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ORIGINAL ARTICLE

Infections in patients hospitalized for external causes in Intensive Care Units

Infecções em pacientes internados por causas externas em Unidades de Terapia Intensiva

Infecciones en pacientes hospitalizados por causas externas en Unidades de Cuidados Intensivos

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Corresponding Author:
Roberta Laíse Gomes Leite Morais
roberta.laise@uesb.edu.br

Address: Av. José Moreira Sobrinho, Jequiezinho, Jequié - BA, 45205-490.

Gabriele de Andrade Oliveira[1];
Clarice Alves dos Santos[1];
Roberta Laíse Gomes Leite Morais[1];
Vanda Palmarella Rodrigues[1];
Juliana da Silva Oliveira[1];

[1] *Universidade Estadual do Sudoeste da Bahia (UESB), Jequié, Bahia, Brazil.*

ABSTRACT

Background and Objectives: given the great demand for hospitalization due to external causes, as well as the growing number of cases of infections in health services, it can be said that these are important issues and that they represent a huge challenge to be faced by professionals and health managers around the world. Therefore, this article aims to describe the profile of individuals hospitalized for external causes in an Intensive Care Units (ICUs) who underwent a culture test and identify the main microorganisms that cause infection. **Methods:** a cross-sectional study carried out with patients suffering from external causes, admitted to an ICU of a general hospital in Bahia. The data were analyzed using descriptive statistics, presented in absolute and relative frequencies. **Results:** a total of 259 admissions to the ICU due to external causes were identified, of which 59 (22.78%) underwent cultures, of which 48 (81.35%) were men, 43 (72.88%) were brown, 32 (54.24%) did not have a partner and 35 (59.32%) suffered transport accidents. Regarding the use of devices, 54 (91.52%) patients were on invasive mechanical ventilation, 54 (91.50%) used an indwelling urinary catheter and 54 (91.52%) had a central venous catheter. The main microorganisms identified in the culture were of the genera *Staphylococcus* (17; 28.9%) and *Pseudomonas* (10; 16.9%). **Conclusion:** it is concluded that admissions to ICU resulting from external causes in patients who underwent culture were of men, who suffered transport accidents, used invasive devices, and the main infections are related to microorganisms of the genus *Staphylococcus*.

Keywords: *Epidemiology. External Causes. Infections. Intensive Care Units.*

RESUMO

Justificativa e Objetivos: Dada a grande demanda por hospitalização devido a causas externas, assim como o crescente número de casos de infecções em serviços de saúde, pode-se dizer que esses são temas importantes e representam um enorme desafio a ser enfrentado por profissionais e gestores de saúde ao redor do mundo. Portan-

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to, este artigo tem como objetivo descrever o perfil dos indivíduos hospitalizados por causas externas em Unidades de Terapia Intensiva (UTIs) que se submeteram a um teste de cultura e identificar os principais microrganismos que causam infecção. **Métodos:** Um estudo transversal foi realizado com pacientes que sofriam de causas externas, admitidos em uma UTI de um hospital geral na Bahia. Os dados foram analisados utilizando estatísticas descritivas, apresentadas em frequências absolutas e relativas. **Resultados:** Um total de 259 internações na UTI devido a causas externas foi identificado, dos quais 59 (22,78%) foram submetidos a culturas, sendo 48 (81,35%) homens, 43 (72,88%) pardos, 32 (54,24%) não tinham parceiro e 35 (59,32%) sofreram acidentes de transporte. Em relação ao uso de dispositivos, 54 (91,52%) pacientes estavam em ventilação mecânica invasiva, 54 (91,50%) usaram cateter urinário de demora e 54 (91,52%) tinham um cateter venoso central. Os principais microrganismos identificados na cultura foram dos gêneros *Staphylococcus* (17; 28,9%) e *Pseudomonas* (10; 16,9%). **Conclusão:** Conclui-se que as internações na UTI decorrentes de causas externas em pacientes que se submeteram à cultura foram de homens, que sofreram acidentes de transporte, usaram dispositivos invasivos, e as principais infecções estão relacionadas a microrganismos do gênero *Staphylococcus*.

