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SUMÁRIO

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ORIGINAL ARTICLE

Assessment of the infrastructure of a COVID-19 unit and health professionals' perception about safety attitudes

Avaliação da infraestrutura de uma unidade COVID-19 e a percepção de profissionais de saúde sobre as atitudes de segurança

Evaluación de la infraestructura de una unidad COVID-19 y la percepción de los profesionales de la salud sobre las actitudes de seguridad

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ABSTRACT

Background and objectives: does the COVID-19 Intensive Care Unit have a favorable structure to sanitize the hands of health professionals? What is the perception of health professionals about the organizational safety of that sector? It aims to assess the structure for hand hygiene in an Intensive Care Unit for patients with COVID-19 and the perception of safety attitude by health professionals. **Methods:** an analytical, cross-sectional study with 62 health professionals from a university hospital in the state of Mato Grosso, Brazil. The unit structure commands for hand alignment and safety attitudes were used. **Results:** flaws were found in the infrastructure that can hinder and prevent hand hygiene by professionals at the point of care. The safety attitude was impaired in all domains. No difference was found between the median scores regarding professional categories. **Conclusion:** investment is urgently needed in improving infrastructure with alcoholic preparation supply at the point of assistance. The study demonstrates the negative impact of the perception of low management involvement in patient safety actions and poor infrastructure for hand hygiene.

Keywords: Hand Hygiene. Patient Safety. Organizational Culture. COVID-19.

RESUMO

Justificativa e objetivos: a Unidade de Terapia Intensiva COVID-19 possui estrutura favorável para a higienização das mãos dos profissionais de saúde? Qual a percepção dos profissionais de saúde acerca da segurança organizacional do referido setor? Tem como objetivo avaliar a estrutura para higiene das mãos de uma Unidade de Terapia

Intensiva destinada a pacientes com COVID-19 e a percepção da atitude de segurança pelos profissionais de saúde. **Métodos:** estudo analítico, transversal, com 62 profissionais de saúde de um hospital universitário do estado de Mato Grosso, Brasil. Foram utilizados os questionários de estrutura da unidade para higienização das mãos e o de atitudes de segurança. **Resultados:** constataram-se falhas na infraestrutura que podem dificultar e impedir a realização da higiene das mãos pelos profissionais no ponto da assistência. A atitude de segurança esteve prejudicada em todos os domínios. Não foi encontrada diferença entre as medianas dos escores com relação às categorias profissionais. **Conclusão:** se faz urgente o investimento na melhoria da infraestrutura com fornecimento de preparações alcoólicas no ponto da assistência. O estudo demonstra o impacto negativo da percepção do baixo envolvimento da gestão nas ações de segurança do paciente e infraestrutura precária para higiene das mãos.
Descritores: Higiene das Mãos. Segurança do Paciente. Cultura Organizacional. COVID-19.

RESUMEN

Justificación y objetivos: ¿La Unidad de Cuidados Intensivos COVID-19 cuenta con una estructura favorable para la higiene de manos de los profesionales de la salud? ¿Cuál es la percepción de los profesionales de la salud sobre la seguridad organizacional en ese sector? Tiene como objetivo evaluar la estructura para la higiene de manos en una Unidad de Cuidados Intensivos destinada a pacientes con COVID-19 y la percepción de actitudes de seguridad por parte de los profesionales de la salud. **Métodos:** estudio transversal analítico con 62 profesionales de la salud de un hospital universitario en el estado de Mato Grosso, Brasil. Se utilizaron los comandos de la estructura de la unidad para la alineación de las manos y las actitudes de seguridad. **Resultados:** se encontraron fallas en la infraestructura que pueden dificultar e impedir la realización de la higiene de manos por parte de los profesionales en el punto de atención. La actitud de seguridad se vio afectada en todos los dominios. No se encontró diferencia entre las medianas de las puntuaciones con respecto a las categorías profesionales. **Conclusión:** urge invertir en mejorar la infraestructura con el suministro de preparados alcohólicos en el punto de atención. El estudio demuestra el impacto negativo de la percepción de una baja implicación de la dirección en las acciones de seguridad del paciente y una infraestructura deficiente para la higiene de manos.
Palabras clave: Higiene de las Manos. Seguridad del Paciente. Cultura Organizacional. COVID-19.

INTRODUCTION

Healthcare-associated infections (HAIs) constitute a serious public health problem, as they are adverse events associated with healthcare that occur with great frequency, demonstrating high morbidity and mortality. In turn, they have a direct impact on patient safety and health service quality, reflecting economic and social aspects for the population, health systems and the economy of countries.[1]

Studies have shown that the highest prevalence of HAIs occurs in Intensive Care Units (ICUs), due to the high number of invasive procedures required by patients with greater complexity, greater severity and greater demand for intensive care.[2] In this environment, patients are more exposed to the risk of infection, given their clinical condition.[2]

HAI occurrence is linked to the health care provided, which may be a consequence of the failure of care systems and processes as well as human behavior. Simultaneously with these factors, one can take into account the inadequate infrastructure of health institutions, the lack of professionals and the lack of knowledge or inability to use preventive and control measures for HAIs.[3]

On January 30, 2020, the World Health Organization (WHO) declared that the outbreak of the new coronavirus constitutes a public health emergency of international concern and, on March 11, 2020, Coronavirus Disease 2019 (COVID-19) was characterized by the WHO as a pandemic.[4]

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), an agent initially known as the new coronavirus, which causes the disease COVID-19, is potentially fatal and represents the main global public health problem of the last 100 years, similar only to the Spanish flu that killed around 25 million people between 1918 and 1920.[5]

Due to the increasing increase in mortality rates related to the aforementioned pandemic, many countries began to introduce measures to prevent the spread of the virus, with hand hygiene (HH) being essential. This is a simple, inexpensive and highly effective measure.[6] According to recommendations, health institutions must guarantee the availability of inputs and the necessary structure for HH, and they must be accessible to all professionals in all areas of patient care, with alcoholic preparations being considered preferable resources.[7]

Since 2009, the WHO has recommended the multimodal strategy (MS) and, each year, in the global HH campaign, it reinforces this practice[8]. It is composed of five intervention components, complementary and interdependent, which have been proven to help improve adherence to HH, such as system changes, training and education, performance observation and feedback, workplace reminders, and supportive institutional safety climate and patient engagement.[8]

With regard to the perception of institutional safety climate and adherence to HH, a recent study found a positive correlation between the two variables, since

the greater perception of organizational safety climate by professionals was related to their greater adherence to HH.[9] Experimental studies have demonstrated that the participation of managers in MS is essential to establish a favorable safety climate in the institution in order to achieve satisfactory levels of adherence to safety protocols.[10,11] Therefore, it is necessary to execute all components of the aforementioned strategy in order to favor the increase and sustainability of HH adherence rates over time.

Considering the above, the following guiding questions were formulated: does the COVID-19 ICU have a favorable structure for HH for health professionals? What is health professionals' perception regarding organizational safety in that sector? Therefore, this study aimed to assess unit structure for HH of an ICU intended for patients with COVID-19 and safety attitude perception by health professionals.

METHODS

This is an analytical and cross-sectional study. To compose the study sample, all health professionals who worked in an ICU designed to care for patients with COVID-19 at a university hospital located in the state of Mato Grosso were chosen. The hospital is medium-sized and offers diagnostic and therapeutic care on an outpatient basis and medical and surgical hospitalization as well as an adult, pediatric and neonatal ICU, and is a reference for patient care in all municipalities in the state.

The unit consisted of eight beds, including one for isolation, represented by 65 health professionals distributed among 29 nursing technicians, 13 nurses, 12 physicians and eight physical therapists. Professionals who performed direct patient care actions during the data collection period and who had completed and delivered the questionnaires were included. Professionals who performed exclusively administrative activities or were undergoing training on biosafety topics at the time of data collection were excluded from the study, in order not to influence the proposed objectives.

Professionals working in that unit were approached by the main researcher during their work activities at times when they were not providing direct assistance to patients and invited to participate in the research, moment in which the study objective was briefly presented and the importance of participation was highlighted. Upon acceptance, they were invited to sign the Informed Consent Form (ICF). The ICF was delivered to the professionals in opaque envelopes, containing the sociodemographic and safety attitudes questionnaires, both self-administered, to be completed and delivered by the end of the shift or the next shift, and the researcher scheduled the best time to collect the envelopes. The mean time to complete both questionnaires was approximately 15 minutes. Up to three attempts were made with each professional. If they agreed to participate in the research and did not submit the completed questionnaire on the chosen date and time or after three unsuccessful attempts, this professional was excluded from the study. The study sample consisted of 62 professionals, as three of them did not answer the Safety Attitudes Questionnaire (SAQ), which resulted in justification for exclusion from the study.

Data collection took place from September to December 2021, with the application of three questionnaires, two of which were self-administered (sociodemographic and SAQ) and the unit infrastructure questionnaire, which was to be completed exclusively by the researcher. The sociodemographic and professional questionnaire application aimed to describe the study population through age, sex, education level, length of professional experience, place of professional activity, participation in training on standard precautions offered by the institution employer, year of training and type of training carried out.

The institutional safety climate was verified using the SAQ Short Form 2006, adapted and validated for Brazilian health professionals.[12] This is a self-administered, checklist-type questionnaire, with 41 items that are divided into six domains: teamwork climate; safety climate; job satisfaction; stress recognition; perceptions of management (sector leadership and hospital management); and working conditions. It has an ordinal Likert scale from 0 to 5 points, with 0 being completely disagree and 5 being completely agree. The score varies from 0 to 100 points, and scores ≥ 75 are considered positive values.[12]

To assess sector infrastructure, the questionnaire on unit structure for HH was used, recommended and validated by the WHO, with an average completion time of 20 minutes, with responsibility for completion by the main researcher. This instrument is a checklist, filled out by the researcher himself, and contains 27 items referring to physical resources for HH existing in the units such as: water availability; existence of alcoholic preparation within reach in perfect working order and/or refilled; types of dispensers; availability and stock of procedure gloves; number of beds; number of sinks with water; soap and paper towel availability; presence/location of illustrative posters about HH; number of health professionals in the sector; participation in HH training; and presence of an audit on adherence to HH in the institution.[13]

Regarding statistical analyses, numerical variables were described using descriptive statistics, in which the mean, median and standard deviation were calculated. Nominal categorical variables were described or presented in frequency tables. Analysis of median comparisons was performed using the Kruskal-Wallis test, as there was data non-normality using the Shapiro-Wilk test ($p<0.05$). For all analyses, a significance level of 0.05 was established.

The project was approved on August 26, 2021 by the Research Ethics Committee (REC) under Opinion 4,934,581. It received the *Certificado de Apresentação para Apreciação Ética* (CAAE - Certificate of Presentation for Ethical Consideration) 75169317.0.0000.5541 so that all ethical requirements of Ministry of Health Resolutions 466/2012, 510/2016 and 580/2018 were met.

RESULTS

Of the 62 professionals who responded to the questionnaires, 29 (46.77%) are nursing technicians, 13 (20.97%) nurses, 12 (19.35%) physicians and eight (12.91%) are physiotherapists. The mean age was 43.44 years, with a minimum age of 24 and a maximum age of 63 years. The highest level of education recorded was specialization, represented by 34 professionals, just after completing higher education, with 21 participants. The others were four participants who had incomplete higher education, and two had master's degree and one had a doctoral degree. The HH infrastructure provided by the institution in the COVID-19 ICU sector for health professionals is represented in Chart 1.

Chart 1. Unit structure for hand hygiene according to variables that make up the instrument on the unit structure for hand hygiene: water, alcoholic preparation and procedure glove availability. Cuiabá/MT, Brazil, 2021.

Variables	COVID-19 ICU
Water availability	Yes
Alcoholic preparation availability	Yes
Types of alcoholic preparation dispensers	Wall-mounted alcohol dispenser
Are dispensers located within easy reach?	Yes
Is there someone responsible for refilling the dispensers?	Yes
Are dispensers refilled with alcoholic preparations?	Sporadically
Do professionals have easy access to pocket flasks with alcoholic preparations?	No
Are procedure gloves available in the units?	Yes
Is stock of gloves stored in the units?	Yes

Chart 2 represents the list of availability of illustrative posters and specific instructions on HH in the COVID-19 ICU.

Chart 2. Unit structure for hand hygiene according to the variables that make up the instrument on unit structure: presence of illustrative posters and training. Cuiabá/MT, Brazil, 2021.

Variables	COVID-19 ICU
Are illustrative posters with hand hygiene techniques with soap and water displayed next to each sink?	Yes
Are posters illustrating the technique of antiseptic hand rubbing with alcoholic preparations displayed at assistance/treatment points?	Yes
Are illustrative posters with instructions for hand hygiene displayed at assistance/treatment points?	No
Are posters promoting hand hygiene displayed in the units?	No
Are written guidelines with recommendations on hand hygiene accessible in the units?	Yes
Have nurses received specific instruction on hand hygiene in the last two years?	Yes
Have physicians received specific instruction on hand hygiene in the last two years?	No

Chart 3 shows the structure of an ICU intended for patients with COVID-19 in terms of number of beds, number of alcoholic preparations present in the environment, number of alcoholic preparations available within reach, number of alcoholic preparations in perfect working order, number of sinks, number of sinks with soap and paper towels available.

Chart 3. COVID-19 ICU structure for hand hygiene. Cuiabá/MT, Brazil, 2021.

COVID-19 ICU	Total
Number of beds	9
Beds with alcoholic preparations available within reach	6
Alcoholic preparation dispensers available in the sector	8
Alcoholic preparation dispensers in perfect working order/ restocked	0
Number of sinks in this area	6
Number of sinks with clean water, soap and paper towels	6
Number of professionals found with pocket-sized bottles of alcoholic preparations	0

Regarding unit infrastructure, it had eight common beds and one isolation bed. Consisting of six sinks with manual taps, operated by hands and without sensors, one of which was at the entrance to the isolation bed, four between the beds and one in the common area, close to the medication preparation space. As for the bins for disposing of paper towels after drying their hands, professionals had to operate them manually, lifting the lid, as pedal operation was impaired.

Regarding alcoholic preparation dispensers, all devices belonging to the unit were activated with fingertips in an upward lever movement, using moderate force applied by professionals. It is important to highlight that some dispensers had difficult access due to inappropriate location, such as poorly positioned behind patients' bed, behind devices such as infusion pump, mechanical respirator, IV pole, chairs, emergency cart, among others. Regarding alcohol and antiseptic soap dispenser replacement and refilling, there was a designated person who was responsible for the task, but dispensers were not always filled.

Table 1 describes the organizational safety attitude perception obtained by health professionals in the sector.

According to table 1, it is noted that there is no statistical difference between the medians of the domains and professional categories. Stress recognition, working conditions and perceptions of unit management domains presented the lowest scores considering all professional categories.

It is noteworthy that, although the teamwork climate domain did not register significant differences between professional categories, nurses obtained a higher median in the job satisfaction domain compared to other professional categories. Stress recognition and job satisfaction domains had the lowest scores in the professional categories of physical therapists and physicians, respectively. Regarding the total score obtained, safety attitude perception was compromised according to all professionals investigated.

Table 1. Distribution of the Safety Attitudes Questionnaire (SAQ) domains by professional categories. Cuiabá/MT, Brazil, 2021 (n=62).

