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Original Article

Emergency Department Utilization for Adnexal Torsion: An Analysis of the Nationwide Emergency Department Sample from 2006 to 2018

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ABSTRACT **Study Objective:** To characterize emergency department (ED) utilization for adnexal torsion (AT) among adult patients in the United States.

Design: Retrospective analysis to identify primary AT diagnoses and ED utilization. Other variables analyzed included primary payer type, income quartile by ZIP code, hospital teaching status, and urban vs rural location. Secondary analyses identified diagnosis codes associated with a primary diagnosis of AT.

Setting: Healthcare Cost and Utilization Project Nationwide Emergency Sample database.

Patients: Women aged 18 to 65 years presenting to the ED with AT from 2006 to 2018.

Interventions: Not applicable.

Measurements and Main Results: From 2006 to 2018, the annual number of ED visits for AT among women aged 18 to 65 years increased from 2791 to 5243. Hospital admission rates for AT declined over the study period from 76% to 37%. Patients with AT were less likely to be admitted if they had private insurance, but admission rates for AT were similar regardless of income quartile and hospital teaching status. Average ED charges for AT nearly quadrupled over the study period compared with ED charges overall, which doubled. The average charge for AT patients in 2006 was $5212 and in 2018 was $20 213—an average annual increase of 24.0%, compared with 14.3% for all other diagnoses in age-matched women.

Conclusion: Although admission rates for AT decreased by 50% from 2006 to 2018, ED utilization nearly doubled, and the average associated charges quadrupled, summing to an annual weighted charge of over $500 million by 2018. The data suggest that women are evaluated similarly for AT regardless of income or insurance status. Journal of Minimally Invasive Gynecology (2022) 29, 1068−1074. © 2022 Published by Elsevier Inc. on behalf of AAGL.

Keywords: Emergency room; Laparoscopy; Ovarian torsion

Adnexal torsion (AT) is a condition in which the ovary, fallopian tube, or both rotate around their ligamentous axis, causing adnexal edema, ischemia, and inflammation. Early diagnosis and surgery are essential to protect ovarian and tubal function by preventing irreversible necrosis. AT is the fifth leading cause of gynecologic emergencies [1], with an estimated prevalence of 2% to 7% among women undergoing surgery for acute pelvic pain [2,3]. It can occur in

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This study has been presented as an abstract virtually at the American Society for Reproductive Medicine's Scientific Congress, October 17, 2020.

The University of Michigan Institutional Review Board reviewed this study (HUM00126946) on October 4, 2017, and determined that it was exempt because the data are deidentified and publicly available.

Data are available from the corresponding author upon reasonable request

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women of all ages, although approximately 80% of women with AT are reproductive-aged [4,5].

Presenting symptoms include severe pain, nausea, vomiting, and fever, which are nonspecific and frequently seen in other gynecologic and nongynecologic conditions [6−8]. Pelvic ultrasound is the first-line imaging modality for AT, although computed tomography and magnetic resonance imaging can help facilitate the diagnosis. Despite the low presurgical diagnostic accuracy of AT of 10% to 50% [5,9−12], urgent surgical detorsion successfully preserves ovarian function in over 90% of cases [13].

Given the time sensitivity and implications of undiagnosed AT, it is a surgical emergency primarily diagnosed in the emergency department (ED); however, little is known about ED utilization for this condition. While other studies have examined ED utilization for AT, they have either focused on pediatric populations [14,15] or have been limited to a single institution [5,11,16−18]. The purpose of this study was to characterize use of United States EDs for adult patients diagnosed with AT and to identify commonly associated conditions.

Materials and Methods

We conducted a retrospective analysis of the Nationwide Emergency Department Sample (NEDS) developed by the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality. Currently, the NEDS dataset includes over 30 million observations of ED visits from 990 hospitals across the United States, estimating a 20% stratified sample of United States hospital-based EDs. The weighted sample represents roughly 143 million ED visits annually [19].

