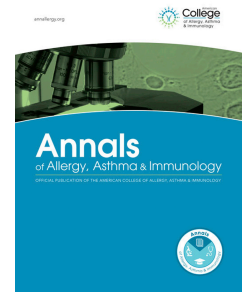


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Title: Predictors of Hospital Readmission in US Children and Adults with Atopic Dermatitis

Short Title: Readmission in AD

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1 Introduction

2 Atopic dermatitis is a chronic inflammatory skin condition affecting approximately 13%
3 of United States (US) children and 7% of US adults^{1,2}. AD patients may experience intermittent
4 severe disease flares or chronically severe disease requiring hospitalization^{3,4}. Hospitalization
5 for AD was associated with more than \$11 million in direct hospital costs annually in United
6 States children and adults. However, previous studies were unable to determine the impact of
7 repeat hospitalizations on the financial burden of AD. We hypothesized that a large proportion of
8 AD hospitalizations are secondary to readmissions.

9 Decreasing hospital readmissions is a major priority in the US in order to reduce
10 healthcare costs⁵. Understanding the predictors of readmissions is essential in order to develop
11 interventions aimed at preventing them. Previous studies found socioeconomic and racial/ethnic
12 differences of AD severity and hospitalization^{4,6}. We hypothesized that socioeconomic and
13 racial/ethnic differences similarly occur in repeat admissions for AD. The present study
14 examines readmission rates among inpatients with AD in the US.

Methods:**Data Source**

The 2012–2014 National Readmissions Database (NRD) provided by the Healthcare Cost and Utilization Project (HCUP) from the Agency for Healthcare Research and Quality was analyzed. NRD contains a stratified representative cross-sectional sample of all US hospital readmissions. Sample weights were created by the NRD that factored the sampling design of hospitals in the US. These sample weights allow for representative estimates of hospital readmissions across the entire country. All data were de-identified. No attempts were made to identify any individuals in the database. All parties with access to NRD were compliant with HCUP's formal data use agreement. The study was approved by the institutional review board at Northwestern University. This study design complies with all Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations⁷.

Identification of admission/readmission for AD and comorbidities

AD and comorbidities were identified using *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes. The index hospital admission for AD was identified using the first instance of primary discharge ICD-9-CM diagnosis code 691.8 for that patient. Previous studies validated use of the discharge diagnosis codes 691.8 in the inpatient setting for identifying AD⁸. The control group was comprised of all discharges without a diagnosis of AD and yielded a representative cohort of hospital readmissions in the US.

NRD contains a de-identified patient linkage variable that allows for tracking of multiple hospital admissions per patient throughout the calendar year. The primary outcome evaluated

was the first readmission for AD at any point in the calendar year. In addition, hospitalizations in January-November, January-October, and January-September were examined to determine 30-, 60-, and 90-day readmission rates, respectively. Readmission for AD or another disorder were determined by the primary discharge diagnosis of subsequent admissions. Patients were excluded if they died during the index admission.

Statistical analysis

All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC). All statistical models used survey procedures that accounted for discharge trend weights, sample strata (based on the hospital's census region or division, ownership and control, location and teaching status, and number of beds), and clustering (by hospital) variables that provided in the NRD.

Readmission rates were calculated for 30/60/90-days and any time in the calendar year. The most prevalent reasons for readmission at each time-point were identified by frequency of ICD-9-CM occurrence. Summary statistics were generated for the first readmission, including weighted frequency, prevalence and 95% confidence intervals (CI) of, and median and interquartile time until readmission (days) among patients who were hospitalized primarily for AD and controls. The total frequency of readmissions was determined to account for those with ≥ 2 admissions. Survival plots for time to readmission for AD or other disorders were generated. The hospital cost for readmissions were estimated based on the total charge of the hospitalization and the cost-to-charge ratio estimated by the HCUP. Hospital cost was also inflation-adjusted to

2014 US dollars, the final year of analysis, based on Gross Domestic Product Price Indices published by the Bureau for Economic Analysis⁹.

Cox proportional hazards regression models were constructed to determine the predictors of *first* readmission for AD. Crude hazard ratios (HR) and 95% CI were estimated. The time-to-event variable in all models was the time elapsed between discharge from the index-admission for AD to either readmission for AD or censoring. The proportional hazards assumption was met based on testing graphically and using the Kolmogorov-type supremum test. The independent variables included socio-demographic (sex [male/female], age group [0-17/18-39/40-59/60+ years], income [less vs greater than median], insurance status [insured/uninsured], number of chronic conditions [0-2/3+], length of stay (LOS) [0-2/3-5/6+ days], elective admission [yes/no], and weekend admission [yes/no]), hospital-level (metropolitan hospital location [yes/no], hospital bed size [small-medium/large], teaching status [yes/no]), asthma [yes/no], and temporal (season [winter/spring/summer/autumn], year [2012/2013/2014]) factors on readmission. Multivariable models were constructed using stepwise variable selection ($\alpha=0.10$) from all of the abovementioned co-variables. Adjusted HR and 95% CI were estimated. Complete case analysis was performed. A two-sided P-value <0.05 was considered statistically significant.

