

ORIGINAL

Determination of Pathogenic Microorganisms on the Caps of Personnel in a Tertiary Care Hospital

Determinación de microorganismos patógenos en cofias del personal de un hospital de tercer nivel de atención

Adela Alba-Leonel¹  , Samantha Papaqui-Alba²  , Roberto Sánchez-Ahedo¹  , Ricardo Medina Torres¹  , Joaquín Papaqui-Hernández²  , Miguel Ángel Germán Mejía Argueta¹  

¹Universidad Nacional Autónoma de México. Ciudad de México, México.

²Instituto Mexicano de Seguridad Social. Ciudad de México, México.

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Corresponding Author: Adela Alba-Leonel 

ABSTRACT

Introduction: healthcare-Associated Infections (HAIs) are the most frequent adverse event during the provision of clinical care and are a public health problem worldwide, which can occur endogenously and exogenously. The cap is an exogenous cause. Therefore, our purpose is to determine the presence of pathogenic microorganisms on nurses' caps.

Method: a cross-sectional study was carried out; the unit of analysis was the caps. Inclusion criteria: caps of the outpatient staff of a tertiary care hospital. The sample consisted of 31 caps before taking the sample, informed consent and a questionnaire with 10 items were applied.

Results: the main pathogenic microorganism found in the caps was: E. Coli with 19,4 %, Staphylococcus SPP 12,9 %, Salmonella 6,4 % and unidentified enterobacteria 6,4 %. 13 % reported that they do not usually wash the cap and of the 87 % who said that they wash it, the average time to sanitize the cap was 1,8 weeks.

Conclusions: the main type of microorganisms found in our study differs from other studies. The cap is a means of transporting pathogenic microorganisms that can favor the increase of HAIs. It is a little-studied topic, so we consider that it is necessary to carry out more research on this subject, with the purpose of evaluating the use of the cap, and of decreasing the prevalence of HAIs.

Keywords: Infections Associated with Health Care; Coping; Nursing.

RESUMEN

Introducción: las Infecciones Asociadas a la Atención de la Salud (IAAS) son el evento adverso más frecuente durante la prestación de la atención clínica y son un problema de salud pública a nivel mundial, que se pueden presentar de forma endógena y exógena. La cofia es una causa exógena. Por lo tanto, nuestro propósito es determinar la presencia de microorganismos patógenos en las cofias de las enfermeras.

Método: se realizó un estudio transversal, la unidad de análisis fue las cofias. Los criterios de inclusión: cofias del personal de consulta externa de un hospital de tercer nivel de atención. La muestra estuvo conformada por 31 cofias antes de la toma de muestra se aplicó el consentimiento informado y un cuestionario con 10 ítems.

Resultados: el principal microorganismo patógeno encontrado en las cofias fue: E. Coli con un-19,4 %, Staphylococcus SPP 12,9 %, Salmonella 6,4 % y enterobacterias sin identificar 6,4 %. El 13 % reportó que no acostumbra a lavar la cofia y del 87 % que dijo que si la lava, el tiempo promedio de higienizar la cofia fue de 1,8 semanas.

Conclusiones: el principal tipo de microorganismos encontrado en nuestro estudio difiere de otros estudios. La cofia es un medio de transporte de microorganismo patógenos que puede favorecer el incremento de las IAAS. es un tema poco estudiado, por lo que consideramos que es necesario realizar más investigaciones al respecto, con el propósito de evaluar el uso de la cofia, y de disminuir la prevalencia de IAAS.

Palabras clave: Infecciones Asociadas a la Atención de la Salud; Cofia; Enfermería.

INTRODUCTION

Healthcare Associated Infections (HAI) are the most frequent adverse event during the provision of clinical care and are a worldwide public health problem.⁽¹⁾ They are also a major patient safety problem. These infections not only compromise patient safety, but also significantly increase the length of hospital stay, ranging from 5,9 to 9,6 days, and increase the probability of death by 6,9 %.⁽²⁾ This scenario generates unnecessary hospital expenses that affect the population, families, patients and healthcare institutions. In addition, HAIs can contribute to the development of antimicrobial resistance in microorganisms, which causes disability and can even lead to premature death.⁽³⁾

The magnitude of the problem is reflected in global figures: approximately 1,4 million patients acquire HAIs⁽⁴⁾ daily worldwide, with an incidence ranging from 4 to 9 cases per 100 hospital admissions. In Europe and other regions, it is estimated that 8,7 % of hospitalized patients present HAIs, indicating the seriousness of this situation in different contexts.

