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Indoor air quality in healthcare and care facilities: chemical pollution and microbiological contamination

Estelle Baurès[1], Alexandre Baudet[2], Olivier Blanchard[1], Hélène Guegan[3], Monique Guillaso[2], Pierre le Cann[1], Jean-Pierre Gangneux[3], Arnaud Florentin[2,4,5]

[1]*Univ Rennes, EHESP, Inserm, Irset (Institut de recherche en santé, environnement et travail) – UMR_S 1085, F-35000 Rennes, France*

[2]*Université de Lorraine, Faculté de Médecine, Département d'Hygiène, des Risques Environnementaux et Associés aux Soins, F-54000, France*

[3]*Univ Rennes, CHU, Inserm, Irset (Institut de recherche en santé, environnement et travail) –UMR_S 1085, F-35000 Rennes, France*

[4]*CHRU-Nancy, Service d'Hygiène et d'Analyses Environnementales, F-54000 Nancy, France*

[5]*Université de Lorraine, APEMAC, équipe MICS, F-54000 Nancy, France*

1. Introduction

Indoor air quality of healthcare and care facilities (elderly care centers, nursing homes ...) and private healthcare facilities (general practitioner's offices, dental offices, pharmacies ...) is poorly studied. However, knowledge of indoor air quality in establishments for public and worker uses is important, especially where people are potentially vulnerable. This is the case of such healthcare institutions. *The aim of our study was to describe the microbiological, chemical and particulate pollution of indoor environment of these facilities.*

2. Materials/Methods

The study was carried out in two urban areas Rennes and Nancy (France) in June 2018 (summer sampling campaign) and in February 2019 (winter campaign). The investigation was conducted in nursing homes, general practitioner's offices, dental offices and in pharmacies - in order to estimate spatial and temporal variability.

Sampled compounds	Sampling	Analysis methods
Aldehydes (7)	Passive Radielo	LC/UV
Hydrogen peroxide	Active Closed-face cartridge	Photometer
Other VOCs (31)	Active Carbopack™/Carboxen® tube	Thermal desorption and GC/MS
SVOCs (13)	Active Polyurethane foam & quartz filter	Pressurized liquid extraction and GC/MS/MS
Particles - $PM_{2.5}$	Particles count	-
Microbiological	Coriolis® air sampler Swabs for surfaces	Bacterial and fungal cultures

3. Results and Discussion

Particles: The median $PM_{2.5}$ concentration was 9.0 µg/m^3 and varied significantly according to the season. Median concentrations were significantly high in the healthcare and care nursing homes (13.2 µg/m^3) than in the private facilities (8.9 µg/m^3).

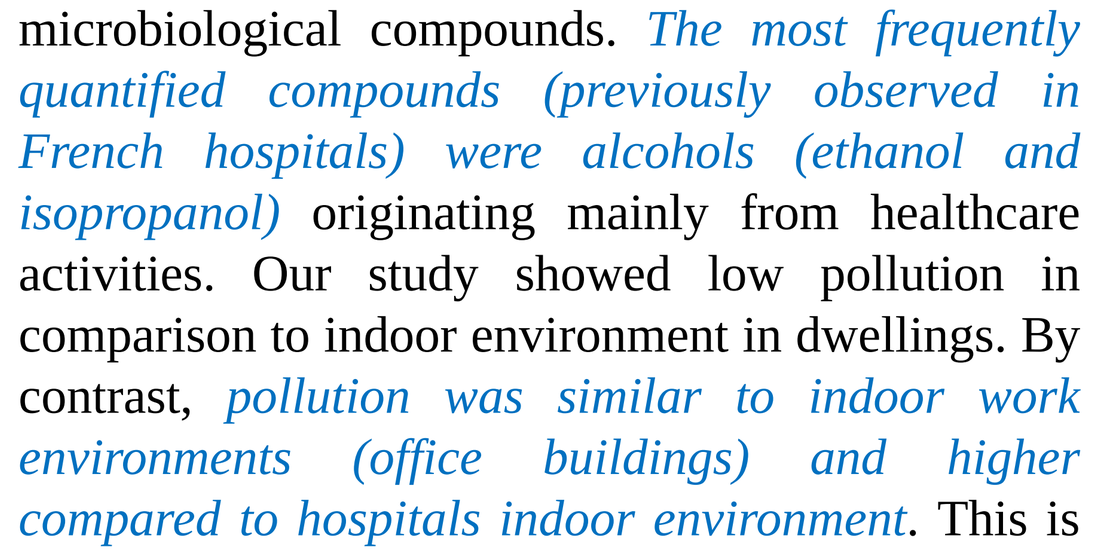
VOC concentrations: Only 51.3% of the target compounds were quantified during both campaigns for all sites. The most-quantified compound, having the highest median, were for alcohols (ethanol: 370.9 µg/m^3 and isopropanol: 23.6 µg/m^3), ketone (acetone: 18.8 µg/m^3), aldehydes (formaldehyde: 11.4 µg/m^3 and acetaldehyde: 6.5 µg/m^3), and terpenes (limonene: 4.3 µg/m^3).

SVOC concentrations: Only 46.2% of the target compounds were quantified during all campaigns and for all sites. Phthalates (DiBP, DEP and DBP) were quantified in 100% of the measures. The highest median concentration was measured for DiBP (270 ng/m^3). Two synthetic musks – galaxolide and tonalide– were detected in 100% of the samples. Median concentration was 23.5 ng/m^3 for tonalide and 130.0 ng/m^3 for galaxolide.

Microbiological contamination: 3 bacteria genera are mainly identified (*Staphylococcus* spp., *Micrococcus* spp., *Bacillus* spp.), as were two fungi genera (*Cladosporium* spp., *Penicillium* spp.).

4. Conclusions

Indoor air in healthcare and care facilities contains a complex mixture of chemical, physical and microbiological compounds. *The most frequently quantified compounds (previously observed in French hospitals) were alcohols (ethanol and isopropanol)* originating mainly from healthcare activities. Our study showed low pollution in comparison to indoor environment in dwellings. By contrast, *pollution was similar to indoor work environments (office buildings) and higher compared to hospitals indoor environment*. This is probably due to different ventilation systems and air exchange rates: lower in the dwellings (0.3 volume/hour) and higher in the hospitals (1 to 11 volume/hour).



5. Acknowledgement

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