Results

Population characteristics

There were 42,679,001 (weighted frequency: 107,351,823) adult or pediatric discharges captured in the NRD between 2012-2014 with 629 (weighted frequency: 1,810) admissions with a primary index diagnosis of AD. Persons hospitalized with vs. without AD were more likely to be male, have younger age, lower income, and fewer chronic conditions, stay in the hospital for 6+ days, non-electively admitted, treated at a metropolitan hospital, and admitted to a teaching hospital (Table 1).

Readmissions for AD and other disorders

Overall, 17.0% (95% CI: 14.0-20.0%) of patients admitted for AD were subsequently readmitted for any reason, including 4.6% (95% CI: 3.0-6.1%) for AD (median [IQR] time to readmission: 41.4 [72.6] days) and 12.5% (95% CI: 9.9-15.0%) for other diagnoses (median [IQR] time to readmission: 55.2 [81.4] days), respectively (Figure 1). Readmission rates for AD and other disorders increased over 30-day (1.75% [95% CI: 0.64-2.86%] and 4.86% [95% CI: 3.53-6.19%]), 60-day (3.47% [95% CI: 1.83-5.11%] and 7.00% [95% CI: 5.28-8.72%]), and 90-day (3.54% [95% CI: 1.83-5.25%] and 9.39% [95% CI: 7.07-11.72%]) periods (Table 2).

The most common reasons for first readmission at any time-point in the calendar year, other than AD, were skin and subcutaneous tissue infections (2.07% [95% CI: 1.09-3.05%]), allergic reactions (1.69% [95% CI: 0.80-2.58%]) and asthma (0.93% [95% CI: 0.02-1.85%]) (Table 3). Allergic reaction was the most common reason for 30-day (14.80% [95% CI: 1.23-

28.38%]), 60-day (1.23% [95% CI: 0.48-1.98%]), and 90-day (1.54% [95% CI: 0.48-2.61%])
readmission.

Most hospitalized AD patients who were readmitted for AD were only readmitted once
following the index admission (n=215; 12.53% [95% CI: 10.20-14.87%]). A minority were
readmitted two (n=47; 2.71% [95% CI: 1.60-3.83%]), three (n=18; 1.06% [95% CI: 0.19-1.94]),
or four or more (n=12; 0.70% [95% CI: 0.19-1.22]) times, with the maximum number of
readmissions being seven.

Predictors of readmission for AD

In bivariable proportional hazards regression models, readmission primarily for AD was
associated with the index admission occurring on a weekend (crude HR [95% CI]: 1.95 [1.13-
3.37]), in a hospital located in a non-metropolitan area (1.95 [1.38-2.76]), and during the autumn
season (3.75 [2.05-6.85]), but inversely associated with older age (0.14 [0.07-0.30]) and number
of chronic conditions (0.38 [0.17-0.85]) (Table 4). Of note, the risk of readmission for AD
decreased between 2012-2014 (0.48 [0.27-0.83]).

In multivariable selection models of children and adults combined, higher readmission
risk for AD was associated with younger age, lower income, lack of insurance coverage, elective
hospitalization, weekend admission, non-metropolitan hospital location, small hospital size,
autumn admission, and no asthma (Table 4). In models of children, higher risk for readmission
for AD was associated with younger age, lack of insurance, higher number of chronic conditions,
prolonged LOS, weekend admission, non-metropolitan hospital location, teaching hospital, and
autumn admission (Supplemental Table 1). In adults, higher risk for readmission for AD was

117 associated with male sex, younger age, lower household income, lack of insurance, hospital
118 location and bed size, but inversely associated with number of chronic conditions, LOS,
119 weekend admissions, asthma diagnosis (Supplemental Table 2).

Cost of readmission

The total annual hospital cost for the index admission of patients with a primary diagnosis of AD was \$3,242,327 with an additional \$3,664,835 spent on subsequent readmissions, of which \$1,162,801 was spent on readmission primarily for AD. However, only \$1,047,432 of the annual financial burden spent on readmissions came from the first readmission visit, including \$165,120 from readmission due to AD. The median hospitalization costs of index admission versus first readmission were \$4008 [IQR: \$4254] and \$5880 [\$7092], respectively. The median annual cost for the first readmission numerically decreased from \$6229 [\$6652] in 2012, to \$5820 [\$7885] in 2013, and \$5066 [\$5798] in 2014.

Discussion

This study found high rates of readmission among hospitalized patients with AD in the US. Nearly 1 in 5 hospitalized AD patients were readmitted within one year. The most common reasons for readmission were AD, allergic reactions and skin infections. The 4.6% rate of primary readmission for AD is lower than the 6.72% readmission rate previously observed for any skin disorder¹⁰. Readmission for AD was higher in inpatients with lower income and no insurance, suggesting that socio-economic and/or healthcare disparities may contribute toward readmission among AD patients. Several hospital characteristics were associated with readmission, including non-metropolitan location, non-teaching status, fewer beds, suggesting that these hospitals may particularly benefit from interventions aimed at reducing readmissions.

