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ORIGINAL ARTICLE

MICROBIOLOGICAL PROFILE OF NOSOCOMIAL INFECTIONS AT INTENSIVE CARE UNITS

PERFIL MICROBIOLÓGICO DAS INFECÇÕES HOSPITALARES NAS UNIDADES DE TERAPIA INTENSIVA

PERFIL MICROBIOLÓGICO DE LAS INFECCIONES NOSOCOMIALES EN LAS UNIDADES DE CUIDADOS INTENSIVOS

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ABSTRACT

Objective: to investigate the microbiological profile of nosocomial infections at intensive care units. ***Method:*** field study, retrospective, exploratory and descriptive, with quantitative approach, which evaluated 33 records of patients with nosocomial infection at a public hospital of Piauí/PI from June to September 2014. The project was approved by the Research Ethics Committee, CAAE 35928214.0.0000.5512. ***Results:*** the nosocomial infection rate was 6,2%, being the respiratory infection the most prevalent one 33,3%, *Klebsiella spp.* accounted 22,2% of the cases and presented 100% sensibility to meropenem, ertapenem and imipenem antimicrobials. The indwelling catheter was the most performed procedure (87,9%); Vancomycin, metronidazole and Tazocin were the most used antimicrobials (33,3%) and the death rate was 57,6%. ***Conclusion:*** the most prevalent topography considering both units is the respiratory tract, with *Klebsiella spp.* as the microorganism responsible for the greatest amount of infections, and sensible, specially, to carbapenem antimicrobials. ***Descriptors:*** Infection; Microbiology; Intensive Care Units.

RESUMO

Objetivo: investigar o perfil microbiológico das infecções hospitalares nas unidades de terapia intensiva. ***Método:*** estudo de campo, retrospectivo, exploratório-descritivo, com abordagem quantitativa em que foram avaliados 33 prontuários de pacientes com infecção hospitalar de um hospital público do Piauí/PI referentes aos meses de junho a setembro de 2014. O projeto foi aprovado pelo Comitê de Ética em Pesquisa, CAAE 35928214.0.0000.5512. ***Resultados:*** a taxa de infecção hospitalar foi de 6,2%, sendo a infecção respiratória à topográfica mais predominante 33,3%, a *Klebsiella spp.* foi responsável por 22,2% dos casos de infecção apresentado sensibilidade de 100% aos antimicrobianos meropenem, ertapenem e imipenem. A sondagem vesical de demora foi o procedimento mais realizado (87,9%); A Vancomicina, o Metronidazol e o Tazocin foram os antimicrobianos mais utilizados (33,3%) e a taxa de óbito foi de 57,6%. ***Conclusão:*** a topografia mais prevalente considerando ambas unidades é a do trato respiratório, tendo como microorganismo responsável pela maior quantidade de infecção a *Klebsiella spp.* que se mostra sensível principalmente aos antimicrobianos carbapenêmicos. ***Descritores:*** Infecção Hospitalar; Microbiologia; Unidades de Terapia Intensiva.

RESUMEN

Objetivo: investigar el perfil microbiológico de las infecciones nosocomiales en las unidades de cuidados intensivos. ***Método:*** estúdio de campo, retrospectivo, descriptivo y exploratorio, con enfoque cuantitativo que evaluó 33 expedientes de pacientes con infección nosocomial en un hospital público de Piauí/PI para los meses de junio a septiembre de 2014. El proyecto fue aprobado por el Comité Ética de la Investigación, CAAE 35928214.0.0000.5512. ***Resultados:*** la tasa de infección hospitalaria fue del 6,2% con infección respiratoria la más prevalente topográfica 33,3%, Klebsiella spp. Se representó el 22,2% de los casos de infección presentados sensibiliadade 100% a meropenem antimicrobiano, ertapenem e imipenem. El catéter permanente era el procedimiento más realizado (87,9%); Vancomicina, metronidazol y Tazocin fueron los antimicrobianos más utilizados (33,3%) y la tasa de mortalidad fue de 57,6%. ***Conclusión:*** la topografía más frecuente, considerando ambas unidades es el tracto respiratorio, con el microorganismo responsable de la mayor cantidad de la infección por Klebsiella spp. que muestra principalmente sensibles a los antibióticos de carbapenem. ***Descriptores:*** Infección; Microbiología; Unidades de Cuidados Intensivos.

