Mortality and Charges of Diabetic Ketoacidosis Hospitalizations in People With Type 2 Diabetes: Differences Between Primary vs. Secondary Diagnosis

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Background

- Diabetic ketoacidosis (DKA) is a serious and potentially life-threatening complication of diabetes
- Recent evidence shows that among people living with type 2 diabetes mellitus (T2DM) the incidence of DKA, previously considered an occasional complication, is higher than has generally been perceived, with around one-third of DKA episodes occurring in people with T2DM[1,2]

Objective

- To assess differences in incidence, morbidity, mortality, and charges of DKA-related hospitalizations in people with T2DM in the U.S., stratified by primary or secondary DKA diagnosis

Methods

Study Design, data source, study population

- This was a retrospective, cross-sectional nationwide analysis of the National Inpatient Sample (NIS)
  - NIS is the largest publicly available inpatient database in the U.S., containing data on over 7 million hospital stays
- Data were captured from January 1, 2019 to December 31, 2022
- Hospitalizations among both children and adults (all ages) with T2DM were included

Identification of admissions with DKA

- DKA hospitalizations were identified using International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10 codes) specific to T2DM (E11.1, E11.10, E11.11)[3]
- Hospitalizations with a T1DM diagnosis code (i.e. E.10.x) were excluded from the analysis

Data collected

- The primary endpoint was the incidence of DKA inpatient hospitalizations
- Secondary endpoints were length of stay, mortality and 2026 inflation-adjusted hospital charges

Results

Primary endpoint – DKA admissions, 2019–2022

- As shown in **Figure 1**, among people with T2DM the total number of admissions with a diagnosis of DKA increased after 2019, with a larger increase in admissions with DKA codes in a secondary position than in primary DKA diagnoses

DKA admissions in 2022

- In total, 7,612,098 people living with T2DM were hospitalized in 2022
- Among these hospitalizations, 1.3% (n = 99,735) had DKA as the primary diagnosis
- A further 1.2% (n = 91,935) had a code for DKA in a secondary position

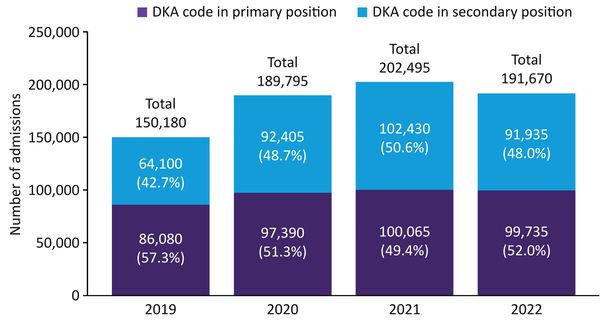
Population characteristics for 2022 admissions

- The characteristics of individuals with T2DM admitted to hospital with a DKA code in 2022 are shown in **Table 1**

Secondary endpoints

- Mortality among people with T2DM who had primary DKA diagnosis codes is shown in **Figure 2**
- Mean length of stay and hospital charges are shown in **Figure 3** and **Figure 4**
- In 2022, the total hospital charges associated with primary and secondary DKA diagnoses among people with T2DM were $5.27 billion and $14.87 billion, respectively

Figure 1. Incidence of hospitalization with DKA diagnosis codes among people living with T2DM, 2019–2022



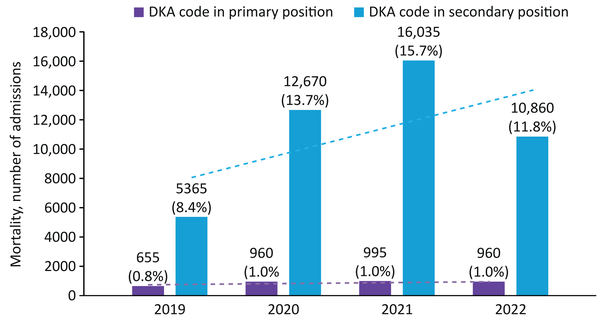
DKA, diabetic ketoacidosis; T2DM, type 2 diabetes mellitus.