SAQ domains	Physicians Median (SD)	Nurses Median (SD)	Physical therapists Median (SD)	Nursing technicians Median (SD)	p-value*
Teamwork climate	75.0 (14.30)	75.0 (15.00)	75.0 (10.62)	75.0 (13.57)	0.715
Safety climate	64.3 (17.05)	67.9 (16.18)	69.6 (8.10)	67.9 (67.9)	0.621
Job satisfaction	77.5 (12.52)	90.0 (15.49)	85.0 (85.0)	85.0 (16.82)	0.690
Stress recognition	75.0 (17.17)	75.0 (23.04)	56.3 (24.19)	62.5 (27.49)	0.315
Perceptions of unit management	52.5 (18.64)	60.0 (18.99)	60.0 (13.87)	60.0 (18.18)	0.496
Perceptions of hospital management	52.5 (19.55)	60.0 (18.07)	57.5 (11.78)	56.3 (20.52)	0.669
Working conditions	75.0 (15.93)	75.0 (17.51)	60.0 (17.04)	70.0 (18.00)	0.404
Total SAQ	64.6 (12.90)	72.0 (11.42)	67.7 (7.43)	66.5 (11.71)	0.735

* p-value obtained by the Kruskal-Wallis statistical test. SD: standard deviation.

DISCUSSION

The results of this study highlighted weaknesses in sector infrastructure, which is directly related to low adherence to HH, according to current studies.[10] In this context, it is important to highlight the dysfunctionality of alcoholic preparation dispensers, as they were activated with the fingertips in up and down movements, using moderate force, which, in addition to making their use difficult, could cause contamination. Furthermore, professionals did not have individual bottles of alcohol gel, dispensers were not always refilled, taps were manually operated, and sink location was difficult to access between beds.

During the COVID-19 pandemic, special attention and notable emphasis was given to HH, as it is a primordial and simple strategy for preventing the disease, which can be carried out independently among individuals.[6] Thus, among the variables that may be implicated in low adherence to HH, unit infrastructure becomes a fundamental element in health care services.[3,9] HH must be performed at the recommended times and exactly at the health care point, without professionals having to leave the place to perform HH. A health care point is understood as a place characterized by the presence of three important elements, simultaneously, such as patient, health professional and care, assistance or treatment carried out, which involves contact with patients and/or their surroundings.[7] However, the present study found the absence of dispensers or bottles of alcohol gel at the point of assistance. Other studies have shown that the deficient structure of a HH unit is related to low adherence of these professionals to HH.[10]

HH must be performed in the five (5) moments that represent care, which are: 1) before touching a patient; 2) before clean/aseptic procedures; 3) after body fluid exposure/risk; 4) after touching a patient; 5) after touching patient surroundings.[14]

A study found a significantly higher adherence rates to HH in the neonatal ICU sector due to better infrastructure, with bottles of alcoholic preparations available within reach of professionals and washbasins with taps that cannot be operated by hands.[9] On the contrary, the aforementioned source found that, in the semi-intensive sector, which had less accessibility to alcoholic preparations at the point of care, the adherence rate was significantly lower (p≤0.001),[9] which demonstrates the impact of unit infrastructure on HH adherence by health professionals, highlighting MS' explanatory model for HH adherence, and infrastructure is the main element recommended and encouraged by the WHO.[13,14]

It happened in the semi-intensive sector, which had less accessibility to alcoholic preparations at the point of care and, consequently, there was significantly less adherence to HH (p≤0.001).[9]

It is known that HH prevents HAIs and the spread of microbial resistance to antimicrobials, but it is also a fundamental strategy for preventing SARS-CoV-2 trans-

mission in health services.[15] Studies show that ICUs are the main places for the occurrence of HAIs, due to the health status of patients in this environment, as they are critically ill patients and, for the most part, immuno-suppressed.[2] Therefore, it is an essential condition that health institutions contain appropriate conditions for HH in each clinical environment, such as clean running water, liquid soap and disposable towels as well as alcohol-based dispensers at each assistance point.[14]

In contrast to the present study, it is noted that simple measures can be implemented in order to increase HH adherence rates and, consequently, prevent the spread of SARS-CoV-2. A study carried out in the pediatric ICU of a hospital in Haiti highlighted the importance of installing automatic dispensers for HH, providing paper towels, lectures on the five moments for HH and use of posters as a way of reminding professionals to clean their hands in the five moments. With this intervention, it was evident that adherence to HH improved significantly (p≤0.001) compared to the pre-intervention period (48.66%) and the post-intervention phase (82.99%).[16]

The COVID-19 pandemic has revived efforts for education and information about HH, both for health professionals and the general public. There was a frequent dissemination of news through videos, advertisements, reminders, billboards about the importance of HH as well as the execution of the correct technique, as it is considered effective in reducing SARS-CoV-2 transmission.[6]

It is worth noting that to encourage HH in health institutions, the main interventions include improving physical infrastructure, a favorable safety climate, training and posters on HH indications and techniques in the workplace. These strategies have shown positive results in reducing HAIs in critical environments and in other health sectors.[17] A prospective study conducted in a COVID-19 ICU in southern India found that HH audit and provision of timely feedback were factors that significantly improved HH adherence rates, recording rates from 26.7% in 2020 to 68.4% in 2021 (p≤0.001).[18]

A study with multimodal interventions carried out in a hospital in Qatar included training on patient safety and HH, ongoing education on HAI control, changes to unit structure, such as installation of sinks, alcohol gel dispensers, taps with automatic activation, in addition to feedback for health professionals and provision of posters with the five moments visible in the washbasins.[19] It is important to highlight that the entire intervention took place with immediate and superior management support and encouragement.

The aforementioned study concluded that reestablishing issues pertaining to unit structure and also to professionals' behavior, emotion and intellect was able to increase HH adherence rates from 60.78% to 94.14%, which highlights the need for institutional administration support in the process, with a view to creating and/or maintaining a favorable safety climate. In this regard, a study found that the use of interventionist strategies based on providing positive feedback to professionals and motivation during care activities facilitated aware-ness of patient safety and the installation of a favorable safety climate, which led to lasting behavioral change could be sustained over time.[20]

Thus, it is important to consider that the investment in the first and fundamental element of MS "change in the system", represented by the investment in adequate physical structure and inputs for HH, consists of a primordial element of the aforementioned strategy, without which the other elements become compromised. However, when used in isolation and disconnected from the other components, it is also not capable of sustaining and promoting improvements in HH adherence. It is necessary to ensure the implementation of all elements of the aforementioned strategy, such as training with provision of individual and collective feedback, adequate monitoring of adherence and involvement of managers.[20,8]

It is noted that the involvement of the institution's management is seen as one of the main components for improvements to occur in patient care provision. A study demonstrated that positive results in safety perception assessment regarding teamwork climate and safety climate domains corroborated lower HAI rates.[21]

It was observed in the present study that SAQ scores for all domains demonstrated weaknesses, which is in line with national studies and therefore represents that the team's safety perception was impaired.[22] Perceptions of hospital administration and perceptions of unit management domains presented the lowest scores in all professional categories, which reflected professionals' low perception regarding support and consent to management actions regarding patient safety in the hospital. This same finding was also found in a study carried out in two ICUs of a public hospital in the state of Goiás, which found negative scores for the management perceptions domain and concluded that management involvement is essential for safety culture consolidation and dissemination.[22]

The safety climate domain also presented low scores in all professional categories, which is in line with international studies that also used the SAQ with health professionals in an ICU, as this is an instrument considered valid in various cultures and nations, therefore facilitating data interpretation, reliability and comparison.[23]

The same was found in a national study carried out in 11 public hospitals in the Federal District, which found that the safety climate was negative [57.7 (SD = 21.4) to 68.8 (SD = 19.1); p = 0.001], as no hospital presented a value higher than 75, which could be harmful to health practices by professionals.[24]

It was noted that in working conditions and stress recognition domains, physiotherapists and nursing technicians had the lowest medians among the professional categories, which can directly influence the care provided to patients. The work overload of nursing technicians may be related to their peculiar, uninterrupted work, with the provision of direct care to patients, often in quantity and quality beyond that recommended by current legislation - still added, almost mostly, to the double and even triple working hours that are necessary for their subsistence.[23]

Regarding work stress in the nursing team, a study

carried out in Spain highlighted some factors that can influence this condition, such as environmental factors experienced in the workplace, exhausting working hours, anxiety generated due to working conditions and lack of resources to carry out their assistance activities during the pandemic. A significant correlation was noted with emotional exhaustion (p=0.001), depersonalization (p=0.02) and personal satisfaction (p=0.05) as well as work overload (p=0.001).[25]

Among the limitations of this study is the fact that data collection was carried out in a short period of time due to the closure of activities in the sector under study and also the fact that it was carried out in only one COVID-19 ICU, which undermines the external validity of results.

The findings of this study suggest the urgent need to develop and execute strategies that aim to promote a positive safety culture in institutions, in order to contribute to the development of best care practices with an emphasis on patient safety. The negative impact of low management involvement in patient safety actions and the sector's precarious infrastructure on adherence to HH by health workers was demonstrated.

It was concluded that all professional categories had a low organizational safety climate perception. The study found the negative impact of low management involvement perception in patient safety actions and precarious infrastructure for HH on adherence to this technique by health workers.

Given the data obtained, the urgent need for investment in the institution's physical structure is evident, since this is a MS' fundamental component for HH, and the absence, poor positioning and/or dysfunctionality of alcohol dispensers have a negative effect on HH adherence rates.

Facilitating and encouraging HH actions are necessary in order to increase adherence rates, with a view to reducing morbidity and mortality related to HAIs.

ACKNOWLEDGMENTS

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

ORIGINAL ARTICLE

High-risk clones of ESBL-producing Klebsiella pneumoniae colonizing ICU patients in Natal, northeastern Brazil

Clones de alto risco de Klebsiella pneumoniae produtores de ESBL colonizando pacientes de UTI em Natal, Nordeste do Brasil

Clones de alto riesgo de Klebsiella pneumoniae productores de BLEE que colonizan pacientes de UCI en Natal, noreste de Brasil

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ABSTRACT

Background and objectives: colonization by extended-spectrum β-lactamase (ESBL)-producing *Klebsiella pneumoniae* in Intensive Care Unit (ICU) patients is considered a risk factor for infections, and poses as a source of spreading these strains in hospital facilities. This study aimed to perform the genetic characterization of ESBL-producing *K. pneumoniae* isolates recovered from surveillance swabs in an ICU in northeastern Brazil. **Methods:** the isolates were recovered between 2018-2019 from the nasal, axillary, and rectal sites of 24 patients admitted to the ICU. Bacterial identification was performed by traditional biochemical tests. Antimicrobial susceptibility was assessed by disk diffusion, and ESBL phenotype was detected by double-disc synergy test. Polymerase chain reaction (PCR) for bla_{CTX-M}, bla_{SHV}, and bla_{TEM} genes, PFGE, and MLST were carried out in representative isolates. **Results:** a total of 27 isolates were recovered from 18 patients (75%). The ESBL production was detected in 85% of isolates. Resistance to ciprofloxacin, sulfamethoxazole/trimethoprim and most of the β-lactams tested was recurrent, except for carbapenems. The bla_{SHV}, bla_{TEM}, and bla_{CTX-M} genes were found in high frequency, and the CTX-M-(1, 2 and 9) groups were identified. Seven sequence types (ST11, ST14, ST17, ST395, ST709, ST855, and ST3827) were described, most of them considered high-risk. **Conclusion:** these findings emphasize the potential threat of well-established high-risk clones in an ICU, and highlight the importance of monitoring these clones to prevent infections.

Keywords: Klebsiella pneumoniae. Intensive Care Unit. Infection Control. Drug-resistance. Beta-lactamases.

RESUMO

Justificativa e objetivos: a colonização por *Klebsiella pneumoniae* produtora de β-lactamase de espectro es-

tendido (ESBL) em pacientes de Unidade de Terapia Intensiva (UTI) é considerada um fator de risco para infecções, e representa uma fonte de disseminação dessas cepas em instalações hospitalares. Este estudo objetivou realizar a caracterização genética de isolados de *K. pneumoniae* produtores de ESBL recuperados de *swabs* de vigilância em uma UTI no Nordeste do Brasil. **Métodos:** os isolados foram recuperados entre 2018-2019 dos sítios nasal, axilar e retal de 24 pacientes internados na UTI. A identificação bacteriana foi realizada por testes bioquímicos tradicionais. A suscetibilidade antimicrobiana foi avaliada por disco-difusão, e o fenótipo ESBL foi detectado pelo teste de sinergia de duplo-disco. *Polymerase chain reaction* (PCR) para os genes bla_{CTX-M}, bla_{SHV} e bla_{TEM}, PFGE e MLST foram realizados em isolados representativos. **Resultados:** foram recuperados 27 isolados de 18 pacientes (75%). A produção de ESBL foi detectada em 85% dos isolados. A resistência à ciprofloxacina, sulfametoxazol/trimetoprima e à maioria dos β-lactâmicos testados foi recorrente, exceto para os carbapenêmicos. Os genes bla_{SHV}, bla_{TEM} e bla_{CTX-M} foram encontrados em alta frequência, e os grupos CTX-M-(1, 2 e 9) foram identificados. Sete *sequence types* (ST11, ST14, ST17, ST395, ST709, ST855 e ST3827) foram descritos, a maioria deles considerados de alto risco. **Conclusão:** esses achados enfatizam a ameaça potencial de clones de alto risco bem estabelecidos em uma UTI, e destacam a importância do monitoramento desses clones para prevenir infecções.

Palavras-chave: Klebsiella pneumoniae. Unidade de Terapia Intensiva. Controle de Infecção. Resistência à Droga. Beta-lactamases.

RESUMEN

Justificación y objetivos: la colonización por *Klebsiella pneumoniae* productora de β-lactamasas de espectro extendido (BLEE) en pacientes de Unidades de Cuidados Intensivos (UCI) se considera un factor de riesgo para infecciones, y se presenta como una fuente de propagación de estas cepas en instalaciones hospitalarias. Este estudio tuvo como objetivo realizar la caracterización genética de aislamientos de *K. pneumoniae* productores de BLEE recuperados de hisopos de vigilancia en una UCI en el noreste de Brasil. **Métodos:** los aislamientos se recuperaron entre 2018-2019 de sitios nasales, axilares y rectales de 24 pacientes ingresados en la UCI. La identificación bacteriana se realizó mediante pruebas bioquímicas tradicionales. La susceptibilidad antimicrobiana se evaluó mediante difusión en disco, y el fenotipo BLEE se detectó mediante la prueba de sinergia de doble-disco. La *polymerase chain reaction* (PCR) para los genes bla_{CTX-M}, bla_{SHV} y bla_{TEM}, PFGE y MLST se llevaron a cabo en aislamientos representativos. **Resultados:** se recuperaron 27 aislamientos de 18 pacientes (75%). La producción de ESBL se detectó en 85% de los aislamientos. La resistencia a ciprofloxacino, sulfametoxazol/trimetoprima y a la mayoría de los β-lactámicos evaluados fue recurrente, excepto a los carbapenémicos. Los genes bla_{SHV}, bla_{TEM} y bla_{CTX-M} se encontraron en alta frecuencia, y se identificaron los grupos CTX-M-(1, 2 y 9). Se describieron siete *sequence types* (ST11, ST14, ST17, ST395, ST709, ST855 y ST3827), la mayoría consideradas de alto riesgo. **Conclusión:** estos hallazgos enfatizan la amenaza potencial de los clones de alto riesgo bien establecidos en una UCI, y resaltan la importancia de monitorear estos clones para prevenir infecciones.

Palabras clave: Klebsiella pneumoniae. Unidad de Cuidados Intensivos. Control de Infección. Resistencia a Medicamentos. Beta-lactamasas.