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INTRODUCTION

Health Care Related Infections (IRAS) are defined as any infection that affects the individual, whether at hospitals, hospital or home outpatient care, and that may be associated with some assistance therapeutic or diagnosis procedure.[1]

The Intensive Care Units (ICUs) are units for the care of clinically severe patients who require continuous monitoring and support of vital functions. It is considered a critical area, both the hemodynamic instability of hospitalized patients, as the high risk of developing IRAS.[2]

At health institutions, inpatients are exposed to a wide variety of pathogenic microorganisms, especially at intensive care units. The ICU is an environment that makes the patient more vulnerable to infection risks, both for its status as the variety of invasive procedures that are daily performed.[3] Intensive care units are responsible for about 5% to 35% of all NI's, and also one of the main factors for high mortality rates ranging between 9% and 38%, with about 60% directly related to the presence of NI.[4]

At these units, infections are initially associated with clinical severity of patients, diagnostic and therapeutic interventions such as the use of invasive procedures (bladder catheterization, intravenous catheters, intubations, tracheostomy, mechanical ventilation), patients using immunosuppressant, with chronic diseases and traumatized, with resistant microorganisms colonization, and prolonged stay at the institution are considered relevant risk factors that can be directly associated with nosocomial infection.[5]

Along with this, it is important the sign of resistant microorganisms (MR) and related infections in health care; it is noticed a gradual emergence of multidrug-resistant bacteria at the hospital environment in recent decades, becoming a threat to public health worldwide, being related to the indiscriminate and inappropriate use of antimicrobials, whether at a hospital or by the community, the situation worsens as it contributes to increased morbidity and mortality of patients and costs related to their hospitalization and, above all, by reducing the technological arsenal or by the lack of therapeutic option for the treatment of infections caused by some microorganisms.[1]

Bacterial populations can become resistant to antimicrobial agents by mutation and selection, or by acquirement of new resistant genetic material from another bacterium. A single change can result in several different resistances to various antimicrobials or even multiple classes of non-related drugs.[6]

This study aims to investigate the microbiological profile of nosomial infections at intensive care units.

METHOD

Field study, retrospective, exploratory and descriptive, with quantitative approach, performed at two intensive care units/ICU of a high complexity hospital, reference at the estate of Piauí/PI, with 15 beds, divided into ICU-1, with eight beds, and ICU-2, with seven beds, with a hospitalization average of 73,5 patients per month. Mostly, their patients have neurological problems and are recovering from major surgeries; one bed of each unit is intended for patients in isolation.

The sample consisted of all patients with nosocomial infection at intensive care units (1 and 2) of the hospital, with positive culture result, and/or nosocomial infection suggestive clinical data as the institution protocol from January to September 2014.

The instrument used for data collecting was a semi-structured form that allowed collecting data directly from medical records of hospitalized patients at intensive care units (1 and 2) with a nosocomial infection diagnosis from June to September 2014.

Data were collected with the help of semi-structured form and tabulated with the help of Microsoft Excel program that allowed calculating the percentages and means, condensed into tables and a figure to be analyzed.

This study research project as approved by the Research Ethics Committee CAAE nº. 35928214.0.0000.5512.

RESULTS

This study was conducted at the two intensive care units (ICU) named ICU-1 and ICU-2, from June to September 2014, with a 33 NI patients sample, 20 positive cultures, among the 533 hospitalized patients, constituting a nosocomial infection rate of 6,2% for the period; 11 types of isolated microorganisms were identified. Table 1 shows the topography of these infections and the main antimicrobials used by the evaluated patients.

Table 1. Profile of the hospitalized patients with nosocomial infection at the ICU's of a Public Hospital between June and September. Teresina-PI, 2014.

Gender	n	%
Male	19	57,6
Female	14	42,4
Age group		
20 to 39	3	9,1
40 to 59	15	45,5
Over 60	15	45,5
Marital Status		
Merried	16	48,5
Single	14	42,4
Widower	3	9,1
Origin		
Teresina	15	45,5
Piauí Countryside	14	42,4
Other states	4	12,6
Total	33	100

Source: Medical records of patients admitted at the ICU of HGV

The research shows that, regarding the gender, male patients are the most common genre for hospitalization at ICUs with 57,6% (n = 19) and female with 42,4% (n = 14); it also shows that the ages ranged from 20 to over 60, but the sample of patients with NI at the two ICUs between 40-59 years old and over 60 were n = 15 (45,5%) at both ICUs as shown in Table 1.

