

## STATISTICAL BRIEF #171

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### Trends in Operating Room Procedures in U.S. Hospitals, 2001–2011

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#### Introduction

More than 24 million hospital stays (63% of all stays) in 2011 involved some type of procedure.<sup>1</sup> Some of these procedures (such as a chest X-ray or skin biopsy) occurred outside of the operating room (OR). Others were major OR procedures (such as hip replacement or heart valve repair). Hospital stays that involve OR procedures are more costly, on average, than stays that do not involve OR procedures.<sup>2</sup>

Over time, some OR procedures have become more prevalent, while others have decreased in frequency. For instance, prior research has found that the volume of coronary artery bypass graft (CABG) decreased by 70 percent from 1997 to 2007, while the volume of percutaneous transluminal coronary angioplasty (PTCA) increased by 20 percent during this same time period.<sup>3</sup> Such trends may reflect changing standards in surgical care, the introduction of new surgical techniques, a shift in procedure setting from inpatient to outpatient, or an aging population, among other reasons.

This Statistical Brief presents data from the Healthcare Cost and Utilization Project (HCUP) on trends in OR procedures from 2001 through 2011. For this Statistical Brief, OR procedures are defined using the HCUP procedure classes tool.<sup>4</sup> In this tool, OR procedures are identified based on diagnosis-related groups (DRGs) that use physician panels to determine whether the procedure would be performed in a hospital OR in most hospitals. The findings in this Statistical Brief represent an update of 2007 statistics reported by Elixhauser and Andrews.<sup>5</sup> We present the 2001 and 2011 volume of OR procedures by major clinical body system. For selected high-volume procedures, we provide the trends and identify differences over the 11-year period examined.

<sup>1</sup> Pfuntner A, Wier LM, Stocks C. Most Frequent Procedures Performed in U.S. Hospitals, 2011. HCUP Statistical Brief #165. October 2013. Agency for Healthcare Research and Quality. Rockville, MD. <http://www.hcup-us.ahrq.gov/reports/statbriefs/sb165.pdf>.

<sup>2</sup> Elixhauser A, Andrews RM. Profile of inpatient operating room procedures in US hospitals in 2007. *Arch Surg.* December 2010;145(12):1201–8.

<sup>3</sup> *Ibid.*

<sup>4</sup> HCUP Procedure Classes. Healthcare Cost and Utilization Project (HCUP). U.S. Agency for Healthcare Research and Quality. Rockville, MD. Updated September 2013. <http://www.hcup-us.ahrq.gov/toolssoftware/procedure/procedure.jsp>. Accessed December 4, 2013.

<sup>5</sup> Elixhauser and Andrews 2010.

#### Highlights

- In 2011, over 15 million operating room (OR) procedures were performed in U.S. hospitals. Although the overall number of procedures remained stable from 2001–2011, the mix of procedures changed.
- In 2001, musculoskeletal procedures constituted 17.9 percent of all procedures. By 2011, this figure rose to 24.2 percent, which is a 38 percent increase in 11 years.
- Within the musculoskeletal system, knee arthroplasty had the largest growth in volume, nearly doubling between 2001 and 2011 (a 93 percent increase). Approximately 718,500 knee arthroplasties were performed in 2011. There was a 70 percent growth in spinal fusion during the 11-year period.
- Among digestive-related procedures, appendectomies decreased by 13 percent, while colorectal resection and cholecystectomy procedures remained relatively stable over time.
- Two common cardiovascular procedures decreased from 2001–2011. Coronary artery bypass graft (CABG) procedures decreased by nearly half to 213,700 procedures in 2011, and percutaneous coronary angioplasty (PTCA) decreased by more than one-fourth to 560,500 procedures in 2011.

All differences between estimates noted in the text are significantly different at the .001 level or better.

## Findings

### *Operating room procedures by clinical body system, 2001 and 2011*

Table 1 presents the number of OR procedures by major clinical body system in 2001 and 2011. Although the overall number of procedures remained relatively unchanged across this time frame, the mix of procedures changed substantially.

**Table 1. Operating room procedures by clinical body system, 2001 and 2011**

Rank (2011)	Clinical body system	2001		2011	
		Number, in thousands	Percent	Number, in thousands	Percent
<b>Total operating room procedures</b>		<b>15,334</b>	<b>100.0</b>	<b>15,662</b>	<b>100.0</b>
1	Musculoskeletal system	2,740	17.9	3,785	24.2
2	Digestive system	2,764	18.0	2,898	18.5
3	Cardiovascular system	2,383	15.5	2,123	13.6
4	Female genital organs	2,000	13.0	1,343	8.6
5	Obstetrical procedures	1,064	6.9	1,307	8.3
6	Male genital organs	1,428	9.3	1,283	8.2
7	Nervous system	796	5.2	917	5.9
8	Integumentary system	596	3.9	473	3.0
9	Urinary system	471	3.1	432	2.8
10	Hemic and lymphatic system	290	1.9	331	2.1
11	Respiratory system	301	2.0	313	2.0
12	Miscellaneous	191	1.2	171	1.1
13	Nose, mouth, and pharynx	146	1.0	125	0.8
14	Endocrine system	96	0.6	116	0.7
15	Eye	41	0.3	24	0.2
16	Ear	29	0.2	20	0.1

Note: The difference in volume between 2001 and 2011 was statistically significant for each clinical body system at  $p < .0001$ .

Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), Nationwide Inpatient Sample (NIS), 2001 and 2011

In 2011, nearly one-fourth (24.2 percent) of the 15,661,700 total OR procedures involved the musculoskeletal system, which is a 38 percent increase from 17.9 percent in 2001. There was a small increase (5 percent) in OR procedures of the digestive system between 2001 and 2011—from 18.0 percent to 18.5 percent of all OR procedures. OR procedures involving the cardiovascular system decreased from 15.5 percent of all OR procedures in 2001 to 13.6 percent in 2011 (an 11 percent decrease in volume). OR procedures involving the female and male genital organs each constituted over 8 percent of all OR procedures in 2011, and both decreased in volume from 2001 (33 percent for female genital organs and 10 percent for male genital organs). Obstetrical procedures also represented just over 8 percent of all OR procedures in 2011—a 23 percent increase in volume since 2001.

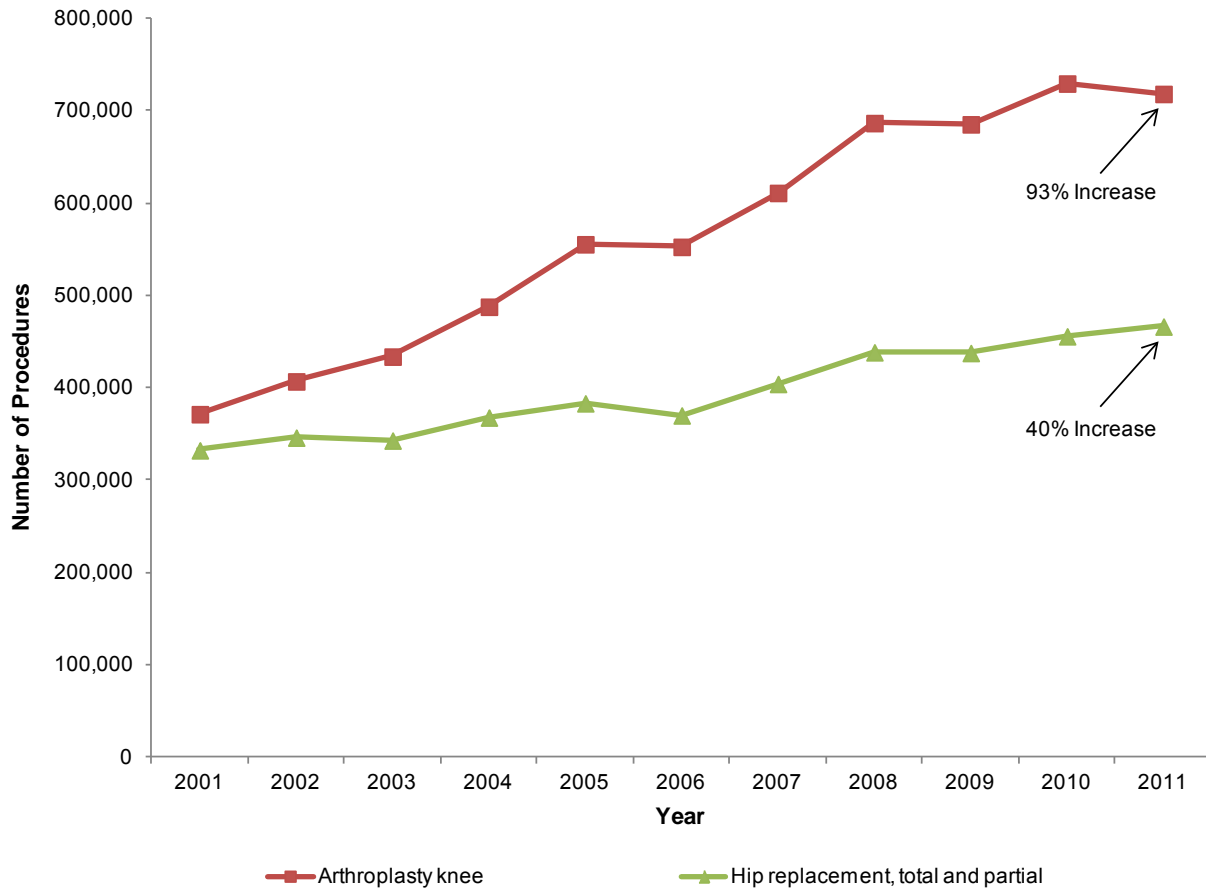
Figures 1 through 7 provide the 2001–2011 trends for selected OR procedures from the clinical body systems in Table 1 that comprise the largest number of procedures performed in 2011. Selected OR

procedures presented in the figures are those with at least 100,000 annual discharges and those that represent relatively homogeneous groups of procedures.<sup>6</sup>

*Trends for selected musculoskeletal OR procedures, 2001–2011*

Figure 1 presents the trend in two orthopedic OR procedures from 2001 through 2011. Knee arthroplasty nearly doubled (93 percent increase) over the 11-year period, from 371,600 procedures in 2001 to 718,500 procedures in 2011. Hip replacement procedures increased by 40 percent over the 10-year period, from 332,500 procedures in 2001 to 466,500 procedures in 2011.

