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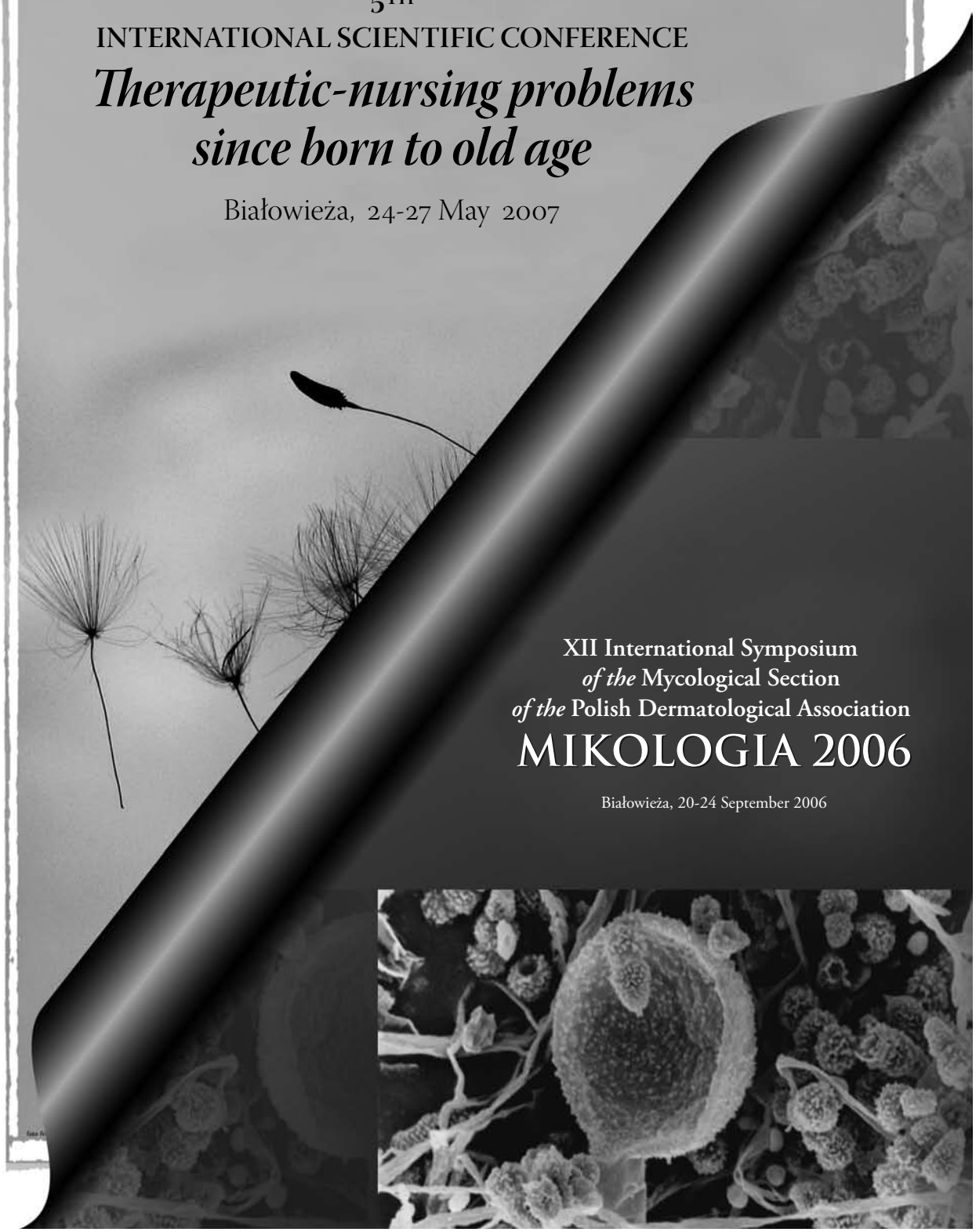

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Indoor air studies of fungi contamination at the Neonatal Department and Intensive Care Unit an Palliative Care in Kavala Hospital in Greece

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Abstract

Purpose: The assessment of the indoor air and walls contamination of fungi at the Kavala Hospital in Greece was made.

