

# Trends in inpatient urinary incontinence surgery in the USA, 1998–2007

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## Abstract

**Introduction and hypothesis** This study was conducted to assess national rates in stress urinary incontinence (SUI) surgery in the USA from 1998 to 2007.

**Methods** We utilized the 1998–2007 Nationwide Inpatient Sample and assessed women aged 20 years and older who underwent SUI surgery based on the International Classification of Diseases, 9th Revision (ICD-9) procedure and diagnosis codes.

**Results** The total number of SUI surgeries performed during this 10-year period was 759,821. The annual number

of procedures increased from 37,953 in 1998 to 94,910 in 2007. The type of SUI surgery performed also changed ( $p < 0.001$ ). In 1998, retropubic suspensions represented 52.3%, decreasing to 13.8% in 2007. “Other repair of SUI” (ICD-9 59.79) comprised 22.4% in 1998, increasing to 75.2% in 2007, likely representing midurethral slings.

**Conclusions** The total number and incidence rates of SUI surgeries have increased from 1998 to 2007. The type of SUI surgery performed has also changed significantly, likely secondary to adoption of midurethral slings.

**Keywords** Stress urinary incontinence · Surgical procedures · Therapy · Trends

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## Introduction

Urinary incontinence is a prevalent condition with 16% of women suffering from bothersome leakage of urine [1]. This prevalence increases dramatically with age, and by 80 years, one third of all women will have significant symptoms. Urinary incontinence will become an even greater public health concern in the future, as the elderly population is expected to more than double from 38.7 million in 2008 to 88.5 million by 2050 [2].

Treatment for stress urinary incontinence (SUI) includes both nonsurgical and surgical options. Although numerous incontinence surgeries have been variably popular in recent decades, retropubic colposuspensions and traditional bladder neck slings have proven long-term efficacy [3]. However, these two procedures are not minimally invasive and require an abdominal incision. The midurethral mesh sling, a minimally invasive procedure that can be performed quickly with comparable outcomes to the Burch colposuspension [4], is now considered by many

in the USA to be the new gold standard since its introduction in the USA 10 years ago [5].

Surgery for SUI has become more widely utilized [6, 7]. Two studies of US trends using the National Hospital Discharge Survey (NHDS) found that the total number of urinary incontinence procedures increased from 33,000 in 1979 to 84,000 in 1997 [6] and then to 103,467 in 2004 [8]. Furthermore, outpatient SUI surgery has increased from 34,968 in 1996 to 105,656 in 2006 [9]. While the NHDS provides national data, it is not as comprehensive as the Nationwide Inpatient Sample (NIS). For example, the 2004 NDHS includes 370,785 discharges from 439 hospitals [10] versus 8,004,571 discharges from 1,044 hospitals in the 2004 NIS [11]. Thus, evaluating trends through 2007 using the NIS may offer additional and more accurate insight into national practices. Furthermore, we will be able to assess whether or not the increasing number of outpatient procedures was reflected as a decrease in inpatient procedures.

Accurate information about the current numbers and types of SUI surgery in the USA will enable our field to assess the demand for skilled surgeons or understand the priority of training future gynecologists and urogynecologists. Without data regarding the type of surgeries being performed, we do not have nationally representative data to support the anecdotal impression that evidence-based surgeries like the midurethral sling have become widely adopted and ineffective surgeries such as Kelly plications and needle suspensions are no longer being performed. Lastly, given the higher prevalence of SUI in the elderly and more readily available minimally invasive techniques, we wanted to evaluate whether contemporary surgeons are performing surgical therapy on older women (despite the fact that they may have more comorbidities) than they have in previous years. Thus, the objectives of this study were to assess the national trends in inpatient surgical procedures for stress urinary incontinence from 1998 to 2007 and to evaluate whether the rates of surgery differ by demographic factors such as age using the Nationwide Inpatient Sample.

## Materials and methods

We used the NIS as source data regarding inpatient surgeries for SUI [11]. The NIS is the largest publicly available database of hospital discharges in the USA. It contains data on five to eight million hospital discharges from approximately 1,000 hospitals, which are sampled randomly to yield a 20% stratified sample of US community hospital discharges. We elected to analyze the NIS dataset from 1998 to 2007 because the sampling and weighting strategy for the NIS changed in 1998.