It also indicates that n = 16 (48,5%) of patients are married, and 42,4% are single, and adds 9,1% of patients who don't have any kind of relationship. The origin of the patients was observed and they are mostly from Teresina, with 45.5%, followed by the Piauí countryside with 42,4% and 12,6% from other states.

At the study of the 33 researched charts, all of them with clinical signs and diagnosis of NI, only 13 had positive culture results for NI. Table 2 shows the topography of these infections.

Table 2. Distribution of episodes of infection according to topography at ICUs 1 and 2 from June to September. Teresina-PI, 2014.

Topography	N	%
Respiratory	8	33,3
Surgical wound	7	29,2
Urinary	5	20,8
Sanguine	4	16,7
TOTAL	24	100

Source: Medical records of patients admitted at the ICU of HGV

According to the results from the research, regarding the distribution of infection cases by topography of the hospitalized patients at ICUs 1 and 2, Table 3 shows the superiority of infection related to respiratory system, with 33,3% (n = 8) of the cases. Followed by surgical wound as the second most prevalent disease, with 29,2% (n = 7) of the cases. The topographies that had minor prevalence of infection were urinary, (n = 5) with 20,8%, and bloodstream, (n = 4) 16,7%.

Table 3. Distribution of microorganisms that cause hospital infections at ICUs 1 and 2, from June to September. Teresina- PI, 2014.

Microorganism	n	%
Klebsiella spp	6	22,2
Acinetobacte rspp	5	18,5
Pseudomonas aeruginosa	4	14,8
Escherichia coli	3	11,1
Staphylococcus aureus	2	7,4
Enterococcus	2	7,4
Others	5	18,5
Total	27	100

Source: Medical records of patients admitted at the ICU of HGV

Looking at the first graphic below, it is noticed that many of the hospitalized patients had the indwelling catheter (SVD) (n = 29), with 87,9%, as the predominant invasive procedure. Followed by the implantation of central venous catheter, n = 23, 69,7% of the cases. As for the prevalence of nasogastric tube (NGT) accompanies the use of endotracheal tube (TOT), both with a prevalence of 66,6% (n = 22) of the cases. Through the graphic, the tracheostomy (TQT) was a method used at 30,3% (n = 10) of patients, followed by others, such as peripheral venous access (AVP), (n = 9) with 27,3%, nasogastric tube (NGT), with number of patients n = 7 (21,2%), and other procedures n = 4 (12,1%).

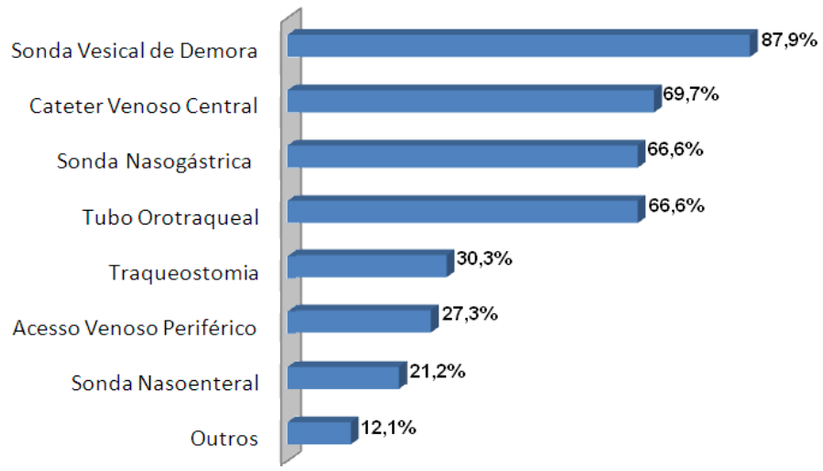

Figure 1. Distribution of types of invasive procedures performed in ICUs 1 and 2, from June to September. Teresina- PI, 2014.
Source: Medical records of patients admitted at the ICU of HGV.

