ARTÍCULO ORIGINAL

Comparison of Resistance to the Antibiotics Penicillin, Erythromycin, Oxacillin, Chloramphenicol and Vancomycin in Staphylococcus aureus Isolated from Healthy Adults in the United States of America and Mexico

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ABSTRACT

Our investigation indicates there are significant differences in the throat carriage of *Staphylococcus aureus* resistant to antibiotics (penicillin G, oxacillin, erythromycin, chloramphenicol and vancomycin) in a population in Mexico compared to a similar population in the United States of America (USA). Throat isolates were obtained from 105 healthy adults from the USA (Kennesaw State University, Kennesaw, Georgia, USA) and from 76 healthy adults from Mexico (Xalapa, Veracruz, Mexico.) The data indicate a significantly greater number of resistant isolates of *Staphylococcus aureus* from the Mexican population (16) than from the USA population (7). Factors that may contribute to these differences were identified from questionnaires completed by each participant. These factors were: 1) a greater percentage of individuals in the Mexico population seek the care of a physician for allergies; 2) a greater percentage of individuals in Mexico have used antibiotics recently; 3) all of the antibiotics used in this investigation are available in Mexico without a prescription from a physician, but none are available in the USA without a prescription from a physician.

WORD KEY: Antibiotic resistance, *Staphylococcus aureus,* penicillin, oxacillin, erythromycin, chloramphenicol, vancomycin

RESUMEN

Nuestra investigación indica que existen diferencias significativas en la portación en garganta de *Staphylococcus aureus* resistente a antibióticos (penicilina G, oxacilina, eritromicina, cloranfenicol y vancomicina) en una población en México comparada con una población similar en los Estados Unidos de Norteamérica (USA). Los aislamientos de garganta se obtuvieron de 105 adultos saludables de los Estados Unidos (Kennesaw State University, Kennesaw, Georgia, USA) y de 76 adultos saludables de México (Xalapa, Veracruz, México). Los datos arrojan un número significativamente mayor de aislamientos resistentes de *Staphylococcus aureus* en la población mexicana (16) que en el de la población de EU (7). Los factores que pueden contribuir a estas diferencias fueron identificados a partir de cuestionarios completados por cada participante. Estos factores fueron: 1) un porcentaje mayor de individuos en la población de México

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acuden al médico por alergias; 2) un porcentaje mayor de individuos en México ha usado antibióticos recientemente; 3) todos los antibióticos usados en esta investigación se encuentran disponibles en México sin prescripción médica, pero ninguno se encuentra disponible en EU sin la misma.

PALABRAS CLAVE: Resistencia antibiótica, *Staphylococcus aureus,* penicilina, oxacilina, eritromicina, cloranfenicol, vancomicina

It is important to have a better understanding of factors that may predispose healthy persons to carriage of antibiotic resistant organisms. This knowledge may help us identify health or environmental factors that could be manipulated to reduce the carriage of antibiotic resistant organisms. Perhaps this knowledge could also reduce the prevalence of these resistant organisms and thus the infections they may cause.

INTRODUCTION

There is a rapid increase world-wide in the numbers of bacteria resistant to antibiotics. Most resistance arises due to the over use or misuse of antibiotics for: medicinal purposes (1), agricultural purposes (2), and purposes of disinfection (3), thus selecting for resistant organisms. Each day it becomes more difficult to find antibiotics that effectively treat common but serious infections (4, 5, 6). The majority of information about antibiotic resistance in the scientific literature pertains to bacterial isolates from infections that did not respond to treatment with antibiotics. There is little data in the scientific literature about resistance to antibiotics in bacteria isolated from healthy individuals (5). In particular, we are not able to find any data about resistance in *Staphylococcus aureus* isolated from healthy adults.

This study attempts to determine the prevalence of carriage of antibiotic resistant *Staphylococcus aureus* by healthy persons. This investigation compared data obtained from healthy adults in two areas, Mexico and the United States of America (USA) for the 1) presence of antibiotic resistant *Staphylococcus aureus*, 2) factors from health histories from each individual, and 3) the availability of antibiotics. This investigation concentrates on *Staphylococcus aureus* because it is one of the most important causes of serious infection in hospitalized patients as well as in persons with immune system impairment. It is easy to identify and grow, and it is the bacterium that was most commonly isolated by our investigation in both countries. Also there is much information in the scientific literature about *Staphylococcus aureus.*

METHODS

Data were obtained from healthy adults (≥ 18 years of age) from two populations: 105 adults from the area of Kennesaw State University (Kennesaw, Georgia, USA) and 76 adults from the area of the Hospital Escuela de Ginecologia y Obstetricia (Xalapa, Veracruz, Mexico) during the summer of 2001 by the students of a research class from Kennesaw State University.

Isolates were obtained from the fauces of adults by means of a sterile swab, and the organisms were isolation streaked onto 5% sheep blood agar. Isolated colonies were further cultured and identified by hemolytic reaction, gram reaction, catalase production, and reaction on Mannitol Salt Agar.