Our results demonstrate that a small subset of AD patients pose a significant financial burden of multiple hospitalizations for AD. A previous study reported an annual inpatient cost of \$8,288,083 in US adults and \$3,333,868 in US children hospitalized for AD or eczema³. The mean annual cost of \$6,907,162 for AD and subsequent readmissions in our cohort was lower, but this may be attributed to the fact that we only included AD in our analysis. Fifty three percent of hospitalization costs for AD were due to readmissions, with more than two-thirds of readmission costs being from 3 or more admissions. This indicates that a small subset of frequent inpatients account for a large proportion of expenditures.

These results are clinically relevant. In order to prevent future hospitalizations, AD patients being discharged from the hospital should have timely outpatient follow-up for AD to assure adequate short-term disease control and provide long-term treatment goals. In addition, hospitalized AD patients may benefit from a multidisciplinary care setting that also addresses their atopic and other health conditions and barriers to care. Moreover, AD patients, particularly

children, hospitalized on weekends may not receive adequate instruction about how to manage their skin disease. This can be mitigated with inpatient evaluation and counseling by a clinician with specialized training in AD. Future studies are warranted to determine the best approaches at reducing readmissions in AD patients.

This study found that AD patients with lower household income and/or who were uninsured had higher rates of readmission. Previous studies similarly found that lower household income and having no or public insurance were associated with increased emergency department (ED) utilization¹¹ and hospitalization for AD⁴. AD patients with lower socio-economic status and who are underinsured may not have the financial resources and/or sufficient time to comply with outpatient clinical visits, over-the-counter, and prescription medications. Two previous US population-based survey-based studies (2010 and 2012 National Health Interview Surveys) found that adults with AD reported difficulty affording prescribed medications, obtaining a timely physician visit, or receiving care because of financial cost¹². Inadequate access to appropriate outpatient care for AD may lead to poor disease control and subsequent hospitalization for AD. Taken together, the results of the present study suggest that disparities and inadequate access to outpatient care may also result in increased readmission rates for AD.

In addition, children initially admitted on a weekend were more likely to be readmitted. It may be that patients with inadequate access to outpatient care for AD on weekends are at higher risk for both initial admission and readmission. Alternatively, patients admitted on weekends may not receive sufficient education about their disease, long-term treatments, or care planning owing to decreased resources and staff count on weekends. Patients admitted for other diseases on weekends have also been observed to have worse clinical outcomes^{13, 14}.

Previous studies showed robust associations between AD and serious infections in both children and adults^{15, 16}. The present study additionally found the most common non-AD diagnosis was skin and subcutaneous tissue infection. These results suggest that strategies aimed at preventing infections in AD patients may reduce readmission rates.

There are several strengths of this study, including the longitudinal tracking of patients over multiple hospitalizations and the large cohort size of >42 million admissions over a three-year period. However, there are limitations. No data were available in NIS for AD severity and phenotypes, outpatient visits, and treatment regimens employed. Future prospective studies are needed to determine the clinical characteristics and treatment patterns in AD patients with readmissions.

In conclusion, this study found that almost 1 in 5 hospitalized patients with AD were readmitted for AD and/or other disorders. However, a small subset of inpatients was associated with the majority of inpatient costs owing to frequent readmissions. Future studies are needed to determine the optimal approaches for identifying patients at risk for frequent admissions and therapeutic interventions to prevent them.

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49

1 **Figure Legends.**

2 **Figure 1. Readmission-free survival among AD inpatients over 1 year.** Results are stratified
3 by AD inpatients who were readmitted for any reason (blue), with a primary diagnosis of AD
4 (red) or secondary diagnosis of AD (green).

Table 1. Demographic and socio-economic associations with hospitalization for atopic dermatitis.