In Mexico, HAI rates vary between 3,8 and 26,1 per 100 admissions⁽⁵⁾ being more prevalent in services such as internal medicine and pediatrics. Antimicrobial resistance is a critical side effect associated with HAIs, as the indiscriminate use of antibiotics to treat these infections can result in more resistant bacterial strains. This not only complicates the treatment of existing infections, but also limits the therapeutic options available to future patients. Therefore, it is essential that healthcare institutions implement effective strategies to prevent and control these infections, including epidemiological surveillance programs and continuing education for healthcare personnel.

It is important to mention that HAIs can occur due to endogenous and exogenous causes. Endogenous causes are related to the patient's own permanent or transient microbial flora, which can become pathogenic under certain circumstances. On the other hand, exogenous causes include cross-infections, which may arise from the microbial flora of other patients or healthcare personnel. In addition, environmental infections, which arise from the flora present in the healthcare environment, also play a crucial role in pathogen transmission. This knowledge is essential to implement effective prevention and control strategies in the hospital setting.

Nowadays, there are other forms of transmission of microorganisms by healthcare personnel through uniforms, gowns, surgical pajamas, headgear, ties and instruments for patient examination, so the World Health Organization (WHO) recommends healthcare personnel to wear and use these responsibly, as well as to carry out epidemiological studies.

According to data reported by the WHO, more than 1,4 million people worldwide contract healthcare-associated infections in hospitals. In addition, the Center for Disease Control and Prevention (CDC) reported that the prevalence of HAIs varies between 3,5 % and 12 % in developed countries, while in developing countries it is estimated at between 5,7 % and 19,1 %, even exceeding 25 % in some cases. In Mexico, approximately 450 000 cases of HAIs were recorded, representing a rate of 32 per 100 000 inhabitants per year, and unfortunately, these infections caused the death of a significant number of patients.⁽³⁾

In 2022, the Epidemiological Surveillance Hospital Network reported 56 859 cases of HAIs, from the ascribed units, with an incidence rate of 3,02 per 100 discharges, the highest rate of hospital discharges occurred in the states of Jalisco, CDMX, Baja California, Veracruz and Hidalgo, with a rate of 8,28, 6,78, 5, 4,68 and 3,83, respectively, and the total number of deaths associated with HAIs was 3 624 and a case fatality rate of 5,17 per 100 infections. The states with the highest case fatality rates were: Baja California with a rate of 10,01, Durango with 8,40 deaths per 100 reported HAIs, in third place, Zacatecas with a rate of 9,27, Yucatan with a rate of 7,92 and CDMX with a rate of 7,33. The rate of HAIs per 1 000 patient days was 8,25.⁽⁶⁾

The main HCAI microorganisms reported were: *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Acinetobacter baumannii* and in fifth place *Staphylococcus aureus*.^(6,7,8,9,10)

In 2009, 17,8 % of HAIs were reported, in a high specialty unit⁽¹¹⁾ and in 2014 it was reported that, 10 out of every 100 patients hospitalized in a second level hospital had an HAI.⁽¹⁾

Therefore, the WHO recommends improving education and promoting greater responsibility among healthcare personnel, as well as conducting epidemiological research, with the purpose of generating actions for the prevention and control of HCAI. Likewise, it has been concluded that the origin of these microorganisms comes mainly from people, including doctors, nurses and patients^(6,8) so the objective of the study was to

determine the presence of pathogenic microorganisms in nurses' gowns and whether these are a means of transport that may favor the increase of HAIs.

METHOD

A cross-sectional study was carried out, the unit of analysis being the caps of the nursing staff. The inclusion criteria were caps from nursing staff from the outpatient department of a tertiary care hospital in Mexico City, from both shifts; exclusion criteria were caps from staff in the hospitalization area and other services; and as elimination criteria, staff who did not want to participate, who did not answer the questionnaire, or who did not attend on the day the sample was taken.

The sample comprised all the staff in the outpatient area on the morning and afternoon shifts, with a sample size of 31 coifs.

Nursing staff were invited to participate in the study. They were given an informed consent letter explaining their participation and stating that all the information would be handled generally and for statistical purposes. They were also told that participating in this project would not represent any reprisal or affect the provision of their services. The sampling procedure was as follows:

The nursing professionals who agreed to participate in the study were given a 10-item questionnaire, which had two sections: the first covered general data and the second dealt with the method and frequency of cap washing and the materials used for washing.

The staff were then asked to provide their caps so that samples could be taken and microorganisms identified.

