An air quality-focused personnel intervention to improve health among skilled nursing facility (SNF) residents

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Industrial Hygiene Resources
Wildfires activity is increasing in the Western US …..and where there’s fire, there’s smoke

Wildfire smoke is a complex mixture of 100’s of constituents/compounds, including:

- Particulate matter
- CO
- VOCs
- CO₂
- NOx
- Hydrocarbons
An air quality-focused personnel intervention to improve health among SNF residents

Goals of project

• Determine the feasibility of deploying low-cost sensors to measure outdoor and indoor air quality
  – Attempt to associate air quality with health data at skilled nursing facilities
• Design and implement an educational workshop focused on air quality, health and HVAC management
  – Survey the utility of the workshop material
  – Explore opportunities to develop a smoke readiness plan and assess potential barriers/challenges
Citing low-cost sensors within SNFs in a Mountain West state

- Participating facilities (n=4) are geographically dispersed and topographically unique
- Three different airsheds are represented

### Facility characteristics

<table>
<thead>
<tr>
<th>Facility</th>
<th>Approximate Building age</th>
<th>Approximate Square feet</th>
<th>Approximate number of beds</th>
<th>Approximate age of original HVAC (years)</th>
<th>Approximate age of HVAC update (years)</th>
<th>HVAC filter rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNF 1</td>
<td>50</td>
<td>30,000</td>
<td>80</td>
<td>50</td>
<td>Unknown</td>
<td>MERV 13</td>
</tr>
<tr>
<td>SNF 2</td>
<td>10</td>
<td>15,000</td>
<td>15</td>
<td>10</td>
<td>NA</td>
<td>MERV 13</td>
</tr>
<tr>
<td>SNF 3</td>
<td>50</td>
<td>15,000</td>
<td>40</td>
<td>15</td>
<td>NA</td>
<td>MERV 13</td>
</tr>
<tr>
<td>SNF 4</td>
<td>45</td>
<td>15,000</td>
<td>35</td>
<td>45</td>
<td>15</td>
<td>MERV 13</td>
</tr>
</tbody>
</table>
Results

- Approximately 300 days of sampling inside & outside at 4 facilities
- Missing data occurred due to power/WiFi outage and sensor failure
- Minimal indoor effects in non-wildfire season
- Smoke events varied by geographic region
- Extreme indoor spikes are possible
Outdoor to indoor comparison demonstrates variability in infiltration across facilities

<table>
<thead>
<tr>
<th>Facility</th>
<th>Sampling Days</th>
<th>Outdoor – Indoor PM$_{2.5}$ Difference (µg/m$^3$) mean (sd) min, median, max</th>
<th>Outdoor/Indoor PM$_{2.5}$ ratio</th>
<th>Infiltration Efficiency (95% CI) mean (sd) min, median, max</th>
<th>Outdoor-generated indoor PM$_{2.5}$ (µg/m$^3$) mean (sd) min, median, max</th>
<th>Percent (%) indoor PM$_{2.5}$ generated outdoors mean (sd) min, median, max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility 1</td>
<td>321</td>
<td>6.5 (8.8) -0.2, 3.5, 52.7</td>
<td>0.3</td>
<td>0.38 (0.38, 0.48) 2.6 (5.6) 0.0, 0.6, 36.8</td>
<td>97.6 (9.1) 29.2, 100.0, 100.0</td>
<td></td>
</tr>
<tr>
<td>Facility 2</td>
<td>321</td>
<td>2.3 (3.7) -1.4, 1.0, 29.1</td>
<td>0.7</td>
<td>0.76 (0.72, 0.79) 4.6 (11.4) 0.0, 0.9, 100.6</td>
<td>97.4 (11.8) 5.2, 100.0, 100.0</td>
<td></td>
</tr>
<tr>
<td>Facility 3</td>
<td>311</td>
<td>5.5 (7.9) -1.5, 3.2, 76.3</td>
<td>0.2</td>
<td>0.22 (0.21, 0.23) 1.0 (2.8) 0.0, 0.2, 35.4</td>
<td>99.7 (4.1) 47.3, 100.0, 100.0</td>
<td></td>
</tr>
<tr>
<td>Facility 4</td>
<td>273</td>
<td>6.2 (11.2) -0.1, 3.5, 102.4</td>
<td>0.5</td>
<td>0.61 (0.57, 0.64) 5.6 (19.4) 0.0, 1.6, 202.5</td>
<td>99.8 (2.6) 56.5, 100.0, 100.0</td>
<td></td>
</tr>
</tbody>
</table>

