



Sean D Candrilli and Sudeep Karve
RTI Health Solutions, Research Triangle Park, NC, United States

BACKGROUND

- Type 2 diabetes mellitus (T2DM), the most common form of diabetes (> 90% of all cases), is typically associated with adult obesity
- Recently, increasing attention has been given to the growing prevalence of disease among pediatric populations
- Among the pediatric population, obesity is the most important predictor for the development of T2DM^{1,2}
- A previous study assessing the incidence of T2DM and its association with obesity among a pediatric population (aged < 20 years) reported a 10-fold increase in the incidence of T2DM during a 12-year period, with all patients being classified as obese (mean body mass index: 37.7) at T2DM diagnosis³
- However, there are limited data assessing recent trends in T2DM-related hospitalizations among the pediatric population (age ≤ 20 years)

OBJECTIVE

- To assess trends in pediatric T2DM hospitalization and aspects of related care in the United States (US)

METHODS

Study Design

- Retrospective database analysis

Data Source

- Discharge data were taken from the 2000, 2003, 2006, and 2009 Healthcare Cost and Utilization Project (HCUP) Kids' Inpatient Database (KID)
 - Largest all-payer pediatric inpatient care database in the US
 - Only national pediatric hospital database with charge information on all patients, regardless of payer
 - Includes many clinical and nonclinical variables for each inpatient stay, including patient demographics, diagnosis codes, length of stay (LOS), total charges, admission and discharge status, payer, and hospital-specific characteristics
 - Sampling weights allow for generating nationally representative estimates

Inclusion Criteria

- Age ≤ 20 years
- Primary diagnosis of T2DM (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] codes 250.x0, 250.x2)
- Unique patient identifiers were not provided, so we were unable to follow patients who moved from facility to facility

Study Measures and Analytical Method

- For each of the four years the following information was gathered for T2DM-related hospitalizations:
 - Weighted estimates of the number of hospitalizations
 - Characteristics
 - Per-discharge total charges and LOS
 - Most frequently observed secondary diagnoses
- Results were compared with hospitalizations unrelated to T2DM
- Analyses were carried out using SAS (Version 9.3) statistical software

RESULTS

Incidence and Patient Characteristics (Table 1)

- Discharges related to T2DM in the US (weighted):
 - 1,636 in 2000 (2.0/100,000 US pediatric population in 2010)
 - 2,201 in 2003 (2.7/100,000 US pediatric population in 2010)
 - 3,004 in 2006 (3.5/100,000 US pediatric population in 2010)
 - 2,320 in 2009 (2.7/100,000 US pediatric population in 2010)
- Female patients accounted for a greater percentage of T2DM-related discharges than male patients in 2000, 2003, and 2006; in 2009, the percentages between the sexes were nearly equal
- In all study years, more than 64% of patients with T2DM-related hospitalizations were aged 16 to 20 years
- Nearly 70% of hospitalizations unrelated to T2DM were among patients aged younger than 5 years
- Black patients accounted for 25.4% to 31.2% of T2DM-related hospitalizations and 10.9% to 13.4% of hospitalizations unrelated to T2DM
- The proportion of discharges unrelated to T2DM was the greatest in the southern region of the US
- In 2000 and 2003, private insurance was the largest payer of T2DM-related hospitalizations, but in 2006 and 2009, the Medicaid system paid for a greater proportion of T2DM-related hospitalizations

Admission Source and Discharge Disposition (Table 2)

- A substantially greater proportion of T2DM-related hospitalizations originated in the emergency department (62.3%-72.2%) compared with hospitalizations unrelated to T2DM (17.4% to 19.7%)
- Approximately 94% of discharges unrelated to T2DM and 90% of discharges related to T2DM were routine discharges
- The death rate in T2DM-related stays ranged from 2.5% to 5.0% across the years; the death rate in stays unrelated to T2DM was generally less and ranged from 2.8% to 3.2%

