

Background

- Significant changes in influenza vaccination coverage and antiviral treatment guidance occurred following the 2009 influenza pandemic in children. However, data are limited describing recent epidemiology, clinical characteristics, antiviral use, vaccine coverage, and outcomes of influenza-related hospitalizations in children.

Methods

Setting and Population

- Children <18 years hospitalized with influenza during seasons 2010–2011 through 2018–2019 were included through the US Influenza Hospitalization Surveillance Network (FluSurv-NET).
- Age-stratified hospitalization rates were calculated using the number of catchment-area residents with laboratory-confirmed influenza within 14 days prior to or ≤3 days after hospital admission during October 1–April 30 of each influenza season. Age-group-specific population denominators were obtained from the National Centers for Health Statistics. National rates of influenza-associated hospitalizations were adjusted for influenza testing practices, using a multiplier approach.¹

Data Collection

- Data on underlying medical history, influenza vaccination, antiviral use, and outcomes were abstracted from medical records using standard case report forms by trained surveillance officers.
- We used logistic regression to evaluate the odds of each dichotomous outcome associated with age.

Results

Table 1. Characteristics and Outcome of Children <18 Years of Age Hospitalized with Laboratory-Confirmed Influenza by Age Group, 2010–2019.

Demographic characteristics and outcome	<6 Months	6 to <24 Months	2 to 4 Years	5 to 8 Years	9 to 12 Years	13 to <18 Years	Total
	n = 2029	n = 3040	n = 2791	n = 2633	n = 1366	n = 1376	n = 13235
Sex, no. (%)							
Male	1176 (58.0)	1717 (56.5)	1571 (56.3)	1527 (58.0)	774 (56.7)	699 (50.8)	7464 (56.4)
Race, no. (%)							
Non-Hispanic White	654 (32.2)	865 (28.5)	920 (33.0)	995 (37.8)	514 (37.6)	555 (40.3)	4503 (34.0)
Non-Hispanic Black	484 (23.9)	785 (25.8)	792 (28.4)	746 (28.3)	381 (27.9)	383 (27.8)	3571 (27.0)
American Indian/Alaska Native	22 (1.1)	59 (1.9)	42 (1.5)	23 (0.9)	12 (0.9)	11 (0.8)	169 (1.3)
Asian/Pacific islander	107 (5.3)	211 (6.9)	146 (5.2)	120 (4.6)	61 (4.5)	58 (4.2)	703 (5.3)
Multiracial	32 (1.6)	61 (2.0)	38 (1.4)	40 (1.5)	19 (1.4)	10 (0.7)	200 (1.5)
Hispanic	494 (24.3)	748 (24.6)	598 (21.4)	487 (18.5)	255 (18.7)	253 (18.4)	2835 (21.4)
Unknown	236 (11.6)	311 (10.2)	255 (9.1)	222 (8.4)	124 (9.1)	106 (7.7)	1254 (9.5)
Underlying diseases, no. (%)							
Immunocompromising status							
Yes	10 (0.5)	123 (4.1)	201 (7.2)	293 (11.1)	177 (13.0)	235 (17.1)	1039 (7.9)
No/Unknown	2019 (99.5)	2917 (96.0)	2590 (92.8)	2340 (88.9)	1189 (87.0)	1141 (82.9)	12196 (92.1)
Any chronic condition							
Yes	531 (26.2)	1342 (44.1)	1574 (56.4)	1748 (66.4)	1035 (75.8)	1079 (78.4)	7309 (55.2)
No/Unknown	1498 (73.8)	1698 (55.9)	1217 (43.6)	885 (33.6)	331 (24.2)	297 (21.6)	5926 (44.8)
Severe outcomes*, no. (%)							
ICU Admission							
Yes	308 (15.2)	623 (20.5)	550 (19.7)	499 (19.0)	336 (24.6)	360 (26.2)	2676 (20.2)
No	1714 (84.5)	2410 (79.3)	2228 (79.8)	2121 (80.6)	1025 (75.0)	1010 (73.4)	10508 (79.4)
Death							
Yes	6 (0.3)	14 (0.5)	13 (0.5)	15 (0.6)	13 (1.0)	11 (0.8)	72 (0.5)
No	2020 (99.6)	3021 (99.4)	2772 (99.3)	2607 (99.0)	1350 (98.8)	1364 (99.1)	13134 (99.2)
Mechanical Ventilation							
Yes	83 (4.1)	154 (5.1)	152 (5.5)	120 (4.6)	89 (6.5)	92 (6.7)	690 (5.2)
No	1935 (95.4)	2872 (94.5)	2623 (94.0)	2494 (94.7)	1270 (93.0)	1279 (93.0)	12473 (94.2)
Pneumonia							
Yes	133 (6.6)	559 (18.4)	623 (22.3)	481 (18.3)	252 (18.5)	214 (15.6)	2262 (17.1)
No	1896 (93.5)	2481 (81.6)	2168 (77.7)	2152 (81.7)	1114 (81.5)	1162 (84.5)	10973 (82.9)