Table 4 points out the prevalence of sensitivity of microorganisms, considering the four highlighted in the tables as the most prevalent among other isolated microorganisms. *Klebsiella* spp. showed increased sensitivity to carbapenems antimicrobials Imipenem (n = 6), Meropenem (n = 6), Ertapenem (n = 6), with 100% sensitivity, as well as Amikacin (n = 6).

The *Acinetobacter* spp. was sensitive only to Poliximine B and Tigecycline, both with (n = 5) 100% and only (n = 1) 20% sensitive to Ampicillin/Sulbactam. *Pseudomonas* spp. was sensible to Amikacin in 100% of the cases, followed by Ciprofloxacin, Poliximine B, Levofloxacin, (n = 3) with 75%. *Escherichia coli* is (n = 3) 100% sensitive to five types of antibiotics: Amikacin, Imipenem, Tigecycline, Cefepime, Gentamicin.

Table 4. Sensitivity profile to antimicrobials of microorganisms isolated from ICUs 1 and 2, from June to September. Teresina- PI, 2014.

	Microorganisms			
Sensibility	*Klebsiela Spp.* n(%)	*Acinetobacter* spp. n(%)	*Pseudomonas spp.* n(%)	*Escherichia coli* n(%)
Amikacin	6(100)	-	4(100)	3(100)
Ertapenem	6(100)	-	-	1(33,3)
Impenem	6(100)	-	1(25)	3(100)
Meropenem	6(100)	-	2(50)	-
Tigecycline	6(100)	5(100)	-	3(100)
Cefepime	3(50)	-	2(50)	3(100)
Cefotaxime	3(50)	-	-	1(33,3)
Ceftazidime	2(33,3)	-	1(25)	1(33,3)
Ceftriaxone	3(50)	-	-	1(33,3)
Gentamicin	4(66,7)	-	1(25)	3(100)
Ciprofloxacin	2(33,3)	-	3(75)	-
Piperacilin/ Tazobactam	-	-	2(50)	-
Levofloxacin	-	-	3(75)	-
Poliximine B	-	5(100)	3(75)	-
Ampicilin/ Sulbactam	-	1(20)	-	-
Tobramycin	-	-	1(25)	-
Aztreonam	-	-	1(25)	-

Source: Medical records of hospitalized patients at ICUs from HGV with positive culture results.

Regarding the high rate of infection mortality in ICU patients, the death occurred in 57,6% of the sample obtained from the research of both ICU's, followed by only 42,4% of patients who were discharged.

DISCUSSION

Intensive care units are very important for providing two main services to critically ill patients: (1) life support for severe organic failure and intensive monitoring enable to early identify and appropriately treat severe medical complications; and (2) acting decisively when there is instability of organs and functional systems at risk of death.[3]

The nosocomial infection rates within intensive care units range between 18 and 54%, being about five to ten times higher than other hospital units. The ICU is responsible for 5-35% of all NI, and for roughly 90% of all outbreaks occurring at these units, with predominance of high mortality rates ranging from 9 to 38%, that can reach 60% mainly due to NI.[4]

Among the records used in this study from ICU 1 and ICU 2, the socio-demographic profiles of both ICUs patients are shown in Table 1, which enhanced the predominance of males (n = 19), 56,6% and also identified the prevalence of adult hospitalized patients, from 40 to over 60 years old (n = 15), 45,5% of the cases, mostly with stable relationship, 48,5%, as well as evidenced in similar studies, where 56% of patients were men, 34,2% of them between 41 and 60 years old, corroborating the findings of our survey.[3]

Retrospective studies conducted from 2007 to 2008, with 37 people diagnosed with infection at the ICU in Toledo, Paraná, identified 73% of male persons, and also with an average of 71 years.[7-8]

The presence of patients from 41 to over 60 years old shows that the adult and elderly population requires a greater demand that should be related to population aging. We know this group of people uses hospital services more intensively than other age groups, also causing an increase at cost, treatment and slow recovery.