Variable	Primary diagnosis of atopic dermatitis					P-Value
	No		Yes		Crude OR [95% CI]	
	Wtd Freq	% Prev [95% CI]	Wtd Freq	% Prev [95% CI]		
Sex						
Male	45,658,015	42.5 [42.3-42.7]	1106	61.1 [55.9-66.4]	1.00 [ref]	–
Female	61,691,998	57.5 [57.3-57.7]	704	38.9 [33.6-44.1]	2.12 [1.7-2.6]	<.0001
Age (years)						
<18	17,033,084	15.9 [14.8-16.9]	1153	63.7 [57.1-70.3]	1.00 [ref]	–
18-39	22,214,706	20.7 [20.4-21.0]	204	11.3 [8.3-14.3]	7.36 [5.22-10.36]	<.0001
40-59	23,094,053	21.5 [21.1-21.9]	274	15.1 [11.5-18.7]	5.71 [4.16-7.85]	<.0001
60+	45,008,170	41.9 [41.3-42.6]	180	9.9 [7.0-12.9]	16.95 [11.68-24.61]	<.0001
Annual household income						
<50 th %'ile	58,914,881	55.7 [54.7-56.8]	1206	67.5 [62.6-72.5]	0.60 [0.48-0.76]	<.0001
≥50 th %'ile	46,832,586	44.3 [43.2-45.3]	579	32.5 [27.5-37.4]	1.00 [ref]	–
Insurance status						
Insured	97,984,313	91.5 [91.2-91.7]	1605	88.8 [85.6-91.9]	1.00 [ref]	–
Uninsured	9,160,389	8.5 [8.3-8.8]	203	11.2 [8.1-14.4]	0.74 [0.54-1.01]	0.054
Number of chronic conditions						
0-2	40,732,057	37.9 [37.1-38.8]	1073	59.2 [53.9-64.6]	1.00 [ref]	–
3+	66,617,9556	62.1 [61.2-62.9]	738	40.8 [35.4-46.1]	2.38 [1.90-2.98]	<.0001
Length of stay						
0-2 days	45,291,088	42.2 [41.8-42.6]	811	44.8 [39.5-50.1]	1.00 [ref]	–
3-5 days	31,313,180	29.2 [29.0-29.4]	761	42.0 [37.1-46.9]	0.74 [0.59-0.92]	0.007
6+ days	30,739,678	28.6 [28.3-29.0]	239	13.2 [9.8-16.6]	2.30 [1.66-3.20]	<.0001
Elective admission						
Non-elective	22,832,359	21.3 [20.8-21.8]	186	10.3 [6.4-14.1]	1.00 [ref]	–
Elective	84,357,258	78.7 [78.2-79.2]	1625	89.7 [85.9-93.6]	2.37 [1.56-3.59]	<.0001
Weekend admission						
No	85,610,605	79.7 [79.7-79.8]	1476	81.5 [77.4-85.7]	1.00 [ref]	–
Yes	21,738,974	20.3 [20.2-20.3]	335	18.5 [14.3-22.6]	1.12 [0.85-1.48]	0.42
Hospital location						
Metropolitan	95,845,826	89.3 [88.6-89.7]	1730	95.6 [93.4-97.7]	1.00 [ref]	–
Not metropolitan	11,504,187	10.7 [10.3-11.1]	80	4.4 [2.3-6.6]	2.59 [1.56-4.28]	0.0002
Hospital bed size						
Small/medium	41,027,881	38.2 [37.2-39.2]	788	43.5 [35.3-51.8]	1.00 [ref]	–
Large	66,322,132	61.8 [60.8-62.8]	1022	56.5 [48.2-64.7]	1.25 [0.89-1.75]	0.20
Hospital teaching status						
Non-teaching	47,628,163	44.4 [43.4-45.4]	306	16.9 [12.9-21.0]	1.00 [ref]	–
Teaching	59,721,850	55.6 [54.6-56.6]	1504	83.1 [79.0-87.1]	0.26 [0.19-0.34]	<.0001

Season						
Winter	26,865,181	25.0 [25.0-25.1]	476	26.3 [21.8-30.7]	0.95 [0.73-1.24]	0.71
Spring	27,263,341	25.4 [25.4-25.4]	459	25.4 [21.0-29.7]	1.00 [ref]	–
Summer	26,873,310	25.0 [25.0-25.1]	438	24.2 [19.9-28.6]	1.03 [0.77-1.39]	0.83
Autumn	26,348,181	24.5 [24.5-24.6]	437	24.1 [20.0-28.3]	1.02 [0.77-1.35]	0.91
Year						
2012	36,464,446	34.0 [32.9-35.0]	602	33.3 [25.4-41.1]	1.00 [ref]	–
2013	35,579,669	33.1 [32.2-34.1]	678	37.5 [29.5-45.5]	0.87 [0.58-1.30]	0.49
2014	35,305,897	32.9 [32.0-33.8]	530	29.3 [22.5-36.0]	1.10 [0.75-1.62]	0.63

Table 2. Readmission rates for AD or other disorders.

Readmission rates	Readmission diagnosis (n=1,717)		
	AD	Other	Either AD or other
30-day	27 (1.75% [0.64-2.86%])	76 (4.86% [3.53-6.19%])	103 (6.61% [4.93-8.30%])
60-day	50 (3.47% [1.83-5.11%])	101 (7.00% [5.28-8.72%])	151 (10.47% [8.11-12.84%])
90-day	45 (3.54% [1.83-5.25%])	120 (9.39% [7.07-11.72%])	166 (12.93% [9.94-15.93%])
Any time	78 (4.56% [3.00-6.11%])	214 (12.46% [9.91-15.00%])	292 (17.02% [14.04-19.99%])

Table 3. Most common non-atopic dermatitis readmission diagnoses among persons previously admitted with a primary diagnosis of atopic dermatitis.