Palavras-chave: *Epidemiologia. Causas Externas. Infecções. Unidades de Terapia Intensiva.*

RESUMEN

Antecedentes y Objetivos: Dada la gran demanda de hospitalización debido a causas externas, así como el creciente número de casos de infecciones en servicios de salud, se puede decir que estos son temas importantes y representan un enorme desafío a enfrentar por profesionales y gestores de salud en todo el mundo. Por lo tanto, este artículo tiene como objetivo describir el perfil de los individuos hospitalizados por causas externas en Unidades de Cuidados Intensivos (UCI) que se sometieron a una prueba de cultivo e identificar los principales microorganismos que causan infección. **Métodos:** Se realizó un estudio transversal con pacientes que sufrían causas externas, admitidos en una UCI de un hospital general en Bahía. Los datos se analizaron utilizando estadísticas descriptivas, presentadas en frecuencias absolutas y relativas. **Resultados:** Se identificó un total de 259 ingresos a la UCI debido a causas externas, de los cuales 59 (22,78%) se sometieron a cultivos, de los cuales 48 (81,35%) eran hombres, 43 (72,88%) eran pardos, 32 (54,24%) no tenían pareja y 35 (59,32%) sufrieron accidentes de transporte. En cuanto al uso de dispositivos, 54 (91,52%) pacientes estaban en ventilación mecánica invasiva, 54 (91,50%) usaron catéter urinario de demora y 54 (91,52%) tenían un catéter venoso central. Los principales microorganismos identificados en el cultivo fueron del género *Staphylococcus* (17; 28,9%) y *Pseudomonas* (10; 16,9%). **Conclusión:** Se concluye que los ingresos a la UCI resultantes de causas externas en pacientes que se sometieron al cultivo fueron de hombres, que sufrieron accidentes de transporte, usaron dispositivos invasivos, y las principales infecciones están relacionadas con microorganismos del género *Staphylococcus*.

Palabras clave: *Epidemiología. Causas Externas. Infecciones. Unidades de Cuidados Intensivos.*

INTRODUCTION

External causes are one of the main reasons for the large demand for hospitalizations in the public health system. In Brazil, from 2020 to May 2023, 4,264,231 hospitalizations were registered in the Brazilian Health System Information Technology Department (DATASUS - *Departamento de Informática do Sistema Único de Saúde*), resulting from transport accidents (18.1%), assaults (3.5 %), self-harm (0.8%) and other undetermined causes (59.8%).[1]

One of the consequences of hospitalizations for external causes, especially those related to the greater degree of impairment of individuals, are infections. They have a high incidence and represent a serious public health problem due to mortality, long-term bed occupancy, repercussions regarding microbial resistance, high costs for treatments and other factors that affect patient, care team as well as health service safety.[2]

According to a publication by the interinstitutional working group organized by the Ministry of Health (MoH), infections are defined as the penetration and development or multiplication of an infectious agent in the patients' body.[3] The term "Healthcare-Associated Infections" (HAIs) is used to designate any infection acquired in a health unit after 72 hours of admission or that manifests itself after discharge, which may be related to procedures carried out during the period of hospitalization or still due to extra hospital care.[4]

The Intensive Care Unit (ICU) is identified by experts as the hospital sector that houses the highest number of HAI cases, and the immunological vulnerability profile of the patients treated and the invasive procedures that are performed must be considered.[5]

Sizing even more objectively, research reveals that, for every 100 patients admitted to hospital environments in developed countries, at least seven will contract some type of HAI, while, in developing countries, this number increases to ten.[6]

Infections are also directly related to invasive procedures, especially due to prolonged use of devices, especially the central venous catheter (CVC), indwelling urinary catheter (IUC) and invasive mechanical ventilation (IMV).[7]

Due to the increase in the frequency of hospitalizations due to external causes as well as the growing number of cases related to HAIs, it can be stated that reducing these numbers is a challenge to be faced by healthcare professionals and managers around the world, since their incidence is directly linked to morbidity and mortality rates.

Considering the above, this study set out to answer the following guiding question: what is the profile of individuals admitted to the ICU for external causes who underwent a culture test and what are the main microorganisms causing infection? The objective was to describe the profile of individuals hospitalized for external causes in the ICU who underwent culture examination and identify the main microorganisms that cause infection.

