR procedure among the sex-age groups).

Other procedures related to GI diseases ranked in the top five most costly OR procedures for individuals aged 18–44 years. These included colectomy for males (\$429 million) and cholecystectomy and gastrectomy (i.e., removal of part or all of the stomach) for females (\$858 and \$678 million, respectively).

- **Cardiovascular procedures were among the most costly principal OR procedures for adults in the older age groups (45–64, 65–74, and 75+ years).**

CABG and PCI ranked in the five most costly principal OR procedures for males aged 45–64, 65–74, and 75+ years. Stays for these two procedures combined constituted 14–16 percent of costs for all stays with OR procedures among these male age groups. PCI was also one of the five most costly procedures for females in the three older age groups, accounting for 4–5 percent of aggregate costs for stays with a principal OR procedure.

Heart valve replacement and other valve procedures (endovascular) also ranked in the five most costly principal OR procedures for males and females aged 75+ years, accounting for 6–7 percent of aggregate costs for stays with a principal OR procedure among these groups.

References

¹ McDermott KW, Freeman WJ, Elixhauser A. Overview of Operating Room Procedures During Inpatient Stays in U.S. Hospitals, 2014. HCUP Statistical Brief #233. December 2017. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/reports/statbriefs/sb233-Operating-Room-Procedures-United-States-2014.pdf. Accessed March 5, 2021.

² Muñoz E, Muñoz W III, Wise L. National and surgical health care expenditures, 2005–2025. *Annals of Surgery*. 2010;251(2):195–200.

About Statistical Briefs

Healthcare Cost and Utilization Project (HCUP) Statistical Briefs provide basic descriptive statistics on a variety of topics using HCUP administrative healthcare data. Topics include hospital inpatient, ambulatory surgery, and emergency department use and costs, quality of care, access to care, medical conditions, procedures, and patient populations, among other topics. The reports are intended to generate hypotheses that can be further explored in other research; the reports are not designed to answer in-depth research questions using multivariate methods.

Data Source

The estimates in this Statistical Brief are based upon data from the HCUP 2018 National Inpatient Sample (NIS). Supplemental sources included population denominator data for use with HCUP databases, derived from information available from Claritas, a vendor that produces population estimates and projections based on data from the U.S. Census Bureau.^b

Definitions

Procedures, ICD-10-PCS, Clinical Classifications Software Refined (CCSR) for ICD-10-PCS Procedures, diagnosis-related groups (DRGs), Procedure Classes

All-listed procedures include all procedures performed during the hospital stay, whether for definitive treatment or for diagnostic or exploratory purposes. The *first-listed procedure* is the procedure that is listed first on the discharge record. Inpatient data define this as the *principal procedure*—the procedure that is performed for definitive treatment rather than for diagnostic or exploratory purposes (i.e., the procedure that was necessary to take care of a complication).

ICD-10-PCS is the International Classification of Diseases, Tenth Revision, Procedure Coding System, which went into effect on October 1, 2015. There are over 75,000 ICD-10-PCS procedure codes.

The CCSR aggregates ICD-10-PCS procedure codes into a manageable number of clinically meaningful categories.^c The CCSR is intended to be used analytically to examine patterns of healthcare in terms of cost, utilization, and outcomes, as well as to perform rank utilization by procedures. ICD-10-PCS coding definitions for each CCSR category presented in this Statistical Brief can be found in the *CCSR reference file*, available at www.hcup-us.ahrq.gov/toolssoftware/ccsr/prccsr.jsp. For this Statistical Brief, v2021.1 of the CCSR was used.

DRGs comprise a patient classification system that categorizes patients into groups that are clinically coherent and homogeneous with respect to resource use. DRGs group patients according to diagnosis, type of treatment (procedure), age, and other relevant criteria. Each hospital stay has one assigned DRG.

Major operating room (OR) procedures were defined using the Procedure Classes Refined for ICD-10-PCS software, which categorizes each ICD-10-PCS procedure code as either major therapeutic, major

^b Claritas. Claritas Demographic Profile by ZIP Code. <https://claritas360.claritas.com/mybestsegments/>. Accessed January 22, 2021.