INTRODUCTION

The *Klebsiella pneumoniae* complex consists of closely related species standing as opportunistic pathogens and related to a wide range of infections, including urinary tract infections, bloodstream infections, and pneumonia, mainly among hospitalized and immunocompromised patients.[1] In the last 30 years, *K. pneumoniae* has become a major cause of healthcare-related infections globally, especially due to its ability to acquire and transfer antimicrobial resistance mechanisms.[2] Brazilian epidemiological and surveillance data highlight *K. pneumoniae* as the most reported Gram-negative microorganism associated with laboratory-confirmed bloodstream infections in adult Intensive Care Units (ICUs) between 2018 and 2019, along with the extended-spectrum β-lactamase (ESBLs) production as the most prevalent phenotype.[3]

The spread of plasmid-mediated ESBLs conferring resistance to oxymino-cephalosporins and monobact-

ams are considered a major threat to global public health, and have been increasingly described among members of Enterobacterales, including *K. pneumoniae*.[4,5] Detection rates of ESBL-producing *K. pneumoniae* strains reach up to 80% in some countries, and have been associated with enhanced risk of treatment failure, patient mortality, and hospital costs.[4] In Brazil, over 70% of *K. pneumoniae* isolates recovered from infected patients were ESBL producers.[3]

Regardless of the infection site, the first stage in some hospital-acquired infections caused by *K. pneumoniae* consists of colonization in patients' gastrointestinal tract, which is important, as it may precede and possibly serve as a source of subsequent clinical infection for patients as well as pose as a reservoir within healthcare institutions.[1,6]

Multidrug-resistant (MDR) *K. pneumoniae* colonizing patients admitted to ICUs is considered a significant risk factor for subsequent infection. Patients who carry this pathogen are more likely to progress to infection when compared to non-carriers.[1,6] Furthermore, coloni-

zation and subsequent infection may be concerning due to the dissemination and establishment of MDR high-risk clones in healthcare facilities, especially in ICUs.[7]

Most surveillance research using genotyping prioritizes strains originating from sites of infection rather than colonization. However, screening of patients at risk for colonization along with the genetic characterization of ESBL-producing *K. pneumoniae* isolates may assist infection control programs.[8] In this regard, the present study describes the phenotypic and genotypic features of ESBL-producing *K. pneumoniae* isolates recovered from surveillance cultures of ICU inpatients in a tertiary hospital in the city of Natal, northeastern Brazil.

METHODS

Study design and bacterial identification

This is a descriptive study of resistance surveillance conducted with ICU inpatients at a referral hospital for infectious diseases, located in the city of Natal, Rio Grande do Norte State, Brazil, from August 2018 to March 2019. A total of fifty-four samples were obtained from nasal (n=24), axillary (n=24), and rectal (n=6) swabs that were collected from 24 ICU inpatients that were admitted to hospital for at least seven days, regardless of age and clinical conditions. The present study was approved by the Research Ethics Committee of the *Universidade Federal do Rio Grande do Norte*, under CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 45184115.5.0000.5537.

For collection, the swabs were soaked in sterile saline solution (0.85%) and were introduced 1 cm into the nostril or rectum with circular movements. For the axillary site, swabs were rubbed in the armpit with rotational movements, comprising 2 cm² of area, approximately. After collection, swabs were transported in a Cary-Blair transport medium (HiMedia, India) for further processing at the *Universidade Federal do Rio Grande do Norte*'s Mycobacterial Laboratory. Swabs were transferred to Brain Heart Infusion (BHI) broth (Sigma-Aldrich, United States) and incubated at 35°C for eight hours, followed by culture in 5% Sheep Blood Agar and MacConkey Agar (KASVI, Brazil) media, and incubation at 35°C for 24 hours.

K. pneumoniae isolates were identified through the macroscopic characteristics of the colonies, Gram stain, and classical biochemical tests, such as growth on triple sugar-iron (TSI) agar, sulfide and indole production, motility, citrate use, lysine, ornithine, and arginine decarboxylation, urease production, phenylalanine deaminase test.[9] Afterwards, isolates were stored at -20°C in BHI broth with 10% glycerol and 10μg/ml of ampicillin.

Phenotypical and molecular antimicrobial susceptibility-related assays

Antimicrobial susceptibility test was determined by disk diffusion method for amikacin (30 μg), amoxicillin/clavulanate (30 μg), aztreonam (30 μg), cefepime (30 μg), cefotaxime (30 μg), ceftazidime (30 μg), ceftriaxone (30 μg), ciprofloxacin (5 μg), gentamicin (10 μg), imipenem (10 μg), meropenem (10 μg), sulfamethoxazole/trimethoprim (25 μg), and tetracycline (30 μg). Methodology and interpretation were performed according to the Clinical and Laboratory Standards Institute breakpoints.[10] ESBL phenotypical detection was performed using the double-disc synergy test (DDST) described elsewhere.[11] *Escherichia coli* ATCC 25922 was used as a control for both assays.

Eleven non-repetitive (one per selected patient) isolates exhibiting phenotypic resistance to 3rd generation cephalosporins were randomly selected for further genetic characterization, following a criterion of equal representation within the collection period. (KP02-JO-VN, KP03-LFN, KP09-FMSN, KP12-MFON, KP14-RHRSN, KP17JMN from nasal site; KP05-ABAJA, KP10-JFSA, KP11-FHSA, KP15-JAA from axillary site; and KP20-FNCR from rectal site). Molecular detection of ESBL-related genes - bla_{CTX-M}, and $bla_{CTX-M-1}$, $bla_{CTX-M-2}$, $bla_{CTX-M-8}$, $bla_{CTX-M-9}$ groups,[12,13] bla_{SHV}, and bla_{TEM} [14] – was performed by polymerase chain reaction (PCR) according to the references, following quality patterns and using internal control strains.

Genotyping by pulsed-field gel electrophoresis (PFGE) and multilocus sequence typing (MLST)

Genetic relatedness of isolates was investigated by PFGE following an adapted protocol.[15] Briefly, genomic DNA was digested with *XbaI*, and fragments separated in 1% agarose gel were submitted to electrophoresis for 23 hours using a CHEF-DR III apparatus (Bio-Rad), with pulses varying from 0.5 to 35 seconds at a voltage of 6 V/cm. After staining with ethidium bromide (0.5 mg/mL), the gels were examined using the GelJ v.2.0. software. Similarity among isolates was estimated using the Dice coefficient with a 1.0% tolerance setting and 85% similarity cut-off.[16]

MLST was performed as described by the Institute Pasteur protocol (https://bigsdb.pasteur.fr/klebsiella/). The housekeeping genes (*gapA*, *infB*, *mdh*, *pgi*, *phoE*, *rpoB*, and *tonB*) were amplified by PCR. Sequencing of PCR products was performed using the BigDye™ Terminator v3.1 Cycle Sequencing Kit (Life Technologies) on an ABI Prism 3130 Genetic Analyzer (Applied Biosystems). Determination of allele profiles and sequence types (STs) was achieved by comparing the obtained sequences with the documented data available at the Klebsiella Pasteur-MLST database (https://bigsdb.web.pasteur.fr/Klebsiella/Klebsiella.html - accessed on June 08, 2022).

RESULTS

A total of 27 isolates identified as *K. pneumoniae* complex were recovered from 18 patients (75%; 18/24), including five from rectal (19%), 10 from nasal (37%), and 12 from axillary (44%) sites. For eight patients, it was possible to recover more than one isolate. All isolates were Gram-negative, Yellow/Yellow on TSI agar, with gas production and no hydrogen-sulfide production. The Citrate, lysine, and urease were positive, and negative for indole and motility. The isolates also were non-susceptible to at least one tested 3rd generation cephalosporin; however,

phenotypical detection revealed 23 ESBL-producing isolates (85%; 23/27). A total of 14 of 24 (58%) patients were colonized by ESBL-producing *K. pneumoniae*. Moreover, most isolates were resistant to ciprofloxacin, gentamicin, sulfamethoxazole/trimethoprim, and all tested β-lactams, except carbapenems and amikacin, as shown in Figure 1.
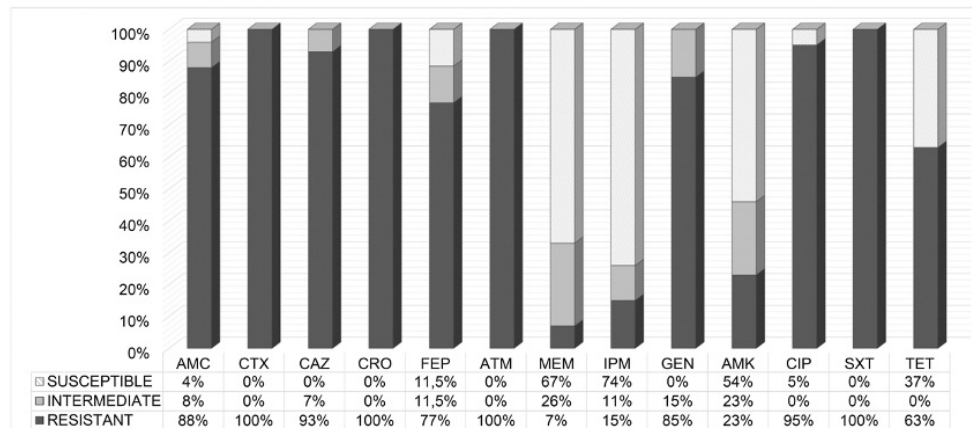
Figure 1. Antimicrobial susceptibility pattern of *Klebsiella pneumoniae* isolated from surveillance swabs in Intensive Care Unit.

Caption: AMC - amoxicillin/clavulanate; CTX - cefotaxime; CAZ - ceftazidime; CRO - ceftriaxone; FEP - cefepime; ATM - aztreonam; MEM - meropenem; IPM - imipenem; GEN - gentamicin; AMK - amikacin; CIP - ciprofloxacin; SXT - sulfamethoxazole/trimethoprim; TET - tetracycline.

Among the 11 isolates selected for molecular characterization, six (54%) harbored bla_{CTX-M} genes, including $bla_{CTX-M-1}$ (27%), $bla_{CTX-M-2}$ (27%), and $bla_{CTX-M-9}$ (9%) groups. Furthermore, $bla_{SHV-like}$ and $bla_{TEM-like}$ were detected in eleven (100%) and six (54%) isolates, respectively. Most isolates (91%) were detected co-harboring at least two of the searched genes, including one isolate co-harboring $bla_{CTX-M-2}$, $bla_{CTX-M-9}$, and $bla_{SHV-like}$ (Figure 2).
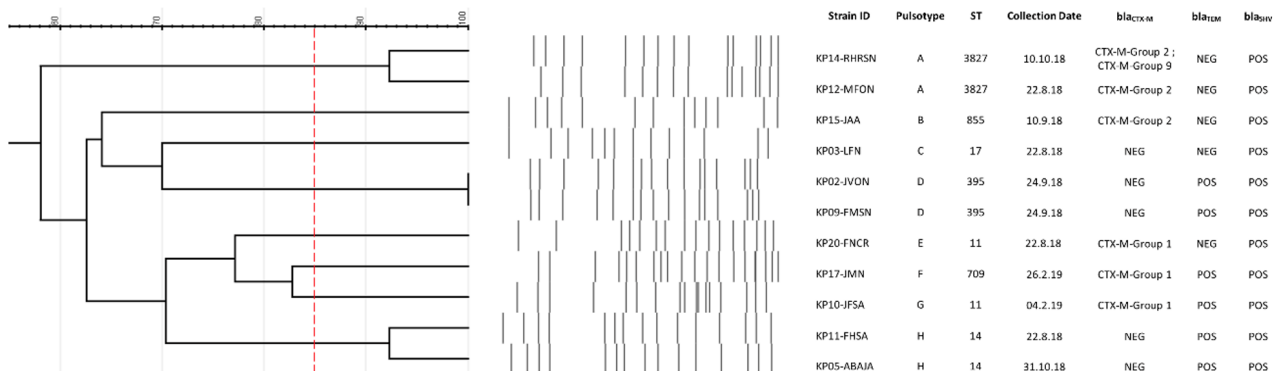
Figure 2. Dendrogram and genetic features of representative *K. pneumoniae* of the study.

Caption: ID – identification; ST - sequence type; NEG – negative; POS – positive.

Genetic relatedness analysis by PFGE demonstrated the presence of eight pulsotypes (A to H), including indistinguishable strains on clusters A, D, and H. MLST genotyping revealed a genetic background composed of seven distinct STs (ST11, ST14, ST17, ST395, ST709, ST855, and ST3827), of which most were associated with high-risk clonal groups (CG258, CG15, and CG20) (Figure 2). Of these, ST395/D, ST3827/A, and ST14/H clones were found in different patients, the latter two with a difference between the collections of 49 and 70 days, respectively. Such data demonstrate the spread and persistence ability of these clones in ICU settings. Finally, despite the small number of samples, no predominance of any specific clone was observed, demonstrating a considerable level of genetic diversity.

DISCUSSION

Overall, studies that survey *K. pneumoniae* genotype prioritize strains from clinical samples of infected sites over those isolated from colonization samples.[17] Therefore, this study is intended to investigate the prevalence of ESBL-producing *K. pneumoniae* and circulating clones in patients colonized in an ICU in Natal-RN to better understand the dynamics of dissemination of these clones in ICU settings.

In this study, we examined only one adult ICU, which had nine beds at the time of study collection. A previous study has already shown that adult patients admitted to hospital in critical wards such as the ICU tend to have higher rates of colonization by ESBL producers, with *K. pneumoniae* being the main microorganism involved.[18] Furthermore, colonization rates can be highly variable.[6] In this study, 58% of patients were colonized by ESBL-producing *K. pneumoniae*, by phenotypic identification. It is worth mentioning that colonization by *K. pneumoniae* was found to be a significant risk factor for later infection by the same pathogen. In other studies, with patients admitted to the ICU, most asymptomatic carriers developed infection by this microorganism when compared to non-carriers.[6]

Isolation rates from the rectal (5/6 – 83%) site were higher when compared with the axillary (12/24 - 50%) and nasal (10/24 - 42%) sites. This finding was expected since the surveillance screening of stool specimens, rectal swabs, or perirectal swabs may produce a greater yield of bacterial growth than other body sites such as nostrils or skin.[19] In addition, from colonization of the patient's gastrointestinal tract, contamination of different parts of the body will likely occur through exogenous or endogenous processes.[20] Even so, the colonization of the axillary and nasal sites was considered high, this leads us to the hypothesis that there is high fecal contamination in this ICU, with intense cross-transmission, and precarious hygiene care for bedridden patients.

Regarding the ESBL testing, sometimes, accuracies could be impaired in organisms with multiple β-lactamase enzymes, mainly the coexistence of enzymes from different Ambler classes.[21] Resistance to other antimicrobial classes was common in this study, mainly to ciprofloxacin and tetracycline. ESBL producers are often co-resistant to multiple antibiotic classes and heavy metals, due to the concomitant presence of these genes in the same plasmid, which could improve bacterial fitness.[18]

Although carbapenems were the drugs with the best activity against the isolates in this study, as seen in Figure 1, resistance to these drugs has grown in bacteria that cause hospital-acquired infections, increasing the need to implement strategies to reduce the excessive consumption of carbapenems.[22] Therefore, surveillance of these patients at risk for ICU-acquired infections caused by ESBL-producers can be an important auxiliary measure.

Among the ESBL enzymes, the most frequent in *K. pneumoniae* belong to the plasmid-mediated TEM, SHV, and CTX-M enzyme families.[7] The TEM and SHV families have many variants with a different spectrum of activity, but not all have the ESBL phenotype.[23] In this work, the presence of these genes was identified in many isolates, although the variants were not identified. Some isolates with the ESBL phenotype carried bla_{TEM} and bla_{SHV} and lacked bla_{CTX-M}, suggesting that the TEM and SHV enzymes present could have ESBL activity, or even other uninvestigated enzymes could be responsible for this phenotype. The CTX-M enzymes have a significant hydrolytic capacity for 3rd generation cephalosporins, and can be clustered into five groups, CTX-M-1, CTX-M-2, CTX-M-8, CTX-M-9, and CTX-M-25, with representatives of groups 1 and 9 being the most prevalent in the world, while group 2 is frequently reported in Latin America,[23] as confirmed in this study.