METHODS

This is an epidemiological, cross-sectional and retrospective study, originating from the project "Factors associated with multimorbidity in individuals treated in an adult intensive care unit". Data were collected from medical records of individuals hospitalized for external causes in ICUs in 2019.

The study scenario consisted of three ICUs, each with ten hospital beds, until the research period, in a general hospital in the countryside of Bahia. This hospital is recognized as a regional emergency reference unit, serving 26 municipalities.

Data collection took place between May and November 2020, through consultations of electronic medical records of patients admitted to the ICU and the respective printed results of culture tests, made available by the Hospital Infection Control Commission (HICC) sector. Medical records of patients whose reason for hospitalization was not related to external causes were excluded. The initial selection of medical records took place through the ICU admission book. Data were collected using an instrument previously developed by the researchers.

The study variables included sociodemographic characteristics: sex (male and female); ethnicity (brown, black, indigenous, yellow); marital status (married and not married); and education (elementary and secondary education). It should be noted that, regarding "white" ethnicity, no record was identified in medical records and, therefore, it was not included in the description of variables. Characteristics relating to hospitalization were: day of the week (Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday); type of external causes (transport accidents, assaults, undetermined cause, intentional self-harm, sequels of external causes and other external causes of accidental trauma). Characteristics referring to condition were: surgery (elective, emergency, both types and not); vasoactive drugs (yes and no); antibiotic therapy (yes and no); IMV (yes and no); acute renal failure (yes and no); blood transfusion (yes and no); IUC (yes and no); nasogastric tube and orogastric tube (yes and no); CVC (yes and no); drain (yes and no); pressure injury (yes and no); and dressings (yes and no). Characteristics relating to culture examination were: cultures in ICU (ICU 1, ICU 2 and ICU 3); type of examination (culture and antibiogram, blood culture and urine culture and antibiogram); type of material collected (tracheal aspirate, blood, lesion secretion, urine, CVC tip and ascitic and pleural fluid); result of cultures by genus (*Staphylococcus, Pseudomonas, Acinetobacter, Klebsiella, Enterobacter, Escherichia, Serratia, Enterococcus, Proteus, Citrobacter, Mycobacterium, Pantoea, Stenotropomonas* and negative).

After data collection, the instruments were organized and tabulated using Microsoft Excel 2010® and subsequently transferred to the Statistical Package for the Social Sciences (SPSS) version 21.0, being analyzed using descriptive statistics and presented in absolute frequencies and relative.

This research follows the ethical standards required in Resolutions 466/2012, 510/2016 and 580/2018 of the MoH, being submitted by the *Universidade Estadual do Sudoeste da Bahia* (UESB) Research Ethics Committee, *campus* Jequié, Certificate of Presentation for Ethical Consideration (CAAE - *Certificado de Apresentação para Apreciação Ética*) 03324918.2.0000.0055, being approved through the Consubstantiated Opinion REC-UESB, Protocol 3,092,575 of December 18, 2018.

RESULTS

A total of 259 patients admitted to the ICU for external causes were identified during 2019, and for 59 (22.78%) patients, material was collected for culture examination. Most patients were male (48; 81.35%), brown (43; 72.88%), did not have a partner (32; 54.24%) and were admitted to the ICU on Sunday (12; 54.24%). 20.34%). The lack of records in medical records regarding education information stands out (56; 94.90%) (Table 1).

Among external causes, transport accidents are the main causes of hospitalizations (35; 59.32%), followed by other external causes of accidental trauma (15; 25.42%).

In table 2, it is observed that, among individuals admitted to ICUs due to external causes and who had samples collected for culture, 39 (66.10%) underwent emergency surgery, 40 (67.80%) received administration of vasoactive drugs (VAD) and 57 (96.6%) underwent treatment with antibiotic therapy.

As for the use of devices, 54 (91.52%) patients were on IMV, 54 (91.50%) on IUC, 54 (91.52%) on CVC, and 31 (45.76%) used drains. Most patients who underwent culture also underwent blood transfusion (35; 59.32%), developed pressure injuries (PI), and 30 (50.84%) were using some type of dressing (57; 96.60%).