Before taking the sample, the staff in charge washed their hands clinically using surgical soap (Antibenzil), put on sterile gloves, and put on a face mask, in accordance with the provisions of the Official Mexican Standard NOM-045-SSA2-2005, which regulates the epidemiological surveillance, prevention, and control of nosocomial infections. These measures are essential to guarantee the safety of both staff and patients, minimizing the risk of contamination and the spread of pathogenic microorganisms during clinical procedures.

The sample was taken by carrying out a total swab of the central area of the inner surface of each cap and the spaces corresponding to the folds. This was taken using the sterile swab technique, according to the guidelines established in the Manual for the taking, sending, and receiving samples for diagnosis by the General Directorate of Epidemiology.⁽¹⁾ For the transportation and conservation of the sample, a sealed and sterile Stuart-Copan transport medium (with a 48-hour conservation period) was used, consisting of a test tube with agar base medium with a snap cap and a swab.

The sample was placed on the transport medium, with the swab rotating, on the previously selected area. It was then sealed and stored in a thermos, with a cold chain at a temperature between 2° and 8°C, with temperature recorded every 15 min. The samples were delivered to the laboratory the same day.

Two pharmacobiological chemists carried out the analysis and interpretation of the cultures. The samples were processed in the culture media of MacKeg Agar, Blood Agar, Salt and Mannitol Agar, and Aiggy Agar and incubated for 48 hours at a temperature of 37°C.

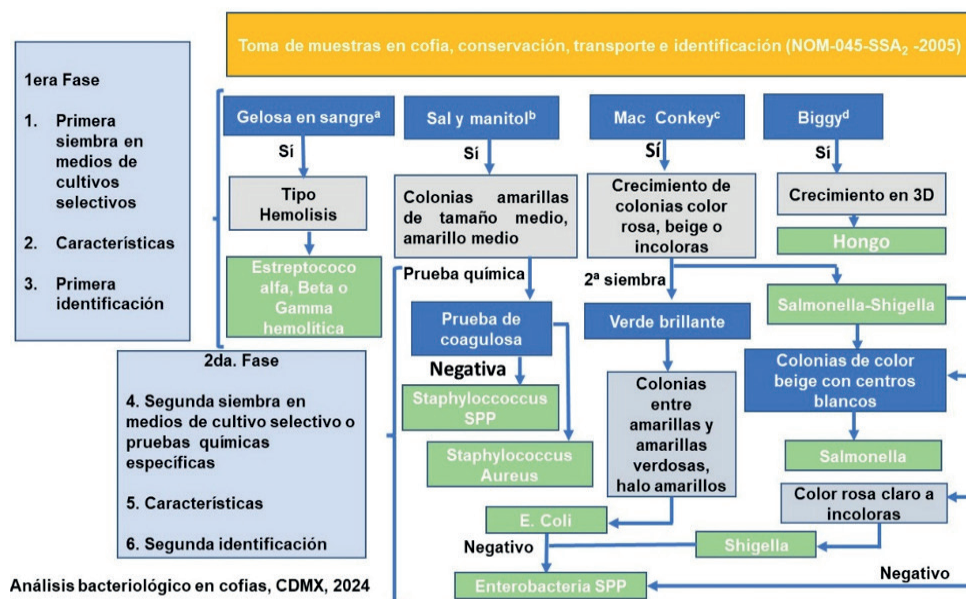


Figure 1. Sampling procedure, analysis and interpretation of cultures

Source: Bacteriological analysis in cofias, CDMX, 2024

For the sampling of bacteria, a sterile technique was used; the material was sterilized at a temperature of between 500° and 1300°C, such as the bacteriological loop, which was used to sow and resow the bacteria in the selective, enriched, and differential culture media (GSa, SMb, MCc and BGd). To prevent contamination of the culture media by bacteria unrelated to the samples and to prevent spread to other areas inside and outside the hospital, incubation lasted 48 hours at a temperature of 37°C. In the case of bacterial growth in SMb and MCc, they were reseeded in VBe and SSf agar under the same conditions or coagulase test figure 1.

The microorganisms in the cultures were classified using specific biochemical tests.

The statistical package for the social sciences (SPSS), version 24.0 for Windows, was used for the analysis

RESULTS

Of the 31 caps, 59,1 % corresponded to the morning shift outpatient clinic staff, 36,4 % to the afternoon shift, and 4,5 % to the mixed shift. Regarding the services the staff were in, 22,6 % belonged to the outpatient clinic, 16,1 % to internal medicine, and 16,1 % to general medicine table 1.