*Number of missing data: ICU admission (51), Death (29), Mechanical ventilation (72), Pneumonia (0)

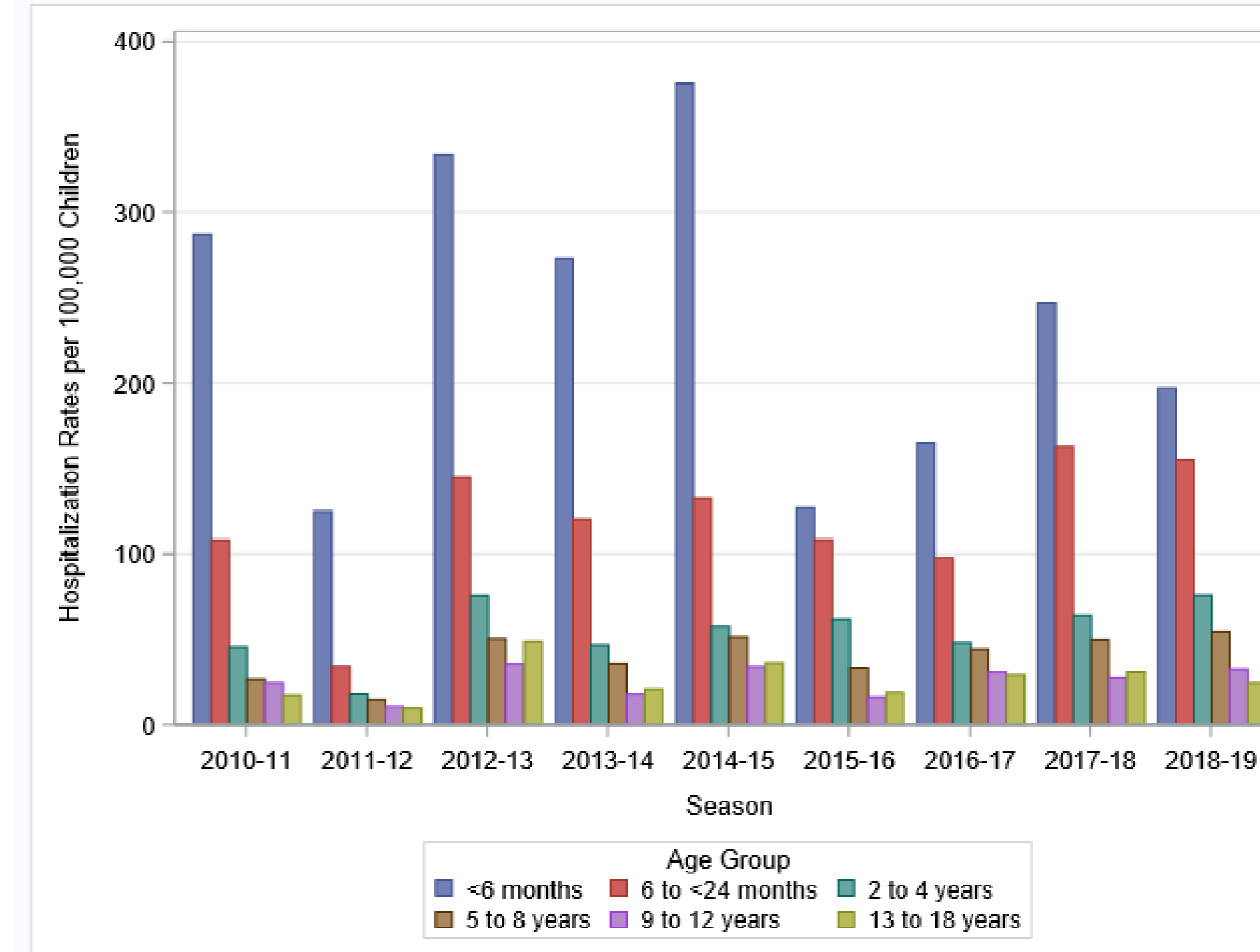


Figure 1. Age-specific, Adjusted Influenza-associated Hospitalization Rates among Children <18 years, by Season and by Age Category, 2010–2019.

Table 2. Unadjusted Odds Ratios for ICU Admission, Mechanical Ventilation, and Pneumonia among Children Hospitalized with Influenza, 2010–2019.

Age Group	ICU Admission ^a		Mechanical Ventilation ^b		Pneumonia ^c	
	Univariable Analysis		Univariable Analysis		Univariable Analysis	
	OR	95% CI	OR	95% CI	OR	95% CI
≥0 months to <6 months	reference		reference		reference	
≥6 months to <2 years	1.4	1.2 - 1.7	1.3	1.0 - 1.6	3.2	2.6 - 3.9
2 - 4 years	1.4	1.2 - 1.6	1.4	1.0 - 1.8	4.1	3.4 - 5.0
5 - 8 years	1.3	1.1 - 1.5	1.1	0.8 - 1.5	3.2	2.6 - 3.9
9 - 12 years	1.8	1.5 - 2.2	1.6	1.2 - 2.2	3.2	2.6 - 4.0
13 - <18 years	2.0	1.7 - 2.4	1.7	1.2 - 2.3	2.6	2.1 - 3.3

^aFor the univariable analysis, n = 13184 and 2676 cases with ICU admission.

^bFor the univariable analysis, n = 13163 and 690 cases with mechanical ventilation.

^cFor the univariable analysis, n = 13235 and 2262 cases with pneumonia.

Summary of Results