International Classification of Diseases (ICD)-9 and ICD-10 codes were used to identify women aged 18 to 65 years who were seen in the ED with a primary diagnosis of AT from January 1, 2006, through December 31, 2018. Specifically, ICD-9 code 620.5 and ICD-10 codes N83.51, N83.511, N83.512, N83.519, N83.52, N83.521, N83.522, N83.529, and N83.53 were used, which identify patients with torsion of the ovary, ovarian pedicle, or fallopian tube. ICD-9 codes were reported in NEDS from 2006 through the third quarter of 2015, while ICD-10 codes were reported from the fourth quarter of 2015 through 2018. Data with <10 patients were excluded from tables, as per HCUP protocol.

Our analysis applied the NEDS complex survey design, which included post-stratification based on several characteristics: United States census region, trauma center designation, urban-rural location of the hospital, ownership, and teaching status.

We elected to analyze AT diagnoses among adult women 18 to 65 years of age. Therefore, females aged <18 years were excluded from analysis. To define our age cohorts, we started with young adult women aged 18 to 24 years and then used 5-year increments from ages 25 to 49. Given the decreased prevalence of AT in menopause, the final age cohort included women aged 50 to 65 years [5,11].

The mean and median ED visit charges for AT were compared with ED visits for all other diagnoses of age-/gender-matched controls across each of the study years. If ED charges were excessively low or high, the value was set to missing by NEDS. The allowable values for ED charges varied by year: 2006, $25−$50 000; 2007−2010, $100−$75 000; and 2011−2018, $100−$950 000. Missing charge values were treated as missing at random and imputed for the calculation of total charges. Age, region, income, and the presence of an AT diagnosis were included as covariates for the imputation analysis. Charges were adjusted for inflation using the Consumer Price Index (CPIAUCSL) relative to the 2018 U.S. dollar [20].

A secondary analysis was completed of the 5 most common diagnoses (grouped by condition using either ICD-9 or ICD-10 codes) associated with a primary diagnosis of AT. Descriptive statistics regarding ED utilization were obtained using SAS 9.4 (Cary, NC).

A weighted multivariable logistic regression model was used to analyze factors associated with hospital admission for AT-related visits. The patient and hospital characteristics were used as covariates in the model. The dependent variable was an indicator of ED visit admission status. The independent variables included in the logistic model were age group, region, payment type, income quartile based on ZIP code, and hospital teaching status. The logistic model estimation incorporated different weights based on national hospital stratum. We obtained estimates of regression parameters and standard errors, as well as the corresponding odds ratios (ORs) and confidence intervals (CIs) for each independent predictor.