PM$_{2.5}$ = fine particulate matter; sd = standard deviation; CI = confidence interval; Wildfire Season = July through October; Wildfire Day = Day with mean 24-hour PM$_{2.5}$ > 21 µg/m$^3$ during Wildfire Season

Only Sampling Days with >12hrs of hourly data for both indoor and outdoor PM$_{2.5}$ are included in table.

This pilot data indicates that neither age of facility nor filter type are good predictors of wildfire smoke infiltration.

Montrose et al. Indoor Air 2022
Summary of health data collection and challenges

- Planned to leverage quality assurance and performance improvement (QAPI) data
- Received aggregated QAPI data relevant to respiratory health from two facilities
- COVID 19 impacted data collection at the SNFs
- Non-COVID adverse respiratory occurrences were not as numerous as anticipated
- Statistical evaluation was limited and a visual assessment of the data did not identify any trends
Building managers play an integral role in maintaining good indoor air quality at SNFs.

HVAC maintenance and operation

Building Envelope Maintenance

Identifying sources of Infiltration

- Building Systems/Areas
  - Doors
  - Windows, especially operable windows
  - Roofs
  - Attic Space
  - Crawl Spaces

- Mechanical Systems
  - Make up Air Units (MAU)
  - Roof top Units (RTU)
  - Air Handler Units (AHU)
  - Air Side Economizers
  - Exhaust Systems
An intervention targeting maintenance personnel

- December 2021: Virtual workshop
- April 2022: Interviews
- July – October 2022: Anticipated wildfire season
Virtual workshop to increase awareness about air quality and health effects

Selected **introductory** polling questions

Selected **concluding** polling questions

**Description:**
This presentation was be broken into three sections
- Smoke and health
- Industrial hygiene
- HVAC operation and maintenance

**Recruitment:**
- Partnered with Idaho and Montana Health Care Associations

**Attendance:**
- 34 maintenance personnel registered
- 24 attended

**Participation:**
- 20 took part in polling questions
Key informant interviews 5 months after virtual workshop

- Four skilled nursing facility maintenance personnel participated in a ~30-minute session

“I was only running MERV 8 filters and I definitely plan on purchasing some MERV 13s as well as I’ve added a kind of corner to corner attic look to my monthly to do list and in the process found about three exhaust belt fans that were broken and ordered and replace those.”

“I definitely had an enhanced perspective of how the indoor air quality was different and sometimes even worse than the outdoor air quality and the sense that I felt like I had a bit more protection indoors versus outdoors and came to realize that I needed to enhance the kind of filtration in order to protect the residents…”

“My goal was making sure that the filtration is changed out monthly instead of you know, every couple three months if the filter look good and yeah I’ve been making sure they are truly changed out monthly and not just saying oh, it looks good.”

“…kind of feel like I’ve been in this one man show, so it was just really nice to know that there was a professional outreach happening that was able to help me digest some of this stuff and guide me in the right direction and actually left me really thirsty for more…”
Extension of originally planned intervention efforts

Onsite wildfire smoke readiness planning

• Smoke preparedness planning
  – Leveraging a SNF corporate structure
  – Site visit with external and internal stakeholders
  – Building tour
  – Draft and discuss a plan
  – Identify pros and cons of planning process

Piloting the delivery of actionable and timely air quality data

On-site dashboard
Thank you