Table 3 reveals that ICU 1 carried out the highest number of collections (29; 49.1%). The most common type of examination performed was culture and antibiogram (30; 50.8%), with the main type of material collected being tracheal aspirate (28; 47.2%), followed by blood material (16; 27.1%) and lesion secretion (8; 13.5%). The microorganisms most present in the results were of the genus *Staphylococcus* (17; 28,9%), followed by the genus

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Table 1. Sociodemographic characteristics of occurrences and type of external causes of individuals admitted to Intensive Care Unit for external causes and who underwent culture. Jequié, BA, Brazil, 2019.

Variables	N	%
Sex		
Male	48	81.35
Female	10	16.95
NI	1	1.70
Race/color		
Brown	43	72.88
Black	1	1.70
Indigenous	1	1.70
Yellow	0	0.00
NI	14	23.72
Marital status		
No partner	32	54.24
With partner	12	20.33
NI	15	25.43
Education		
Elementary school	2	3.40
High school	1	1.70
NI	56	94.90
Week day		
Sunday	12	20.34
Monday	9	15.26
Tuesday	3	5.09
Wednesday	7	11.85
Thursday	4	6.78
Friday	8	13.55
Saturday	6	10.17
NI	10	16.96
Types of external causes		
Transport accident	35	59.32
Aggressions	6	10.17
Undetermined cause	1	1.70
AC	0	0.00
ISH	1	1.70
SEC	0	0.00
OECAT	15	25.42

Caption: *NI = no information; AC = assistance complications; ISH = intentional self-harm; SEC = sequels of external causes; OECAT = other external causes of accidental trauma.*
Source: *Authorization of Hospital Admissions – AHA and Hospital Infection Control Commission - HICC of Hospital Geral Prado Valadares.*

Table 2. Characteristics of hospitalizations of individuals admitted to Intensive Care Unit for external causes and who underwent culture. Jequié, BA, Brazil, 2019.

Variables	N	%
Surgery		
Elective	7	11.86
Emergency	39	66.10
Both	4	6.78
No	8	13.56
NI	1	1.70
Vasoactive drugs		
Yes	40	67.80
No	18	30.50
NI	1	1.70
Antibiotic therapy		
Yes	57	96.6
No	1	1.70
NI	1	1.70
Invasive mechanical ventilation		
Yes	54	91.52
No	4	6.78
NI	1	1.70
Acute kidney failure		
Yes	11	18.64
No	46	77.96
NI	2	3.40
Blood transfusion		
Yes	35	59.32
No	20	33.88
NI	4	6.80
Indwelling urinary catheter		
Yes	54	91.50
No	4	6.80
NI	1	1.70
Nasogastric and orogastric tube		
Yes	18	30.50
No	39	66.10
NI	2	3.40
Central venous catheter		
Yes	54	91.52
No	4	6.78
NI	1	1.70
Drain		
Yes	27	45.76
No	31	52.54
NI	1	1.70
Pressure injury		
Yes	30	50.84
No	28	47.45
NI	1	1.70
Dressing		
Yes	57	96.60
No	1	1.70
NI	1	1.70

Caption: *NI = no information.*
Source: *Authorization of Hospital Admissions – AHA and Hospital Infection Control Commission - HICC of Hospital Geral Prado Valadares.*

Table 3. Univariate analysis of cultures by Intensive Care Unit, type of examination, type of material collected and results of cultures performed on patients admitted due to external causes in Intensive Care Units. Jequié, BA, Brazil, 2019.

Variables	N	%
ICU culture		
ICU 1	29	49.1
ICU 2	13	22.0
ICU 3	17	29.9
Type of examination		
Antibiogram	30	50.8
Blood culture	11	18.6
Urine culture and antibiogram	4	6.7
NI	14	23.9
Type of material collected		
Tracheal aspirate	28	47.2
Blood	16	27.1
Lesion secretion	8	13.5
Urine	4	6.7
Central venous catheter tip	1	1.7
Ascitic and pleural fluids	2	3.4
Results of cultures (by genus)		
Staphylococcus sp.	17	28.9
Pseudomonas sp.	10	16.9
Acinetobacter sp.	6	10.3
Klebsiella sp.	5	8.5
Enterobacter sp.	4	6.7
Escherichia sp.	3	5.0
Serratia sp.	3	5.0
Enterococcus sp.	2	3.4
Proteus sp.	2	3.4
Citrobacter sp.	1	1.7
Mycobacterium sp.	1	1.7
Pantoea sp.	1	1.7
Stenotrophomonas sp.	2	3.4
Negative	2	3.4