The average age of the professionals wearing the cap was 40 years old, with a range of 18 to 58 years old; in terms of educational level, 29 % have a bachelor's degree, 22,6 % are assistants, and 22,6 % are general nurses, and 19,4 % have a technical level, and only 13 % reported that they work in another institution or hospital 42 % of the caps had some pathogenic microorganism; in terms of the number of microorganisms found, 9,7 % had two microorganisms and 32,2 % only one. 23 % of the caps from the morning shift were contaminated, and 19,2 % from the afternoon. When analyzed by the maximum level of education, it was observed that these pathogenic microorganisms are more prevalent among auxiliary staff, technicians, and general nurses table 2.

Table 1. Outpatient departments where tampon samples were taken in a tertiary care hospital

Outpatient department	Frequency	%
Outpatient and teaching department management	3	9,7
Ophthalmology	2	6,5
Dermatology	1	3,2
Wound care	2	6,5
Gynaecology	2	6,5
Orthopaedics	1	3,2
Colposcopy	1	3,2
Endoscopy	1	3,2
Preventive medicine	5	16,1
Internal medicine	5	16,1
General outpatient department	7	22,6
Pap smear test	1	3,2
Total	31	100

Table 2. Number of pathogenic microorganisms in caps according to the highest level of education of outpatient nursing staff at a tertiary care hospital in Mexico City, 2024

Level of education	Number of microorganisms			Frequency
Auxiliary nurse	2	4	1	7
Technical nurse	5	1	0	6
General nurse	4	1	2	7
Bachelor's degree in nursing	5	4	0	9
Master's degree	1	0	0	1
Specialty	1	0	0	1
Total	18	10	3	31

When determining the existence of pathogenic microorganisms in the caps, it was found that 32,2 % had at least one microorganism. The main microorganism found in the caps was *E. coli* with 19,4 % (6), *Staphylococcus SPP* 12,9 % (4), *Salmonella* 6,4 % (2) and unidentified enterobacteria 6,4 % (2), *Staphylococcus aureus* 3,2 % (1) and *Shigella* 3,2 % (1) (figure 2).

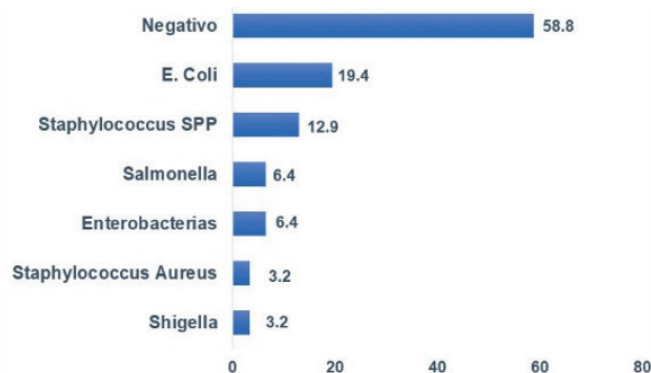


Figure 2. Type of microorganisms found in the swabs of outpatient personnel at a tertiary care hospital

Thirteen percent reported that they do not usually wash the cap, and 87 % said that they do. The average time for sanitizing the cap was 1,8 weeks $\pm$ 0,77 59 % wash it weekly, 30 % fortnightly, and 26 % once a month. In terms of the highest level of education, there are no statistically significant differences, as 45,4 % of staff with a bachelor's degree or higher wash their caps every eight days, as do those with a lower level of education table 3.

When asked what they use to wash it, 12,9 % use soap and water; 29 % use soap, water, and bleach; and the other 12,9 % use soap, water, and non-chlorine detergent to remove tough stains.

Nivel de Escolaridad	Lava la cofia		Periodicidad de lavado				frecuencia
	Si	No	Cada 8 días	Cada 15 días	Al mes	No contesto	
Enfermería auxiliar	7		5	2	0		7
Enfermera Técnica	4	2	2	1	2	1	6
Enfermera General	5	2	2	2	2	1	7
Lic. en Enfermería	9	0	3	3	3	0	9
Maestría	1	0	1	0	0	0	1
Especialidad	1	0	1	0	0	0	1
Total	27	4	14	8	7	2	31

Figure 3. Frequency of cap washing and how often it is done by staff according to the highest level of education of outpatient nursing staff at a tertiary care hospital in México City

To calculate the effect size, we divided the caps according to the maximum level of education of the personnel with a bachelor's degree or higher and without a bachelor's degree and the presence of microorganisms; the PR was 1,43. Regarding the cap's level of education and hygiene, the PR was 1,5. However, the hypothesis test was not statistically significant due to the sample size.