The emergence, persistence, and dispersion of certain resistance mechanisms, such as ESBL, are enhanced by the presence of so-called MDR high-risk clones.[24] Of the 11 representative isolates, nine belong to high-risk clones spread worldwide: ST11, ST395, ST855 (CG258), ST14, ST709 (CG15), and ST17 (CG20). All these CGs are known to be associated with multidrug resistance, including carrying genes encoding ESBL and carbapenemases.[7] In Brazil, these clones (mainly CG258) are endemic and associated with the presence of ESBL genes and carbapenemases such as *Klebsiella pneumoniae* carbapenemase (KPC) and New-Delhi Metallo-β-lactamase (NDM).[17,25,26] Besides that, isolates belonging to ST11 were the only ones grouped into two pulsotypes (E and G); this intraclonal variability is a phenomenon commonly described in ST11.[17]

ST3827 was the only non-high-risk clone. Isolates belonging to this clone have already been reported carrying bla_{SHV-11} in food samples from Europe [27] and $bla_{CTX-M-15}$ isolated from a native Amazonian fish in Brazil.[28] As far as we know, this is the first time this clone has been associated with human colonization.

Two points deserve to be emphasized - the hospital in which the study was conducted did not carry out surveillance of colonization by MDR bacteria in patients admitted to hospital at the time of the study. Furthermore, this study was performed one year before the spread of the COVID-19 pandemic in Brazil. Therefore, this study could serve as a basis for future adaptations to local measures to prevent and control infections and install protocols of hygiene and as a comparison of the clonal population of *K. pneumoniae* before and after the pandemic period.

It is worth indicating the limitations of this study. Firstly, the low number of rectal swabs occurred because collections were often performed after patient diaper changes; therefore, due to hospital constraints, there were no possibilities for a second diaper change on the same day. Secondly, a random selection of isolates for molecular characterization was necessary due to budgetary constraints of the involved laboratories.

Finally, this study identified a high rate of ESBL-producing *K. pneumoniae* isolates colonizing ICU patients, which suggests reduced hygiene care, allowing intense cross-transmission. Moreover, most of the isolates belonged to high-risk clones and carried highly disseminated

resistance determinants, such as bla_{CTX-M}, which increases the risk of possible infections for patients admitted to hospital. These findings warn of the intensification of hygiene, infection control, and surveillance measures as well as monitoring the dynamics of these endemic clones.

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AUTHOR'S CONTRIBUTIONS

Isabela Maria Fortaleza Neves Bomfim contributed to the design of the project, analysis and interpretation of data, and final approval of the version to be published.

Marcileide Almeida Amaral contributed to the analysis and interpretation of the data, and final approval of the version to be published.

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

ORIGINAL ARTICLE

Analysis of theses and dissertations on hand hygiene in Brazil: a bibliometric study

Análise de teses e dissertações sobre higienização das mãos no Brasil: estudo bibliométrico

Análisis de tesis y disertaciones sobre higiene de manos en Brasil: un estudio bibliométrico

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ABSTRACT

Background and Objectives: in relation to hand hygiene, it is important to highlight the absence of documented investigations in the scientific literature that address the analysis of theses and dissertations related to this practice. This gap justifies the carrying out of this study, which aims to strengthen and expand the knowledge base related to this topic, highlighting its relevance in the areas of teaching, research, extension and innovation. The objective was to analyze theses and dissertations published in *stricto sensu* graduate programs on hand hygiene practices in Brazil. **Methods**: this is a bibliometric study conducted in the Coordination for the Improvement of Higher Education Personnel Theesis and Dissertation Catalog, considering the period from 2013 to 2022. **Results:** thirty-one (100%) studies were included, 21 (67.7%) dissertations and six (19.3%) theses. Nursing was the main area of assessment (65.6%), which mainly analyzed adherence to hand hygiene practices (29.0%), health education (12.9%), and carried out microbiological analysis of hands (12.9%). Only three publications used theoretical bases as the central core of the research. **Conclusion:** this study allowed us to identify the need to study the topic at doctoral level, using theoretical bases that will provide the conceptual and philosophical foundation for clinical practice.

Keywords: Hand Disinfection. Patient Safety. Nursing. Health Education. Health Personnel.

RESUMO

Justificativa e Objetivos: em relação à higienização das mãos, é importante ressaltar a ausência de investigações documentadas na literatura científica que abordem a análise de teses e dissertações relacionadas a essa prática. Tal lacuna justifica a realização deste estudo, que visa fortalecer e expandir a base de conhecimento relativa a essa temática, destacando sua relevância nos domínios do ensino, da pesquisa, extensão e inovação. Objetivou-se analisar teses e dissertações publicadas em programas de pós-graduação *stricto sensu* sobre as práticas de higienização das mãos no Brasil. **Métodos:** estudo bibliométrico, realizado no Catálogo de Teses e Dissertações da Coordenação de

Aperfeiçoamento de Pessoal de Nível Superior, considerando o período de 2013 a 2022. **Resultados:** foram incluídos 31 (100%) estudos, sendo 21 (67,7%) dissertações e seis (19,3%) teses. A enfermagem foi a principal área de avaliação (65,6%) que analisou, principalmente, a adesão às práticas de higiene das mãos (29,0%), a educação em saúde (12,9%), e realizou análise microbiológica das mãos (12,9%). Apenas três publicações utilizaram bases teóricas como núcleo central da pesquisa. **Conclusão:** este estudo permitiu identificar a necessidade de estudar a temática em nível de doutorado, utilizando bases teóricas que fornecerão o alicerce conceitual e filosófico para a prática clínica.

Descritores: *Desinfecção das Mãos. Segurança do Paciente. Enfermagem. Educação em Saúde. Pessoal de Saúde.*

RESUMEN

Justificación y Objetivos: en relación a la higiene de manos, es importante resaltar la ausencia de investigaciones documentadas en la literatura científica que aborden el análisis de tesis y disertaciones relacionadas con esta práctica. Este vacío justifica la realización de este estudio, que tiene como objetivo fortalecer y ampliar la base de conocimientos relacionados con este tema, destacando su relevancia en las áreas de docencia, investigación, extensión e innovación. El objetivo fue analizar tesis y disertaciones publicadas en programas de posgrado estricto sensu sobre prácticas de higiene de manos en Brasil. **Métodos:** estudio bibliométrico realizado en el Catálogo de Tesis y Disertaciones de la Coordinación de Perfeccionamiento del Personal de Educación Superior, considerando el período de 2013 a 2022. **Resultados:** se incluyeron 31 (100%) estudios, 21 (67,7%) disertaciones y seis (19,3%) tesis. Enfermería fue la principal área de evaluación (65,6%), que analizó principalmente la adherencia a las prácticas de higiene de manos (29,0%), educación para la salud (12,9%) y realizó análisis microbiológicos de las manos (12,9%). Sólo tres publicaciones utilizaron bases teóricas como núcleo central de la investigación. **Conclusión:** este estudio identificó la necesidad de estudiar el tema a nivel de doctorado, utilizando marcos teóricos que proporcionarán la base conceptual y filosófica para la práctica clínica.

Palabras clave: *Desinfección de las Manos. Seguridad del Paciente. Enfermería. Educación en Salud. Personal de Salud.*

INTRODUCTION

Hand hygiene (HH) is a necessary measure for the prevention and control of healthcare-associated infections (HAIs). At different levels of health care, professionals, patients, companions and visitors become major players of safe care, which requires the correct HH technique to reduce cross-transmission of microorganisms.[1]

By analyzing research that focused on HH practices, whether using alcoholic preparation and/or liquid soap, it was possible to identify some common trends and approaches.[1-3] Its importance and need for awareness among those involved directly reflects the quality of care based on patient safety.[2] However, studies warn that failures and errors in the application of HH influence the effectiveness of the technique, promoting indicators of low adherence to the five moments recommended by the World Health Organization (WHO).[3]

Factors such as unavailability of inputs, inadequate physical structure, low commitment to patient safety culture, ineffective preparation of protocols and work overload have an influence on low adherence to HH.[4-5] Furthermore, it correlates with health professionals' ineffective knowledge, reinforcing the gaps in clinical practice in relation to health education promotion and risk perception.[6-7]

The information available in the literature on HH generally focuses on assessing health professionals' knowledge, attitude, and adherence, and the impact of educational and awareness interventions.[1,3-5-7] In another overview, it is worth highlighting that articles available in scientific journals may originate from theses and dissertations developed by *stricto sensu* graduate programs at master's and doctoral level.[8]

Researchers state that thinking about training and research in higher education institutions (HEIs) reflects the transformation of science and society, contributing to the resolution of a community problem.[8] In the context of HH, it is noteworthy that there are no published studies in the literature that analyze theses and dissertations on HH practices, justifying their elaboration to strengthen and expand production indicators on the subject and their relevance in teaching aspects, research, extension and innovation. It should be added that this preventive measure is an essential pillar in promoting safe clinical practices, contributing to the quality of care and the construction of a safer and more reliable environment. In this regard, the following guiding question for this research arises: how are HH practices studied and described in theses and dissertations in Brazil?

The objective, therefore, was to analyze theses and dissertations published in *stricto sensu* graduate programs on HH practices in Brazil.

METHODS

Design

This is a bibliometric, descriptive study, of a quantitative nature. This methodology involves assessing knowledge production in a given field of research. Through statistical analysis, bibliometrics promotes top-down review of works, checking publication patterns on a given subject to facilitate decision-making.[9]

Setting studied and Population

The setting for this research involved the Coordination for the Improvement of Higher Education Personnel (CAPES - *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*) Thesis and Dissertation Catalog, available at: https://catalogodeteses.capes.gov.br/catalogo-teses/.

Selection criteria

Theses and dissertations published in the major area of knowledge "health sciences" from 2013 to 2022 were included. The temporal delimitation was chosen because HH has been widely disseminated in Brazil, from 2013 onwards, as the fifth international goal for patient safety.[10] Research that was not available for consultation was excluded.

Data source

The methodological path was defined through a protocol drawn up by the researchers themselves to collect data and collect information. Recording and extracting information involved reading all studies in full. The data was fed into a spreadsheet created in Microsoft Excel 2021® using the following variables: type (academic, professional master's degree or thesis); year of publication; advisor); areas of knowledge, assessment and concentration; program name; name of the HEI; and keywords or descriptors. Furthermore, data were collected on the study design and nature, the place where the research was carried out, the subjects involved and theme specification.

Data collection

Data collection was carried out between the fourth and ninth of February 2023, through the CAPES Catalog of Theses and Dissertations with the following keywords "Hand Hygiene" and "Hand Disinfection". The insertion of other terms was avoided so as not to limit the searches, making the search more comprehensive. We chose to use quotation marks and the Boolean operator "OR". Initially, 155 studies available on the platform were identified, and after selecting the filters "Year (2013 to 2022)", "Major area of knowledge (Health Sciences)", in addition to reading the title and abstract carried out by two researchers, independently, 32 potential publications remained. A dissertation was excluded due to restricted access to the text, and a search was carried out on the Sucupira Platform and Google Scholar in an attempt to recover the document, but the publication was not found. Therefore, a final sample of 31 theses and dissertations was constituted.

Data analysis

Data were analyzed using descriptive statistics to present absolute and relative values using the IBM® Statistical Package for the Social Sciences (SPSS) version 21. The temporal distribution graph of theses and dissertations was prepared in Microsoft Excel 2021®.

Ethical aspects

As this was a bibliometric study that did not involve human beings, an opinion from the Research Ethics Committee (REC) was not necessary.

RESULTS

The majority of research was carried out at academic master's level (46.9%), professional master's degree (34.4%) and doctoral level (19.8%), with nursing as the main area of knowledge and assessment (65.6 %) (Table 1). A total of 24 (100%) areas of concentration were identified, highlighting health and nursing (9.7%), nursing in human health care (6.5%), health sciences (6.5%), nursing practice (6.5%) and nursing care processes (6.5%). There was a homogeneous distribution in relation to thesis and dissertation advisors.

Table 1. Description of theses and dissertations published by stricto sensu graduate programs. Juiz de Fora, MG, Brazil, 2023 (n=31).

Variables	n	%
Type		
Academic master's degree	15	46.9
Professional master's degree	11	34.4
Doctoral degree	06	18.8
Knowledge area		
Nursing	21	65.6
Public health	03	9.4
Medical clinic	03	9.4
Collective health	02	6.3
Surgery	01	3.1
Medicine	01	3.1
Infectious and parasitic diseases	01	3.1
Assessment area		
Nursing	21	65.6
Public health	05	15.6
Medicine I	04	12.5
Medicine II	01	3.1
Medicine III	01	3.1

In relation to temporal distribution, the year 2016 accounted for the largest number of dissertation publications. In the assessment of theses, 2013 stood out, while in 2014, 2016, 2017, 2021 and 2022, no studies were found (Figure 1).

In relation to the HEIs that carried out studies on HH practices, the *Pontifícia Universidade Católica de Goiás* (9.7%) and the *Universidade Estadual Paulista Júlio de Mesquita Filho* (9.7%) stood out. However, it is worth noting that the topic presented a low frequency among 15 institutions, with only one study, respectively, found between 2013 and 2022.

The highest frequency of descriptive (25.8%) and quasi-experimental (19.4%), quantitative studies (74.2%) was identified, which were carried out in health sectors (74.2%). The majority involved health professionals (71.0%) whose object of study included adherence to HH (29.0%), health education (12.9%) and microbiological
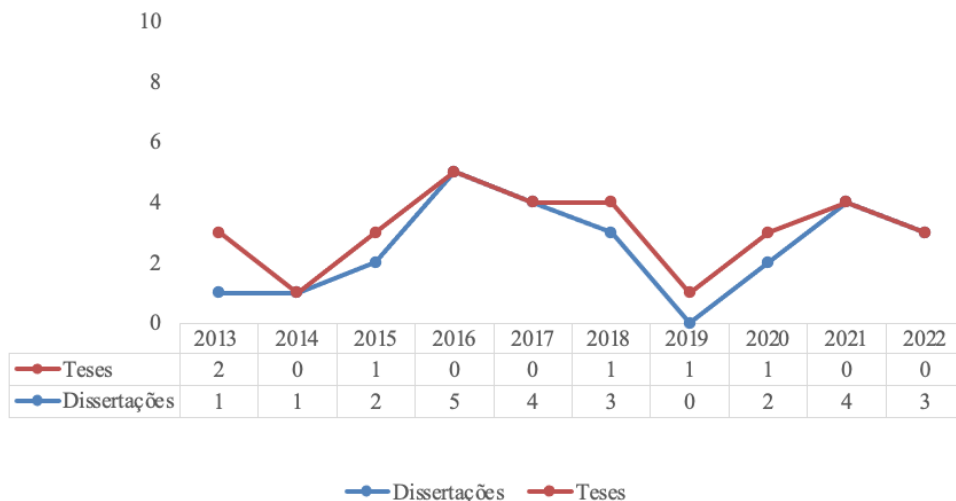
Figure 1. Temporal distribution of theses and dissertations included in this study between 2013 and 2022. Juiz de Fora, MG, Brazil, 2023 (n=31).

TRANSLATION = theses, dissertations

analysis of hands (12.9%) (Table 2). Only three studies used theoretical bases in theses and dissertations, namely, Social Representation Theory, Health Promotion Model and Grounded Theory.

Table 2. Description of design, nature, location, subject and theme of theses and dissertations published by *stricto sensu* graduate programs. Juiz de Fora, MG, Brazil, 2023.