Table 1. Characteristics of T2DM-Related Hospitalizations^{a,b}

Hospitalization Characteristic	2000		2003		2006		2009	
	Without T2DM (N = 7,289,402)	With T2DM (N = 1,636)	Without T2DM (N = 7,406,960)	With T2DM (N = 2,201)	Without T2DM (N = 7,555,809)	With T2DM (N = 3,004)	Without T2DM (N = 7,367,883)	With T2DM (N = 2,320)
	n	%	n	%	n	%	n	%
Sex								
Male	3,411,133	46.80	720	44.02	3,476,973	46.94	1,006	45.68
Female	3,875,813	53.17	914	55.87	3,856,654	52.07	1,147	52.08
Missing/invalid	2,456	0.03	2	0.11	73,334	0.99	49	2.24
Age								
< 5	5,081,534	69.71	85	5.21	5,186,898	70.03	94	4.27
5-10	348,419	4.78	94	5.73	370,128	5.00	143	6.50
11-15	392,080	5.38	379	23.17	406,302	5.49	531	24.10
16-20	1,460,427	20.03	1,078	65.88	1,403,916	18.95	1,418	64.42
Missing/invalid	6,943	0.10	0	0.00	39,717	0.54	16	0.71
Race								
White	3,401,188	46.66	540	33.03	2,746,180	37.08	635	28.86
Black	935,430	12.83	510	31.17	806,489	10.89	566	25.71
Hispanic	1,213,965	16.65	222	13.59	1,261,426	17.03	329	14.95
Other	497,636	7.00	68	4.00	508,797	7.00	102	5.00
Missing/invalid	1,241,183	17.03	295	18.02	2,084,070	28.14	569	25.86
Region								
Northeast	1,318,090	18.08	286	17.49	1,265,646	17.09	354	16.07
Midwest	1,543,066	21.17	325	19.87	1,664,535	22.47	403	18.28
South	2,717,293	37.28	709	43.34	2,787,756	37.64	1,023	46.48
West	1,710,953	23.47	316	19.30	1,689,023	22.80	422	19.17
Payer type								
Medicare	19,092	0.26	12	0.74	16,029	0.22	14	0.65
Medicaid	2,776,984	38.10	583	35.61	3,138,762	42.38	860	39.09
Private insurance	3,846,153	52.76	807	49.33	3,609,499	48.73	883	40.12
Other	614,227	8.00	228	14.00	630,075	9.00	429	20.00
Missing/invalid	32,948	0.45	6	0.37	12,595	0.17	14	0.63

^a Percentages and counts across categories may not add up to 100% due to rounding errors
^b Counts were weighted to obtain nationally representative estimates

Table 2. Admission Source and Discharge Disposition of T2DM-Related Hospitalizations^{a,b}

Admission Source and Discharge Disposition	2000		2003		2006		2009	
	Without T2DM (N = 7,289,402)	With T2DM (N = 1,636)	Without T2DM (N = 7,406,960)	With T2DM (N = 2,201)	Without T2DM (N = 7,555,809)	With T2DM (N = 3,004)	Without T2DM (N = 7,367,883)	With T2DM (N = 2,320)
	n	%	n	%	n	%	n	%
Admission Source								
Emergency department	1,241,885	17.04	1,020	62.32	1,456,808	19.67	1,477	67.10
Another hospital	155,874	2.14	72	4.38	192,508	2.60	127	5.78
Other health facility, including long-term care	33,929	0.47	26	1.61	36,975	0.50	23	1.06
Court/law enforcement	8,635	0.12	0	0.00	7,000	0.09	0	0.00
Routine, including births and other sources	4,944,623	67.83	451	27.57	5,463,571	73.76	567	25.78
Unknown/missing	904,456	12.41	67	4.11	250,098	3.38	6	0.28
Disposition at discharge								
Routine	6,860,951	94.12	1,485	90.74	6,950,739	93.84	1,958	88.95
Transfer to short-term hospital	114,735	1.57	39	2.38	118,417	1.60	55	2.49
Against medical advice	65,527	0.90	33	2.04	63,553	0.86	24	1.11
Died	201,766	2.77	41	2.51	224,963	3.04	110	5.00
Unknown/missing	46,423	0.64	38	2.33	49,288	0.67	54	2.45

^a Percentages and counts across categories may not add up to 100% due to rounding errors
^b Counts were weighted to obtain nationally representative estimates

Total Charges and LOS (Figures 1 and 2)

- Mean total charges (2012 US dollars) for T2DM-related discharges increased nearly 34%, from \$13,775 (2000) to \$18,432 (2009)
- The mean total charge per discharge for hospitalizations unrelated to T2DM also increased over time, eventually nearly equaling the mean total charge for T2DM-related hospitalizations (from \$12,262 in 2000 to \$18,563 in 2009)