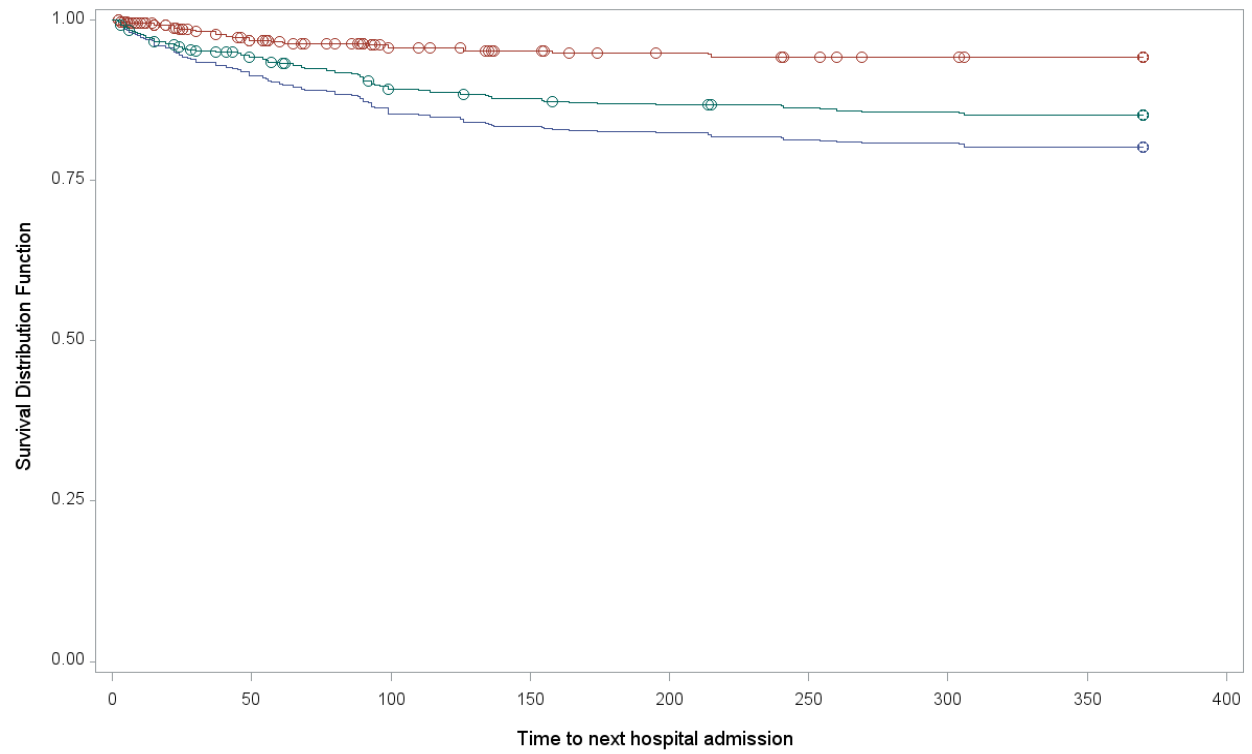
Readmission diagnosis	Readmission time-frame							
	Any		30-day		60-day		90-day	
	Wtd Freq	Percent (95% CI)	Wtd Freq	Percent (95% CI)	Wtd Freq	Percent (95% CI)	Wtd Freq	Percent (95% CI)
Skin and subcutaneous tissue infections	36	2.07% (1.09-3.05%)	≤10	0.65% (0.12-1.17%)	≤10	0.70% (0.13-1.28%)	13	1.00% (0.30-1.70%)
Allergic reactions	29	1.69% (0.80-2.58%)	15	14.80% (1.23-28.38%)	18	1.23% (0.48-1.98%)	20	1.54% (0.48-2.61%)
Asthma	16	0.93% (0.02-1.85%)	-	-	-	-	≤10	0.45% (0.00-0.97%)
Viral infection	14	0.79% (0.11-1.46%)	≤10	0.16% (0.00-0.48%)	≤10	0.55% (0.00-1.11%)	≤10	0.61% (0.11-1.12%)
Septicemia	13	0.77% (0.56-0.98%)	≤10	0.34% (0.13-0.56%)	≤10	0.66% (0.42-0.91%)	13	1.03% (0.74-1.32%)
Other inflammatory condition of skin	≤10	0.48% (0.11-0.86%)	≤10	0.39% (0.08-0.70%)	≤10	0.58% (0.13-1.03%)	≤10	0.65% (0.14-1.16%)
Other gastrointestinal disorders	≤10	0.33% (0.00-0.79%)	≤10	0.18% (0.00-0.53%)	≤10	0.19% (0.00-0.58%)	≤10	0.22% (0.00-0.65%)
Other nutritional, endocrine, or metabolic disorder	≤10	0.31% (0.00-0.77%)	-	-	-	-	≤10	0.28% (0.00-0.85%)

Table 4. Predictors of readmission for atopic dermatitis in patients who were hospitalized for atopic dermatitis.

