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Among Pediatric Patients Hospitalized for Influenza Infection, Pre-Existing Cardiomyopathy Confers Significantly Higher Morbidity and Mortality

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Influenza infection generally presents as an acute self-limited and uncomplicated infection in healthy children, but children <5 years and those with chronic medical conditions are at risk of serious complications of influenza including pneumonia and acute respiratory failure. Recently we reported that in-hospital mortality and morbidity were increased in those with congenital heart disease hospitalized with influenza.¹ Although there are reports of increased mortality and complications in influenza in children with other chronic diseases^{2,3} the literature is lacking information on complications of influenza infection in children with cardiomyopathy. Here, we report a recent nationwide retrospective study from Kids' Inpatient Database (KID) of the United States to examine risk of mortality and in-hospital complications of influenza infection in children with cardiomyopathy.

We analyzed data of hospital discharge records of patients with the nationally representative KID for years 2003, 2006, 2009, 2012, and 2016. Using International Classification of Disease, Ninth and Tenth Revision, Clinical Modification, we identified children hospitalized with cardiomyopathy, influenza infection and other variables studied. Cardiomyopathy includes dilated cardiomyopathy, hypertrophic cardiomyopathy, restrictive cardiomyopathy and other unspecified cardiomyopathy. We excluded children with myocarditis secondary to influenza to only include the children with pre-existing cardiomyopathy. The outcomes of interest were comparison of in-hospital mortality and morbidities between those children with influenza infection with and without concomitant cardiomyopathy. We adjusted for age, gender, race/ethnicity, hospital discharge quarter, year of admission and history of asthma, and presence of structural congenital heart disease for a logistic regression model to calculate outcome of interest. All statistical analyses were performed

using R version 3.6.0,⁴ R Studio 1.2⁵ (<http://www.R-project.org>) and *survey* package.⁶

We retrieved records of 171,933 children who were admitted with a diagnosis of influenza over the 5 years of available data; 231 cases of influenza-related myocarditis were excluded from analysis. Of the remainder, 491 (0.3%) had a diagnosis of cardiomyopathy prior to the influenza admission. The in-hospital mortality rate for children hospitalized with influenza was 0.47% (n = 817). In-hospital mortality was higher in children with cardiomyopathy 6.5% (n = 32) compared with those without cardiomyopathy 0.5% (n = 785) [adjusted odds ratio 8.1(5.0 to 13.3), p <0.001]. Acute respiratory failure was more common among those with cardiomyopathy compared to those without cardiomyopathy, 28.0% (n = 137) versus 4.9% (n = 8,469) [aOR of 5.1(3.9 to 6.6), p <0.001]. Similarly, acute kidney injury was more common in those with cardiomyopathy versus without, 7.5% (n = 37) versus 0.9%(n = 1586) [aOR 3.9(2.4 to 6.3), p <0.001]. Children with cardiomyopathy were more likely to experience other complications as well (Table 1). Hospital stay in children with cardiomyopathy was longer than those without cardiomyopathy at median 6(the interquartile range 3 to 15) days versus 2 (the interquartile range 2 to 4) days, p <0.001.

Ours is the first study to report in-hospital outcomes in children with pre-existing cardiomyopathy who were hospitalized for influenza infection. We found that the presence of cardiomyopathy significantly increased the risk of in-hospital mortality and morbidity in children with influenza infection. The methodology does not allow us to pinpoint the exact etiology of this difference, but it is likely that co-morbid pulmonary disease and limited cardiac reserves are important factors. In addition, acute systemic inflammatory response caused by an influenza infection may lead to acute decompensated heart failure to an already failing myocardium.⁷

Influenza vaccination offers significant protection against severe influenza disease and influenza-related hospitalization.^{8,9} Annual influenza vaccination is recommended for all children, but particularly for those with chronic diseases to prevent the serious complications from influenza.

Table 1

Comparison of characteristics and in-hospital complications between children with and without cardiomyopathy over the 5 years studied

Variable	Presence of cardiomyopathy	
	No	Yes
Total influenza cases	171,442	491
Age, years (median, IQR)	2.0 (0-8)	8.0 (2-16)*
Female	76,325 (44.7%)	200 (41.0%)
Race		
White	63,682 (44.9%)	185 (42.1%)
Black	28,101 (19.8%)	91 (20.7%)
Hispanic	36,001 (25.4%)	119 (27.0%)
Others	14,087 (9.9%)	45 (10.3%)
Discharge quarter		
Jan-Mar	52,314 (30.5%)	148 (30.3%)
Apr-Jun	21,548 (12.6%)	103 (21.0%)
Jul-Sep	13,221 (7.7%)	37 (7.4%)
Oct-Dec	84,279 (49.2%)	202 (41.3%)
Comorbid conditions		
Asthma	37,946 (22.1%)	76 (15.5%)*
Congenital heart diseases	4,561 (2.7%)	82 (16.7%)*
Complications		
Respiratory failure	8,469 (4.9%)	137 (28.0%)*
Acute kidney injury	1,586 (0.9%)	37 (7.5%)*
Invasive mechanical ventilation(IMV)	7,647 (4.5%)	122 (24.9%)*
Noninvasive mechanical ventilation(NIMV)	2,336 (1.4%)	35 (7.2%)*
Tachyarrhythmias	546 (0.3%)	50 (10.2%)*
Heart block/conduction disorders	336 (0.2%)	28 (5.7%)*
Sudden cardiac arrest	290 (0.2%)	29 (5.9%)*
ECMO [#]	239 (0.14%)	11 (2.2%)*
In-hospital mortality	785 (0.5%)	32 (6.5%)*
Length of stay, days(median, IQR)	2(2-4)	6 (3-15)*

[#] Extracorporeal membrane oxygenation.

CHD = congenital heart disease.

* p value is <0.001 for these comparisons.

Regarding limitations of this report, data in the KID database were not collected for research, but were for medical coding and billing. KID captures only inpatient records, so the findings may not be extrapolatable to the outpatient settings.

In conclusion, our findings indicate that children with influenza infection and a concomitant cardiomyopathy are at dramatically increased risk of in-hospital mortality and adverse clinical outcomes. Our findings support increased efforts of medical teams, parents, and health officials working together to increase influenza vaccination rates in all children, especially in those with chronic medical conditions, to prevent morbidity and mortality.

Disclosures

All authors declare they have not conflict of interests to declare.

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Temporal Trends in the Prevalence of Current E-Cigarette and Cigarette Use by Annual Household Income from 2016 to 2018 (from the Behavioral Risk Factor Surveillance System [BRFSS] Survey)



E-cigarettes have become more prevalent in the United States¹ and have been used for recreational purposes or for smoking cessation. E-cigarettes may be equal in cost or even more expensive than traditional cigarettes, and therefore, prevalence of e-cigarettes may differ by income.

Our study population consisted of individuals from the Behavioral Risk Factor Surveillance System (BRFSS) survey, a nationwide telephone-based questionnaire of a random sample of US adult residents in all 50 states as well as the District of Columbia and 3 US territories regarding chronic health conditions, health-related risk behaviors, and the use of preventive services. We utilized data from the 2016, 2017, and 2018 BRFSS datasets. All variables were self-reported and prevalence values were weighted to reflect the sampling methodology.² All