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PHYSICIAN AS AN INFECTIVE VECTOR AT A DEPARTMENT OF SURGERY

KATARZYNA PADUSZYŃSKA[1], LUDMIŁA GAGIS[2], MONIKA RUCIŃSKA[1], LECH POMORSKI[1]

Department of General and Oncological Surgery, University Hospital and Educational Centre of Medical University in Łódź[1]
Kierownik: prof. dr hab. *L. Pomorski*
Department of Laboratory Diagnostics Provincial Specialist Hospital in Zgierz[2]
Kierownik: mgr *M. Malinowska*

This study was designed to assess the degree of risk of bacterial transmission from physician to patient through hands, equipment and enclosing surfaces (shoe soles).
Material and methods. The study was conducted in the Clinical Department of General and Oncological Surgery UM in Łódź. In days 16.10.2013, 17.10.2013, 18.10.2013 there were done swabs from hands, stethoscopes and soles of shoes from the same group of physicians before and after doctor's rounds. The presence of alert-pathogens in swabs was regarded as positive result.
Results. Isolates included mostly aerobic saprophytic bacilli and Staphylococcus species coagulase-negative. There were detected a singly cases of Acinetobacter Baumani and Escherichia coli. Alert-pathogens were found in 4 (16%) swabs taken from hand before doctor's rounds and in 7 (28%) swabs taken after rounds. Stetoscopes were contaminated by alert-pathogens in 3 (12%) cases before doctor's rounds and in 3 (12%) cases taken after doctor's rounds. Soles of shoes were contaminated by alert-pathogens in 14 (56%) cases taken before and 16 (65%) cases taken after doctor's rounds.
Conclusions. 1. Physicians are important factor of bacterial transmission in hospital. 2. Hands, stetoscopes and particularly soles of shoes of medical staff is the source of infection.
Key words: transmission routes, hospital infection

Hospital acquired infections occur in all hospitals and currently are one of the main cause of prolongation of hospitalization, increase of treatment costs and furthermore contribute to increased mortality. There are an estimated 2 million hospital acquired infections annually worldwide and they affect 10% of hospitalized patients (1, 2). In the US hospital acquired infections are the cause of death of 90,000 patients annually and costs related to the treatment of hospital acquired infections amount to 5.7 billion US dollars (3, 4). According to data of Central Statistical Office (GUS) of Poland, approximately 7 million patients were hospitalized in 2006 in Poland. If we assumed 10% rate of hospital acquired infections, this would result in approximately 700 thousand episodes of hospital acquired infections. If we assumed an average mortality rate of 1%, hospital acquired infections could annually lead to approximately 7 thousands of deaths in Poland.

Sources of hospital acquired infections can be variable. They are most commonly caused by endogenous flora, less often by microorganisms originating from another patient, staff or environment.

With prolonged stay of a patient in a hospital, patient's endogenous flora is gradually replaced by hospital flora. Bacteria comprising the hospital flora exhibit antibiotic resistance (5). Exogenous infections, due to their mode of transmission, are called cross infections. A hospital infection can spread through direct contact with an infected patient or his/her secretions, though the air-borne route (as aerosol or with dust particles) and through blood borne route. The microorganism can be

transmitted from patient to patient, from staff to patient through staff's hands, infected equipment, environmental surfaces. Hands are the most important vector of transmission at a hospital. An estimated 50% of hospital acquired infections could be avoided if the staff used proper hand hygiene measures (2, 6, 7). Objects situated in the patient's environment, such as bed, bedclothes, cabinets, drapes, bedpans and other, contaminated by potentially pathogenic microorganisms that can be further transmitted to other patients, are another source of infection.

The aim of this study was to assess the risk of bacterial transmission from a physician to a patient through hands, equipment (stethoscope) and environmental surfaces (shoe soles).

MATERIAL AND METHODS

On 16.10.2013, 17.10.2013, and 18.10.2013 swabs were taken from hands, stethoscopes and soles of shoes from the team of physicians before and after doctor's rounds at the Clinical Department of General and Oncological Surgery, Medical University in Łódź. Shoes were the doctors' property and were used solely at the hospital. The material was collected from 11 subjects (2 or 3 samples were taken from some physicians).