Variable	Readmission							
	No	Yes	% Prev [95% CI]	Median [IQR]	Crude HR [95% CI]	P	Adjusted HR [95% CI]	P
	Wtd Freq	Wtd Freq						
Sex								
Male	990	53	5.1 [2.9-7.2]	38.4 [31.8]	1.00 [ref]	–		
Female	648	25	3.8 [1.4-6.2]	60.6 [158.5]	0.76 [0.47-1.23]	0.25		
Age (years)								
<18	1025	60	5.5 [3.3-7.8]	42.3 [82.4]	1.00 [ref]	–	1.00 [ref]	–
18-39	188	≤10	3.1 [0.1-6.0]	31.7 [47.0]	0.51 [0.15-1.75]	0.27	2.73 [0.39-19.16]	0.30
40-59	251	≤10	4.0 [1.0-6.9]	38.0 [18.8]	0.49 [0.24-1.01]	0.05	0.55 [0.10-2.98]	0.47
60+	174	≤10	1.0 [0.0-3.0]	28.0 [0.0]	0.14 [0.07-0.30]	<.0001	0.13 [0.01-1.24]	0.07
Annual household income								
<50 th %'ile	1062	60	5.4 [3.3-7.4]	33.0 [45.7]	1.19 [0.65-2.18]	0.55	2.28 [1.15-4.52]	0.02
≥50 th %'ile	550	18	3.2 [0.2-6.1]	58.2 [42.1]	1.00 [ref]	–	1.00 [ref]	–
Insurance status								
Insured	1451	69	4.5 [2.8-6.2]	24.8 [25.1]	1.00 [ref]	–	1.00 [ref]	–
Uninsured	186	≤10	4.9 [1.1-8.7]	42.8 [76.1]	1.26 [0.65-2.46]	0.48	3.47 [1.55-7.75]	0.004
Number of chronic conditions								
0-2	970	60	5.8 [3.4-8.2]	47.8 [81.2]	1.00 [ref]	–		
3+	668	18	2.7 [0.8-4.6]	34.0 [17.3]	0.38 [0.17-0.85]	0.02		
Length of stay								
0-2 days	768	24	3.0 [0.8-5.3]	33.6 [28.9]	1.00 [ref]	–		
3-5 days	681	39	5.4 [2.3-8.5]	60.4 [83.3]	1.65 [0.69-3.96]	0.25		
6+ days	189	15	7.5 [2.6-12.5]	30.6 [23.0]	1.44 [0.45-4.60]	0.53		
Elective admission								
Non-elective	1481	66	4.3 [2.7-5.8]	42.5 [71.4]	1.00 [ref]	–	1.00 [ref]	–
Elective	158	12	7.2 [0.3-14.1]	23.8 [43.1]	1.55 [0.68-3.51]	0.28	4.45 [1.40-14.18]	0.01
Weekend admission								
No	1343	60	4.3 [2.5-6.0]	50.4 [72.4]	1.00 [ref]	–	1.00 [ref]	–
Yes	295	18	5.9 [1.4-10.3]	21.6 [27.0]	1.95 [1.13-3.37]	0.02	3.61 [1.75-7.45]	0.001
Asthma								
No	1139	51	4.3 [2.4-6.2]	45.6 [63.5]	1.00 [ref]	–	1.00 [ref]	–
Yes	500	27	5.2 [2.4-8.0]	31.6 [44.5]	0.78 [0.45-1.34]	0.35	0.26 [0.07-0.95]	0.04
Hospital location								
Metropolitan	1575	70	4.3 [2.6-5.9]	45.1 [72.7]	1.00 [ref]	–	1.00 [ref]	–
Not metropolitan	64	≤10	11.3 [11.3-11.3]	15.0 [11.4]	1.95 [1.38-2.76]	0.0005	21.98 [2.29-211.26]	0.009
Hospital bed size								
Small/medium	711	41	5.5 [2.6-8.4]	44.0 [75.4]	1.00 [ref]	–	1.00 [ref]	–
Large	927	37	3.8 [2.3-5.4]	35.0 [37.0]	0.70 [0.39-1.26]	0.22	0.20 [0.06-0.67]	0.01
Hospital teaching status								
Non-teaching	282	13	4.5 [3.0-6.1]	29.4 [26.5]	1.00 [ref]	–	1.00 [ref]	–
Teaching	1357	65	4.6 [2.7-6.4]	44.4 [75.3]	1.22 [0.78-1.93]	0.37	4.59 [1.01-20.92]	0.05
Season								
Winter	447	18	3.8 [0.5-7.1]	69.9 [83.3]	0.68 [0.19-2.46]	0.54	0.45 [0.09-2.22]	0.32
Spring	402	27	6.4 [1.6-11.1]	54.1 [85.8]	1.00 [ref]	–	1.00 [ref]	–

Summer	407	13	3.1 [1.3-4.9]	27.5 [23.2]	1.12 [0.46-2.73]	0.79	2.04 [0.82-5.05]	0.12
Autumn	382	20	5.0 [1.6-8.4]	15.2 [36.5]	3.75 [2.05-6.85]	0.0001	15.41 [4.69-50.60]	<.0001
Year								
2012	523	37	6.7 [3.6-9.8]	33.8 [46.4]	1.00 [ref]	–		
2013	613	26	4.0 [1.8-6.3]	46.0 [43.4]	0.72 [0.33-1.58]	0.40		
2014	503	15	2.9 [0.2-5.7]	22.9 [89.5]	0.48 [0.27-0.83]	0.01		

5 Data were missing in 688,562 (1.5%) discharges for income, 80,095 (0.2%) for insurance status,
6 3273 (0.006%) for length of stay, 59984 (0.1%) for elective admission, 148 (0.0004%) for
7 admission day of the week, 0 (0.0%) for admission year, season, LOS and diagnoses. The
8 proportion of missing data was not significantly different for income and insurance status
9 ($P \geq 0.54$). Gray cells indicate that the variable was not included in the final selection models.



Supplemental Table 1. Predictors of readmission for atopic dermatitis in children who were hospitalized for atopic dermatitis.