**Figure 1. Orthopedic operating room procedures, 2001–2011**



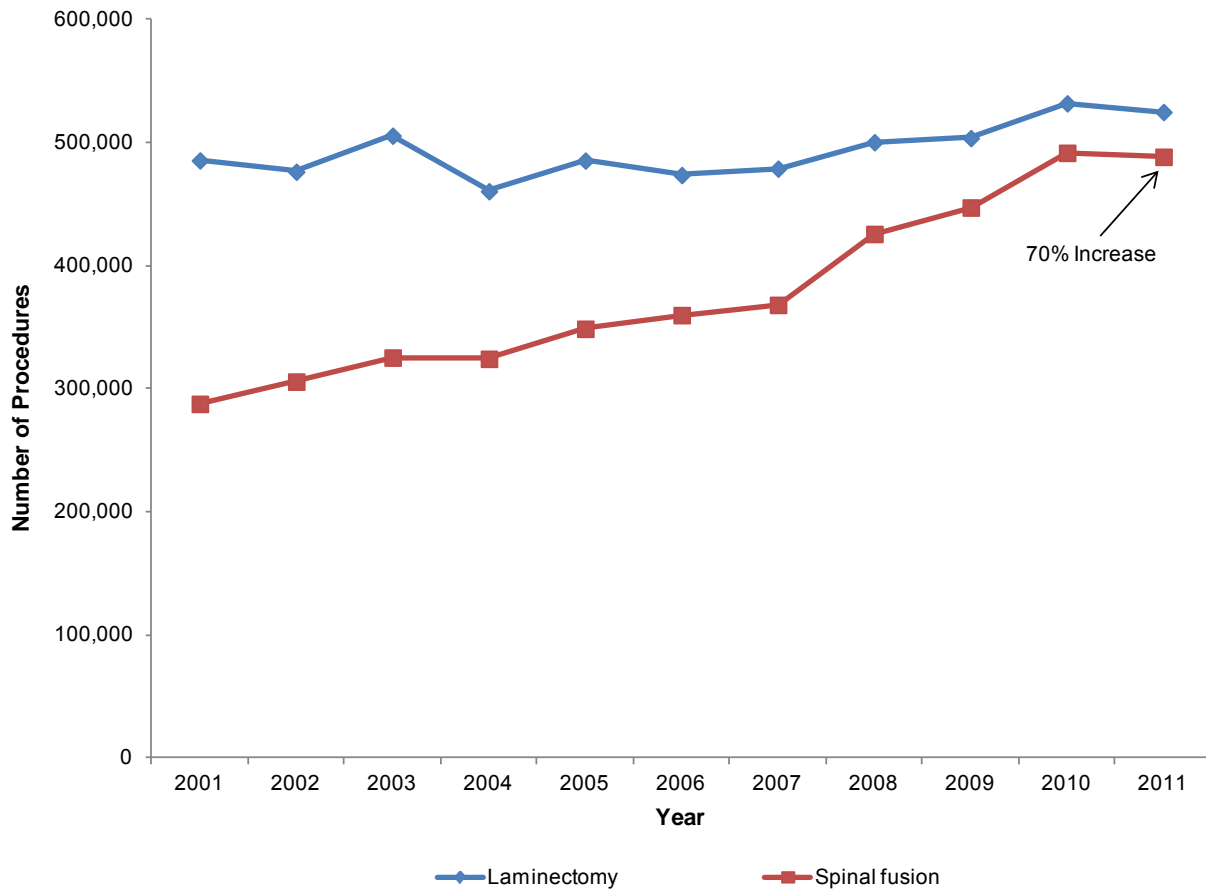
Note: Percentage differences presented in the figure refer to changes in procedure volume between 2001 and 2011.

Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), Nationwide Inpatient Sample (NIS), 2001–2011

<sup>6</sup> Procedures are identified using AHRQ’s Clinical Classifications Software (CCS). Certain CCS procedure categories with at least 100,000 annual discharges are not reported: procedures that are identified as “other”; procedures that are nonspecific and could be performed for a variety of reasons (e.g., treatment, fracture, or dislocation of lower extremity other than hip or femur; small bowel resection; amputation of lower extremity; partial excision of the bone); and procedures that are likely to be adjuncts to other procedures (e.g., excision, lysis peritoneal adhesions; treatment, fracture, or dislocation of hip and femur).

Back-related OR procedures are shown in Figure 2. Spinal fusion increased by 70 percent, from 287,600 procedures in 2001 to 488,300 procedures in 2011. Laminectomy remained relatively stable during the same time period at about 490,000 procedures each year.

**Figure 2. Back-related operating room procedures, 2001–2011**



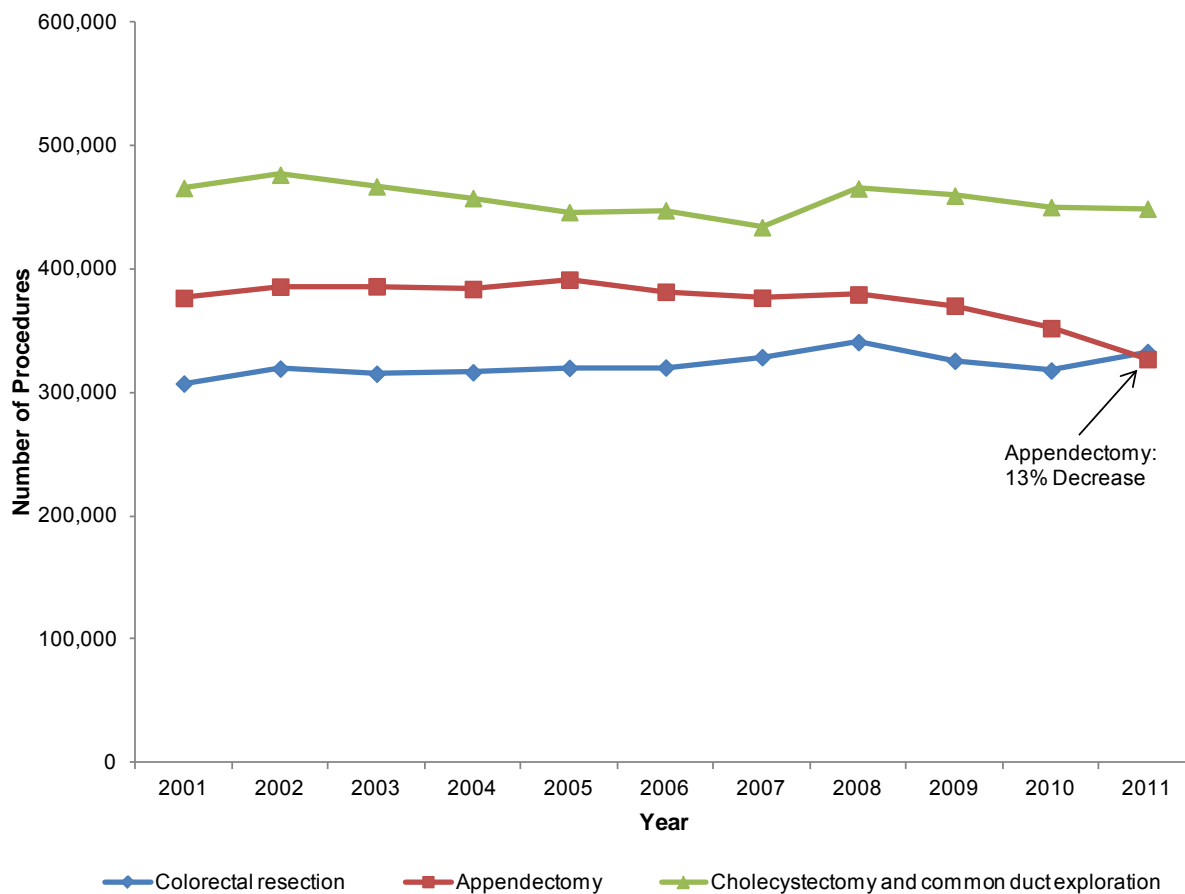
Note: Percentage differences presented in the figure refer to changes in procedure volume between 2001 and 2011.

Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), Nationwide Inpatient Sample (NIS), 2001–2011

*Trends for selected digestive OR procedures, 2001–2011*

As shown in Figure 3, the volume of appendectomy procedures decreased by 13 percent over the 11-year period, from 376,700 procedures in 2001 to 327,100 procedures in 2011. Colorectal resection procedures and cholecystectomy/common duct exploration procedures remained relatively stable during this time: colorectal resection (about 320,000 procedures per year) and cholecystectomy (about 460,000 procedures per year).

**Figure 3. Digestive-related operating room procedures, 2001–2011**



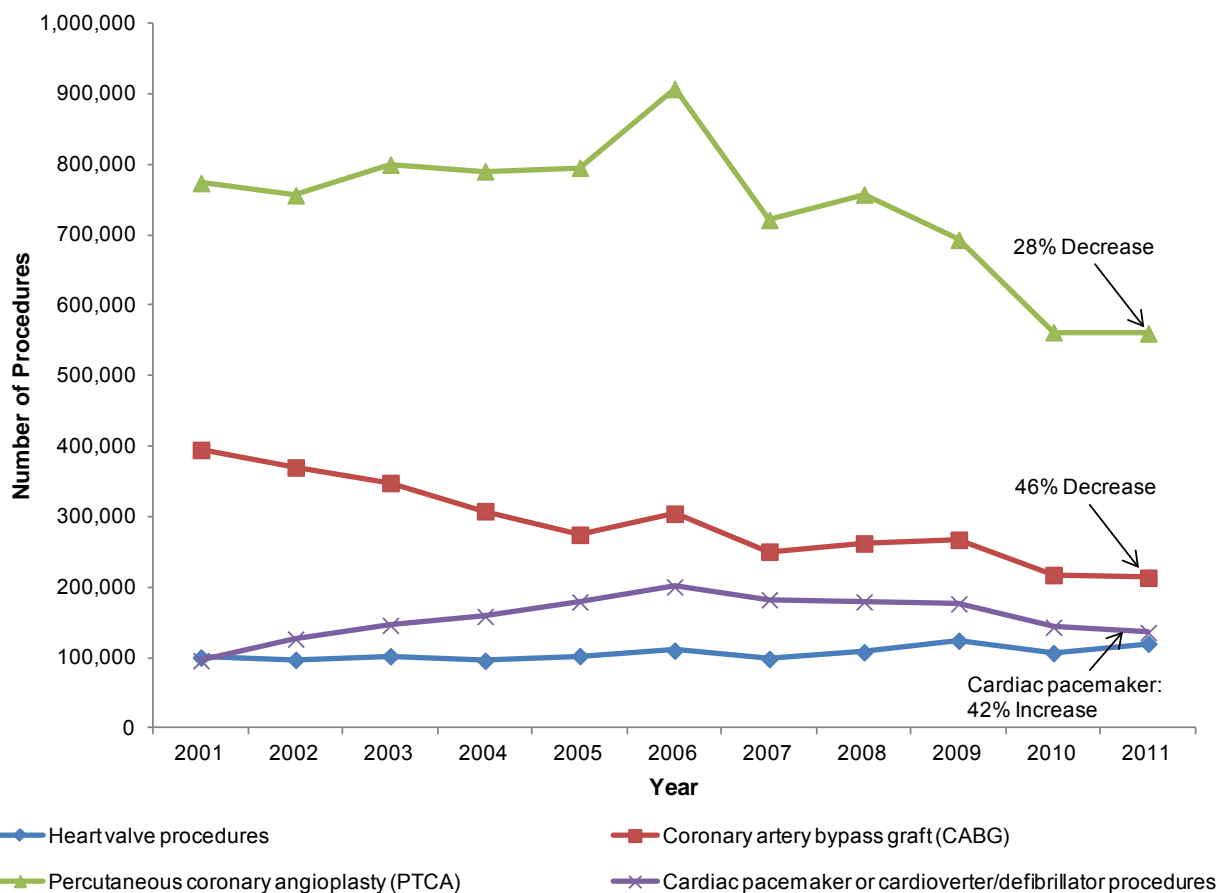
Note: Percentage differences presented in the figure refer to changes in procedure volume between 2001 and 2011.

Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), Nationwide Inpatient Sample (NIS), 2001–2011

*Trends for selected cardiovascular OR procedures, 2001–2011*

Figure 4 shows that the number of coronary artery bypass graft (CABG) procedures decreased by 46 percent, from 395,100 procedures in 2001 to 213,700 procedures in 2011. Similarly, percutaneous coronary angioplasty (PTCA) decreased by 28 percent, from 773,900 procedures in 2001 to 560,500 procedures in 2011; the decrease occurred primarily between 2006 and 2011. The volume of cardiac pacemaker or cardioverter/defibrillator procedures increased by 42 percent during this time, from 96,000 procedures in 2001 to 135,800 procedures in 2011. Heart valve procedures remained relatively stable during the 11-year time period at about 110,000 procedures each year.

**Figure 4. Heart-related operating room procedures, 2001–2011**

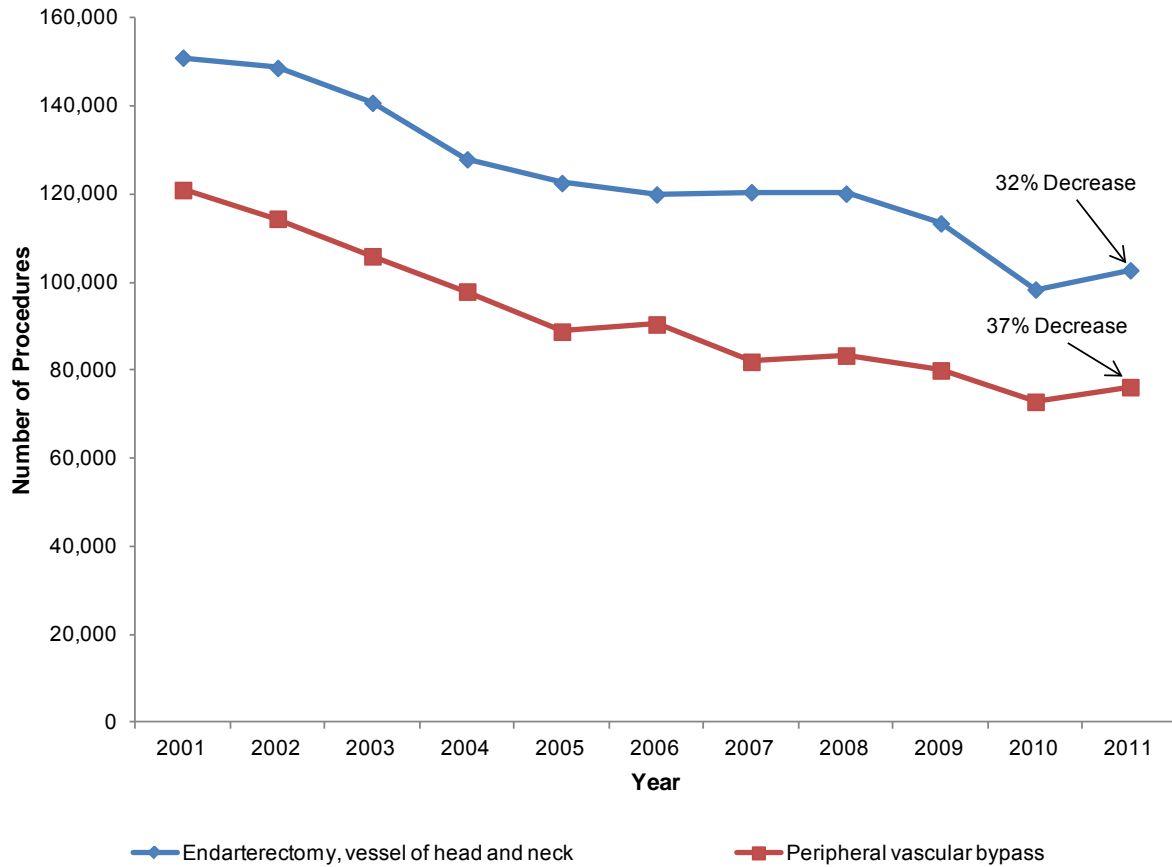


Note: Percentage differences presented in the figure refer to changes in procedure volume between 2001 and 2011.

Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), Nationwide Inpatient Sample (NIS), 2001–2011

Figure 5 shows a decrease in two specific vascular OR procedures that are not related to the heart. Both endarterectomy and peripheral vascular bypass decreased by approximately one-third between 2001 and 2011. Endarterectomy decreased from 151,000 procedures in 2001 to 102,700 procedures in 2011. Peripheral vascular bypass decreased from 121,000 procedures in 2001 to 76,200 procedures in 2011.

