3. Myny D, Depuydt P, Colardyn F, Blot S. Ventilator-associated pneumonia in a tertiary care ICU: analysis of risk factors for acquisition and mortality. *Acta Clin Belg* 2005;60:114–121.
4. Harris BD, Thomas GA, Greene MH, Spires SS, Talbot TR. Ventilator bundle compliance and risk of ventilator-associated events. *Infect Control Hosp Epidemiol* 2018;39:637–643.
5. Klompas M, Speck K, Howell MD, Greene LR, Berenholtz SM. Reappraisal of routine oral care with chlorhexidine gluconate for patients receiving mechanical ventilation: systematic review and meta-analysis. *JAMA Intern Med* 2014;174:751–761.
6. Price R, MacLennan G, Glen J, SuDDICU Collaboration. Selective digestive or oropharyngeal decontamination and topical oropharyngeal chlorhexidine for prevention of death in general intensive care: systematic review and network meta-analysis. *BMJ* 2014;348(Mar 31 2):g2197–g2197.
7. Klompas M, Li L, Kleinman K, Szumita PM, Massaro AF. Associations between ventilator bundle components and outcomes. *JAMA Intern Med* 2016;176:1277–1283.
8. Blot SI, Poelaert J, Kollef M. How to avoid microaspiration? A key element for the prevention of ventilator-associated pneumonia in intubated ICU patients. *BMC Infect Dis* 2014;14:119.
9. Bouadma L, Karpanen T, Elliott T. Chlorhexidine use in adult patients on ICU. *Intensive Care Med* 2018;30(Suppl 1):S827–S823.
10. Deschepper M, Waegeman W, Eeckloo K, Vogelaers D, Blot S. Effects of chlorhexidine gluconate oral care on hospital mortality: a hospital-wide, observational cohort study. *Intensive Care Med* 2018; 37:2709–2710.
11. Ricard JD, Lisboa T. Caution for chlorhexidine gluconate use for oral care: insufficient data. *Intensive Care Med* 2018;11:845–843.
12. Bouadma L, Klompas M. Oral care with chlorhexidine: beware! *Intensive Care Med* 2018;35(Suppl 2):915–913.
13. Labeau SO, Van de Vyver K, Brusselaers N, Vogelaers D, Blot SI. Prevention of ventilator-associated pneumonia with oral antiseptics: a systematic review and meta-analysis. *Lancet Infect Dis* 2011;11: 845–854.

Detection of influenza myocarditis using national healthcare safety network surveillance definitions accounting for fever in older adults

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To the Editor—Cardiovascular complications following influenza infection are often severe.[1,2] National Healthcare Safety Network (NHSN) surveillance definitions monitor cardiovascular complications such as myocarditis. However, NHSN surveillance definitions for myocarditis do not account for immunosenescence in older adults. Specifically, older adults frequently have lower baseline temperatures and blunted febrile responses.[3] Accordingly, Infectious Diseases Society of America (IDSA) guidelines for older adults define fever as (1) a single oral temperature >100°F; (2) repeated oral temperatures >99°F; or (3) an increased temperature >2°F above baseline.[4] This is important because older adults incur high risks of influenza-associated complications,[5] and 2017 NHSN criteria define fever exclusively as temperature >100.4°F.

We compared the detection of myocarditis following influenza infection using the 2017 NHSN definition and a proposed modified definition that accounts for fever in older adults. We performed a cohort study of all inpatients ≥18 years of age with influenza A or influenza B between November 1, 2014, and April 30, 2015, and November 1, 2015, and April 30, 2016, at Yale New Haven Hospital, a 1,541-bed tertiary-care medical center in New Haven, Connecticut. Influenza was detected using real-time Taqman polymerase chain reaction according to the protocol developed by the Yale New Haven Hospital Clinical Virology Laboratory. The Yale Human Investigation Committee approved this study.

We identified all patients developing myocarditis within 30 days following influenza detection using the 2017 NHSN definition and proposed modified definition. The 2017 NHSN definition considered myocarditis as meeting 1 of the following criteria: (1) influenza identified from myocardial tissue or (2) ≥2 clinical features including fever (>100.4°F), chest pain, paradoxical pulse, or increased heart size with no other recognized cause plus ≥1 additional parameter including an EKG consistent with myocarditis, histological evidence of myocarditis, 4-fold rise in paired sera from IgG antibody titer, or pericardial effusion. Our proposed modified definition had criteria identical to those of the 2017 NHSN definition except for fever, which was defined according to the IDSA guidelines for older adults ≥65 years of age.[4]

For all patients, we recorded demographics, comorbidities, antiviral therapy, receipt of seasonal influenza vaccine, hospital characteristics, all-cause mortality, and whether NHSN criteria were present. Influenza infection was categorized as community-acquired versus hospital-acquired based on detection within 48 hours of admission. We compared differences in the proportions of myocarditis detected with the 2017 NHSN definition versus the proposed modified definition using the McNemar test.