Studies showed that most of the patients comes from the state countryside, with 53,9%, as opposed to the result of this study, which showed that most of the hospitalized patients comes from the capital, n = 15 (45,5%), which was close to the rate of hospitalized patients from other cities, n = 14 (42,4%). Since this hospital is a benchmark for the treatment of highly complex diseases, this excess demand complicates, thus, the organization of health assistance, as these patients who need specialized care needs to be reallocated to capital hospitals.[3]

Table 3 shows the prevalence of infection by topography of both ICUs. The most frequent NI is respiratory (33,3%); the second one, surgical wound (29,2%), followed by urinary (20,8%) and sanguine (16,7%). The researches conducted at the ICUs from the same hospital confirms the conducted study, stating that 59,4% of NI cases have, as main topography, the respiratory system, considering that both surveys were conducted at the same hospital where it was found that this type of infection is mainly related to patients who use mechanical ventilators.[2-3]

In the survey conducted for this study, we must take into account that, among the whole sample, n = 33, only 13 patients were diagnosed with infection with presumptive clinical data and a protocol created by the institution where the research was conducted. This protocol also includes the National Nosocomial Infection Surveillance System (NNISS) methodology, which is a criterion for identification and diagnosis of nosocomial infection. The other 20 NI diagnoses were confirmed by performing culture with positive result.[8]

At the laboratory, 20 NI cases were confirmed, with *Klebsiella spp.* (22,2%) as the prevailing microorganism, followed by *Acinetobacter spp.* (18,5%), *Pseudomonas spp.* (14,8%), and *Escherichia coli* (11,1%). These microorganisms were also identified as main NI causes in similar studies, which state that *Klebsiella* is a bacillus that lives in the gastrointestinal tract of colonized individuals and an important pathogen for NI, especially at critical treatment units such as ICUs.[2-3,9]

Data from several other studies indicate *Klebsiella spp.* as a huge concern since this microorganism has different resistance mechanisms and can initiate and be involved in several severe pathologies, which can cause death of many patients.[9]

K. pneumoniae was the pathogen classically described by Friedlander (Friedlander bacillus) as a cause of lobar pneumonia acquired at the community, particularly in people with chronic alcoholism. This pneumonia is characterized by severe pyogenic infection and has high mortality rates. As community infections agent, *K. pneumoniae* is a pathogen that can cause ITU's, pneumonia, bacteremia and focal suppurative infections, including liver abscess and its serious complications such as meningitis and endophthalmitis.[10]

In the *Klebsiella spp.* genus, an important resistance mechanism is provided by beta-lactamases of broad spectrum (ESBL). These enzymes have the ability to hydrolyze a wide variety of penicillins and third generation cephalosporins, which, at first, were developed as drugs able to overcome bacterial resistance conferred by the common beta-lactamases.[9]

A research conducted at the ICU from a hospital in São Paulo revealed that, during the observation period, seven hospitalizations were recorded at this unit, resulting at the total capacity of the sector. Among hospitalized patients, five of them (71% of the sample) were infected by *Acinetobacter baumannii*.[11]

This microorganism can cause infection in any organ and the most frequently affected site is the respiratory tract. Currently, it is among the microorganisms commonly related to nosocomial pneumonia, along with *S. aureus*, *P. aueruginosa* and enterobacteria.[1]

Pseudomonas aeruginosa is the main pathogen of the Gram-negative bacteria group, causing infections in patients with low antimicrobial defense, and considered an important nosocomial pathogen. These microorganisms can produce symptoms as fever, shock, oliguria, leukocytosis and leucopenia, disseminated intravascular coagulation, and respiratory distress syndrome in adults.[12]

Generally, aminoglycosides are not active against *S. maltophilia*, probably because of inactivating enzymes and changes in cell surface in the microorganism. Trimethoprim-sulfamethoxazole, a bacteriostatic agent, is the chosen treatment for infections caused by *S. maltophilia.* Ticarcilin-clavulanate is the unique combination of beta-lactam/beta-lactamase inhibitor with effective action and can also be used in patients with sulfamethoxazole/trimethoprim intolerance.[6] *Enterobacter spp.*, *E. coli* and *Klebsiella* are non-fermenters enteric gram-negative considered opportunistic pathogens.[13]

The study shows that most patients used invasive procedures, such as indwelling urinary catheter (68,5%), central venous catheter (49,6%), as well as nasogastric tube and mechanical ventilation, both in 66,6% of the cases. As identified in our research, studies show that the use of invasive procedures increases the risk for developing an infection.[1]