**Figure 5. Other vascular operating room procedures, 2001–2011**



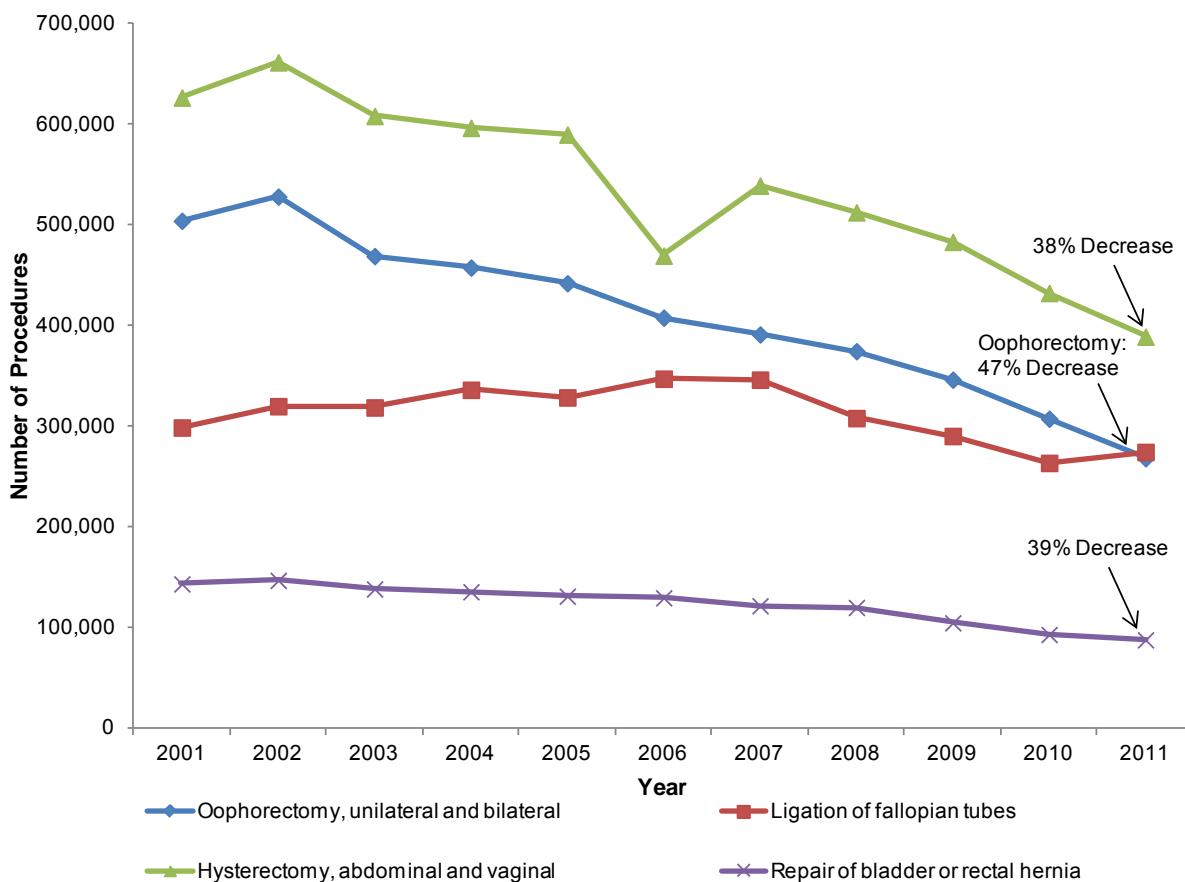
Note: Percentage differences presented in the figure refer to changes in procedure volume between 2001 and 2011.

Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), Nationwide Inpatient Sample (NIS), 2001–2011

*Trends for selected OR procedures related to female genital organs, 2001–2011*

Figure 6 shows that the volume of hysterectomy, oophorectomy, and repair of bladder or rectal hernia procedures each decreased by about 40 percent between 2001 and 2011. Hysterectomy decreased from 626,600 procedures in 2001 to 389,100 procedures in 2011. Oophorectomy decreased from 504,100 procedures in 2001 to 268,200 procedures in 2011. Repair of bladder or rectal hernia procedures decreased from 143,400 procedures in 2001 to 87,800 procedures in 2011. In contrast, ligation of the fallopian tubes remained relatively stable during the 11-year time period at about 310,000 procedures each year.

**Figure 6. Operating room procedures related to female genital organs, 2001–2011**



Note: Percentage differences presented in the figure refer to changes in procedure volume between 2001 and 2011.

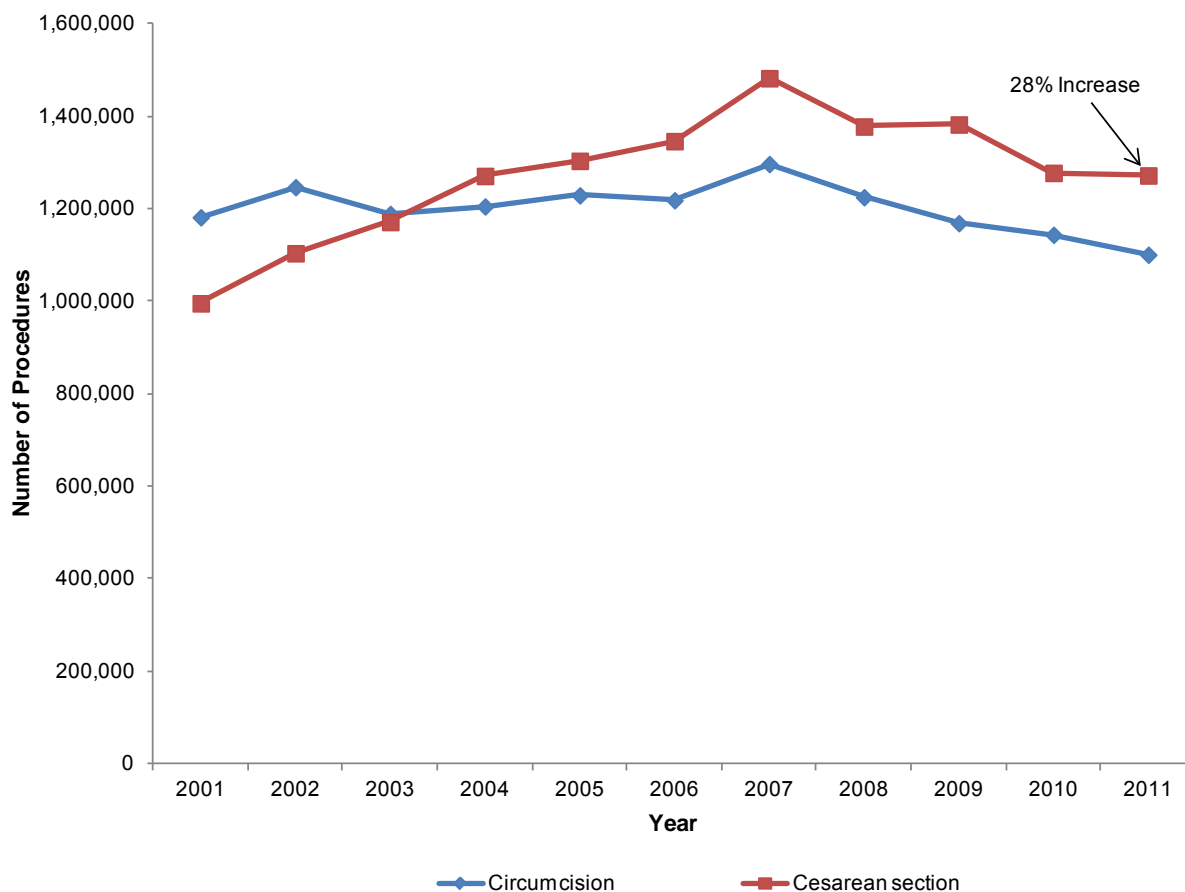
Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), Nationwide Inpatient Sample (NIS), 2001–2011



