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Epidemiology

Assessment of microbial quality of drinks not included in the hospital diet as consumed by patients during hospitalization and the assessment of microbial contamination of hospital air

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Summary:

Introduction: According to epidemiological data from different countries, the incidence of nutrition-related poisonings and infections is constant, and even growing in some regions. Currently, there are no standards defining acceptable levels of airborne microorganisms in indoor air (hospital facilities) in Poland
Material and methods: 100 juice samples collected from previously opened packagings between March 2007 and December 2009 in the Voivodship Specialist Hospital in Krakow were subjected to microbial examination. Open juice packagings were kept for 48 hours at room temperature in patient rooms at the hospital wards. Ninety-one air quality measurements were also conducted at different locations in the hospital to monitor microbial infections. The control group consisted of 50 juice samples stored in home conditions.
Conclusions: Significant transgression of the acceptable air contamination limits in hospital rooms, together with the transgressed limits of microbial contamination in juices suggest that the juices might be a potential source of nosocomial infections. Opened juices should not be stored at room temperature for periods longer than 24 h.

Key words: microbial contamination, juices, air, nosocomial infections.

Introduction

According to epidemiological data from different countries, the incidence of nutrition-related intoxications and infections is constant, and even growing in some regions. In the past, juices were excluded from food safety studies due to their low pH values resulting from the presence of organic acids with antibacterial properties. However, recent studies suggested a possibility of food poisoning induced by contaminated juices [1-3].

Intestinal infections occurring in different groups of patients during hospitalization may

be not only due to patient-to-patient transmission, but also to the consumption of food of poor microbial quality. The threat may originate mainly from products brought to patients by visitors [1]. It is common for the visitors to bring drinks in large packagings, both carton and plastic bottles. Patients, particularly children and the elderly, have difficulties using such packagings. This also pertains to patients who cannot move easily after procedures they underwent. With water consumption recommendations suggesting that a single serving should not exceed ca. 100 mL (in adults), depletion of a 1.5 L, or sometimes even a 2 L takes a significant amount of time [4]. This poses a significant threat of microbial infection with bacteria, fungi and molds present in the hospital environment [5].

Currently, there are no standards defining acceptable levels of airborne microorganisms in indoor air (hospital facilities) in Poland *The Ordinance of the Minister of Health of 26 June 2012 on detailed requirements for the facilities and equipments in entities engaged in medical activities, being the executive act for the Act of 15 April 2011 on medical activities (Journal of Laws of 2011, No. 112 item 654)* contains only one paragraph regarding air quality. Paragraph 37 of Section 6 of the Ordinance, titled *System requirements reads that In operating, theaters, isolation wards and immunocompromised patient rooms, ventilation systems should be used that ensure air quality parameters suited to the function of these facilities*. There are no numerical values indicating air quality assessments [6,7].

French standard NF S 90-351: 2003 classifies the facilities into 4 infection risk zones. The standard's guidelines classify corridors, elevators, staircases, waiting rooms, physician's offices accessible to outpatients, rehabilitation rooms, pregnancy wards, facilities for patients requiring long or medium hospitalization periods, mental health care facilities, central sterilization facilities (washing zones), drugstores, laundries and toilets as zone 2 facilities. According to the authors of the guidelines, zone 2 is a medium risk level zone [8]. Of highest interest to microbiologists is the quality of air in operating rooms [9-11]. Studies in residential facilities may provide basis to comparisons of conditions in the areas where patients are staying.

The study of hazardous factors published by J.L. Górny in 2004, which included standards, recommendations and proposed acceptable level fully illustrates the vastness of public health issues which have to be considered, including issues regarding patients staying at healthcare facilities [15].

No studies of the contaminating effect of hospital air on food brought to patients' rooms and consumed by patients were found in the available literature. Thus, fruit juices were selected for analysis, as they are the drinks that are most commonly consumed by both children and adults staying in hospital facilities (unpublished data from own observations).

The objective of the study was to evaluate the microbial risks for hospitalized patients in relation to juices brought to the hospital by visitors.

Material and methods

The study took place in one of the Voivodship Specialist Hospitals in Krakow. Selection of juices followed an analysis of consumption patterns in patients staying in patient rooms and surveys regarding the frequency of drink consumption (unpublished data from own observations). A total of 100 juice samples were collected for microbial analysis from previously opened carton, glass or plastic packagings between March 2007 and December 2009. Opened juices were stored in patient rooms for 48 hours at room temperature. Ninety-one air quality measurements were also conducted at different locations in the hospital to monitor microbial infections.