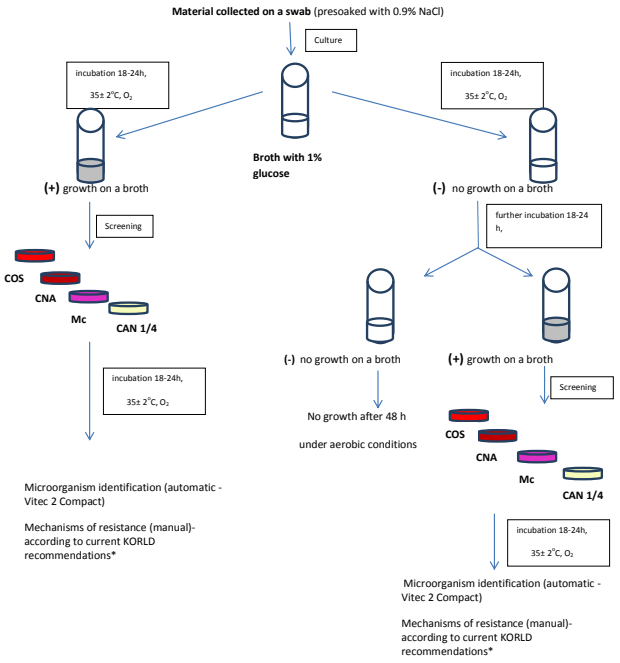

Fig. 1. Cleanness monitoring – culture scheme

Swabs from hands, surfaces of phonendoscope membranes and soles of the shoes were used as a source for the cultures. The material was collected in a conventional manner and immediately was transferred to an accredited laboratory of bacteriology and processed according to guidelines of national coordination center – fig. 1.

The presence of alert-pathogens in swabs was regarded as a positive result.

Doctor's rounds started from so called "clean" rooms. The physician who led the rounds and managed a room, at the entrance to the room and when leaving the room, disinfected his or her hands using an alcohol based disinfecting agent from a dispenser placed in the room. An auscultating physician disinfected his or her phonendoscope using the same liquid as was used for hands. Disinfecting pads were not placed in the rooms.

RESULTS

Conducted cultures demonstrated mainly saprophytic flora – saprophytic aerobic bacilli and coagulase-negative Staphylococcus species. Alert bacteria were also found: Staphycococcus aureus MRSA and Enterococcus faecalis HLAR +. There were sporadic cases of the following bacteria: Acinetobacter baumanii, Escherichia coli.

Alert bacteria were found in 4 (16%) swabs taken from hands before doctor's rounds and in 7 (28%) swabs taken after rounds (tab. 1).

Swabs taken from stethoscopes before doctor's rounds demonstrated alert bacteria in 3 (12%) of cases. Similarly, bacteriological tests demonstrated alert pathogens in swabs taken after doctor's rounds from 3 (12%) of physicians (tab. 2).

Cultures of swabs taken from soles of shoes before doctor's rounds demonstrated alert bacteria in 14 (56%) of cases, while after doctor's rounds – in 16 (65%) of cases (tab. 3).

DISCUSSION

Drug resistance of microorganism that live in the closed hospital environment and attack the weakest patients, is an integral factor that accompanies hospital acquired infections. At a hospital, where antibiotic therapy is used,

Table 1. Results of cultures collected from hands before and after doctor's rounds

Number	Before doctor's rounds	After doctor's rounds
1	Aerobic saprophytic bacilli	Aerobic saprophytic bacilli
2	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Staphycococcus aureus MRSA
3	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
4	Aerobic saprophytic bacilli	Coagulase-negative Staphylococcus spp.
5	Aerobic saprophytic bacilli	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
6	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli
7	Sterile cultures after 48 h	Sterile cultures after 48 h
8	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +	Aerobic saprophytic bacilli
9	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Sterile cultures after 48 h
10	Aerobic saprophytic bacilli	Aerobic saprophytic bacilli
11	Aerobic saprophytic bacilli Enterococcus faecalis HLAR + Staphycococcus aureus MRSA	Staphycococcus aureus MRSA
12	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
13	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Sterile cultures after 48 h
14	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
15	Coagulase-negative Staphylococcus spp.	Sterile cultures after 48 h
16	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
17	Coagulase-negative Staphylococcus spp.	Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +
18	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Acinetobacter baumanii Enterococcus faecalis HLAR +
19	Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
20	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +
21	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +	Aerobic saprophytic bacilli Enterococcus faecalis HLAR +
22	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
23	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Acinetobacter baumanii Enterococcus faecalis HLAR +
24	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
25	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli

Table 2. Results of cultures collected from stethoscopes before and after doctor's rounds

Number	Before doctor's rounds	After doctor's rounds
1	Aerobic saprophytic bacilli	Aerobic saprophytic bacilli
2	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli
3	Aerobic saprophytic bacilli	Aerobic saprophytic bacilli
4	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Coagulase-negative Staphylococcus spp.
5	Coagulase-negative Staphylococcus spp.	Coagulase-negative Staphylococcus spp.
6	Coagulase-negative Staphylococcus spp.	Sterile cultures after 48 h
7	Sterile cultures after 48 h	Sterile cultures after 48 h