Procedures and diagnoses were based on the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes. Each discharge in the NIS contains up to 15 procedure and 15 diagnosis codes. For this analysis, we included any discharge with both a urinary incontinence diagnosis and any SUI surgery procedure code. SUI procedure codes included the following: 59.3 plication of the urethrovesical junction, 59.4 suprapubic sling operation, 59.5 retropubic urethral suspension, 59.6 paraurethral suspension, 59.70 or 59.79 other repair of SUI, 59.71 levator muscle operation for urethrovesical suspension, or 59.72 injection of implant. The following ICD-9 diagnosis codes were used to confirm a diagnosis of urinary incontinence: 625.6 stress urinary incontinence, 599.82 intrinsic sphincter deficiency, 788.30 or 788.39 other urinary incontinence, 788.33 mixed incontinence, 788.34 incontinence without sensory awareness, or 788.37 continuous leakage.

We included female subjects who were 20 years or older and excluded women with a diagnosis of gynecologic, colorectal, or urologic malignancy. We abstracted data regarding age, race, primary payor, and length of stay. Hospital characteristics included geographic region (Northeast, Midwest, South, or West), location and teaching status (rural, urban non-teaching, or urban teaching), and hospital bed size (small, medium, and large).

Given the complex sampling design of the NIS, we used STATA 9.1 (StataCorp, College Station, TX, USA) to account for sampling weights, strata, and clusters. In addition, our research questions were formulated using the question diagram templates developed by Pietrobon et al. [12]. For each year from 1998 to 2007, we used the sampling weights provided in the NIS database to estimate and examine the total number and the type of SUI surgery performed. Crude and age-adjusted incidence rates were then calculated based on population data from the US Census Bureau [13]. For crude rates, the total number of SUI surgeries in a particular year was divided by the number of women aged 20 years or older in the same year. For age-adjusted rates, women were divided into 20-year age cohorts (ages 20–39, 40–59, 60–79, and  $\geq 80$  years), and age-adjusted rates were calculated using a direct method of standardization based on the published 2000 US Census adjustment weights by age [14]. By standardizing the data in this fashion, we adjusted for the potential impact of different age distributions during the study period. Rates of SUI surgeries over the study period were assessed using chi-square test for linear trends. We also assessed the crude incidence rate of surgery between elderly (age  $\geq 65$ ) and non-elderly. This study was exempt from institutional review board review because only publicly available data were analyzed.

## Results

From 1998 to 2007, a total of 759,821 women underwent inpatient surgery for SUI. The total number of procedures per year increased from 37,953 in 1998 to 94,910 in 2007 (Table 1 and Fig. 1). A dramatic increase was seen from 2001 to 2002 with surgeries increasing from 34,584 to 117,235 annually. The crude incidence rates of inpatient SUI surgeries also increased during the entire study period from 37.2 to 84.3 per 100,000 women ( $p < 0.0001$ ) with a similar marked increase from 2001 to 2002 (Table 1). The age-adjusted rates are also presented in Table 1.

In 1998, the most common procedure was retropubic urethral suspension (52.3%) followed by “other repair of SUI” (22.4%) (Table 2). This finding had reversed by 2007, when the most common procedure was “other repair of SUI” (75.2%) followed by retropubic procedures (13.8%) (“other repair of SUI” represents the ICD-9 procedure code 59.79) (Table 2 and Fig. 1). Suprapubic slings remained the third most common procedure at 15.8% in 1998 and 8.2% in 2007. Notably, both paraurethral (needle) suspensions and plication of the urethrovesical junction (Kelly plication) decreased to 1.1% and 0.7% cases in 2007.

Women undergoing SUI surgery were similarly aged in 1998 and 2007 (Table 3). When age was dichotomized between non-elderly ( $\leq 65$  years) and elderly ( $> 65$  years), a similar proportion of elderly women underwent surgery during these two periods. We assessed crude incidence rates in the non-elderly and elderly over the study period and noted that the rates in the elderly remained consistently higher than those in the non-elderly (Fig. 2). By 2007, the crude rates in non-elderly and elderly were 74.8 and 123.4 per 100,000 women, respectively. In terms of the types of SUI surgeries performed in the non-elderly versus the elderly, similar overall trends were seen in women  $\geq 65$  compared to the national trends, with an increase of “other repair of SUI” from 27.5% to 81.4% of procedures and a decrease of retropubic procedures from 40.2% to 7.5%

when comparing 1998 to 2007. Caucasians were the most common racial group undergoing inpatient SUI surgery throughout the study period, whereas Hispanic women comprised 6.3% in 1998 and increased to 12.4% of inpatient SUI surgeries in 2007 (Table 3). Because some states do not collect race data for the NIS, race is shown as “missing” for 21.0–26.5% of the study cohort. We found that SUI procedures were performed in similar hospital settings in 1998 and 2007. A majority of surgeries were performed in hospitals with a large number of beds and in urban non-teaching and urban teaching hospitals (Table 3). The highest number of surgeries was performed in the South and the fewest in the Northeast, with little change over the study period.

