Diagnosis Codes for Mold Infections and Mold Exposure Before and After Hurricane Harvey Among a Commercially Insured Population—Houston, Texas, 2016–2018

Kaitlin Benedict MPH [ID], Brendan R. Jackson MD, MPH and Mitsuru Toda PhD

Centers for Disease Control and Prevention, Atlanta, GA, USA

Abstract

Objective: Indoor mold after flooding poses health risks, including rare but serious invasive mold infections. The purpose of this study was to evaluate use of International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnosis codes for mold infection and mold exposure in Houston, Texas, during the year before and the year after Hurricane Harvey.
Methods: This study used data from MarketScan, a large health insurance claims database.
Results: The incidence of invasive mold infections remained unchanged in the year after Hurricane Harvey; however, the incidence of diagnosis codes for mold exposure nearly doubled compared with the year before the hurricane (6.3 vs 11.0 per 100 000 enrollees, rate ratio: 1.7, 95% confidence interval 1.0–3.1).
Conclusions: Diagnosis codes alone may not be sufficiently sensitive to detect changes in invasive mold infection rates within this population and time frame, demonstrating the need for more comprehensive studies.

In 2017, Hurricane Harvey resulted in one of the largest flooding events in US history, involving over 300 000 buildings, displacing an estimated 40 000 residents, and causing an estimated US $125 billion in damage throughout southeastern Texas and severely affecting the Houston metropolitan area.[1] Indoor mold is a serious concern after flooding. Mold can cause a range of health effects, including exacerbation of allergies or asthma, and invasive mold infections (IMI), which are rare but cause high morbidity and mortality in immunocompromised or critically ill people. The incubation period for most types of IMI is not well-established but can range from days to months. Upper respiratory allergic symptoms were commonly reported by people exposed to flooding after Hurricane Harvey.[2] However, whether flooding increases the risk for IMI remains unclear, as previous studies of Hurricane Harvey and other hurricanes have not shown an association.[3–5] This study sought to compare rates of IMI and mold exposure before and after Hurricane Harvey, using commercial health insurance claims data.

Methods

This study used data from the Merative™ MarketScan® 2016–2018 Commercial and Medicare Databases. These databases constitute one of the largest collections of de-identified patient-level data in the United States and are widely used in public health and health services research. The databases include private health insurance claims data and enrollment data from large employers and health plans that provide health care for > 39 million employees, dependents, and retirees. Because the data are fully de-identified, this analysis was not subject to review by the Centers for Disease Control and Prevention (CDC) institutional review board.

The analysis was conducted partly using the Merative™ MarketScan® Treatment Pathways online analytic tool. The analysis compared rates of mold-related illnesses in the year before (September 1, 2016–August 31, 2017) with the year after (September 1, 2017–August 31, 2018) Hurricane Harvey, among residents of the Houston, Texas, metropolitan area during September 2017. The databases contained information on approximately 300 000 Houston, Texas, residents. Mold-related illnesses were defined by International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes for mold infection (aspergillosis [B44], mucormycosis [B46], and unspecified mycosis [B49]) and "contact with and (suspected) exposure to mold (toxic)" (Z77.120). The index date was the date the diagnosis code was first used during the analytic period. For each of the 2 cohorts, inclusion criteria included continuous insurance enrollment during the analytic period and absence of diagnosis codes for mold-related illness in the year before the index date, in an attempt to identify incident illnesses.

Table 1. Diagnosis codes for mold infections and mold exposure before and after Hurricane Harvey among a sample of patients with commercial health insurance, Houston, Texas

Condition, ICD-10 code(s)	Before Hurricane Harvey		After Hurricane Harvey		Rate ratio (95% CI)
	Number of patients	Rate per 100 000 enrollees	Number of patients	Rate per 100 000 enrollees	
Aspergillosis, B44	18	5.4	15	5.2	0.95 (0.47–1.90)
Mucormycosis, B46	*	0.9	*	0.7	0.76 (0.09–5.11)
Unspecified mycosis, B49	87	26.3	84	28.9	1.10 (0.81–1.49)
Contact with and (suspected) exposure to mold (toxic), Z77.120	21	6.3	32	11.0	1.74 (1.00–3.06)

*Cells with < 10 patients have been suppressed.
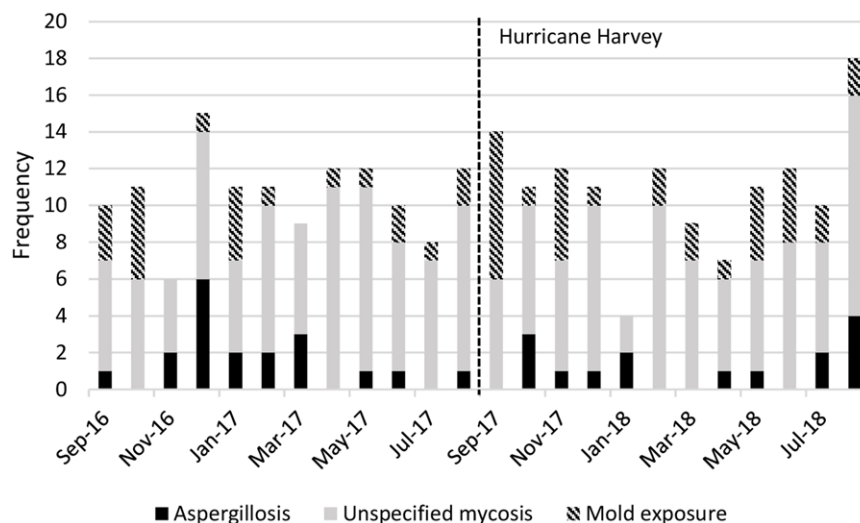
Figure 1. Monthly number of patients with mold-related illnesses among a sample of patients with commercial health insurance, Houston, Texas, 2016–2018. (Mucormycosis is not shown due to small counts).