*Trends for selected obstetrical and newborn OR procedures, 2001–2011*

Figure 7 shows that the volume of Cesarean section increased 28 percent from 995,700 procedures in 2001 to 1,272,000 procedures in 2011, although there appears to be some retreat from the high point in 2007. Circumcision remained relatively stable during the 11-year period at about 1,200,000 procedures each year.<sup>7</sup>

**Figure 7. Delivery and newborn operating room procedures, 2001–2011**



Note: Percentage differences presented in the figure refer to changes in procedure volume between 2001 and 2011.

Source: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), Nationwide Inpatient Sample (NIS), 2001–2011

<sup>7</sup> Non-neonatal circumcisions represent fewer than 1 percent of all OR circumcision procedures and were excluded from Figure 7.

## Data Source

The estimates in this Statistical Brief are based upon data from the Healthcare Cost and Utilization Project (HCUP) 2001 through 2011 Nationwide Inpatient Sample (NIS). Estimates of the volume for selected operating room (OR) procedures were taken from HCUPnet, the online query system that provides free access to information from HCUP: <http://hcupnet.ahrq.gov/>. HCUPnet provides the ability to retrieve health statistics and information on hospital inpatient and emergency department utilization. For the purposes of this Statistical Brief, the number of OR procedures is reported to the nearest hundred.

Many hypothesis tests were conducted for this Statistical Brief. Thus, to decrease the number of false-positive results, we reduced the significance level to .001 for individual tests.

## Definitions

### *Procedures, ICD-9-CM, and Clinical Classifications Software (CCS)*

*All-listed procedures* include all procedures performed during the hospital stay, whether for definitive treatment or for diagnostic or exploratory purposes. ICD-9-CM is the International Classification of Diseases, Ninth Revision, Clinical Modification, which assigns numeric codes to procedures. There are about 4,000 ICD-9-CM procedure codes.

CCS categorizes procedure codes into clinically meaningful categories.<sup>8</sup> This "clinical grouper" makes it easier to quickly understand patterns of procedure use. CCS categories identified as "Other" typically are not reported; these categories include miscellaneous, otherwise unclassifiable procedures that may be difficult to interpret as a group.

Major OR procedures were defined using procedure classes, which categorize each ICD-9-CM procedure code as either major therapeutic, major diagnostic, minor therapeutic, or minor diagnostic.<sup>9</sup>

Table 2 lists the specific CCS procedure categories and clinical body systems for the selected OR procedures presented in the trend figures in this Statistical Brief.

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<sup>8</sup> HCUP Clinical Classifications Software (CCS). Healthcare Cost and Utilization Project (HCUP). U.S. Agency for Healthcare Research and Quality, Rockville, MD. Updated March 2013. <http://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp>. Accessed December 4, 2013.

<sup>9</sup> HCUP Procedure Classes. Healthcare Cost and Utilization Project (HCUP). U.S. Agency for Healthcare Research and Quality, Rockville, MD. Updated August 30, 2012. <http://www.hcup-us.ahrq.gov/toolssoftware/procedure/procedure.jsp>. Accessed December 4, 2013.

**Table 2. Clinical Classifications Software procedure category and clinical body system for selected operating room (OR) procedures presented in trend figures**

Trend figure	CCS procedure category	Clinical body system
Figure 1: Orthopedic OR procedures	152: Arthroplasty knee	Musculoskeletal system
	153: Hip replacement, total and partial	Musculoskeletal system
Figure 2: Back-related OR procedures	3: Laminectomy	Nervous system
	158: Spinal fusion	Musculoskeletal system
Figure 3: Digestive-related OR procedures	78: Colorectal resection	Digestive system
	80: Appendectomy	Digestive system
	84: Cholecystectomy and common duct exploration	Digestive system
Figure 4: Heart-related OR procedures	43: Heart valve procedures	Cardiovascular system
	44: Coronary artery bypass graft (CABG)	Cardiovascular system
	45: Percutaneous coronary angioplasty (PTCA)	Cardiovascular system
	48: Cardiac pacemaker or cardioverter/defibrillator procedures	Cardiovascular system
Figure 5: Other vascular OR procedures	51: Endarterectomy, vessel of head and neck	Cardiovascular system
	55: Peripheral vascular bypass	Cardiovascular system
Figure 6: OR procedures related to female genital organs	119: Oophorectomy, unilateral and bilateral	Female genital organs
	121: Ligation of fallopian tubes	Female genital organs
	124: Hysterectomy, abdominal and vaginal	Female genital organs
	129: Repair of bladder or rectal hernia	Female genital organs
Figure 7: Delivery and newborn OR procedures	115: Circumcision	Male genital organs
	134: Cesarean section	Obstetrical procedures

#### *Types of hospitals included in HCUP*

HCUP is based on data from community hospitals, which are defined as short-term, non-Federal, general, and other hospitals, excluding hospital units of other institutions (e.g., prisons). HCUP data include obstetrics and gynecology, otolaryngology, orthopedic, cancer, pediatric, public, and academic medical hospitals. Excluded are long-term care, rehabilitation, psychiatric, and alcoholism and chemical dependency hospitals. However, if a patient received long-term care, rehabilitation, or treatment for psychiatric or chemical dependency conditions in a community hospital, the discharge record for that stay will be included in the Nationwide Inpatient Sample (NIS).