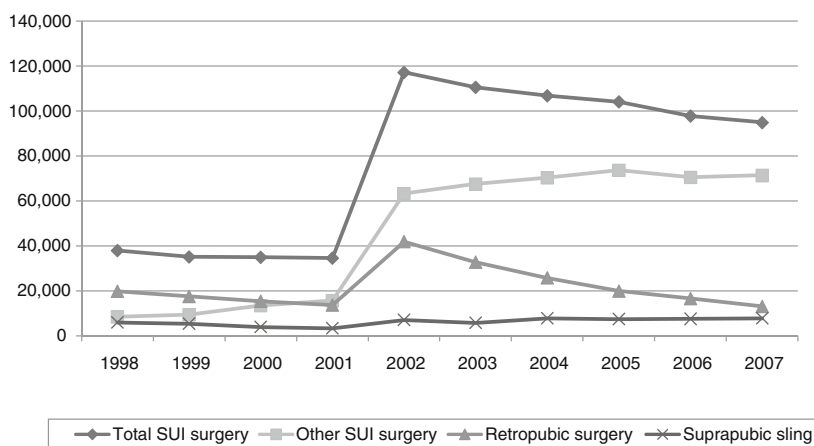
## Discussion

Based on the Nationwide Inpatient Sample database, the number and rates of inpatient surgeries for urinary incontinence in women have increased during the time period from 1998 to 2007. In the last several years prior to this report, the annual number of women who underwent inpatient SUI surgery is over 90,000. We found that the type of SUI surgery most frequently performed has changed dramatically, with a pronounced shift toward “other repair of SUI” in 75% of cases and that the surgical rate in the elderly is higher than that in the non-elderly.

These estimates are fairly similar to those of prior studies of urogynecologic procedures using national databases. Using the NHDS data, Shah et al. [6, 15] found that 130,000 women had inpatient SUI surgery in 2003 and Oliphant et al. [8] reported that this estimate was 103,467 in 2004. As the NIS reflects over twice the number of hospitals as the NHDS (1,044 versus 439 in 2004) and over 20 times the number of discharges (8,004,571 versus 370,785 in 2004), we believe that evaluating national trends using the NIS is particularly valuable [16].

**Table 1** Inpatient surgery for urinary incontinence in the USA from 1998 to 2007

Year	No. of women	Crude rate per 100,000 women	Age-adjusted rate per 100,000 women
1998	37,953	37.2	37.5
1999	35,113	34.1	34.2
2000	34,951	33.5	33.4
2001	34,584	32.8	32.5
2002	117,235	109.8	108.5
2003	110,620	102.4	100.8
2004	106,862	97.9	95.9
2005	104,160	94.5	92.2
2006	97,839	87.8	85.2
2007	94,910	84.3	81.6



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
<b>Total SUI surgery</b>	37,953	35,113	34,951	34,584	117,235	110,620	106,862	104,160	97,839	94,910
<b>Other SUI surgery</b>	8,491	9,472	13,541	15,772	63,322	67,675	70,411	73,704	70,520	71,412
<b>Retropubic surgery</b>	19,850	17,534	15,417	13,731	41,873	32,742	25,805	19,928	16,591	13,115
<b>Suprapubic sling</b>	6,012	5,375	3,853	3,349	7,077	5,736	7,769	7,471	7,526	7,782

**Fig. 1** Total number of stress urinary incontinence inpatient surgeries and different types of SUI surgeries in the USA based on the Nationwide Inpatient Sample data from 1998 to 2007

Regarding differences in the type of SUI surgery performed in 1998 versus 2007, it was encouraging to see that the proportion of paraurethral/needle suspensions and Kelly plications (urethrovesical plications) were low in 1998 and still lower by 2007, as studies have shown that these two procedures are not effective for long-term treatment of SUI [17–19]. In contrast, retropubic colposuspensions, traditional bladder neck slings, and midurethral slings are effective procedures for urinary incontinence [4, 20, 21]. While effective, Burch colposuspensions declined from 52.3% of procedures in 1998 to 13.8% of procedures

in 2007, likely because of the wide adoption of the midurethral sling by clinicians. Unfortunately, there is no specific ICD-9 procedure code for a midurethral sling; midurethral slings can be coded as ICD-9 59.79 (“other repair of SUI”) or 59.4 (suprapubic sling). Given the fact that the proportion of “other repair of SUI” increased dramatically to 75.2% of all procedures in 2007 and suprapubic slings remained relatively low at 8.2%, we strongly suspect that this shift can be attributed to the adoption of midurethral slings in the USA and that midurethral slings are being coded as 59.79.