^c Agency for Healthcare Research and Quality. HCUP Clinical Classifications Software Refined (CCSR) for ICD-10-PCS Procedures. Healthcare Cost and Utilization Project (HCUP). Agency for Healthcare Research and Quality. Updated November 2020. www.hcup-us.ahrq.gov/toolssoftware/ccsr/prccsr.jsp. Accessed June 14, 2021.

diagnostic, minor therapeutic, or minor diagnostic.^d If at least one major diagnostic or major therapeutic procedure was on a hospital record, the hospital stay was classified as involving a major OR procedure.

Unit of analysis

The unit of analysis is the hospital discharge (i.e., the hospital stay), not a person or patient. This means that a person who is admitted to the hospital multiple times in 1 year will be counted each time as a separate discharge from the hospital.

Population rates

Rates of stays per 100,000 population were calculated using 2018 hospital discharge totals in the numerator and Claritas^e estimates of the corresponding 2018 U.S. population (e.g., the population for a specific sex-age group) in the denominator. Individuals hospitalized multiple times are counted more than once in the numerator.

$$\text{Population rate of stays} = \left(\frac{\text{number of stays among patients in group}}{\text{number of U.S. residents in group}} \right) \times 100,000$$

Costs and charges

Total hospital charges were converted to costs using HCUP Cost-to-Charge Ratios based on hospital accounting reports from the Centers for Medicare & Medicaid Services (CMS).^f *Costs* reflect the actual expenses incurred in the production of hospital services, such as wages, supplies, and utility costs; *charges* represent the amount a hospital billed for the case. For each hospital, a hospital-wide cost-to-charge ratio is used. Hospital charges reflect the amount the hospital billed for the entire hospital stay and do not include professional (physician) fees. For the purposes of this Statistical Brief, missing charges were imputed using the mean charge for the DRG before converting charges to costs. Costs are reported to the nearest hundred dollars.

How HCUP estimates of costs differ from National Health Expenditure Accounts

There are a number of differences between the costs cited in this Statistical Brief and spending as measured in the National Health Expenditure Accounts (NHEA), which are produced annually by CMS.^g The largest source of difference comes from the HCUP coverage of inpatient treatment only in contrast to the NHEA inclusion of outpatient costs associated with emergency departments and other hospital-based outpatient clinics and departments as well. The outpatient portion of hospitals' activities has been growing steadily and may exceed half of all hospital revenue in recent years. On the basis of the American Hospital Association Annual Survey, 2018 outpatient gross revenues (or charges) were about 49 percent of total hospital gross revenues.^h

Smaller sources of differences come from the inclusion in the NHEA of hospitals that are excluded from HCUP. These include Federal hospitals (Department of Defense, Veterans Administration, Indian Health Services, and Department of Justice [prison] hospitals) as well as psychiatric, substance abuse, and long-term care hospitals. A third source of difference lies in the HCUP reliance on billed charges from hospitals to payers, adjusted to provide estimates of costs using hospital-wide cost-to-charge ratios, in contrast to the NHEA measurement of spending or revenue. HCUP costs estimate the amount of money required to produce hospital services, including expenses for wages, salaries, and benefits paid to staff as well as utilities, maintenance, and other similar expenses required to run a hospital. NHEA spending or revenue measures the amount of income received by the hospital for treatment and other services

^d Procedure Classes Refined for ICD-10-PCS. Healthcare Cost and Utilization Project (HCUP). U.S. Agency for Healthcare Research and Quality. Rockville, MD. Updated March 2021. www.hcup-us.ahrq.gov/toolssoftware/procedureicd10/procedure_icd10.jsp Accessed June 28, 2021.

^e Claritas. Claritas Demographic Profile by ZIP Code. <https://claritas360.claritas.com/mybestsegments/>. Accessed January 22, 2021.

^f Agency for Healthcare Research and Quality. HCUP Cost-to-Charge Ratio (CCR) Files. Healthcare Cost and Utilization Project (HCUP). 2001–2017. Agency for Healthcare Research and Quality. Updated September 2020. www.hcup-us.ahrq.gov/db/state/costtocharge.jsp. Accessed January 22, 2021.

^g For additional information about the NHEA, see Centers for Medicare & Medicaid Services (CMS). National Health Expenditure Data. CMS website. Updated December 17, 2019. www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/index.html?redirect=/NationalHealthExpendData/. Accessed January 22, 2021.