Table 4 shows *Klebsiella spp.* 100% sensibility to five difrerent types of antimicrobials: Amikacin, Ertapenem, Imipenem, Meropenem and Tygeciclin. *Acinetobacter spp.* was sensible to only two types of antimicrobials: Tygeciclin and Poliximine B; at a study conducted at a University Hospital from Rio de Janeiro, this microorganism was sensible only to Poliximine B.[5]

This microorganism is an important cause of nosocomial infection, surpassed only by *Pseudomonas aeruginosa,* and has been implicated in various NI. Generally, it has numerous antimicrobials resistance mechanisms, related to beta-lactam antibiotic resistance and to the beta-lactamase production.[6]

Pseudômonas aeruginosa is an omnipresent microorganism that has the ability to grow at low nutrient availability conditions and

extreme temperature and is intrinsically resistant to many types of antibiotics by the combination of resistance mechanisms. It was 100% sensible to amikacin, as well as other studies have shown its sensibility (64,9%) to such antibiotic, and 62,2% to meropenem, unlike this study which showed sensibility only in 50 % (n = 2) of NI cases caused by this pathogen.[6]

E. coli is one of the most common gram-negative bacilli associated to NI, and the first one among urinary tract infections agents. Its resistance to broad spectrum Cephalosporin is basically mediated by ESBL. Most ESBL has increased activity against Aztreonam and Ceftazidime and, decreased activity against Cefotaxime, although the opposite way may be true in some cases. In this study the *E. coli* showed 100% sensibility to Amikacin, Imipenem, Tigecycline, Cefepime and Gentamicin.[6]

ESBLs are enzymes that hydrolyze penicillin, first, second and fourth generations' cephalosporins and monobactamic aztreonam, but do not act at cefaminas and carbapenems. In contrast, ESBL are inhibited by commercially available beta-lactamase inhibitors, including clavulanic acid, tazobactam and sulbactam.

Among the mortality and discharge rates of the patients from the study, the death rate was higher (57,6%) than the rate of patients discharged (42,4%), whereas patients who had ICU discharge continued in the context of hospitalization.

The study reveals that, among the 195 deaths (10,3%), 39,5% (77) were patients who developed NI, as showed by another retrospective study[14], in which the nosocomial infection deaths reached n = 77, 56,4% of the cases, and about 110 (82,7%) related to multidrug-resistant microorganism, corroborating our research.[9]

In a study performed with only multidrug-resistant microorganisms at an intensive care unit, the mortality rate was n = 35 (42,7%).[15] It is imperative that the team remains updated to the resident flora and its resistance standard at the hospital unit where they work, since this is different at each unit and changes with the time, for the acquisition of resistance is a dynamic process[9].

CONCLUSION

According to the findings of our research, regarding our goals, it is observed the prevalence of NI related to the respiratory tract at ICUs. *Klebsiella* spp. stood out as the most prevalent isolated microorganism that causes NI at the studied hospital, accounting 22,2% of cases of infection.

Among the most commonly used antimicrobial, Vancomycin, Metronidazole, and Tazocin prevailed, used about eleven times (33.3%) of NI cases. As for the sensibility of microorganisms to the used antibiotics, *Klebsiella* spp. is most sensitive to the carbapenems class (Ertapenem, Imipenem, Meropenem), Amikacin and Tigecycline, which also showed effectiveness (100%) against coccobacillus *Acinetobacter* with Poliximine B. *Pseudomonas aeruginosa* had sensibility of 100% to Amikacin, followed by (75%) to Ciprofloxacin, Levofloxacin, Poliximine B and 50% to Meropenem, Cefepime and Piperacillin + Tazobactam antimicrobials. *E.coli* showed 100% of sensibility to Amikacin, Imipenem, Tigecycline, Cefepime and Gentamicin antimicrobials.

Based on the findings of this study, we suggest conducting future studies, regular discussions among the health teams at the same hospital in order to analyze these nosocomial infection rates indicators, microbial resistance profile, expecting to avoid these NI, working with the CCIH from the institution, promoting ongoing education guidelines and activities, encouraging the participation of the teams to increase infection control measures, and providing information for the creation of antibiotic prescribing protocols according to the microorganisms resistance profile and revision.

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