DISCUSSION

The cap represents a symbol of identity but is also an item exposed to the hospital environment, carrying all kinds of microorganisms capable of growing on it. From an epidemiological point of view, the cap can be considered a fomite since it was found that 42 % of the caps had at least one pathogenic microorganism. Even though the prevalence was lower concerning the study carried out in the state of Veracruz in the internal medicine, surgery and traumatology, gynecology and pediatrics services of a second level hospital, perhaps this difference is due to the level of care, as well as to the different services.⁽¹⁾ Likewise, the prevalence was lower than the study on nursing students in the Doctor Juan I Menchaca Civil Hospital in Guadalajara Jalisco on internal medicine and general surgery personnel.⁽²⁾

On the other hand, it is worth mentioning that after the results obtained in 1988 in the study called "Transcendence and use of the cap in the nurse of the New Civil Hospital of Guadalajara," the cap was dispensed with as part of the uniform of the nurses of the New Civil Hospital of Guadalajara.

About the type of microorganism, the main one found in our study was E. E. coli, with 19,4 %. This differs from other studies since the main microorganism reported has been *Streptococcus pyogenes* with 82 %⁽¹³⁾ and in

the survey carried out on students, it was *Micrococcus* spp with 89,6 %⁽¹⁴⁾ and in Shintani's⁽³⁾ it was *Bacillus* spp. However, it is worth mentioning that the primary type of microorganism found on caps in the study is consistent with that reported in the Epidemiological Overview of Healthcare-Associated Infections (HAI) of 2022.⁽⁶⁾ The organism found in our study may be due to inadequate hand hygiene habits and the constant frequency of touching the cap or hair.

Regarding cap hygiene, our data differ from the study by Fernández⁽¹⁴⁾, in which an average of 8,6 weeks $\pm$ 25,6 was reported; the data reported by the professionals in the study was 1,8 weeks $\pm$ 0,77; this data agrees with that of Macias where he reports that 48,3 % do it every 8 days. It was impossible to compare how the cap is usually cleaned with other studies as there are no studies with this data. 29 % of professionals mentioned doing it with soap, water, and chlorine, 12,9 % only with soap and water.

It is essential to note that the cap is part of the nursing professional's attire. It was initially used as hair protection, and in the mid-20th century, it was established as a symbol of identity as part of the clinical uniform; however, the cap is a risk factor as mentioned by Heideraru,⁽⁴⁾ Zuñiga⁽⁵⁾ and Aguilar⁽⁶⁾.

Likewise, Ayala et al.⁽⁷⁾ considers that the cap is not functional in nursing practice and argues that nurses wash their hair frequently and always wear it up, that they do not need to cover it to prevent the spread of bacteria.

While the cap is part of the nursing profession's identity and symbol, nurses are also distinguished by their professional care. Therefore, the use of the cap is questionable nowadays, as it is a means of transportation for microorganisms that can favor the increase of HAIs. Thus, Zuñiga⁽¹⁸⁾ suggests that nursing professionals avoid touching their caps, hair, and skin during the workday and perform hand hygiene.^(19,20)

CONCLUSIONS

The forelock is a means of transportation for pathogenic microorganisms that can favor the increase of SIAs. Although countless studies have been carried out on the cap, all of them have focused on the psychosocial areas, not the biological ones. This is an understudied topic, so it is necessary to carry out more research to evaluate the use of the cap and reduce the prevalence of HAIs due to exogenous causes. As well as reducing costs, risks, and days spent in the hospital. The lack of publications on the subject suggests that new research should be carried out to improve the SIDS programs and make decisions about using the cap.

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FINANCING

None.

CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Adela Alba-Leonel, Samantha Papaqui-Alba, Roberto Sánchez-Ahedo, Ricardo Medina Torres, Joaquín Papaqui-Hernández, Miguel Ángel Germán Mejía Argueta.

Data curation: Adela Alba-Leonel, Samantha Papaqui-Alba, Roberto Sánchez-Ahedo, Ricardo Medina Torres, Joaquín Papaqui-Hernández, Miguel Ángel Germán Mejía Argueta.

Formal analysis: Adela Alba-Leonel, Samantha Papaqui-Alba, Roberto Sánchez-Ahedo, Ricardo Medina Torres, Joaquín Papaqui-Hernández, Miguel Ángel Germán Mejía Argueta.

Drafting - original draft: Adela Alba-Leonel, Samantha Papaqui-Alba, Roberto Sánchez-Ahedo, Ricardo Medina Torres, Joaquín Papaqui-Hernández, Miguel Ángel Germán Mejía Argueta.

Writing - proofreading and editing: Adela Alba-Leonel, Samantha Papaqui-Alba, Roberto Sánchez-Ahedo, Ricardo Medina Torres, Joaquín Papaqui-Hernández, Miguel Ángel Germán Mejía Argueta.