**Table 2** Inpatient stress incontinence procedures, 1998 versus 2007

Surgical procedures	1998		2007	
	N (%)	95% CI	N (%)	95% CI
Total number of SUI surgeries	37,953	33,911–41,995	94,910	84,982–104,383
Type of SUI surgery [ICD-9 code]				
Retropubic urethral suspension [59.5]	19,850 (52.3%)	17,526–22,174	13,115 (13.8%)	11,054–15,175
Other repair of SUI [59.79]	8,491 (22.4%)	7,202–9,780	71,412 (75.2%)	63,293–79,530
Suprapubic sling [59.4]	6,011 (15.8%)	4,858–7,165	7,782 (8.2%)	6,427–9,137
Paraurethral suspension [59.6]	1,271 (3.4%)	939–1,603	1,074 (1.1%)	505–1,644
Plication of the urethrovesical junction [59.3]	820 (2.2%)	513–1,126	649 (0.7%)	426–871
Levator muscle for urethrovesical suspension [59.71]	1,305 (3.4%)	1,025–1,585	681 (0.7%)	475–886
Injection [59.72]	205 (0.5%)	113–297	199 (0.2%)	115–282

SUI stress urinary incontinence, ICD International Classification of Diseases

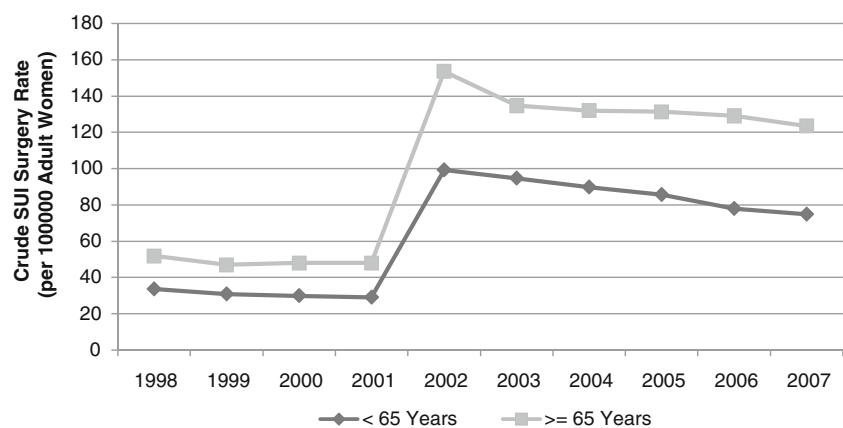
**Table 3** Patient demographics and hospital characteristics for SUI surgeries, 1998 versus 2007

Characteristic	1998, n=37,953	2007, n=94,910
Age (years)	55.5±0.2	55.6±0.2
Women <65	27,374 (72.1)	67,836 (71.5)
Women ≥65	10,579 (27.9)	27,074 (28.5)
Race		
White	25,101 (87.7)	53,604 (79.5)
Black	997 (3.5)	2,484 (3.7)
Hispanic	1,789 (6.3)	8,384 (12.4)
Other	739 (2.6)	2,947 (4.4)
Insurance type		
Medicare	10,444 (27.6)	26,800 (28.3)
Medicaid	2,190 (5.8)	5,116 (5.4)
Private/HMO	23,741 (62.8)	57,911 (61.1)
Other	1,437 (3.8)	4,884 (5.2)
Hospital bed size		
Small	3,790 (10.0)	11,639 (12.3)
Medium	10,722 (28.3)	21,876 (23.1)
Large	23,442 (61.8)	61,165 (64.6)
Hospital type		
Rural	5,794 (15.3)	11,017 (11.6)
Urban, non-teaching	15,597 (41.1)	43,978 (46.4)
Urban, teaching	16,561 (43.6)	39,685 (41.9)
Region		
Northeast	5,957 (15.7)	13,864 (14.6)
Midwest	8,451 (22.3)	23,448 (24.7)
South	14,880 (39.2)	35,383 (37.3)
West	8,665 (22.8)	22,214 (23.4)