Figure 1. Mean Total Charge, by Year, Among Those With and Without T2DM

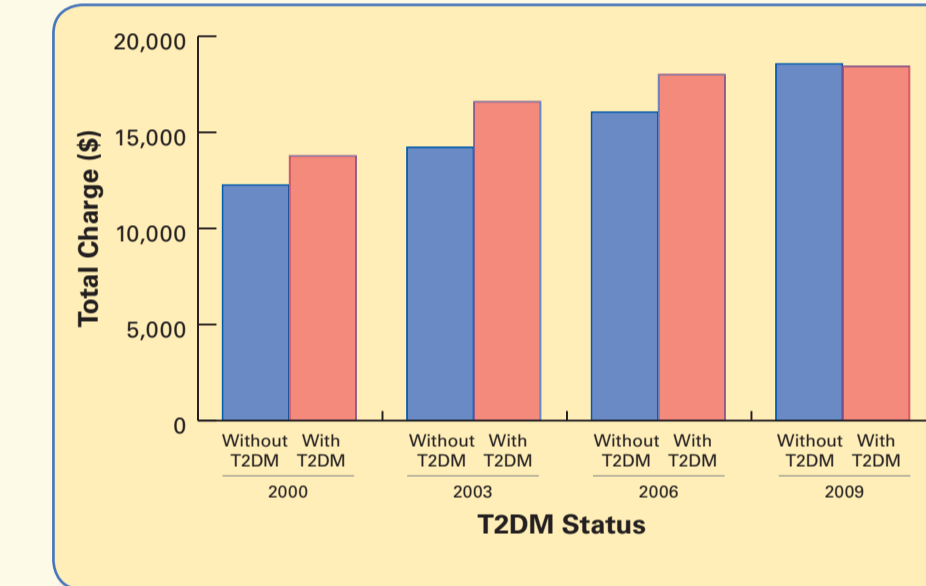
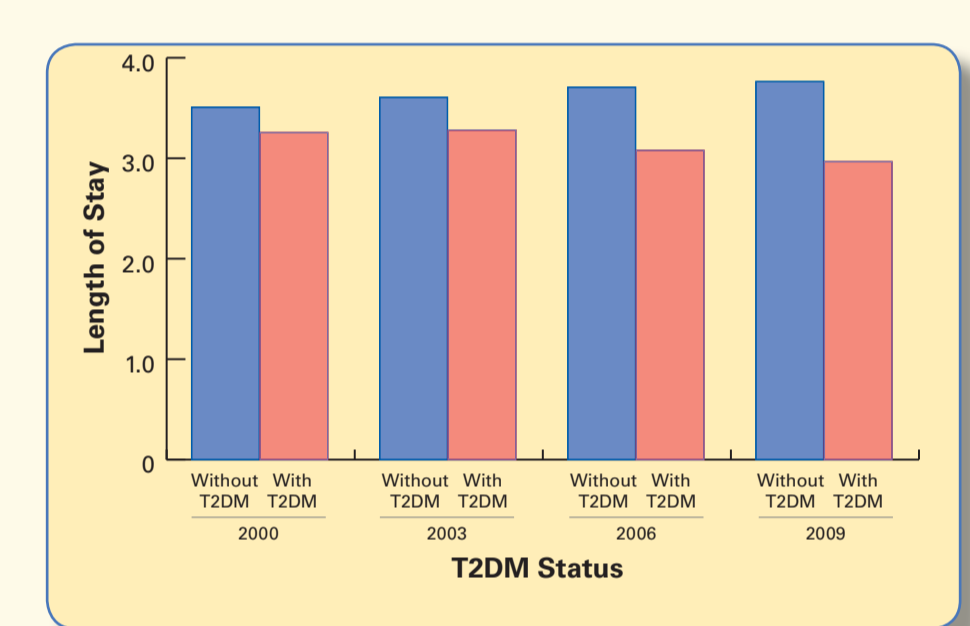


Figure 2. Mean LOS, by Year, Among Those With and Without T2DM



Most Frequently Observed Secondary Diagnoses During T2DM-Related Hospitalizations

- In each of the study years, the most frequently observed secondary diagnosis was for diabetic ketoacidosis (either ICD-9-CM diagnosis code 250.10 or 250.12)
- In each of the study years, "Personal history of noncompliance with medical treatment, presenting hazards to health" (ICD-9-CM diagnosis code V15.81) was in the top-five most frequently observed secondary diagnoses
- In 2006 and 2009, "Long-term (current) use of insulin" (ICD-9-CM diagnosis code V58.67) was the second most frequently observed secondary diagnosis code, indicating that a significant proportion of these patients are treated, at least in part, with insulin

LIMITATIONS

- Patient discharges were identified based upon diagnosis codes that, if recorded inaccurately, may cause misidentification of T2DM
- Because unique patient identifiers were not provided, we were unable to assess how many distinct patients were represented by the admissions in the database, or to follow patients who moved from facility to facility or had a readmission
- Results may be biased somewhat if the experiences of patients who transferred from facility to facility differed from those who remained in the same facility, or if readmissions differed from initial admissions

CONTACT INFORMATION

Sean D Candrilli, PhD
Head, Health Economics
Phone: +1.412.384.2790
Fax: +1.919.541.7222

RTI Health Solutions
200 Park Offices Drive
Research Triangle Park, NC 27709
E-mail: scandrilli@rti.org

CONCLUSIONS

- We observed significant increases in the rate of pediatric T2DM-related hospitalization over time, with tremendous growth in the economic burden associated with these stays (i.e., nearly a 150% increase in total charges between 2000 and 2006)
- Total pediatric T2DM-related inpatient charges increased from \$21.5 million (2012 US dollars) to \$53.3 million, before falling slightly in 2009 to \$42.4 million
- The increasing hospitalization rates are consistent with the growing prevalence of obesity among children in the US
- These findings further emphasize the need for interventions targeted at mitigating and managing factors associated with the risk of T2DM (e.g., obesity) among children

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