Material and methods: The study was carried out at the Neonatal Department and Intensive Care Unit and Palliative Care in Kavala Hospital (Greece). Materials for the tests were: the air samples (in front of the building and the selected rooms) and swabs from the walls. The air pollution was determined using SAS SUPER 100 (Pbi International). The microbial flora from walls was assessed using the Count-Tact applicator and the plate Count-Tact (BioMerieux). Fungi were identified using standard microbial procedures. Classification of isolated fungi was made with an accordance to the current procedures. Humidity and temperature were evaluated by a termohigrometr.

Results: The following fungal pathogens isolated from air were *Candida albicans*, non-*Candida albicans*, *Penicillium* species *Acremonium*, *Rhodotorula species*, and *Aspergillus species*.

Candida albicans and *Penicillium* species were dominated fungi in the air of Neonatal Department and Intensive Care Unit. Mean number of fungi colonies isolated from air in the Neonatal Department was significantly ($p<0.001$) higher compared to Intensive Care Unit. No significant correlations between CFU of fungi in air and temperature in both Departments were noted.

Conclusions: The main fungal pathogen isolated from the air samples was *Candida albicans*. No significant differences between number of fungal colonies temperature and humidity of air were found. Further investigations on isolation of the fungal pathogenes from the air samples of operating rooms are needed.

Key words: indoor air, fungi, Neonatal Department.

Introduction

Critically ill infants receiving care in Nneonatal Intensive-Care Units are at increased risk for hospital-acquired infections due to their developmentally immature immune system and the invasive diagnostic and therapeutic procedures they undergo [1]. Fungal infections of hospital origin are gaining in importance in recent years due to their progressive increase and to the high rates of morbidity and mortality with which they are associated [2,3]. Many of these infections are endogenous in nature, but others can be acquired by exogenous routes, through the hands of healthcare workers, contaminated infusion products and biomaterials, and abiotic environmental sources [3,4]. Nosocomial infection remains an important problem in intensive care units. Hospital wards had been shown to act as reservoirs of pathogenic microorganisms associated with infection

The object of the present research was to assess the presence of airborne fungi in at the Neonatal Department and Intensive Care Unit and Palliative Care in Kavala Hospital (Greece).

Material and methods

Air sampling was carried out at the Neonatal Department and Intensive Care Unit and Palliative Care in Kavala Hospital – Greece in September 2005. Material into mycological studies was air sampled at the entrance of hospital building, the entrance

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Table 1. **Fungal occurrence in the air of rooms of the Intensive Care Unit in the Kavala Hospital in Greece**

Intensive Care Unit						
Site of sampling	**Number of colonies**	**Corrected number**	**CFU/1000L of air**	**Temp.**	**Humidity**	**Taxonomy**
Corridor entrance to Department	15	15	150	25.7	62,1	14 *Candida albicans* 1 non-*Candida*
Corridor of the second entrance	48	50	500	24.3	62.1	23 *Candida albicans* 24 *Penicllium* spp. 1 non-*Candida alb*.
Main corridor	20	20	200	26.5	56.4	16 *Candida albicans* 3 *Penicllium* spp. 1 *Acremonium* spp.
Room I	11	11	110	24.6	58	11 *Candida albicans*
Room II	45	47	470	24.1	56.4	45 *Candida albicans*
Nurses's stadion	23	24	240	24.1	58.7	23 *Candida albicans*
Infusion room	11	11	110	25.5	55	11 *Candida albicans*
Laboratory	10	10	100	24.8	57	10 *Candida albicans*
Physician's/ nurses's room	6	6	60	25.8	56.2	4 *Candida albicans* 1 *Penicllium* spp. 1 *Acremonium* spp.
WC	12	12	120	25.3	56.4	8 *Candida albicans* 3 *Penicllium* spp. 1 *Acremonium* spp.
Soiled-lien closet I	8	8	80	25.9	56.1	8 *Candida albicans*
Soiled-lien closet II	7	7	70	25.5	57.7	7 *Candida albians*
Storing room	4	4	40	25.8	55.3	3 *Candida albicans* 1 non-*Candida*
Kitchen	26	27	270	25.6	57.4	23 *Candida albicans* 3 *Penicllium* spp.
		Total 252	**Mean 180±140.3**	**Mean 25.3±0.7**	**Mean 57.5±2.1**	