#### *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 one year will be counted each time as a separate "discharge" from the hospital.

#### **About HCUP**

HCUP is a family of powerful health care databases, software tools, and products for advancing research. Sponsored by the Agency for Healthcare Research and Quality (AHRQ), HCUP includes the largest all-payer encounter-level collection of longitudinal health care data (inpatient, ambulatory surgery, and emergency department) in the United States, beginning in 1988. HCUP is a Federal-State-Industry Partnership that brings together the data collection efforts of many organizations—such as State data organizations, hospital associations, private data organizations, and the Federal government—to create a national information resource.

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

**Alaska** State Hospital and Nursing Home Association  
**Arizona** Department of Health Services  
**Arkansas** Department of Health  
**California** Office of Statewide Health Planning and Development  
**Colorado** Hospital Association  
**Connecticut** Hospital Association  
**Florida** Agency for Health Care Administration  
**Georgia** Hospital Association  
**Hawaii** Health Information Corporation  
**Illinois** Department of Public Health  
**Indiana** Hospital Association  
**Iowa** Hospital Association  
**Kansas** Hospital Association  
**Kentucky** Cabinet for Health and Family Services  
**Louisiana** Department of Health and Hospitals  
**Maine** Health Data Organization  
**Maryland** Health Services Cost Review Commission  
**Massachusetts** Center for Health Information and Analysis  
**Michigan** Health & Hospital Association  
**Minnesota** Hospital Association  
**Mississippi** Department of Health  
**Missouri** Hospital Industry Data Institute  
**Montana** MHA - An Association of Montana Health Care Providers  
**Nebraska** Hospital Association  
**Nevada** Department of Health and Human Services  
**New Hampshire** Department of Health & Human Services  
**New Jersey** Department of Health  
**New Mexico** Department of Health  
**New York** State Department of Health  
**North Carolina** Department of Health and Human Services  
**North Dakota** (data provided by the Minnesota Hospital Association)  
**Ohio** Hospital Association  
**Oklahoma** State Department of Health  
**Oregon** Association of Hospitals and Health Systems  
**Oregon** Health Policy and Research  
**Pennsylvania** Health Care Cost Containment Council  
**Rhode Island** Department of Health  
**South Carolina** Budget & Control Board  
**South Dakota** Association of Healthcare Organizations  
**Tennessee** Hospital Association  
**Texas** Department of State Health Services  
**Utah** Department of Health  
**Vermont** Association of Hospitals and Health Systems  
**Virginia** Health Information  
**Washington** State Department of Health  
**West Virginia** Health Care Authority  
**Wisconsin** Department of Health Services  
**Wyoming** Hospital Association

## About the NIS

The HCUP 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 is a sample of hospitals and includes all patients from each hospital, regardless of payer. It is drawn from a sampling frame that contains hospitals comprising more than 95 percent of all discharges in the United States. The vast size of the NIS allows the study of topics at both the national and regional levels for specific subgroups of patients. In addition, NIS data are standardized across years to facilitate ease of use.

## About HCUPnet

HCUPnet is an online query system that offers instant access to the largest set of all-payer health care databases publicly available. HCUPnet has an easy step-by-step query system, allowing for tables and graphs to be generated on national and regional statistics as well as trends for community hospitals in the United States. HCUPnet generates statistics using data from HCUP's Nationwide Inpatient Sample (NIS), the Kids' Inpatient Database (KID), the Nationwide Emergency Department Sample (NEDS), the State Inpatient Databases (SID), and the State Emergency Department Databases (SEDD).

## For More Information

For more information about HCUP, visit <http://www.hcup-us.ahrq.gov/>.

For additional HCUP statistics, visit HCUPnet, our interactive query system, at <http://hcupnet.ahrq.gov/>.

For information on other hospitalizations in the United States, refer to the following HCUP Statistical Briefs located at <http://www.hcup-us.ahrq.gov/reports/statbriefs/statbriefs.jsp>:

- Statistical Brief #144, Overview of Hospital Stays in the United States, 2010
- Statistical Brief #146, Costs for Hospital Stays in the United States 2010
- Statistical Brief #148, Most Frequent Conditions in U.S. Hospitals, 2010
- Statistical Brief #149, Most Frequent Procedures Performed in U.S. Hospitals, 2010

For a detailed description of HCUP, more information on the design of the Nationwide Inpatient Sample (NIS), and methods to calculate estimates, please refer to the following publications:

Introduction to the HCUP Nationwide Inpatient Sample, 2009. Online. May 2011. U.S. Agency for Healthcare Research and Quality. [http://hcup-us.ahrq.gov/db/nation/nis/NIS\\_2009\\_INTRODUCTION.pdf](http://hcup-us.ahrq.gov/db/nation/nis/NIS_2009_INTRODUCTION.pdf). Accessed December 4, 2013.

Houchens R, Elixhauser A. Final Report on Calculating Nationwide Inpatient Sample (NIS) Variances, 2001. HCUP Methods Series Report #2003-2. Online. June 2005 (revised June 6, 2005). U.S. Agency for Healthcare Research and Quality. <http://www.hcup-us.ahrq.gov/reports/CalculatingNISVariances200106092005.pdf>. Accessed December 4, 2013.

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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 health care 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 e-mail us at [hcup@ahrq.gov](mailto:hcup@ahrq.gov) or send a letter to the address below:

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