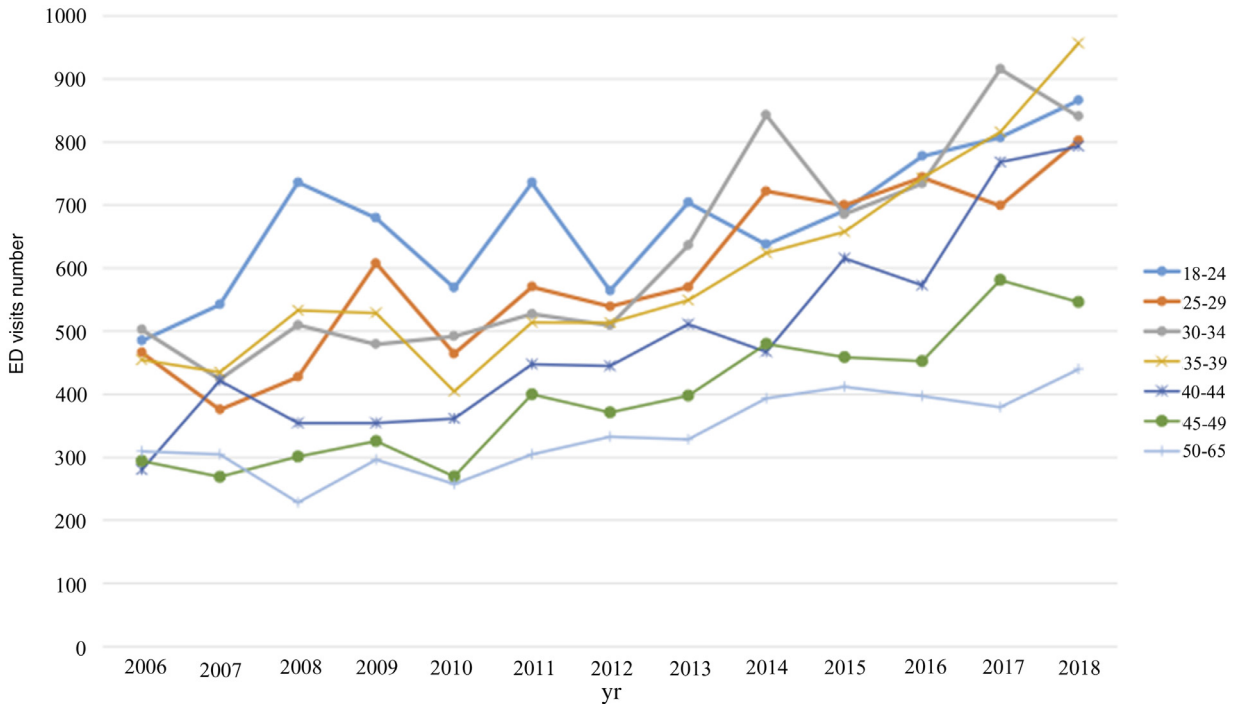
Results

During the study period, 48 222 women were diagnosed with AT, with women aged 18 to 24 constituting the largest group at 18.2% and women aged 50 to 65 constituting the smallest group at 9.1%. The annual number of patients aged 18 to 65 diagnosed with AT in the ED increased by 88%—from 2791 in 2006 to 5243 in 2018—compared with a 20% increase in total ED visits for age-matched women. The increase in women diagnosed with AT over time was uniform across all age cohorts (Fig. 1).

The proportion of patients diagnosed with AT from the bottom 50% of income based on ZIP code represented 42.8% of patients in 2006, whereas this same group had increased to represent 54.0% of AT cases by 2018. In 2006, the lowest quartile represented 19.2% of patients, the second quartile represented 23.6% of patients, the third quartile represented 25.8% of patients, and the highest quartile represented 29.1% of patients. By 2018, the distribution was 26.8%, 27.2%, 22.7%, and 21.7% by the same quartiles, respectively (Fig. 2).

Fig. 1

Yearly ED visits among women aged 18 to 65 years with primary diagnosis of adnexal torsion by age groups. ED = emergency department.



The proportion of patients diagnosed with AT who were on Medicaid increased from 13.3% in 2006 to 30.2% in 2018, whereas the percentage of patients with AT using private insurance decreased from 63.2% to 47.2% (Fig. 3).

The rate of hospital admission for patients diagnosed with AT decreased from 76.2% in 2006 to 37.4% in 2018. This decrease in admission rates for AT was significantly greater than the decrease in admission rates among all age-/gender-matched ED patients (11.2% in 2006 and 10.0% in 2018). The total number of patients admitted for AT remained relatively stable at 2126 in 2006 compared with 1963 in 2018.

Table 1 shows multivariable analysis of predictors of hospital admission. The probability of admission increased beyond the age of 44 (45−49 years: adjusted OR [aOR] 1.49; 95% CI, 1.27−1.75; p <.001; 50−65 years: aOR 2.07; 95% CI, 1.72−2.48; p <.001). ED visits for AT were most likely to result in admission in the West (aOR 2.55; 95%

Fig. 2

Yearly ED visits among women aged 18 to 65 years with primary diagnosis of adnexal torsion by ZIP code income quartile. ED = emergency department.