8	Sterile cultures after 48 h	Sterile cultures after 48 h
9	Sterile cultures after 48 h	Sterile cultures after 48 h
10	Coagulase-negative Staphylococcus spp.	Coagulase-negative Staphylococcus spp.
11	Sterile cultures after 48 h	Sterile cultures after 48 h
12	Sterile cultures after 48 h	Staphycococcus aureus MRSA
13	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Sterile cultures after 48 h
14	Coagulase-negative Staphylococcus spp.	Staphycococcus aureus MRSA Enterococcus faecalis HLAR +
15	Sterile cultures after 48 h	Sterile cultures after 48 h
16	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Acinetobacter baumanii	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
17	Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +	Aerobic saprophytic bacilli
18	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Sterile cultures after 48 h
19	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Sterile cultures after 48 h
20	Enterococcus faecalis HLAR +	Sterile cultures after 48 h
21	Aerobic saprophytic bacilli Enterococcus faecalis HLAR +	Sterile cultures after 48 h
22	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
23	Coagulase-negative Staphylococcus spp.	Coagulase-negative Staphylococcus spp.
24	Aerobic saprophytic bacilli	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
25	Aerobic saprophytic bacilli	Aerobic saprophytic bacilli

Table 3. Results of cultures collected from soles of shoes before and after doctor's rounds

Number	Before doctor's rounds	After doctor's rounds
1	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Coagulase-negative Staphylococcus spp.
2	Aerobic saprophytic bacilli Enterococcus faecalis HLAR +	Aerobic saprophytic bacilli Enterococcus faecalis HLAR +
3	Aerobic saprophytic bacilli Enterococcus faecalis HLAR +	Aerobic saprophytic bacilli Enterococcus faecalis HLAR +
4	Aerobic saprophytic bacilli	Aerobic saprophytic bacilli
5	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli
6	Enterococcus faecalis HLAR +	Coagulase-negative Staphylococcus spp.
7	Enterobacter cloacae Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +
8	Acinetobacter baumanii Enterobacter cloacae Aerobic saprophytic bacilli Staphycococcus aureus MRSA	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
9	Enterococcus faecalis HLAR + Staphycococcus aureus MRSA	Aerobic saprophytic bacilli Staphycococcus aureus MRSA
10	Aerobic saprophytic bacilli	Staphycococcus aureus MRSA
11	Aerobic saprophytic bacilli Enterococcus faecalis HLAR +	Enterococcus faecalis HLAR + Staphycococcus aureus MRSA
12	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
13	Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli
14	Staphycococcus aureus MRSA	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.
15	Sterile cultures after 48 h	Aerobic saprophytic bacilli
16	Acinetobacter baumanii Aerobic saprophytic bacilli Enterococcus faecalis HLAR +	Enterococcus faecalis HLAR + Staphycococcus aureus MRSA
17	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +
18	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +

19	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp.	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +
20	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +
21	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR + Staphycococcus aureus MRSA
22	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Acinetobacter baumanii Enterococcus faecalis HLAR +	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR + Staphycococcus aureus MRSA
23	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Acinetobacter baumanii	Aerobic saprophytic bacilli Enterococcus faecalis HLAR +
24	Coagulase-negative Staphylococcus spp. Acinetobacter baumanii Escherichia coli Enterococcus faecalis HLAR +	Aerobic saprophytic bacilli Coagulase-negative Staphylococcus spp. Enterococcus faecalis HLAR +
25	Acinetobacter baumanii Enterococcus faecalis HLAR +	Staphycococcus aureus MRSA

selected strains are resistant to multiple antibiotics. Treatment of infections caused by these bacteria is difficult. It requires an empiric therapy with broadest spectrum antibiotics, and when an antiobiogram is obtained, selected, often expensive or more toxic agents.

In some cases microorganisms may be resistant to all available drugs. Multiresistant intestinal bacilli, methicillin-resistant Staphylococci or Pseudomonas or Klebsiella sp. with particular resistance are the examples. We found two alert-pathogens in our material: Staphylococcus aureus – MRSA and Enterococcus faecalis HLAR as well as other microorganisms belonging to the hospital flora, Acinetobacter sp., that are difficult to treat (8). Obviously transfer of such bacteria to the patient can often cause life threatening infections, in particular in subjects with impaired immunity.

Multiple publications indicate that hands of the hospital staff are a common route of transmission of the hospital acquired infection (1, 2, 6, 7). An estimated total number of bacteria on the skin of health care professionals is 10^4-10^6 colonies per cm^2. This flora includes Staphylococcus epidermidis and other coagulase-negative staphylococci (CoNS), including a high rate of methicillin-resistant species. Transient flora is dependent on microbiological environmental pollution (9). Casewell and Philips demonstrated that nurses during "clean" activities such as measurement of blood pressure or temperature, may get their hands contaminated with as many as 100 to 1000 colonies of Klebsiella sp. (10). Daschner found Staphylococcus aureus in 21% cultures from employees of the intensive care units (11).

