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A polymicrobial fungal outbreak in a regional burn center after Hurricane Sandy

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Key Words:
Burn unit
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Objective: To describe a polymicrobial fungal outbreak after Hurricane Sandy.
Design: An observational concurrent outbreak investigation and retrospective descriptive review.
Setting: A regional burn intensive care unit that serves the greater Baltimore area, admitting 350-450 burn patients annually.
Patients: Patients with burn injuries and significant dermatologic diseases such as toxic epidermal necrolysis who were admitted to the burn intensive care unit.
Methods: An outbreak investigation and a retrospective review of all patients with non-candida fungal isolates from 2009-2016 were performed.
Results: A polymicrobial fungal outbreak in burn patients was temporally associated with Hurricane Sandy and associated with air and water permeations in the hospital facility. The outbreak abated after changes to facility design.
Conclusions: Our results suggest a possible association between severe weather events like hurricanes and nosocomial fungal outbreaks. This report adds to the emerging literature on the effect of severe weather on healthcare-associated infections.

Mold infections cause significant morbidity and mortality in high-risk patients such as burn patients and can be associated with a mortality rate of 30%-80% in this patient population.[1,2] Mold species are ubiquitous in the environment and have been associated with multiple outbreaks in hospital settings, including burn units.[3,4] Many of these outbreaks have been attributed to construction and almost all have been attributed to airborne dissemination of fungal spores.[3,5]

Severe weather may have an effect on growth of fungal species and may contribute to hospital outbreaks of infection. For example, flooding has been associated with several outbreaks and pseudo-outbreaks.[6,7] With increasing concerns about escalation of severe weather events due to global warming,[8] it is important to understand the effect of severe weather on hospital outbreaks.

We report a polymicrobial outbreak of mold infections in a regional burn center after Hurricane Sandy, which occurred on October 29, 2012.

METHODS

The burn intensive care unit is a 10-bed intensive care unit with an adjoining stepdown unit, which admits 300-400 patients annually for burn injurie and serves the state of Maryland and surrounding areas.

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Table 1
Non-candida fungal cultures in the burn unit from January 2009 through December 2016

Patient	Percent TBSA burn	Date admitted	Species
1	64%	5/21/2009	*Fusarium*
2	Non-burn	7/29/2010	*Aspergillus fumigatus*
3	55%	11/16/2010	*Penicillium*
4	50%	10/23/2010	*Aspergillus flavus*
			Trichosporon asahii
			Mucor
5	Non-burn	12/19/2010	*Aspergillus flavus*
6	2%	3/5/2012	*Trichoderma*
7	Non-burn	4/30/2012	*Aspergillus fumigatus*
8	85%	10/20/2012	*Aspergillus fumigatus*
			Rhizopus
			Aspergillus terrus
			Aspergillus flavus
9	4%	12/1/2012	*Rhizopus*
10	60%	12/22/2012	*Fusarium*
			Mucor
			Aureobasidium
11	42%	1/14/2013	*Aspergillus fumigatus*
12	45%	2/6/2013	*Aspergillus fumigatus*
13	50%	8/16/2013	*Aspergillus fumigatus*
			Trichosporon
			Curvularia
			Bipolaris
14	Non-burn	10/2/2013	*Aspergillus niger*
			Aspergillus flavus
15	4%	4/2014	*Aspergillus fumigatus*
16	31%	9/2014	*Fusarium*
20	Non-burn	4/2015	*Aspergillus fumigatus*
21	25%	9/2015	*Aspergillus niger*
22	50%	10/2015	*Mucor*
23	75%	1/2016	*Aspergillus flavus*

TBSA, total body surface area.