Variables	n	%
Study design		
Descriptive	08	25.8
Quasi-experimental	06	19.4
Cross-sectional	04	12.9
Descriptive and analytical	04	12.9
Methodological	02	6.5
Intervention	02	6.5
Ecological	01	3.2
Prospective (longitudinal)	01	3.2
Systematic review	01	3.2
Case-control	01	3.2
Integrative review	01	3.2
Nature		
Quantitative	23	74.2
Qualitative	06	19.4
Not applicable	02	6.5
Local		
Care sectors (hospital)	23	74.2
Data base	02	6.5
Support sectors	01	3.2
Long-term care institution	01	3.2
Materials and sterilization center	01	3.2
Monitoring system	01	3.2
Emergency Medical Care Service	01	3.2
Urban households	01	3.2
Subjects involved		
Health professionals*	22	71.0
Health professionals and patients	02	6.5
Patients	02	6.5
Companion caregivers	02	6.5
Health professionals and students	01	3.2
Health and administrative professionals	01	3.2
Household residents	01	3,2
Theme specification		
Adhesion to hand hygiene	09	29.0
Health education	04	12.9
Microbiological analysis of hands	04	12.9
Multimodal strategy	03	9.7
Knowledge and attitude	02	6.5
Physical resources, materials and adhesion	02	6.5
Practices and narratives	01	3.2
Monitoring system for hand hygiene	01	3.2
Instrument validity	01	3.2
Academic and professional training	01	3.2
Nursing team's interactional experience	01	3.2
Alcoholic preparation consumption	01	3.2
Health care costs	01	3.2

Note: *Nurses, physiotherapists, doctors and nursing technicians.*

In the assessment of the descriptors and/or keywords identified in theses and dissertations, 112 (100%) compound terms were identified, highlighting those that were most repeated, such as HH (18.7%), patient safety (7.1%), health professionals or health personnel (5.4%), HAIs or nosocomial infection (5.4%) and infection control (3.6%).

DISCUSSION

It was observed that the production of studies on HH is carried out mainly at the master's degree, whether academic or professional, and, shortly thereafter, at the doctoral level.[11] It is worth mentioning that, in 2021, the master's degree concentrated the largest contingent of students enrolled within graduate programs, and the

health sciences course ranked third, among all areas of knowledge, with the highest number of enrollments.[11-12]

HH is an essential practice in the care context, but its implementation can be improved in several aspects, including health professionals' adherence, available infrastructure, education, cultural approach and the recognition that it is just one part of a set of infection prevention measures. One of the main criticisms of HH in the care context is the lack of consistency in adherence by health professionals. Although it is widely recognized as an essential measure to prevent the spread of infections, studies show that the HH adherence rate among health professionals is not always as high as it should be.[1-2,6-7]

In this study, another highlight refers to the large volume of productions carried out in the area of nursing knowledge and assessment. The areas of concentration were directly related to health care, inherent to the practice of caring for the profession. The data corroborated two other bibliometric reviews on patient safety in different hospital contexts, with the majority of researchers being nurses.[13,14]

Regarding the place of publication, when universities are assessed individually, the *Pontifícia Universidade Católica de Goiás* and the *Universidade Estadual Paulista Júlio de Mesquita Filho* stand out, with the largest number of publications on the topic. However, when assessing the region of Brazil where the universities are located, the largest volume of theses and dissertations was attributed to the southeast. Similar data was observed in another study that highlighted 66% of publications carried out in the same region,[14] which can be justified by the fact that it receives several investments from public and private authorities in the country, hosts a large part of public educational institutes as well as groups a large part of Brazilian hospitals.

The year 2016 accounted for the highest number of dissertation publications, with a subsequent decline. This fact can be attributed, according to researchers, to Derek de Solla Price's Law (Prince's Law), which assessed the general growth of scientific publications in a specific field of study.[15] In this case, the growth of a research topic goes through four phases: a period in which publications are carried out by precursors, in which a small number of scientists begin to publish in a new field; exponential growth, which promotes an increasing number of researchers attracted by the different aspects of the topic that still need to be investigated; a consolidation and stabilization of the scope of knowledge; and a decrease in the number of publications.[16]

It is worth adding that this study showed that the most used keywords and/or descriptors were "Hand Hygiene", "Patient Safety" and "Health Personnel". These results follow the temporal trajectory of the Brazilian National Patient Safety Program dissemination and implementation, starting in 2013, by the Ministry of Health, to meet the goals established by the WHO. Thus, the search for new studies was consolidated, seeking different methodological approaches.[17]

Regarding the methodological design used between the theses and dissertations, the descriptive and quasi-experimental approach stands out, whose target audience was health professionals and the main object of study was adherence to HH. The choice of method was justified by the objective defined by the researchers to describe processes and practices, classifying and interpreting them to facilitate the understanding of the realities encountered during the research.[18] In this context, it is worth adding that HH can be seen as a routine task that health professionals perform automatically, without really understanding the importance of the act. This can lead to complacency and inadequate execution of the technique. A more educational and oriented approach to understanding the principles behind HH could be more effective.

Most of the studies contributed to the achievement of an important objective of public higher education, which is to transfer knowledge between academia-professors/students-community and professionals.[19] With regard to health professionals, the impact of the activities developed by graduate programs and, subsequently, the translation of knowledge are measured by the occurrence of improvements in care practices.[20] It is inferred that professionals understand not only the importance of this measure, but also the correct techniques to carry it out. Lack of adequate training can compromise patient safety and quality of care.

Of the total number of theses and dissertations included in this research, only three used theoretical bases that are consolidated as a theoretical and philosophical foundation for the theme. The first was the Social Representation Theory, which aims to understand and explain how common knowledge is constructed as well as understand the practices associated with it. It contemplates the concepts that are linked to each other to form a social identity, guide conduct and give meaning to the reality experienced.[21] In this case, the applicability of this theory revolves around understanding what people know about HH, how they carry out this preventive measure or how they see the practice in their daily lives.

Another theory used was Nola Pender's Health Promotion Model, which can be understood as a method that assists in the implementation and assessment of actions associated with health promotion through the analysis of individuals' experiences, knowledge about a given subject and behaviors adopted to improve actions. Correlating with the present study, this theory aims to understand how people perform HH and how such behavior can be improved.[22]

The third and final theoretical basis found in the works is the Grounded Theory, which describes the possibility of generating explanations through understanding individuals' actions when faced with problems and situations experienced. It is possible to understand how people deal with problem situations arising from the HH process and what mechanisms are used to face them.[23]

This study presented some limitations that must be considered. The first concerns the non-inclusion of other keywords. Moreover, only the CAPES Thesis and Dissertation Catalog is used, justified because it is considered the official publication and dissemination vehicle for *stricto sensu* graduate programs in Brazil. To mitigate this aspect, the

researchers carried out repeated searches to obtain consensus regarding the number of studies included in this research.

In this context, it was possible to analyze theses and dissertations published *in stricto sensu* graduate programs on HH practices. There is a need to study the topic in the doctoral course, using theoretical bases to guide the construction of knowledge in the area of nursing. Most studies were descriptive and quasi-experimental, reinforcing the need for new research, with different methodological approaches and higher levels of evidence to strengthen the quality of scientific production. The importance of nursing is also highlighted with regard to scientific production on HH as well as patient safety. The profession remains at the forefront of care and needs to master various technologies, in addition to adding, at all times, new theoretical-practical knowledge to support its work process.

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

ORIGINAL ARTICLE

Recommendations on specific precautions for companions/ visitors of patients hospitalized: characteristics and barriers to implementation

Recomendações sobre precauções específicas para acompanhantes/visitantes de pacientes hospitalizados: características e barreiras para implementação

Recomendaciones sobre precauciones específicas para acompanhantes/visitantes de pacientes hospitalizados: características y barreras para su implementación

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ABSTRACT

Justification and Objectives: despite the importance of companions/visitors for hospitalized patients under specific precautions, it is noted that risks of exposure and dissemination of microorganisms in health services by this population are still incipient in the literature. Thus, the objective was to characterize the current recommendations on specific precautions for companions and visitors of hospitalized patients and to analyze the barriers to their implementation from infection preventionists' perspective. **Methods:** a descriptive and exploratory study with a quantitative approach, with 89 infection preventionists, between March and June 2020. Data collected by electronic questionnaire, "snowball" sampling and analyzed according to frequency of responses. **Results:** hand hygiene was the most recommended recommendation (>95.0%). As for non-conformities, staying in the room without attire (78.6%), going to other rooms (53.9%) and keeping doors open as aerosol precaution (51.7%) stood out. Regarding the strategies adopted to guide companions/visitors, there was a predominance of individual verbal guidance (92.4%). The main barrier cited was the lack of institutional policy (56.2%). **Conclusion:** there was no uniformity in the recommendations, and non-conformities and barriers were listed. The importance of specific prevention guidelines for this public and effective educational strategies for its implementation are highlighted.

Keywords: Hospital Infection Control Program. Patient Isolation. Patient Safety. Patient Companions. Infection Control. Infection Control Professionals.

RESUMO

Justificativa e Objetivos: apesar da importância dos acompanhantes/visitantes para pacientes hospitalizados em precauções específicas, nota-se que os riscos de exposição e disseminação de microrganismos nos serviços de saúde por essa população ainda são incipientes na literatura. Dessa forma, objetivou-se caracterizar as recomendações vigentes sobre precauções específicas para acompanhantes e visitantes de pacientes hospitalizados e analisar as barreiras para a sua implementação sob a ótica de prevencionistas de infecção. **Métodos:** estudo descritivo e exploratório, de abordagem quantitativa, com 89 prevencionistas de infecção, entre março e junho de 2020. Dados coletados por questionário eletrônico, com amostragem tipo "bola de neve" e analisados segundo frequência das respostas. **Resultados:** a higienização das mãos foi a recomendação mais indicada (>95,0%). Quanto às não conformidades, destacou-se permanecer no quarto sem paramentação (78,6%), frequentar outros quartos (53,9%) e manter portas abertas em precaução para aerossóis (51,7%). Referente às estratégias adotadas para a orientar os acompanhantes/visitantes, houve predomínio da orientação verbal individual (92,4%). A principal barreira citada foi a falta de política institucional (56,2%). **Conclusão:** não houve uniformidade nas recomendações, e não conformidades e barreiras foram elencadas. Destaca-se a importância de diretrizes de prevenção específicas para esse público e estratégias educativas efetivas para sua implementação.

Descritores: Programa de Controle de Infecção Hospitalar. Isolamento de Pacientes. Segurança do Paciente. Acompanhantes de Pacientes. Controle de Infecções. Profissionais Controladores de Infecções.

RESUMEN

Justificación y Objetivos: a pesar de la importancia de los acompañantes/visitantes para pacientes hospitalizados bajo precauciones específicas, se advierte que los riesgos de exposición y diseminación de microorganismos en los servicios de salud por parte de esta población son aún incipientes en la literatura. Así, el objetivo fue caracterizar las recomendaciones vigentes sobre precauciones específicas para acompañantes y visitantes de pacientes hospitalizados y analizar las barreras para su implementación desde la perspectiva de los preventivos de infecciones. **Métodos:** estudio descriptivo y exploratorio con enfoque cuantitativo, con 89 prevencionistas de infecciones, entre marzo y junio de 2020. Datos recolectados por cuestionario electrónico, muestreo "bola de nieve" y analizados según frecuencia de respuestas. **Resultados:** la higiene de manos fue la recomendación más recomendada (>95,0%). En cuanto a las no conformidades, se destacó permanecer en la habitación sin atuendo (78,6%), ir a otras habitaciones (53,9%) y mantener las puertas abiertas como precaución contra los aerosoles (51,7%). En cuanto a las estrategias adoptadas para orientar a los acompañantes/visitantes, hubo predominio de la orientación verbal individual (92,4%). La principal barrera citada fue la falta de política institucional (56,2%). **Conclusión:** no hubo uniformidad en las recomendaciones, y se enumeraron las no conformidades y las barreras. Se destaca la importancia de pautas de prevención específicas para este público y estrategias educativas efectivas para su implementación.

Palabras clave: Programa de Control de Infecciones Hospitalarias. Aislamiento de Pacientes. Seguridad del Paciente. Compañeros de Pacientes. Control de Infecciones. Profesionales del Control de Infecciones.

INTRODUCTION

Hospitalizations of patients under specific precautions (SP) for contact, droplets or aerosols have increased significantly in recent years, with emphasis on: the growing number of patients colonized by resistant microorganisms (RM); the resurgence of already controlled diseases, such as measles; and more recently the coronavirus (COVID-19) pandemic.[1-2] Causes such as the increase in rates of healthcare-associated infections (HAIs) and the fact that these rates are 20 times higher in developing countries, when compared to those in developed countries[3], reflect the seriousness of the issue and the need to understand the impacts generated for public health.

Patients hospitalized in SP, normally restricted to their rooms, may feel vulnerable and develop feelings involving fear of worsening their health condition as well as judging themselves a threat to the community as they consider that their condition is transmissible and requires special care.[4-5] In view of this, the inclusion of a companion or permission for visits could positively impact emotional well-being, safety and the quality of care provided, in addition to making hospitalization more humane.[4-7] On the other hand, one cannot forget the risk of transmission inherent to patients' pathology and, consequently, the need for companions and visitors (CV) to also comply with HAI prevention and control standards established by health services.[5,8]

Although emotional support is responsible for most of CV involvement during hospitalization, assisting patients in activities such as bathing, feeding, hygiene and positioning, i.e., activities associated with hand contamination, is common practice and does not differ from activities carried out by health professionals during patient care. Considering the aforementioned activities and the time that companions remain with patients, it is theorized that these people can acquire and contribute

to the dissemination of microorganisms, if they do not follow guidelines for HAI prevention and control.[9-10]

Previous studies indicate that difficulties related to the systematization of guidelines on measures to prevent the transmission of microorganisms, not valuing the reason for its use as well as difficulties in implementing and using scientific language, hinder the understanding and compliance of CV with SP, which can increase the risk of self-contamination, contamination of the environment and other patients.[6,8-11]

HAI are one of the main indicators of quality of care during hospitalization. Thus, involving patients, family members, visitors and health professionals is fundamental for its effective control. Accrediting agencies, such as the Joint Commission International, mention that health services should educate and encourage patients and their families to follow the recommendations for HAI prevention and control. Likewise, the Centers for Disease Control and Prevention (CDC) precautions and isolation guide mentions that patients and family members should be instructed on standard precautions at the time of admission, and additional information on SP to be provided once SP is instituted.[7] The Brazilian National Health Regulatory Agency (ANVISA - *Agência Nacional de Vigilância Sanitária*) recommends that the Brazilian National Program for Healthcare-Associated Infection Prevention and Control (PNCPIRAS - *Programa Nacional de Prevenção e Controle de Infecções Relacionadas à Assistência à Saúde*) should provide minimum protection and safety to patients, health professionals and visitors.[12]

Despite the magnitude of the topic, the emotional support provided by CV for patients in SP and the risks of exposure and dissemination of microorganisms in health services, the literature on this topic is limited. Thus, this study aims to characterize the current recommendations on SP for CV in hospitalized patients and analyze the barriers to their implementation from infection preventionists' perspective.

METHODS

This is a descriptive and exploratory study with a quantitative approach. The study followed the aspects listed in STrengthening the Reporting of OBservational studies in Epidemiology (STROBE).[13] Data collection was carried out between March and June 2020, online, with professionals from the Healthcare Infection Control Practices Advisory Committee (HICPAC) from Brazilian hospitals.

It was adopted as an inclusion criterion to be a health professional (physician, nurse, pharmacist, other) and perform their duties in HICPAC in a Brazilian hospital institution. Participants were recruited through snowball non-probabilistic sampling. First, the São Paulo Association of Epidemiology and Control of Healthcare--Associated Infection (APECIH - *Associação Paulista de Epidemiologia e Controle de Infecção Relacionada à Assistência à Saúde*) was contacted, which released the study to its members. Each associate received an invitation by email containing the link to access the Informed Consent

Form (ICF), a self-administered questionnaire, in addition to instructions to forward the invitation to a co-worker, who is also an infection preventionist.

The research instrument consisted of a self-administered questionnaire, developed by researchers, which used as a basis the measures for precautions and isolation recommended by the current literature.[14-15] The questionnaire, with 15 closed-ended and multiple-choice questions, was made available on Google Forms®, organized into three parts (demographic data - with nine questions; recommendations on precautions and isolation in force at the institution - with four questions; conduct of CV of patients in SP and barriers to its implementation – with 2 questions). All questions allowed indicating more than one answer option.