Caption: *NI = no information; ICU = Intensive Care Unit.*
Source: *Authorization of Hospital Admissions – AHA and Hospital Infection Control Commission - HICC of Hospital Geral Prado Valadares.*

DISCUSSION

Male, brown and unmarried individuals had a higher prevalence of hospitalization and cultures. These data corroborate studies that indicate a greater number of hospitalizations for external causes in male individuals.[8,9] There are few studies that demonstrate the characterization of individuals who underwent culture in ICUs; however, they pointed to the direct presence of infections, such as trauma complications and other pre-existing comorbidities.[10]

Data regarding the level of education among individuals hospitalized for external causes were highly incomplete, which compromises monitoring and critical analysis for the development of strategies related to prevention in this population.[11]

According to the day of admission to the ICU, there were a greater number of admissions on Sundays, resulting from transport accidents and other unidentified causes. These results may be related to the higher prevalence of accidents among males due to greater exposure to risky behaviors, represented by lifestyle, especially on weekends, increasing alcohol consumption, increasing the likelihood of external causes related to transport accidents.[12]

Considering that the highest prevalence of external causes arises from transport accidents, there is a need for correction of fractures, which are very common among injuries caused by some type of traumatic external cause.[13]

The time interval between the need for surgical intervention and its completion represents a great risk of infections.[14] A study carried out in Belo Horizonte points out the main risk factors associated with surgical site infections as preoperative length of hospitalization for more than 24 hours, longer duration of surgery, American Society of Anesthesiologists (ASA) index classification, with clinical status ASA II, III or IV/V and with greater Potential for Contamination of the Operative Wound (PCOW).[15]

A greater number of individuals who underwent culture for a possible diagnosis of HAI were identified among those who were using VAD and IMV. VAD are used in patients with a high degree of hemodynamic compromise. Studies describe the association between the use of VAD and IMV among patients positive for some type of infection, and also highlight the occurrence of deaths in these patients.[7]

The use of antibiotic therapy was identified in most patients suffering from external causes who underwent culture. This study does not allow us to say when drug treatment was started, whether before or after collecting material for culture, which is a worrying fact, since resistance to pathogenic microorganisms can worsen patients' condition.

A review study, which consisted of a sample of 16 articles, describes the ICU as the main sector for the occurrence of bacterial mutations associated with the indiscriminate use of antimicrobial agents, prescription failures as well as contamination of equipment by healthcare workers' hands.[16]

However, there is a need to implement a surveillance culture aimed at identifying multi-resistant microorganisms that enter healthcare institutions, generally in two ways: colonization and/or infection of patients by multi-resistant microorganisms, resulting from the selective pressure generated by antimicrobial agents.[17]

Invasive devices are considered risk factors for a greater occurrence of HAIs, especially in ICUs, such as the orotracheal tube (OTT), due to IMV, CVC, tracheostomy and IUC.[18]

Correct handling of invasive devices is necessary. Ordinance 2,616, of May 12, 1998, in its body, addresses the relevance of hand hygiene before and after carrying out invasive procedures, such as dressings, catheters, drains, probes, as violating this care when handling them may violate patient safety, leading to the risk of developing nosocomial infections.[4]

Due to the impact of HAIs, the Brazilian National Health Regulatory Agency regularly launches the Brazilian National Program for the Prevention and Control of Healthcare-Associated Infections, and one of its objec-

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tives is to support surveillance and monitoring actions of microbial resistance in health services through the identification and molecular typing of multi-resistant microorganisms. This program highlights the mandatory reporting regarding primary bloodstream infections related to the use of CVC, ventilator-associated pneumonia (VAP) and urinary tract infection (UTI) associated with the use of IUC in ICUs.[6]

In this regard, it is necessary to implement an active surveillance culture service, as this can be used to direct the standardization of antimicrobial agents in ICUs, since there is a greater risk of already colonized patients developing any of the HAIs with the microorganism already existing on their skin.[16,17]