CFU – colony forming unit

into operating room, hall and the selected rooms of operating department and nurses' stations. The microbial flora from the walls was detected using the Count-Tact applicator and the plate Count-Tact (BioMerieux). Fungi were identified using the standard microbial procedures. The monitoring of airborne fungi pollution was done using a SAS SUPER 100 (pbi international). Classification of isolated fungi was made with an accordance to the current procedures. Sample has a flow rate of 100 liters air/ /min. At each site, a 100 liters sample was taken with the sampler placed at a height of 150 cm above floor level in the middle of the room, with all windows and doors closed. After incubation at 27°C for three days quantitative analysis and morphological evaluation of fungal colonies were carried out, and depending on the nature of the fungi cultures the plates were incubated for up to 14 days to allow identification. The raw counts of colonies on the agar plates were adjusted by reference to statistical scaling tables applying to the particular sampler. The fungi cultured were identified from macroscopic and microscopic characteristics, and biochemical tests were appropriate. Yeast-like fungi were identified by means of original Candida ID (bioMerieux) medium, API 20C AUX (bioMerieux) identification sequence as well as CandiSelect (Bio-Rad) medium. For moulds, microscopical evaluation of morphological elements in preparations stained with lactophenol/methylene blue (Merck). Humidity and temperature were evaluated by a termohigrometr.

Results

Tab. 1 presents of fungal occurrence in the air of rooms of the Intensive Care Unit in the Kavala Hospital in Greece.

Numbers of airborne culturable fungi were lowest in the storing room but the highest number of fungi were found in the corridor of the second entrance. Similarly, the highest number of air borne fungi were detected in the corridor of the second entrance and room II (*Tab. 1*).

Mean number of fungi colonies isolated from air was 180±140.3, mean temperature 25.3±0.7°C and humidity 57.5±2.1. No significant correlation (p=0.119) between CFU of fungi in air and temperature was noted. Similarly, no relationship between CFU of fungi in air and humidity was found. The following fungal pathogens isolated from air were: *Candida albicans*, non-*Candida albicans*, *Penicillium species* and *Acremonium species*. *Tab. 2* presents of fungal occurrence in the air of rooms of the Neonatal Department in the Kavala Hospital in Greece. Numbers of airborne culturable fungi were lowest in

Table 2. **Fungal occurrence in the air of rooms of the Neonatal Department in the Kvala Hospital in Greece**

Neonatal Departament						
Site of sampling	**Number of colonies**	**Corrected number**	**CFU/1000L of air**	**Temp.**	**Humidity**	**Taxonomy**
Corridor entrance to Department	20	20	200	25.8	64.1	17 *Candida albicans* 3 *Acremonium* spp.
Corridor at Departament	26	27	270	26.1	60.6	24 *Candida albicans* 1 *Acremonium* spp. 1 *Rhodotorula* spp.
Septic room	250	330	3300	27.0	59.4	10 *Candida albicans* 240 *Penicillium* spp.
Incubator room	241	330	3300	27.8	57.2	1 *Candida albicans* 240 *Penicillium* spp
Nurses's stadion	8	8	80	27.6	57.0	8 *Candida albicans*
		Total 715	**Mean 1430±1528.1**	**Mean 26.9±0.8**	**Mean 59.9±2.6**	