Table 2
Timeline of interventions

12/2012	Increase in the number of fungal isolates noted
1/2013	Convening of a multidisciplinary outbreak team
1/2013	Visual inspection 1. Leaky windows and porous ceilings noted with leaks 2. Dust accumulation noted 3. No evidence of gross mold infestation in walls or above false ceilings
1/2013	Enhanced cleaning with checklist and use of a sporocidal agent
1/2013	Use of portable HEPA filters in all burn patient rooms
1/2013	Encouraged practice of keeping doors closed
1-2/2013	Environmental cultures and air particle counts
2/2013	Window leaks sealed
2/2013	HVAC system evaluated 1. Central air handling filters at 99.9% efficiency 2. 10-12 air exchanges per hour (above recommendations for ICU rooms) 3. Slightly positive pressure in all ICU rooms
2/2013	Pathway to interstitial space above false ceilings evaluated and leaks sealed
3/2013	*Penicillium* in air ducts remediated
5/2013	OR HEPA filters tested
4/2014	Ceilings sealed and light fixtures replaced with sealed lighting

HEPA, high-efficiency particle; *HVAC*, heating, ventilation, and air conditioning; *ICU*, intensive care unit; *OR*, operating room.

In November 2012, an increased number of patients with mold isolated from clinical samples was observed in the burn intensive care unit.

A concurrent and retrospective epidemiologic review of cases was performed using electronic medical records. Cases were defined as patients admitted to the burn unit from 2009 to 2016 who were growing a non-candida fungal isolate from a clinical specimen. Microbiological records were searched to identify all cases. Several patients had more than one mold species isolated during the outbreak time period (Table 1). A secondary case definition of unique fungal isolates from a clinical specimen was created to capture the diversity of fungal species. Chart review was performed on all cases to assess risk factors for fungal infections and common epidemiologic links.

The facility structure was evaluated. The burn intensive care unit faces south and is part of the medical complex, which is located on a hill at one of the highest elevations in Baltimore. Construction was occurring on the west side of the building (not adjacent to the burn unit) that had begun in the earlier part of 2012.

The physical environment and clinical practices were evaluated. Burn unit staff were interviewed; clinical care practices were observed; the physical unit was inspected; and particle counts and microbiologic cultures of air and surfaces were obtained. Additinally, the air handling system and air pressures in the burn patient rooms were evaluated; the plenum (the space between the finished ceiling of a space and the floor or roof structure above) was visualized; and air filter efficiencies were evaluated. In our burn unit, it has been standard practice to use contact precautions for all patients. Quaternary ammonia agent was used for daily cleaning. In December 2012, when the increase in cases of mold infection was noted, enhanced cleaning with a sporicidal agent was implemented, and portable high-efficiency particle (HEPA) filters were placed in the patient rooms. The patient rooms in the burn unit have suspended acoustical tile ceilings and do not have point-of-exit continuous HEPA filtration (Table 2).

Hurricane Sandy hit Baltimore on October 29, 2012, several weeks prior to the identification of an increased number of mold species. This storm caused 37 visible areas of water infiltration across the campus. Two patient rooms were closed to patients during the storm due to water infiltration. One of the closed rooms was on the floor above the burn intensive care unit. During this time period, no changes were made to cleaning protocols, culturing protocols, or laboratory techniques.

We created epidemic curves for the number of affected patients and the number of unique fungal isolates from January 2009 through December 2016 (Fig 1 and 2).[9,10]

RESULTS

From January 2009 through December 2016, 23 patients with 31 unique fungal isolates per patient were identified in the burn intensive care unit. During the outbreak period, which was defined from the time of the first identified mold isolate after Hurricane Sandy to the time of repair of the facility ceiling in April 2014, 4 of 7 patients (64%) had 2-4 different mold species isolated. In the previous time period, from 2009-2012, only 1 of 10 patients (10%) had multiple species of mold isolated from their clinical specimens. This suggests diffuse environmental contamination rather than a point-source outbreak. The rate of mold infections was 0.6/1000 patient days prior to the outbreak, 2.0/1000 patient days during the outbreak, and 0.8/1000 patient days after the outbreak. If the number of unique fungal isolates per patient are used, the rate was 0.76/1000 patient days before the outbreak, 4.56/1000 patient days during the outbreak and 0.8/1000 patient days after the outbreak.

The case patients were mostly in the corner rooms with windows on 2 sides of the room. These rooms are also preferentially used to house the sickest patients. The facility design was consistent with American Institute of Architects (AIA) intensive care unit room recommendations;[11] however, air permeation was noted around the window seals. The false ceiling was in continuity with residual space, which was in continuity with the outdoor air.