In order to diagnose HAI, methods are used to observe clinical practices of observing the signs and symptoms presented by patients, such as hypothermia, mental confusion and homeostatic imbalance, and carrying out laboratory tests.[19]

Concerning sample collection for laboratory tests, tracheal aspirate had a higher prevalence, in line with positive results for species of microorganisms of the genera *Staphylococcus* and *Pseudomonas*, supporting a study that presents similar results.[20] ICU-acquired pneumonia is related to VAP, leading to increased length of stay and increased hospital costs.[21] A study carried out in the ICU of a hospital in Santa Catarina identified that VAP is the most common among infections associated with invasive devices, with a prevalence of 31.8% and a mortality of 51.7%, and was associated with males, IMV duration and ICU stay.[22]

In relation to microorganisms, it is noteworthy that *Pseudomonas* sp. and *Acinetobacter* sp. are pathogens frequently involved in infections when patients received excessive antimicrobial therapy. A study shows that *Klebsiella* sp. was penicillin-resistant; *Pseudomonas* sp. were imipenem-, cefepime- and ciprofloxacin-resistant; and all *Acinetobacter* were ceftazidime-resistant, followed by ceftriaxone and cefepime.[23]

The genus *Staphylococcus* contains species with a high risk of pathogenicity, such as methicillin-resistant coagulase-negative *Staphylococci* (MRSCoN), which can be found in the skin microbiota. A study carried out in a large hospital in Minas Gerais identified methicillin-resistant S. *aureus*, and carbapenem-resistant *Klebsiella pneumoniae* and *Acinetobacter baumannii* in surveillance cultures.[16]

Pseudomonas are also in the group of bacteria with a high power to cause infections. The characteristics of this gram-negative wall bacterium are a crucial factor for multidrug resistance; therefore, caution should be exercised when using antibiotic therapy.[24]

Despite being considered one of the most prevalent infections, in the present study, sample collection from the urinary site obtained a low quantity, followed by CVC tip collection. UTIs caused by fungi of the genus *Candida* have a high prevalence in ICUs, being related to the use of IUC.[25]

In addition to the constant encouragement from HICC and the Patient Safety Center for reporting HAIs, it is extremely important that the healthcare team dedicates itself to following the protocols established for infection control and prevention in healthcare. The prevention of these infections, which can lead to high morbidity and mortality rates, can be achieved through simple but effective measures, such as hand hygiene, use of Personal Protective Equipment, efficiency in sterilizing material, in addition to care with invasive procedures.[19]

It is also noteworthy that HAIs are considered a serious public health problem, as they are the most frequent adverse events associated with healthcare, having high morbidity and mortality, which consequently impacts patient safety and the quality of health services.

It is necessary to encourage the strengthening of HICC as well as the implementation of a culture of surveillance, in order to enable protocols to be implemented through the training of professionals who work in ICUs and other inpatient units, with the aim of reducing damage caused by HAIs. We emphasize, however, that this study has as limitations the under-reporting related to some sociodemographic variables and the non-identification of the susceptibility of microorganisms isolated in cultures.

Finally, we understand that external causes generate impacts on health services, and patients' clinical condition, negligent handling of invasive equipment and failure to adopt good practices in prescribing antibiotics have great repercussions for the proliferation of microorganisms in critically ill patients.

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AUTHORS' CONTRIBUTIONS

Gabriele de Andrade Oliveira contributed to the research, writing the abstract, data collection, introduction, methodology, discussion, interpretation and description of results, preparation of tables, conclusions, review and final approval of the version to be published. **Clarice Alves dos Santos** contributed to the review of abstract writing, discussion, interpretation and description of results, conclusions and final approval of the version to be published. **Roberta Laíse Gomes Leite Morais** contributed to the review of abstract writing, discussion, interpretation and description of results, conclusions and final approval of the version to be published. **Vanda Palmarella Rodrigues** contributed to the review of abstract writing, discussion, interpretation and description of results, conclusions and final approval of the version to be published**. Juliana da Silva Oliveira** contributed to the project administration and supervision, data collection and processing, interpretation and description of results, preparation of tables, conclusions, review and final approval of the version to be published.

All authors approved the final version to be published and are responsible for all aspects of the work, including ensuring its accuracy and integrity.