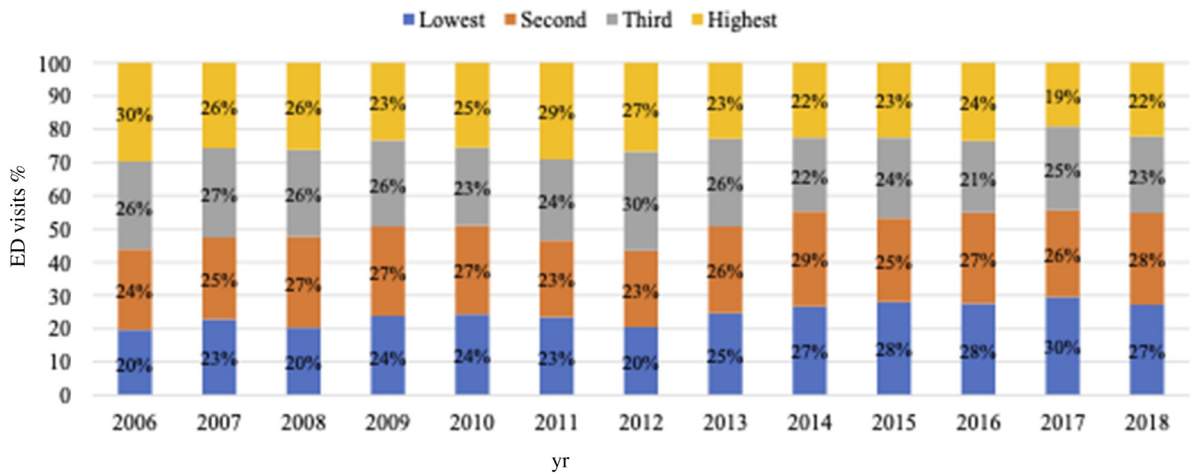
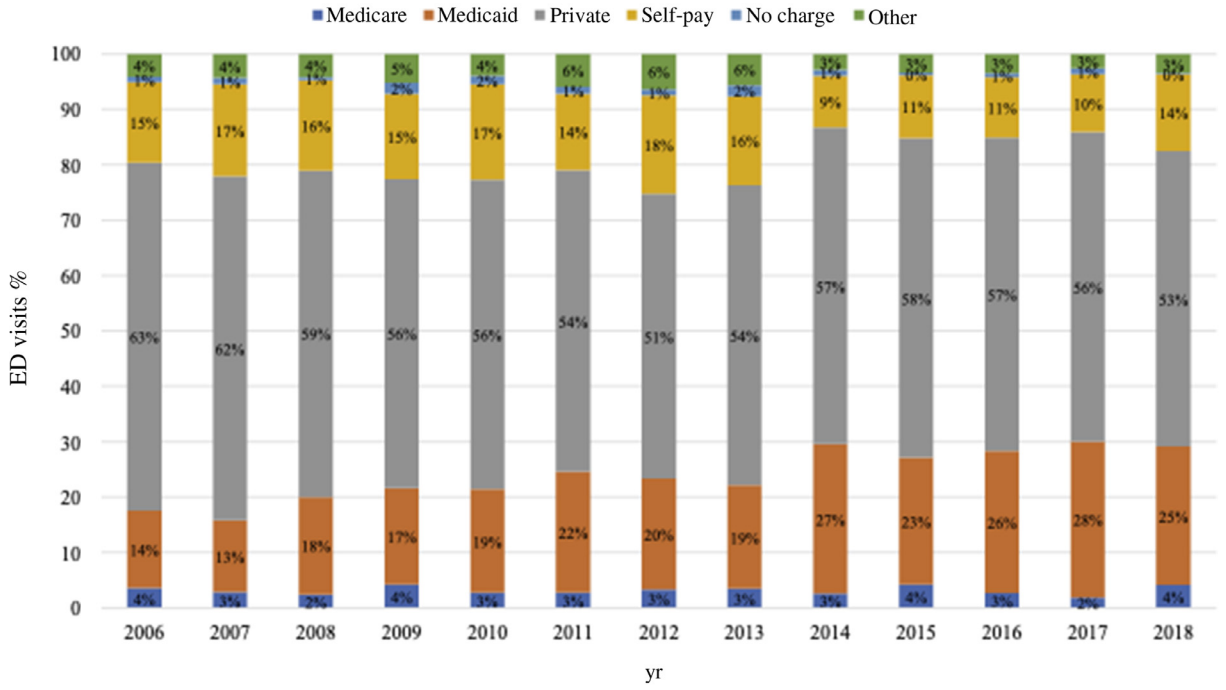


Fig. 3

Yearly ED visits among women aged 18 to 65 years with primary diagnosis of adnexal torsion by payment type. ED = emergency department.



CI, 2.15−3.02; p <.001) and least likely to result in admission in the Midwest. There were decreased odds of admission with private insurance payers (aOR 0.72; 95% CI, 0.63−0.83, p <.001) compared with self-pay, but there was no difference in admission rate based on other payer types. In addition, the odds of admission did not vary by income ZIP code quartile. Large metropolitan teaching hospitals were associated with an increased odds of admission (aOR 1.83; 95% CI, 1.53−2.19; p <.001), but there was no difference in admission rate based on hospital teaching status.