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Table 1. Descriptive Characteristics of Adult Patients With Influenza

Characteristic	2014–15 Season (N = 454), No. (%)	2015–16 Season (N = 304), No. (%)
Female gender	257 (57)	162 (53)
White race	313 (69)	171 (56)
Acquisition type		
Community-acquired	415 (91)	275 (90)
Hospital-acquired	39 (9)	29 (10)
Influenza type		
A	380 (84)	251 (83)
B	74 (16)	53 (17)
Comorbidities		
Chronic obstructive pulmonary disease	163 (36)	110 (36)
Solid organ tumor	96 (21)	46 (15)
Diabetes mellitus	113 (25)	68 (22)
End-stage renal disease	21 (5)	9 (3)
Pregnancy	6 (1)	5 (2)
Cerebrovascular disease	171 (38)	83 (27)
Immunocompromised	50 (11)	38 (13)
Body mass index > 40	46 (10)	38 (13)
Admission location		
Home	373 (82)	259 (85)
Skilled nursing facility	63 (14)	30 (10)
Transfer	8 (2)	7 (2)
Other	10 (2)	8 (3)
Discharge disposition		
Home	282 (62)	218 (72)
Skilled nursing facility	132 (29)	63 (21)
Death	23 (5)	15 (5)

Overall, we identified 758 influenza-positive patients. Median age was 66 years (range, 18–97 years). Table 1 provides patient characteristics. Among all patients, 181 patients (23.9%) received the seasonal influenza vaccine, and 534 patients (70.4%) received antiviral therapy. The median length of stay was 4 days (interquartile range, 2–9 days).

There was no difference in detection of influenza-associated myocarditis using the proposed modified (N = 6, 0.8%) versus the 2017 NHSN (N = 5, 0.7%) definition ($P = .32$). Among the 6 myocarditis cases, 4 patients were ≥65 years of age. The additional case was detected using the proposed modified definition; this patient had fever (defined by a single temperature >100°F) and repeated temperatures >99°F. Overall, 5 cases met both definitions. The most common criteria included EKG findings (N = 6), fever (N = 5), and chest pain (N = 4). Furthermore, 3 case patients required intensive care, 2 patients required intubation and inotropic support, and 1 patient died.

Although not statistically significant, our results suggest that the 2017 NSHN definition may underestimate the frequency of myocarditis when compared to a proposed modified definition that accounts for fever in older adults per IDSA guidelines. Despite an absolute difference of 1 case, the differential detection of myocarditis may be more pronounced across larger populations with predominantly older adults, such as that cared for by the Veterans Health Administration. Moreover, these data contribute to the limited body of evidence evaluating myocarditis surveillance definitions. Collectively, our findings underscore the need for increased recognition for cardiovascular complications following influenza infection in older adults.

The variable presentation of myocarditis from asymptomatic infection to cardiogenic shock has implications for surveillance.[4,6,7] Without myocardial biopsy, which is often reserved for fulminant cases, we show that NSHN criteria may selectively detect nonsevere cases. Additionally, EKG changes in myocarditis are variable, which may impact sensitivity and specificity of surveillance definitions.[8] Revised NSHN criteria accounting for immunosenescence in older adults may broaden recognition of influenza-associated myocarditis and promote early supportive care.

This work has several limitations. First, our analysis is limited by the small number of cases consistent with the rarity of myocarditis. Second, referenced IDSA guidelines were established for long-term care facilities.[4] However, the frequency of admissions from long-term care facilities and prevalence of multiple comorbidities and functional disabilities among inpatients suggest that these guidelines may be generalizable. Finally, data collection was subject to observation bias.

In summary, ~1% of adult inpatients with laboratory-proven influenza meet criteria for myocarditis within 30 days of influenza detection. When applying a proposed modified definition of myocarditis that accounts for fever in older adults, only 1 additional case was detected compared to the 2017 NHSN definition. Larger studies are needed to compare differences in myocarditis detection using surveillance definitions that account for immunosenescence in older adults.

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References

1. Kwong JC, Schwartz KL, Campitelli MA, *et al*. Acute myocardial infarction after laboratory-confirmed influenza infection. *N Engl J Med* 2018;378:345–353.
2. Ludwig A, Lucero-Obusan C, Schirmer P, Winston C, Holodniy M. Acute cardiac injury events ≤30 days after laboratory-confirmed influenza virus infection among US veterans, 2010–2012. *BMC Cardiovasc Disord* 2015;15:109.
3. Norman DC. Clinical features of infection in older adults. *Clin Geriatr Med* 2016;32:433–441.
4. High KP, Bradley SF, Gravenstein S, *et al*. Clinical practice guideline for the evaluation of fever and infection in older adult residents of long-term care facilities: 2008 update by the Infectious Diseases Society of America. *Clin Infect Dis* 2009;48:149–171.

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5. Loubet P, Samih-Lenzi N, Galtier F, *et al*. Factors associated with poor outcomes among adults hospitalized for influenza in France: a three-year prospective multicenter study. *J Clin Virol* 2016;79:68–73.
6. Al-Amoodi M, Rao K, Rao S, Brewer JH, Magalski A, Chhatriwalla AK. Fulminant myocarditis due to H1N1 influenza. *Circ Heart Fail* 2010;3:e7–e9.
7. Kumar K, Guirgis M, Zieroth S, *et al*. Influenza myocarditis and myositis: case presentation and review of the literature. *Can J Cardiol* 2011;27:514–522.
8. Morgera T, Di Lenarda A, Dreas L, *et al*. Electrocardiography of myocarditis revisited: clinical and prognostic significance of electrocardiographic changes. *Am Heart J* 1992;124:455–467.

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