The control group consisted of 50 juice samples stored in home conditions. Microbial quantitative analysis of juices was performed by the Koch's plate dilution method. Bacterial counts were performed after 72 h of incubation at 37°C.

Air samples were collected for microbial analyses using a MAS-100 Microbial Air Monitoring System by MERCK. The system automatically sampled a pre-defined volume of air into the instrument head containing a sterile single-use Petri dish with agar medium suitable for tested microbial groups. Following solid selective media were used for quantitative determinations of microorganisms:

1) Total bacterial count — Columbia agar medium.
2) Staphylococci — Chapman ager medium.
3) Gram-negative rods — MacConkey agar.
4) Fungi — Sabourand agar medium.

Petri dishes with air samples and selective culture media were incubated in appropriate conditions.

The results of analyses were compared to relevant standards and literature data.

Results and discussion

Microbial contamination of foods (including drinks) may be due to both improper pasteurization process, and to contamination with pathogenic bacteria after pasteurization. As mentioned before, large-size juice packagings purchased by visitors are commonly found in patient rooms. They are usually stored at patients' beds. Microbial purity of these juices may be doubtful, particularly after a prolonged time of storage at room temperature. Food safety monitoring procedures might reduce hospitalization costs as well as to potentially allow to avoid e.g. nosocomial infectious diarrhea, which is a factor that prolongs hospitalization of children [16,17].

Of all biological risk factors, bacteria and molds are characterized by the furthest range of allergic and toxic effects. They are also emitted with dust into the air, which might lead to chronic organ diseases, such as respiratory or gastrointestinal diseases [18].

Microbial evaluation of juice samples collected at hospitals revealed the total bacterial count standard limits being exceeded in 56% of samples. Fungal count standard limits were exceeded in 23% of samples. Evaluation of control samples revealed the total bacterial count standard limits being exceeded in 21 cases (42%), with the remaining samples being within limits. Fungal count standard limits were exceeded in 5 (10%) control samples (Table 1).

In 26 cases, juices standing at patients' bedsides were not contaminated with either bacteria or fungi. Statistical analysis revealed that compared

Table 1: Number of pathogenic bacteria and fungi in juices.

Sampling site	Pathogenic bacteria (Columbia agar medium)			Pathogenic fungi (Sabourand agar medium)		
	None	0 < ..< Normal	Above normal	None	0 < ..< Normal	Above normal
Hospital N=100						
n (%)	28 (28)	16 (16)	56 (56)	64 (64)	13 (13)	23 (23)
X±SD	-	70.92±44.6*	151,467.5 ±307,313.8*	-	55.5±54.8*	261,929.7 ±345,018.2*
Median	-	71.25	9,875	-	45	72,000
Minimum	-	10	280	-	1	600
Maximum	-	155	1,724,000	-	158	1,280,000
Control — private houses N=50						
n (%)	23 (46)	6 (12)	21 (42)	39 (78)	6 (12)	5 (10)
X±SD	-	89.2±56.9**	44,438.6 ±191,496.2**	-	35.0±52.8**	318,572.6 ±537,984.4**
Median	-	85	2,023	-	13	146
Minimum	-	10	350	-	2	2,733
Maximum	-	155	880,000	-	140	1,250,000

n – number of samples, X±SD - arithmetic mean ± standard deviation; *,** statistically significant differences between groups.
PN-A-79034 Non-carbonated soft drinks. Bacterial counts determined after 72 h of incubation not larger than 200 per 1 mL.
Mold content per 1 mL: unacceptable.
Yeast counts not larger than 200 per 1 mL [19].

to juices stored in home conditions, juices opened by patients in hospital wards significantly more often contained pathogenic bacteria and fungi ($p<0.05$). However, the latter were also observed in ranges exceeding the normal limits in home conditions ($p<0.05$).

All objects surrounding the patients may be potential sources of nosocomial pathogens. Patients themselves are most responsible for contamination of hospital surfaces. This is particularly true in children who show significant mobility and willingness to explore their surroundings typical for their age [20].

Staphylococcal count limits were exceeded in 87% of 91 air quality measurements. Total bacterial counts were exceeded in 63% of samples, while fungal counts were exceeded in 16% of samples (Table 2).