In 2006, the mean and median charges for women who presented to the ED with AT were $5212 and $1856, respectively, rising to $20 213 and $16 576 in 2018. Meanwhile, the mean and median charges for all age-matched women who presented to the ED only increased from $1791 and $1365 in 2006 to $4671 and $3115 in 2018, respectively (Fig. 4).

The most common associated secondary diagnosis was an ovarian cyst (ICD-9 = 41.4%, ICD-10 = 38.9%), and other frequently associated gynecologic diagnoses included pelvic adhesions (ICD-9 = 11.4%, ICD-10 = 9.1%), hemoperitoneum (ICD-9 = 4.1%, ICD-10 = 4.7%), and surgical absence of cervix and uterus (ICD-9 = 3.3%, ICD-10 = 8.0%). Prevalent nongynecologic secondary diagnoses included nicotine use (ICD-9 = 15.8%, ICD-10 = 15.7%), hypertension (ICD-9 = 10.8%, ICD-10 = 11.2%), and asthma (ICD-9 = 5.3%, ICD-10 = 5.7%). The top 5 secondary diagnoses associated with AT are in Table 2 (ICD-9) and Table 3 (ICD-10).

Discussion

ED usage for AT increased significantly across all United States regions during the 13-year study period. Despite increased ED utilization, admission rates for AT fell by nearly half, a trend that persisted regardless of insurance status. Admission was more likely in women aged ≥45. Average charges associated with AT also increased nearly 4-fold.

Our primary objective was to characterize utilization of EDs for women diagnosed with AT. To date, there have been extensive publications about imaging findings [1,2,13,21,22] or exam features [9,10,23] that are most predictive of torsion. The majority of publications investigating AT factors over time have been limited to a single institution [5,11,16−18]. Two studies utilized HCUP databases to describe AT at the United States population level, but they included only pediatric patients [14,15]. Our study is novel because it focuses on the adult population and includes a much longer study period of 13 years.

The 50% reduction in admission rate for AT from 2006 to 2018 is striking, especially compared with the 10% decrease in admission rate for all conditions in the ED during the same time frame among the same population. This may be due to improved detection of AT versus intermittent AT, an increase in outpatient surgical management, or perhaps both. A recent meta-analysis by Wattar et al [2] reported a pooled specificity for detecting AT of 0.76 for conventional ultrasound, which increased

Table 1

ORs of admission by variable

Effect	p value	OR	Adjusted ORs	95% CI
Hospital region				
West vs Midwest	<.001	2.70	2.55	2.15−3.02
South vs Midwest	<.001	1.28	1.23	1.07−1.42
Northeast vs Midwest	.007	2.00	1.86	1.53−2.25
Age group, yrs				
50−65 vs 18−24	<.001	1.83	2.07	1.72−2.48
45−49 vs 18−24	<.001	1.31	1.49	1.27−1.75
40−44 vs 18−24	.316	1.02	1.11	0.95−1.29
35−39 vs 18−24	.002	0.89	1.00	0.87−1.16
30−34 vs 18−24	<.001	0.87	0.93	0.81−1.08
25−29 vs 18−24	<.001	0.90	0.93	0.81−1.07
Payment type				
Private vs self-pay	<.001	0.80	0.72	0.63−0.83
Other vs self-pay	.641	0.98	0.85	0.65−1.12
Medicare vs self-pay	.068	1.30	1.10	0.82−1.47
Medicaid vs self-pay	.362	1.02	0.85	0.74−0.99
Income quartile				
Highest vs third	.003	1.05	0.89	0.77−1.01
Second vs third	.182	0.92	1.07	0.95−1.21
Lowest vs third	.016	0.97	1.13	0.99−1.29
Hospital metropolitan status				
Metro, 50,000 to < 1 million vs nonmetro	.005	1.14	1.13	0.95−1.35
Metro, ≥1 million vs nonmetro	<.001	1.87	1.83	1.53−2.19
Hospital teaching status				
Metro nonteaching + nonmetro vs metro teaching	.211	0.93	1.08	0.96−1.22

OR = odds ratio.