Results

Before versus after Hurricane Harvey, the incidence of aspergillosis (5.4 vs 5.2 per 100 000 enrollees), mucormycosis (0.9 vs 0.7), and unspecified mycosis (26.3 vs 28.9) was not significantly different (Table 1). The incidence of diagnosis codes for mold exposure increased from 6.3 before the hurricane to 11.0 (rate ratio: 1.7, 95% confidence interval 1.0–3.1). This increase was particularly noticeable in September 2017, immediately after the hurricane (Figure 1).

Discussion

This analysis of administrative data in a large commercially insured population did not reveal significant differences in rates of IMI before and after Hurricane Harvey, similar to previous studies evaluating IMI after Hurricane Harvey and other flooding events.[3,4,6] However, a near doubling of diagnosis codes for "contact with and (suspected) exposure to mold (toxic)" occurred, indicating health care visits for concerns related to mold exposure, consistent with the known non-infectious health risks of mold after flooding.

The increase in diagnosis codes for "contact with and (suspected) exposure to mold (toxic)" in the month after the hurricane is not particularly surprising but is challenging to interpret in terms of its clinical importance (eg, whether it corresponds to mold-related illness). Only certain molds are toxigenic, and they present similar hazards as other common indoor molds. Further studies would be useful to characterize the types of illness among people who receive this diagnosis code. Another explanation for the increase in this diagnosis code is increased health care seeking due to fears about the potential health effects of mold, for which public awareness appears to be high.[7,8]

Possible reasons for the absence of an observed increase in IMI rates post-hurricane include (1) lack of mold exposures in people at highest risk for IMI, (2) limited access to health care, (3) the possibility that exposure to flood- and mold-damaged homes does not meaningfully increase IMI risk, and (4) limited sensitivity of ICD-10-CM codes to detect IMI. Lack of mold exposures as an explanation for the stable IMI rates seems somewhat unlikely, particularly considering the finding about increased diagnosis codes for contact with or exposure to mold; although, those patients may be different from the IMI patients in terms of underlying risk factors, which the study was unable to evaluate. Furthermore, in a convenience sample study of immunosuppressed Houston residents, over three-quarters reported seeing or smelling mold inside their home, and half participated in cleanup activities, often without personal protective equipment, which could increase the chance of mold exposures.[9] Mold exposures also could have been avoided by people who evacuated their homes or relocated, but many (75%) immunosuppressed people reported staying in their homes most of the time during August to November 2017.[9] This study accounts for

real-world movement of a sample of enrollees in and out of the Houston area before and after September 2017, which could have affected the results in either direction.

Limited access to health care after the hurricane, either due to facility closures or financial concerns, could also affect IMI rates. However, 1 report showed that only 9% of households reported increased difficulty in getting medical care after Hurricane Harvey.[10] Access to health care is unlikely to be a major issue in this study, which represents patients with uninterrupted commercial health insurance. The inability to examine IMI rates among patients with other types of health insurance or those without health insurance is a limitation. Lower socioeconomic status may be associated with higher levels of mold in the home[11] as well as with certain underlying medical conditions that increase the risk for fungal infections.[12] Further studies accounting for the critical role of health disparities in post-disaster health effects of mold are warranted.

This study cannot rule out the possibility that mold exposures resulting from flood damage do not meaningfully increase risk of IMI. Data are limited on the types of molds that grow in flood-damaged homes, which may vary by geography and climate, and it is possible that the relatively small number of infectious molds (eg, *Aspergillus* spp. and mucormycetes) do not increase in prevalence after flooding compared with the many other molds that do not cause invasive disease. It is also possible that an increase in household exposures to infectious molds does not increase risk of IMI beyond risks from typical exposures for immunocompromised patients; however, numerous health-care-associated IMI outbreaks suggest that greater exposures can lead to more IMI infections, at least in the health care setting.[13,14]

Perhaps the most likely explanation for this study's findings is that ICD-10-CM codes alone are not sensitive enough to identify changes in IMI rates within this population and time frame, in which relatively few cases were available for analysis. In general, IMI are challenging to diagnose and can be difficult to distinguish from mold colonization using laboratory results. Therefore, a thorough medical record review is often required to identify IMI by evaluating underlying conditions, clinical features, and microbiology records. One such study showed that only 40% of patients with IMI before and after Hurricane Harvey had an ICD-10-CM code for mold infection documented in the medical record (CDC, unpublished data). In other patient populations, the sensitivity of diagnosis codes for IMI is approximately 60%, suggesting that they are not adequate as the sole mechanism for case ascertainment.[15,16]

In conclusion, ICD-10-CM codes alone were insufficient for identifying any potential increase in IMI after Hurricane Harvey in this privately insured population. More robust and detailed studies are needed to better evaluate IMI and other mold-related health effects after flooding events.

Author contribution. All authors were responsible for the study conceptualization and methodology. Kaitlin Benedict performed the data analysis and prepared the first draft of the manuscript. All authors edited the manuscript. Brendan Jackson and Mitsuru Toda supervised the study. All authors read and approved the final manuscript. (The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.)

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