CFU – colony forming unit

the nurses's station but the highest number of fungi were found in the septic room (*Tab. 2*). Similarly, the highest number of air borne fungi were detected in the septic and incubator rooms but the lowest number in the nurses's station. Mean number of fungi colonies isolated from air was 1430±1528.1, mean temperature 26.9±0.8°C and humidity 59.9±2.6. Mean number of fungi colonies isolated from air in the Neonatal Department was significantly ($p<0.001$) higher compared to Intensive Care Unit. No significant correlation ($p=0.119$) between CFU of fungi in air and temperature was noted. The following fungal pathogens isolated from air were *Candida albicans*, *Penicillium species*, *Acremonium species* and *Rhodotorula species*. No non-*Candida albicans* species were detected in the Neonatal Department.

Discussion

In the present study, we demonstrated considerable numbers of fungi in the air of the two Departments of Kavala Hospital in Greece. This is the first study carried out in Kavala Hospital comparing the fungal contamination of air in the Neonatal Department and Intensive Care Unit.

In the literature there is clear evidence of seasonal differences in the numbers of fungi in indoor air. For example, Lumpkins et al. [5,6] reported that numbers were higher in summer and autumn than in spring and winter.

In our previous report [7] in the various four social welfare homes in Poland air borne fungi counts were the highest in either summer or autumn and mainly the lowest in winter. *Penicillium* and *Cladosporium* were dominated isolates in the air in these homes during all seasons of the year. In contrast, in the present study we found significant number of *Candida albicans* and *Penicillium*. The environmental fungal load of three hospitals was studied in representative regions in Greece (Thessalonika, Northern Greece, Athens, Central Greece and Heraklion, Southern Greece) [8]. Air, surfaces and tap water from high-risk departments were sampled monthly during one year. Air fungal load was lower in winter and higher in summer and autumn but seldom above acceptable levels. *Aspergillus* spp. constituted 70.5% of the filamentous fungi isolated. *Aspergillus niger* was the most prevalent species in the air of all the hospitals followed by *Aspergillus flavus* and *Aspergillus fumigatus*. The least contaminated departments were the intensive care units, whilst most contaminated were the solid organ transplantation in Athens and haematology departments in Thessalonika. No correlation between fungal species, season, hospital or departments was observed. The presence of *Penicillium*, or *Aspergillus*, may pose a potential threat to the health of patients of these rooms. Fungi in these and other genera affect humans in complex ways and are capable of causing a variety of diseases, such as infection, allergy and irritation, and toxicosis. Exposure to fungi has been unequivocally associated with exacerbation of asthma, although the role of fungi in causing the disease may not yet have been fully determined. Neonates, especially premature babies, are considered as immunocompromised patients due to immature T-cell activity and incompetent phagocytosis [9]. Fungi, especially moulds, can cause devastating infections in these high-risk patients [10]. Moreover, surface contamination with settled fungal spores, which is not detected by air sampling, could also present a source of potential colonization. The role of nasopharyngeal surveillance cultures in high-risk neonates during periods of increased exposure could not be assessed and the need for air sampling as a tool for prevention of pulmonary aspergillosis is questionable [11].

Fungal conidia enter buildings through windows, doors or ventilation systems and sediment onto surfaces, survive in dust or grow on organic matter present in materials such as ceiling tiles [12]. In the hospital setting, construction work that liberates large amounts of *Aspergillus* spores has been identified as the source of nosocomial aspergillosis. In contrast, in our study we found a high occurrence of *Candida* and *Penicillium* in the air in the both departments.

In conclusion, the main fungal pathogen isolated from the air samples was *Candida albicans*. No significant differences between number of fungal colonies, temperature and humidity of air were found. Further investigations on isolation of the fungal pathogenes from the air samples of operating rooms are needed.

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