Table 1. Cohort characteristics

Characteristic	Primary DKA	Secondary DKA	*p* value
N	99,735	91,935	
Age, mean (SD)	52.18 (16.16)	59.45 (15.22)	< 0.001
Sex, n (%)			< 0.001
Female	44,425 (44.5)	43,330 (47.1)	
Male	55,300 (55.5)	48,605 (52.9)	
Age group, n (%)			< 0.001
18–64 years	75,365 (75.6)	55,745 (60.6)	
≥ 65 years	23,300 (23.4)	36,025 (39.2)	
< 18 years	1065 (1.1)	155 (0.2)	
Race, n (%)			< 0.001
Asian or Pacific Islander	1805 (1.8)	2875 (3.2)	
Black	29,160 (29.8)	17,530 (19.5)	
Hispanic	17,070 (17.5)	16,335 (18.2)	
Native American	1150 (1.2)	1085 (1.2)	
White	45,710 (46.8)	49,060 (54.5)	
Other	2810 (2.9)	3075 (3.4)	
Insurance, n (%)			< 0.001
Medicaid	27,740 (27.8)	19,640 (21.4)	
Medicare	29,800 (29.9)	41,050 (44.7)	
Private	28,045 (28.1)	21,520 (23.4)	
Other	14,150 (14.2)	9725 (10.6)	

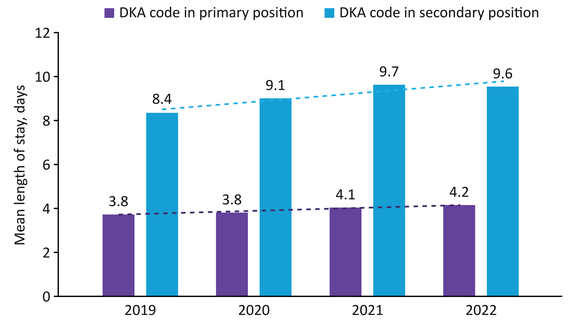
DKA, diabetic ketoacidosis; SD, standard deviation.

Figure 2. Mortality rate for patients with DKA diagnosis codes among people living with T2DM, 2019–2022



Data are total number of deaths and percentage of admissions among poeple with T2DM. Dashed lines indicate linear trends.
DKA, diabetic ketoacidosis; T2DM, type 2 diabetes mellitus.

Figure 3. Mean length of stay for admissions with DKA diagnosis codes among people living with T2DM, 2019–2022



Dashed lines indicate linear trends.
DKA, diabetic ketoacidosis; T2DM, type 2 diabetes mellitus.

Funding source

This study, the preparation of the manuscript, and publication fees were funded by Abbott.

Disclosures

RJG

NV, AL and YP are employees of Abbott.

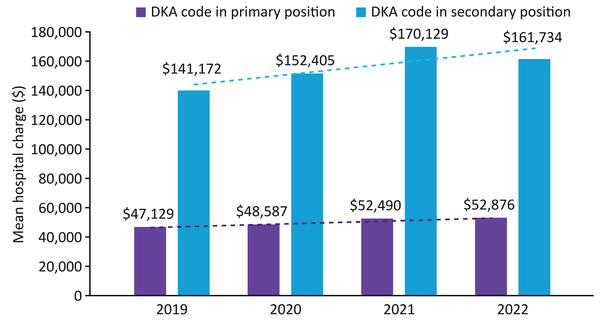
Acknowledgments

Medical writing support was provided by Dr Paul Overton (Beacon Medical Communications Ltd, Brighton, UK) in accordance with Good Publication Practice (GPP 2022) guidelines and was funded by Abbott.

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Figure 4. Mean hospital charges for admissions with DKA diagnosis codes among people living with T2DM, 2019–2022



Dashed lines indicate linear trends.
DKA, diabetic ketoacidosis; T2DM, type 2 diabetes mellitus.

Discussion

- This analysis provides recent U.S. national estimates of the incidence, length of stay, mortality and charges of hospitalizations for DKA events in people with T2DM
- In 2022 ~2.5% of hospitalizations among people with T2DM in the U.S. had diagnosis codes for DKA, which equates to a considerable clinical and economic burden across the large T2DM population
- These findings show that it is relatively common for people with T2DM hospitalized for other causes to have a secondary diagnosis of DKA; studies limited to hospitalizations with a primary DKA diagnoses may underestimate the true impact of the condition
- The increase in DKA diagnosis codes in 2020 could be related to the Covid-19 pandemic or to changes in billing coding trends
- Limitations include the possibility of residual confounding due to unmeasured variables such as glycated hemoglobin levels
  - In addition, administrative claims data are subject to data coding limitations and data entry error

Conclusions

- DKA hospitalizations constitute a significant use of healthcare resources, with considerable hospital charges per admission and total hospital charges in excess of $20 billions per year in 2022
- Secondary DKA hospitalizations are associated with higher mortality, longer length of stay, and greater charges, suggesting that reliance on primary coding alone underestimates DKA's true impact

Presented at the American Diabetes Association 86th Scientific Sessions, June 5–8 2026, New Orleans, LA