Both internal and external factors have significant impact on airborne microbial counts. Most commonly, microorganisms migrate on dust particles. Air dustiness is several times higher in large urban areas than in green regions. Seasonal changes and precipitations may periodically reduce this difference [22,23].

The degree of microbial air contamination depends on various factors. Literature reports report the role of facility population, sanitary and hygienic conditions and intensity of air exchange. The type of airborne microorganisms also depends on the type of the surrounding environment [24].

One of the possible approaches is to reduce patients' exposure to airborne microbial pathogens. An efficient way to obtain air characterized by low microbial levels in hospital facilities is the use of state of the art ventilation and air conditioning systems. In many hospitals, there is virtually no collaboration or communication between epidemiology physicians and nurses and the technical staff.

This is largely due to the lack of appropriate knowledge and care for proper exploitation of ventilation/air conditioning system in hospital administration, technical and medical staff [25,26].

Table 2: Prevalence of microbial contamination of air in hospital facilities.

Sampling site	Number of measurements n (%)	Prevalence of microbial contamination of air		
		Number of measurements – bacteria (Columbia agar medium) n (%)	Number of measurements – fungi (Sabourand agar medium) n (%)	Number of measurements – pathogenic staphylococci (Chapman agar medium) n (%)
Patient room 1 table	12 (100%)	9 (75%)	2 (17%)	11 (92%)
Patient room 2 floor	13 (100%)	8 (62%)	3 (23%)	11 (85%)
Patient room neighbouring the toilet	13 (100%)	9 (69%)	0 (0%)	9 (69%)
Corridor near the toilet	12 (100%)	9 (75%)	4 (33%)	12 (100%)
Corridor near patient rooms	19 (100%)	12 (63%)	3 (16%)	15 (79%)
Corridor at main entrance	22 (100%)	19 (86%)	3 (14%)	21 (95%)
Total	91 (100%)	57 (63%)	15 (16%)	79 (87%)

n – number of samples
Acceptable microbial contamination of air in service facilities (accd. to B. Krzysztofik)
Acceptable microbial counts per 1 m^3 of air
Patient room
MPA total bacterial count – 1,000
Number of microorganisms causing hemolysis in blood-containing agar (e.g. pathogenic staphylococci) – 50
Total fungal count – 200 [21]

Bacterial cultures

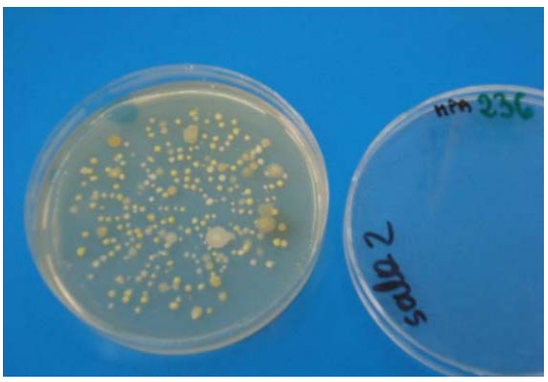

Figure 1: Total number of bacteria in the hospital air (Columbia agar medium).

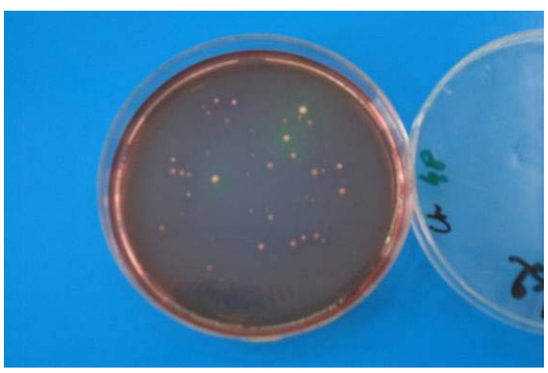

Figure 2: Total number of staphylococci in the hospital air (Chapman agar medium).

Figure 3: Total number of fungi in a juice sample (Sabourand agar medium).

Conclusions

Transgression of acceptable limits of air purity in hospital rooms, as well as of the microbial contamination of juices, is alarming.

Significant transgression of the acceptable air contamination limits in hospital rooms, together with the transgressed limits of microbial contamination in juices suggest that the juices might be a potential source of nosocomial infections.

Opened juices should not be stored at room temperature for periods longer than 24 h.

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