- Over 9 seasons, 13,235 children were identified. Stepwise decreases in unadjusted hospitalization rates with age occurred, with the highest rates in infants <6 months (ranging 165–375 per 100,000 persons).
- Among these children, 56% were male, 34% were non-Hispanic White, 55% had a preexisting medical condition, and 8% were immunocompromised.
- Use of antiviral treatment substantially increased from 56% to 85%, and influenza vaccination rates among hospitalized children increased from 34% to 43% over time (data not shown).
- 2,676 (20%) were admitted to ICU, 2,262 (17%) had pneumonia, 690 (5%) required mechanical ventilation, and 72 (0.5%) died. In univariable analysis, compared to hospitalized infants <6 months, children >13 years had higher odds of ICU admission (OR), 2.0; 95% CI, 1.7–2.4), mechanical ventilation (OR, 1.7; 95% CI, 1.2–2.3), and pneumonia (OR, 2.6; 95% CI, 2.1–3.3).

Conclusions

- Although influenza-related hospitalization rates decreased with increasing age, in-hospital severe outcomes were more common among hospitalized older children.
- Room for improvement exists in influenza vaccination coverage and antiviral use.
- While 20% of children were admitted to ICU, death was uncommon.

Reference) 1. Reed, et al. PLoS One. 2015. doi:10.1371/journal.pone.0118369