^h American Hospital Association. TrendWatch Chartbook, 2020. Table 4.2. Distribution of Inpatient vs. Outpatient Revenues, 1995–2018. www.aha.org/system/files/media/file/2020/10/TrendwatchChartbook-2020-Appendix.pdf. Accessed January 22, 2021.

provided, including payments by insurers, patients, or government programs. The difference between revenues and costs includes profit for for-profit hospitals or surpluses for nonprofit hospitals.

Location of patients' residence

Place of residence is based on the urban-rural classification scheme for U.S. counties developed by the National Center for Health Statistics (NCHS) and based on the Office of Management and Budget (OMB) definition of a metropolitan service area as including a city and a population of at least 50,000 residents:

- Large Central Metropolitan: Counties in a metropolitan area with 1 million or more residents that satisfy at least one of the following criteria: (1) containing the entire population of the largest principal city of the metropolitan statistical area (MSA), (2) having their entire population contained within the largest principal city of the MSA, or (3) containing at least 250,000 residents of any principal city in the MSA
- Large Fringe Metropolitan: Counties in a metropolitan area with 1 million or more residents that do not qualify as large central metropolitan counties
- Medium Metropolitan: Counties in a metropolitan area of 250,000–999,999 residents
- Small Metropolitan: Counties in a metropolitan area of 50,000–249,999 residents
- Micropolitan: Counties in a nonmetropolitan area of 10,000–49,999 residents
- Noncore: Counties in a nonmetropolitan and nonmicropolitan area

For this Statistical Brief, we combined the medium and small metropolitan categories and the micropolitan and noncore categories.

Community-level income

Community-level income is based on the median household income of the patient's ZIP Code of residence. Quartiles are defined so that the total U.S. population is evenly distributed. Cut-offs for the quartiles are determined annually using ZIP Code demographic data obtained from Claritas, a vendor that produces population estimates and projections based on data from the U.S. Census Bureau.¹ The value ranges for the income quartiles vary by year. The income quartile is missing for patients who are homeless or foreign.

Expected payer

To make coding uniform across all HCUP data sources, the primary expected payer for the hospital stay combines detailed categories into general groups:

- Medicare: includes fee-for-service and managed care Medicare
- Medicaid: includes fee-for-service and managed care Medicaid
- Private insurance: includes commercial nongovernmental payers, regardless of the type of plan (e.g., private health maintenance organizations [HMOs], preferred provider organizations [PPOs])
- Self-pay/No charge: includes self-pay, no charge, charity, and no expected payment
- Other payers: includes other Federal and local government programs (e.g., TRICARE, CHAMPVA, Indian Health Service, Black Lung, Title V) and Workers' Compensation

Hospital stays that were expected to be billed to the State Children's Health Insurance Program (SCHIP) are included under Medicaid.

For this Statistical Brief, when more than one payer is listed for a hospital discharge, the first-listed payer is used.

Admission source or point of origin

Admission source (now known as the patient's point of origin) indicates where the patient was located prior to admission to the hospital. Emergency admission indicates that the patient was admitted to the hospital through the emergency department.

¹ Claritas. Claritas Demographic Profile by ZIP Code. <https://claritas360.claritas.com/mybestsegments/>. Accessed January 22, 2021.

Discharge status

Discharge status reflects the disposition of the patient at discharge from the hospital and includes the following five categories: routine (to home) or to home healthcare; transfer to another short-term hospital; other transfers (including skilled nursing facility, intermediate care, and another type of facility such as a nursing home); died in the hospital; or other (including against medical advice [AMA] or discharge alive, destination unknown).

About HCUP

The Healthcare Cost and Utilization Project (HCUP, pronounced "H-Cup") is a family of healthcare databases and related software tools and products developed through a Federal-State-Industry partnership and sponsored by the Agency for Healthcare Research and Quality (AHRQ). HCUP databases bring together the data collection efforts of State data organizations, hospital associations, and private data organizations (HCUP Partners) and the Federal government to create a national information resource of encounter-level healthcare data. HCUP includes the largest collection of longitudinal hospital care data in the United States, with all-payer, encounter-level information beginning in 1988. These databases enable research on a broad range of health policy issues, including cost and quality of health services, medical practice patterns, access to healthcare programs, and outcomes of treatments at the national, State, and local market levels.