Another study demonstrated, in serial cultures from hands of the hospital employees, that 100% of them had Gram-negative bacilli at least once and 64% of them had Staphylococcus aureus at least once (12). Our studies also confirmed role of hands in the pathogen transmission. Alert-pathogens were found in 16% of cultures from hands of physicians conducted before doctor's rounds and 28% of cultures conducted after doctor's rounds, despite implementation of the above mentioned management. Prevention of microorganism transmission through this route involves predominantly adherence to principles of hospital hygiene – proper hand washing. Hands contaminated with pathogens should be disinfected with an agent obtained from a dispenser and adequately rubbed into the skin. Alcohols are best for the hygienic hand disinfection. To prevent transmission of bacterial flora, one should avoid touching the contaminated material and use protective gloves that should be replaced immediately after their contamination (1).

Despite principles of proper hand hygiene of medical professionals that have been known for years, their adherence continues to be insufficient. Conducted studies demonstrated that these principles are followed only in 40% of cases, including situations before and after examination of a patient, touching objects in the vicinity of the patient and even before sterile procedures and after contact with patient's body fluids (2, 13, 14). Of note, physicians less commonly adhere to hand washing procedures than nurses (14). Multiple methods are available to improve this situation. Train-

ings are one of these methods. Studies indicate that they are not universally successful or that their results are only transient (14, 15). Another solution involves a monitoring system that can include microbiological monitoring, observation, assessment of amount of used disinfectant (16, 17). Electronic monitoring systems have also been suggested (18). Suggestions of various monitoring systems indicate that such simple measure as proper hand washing is still underestimated by medical personnel. Our study also emphasizes significance of special attention that should be paid to hand washing. High percentage of positive cultures before the start of work and almost two-fold increase of percentage of positive cultures after doctor's rounds indicate that utilized hand hygiene is still insufficient, improper and/or often superficial. In view of the fact that results of all studies indicate the importance of adequate hand hygiene in prevention of hospital-acquired infections, one cannot explain negligence with being in a hurry because of large amount of work or with administrative problems such as lack of dispensers at each patient's bed, empty dispensers or lack of paper towels.

Equipment used in the patient care can be another reservoir of microorganisms causing infections. Most of the infections caused by contaminated diagnostic equipment (e.g. endoscopes) or equipment used in the life saving procedures, are related to insufficient decontamination (19). A stethoscope is an equipment that is most commonly used in the patient diagnostics. Wood et al. collected swabs from surfaces of the stethoscope membranes used by physicians and nurses working at intensive care units and emergency rooms. They found on average 246.5 bacterial colonies on one membrane of the stethoscope (20). Another study demonstrated positive cultures in swabs collected from 99% of the stethoscopes (21). Other authors also confirm role of stethoscopes as vectors of infection (22, 23).

Our study demonstrates that the alert-pathogens were found in marked percentage of cultures from phonendoscopes. Just as hands should be washed before and after examination of a patient, stethoscope membrane should be disinfected after each examination. As with hand disinfection, disinfection of stethoscopes is usually insufficient. An anonymous survey conducted among physicians and nurses working at a department of pediatrics found that 76% of the surveyed employees were aware of the risk of infection transmission through the stethoscope membrane, but only 26% of subjects disinfected the stethoscope membrane after each use (24).

When results of examination of swabs collected from hands and stethoscopes should be considered unsatisfactory, results of examination of swabs collected from soles of shoes before and after doctor's rounds are very bad. The alert bacteria were found in 56% of swabs collected before doctor's rounds and 68% of swabs collected after doctor's rounds. These results reveal that among objected examined by us, shoes are the largest reservoir of the alert bacteria; this issue has never been raised previously. While we can easily prevent infections transmitted by hands and stethoscopes by adhering to principles of proper hand washing and disinfection procedures, presence of the alert bacteria on soles of shoes indicates that the whole floor of the department is contaminated with the alert bacteria and they can be easily transmitted to other facilities in the whole hospital, in particular in view of the fact that communication routes of patients, medical staff, consultants are crossed. Certainly one of the possible solutions would be to clean the floor more often and more carefully with disinfecting agents and maybe use mats soaked with disinfecting agents. Use of adequate shoes and their daily sterilization should also be considered.

As our study indicates, particular emphasis should be put on hygiene of the floor in patient rooms and hospital communication routes.

Hospital acquired infections occur throughout the world – from the lowest levels to highly specialist clinics, university hospitals and institutes. They are favored by poor hygienic status and impaired patient immunity. Many of these infections could be avoided by implementing sanitary regime among the medical staff according to recommendations of the infection teams.

CONCLUSIONS

1. A physician is an important factor of infection transmission at a hospital.
2. Hands, stethoscopes and in particular shoes of the staff are the source of infection.

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Received: 30.09.2014 r.
Adress correspondence: 92-213 Łódź, ul. Pomorska 251
e-mail: kpadi@onet.pl