Fig. 4

Yearly national estimates of mean and median ED charges in 2018 U.S. Dollars for women aged 18 to 65 years by diagnosis. ED = emergency department.

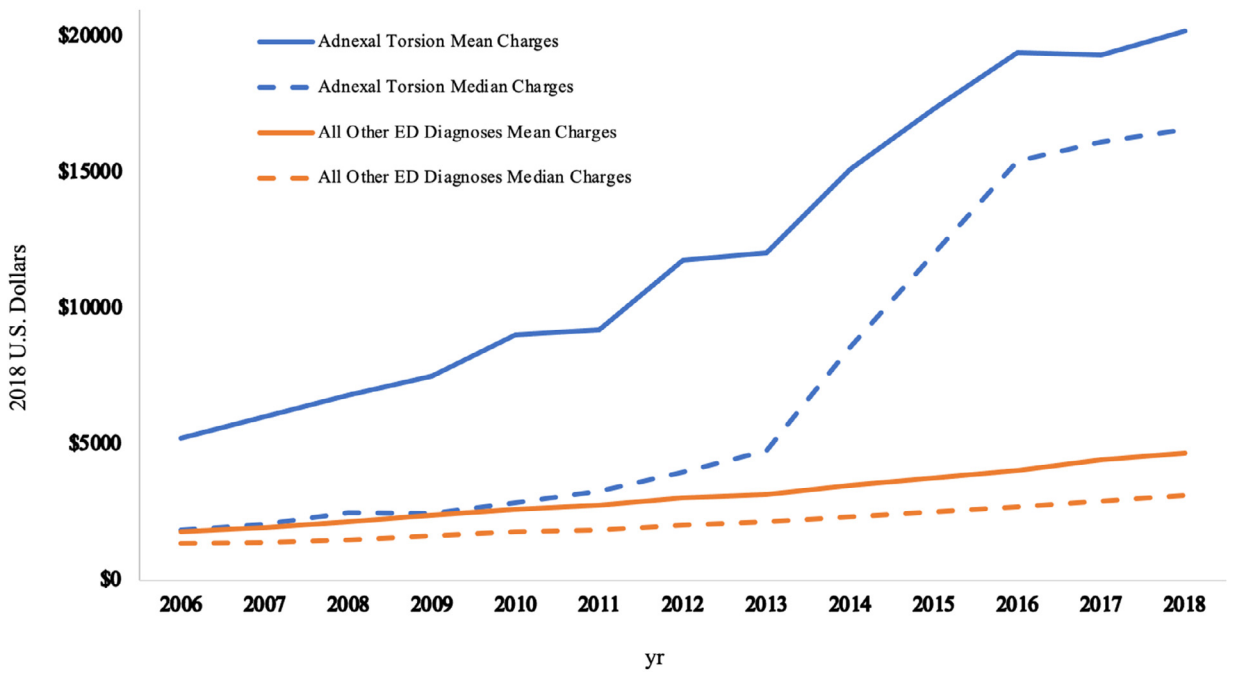


Table 2

Top 5 diagnoses associated with AT using ICD-9 codes (2006–2015)

Diagnosis	ICD-9 code	ICD-9 description	n	%
1. Ovarian cyst				41.4
	620.2	Other and unspecified ovarian cyst	9634	29.7
	220	Benign neoplasm of the ovary	3797	11.7
2. Nicotine use				15.8
	305.1	Tobacco use disorder	4480	13.8
	V15.82	Personal history of tobacco use	661	2.0
3. Pelvic/peritoneal adhesions				11.8
	614.6	Pelvic peritoneal adhesions, female (postoperative or postinfective)	2505	7.7
	568.0	Peritoneal adhesions (postoperative or postinfective)	1338	4.1
4. Hypertension	401.9	Unspecified essential hypertension	3515	10.8
5. Noninflammatory disorder of adnexal structures	620.8	Other noninflammatory disorders of the ovary, fallopian tube, and broad ligament	3043	9.4

AT = Adnexal torsion; ICD-9 = *International Classification of Diseases, Ninth Revision*.