The data obtained were analyzed using descriptive statistics, establishing absolute and relative frequencies for the studied variables. The results were presented in the form of tables.

The study was approved by the Research Ethics Committee of the study institution, Certificate of Presentation for Ethical Consideration (CAAE - *Certificado de Apresentação para Apreciação Ética*) 25450819.0.0000.5504, Opinion 3,750,360, and respected all the ethical precepts of Resolutions 466/2012, 510/2016 and 580/2018 of the Ministry of Health.

RESULTS

Initially, 92 professionals responded to the instrument, however three participants were discarded, as they only worked in higher education institutions, not meeting the inclusion criteria. Therefore, the final sample consisted of 89 participants, of which 13 worked in two (n=10) or three (n=03) different HICPAC.

Of the 89 participants, 67 (75.3%) were nurses, 21 (23.6%) physicians, and 01 (1.1%) nursing technicians, of which 08 (9.0%) had less than 01 year of experience in the area of infection control, 26 (29.2%), from 01 to 03 years, and 55 (61.8%), more than 03 years.

As for the type of institution, most participants reported working at a private hospital (43.8%), followed by public (35.2%), philanthropic (14.3%) and university (6.7%), located in the Southeast region (77.5%), followed by the Midwest (9.0%), Northeast (7.9%), South (4.5%) and North (1.2%).

With regard to the recommendations made to CV on prevention measures by type of SP, it was observed that 71 (79.8%) participants stated that they advocated wearing an N95 mask for the CV of patients under aerosol precaution (AP); 78 (74.3%) stated that they advocated wearing surgical masks for CV of patients in droplet precaution (DP); and 50 (56.2%) stated that they recommend wearing gloves for CV in patients undergoing contact precautions (CP). The recommendation on wearing gloves was referred by 29 (32.5%) participants for CV of patients in PD precaution and 68 (64.4%) for CV of patients in AP. Guidance on hand hygiene (HH) was greater than 95% in all types of specific precautions (Table 1).

Table 1. Recommendations established for companions and visitors of patients hospitalized under specific precautions, according to the type of precaution, from the perspective of infection preventionists participating in the study (n=89) Brazil, 2020.

Recomendations	Contact precaution *total (%)	Droplet precaution total (%)	Aerosol precaution total (%)
Perform hand hygiene	88 (98.9)	87 (97.6)	85 (95.5)
Do not enter other patients' rooms	76 (85.4)	69 (77.5)	68 (69.4)
Do not leave the room dressed	62 (69.7)	54 (60.1)	55 (61.8)
Keep the bedroom door closed	39 (43.8)	77 (86.5)	80 (89.9)
Wear gloves	50 (56.2)	29 (32.6)	32 (35.9)
Wear disposable apron/cloak	52 (58.4)	19 (21.4)	21 (23.6)
Wear surgical mask	8 (9.0)	78 (74.3)	15 (18.8)
Wear N95 mask	3 (3.4)	2 (2.3)	71 (79.8)
Do not touch the environment	18 (20.2)	12 (13.5)	12 (13.5)
Do not provide for companions	7 (7.9)	11 (12.4)	16 (18.0)
Do not allow visits	5 (5.6)	11 (12.4)	18 (20.2)
Wear goggles	11 (12.4)	19 (21.4)	18 (20.2)
Wear a fabric apron/cloak	15 (16.8)	8 (9.0)	7 (7.9)
Do not touch patient	14 (15.7)	9 (10.1)	10 (11.2)
Have restricted visits	1 (1.1)	5 (5.6)	3 (3.4)
Allow companion without attire	0 (0)	0 (0.0)	0 (0.0)
There are no recommendations	1 (1.1)	0 (0.9)	1 (1.1)

*Note: *corresponds to the number of times the recommendation was indicated according to the type of precaution, and its sum exceeds 100%, as these are non-excluding items.*

When questioned about which professional was responsible for guiding CV regarding such recommendations, the inpatient unit nurses (76; 85.1%) and the executing members of HICPAC (43; 48.6%) were the main professionals mentioned.

Regarding the strategies adopted to guide CV, there was a predominance of individual verbal guidance (82; 92.4%), followed by conversation circles and lectures (21; 23.8%), availability of printed material (13; 14, 3%) and use of electronic media (12; 13.3%). It is reinforced that the participants could indicate more than one type of strategy, if this occurred in their work institution.

Despite the current recommendations, the study participants reported inappropriate conduct performed by CV (Table 2).

Table 2. Conduct of companions and visitors of hospitalized patients under specific precautions from the perspective of infection preventionists participating in the study (n=89) Brazil, 2020.

Inadequate conducts	*Total (%)
Companions and visitors remain without personal protective equipment inside the room	70 (78.6)
Companions and visitors attend more than one room (of different patients)	48 (53.9)
Companions and visitors leave room doors open with aerosol precaution/isolation	46 (51.7)
Companions and visitors leave the room wearing gloves	46 (51.7)
Companions and visitors leave the room using an apron/cloak	43 (48.3)
Companions and visitors circulate outside the room with a child under specific precautions	30 (33.8)
They do not perform hand hygiene	5 (5.6)
Companions meet outside the room for social contact	2 (2.5)

*Note: *corresponds to the number of times the recommendation was indicated, and its sum exceeds 100%, as these are non-excluding items.*

According to the study participants, such behaviors result from a lack of guidance for CV, structure and even the absence of recommendations (Table 3).

Table 3. Barriers to the implementation of infection prevention recommendations for companions and visitors of hospitalized patients under specific precautions from the perspective of infection preventionists participating in the study (n=89), Brazil, 2020.

Barriers to implementation	*Total (%)
Lack of institutional policy for companions and visitors	50 (56.2)
Companions and visitors are unaware of specific precautions/isolation	46 (51.7)
Inadequate structure	30 (33.7)
Health professionals' lack of knowledge about specific precautions/isolation	22 (24.7)
Absence of institutional policies	18 (20.2)
Difficulty communicating between health professionals and companions and visitors about specific precautions/isolation	17 (19.1)
Banalization of guidelines	10 (11.2)
Unavailability of personal protective equipment	7 (7.9)

*Note: *corresponds to the number of times the recommendation was indicated, and its sum exceeds 100%, as these are non-excluding items.*

DISCUSSION

This study aimed to characterize the current recommendations on SP for CV in hospitalized patients and to analyze the barriers to their implementation from infection preventionists' perception.

Among the main results achieved, HH was the most indicated recommendation (>95.0%). As for non-confor-

mities, staying in the room without attire (78.6%), going to other rooms (53.9%) and keeping doors open as AP (51.7%) stood out. Regarding the strategies adopted to guide companions/visitors, there was a predominance of individual verbal guidance (92.4%). The main barrier cited was the lack of institutional policy (56.2%).

In the present research, the profile of participants was similar to that of previous studies, that is, HICPAC are predominantly composed of nurses and physicians with more than three years of experience in the area.[16-17]

Among the recommendations for CV of patients hospitalized in SP, HH was the most frequent and equally mentioned in all types of precautions. Although it is recognized as the most economical and efficient strategy to prevent the transmission of microorganisms in health services,[12,14] CV HH is often neglected in health services and little addressed in the literature.[18] A descriptive study carried out with CV in pediatric hospitals and maternity hospitals in Canada found that the rate compliance with HH of CV was 10.3% and that less than half claimed to have received guidance on this topic during hospitalization.[18]

As for the recommendations on using personal protective equipment (PPE) by CV, there were important differences in the responses of study participants, particularly regarding wearing gloves for AP and DP and a mask for CP. Likewise, a literature review conducted during the COVID-19 pandemic showed that recommendations on wearing aprons, gloves, surgical masks and N95 respirators varied between studies[19]. According to the CDC Recommendations Guide, recommendations on using PPE should be determined by the level of interaction between patients and CV.[14] ANVISA and The Society for Healthcare Epidemiology of America (SHEA) recommend that, in non-endemic situations, CV follow the same recommendations for using PPE established for health professionals.[20-21] The divergences found reflect the fragility of the subject so that the adoption of isolation measures still divides HICPAC's opinion about contradictions between guaranteeing a safe protocol and providing, at the same time, a humanized care to patients assisted.[5]

With regard to restricting or not allowing CV for patients on SP, about 20% of participants reported that this recommendation was foreseen in their institutions, which may imply negative aspects for the recovery of patients.[4-5,22] During the COVID-19 pandemic, visits were restricted due to the high risk of virus transmission, which may have influenced the responses of participants in our study. However, a Canadian study pointed out that little evidence supports that visitors play an important role in intra-hospital transmission of the virus that causes COVID-19. For instance, in China, 2% of visitors reported in-hospital acquisition of COVID-19, while in the United States, only one case was considered to have been acquired from a pre-symptomatic visitor.[23]

Regarding health education, nurses from inpatient units were cited as responsible for guiding VC, which was also found in an observational study, which revealed that nurses were fundamental in educating visitors

about effective PPE use.[24] Among the strategies used for education, our results are consistent with other studies, which point out that booklets with simple and easy-to--understand language, group meetings and even recreational activities proved to be efficient for CV, encouraging awareness and exchange of information between them and health professionals.[5,25,26]

The present study identified practices of inappropriate conducts of CV of patients in SP, such as not using PPE in patients' room, leaving the room wearing PPE, and this is consistent with a previous study.[18] It is known that, when used correctly, PPE works as a physical barrier to the transmission of microorganisms. However, its inappropriate use can expose both CV to the microorganism and can also cause cross-transmission to other patients and the community.[10,12,17] Additionally, it is worth noting that the behavior of health professionals in using or not using PPE influences CV's compliance with this practice.[6] Thus, it is suggested to guide health professionals about the importance that their behavior has in CV as well as guide CV on PPE use, emphasizing that using such equipment protects both patients and themselves. Such an approach can motivate them to comply with the recommendations.

CV's lack of knowledge about SP, lack of guidance, inadequate infrastructure and lack of institutional policy were identified as barriers to implementation. When we consider that the choice of companions is made according to the family's preference or need, not necessarily having personal skills or previous experiences in health care,[25] the principles of using SP are not always clear. A study carried out in the interior of São Paulo showed that patients in SP considered that SP measures were aimed only at reducing the risk of acquiring new diseases,[4] which reinforces the need for regular and structured guidance for this public. For this, it is suggested to include the guidelines as part of care planning.

Research indicates that institutional support is essential for the implementation of HAI prevention measures.[12-14] With regard to infrastructure, the unavailability of rooms prepared specifically for patients in SP and the poor location of washbasins or soap and antiseptic dispensers for HH are pointed out in the literature as important factors that hinder the process of compliance with HAI prevention measures.[12,27] Moreover, the unfavorable institutional climate, insufficient commitment from leadership and individuals, and lack of understanding of concepts were the main barriers encountered in implementing an effective communication protocol with patients in SP in a Brazilian teaching hospital.[11]

As limitations of this study, it can be pointed out the impossibility of identifying the number of HICPAC represented by respondents, since more than one professional from the same institution could answer the instrument; the data collection period coincided with the outbreak of the SARS-CoV-2 pandemic in Brazil, which may have generated a smaller number of responses, due to the high workload of professionals involved.

Despite such limitations, this study provides important elements, contributing to health services reviewing

their care practices, developing institutional policies based on scientific evidence to guide the CV of patients in SP, in a coherently and standardized manner, and assessing CV's compliance with recommendations. The present study exposes the topic's relevance and the need for future studies to seek a balance between reducing the risk of transmission of microorganisms and the positive impact of CV on the recovery of patients hospitalized in SP.

It is concluded that, among the participants, there is no uniformity in the recommendations for CV of patients in SP. Among the recommendations, HH was the most frequent measure and was also mentioned in all types of precautions. The recommendation on wearing surgical mask and N95 was not adequate for CV of patients in DP and AP as well as wearing gloves for these types of SP.

With regard to the main inappropriate behaviors presented by CV, it is worth mentioning staying in the room without PPE, going to different patients' rooms and leaving the doors of rooms of patients in AP open. As barriers to implementation, infection preventionists mentioned the lack of institutional policies and the CV's lack of knowledge about SP and transmission of microorganisms.

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Jeanine Geraldin Estequi: conception and design or data analysis and interpretation; article writing or relevant critical review of intellectual content; final approval of the version to be published; being responsible for all aspects of the work in ensuring the accuracy and completeness of any part of the work.

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ORIGINAL ARTICLE

Clinical and sociodemographic aspects of cases of severe acute respiratory syndrome in southern Brazil

Aspectos clínicos e sociodemográficos dos casos de Síndrome Respiratória Aguda Grave no sul do Brasil

Aspectos clínicos y sociodemográficos de casos de Síndrome Respiratorio Agudo Severo en el sur de Brasil

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ABSTRACT

Background and objectives: to compare the clinical and sociodemographic aspects of individuals with SARS reported in the countryside of Rio Grande do Sul in 2020 and 2021. **Methods:** a cross-sectional study, from March 2020 to October 2021. Clinical and sociodemographic variables of individuals with SARS symptoms were analyzed, compared through descriptive, univariate analyses, according to the year of reporting. **Results:** a total of 4,710 cases of SARS were reported; 53.4% were SARS related to COVID-19 in 2020 and 87.5% in 2021 (p<0.001). Comparing 2020 and 2021, the sociodemographic profile changed in terms of age group, skin color and education (p<0.001). Regarding clinical aspects, there was a reduction in prevalence of pre-existing health conditions, except obesity, changes in reported signs and symptoms and reduction in hospital and Intensive Care Unit admissions. **Conclusion:** the changes in the profile may reflect the effect of the different variants and the start of immunization for SARS-CoV-2.

Keywords: Severe Acute Respiratory Syndrome. COVID-19. Epidemiology.

RESUMO

Justificativa e objetivos: comparar, entre os anos de 2020 e 2021, os aspectos clínicos e sociodemográficos dos indivíduos com Síndrome Respiratória Aguda Grave (SRAG) notificados em uma região de saúde do interior do Rio Grande do Sul. **Métodos:** estudo transversal descritivo, realizado de março de 2020 a outubro de 2021. Foram analisadas variáveis clínicas e sociodemográficas de indivíduos com sintomas de SRAG, comparadas através de análises descritivas, univariadas, conforme o ano de notificação. **Resultados:** foram notificados 4.710 casos com SRAG; 53,4% foram SRAG relacionados à COVID-19 em 2020 e, 87,5%, em 2021 (p<0,001). Comparando os anos 2020 e 2021, o perfil sociodemográfico modificou quanto faixa etária, cor da pele e escolaridade (p<0,001). Quanto aos aspectos

clínicos, houve redução da prevalência de condições de saúde preexistente, exceto obesidade, alterações nos sinais e sintomas relatados e diminuição de internações hospitalares e na Unidade de Terapia Intensiva. **Conclusão:** as mudanças no perfil podem refletir o efeito das diferentes variantes e o início da imunização para SARS-CoV-2.

Descritores: Síndrome Respiratória Aguda Grave. COVID-19. Epidemiologia.

RESUMEN

Justificación y objetivos: comparar los aspectos clínicos y sociodemográficos de individuos con SARS notificados en el interior de Rio Grande do Sul en los años 2020 y 2021. **Métodos:** estudio descriptivo transversal, realizado de marzo de 2020 a octubre de 2021. Se analizaron variables clínicas y sociodemográficas de individuos con síntomas de SARS, comparadas mediante análisis descriptivos univariados, según el año de notificación. **Resultados:** se notificaron 4.710 casos de SARS; el 53,4% fueron SARS relacionados con COVID-19 en 2020 y el 87,5% en 2021 (p<0,001). Comparando los años 2020 y 2021, el perfil sociodemográfico cambió en cuanto a grupo de edad, color de piel y escolaridad (p<0,001). En cuanto a los aspectos clínicos, hubo reducción en la prevalencia de condiciones de salud preexistentes, excepto obesidad, cambios en los signos y síntomas reportados y reducción en los ingresos hospitalarios y en la Unidad de Cuidados Intensivos. **Conclusión:** los cambios en el perfil pueden reflejar el efecto de las diferentes variantes y el inicio de la inmunización para el SARS-CoV-2.