Variable	Readmission							
	No		Yes					
	Wtd Freq	Wtd Freq	% Prev [95% CI]	Median [IQR]	Crude HR [95% CI]	P	Adjusted HR [95% CI]	P
Sex								
Male	646	37	5.4 [2.7-8.1]	34.1 [31.0]	1.00 [ref]	–		
Female	379	23	5.8 [1.9-9.8]	74.4 [166.3]	1.19 [0.61-2.31]	0.58		
Age (years)								
≤6	634	27	4.0 [0.8-7.2]	86.6 [106.1]	1.00 [ref]	–	1.00 [ref]	–
7-12	282	28	9.1 [4.1-14.1]	23.1 [32.4]	6.24 [2.74-14.23]	0.0005	1.07 [0.37-3.16]	0.89
13-17	109	≤10	4.6 [0.0-10.8]	39.4 [102.7]	1.14 [0.58-2.27]	0.67	0.06 [0.00-0.83]	0.04
Annual household income								
<50 th %'ile	692	44	6.0 [3.5-8.6]	27.4 [85.2]	0.86 [0.52-1.41]	0.51		
≥50 th %'ile	331	16	4.5 [0.0-9.2]	54.4 [44.3]	1.00 [ref]	–		
Insurance status								
Insured	61	≤10	3.8 [0.0-10.8]	24.0 [0.0]	1.00 [ref]	–	1.00 [ref]	–
Uninsured	964	58	5.7 [3.5-7.8]	43.8 [86.2]	3.13 [0.89-11.04]	0.07	19.44 [1.18-319.47]	0.04
Number of chronic conditions								
0-2	794	52	6.1 [3.5-8.8]	46.2 [91.1]	1.00 [ref]	–		
3+	231	≤10	3.5 [0.0-8.0]	8.4 [19.7]	1.33 [0.48-3.70]	0.56	10.05 [1.08-93.17]	0.04
Length of stay								
0-2 days	508	18	3.5 [0.1-6.8]	31.4 [30.3]	1.00 [ref]	–	1.00 [ref]	–
3-5 days	450	30	6.3 [2.2-10.5]	93.6 [102.3]	2.31 [0.66-8.07]	0.17	36.97 [1.09-1258.79]	0.05
6+ days	66	11	14.6 [4.1-25.2]	20.2 [17.9]	5.00 [1.29-19.31]	0.02	35.09 [1.15-1071.46]	0.04
Elective admission								
Non-elective	929	50	5.1 [2.9-7.3]	44.6 [78.7]	1.00 [ref]	–		
Elective	96	10	9.4 [2.5-16.3]	17.3 [29.0]	1.93 [1.07-3.48]	0.03		
Weekend admission								
No	859	45	5.0 [2.7-7.4]	48.6 [94.2]	1.00 [ref]	–	1.00 [ref]	–
Yes	167	15	8.1 [0.3-16.0]	19.1 [15.2]	5.54 [3.11-9.87]	<.0001	366.97 [5.25-25672.12]	0.01
Asthma								
No	673	37	5.2 [2.4-7.9]	47.0 [88.0]	1.00 [ref]	–		
Yes	352	24	6.3 [3.1-9.4]	31.7 [44.1]	0.58 [0.30-1.13]	0.10		
Hospital location								
Metropolitan	1008	56	5.2 [3.1-7.4]	44.7 [83.4]	1.00 [ref]	–	1.00 [ref]	–
Not metropolitan	17	≤10	20.9 [20.9-20.9]	15.0 [0.0]	1.68 [1.08-2.60]	0.03	11877.76 [166.65-846578.80]	0.0005
Hospital bed size								
Small/medium	509	38	7.0 [3.5-10.4]	40.2 [82.3]	1.00 [ref]	–		
Large	516	22	4.1 [1.9-6.3]	32.0 [79.8]	0.89 [0.47-1.69]	0.69		
Hospital teaching status								
Non-teaching	79	≤10	5.4 [5.4-5.5]	15.0 [0.0]	1.00 [ref]	–	1.00 [ref]	–
Teaching	946	56	5.6 [3.3-7.8]	44.7 [83.4]	0.81 [0.51-1.29]	0.34	13385.55 [198.83-901155.30]	0.0004
Season								
Winter	302	18	5.5 [0.8-10.3]	69.9 [83.3]	0.84 [0.22-3.26]	0.78	0.55 [0.10-3.11]	0.46
Spring	256	24	8.5 [1.5-15.6]	55.4 [121.9]	1.00 [ref]	–	1.00 [ref]	–
Summer	239	≤10	1.9 [1.5-2.2]	15.0 [0.0]	0.81 [0.42-1.55]	0.49	0.11 [0.01-1.19]	0.07
Autumn	228	14	5.8 [1.8-9.8]	12.2 [24.3]	8.28 [3.70-18.52]	0.0001	17.71 [4.04-77.67]	0.001
Year								
2012	329	29	8.1 [4.4-11.8]	21.4 [28.3]	1.00 [ref]	–		
2013	384	18	4.5 [1.5-7.5]	46.4 [65.9]	0.63 [0.21-1.87]	0.37		
2014	312	13	4.0 [0.0-8.3]	54.6 [91.9]	0.71 [0.49-1.04]	0.08		

Supplemental Table 2. Predictors of readmission for atopic dermatitis in adults who were hospitalized for atopic dermatitis.