Finally, they were analyzed using the disk method on Mueller Hinton Agar for resistance to five antibiotics: penicillin G, oxacillin, erythromycin, chloramphenicol, and vancomycin. The methods and materials were the same in both countries, following the guidelines of "The National Committee for Clinical

Laboratory Standards for Antimicrobial Disk Susceptibility" (7). The results were recorded and analyzed using Chi-Square analysis, with $p = 0.05$.

Each individual tested was asked to complete a questionnaire. This data was used to compare population characteristics and to identify the possible factors that might influence the numbers of antibiotic resistant strains isolated from each population. The factors investigated included: demographic data, information about smoking, medical history, and the availability of antibiotics in both countries.

RESULTS

There were significantly more isolates of *Staphylococcus aureus* from the Mexican population (16 isolates from 76 persons) than from the USA population (7 isolates from 105 persons). The data indicate more isolates of antibiotic resistant *Staphylococcus aureus* in the Mexican population than in the USA population. Of the 16 isolates of *Staphylococcus aureus* in Mexico, 11 showed multiple resistance to penicillin, erythromycin, and oxacillin; 8 showed resistance to chloramphenicol, and 4 showed intermediate resistance to vancomycin. Of the 7 Staphylococcus aureus isolated from the USA population, 2 showed resistance to penicillin, 2 to erythromycin, 5 were resistant to oxacillin and 5 to chloramphenicol, and 7 showed intermediate resistance to vancomycin. (Table 1) Obviously, from this data, many isolates were multiply resistant. This data has been combined for brevity because each isolate had its own resistance pattern.

Table 1
Comparison of Resistance and Intermediate Resistance in *Staphylococcus aureus*

Number of *Staphylococcus aureus* Isolates						
Country	**Total**	**P**	**E**	**O**	**C**	**V**
Mexico	**16**	**11**	**11**	**11**	**8**	**4**
USA	**7**	**2**	**2**	**5**	**5**	**7**

P = penicillin, intermediately resistant or resistant
E = erythromycin, intermediately resistant or resistant
O = oxacillin, intermediately resistant or resistant
C = cloramphenicol, intermediately resistant or resistant
V = vancomycin, intermediately resistant or resistant

There is a significant difference between Mexico and the USA in each category
Evaluated by Chi-Square $p \leq 0.05$

Using the data from the questionnaires to compare the characteristics of the two populations, there were no significant differences in the average age (in Mexico 36 years, and in the USA 34 years) or in the distribution by sex (in Mexico 24 men, 52 women; in the USA 39 men, 65 women). (Table 2)

Table 2
Comparison of Characteristics of the Populations

Country	Sex		Average age
	Male	**Female**	**Years**
Mexico	**24**	**52**	**36**
USA	**39**	**65**	**34**

There are no significant differences

Data from the questionnaires show that there are significant differences between the two populations that might influence whether or not a person carried antibiotic resistant Staphylococcus. More persons in Mexico (43% -- 32 of 76 persons) have allergies severe enough to consult a physician compared with the USA population (16% -- 17 of 105 persons). (Table 3)

Unpublished data indicate that a person who consults a physician for allergy problems is more likely to carry antibiotic resistant Staphylococcus than a person who does not consult a physician because of allergies. (Perhaps this increase of carriage of resistant Staphylococcus by allergic persons is due to increased likelihood of respiratory tract infections and resulting greater antibiotic use.) (8) The data indicate that more persons in the Mexico population (19 of 76 persons) have recently used antibiotics compared to the USA population (21 of 105 persons). (Table 3)

Table 3
Comparison of allergy prevalence and recently taking antibiotics

Country	Consult a doctor for allergies	Have taken antibiotics recently*
Mexico	**43%**	**25%**
USA	**16%**	**20%**

There is a significant difference between Mexico and the USA in both categories
Evaluated by Chi-Square $p \leq 0.05$
Actual numbers used, not percentages, in Chi-Square evaluation
*within the past 6 months

Another factor of importance is that all the antibiotics used in this investigation are available without a prescription from a physician in Mexico. None of these antibiotics are available without a prescription from a physician in the USA.

CONCLUSIONS

This investigation has found a significantly greater number of antibiotic resistant isolates of *Staphylococcus aureus* in the Mexican population tested than in the USA population tested. The numbers of persons sampled in each population were relatively small (76 in Mexico, 105 in USA), but the comparisons were so strikingly different that the significant differences seem reliable. We were not able to determine all the factors that may contribute to the differences in numbers of resistant isolates. However, there are significant differences in the data from the questionnaires that show greater numbers of persons with serious allergies, greater use of antibiotics, and less restrictive availability of antibiotics without a prescription in Mexico. These may be important factors contributing to the selection of antibiotic resistant bacteria. Further investigations are needed to increase the database and sample size so that we can understand more completely the serious problem of antibiotic resistance and thus promote the health of persons in both countries. (9)

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