Predictors of Admission for Diabetic Ketoacidosis to the University of Oklahoma Children's Hospital: A Five-Year Retrospective Chart Review

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Background

Type 1 diabetes mellitus (T1DM) is one of the most common chronic diseases of childhood, with approximately 1 in 300 people in the US receiving a diagnosis by age 18. Among this population, diabetic ketoacidosis (DKA) remains the leading cause of morbidity and mortality. Previous studies examining predictive factors for DKA admission have found relationships with age, sex, race, insurance, and location. The objective of this study is to identify predictive factors of admission for DKA among patients in Oklahoma served by OU Children's Hospital.

Methods

This study is a retrospective chart review of admissions for DKA to OU Children's Hospital over a five-year period from January 2015 through December 2019. Factors studied include date of admission, type of diabetes, status of diabetes (new-onset vs. previous diagnosis), age, sex, insurance, and zip code +4-digit code. Each zip code +4-digit code was cross-referenced with the University of Wisconsin School of Medicine and Public Health's Neighborhood Atlas + Area Deprivation Index (ADI), a proxy for socioeconomic status to the neighborhood level, where a score of 1 corresponds to the highest socioeconomic status and a score of 100 corresponds to the lowest socioeconomic status. Relationships were analyzed using the chi-square test, Fisher's exact test, and Student's t-test. Maps were created in ArcGIS.

Results

Table 1: Patient characteristics

	Single admission	Multiple admissions
Total number of patients	281	68
Total number of admissions	281	205
Admissions per patient	1	3.01
Sex		
Male	152	29
Female	129	39
Median age (years)	12.95	14.19
Median ADI, state decile	5	6
Median ADI, national percentile	67	75.5
Admissions by type of insurance		
Uninsured	18	6
Public insurance	160	161
Private insurance	103	38
Admissions by type of admission		
New-onset	158	23
Previous diagnosis	123	182
Patients by type of diabetes		
Type 1	263	67
Type 2	18	1

Figure 1: Admissions per year

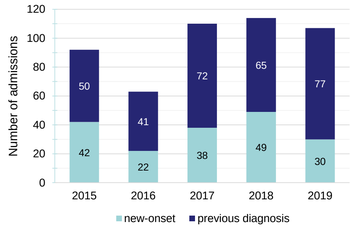

Table 2: Number of patients by number of admissions

Admissions received	Number of patients
1	281
2	38
3	12
4	5
5	8
6	3
7	1
8	1

Figure 2: Time to readmission

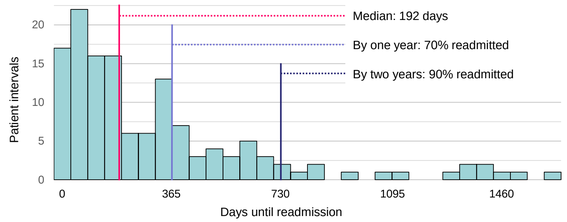

Table 3: Readmission risks

	Single admission	Multiple admissions
Type of initial admission (all patients)		
New-onset	158	23
Previous diagnosis	123	45
Difference in readmission risk by type of admission?	p = 0.0011	
Type of insurance at new-onset admissions		
Uninsured	8	5
Public insurance	87	15
Private insurance	63	3
Difference in readmission risk if:		
Uninsured vs. insured?	p = 0.0138	
Public vs. private insurance?	p = 0.0426	
Median ADI at new-onset admissions		
State decile	4.8	6.9
National percentile	61.4	75.8
Difference in readmission risk if:		
Comparing median ADI, state decile?	p = 0.0073	
Comparing median ADI, national percentile?	p = 0.0091	

Table 4: Median ADI by type of insurance

	Single admission		Multiple admissions	
Type of insurance	# Admissions	Median ADI, national percentile	# Admissions (# patients)	Median ADI, national percentile
Uninsured	18	72.5	6 (6)	76.5
Public insurance	160	71	161 (57)	76
Private insurance	103	57	38 (17)	66

Figure 3: Zip codes with DKA admissions to OU Children's Hospital

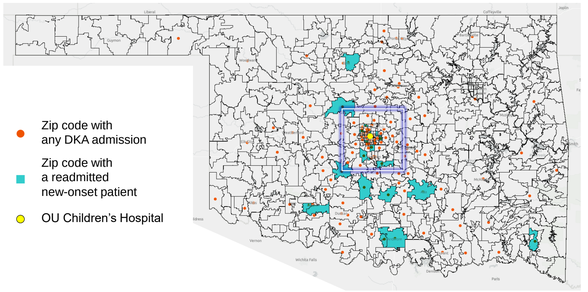

Figure 4: Zip codes with DKA admissions to OU Children's Hospital, Oklahoma City metro area

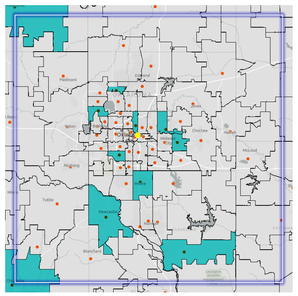

Table 5: Zip codes

Number of patients in one zip code	Number of such zip codes
15	1
9	3
8	2
7	7
6	6
5	4
4	6
3	14
2	29
1	62

Total number of zip codes represented	134
Zip codes with readmitted new-onset patients	20

Table 6: Comparison of select new-onset admissions

	Single admission	Multiple admissions
Total patients	30	23
Subsequent admissions	0	43
Median ADI, national percentile	69	82
Type of insurance at new-onset		
Uninsured	2	5
Public insurance	15	15
Private insurance	13	3

The group of patients with subsequent admissions after an initial new-onset admission represents 20 zip codes, highlighted in the state and metro maps in Figures 3 and 4, respectively. This table compares all patients with an initial new-onset admission who live in the highlighted 20 zip codes.

Discussion

Distance and deprivation are important drivers for admission (and readmission) for DKA. Patients with multiple admissions following an initial new-onset admission represent areas that tend to be far from our clinic and/or are in significantly-deprived neighborhoods. The challenge for a parent to take time off of work and remove a child from school for an endocrinologist's appointment is made more difficult if a family lives far or has transportation issues. Likewise, patients and families in more deprived areas have access to fewer healthy nutritional resources, psychosocial support systems, diabetes technology options, and transportation options for appointments.

The predominance of adolescent patients may be due to evolving insulin needs from hormonal changes of puberty and less adult supervision of diabetes management. Body image concerns also increase in adolescence, and adolescents with diabetes are aware that insulin omission leads to weight loss.

In 2016, there were relatively fewer admissions for DKA as the OU Children's PICU was on divert. It is possible that a patient who only had a single DKA admission (for new-onset diabetes) may have had a subsequent admission at a different receiving institution. As these admissions were not tracked, they represent a limitation in this study.

Conclusion

A patient's ADI, insurance status, and history of previous admissions for DKA are significant risk factors for DKA admission. Outreach should be directed to patients from distant or deprived neighborhoods. Virtual visits of greater frequency may be one bridging solution. I intend to perform a future study to explore if providing additional resources (including virtual visits and CGM technology) can reduce rates of DKA admission among higher-risk patients.