Descriptores: Síndrome Respiratorio Agudo Severo. COVID-19. Epidemiología.

INTRODUCTION

Severe acute respiratory syndromes (SARS) can be defined by the presence of fever, cough or sore throat, and dyspnea or O_2 saturation <95%, with hospital admission or death regardless of hospital admission. SARS must be compulsorily reported in the Influenza Epidemiological Surveillance Information System (SIVEP-Gripe - *Sistema de Informação de Vigilância Epidemiológica da Gripe*) or Disease and Reporting Information System (SINAN - *Sistema de Informação de Agravos e Notificações*), databases used for this purpose since the H1N1 influenza pandemic in 2009,[1,2] while the e-SUS Notifica system receives reports of suspected and confirmed COVID-19 flu syndrome in Brazil. Regarding etiology, several infectious agents can cause SARS, and between 2010 and 2019, influenza A, influenza B and respiratory syncytial virus were the most reported.[2]

Since March 2020, there has been an increase in the number of deaths from SARS in Brazil compared to previous years, with 70% resulting from infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a virus responsible for COVID-19 and 28% were of undefined etiology. However, based on clinical criteria, it was observed that about half of undefined SARS cases could be considered suspicious for COVID-19, therefore increasing the rate of deaths from SARS resulting from infection with the new coronavirus.[3]

In Brazil, in 2020, 7.7 million confirmed cases of COVID-19 were recorded, resulting in 196,000 deaths related to the disease. The following year, in 2021, there was a significant increase, with 21.9 million cases and 541,000 deaths reported. In 2022, there was a downward trend, although the numbers are still considerable, with 8.3 million cases and 158,000 deaths recorded. In the year 2023, a progressive improvement was observed, with 1.9 million cases and 33,000 deaths. It is important to highlight that, during these years, Brazil implemented an extensive vaccination campaign against COVID-19, administering millions of doses to its population. Vaccination played a crucial role in reducing the severity of the disease, preventing serious cases and deaths, and contributed to the effective control of the pandemic. Among the 342,636 deaths reported from SARS due to COVID-19 in 2021 up to the 36th Epidemiological Week, 59.5% had at least one pre-existing health condition, with heart disease, cerebrovascular disease, hypertension and Diabetes *Mellitus* being the most reported.[4] Furthermore, respiratory symptoms of COVID-19 are extremely heterogeneous, ranging from mild symptoms to significant hypoxia with SARS.[5]

Since the pandemic started, more than 518 million confirmed cases of COVID-19 have been reported worldwide.[6] The SARS-CoV-2 variants of concern (VoCs) such as Alpha (UK), Beta (South Africa), Gamma (Brazil), Delta (India) and Omicron (South Africa) are associated with high transmissibility, virulence and reduced efficiency of public health and social measures[7] as well as the diversity of common symptoms in people infected by different variants. The emergence of more transmissible VoCs and the resulting waves of infection and reinfection renew the need for new studies every day to discuss the characteristics of infected people and the maintenance of strategies to control COVID-19 transmission in the community.

Considering the above, the present study seeks to compare, between 2020 and 2021, the clinical and sociodemographic aspects of individuals with SARS reported in a health region in the interior of Rio Grande do Sul and, thus, analyze the clinical and sociodemographic profile between 2020 and 2021 to help understand SARS.

METHODS

Outline

This is a population-based descriptive cross-sec-

tional study, using sociodemographic and clinical data extracted from SIVEP-Gripe, hospital admissions and deaths from SARS regardless of hospital admission, in which analysis was carried out in municipalities belonging to the 28th Health Region of Rio Grande do Sul, Brazil.

The 28th Health Region is made up of 13 municipalities (Candelária, Gramado Xavier, Herveiras, Mato Leitão, Pantano Grande, Passo do Sobrado, Rio Pardo, Santa Cruz do Sul, Sinimbu, Vale Verde, Vale do Sol, Venâncio Aires and Vera Cruz) (Figure 1), and has an estimated population of 354.888 inhabitants in 2021, according to data from the Brazilian Institute of Geography and Statistics (IBGE - *Instituto Brasileiro de Geografia e Estatística*).
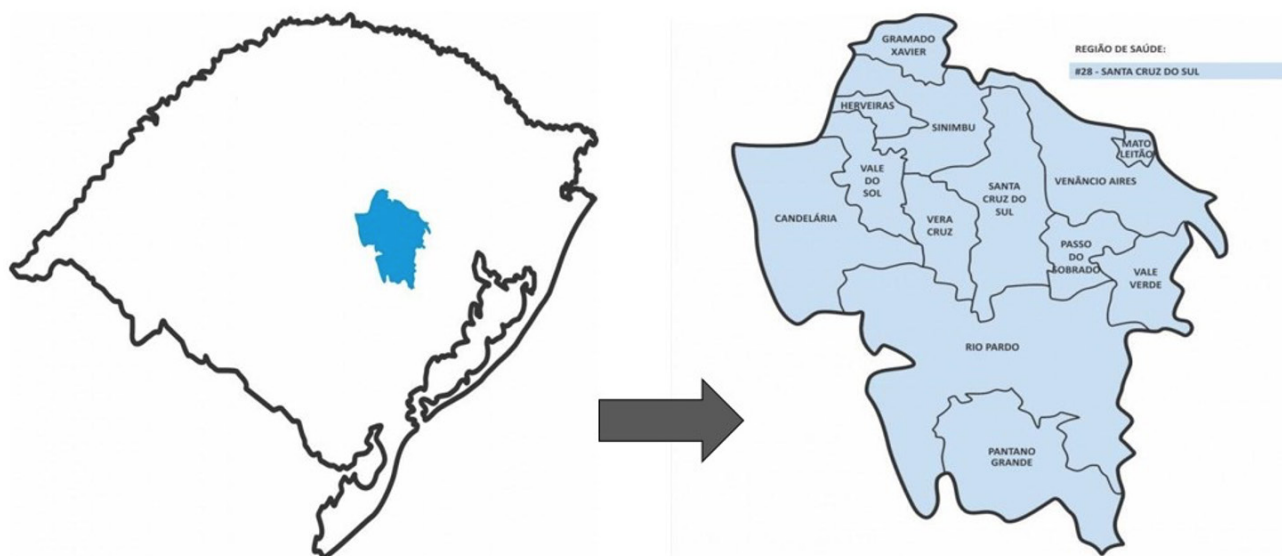

Figure 1. Map of municipalities in the 28th Health Region (State Department of Rio Grande do Sul, 2016).

Data source

Data were extracted from SIVEP-Gripe, whose update brings together all reports from health facilities in the country regarding hospital admissions due to SARS and deaths due to SARS regardless of hospital admission. SIVEP-Gripe data were obtained from the 28th Health Region Epidemiological Surveillance with reports from March 1, 2020 to October 31, 2021. Analyzes were carried out by grouping the cases by year of report (2020 and 2021).

Variables

Sociodemographic variables were extracted from the SIVEP-Gripe database: sex (female, male); age group (years: up to 19, 20 to 49, 50 to 89, 90 or older); self-reported race/skin color (white, black, yellow, brown, indigenous, unknown); self-reported education (illiterate, complete or incomplete elementary school, complete or incomplete high school, complete or incomplete higher education, unknown); residential area (urban, rural, peri-urban). Regarding clinical variables, they were included in the analysis of signs and symptoms (fever, cough, sore throat, dyspnea, respiratory distress, O_2 saturation <95%, diarrhea, vomiting, abdominal pain, fatigue, loss of smell, loss of taste, others); presence of pre-existing health conditions (postpartum woman, cardiovascular disease, chronic hematological disease, lung disease, Down's syndrome, chronic liver disease, asthma, Diabetes *Mellitus*, chronic neurological disease, immunosuppression, chronic kidney disease, obesity; use of ventilatory support devices (invasive, non-invasive); duration of symptoms (time between symptom onset and report); length of hospital stay; length of stay in the Intensive Care Unit (ICU); final classification of the case (SARI due to COVID-19, SARS due to another virus or etiological agent, SARS not specified – ruled out SARS due to SARS-CoV-2); and analysis of outcome (cure, death or death from other causes).

SIVEP-Gripe spreadsheets in Excel® format were analyzed for data consistency, excluding duplicates and inconsistent data.

Statistical methods

For statistical analysis, the Statistical Package for the Social Sciences (SPSS) version 22.0 was used. Descriptive analyzes constituted the calculation of the simple and relative frequencies of studied variables. Categorical variables were reported as absolute numbers and percentages. Continuous variables were described using mean and standard deviation, or median and interquartile range (IQR) according to normal distribution. Bivariate analysis was performed using the chi-square test for heterogeneity of proportions for dichotomous or nominal variables and linear trend for ordinal variables. Statistical significance was represented by a p-value<0.05.

Ethical aspects

The present study was carried out with secondary data and complied with the ethical recommendations of the Brazilian National Health Council (CNS – *Conselho Nacional de Saúde*) Resolution 466 of December 12, 2012. It was approved by the Institutional Review Board (IRB) of the *Universidade de Santa Cruz do Sul* on April 6, 2021, Certificate of Presentation for Ethical Consideration (CA-AE - *Certificado de Apresentação para Apreciação Ética*) 43906021.0.0000.5343, under Consubstantiated Opinion 4.633.404, and by the IRB of the State Department of Health of Rio Grande do Sul on November 24, 2021, with CAAE 43906021.0.3001.5312, under Opinion 5.124.723.

RESULTS

A total of 4,710 people with SARS symptoms were reported during the study period, 1,313 in 2020 and 3,397 in 2021. In 2020, 701 (53.4%) had SARS due to COVID-19; 604 (46.0%) patients had unspecified SARS; and 4 (0.3%) patients had SARS due to another virus or etiological agent (leptospirosis and dengue). In 2021, there were 2,971 (87.5%) reports of SARS cases due to COVID-19; 404 (11.9%) patients had unspecified SARS; and 5 (0.1%) had SARS caused by another virus or etiological agent (unspecified). Among the reported cases, 2,515 were male (53.4%) and 3,101 (65.8%) were in the age group of 50-89 years. White race/color was predominant (86.9%). Regarding education, 1,574 (57.4%) had elementary school and 3,441 (73.1%) lived in urban areas (Table 1).

When comparing cases of infections with SARS symptoms in 2020 and 2021, it was possible to observe that, in both periods, the most affected age group was 50-89 years (69.1% vs 64.6% $p<0.001$), with an increase in prevalence in the age group 20-49 in 2021 (22.7% vs 29.8, $p <0.001$), self-declared white skin color (88.7% vs 86.3%, $p <0.001$), and the majority of patients (33.4%), regardless of the year, had elementary school ($p<0.001$). There was no statistically significant difference between gender and area of residence (Table 1).

Table 1. Distribution of cases of respiratory infection with severe acute respiratory syndrome symptoms by sociodemographic characteristics in 2020 and 2021 in the 28th Health Region of Rio Grande do Sul until October 31, 2021.

Variables	2020 n (%)	2021 n (%)	Total n (%)	p-value
	N=1313 (27.9)	N=3397 (72.1)	4710 (100)	
Sex				0.430
Female	624 (47.5)	1571 (46.2)	2195 (46.6)	
Male	689 (52.5)	1826 (53.8)	2515 (53.4)	
Age group (years)				<0.001
≤19 years	61 (4.6)	140 (4.1)	201 (4.3)	
20-49	299 (22.7)	1012 (29.8)	1311 (27.9)	
50-89	907 (69.1)	2194 (64.6)	3101 (65.8)	
≥90	46 (3.6)	51 (1.5)	97 (2.0)	
Race/color				<0.001
White	1165 (88.7)	2930 (86.3)	4095 (86.9)	
Black	53 (4.0)	152 (4.5)	205 (4.4)	
Yellow	3 (0.2)	12 (0.4)	15 (0.3)	
Brown	61 (4.3)	112 (3.3)	173 (3.7)	
Education				<0.001
Illiterate	39 (5.3)	77 (3.8)	116 (4.2)	
Elementary school	444 (60.4)	1130 (56.1)	1574 (57.3)	
High school	140 (19.0)	559 (27.8)	699 (25.4)	
Higher education	112 (15.2)	247 (12.3)	359 (13.0)	
Residential area				0.234
Urban	942 (77.0)	2499 (77.7)	3441 (73.1)	
Rural	271 (22.1)	694 (21.6)	965 (20.5)	
Peri-urban	10 (0.8)	21 (0.6)	31 (0.7)	

n: absolute frequency, %: relative frequency, p-value: Pearson's chi-square test.

Table 2 presents pre-existing health conditions in the general study population. In 2020 and 2021, the most common pre-existing health condition was cardiovascular disease (37.2% vs 25.0%), being significantly higher in 2020 ($p<0.001$), followed by Diabetes *Mellitus* (20.6% vs. 19.3%), significantly higher in 2020 ($p<0.001$). Lung diseases were the third most cited preexisting health condition (13.8%) in 2020, being significantly higher than in 2021 ($p<0.001$). Finally, obesity was the third most cited preexisting health condition in 2021 (8.5%), being significantly higher than in 2020 ($p<0.001$).

Table 2. Distribution of cases of respiratory infection with severe acute respiratory syndrome symptoms according to clinical variables in 2020 and 2021 in the 28th Health Region of Rio Grande do Sul until October 31, 2021.

Pre-existing health condition	2020 n (%)	2021 n (%)	Total n (%)	p-value
Cardiovascular disease	489 (37.2)	848 (25.0)	1337 (28.4)	p<0.001
Diabetes Mellitus	270 (20.6)	655 (19.3)	925 (19.6)	p<0.001
Lung disease	181 (13.8)	196 (5.8)	377 (8.0)	p<0.001
Obesity	112 (8.5)	519 (15.3)	631 (13.4)	p<0.001
Neurological disease	100 (7.6)	287 (8.4)	387 (8.2)	p<0.001
Asthma	84 (6.4)	122 (3.6)	206 (4.4)	p<0.001
Immunosuppression	78 (5.9)	76 (2.2)	154 (3.3)	p<0.001
Kidney disease	33 (2.5)	72 (2.1)	105 (2.2)	p<0.001
Hematological disease	13 (1.0)	10 (0.3)	23 (0.5)	p<0.001
Postpartum woman	6 (0.5)	10 (0.3)	16 (0.3)	p<0.001
Liver disease	7 (0.5)	19 (0.6)	26 (0.6)	p<0.001
Down's syndrome	4 (0.3)	11 (0.3)	15 (0.3)	p<0.001

n: absolute frequency; %: relative frequency; p-value: Pearson's chi-square test.
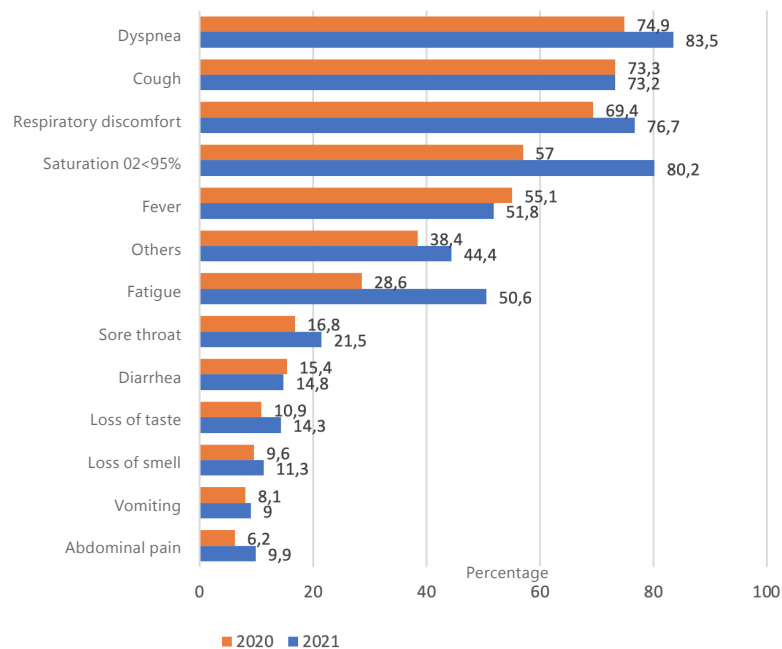
Figure 2. Distribution of cases of severe acute respiratory syndrome by signs and symptoms presented in 2020 and 2021 in the 28th Health Region of Rio Grande do Sul (n=4710, p<0.001 for all signs and symptoms).