Table 3

Top 5 diagnoses associated with AT using ICD-10 codes (2015–2018)

Diagnosis	ICD-10 code	ICD-10 Description	n	%
1. Ovarian cyst				38.9
	N83.202	Unspecified ovarian cyst, right side	1741	11.1
	N83.20	Unspecified ovarian cyst, left side	1497	9.5
	D27.0	Unspecified ovarian cyst	1085	6.9
	D27.1	Benign neoplasm of right ovary	991	6.3
	D27.9	Benign neoplasm of left ovary	770	4.9
	N83.202	Benign neoplasm of ovary, unspecified side	47	0.3
2. Nicotine use				15.7
	F17.210	Nicotine dependence, cigarettes, uncomplicated	1543	9.8
	Z87.891	Personal history of nicotine dependence	929	5.9
3. Hypertension	I10	Essential (primary) hypertension	1767	11.2
4. Noninflammatory disorder of adnexal structures	N83.8	Other noninflammatory disorder of ovary, fallopian tube, and broad ligament	1544	9.8
5. Pelvic/peritoneal adhesions				9.1
	N73.6	Female pelvic peritoneal adhesions (postinfective)	901	5.7
	K660	Peritoneal adhesions (postprocedural or postinfective)	534	3.4

AT = Adnexal torsion; ICD-10 = *International Classification of Diseases, Tenth Revision*.

to 0.88 when Doppler techniques were employed. Pooled specificity yielded a specificity of 0.91 for magnetic resonance imaging and a specificity range of 0.80 to 0.90 for computed tomography. Improved access to these advanced imaging modalities may partially explain the perceived increased incidence of AT; however, a significant increase in the true incidence is less probable because risk factors for AT such as presence of an ovarian cyst, pregnancy, or post-tubal sterilization status have not significantly increased [10]. A more likely contributing factor is the predilection toward laparoscopic surgery over laparotomy with the potential for surgical management without admission, allowing direct discharge of patients home from the postsurgical recovery area without ever getting admitted to the hospital [18,24].

The significant increase in charges for women diagnosed with AT, summing to a weighted average of over $500 million annually by 2018, is equally noteworthy. The average charges for AT quadrupled from 2006 to 2018; this effect is more pronounced among median charges, which increased almost 9-fold. Comparatively, the average and median charges for all other conditions in the ED during the same time frame only increased by factors of 2.6 and 2.2, respectively. It is worth highlighting that reported charges are typically an overestimation of actual cost, with an average charge-to-cost ratio of 3.4 in 2012 [25]. Regardless, this analysis of NEDS data demonstrates that AT represents a significant cost to the healthcare system.

There were several interesting patterns in the admission data that are worth highlighting. The lower admission rate

for patients using private insurance may reflect improved resources and social support, allowing for both timelier initial presentation and close and reliable outpatient follow-up. Interestingly, the admission rate for AT was similar across income quartiles, suggesting that differences in admission patterns may be driven more by social support than financial means. Although differences between individual hospitals certainly exist, admission rates among teaching and nonteaching hospitals were broadly similar. While treatment outcomes cannot be compared using NEDS data, these findings suggest that AT is diagnosed at similar rates regardless of a patient's income or the type of hospital they present to.

Our study has some limitations. First, the NEDS database characterizes each encounter as a new data point, so patients with multiple visits for AT may lead to a slight overestimation of AT incidence rates. In addition, not all diagnoses may get reported for each patient encounter, leading to incomplete understanding of associated conditions. Finally, patients who are observed in short stay units for prolonged monitoring but not formally admitted to the hospital are not always captured in the NEDS database.

Despite these limitations, this study has many strengths. It is based on the largest publicly available all-payer ED database in the United States. The large number of ED records and stratified nature of the NEDS database decrease the risk of sampling error and increase generalizability to the entire United States. Although the transition from ICD-9 to ICD-10 codes occurred during the study period, the proportion of patients diagnosed with AT who had some type of ovarian cyst remained between 39% to 41% regardless of the ICD iteration, suggesting that the introduction of ICD-10 minimally impacted our results. By analyzing a variety of variables over a 13-year time frame, this study elucidates the role EDs serve in managing AT as well as temporal trends.

In conclusion, this represents the most comprehensive characterization of ED utilization of AT in the United States. We hope that future work can build on this study to mitigate the rapidly increasing cost of AT without impacting treatment outcomes.

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