Variable	Readmission							
	No		Yes					
	Wtd Freq	Wtd Freq	% Prev [95% CI]	Median [IQR]	Crude HR [95% CI]	P	Adjusted HR [95% CI]	P
Sex								
Male	344	16	4.4 [1.9-7.0]	40.3 [28.1]	1.00 [ref]	–	1.00 [ref]	–
Female	269	≤10	0.8 [0.0-2.3]	11.0 [0.0]	0.16 [0.02-1.55]	0.10	0.08 [0.02-0.36]	0.003
Age (years)								
18-39	188	≤10	3.1 [0.1-6.0]	31.7 [47.0]	1.00 [ref]	–	1.00 [ref]	–
40-59	251	≤10	4.0 [1.0-6.9]	38.0 [18.9]	0.96 [0.30-3.09]	0.95	0.30 [0.08-1.14]	0.07
60+	174	≤10	1.0 [0.0-3.0]	28.0 [0.0]	0.30 [0.08-1.06]	0.06	0.19 [0.06-0.66]	0.01
Annual household income								
<50 th %'ile	371	16	4.1 [1.6-6.6]	35.6 [24.5]	3.23 [2.02-5.16]	0.0001	2.73 [2.14-3.50]	<.0001
≥50 th %'ile	219	≤10	1.0 [0.0-3.0]	61.0 [0.0]	1.00 [ref]	–	1.00 [ref]	–
Insurance status								
Insured	125	≤10	5.5 [0.7-10.3]	38.5 [20.4]	1.00 [ref]	–	1.00 [ref]	–
Uninsured	487	11	2.2 [0.5-3.8]	26.0 [33.0]	2.04 [0.97-4.30]	0.06	9.31 [3.44-25.25]	0.0004
Number of chronic conditions								
0-2	176	≤10	4.3 [0.1-8.5]	54.0 [49.3]	1.00 [ref]	–	1.00 [ref]	–
3+	437	≤10	2.3 [0.8-3.8]	33.9 [10.2]	0.17 [0.10-0.28]	<.0001	0.10 [0.04-0.26]	0.0002
Length of stay								
0-2 days	260	≤10	2.1 [0.6-3.7]	17.5 [18.3]	1.00 [ref]	–	1.00 [ref]	–
3-5 days	231	≤10	3.5 [0.3-6.7]	48.0 [25.9]	1.20 [0.40-3.61]	0.73	0.12 [0.05-0.29]	0.0003
6+ days	122	≤10	3.2 [0.0-7.3]	31.5 [18.3]	0.65 [0.25-1.65]	0.33	0.30 [0.20-0.45]	<.0001
Elective admission								
Non-elective	552	16	2.8 [1.1-4.4]	35.6 [24.5]	1.00 [ref]	–		
Elective	61	≤10	3.6 [0.0-9.6]	61.0 [0.0]	0.88 [0.56-1.38]	0.55		
Weekend admission								
No	484	14	2.9 [0.8-4.9]	38.7 [34.8]	1.00 [ref]	–	1.00 [ref]	–
Yes	129	≤10	2.7 [1.9-3.6]	41.0 [0.0]	0.94 [0.54-1.66]	0.82	0.32 [0.13-0.82]	0.02
Asthma								
No	466	14	2.9 [1.0-4.9]	38.3 [26.5]	1.00 [ref]	–	1.00 [ref]	–
Yes	147	≤10	2.6 [0.0-5.3]	11.0 [24.1]	0.73 [0.19-2.87]	0.62	0.73 [0.60-0.89]	0.005
Hospital location								
Metropolitan	567	14	2.5 [0.7-4.2]	38.7 [34.8]	1.00 [ref]	–	1.00 [ref]	–
Not metropolitan	47	≤10	7.2 [7.2-7.2]	41.0 [0.0]	2.97 [1.89-4.69]	0.0002	14.00 [8.93-21.95]	<.0001
Hospital bed size								
Small/medium	202	≤10	1.7 [0.2-3.2]	62.0 [0.0]	1.00 [ref]	–	1.00 [ref]	–
Large	411	15	3.4 [1.1-5.7]	34.3 [19.5]	1.24 [0.46-3.32]	0.64	4.05 [1.76-9.31]	0.003
Hospital teaching status								
Non-teaching	203	≤10	4.2 [2.0-6.4]	37.4 [18.9]	1.00 [ref]	–		
Teaching	410	≤10	2.2 [0.0-4.4]	30.4 [43.5]	0.74 [0.35-1.58]	0.40		
Season								
Winter	146	≤10	0.0 [0.0-0.0]	-	0.00 [0.00-0.00]	<.0001		
Spring	146	≤10	2.2 [0.0-5.4]	28.0 [15.8]	1.00 [ref]	–		
Summer	168	≤10	4.8 [0.9-8.8]	36.0 [7.7]	2.48 [0.93-6.66]	0.07		
Autumn	154	≤10	3.9 [0.1-7.6]	33.7 [50.2]	3.24 [1.11-9.46]	0.03		
Year								
2012	194	≤10	4.2 [0.6-7.9]	50.2 [28.4]	1.00 [ref]	–		
2013	228	≤10	3.2 [0.9-5.5]	34.9 [14.0]	0.93 [0.48-1.83]	0.82		
2014	191	≤10	1.1 [0.0-3.2]	11.0 [0.0]	0.25 [0.02-2.66]	0.23		