Percentages are based on the number of subjects with data for each variable

We noted a dramatic increase from 2001 to 2002 in both the total number of SUI surgeries and the number of “other repair of SUI” (Fig. 1). We postulate that characteristics of a midurethral sling (minimally invasive, short operating time,

reasonable adverse event profile, and promising effectiveness data) may have encouraged providers who were not previously performing SUI surgeries to start performing this anti-incontinence procedure. We have attributed this increase to midurethral slings because of the timing of the following events: (1) in 1998, the FDA approved of the first midurethral sling, the tension-free vaginal tape (TVT) [5]; (2) in 2001, long-term 5-year data for the TVT were published that reported 84.7% subjective and objective cure rates with an additional 10.6% with significant improvement [22]; and (3) in 2002, the Ward and Hilton [23] randomized trial of Burch colposuspension and TVT found no significant differences in cure rates at 6 months. The timing of these events correlates well with the increase in “other repair of SUI” surgery, which shows a dramatic increase from 2001 to 2002 and then a more gradual increase after 2002. Interestingly, the trend of a dramatic increase in SUI surgeries after the introduction of the midurethral slings has been documented in other countries. In Australia, SUI surgeries almost doubled during the 3-year period after the introduction of midurethral sling [24], and in Belgium, there was a fourfold increase in the rate of surgery from 1997 to 2004, with this increase coinciding with the introduction of the TVT [25]. In contrast, there has not been a dramatic increase in SUI surgeries in Taiwan, and in 2005, slightly more retropubic procedures were performed compared to midurethral slings, 993 versus 819, respectively [26]. Given the growing elderly population in the USA, we wanted to compare surgery rates in the non-elderly versus elderly. Although the elderly population is at higher risk for morbidity and mortality from urogynecologic surgery [27], the rate of SUI surgery has been and remains higher in the elderly. This higher rate is likely secondary to a higher prevalence of urinary incontinence in older women [1]. With the changing demographics in the USA, it is likely that the total number of SUI surgeries will continue to increase in the future unless improved preventative strategies are developed.

**Fig. 2** Crude rates for SUI inpatient surgery in non-elderly (age <65) versus elderly (age ≥65) from 1998 to 2007

The strengths of this study include the fact that we used a national US database, which is more representative and generalizable than local or regional data. In addition, we chose the Nationwide Inpatient Sample over the National Hospital Discharge Survey database which represents a greater number of hospitals and discharges and thus likely provides more accurate national estimates. Furthermore, we assessed trends in SUI surgery over 10 years instead of evaluating surgeries in just 1 year.

One of the limitations of this study is that by using the NIS, we are only able to account for inpatient procedures. The NIS does not include any outpatient procedural data. As of August 2009, the 2006 National Survey of Ambulatory Surgery was released, and Erikson et al. reported that 105,656 (95% CI 79,033–132,279) were performed in 2006 compared to 34,968 in 1996 [9]. They did not discuss the different types of SUI surgeries performed, but these data suggest that the number of SUI surgeries, both inpatient and outpatient in 2006, was 203,495 (97,839 inpatient+105,656 outpatient). Thus, the total number of SUI surgeries performed in the USA is likely almost double those presented in this study when outpatient procedures are considered. Although there has been a dramatic increase in the number of outpatient SUI surgeries, the number of inpatient procedures has only decreased slightly from a high of 117,235 in 2002 to 94,910 in 2007.

Another limitation of our study is that the NIS uses ICD-9 codes, and there is not a specific code for midurethral slings. Although we suspect that these slings are the most common procedure currently performed, we cannot definitively prove this based solely on ICD-9 codes. However, our conclusion is based on the significant increase in “other repair of SUI” and the timing of this increase, which occurred after several key events regarding the TVT. Because the two largest national discharge databases, NHDS and NIS, both utilize ICD-9 codes, one important consideration will be to develop specific codes that reflect specific procedures such as the midurethral sling.

This study of the National Inpatient Sample demonstrates dramatic trends in inpatient SUI surgery in the USA, with over 90,000 procedures annually, and an incidence rate which has increased from 37.2 to 84.3 per 100,000 women. An increase in the rate of surgery was demonstrated both in the non-elderly as well as the elderly. Given the growing proportion of the elderly in the USA, it will be critical to train sufficient numbers of gynecologists and urogynecologists to care for women of all ages who suffer from stress urinary incontinence.

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**Conflicts of interest** None.

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