HCUP would not be possible without the contributions of the following data collection Partners from across the United States:

Alaska Department of Health and Social Services	Nevada Department of Health and Human Services
Alaska State Hospital and Nursing Home Association	New Hampshire Department of Health & Human Services
Arizona Department of Health Services	New Jersey Department of Health
Arkansas Department of Health	New Mexico Department of Health
California Office of Statewide Health Planning and Development	New York State Department of Health
Colorado Hospital Association	North Carolina Department of Health and Human Services
Connecticut Hospital Association	North Dakota (data provided by the Minnesota Hospital Association)
Delaware Division of Public Health	Ohio Hospital Association
District of Columbia Hospital Association	Oklahoma State Department of Health
Florida Agency for Health Care Administration	Oregon Association of Hospitals and Health Systems
Georgia Hospital Association	Oregon Office of Health Analytics
Hawaii Lauilima Data Alliance	Pennsylvania Health Care Cost Containment Council
Hawaii University of Hawai'i at Hilo	Rhode Island Department of Health
Illinois Department of Public Health	South Carolina Revenue and Fiscal Affairs Office
Indiana Hospital Association	South Dakota Association of Healthcare Organizations
Iowa Hospital Association	Tennessee Hospital Association
Kansas Hospital Association	Texas Department of State Health Services
Kentucky Cabinet for Health and Family Services	Utah Department of Health
Louisiana Department of Health	Vermont Association of Hospitals and Health Systems
Maine Health Data Organization	Virginia Health Information
Maryland Health Services Cost Review Commission	Washington State Department of Health
Massachusetts Center for Health Information and Analysis	West Virginia Department of Health and Human Resources, West Virginia Health Care Authority
Michigan Health & Hospital Association	Wisconsin Department of Health Services
Minnesota Hospital Association	Wyoming Hospital Association
Mississippi State Department of Health	
Missouri Hospital Industry Data Institute	
Montana Hospital Association	
Nebraska Hospital Association	

About the NIS

The HCUP National (Nationwide) Inpatient Sample (NIS) is a nationwide database of hospital inpatient stays. The NIS is nationally representative of all community hospitals (i.e., short-term, non-Federal, nonrehabilitation hospitals). The NIS includes all payers. It is drawn from a sampling frame that contains hospitals comprising more than 96 percent of all discharges in the United States. The vast size of the NIS allows the study of topics at the national and regional levels for specific subgroups of patients. In addition, NIS data are standardized across years to facilitate ease of use. Over time, the sampling frame for the NIS has changed; thus, the number of States contributing to the NIS varies from year to year. The NIS is intended for national estimates only; no State-level estimates can be produced. The unweighted sample size for the 2018 NIS is 7,105,498 (weighted, this represents 35,527,481 inpatient stays).

For More Information

For other information on hospital inpatient procedures, refer to the HCUP Statistical Briefs located at www.hcup-us.ahrq.gov/reports/statbriefs/sb_procedures.jsp.

For additional HCUP statistics, visit:

- HCUP Fast Stats at www.hcup-us.ahrq.gov/faststats/landing.jsp for easy access to the latest HCUP-based statistics for healthcare information topics
- HCUPnet, HCUP's interactive query system, at www.hcupnet.ahrq.gov/
- HCUP Summary Trend Tables at www.hcup-us.ahrq.gov/reports/trendtables/summarytrendtables.jsp for monthly information on hospital utilization

For more information about HCUP, visit www.hcup-us.ahrq.gov/.

For a detailed description of HCUP and more information on the design of the National Inpatient Sample (NIS), please refer to the following database documentation:

Agency for Healthcare Research and Quality. Overview of the National (Nationwide) Inpatient Sample (NIS). Healthcare Cost and Utilization Project (HCUP). Rockville, MD: Agency for Healthcare Research and Quality. Updated December 2020. www.hcup-us.ahrq.gov/nisoverview.jsp. Accessed January 22, 2021.

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AHRQ welcomes questions and comments from readers of this publication who are interested in obtaining more information about access, cost, use, financing, and quality of healthcare in the United States. We also invite you to tell us how you are using this Statistical Brief and other HCUP data and tools, and to share suggestions on how HCUP products might be enhanced to further meet your needs. Please email us at hcup@ahrq.gov or send a letter to the address below:

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