In general, the most frequent signs and symptoms were dyspnea, cough, respiratory distress and O_2 saturation <95%. However, statistically significant differences (p<0.001) were observed in the prevalence of signs and symptoms between 2020 and 2021. In 2020, the most reported symptoms were dyspnea (74.9%), cough (73.3%) and respiratory distress (69.4%). In 2021, the most frequent symptom was also dyspnea (83.5%), followed by O_2 saturation <95% (80.2%) and cough (73.2%) (Figure 1).

Regarding the hospital admission profile, it was observed that, from 2020 to 2021, there was a decrease in the prevalence of hospital admissions (99.3% vs 98.3%, p<0.001), ICU admissions (27.4% vs 23.6%, p<0.001), use of invasive ventilatory support (13.4% vs 12.1% p<0.001).

Furthermore, from 2020 to 2021, an increase in the prevalence of death (18.7% vs 22.3%, p<0.001) and SARS reports due to COVID-19 (53.4% vs 87.5%, p<0.001) was observed (Table 3

As for the median time from onset of signs and symptoms to diagnosis, in 2020 it was 5 days (IQR 3–9), while in 2021 it was 9 days (IQR 6-13). In 2020, the observed median length of stay (n=1,304) was 11 days (IQR 6–22) and, in 2021, it was 13 days (IQR 7–29) (n=3,336). Regarding ICU length of stay, in 2020, 359 (360) patients were admitted, and the median length of stay was 8 days (IQR 4–16), while 760 (802) patients were admitted in 2021 and the median was 9 (IQR 4–16) days of hospital admission.

Table 3. Variables related to hospital admission of individuals with respiratory infection with severe acute respiratory syndrome symptoms in 2020 and 2021 in the 28th Health Region of Rio Grande do Sul until October 31, 2021.

Variables	2020 n (%)	2021 n (%)	Total n (%)	p-value
Hospital internment	1304 (99.3)	3336 (98.2)	4640 (98.5)	0.015
ICU admission	360 (27.4)	802 (23.6)	1162 (24.7)	<0.001
Use of ventilatory support				<0.001
Yes, invasive	176 (13.4)	411 (12.1)	587 (12.5)	
Yes, non-invasive	695 (52.9)	2364 (69.6)	3059 (64.9)	
No	411 (31.3)	529 (15.6)	940 (20.0)	
Outcome				<0.001
Cure	1029 (78.4)	2498 (73.5)	3527 (74.9)	
Death	245 (18.7)	756 (22.3)	1001 (21.3)	
Death from other causes	22 (1.7)	35 (1.0)	57 (1.2)	
SARS classification				<0.001
SARS by COVID-19	701 (53.4)	2971 (87.5)	3672 (78.0)	
SARS by another virus or agent	4 (0.3)	5 (0.1)	9 (0.2)	
SARI unspecified	604 (46.0)	404 (11.9)	1008 (21.4)	

n: absolute frequency; %: relative frequency; SARS: severe acute respiratory syndrome; ICU: Intensive Care Unit; p-value: Pearson's chi-square test.

DISCUSSION

The present study describes the clinical and socio-demographic characteristics of 4,710 people reported that they had a respiratory infection with SARS symptoms in a health region in Rio Grande do Sul. The population studied was mostly men, white, aged 50-89 years, similar to studies carried out in Argentina, China and Brazil (Minas Gerais, Rio Grande do Sul and São Paulo).[8–10] The majority had a basic level of education and were residents of urban areas. Pre-existing health conditions were similar to those described by other authors in reports of SARS due to COVID-19, such as obesity and Diabetes *Mellitus*.[9,10] The most frequent signs and symptoms were dyspnea, cough, respiratory discomfort and O_2 saturation <95%. Loss of smell and taste were reported in less than 15% of cases, reinforcing the findings of other published cohorts.[9–11]

Regarding classification, the frequency of SARS due to COVID-19 was higher in 2020 and 2021 (53.4% vs 87.5%), while unspecified SARS had rates of 46% in 2020 and 11.9% in 2021. This finding can be explained by the lack of or unavailability of tests at the beginning of the pandemic, since the distribution of diagnostic kits and the availability of free tests were still deficient, and the amounts charged for carrying them out in the private sector were high.

The highest frequency of cases was found in older age groups in 2020 and 2021: 50-89 years old (69.1% vs 64.6%). The pandemic revealed that older adults were more vulnerable to infection, whose natural decline in physiological functions is related to aging, having repercussions on these individuals' daily lives and resulting in a greater frequency of chronic diseases, which cause susceptibility. The more vulnerable older adults are, the greater the risk of developing severe SARS due to COVID-19 and dying.[12] A small but significant change in the age group was also observed between 2020 and 2021, with an increase in cases among the 20-49 age group.

Findings from another study demonstrated an increase in the proportion of young adults without comorbidities with severe COVID-19 during the second wave (February 2021), shortly after confirmation of local circulation of the Gamma variant.[13]

The most common pre-existing health conditions, such as cardiovascular disease (37.2% in 2020 vs 25.0% in 2021), Diabetes *Mellitus* (20.6% in 2020 vs 19.3% in 2021), lung disease (13.8% in 2020) and obesity (15.3% in 2021), had rates similar to those reported in Chinese and American studies.[9,14] The frequencies found for the different pre-existing health conditions reported are consistent with the findings of a study carried out in China.[4] It was found that the majority of SARS deaths due to COVID-19 occurred in men (73%) who were diabetic (13%), while another study[15] reported that, of the total deaths from SARS due to COVID-19, 62% were men, 19% had Diabetes *Mellitus* and 8% had cardiovascular disease. Physiologically, all of these conditions are related to a greater risk of complications from COVID-19 and can coexist in the same individual. SARS-CoV-2 uses the angiotensin-converting enzyme 2 (ACE2) as a receptor to invade the body's cells.[16]

COVID-19 acts on alveolar epithelial cells, causing more severe respiratory symptoms in people with cardiovascular diseases, a fact that may be related to the increased secretion of ACE2 in these patients.[17] In diabetic people infected by SARS-CoV-2, an increase in the levels of interleukin-6 and C-reactive protein was observed so that the pro-inflammatory state of diabetes may favor the cytokine storm and the systemic inflammatory response, accompanying acute respiratory distress syndrome in patients with COVID-19,[18] progressing to more serious conditions. ACE2 is highly expressed in adipose tissue, and patients with obesity tend to have more adipose tissue than the general population. This may explain why obese and diabetic people are more likely to have serious

clinical outcomes.[19]

Regarding the symptoms described in this study, in 2020, the most frequent signs and symptoms upon admission were dyspnea (74.9%) and cough (73.3%), and, in 2021, the most observed were dyspnea (83.5 %) and respiratory discomfort (76.7%), which were also described by other authors in studies carried out in China, the United States, Spain, Italy and the United Kingdom.[9,11,14,15] The SARS-CoV-2 virus causes dysregulation of the renin-angiotensin-aldosterone system, which can cause lung damage due to inflammatory cascade activation,[20] with consequent apoptosis of alveolar cells. Despite this, only 5% of cases evolve into critical conditions.[21] The median time from the onset of signs and symptoms to hospital admission was 5 days (IQR 3–9) in 2020 and 9 days (IQR 6–13) in 2021, a finding that was similar to that published in a study carried out in Argentina, which lasted 5 days (IQR 2-7).[22]

In 2020, 13.4% of the total sample analyzed in this study required invasive ventilatory support and 52.9% used non-invasive ventilatory support, corroborating data from a study carried out in Argentina, in which 12% of the total required invasive ventilatory support and 49% required non-invasive ventilatory support.[22] In 2021, 69.6% of patients required invasive support and 12.1% required non-invasive support in 2021. Patients with pre-existing health conditions presented the most severe form of the disease, with a greater need for ICU admission as well as an association between the use of ventilatory support and ICU admission for patients with cardiovascular disease and SARS infection due to COVID-19, corroborating the findings of this study. Several factors may be associated with this result, such as decreased access to health services and reduced availability of supplies and health professionals trained to treat individuals with SARS due to COVID-19 and its complications during 2020, especially at the beginning of the pandemic, with health sectors unprepared for the scenario, with restrictions on the number of beds available and the need to reorganize hospital infrastructure and health professionals to meet demand. Furthermore, specialized services in the countryside, in general, have fewer professionals specialized in this care, which has been associated with higher in-hospital mortality.[23]

In the present study, the frequency of deaths from SARS due to COVID-19 was 18.7% in 2020 and 22.3% in 2021, which is close to what was observed in other studies, such as in New York (21%)[14] and Wuhan (28.3%).[15] In the United Kingdom (37%)[24] and in Italy (43,6%),[25] the frequency of deaths was higher than that found in this study. Multicenter retrospective study in Spain [11] showed a death rate from SARS due to COVID-19 of 21% and ICU admission of 8.3%, while our study showed a hospital admission rate of 27.4% in 2020 and 23.6% in 2021 in ICU. The higher rates may be explained, in part, by differences between health systems and the ratio of ICU beds to hospital beds between countries.[24]

The limitations of this study concern the quality of information, since it was based on secondary data from reports, mainly because it is an event of great magnitude, with incomplete data and non-standardization of its completion. The possible underreporting and under-registration of data ends up restricting the use of important variables to describe the sociodemographic and epidemiological profile, including the possibility of loss of cases resulting from inconclusive laboratory results. When analyzing self-reported information, accuracy may be compromised.

Considering the pandemic context, SIVEP-Gripe's limitations are also faced with regard to the correction of duplications, the delay in updating the closure and the evolution of cases, in addition to health teams' work overload, compromising the adequate operationalization of this information system. However, this does not invalidate the importance of using data from SIVEP-Gripe, as this system makes it possible to analyze the profile of serious cases of the disease in the country.

Thus, when comparing cases of infections with SARS symptoms in 2020 and 2021, it was possible to observe changes in the sociodemographic and clinical profile of individuals. Highlights include an increase in SARS in the 20-49 age group, a reduction in pre-existing health conditions, except obesity, changes in reported signs and symptoms, and a decrease in hospital admissions and ICU admissions. An increase in the prevalence of death and SARS reports due to COVID-19 was also observed. These changes may reflect the effect of different variants of SARS-CoV-2, which have emerged over time, associated with the fact that the population has incomplete or no immunization, contributing to greater chances of presenting more serious clinical conditions.

The set of clinical and sociodemographic information increases the current evidence, adding important data capable of benefiting the conduct of health professionals and hospital management, demonstrating the importance of an efficient system for reporting and monitoring health problems.

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AUTHORS' CONTRIBUTION

Beck PB, Possuelo LG, Renner JDP contributed to study conception or design, work data interpretation, preparation of preliminary versions and critical review of important intellectual content. **Carneiro M, Gregiani, Schneider APH, Valim, ARM**, contributed to data analysis, work discussion and formatting and critical review. All authors approved the final version of the manuscript and declare themselves responsible for all aspects of the work.

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ORIGINAL ARTICLE

Availability of complementary resources and equipment for use in the prevention of healthcare-associated infections

Disponibilidade de recursos e equipamentos complementares para uso na prevenção de infecções relacionadas à assistência à saúde

Disponibilidad de recursos y equipos complementarios para prevenir las infecciones asociadas a la atención de la salud

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ABSTRACT

Background and Objectives: Recently, complementary resources and equipment have emerged to improve prevention of healthcare-associated infections (HAIs). Our aim is to verify availability and use of different resources/equipment by infection controllers. **Methods:** We conducted a survey with infection controllers from the State of Rio de Janeiro, Brazil, by invitation using a social media group, in August 2022. Nine different resources and equipment were evaluated. Categorical and continuous variables were evaluated by the chi-square test and Mann–Whitney U test, respectively. A p value of less than 0.05 was considered statistically significant. **Results:** One hundred and eight persons answered the questionnaire. The mean age was 42.8 years (SD +/- 8.5 years) and 53 (49.1%) reported most of their workload in public hospitals, 45 (41.7%) in private hospitals and 10 (9.2%) reported the same workload in public and private hospitals. Sixty-there percent reported teaching activities in their institutions. There was no correlation between the existence of teaching activities and hospital profile (p=0.42). The most common resource available was molecular biology (PCR) for microbiological samples research for 73 (67.6%) participants. The second resource most available was applications (Apps) for HAIs prevention and control for 33 (30.6%), 19 (17.6%) reported no availability of resource/equipment technology. **Conclusion:** Molecular biology (PCR) for microbiological samples research was the most common resource available for infection controllers of an important state of Brazil.

Keywords: Cross Infection. Hospital Infection Control Program. Biomedical Technology.

RESUMO

Justificativas e Objetivos: Recentemente, recursos e equipamentos complementares têm surgido para melho-

rar a prevenção de infecções relacionadas à assistência à saúde. O objetivo deste artigo é verificar a disponibilidade e o uso de diferentes recursos e equipamentos pelos controladores de infecção. **Métodos:** Realizamos uma pesquisa do tipo *survey* com controladores de infecção do estado do Rio de Janeiro, por meio de convite pela mídia social, em agosto de 2022. Nove diferentes recursos e equipamentos foram avaliados quanto à disponibilidade e ao uso. Variáveis categóricas e contínuas foram avaliadas pelo teste qui-quadrado e Mann-Whitney, respectivamente. Um valor de p menor que 0,05 foi considerado estatisticamente significativo. **Resultados:** Cento e oito pessoas responderam ao questionário. A média de idade foi de 42,8 anos (DP +/- 8,5 anos), e 53(49,1%) relataram maior carga de trabalho em hospitais públicos, 45 (41,7%) em hospitais privados e 10(9,2%) carga horária similar nos dois tipos de hospitais. Dos 108, 63% relataram a existência de atividades de ensino nas instituições. Não houve correlação entre existência de atividades de ensino e tipo de hospital (p=0,42). O recurso mais disponível foi o uso de biologia molecular (reação em cadeia de polimerase) por 73 (67,6%) participantes. A segunda ferramenta mais encontrada foi o uso de aplicativos para prevenção e controle de infecção para 33 (30,6%) desses participantes. Dezenove deles (17,6%) relataram ausência de todos os recursos/equipamentos. **Conclusão:** O uso de biologia molecular para pesquisa de amostras biológicas foi o recurso mais disponível para controladores de infecção de um importante estado brasileiro.

Descritores: *Infecção Hospitalar. Programa de Controle de Infecção Hospitalar. Tecnologia Biomédica*

RESUMEN

Antecedentes y objetivos: Recientemente han surgido recursos y equipos complementarios para mejorar la prevención de las infecciones asociadas a la atención de la salud. El objetivo es verificar la disponibilidad y el uso de diferentes recursos/equipos por los controladores de infecciones. **Métodos:** Realizamos una encuesta entre los controladores de infecciones del estado de Rio de Janeiro, Brasil, por invitación en redes sociales, en agosto de 2022. Se evaluó la disponibilidad y uso de nueve recursos y equipos diferentes. Las variables categóricas y continuas se evaluaron mediante las pruebas de chi-cuadrado y Mann-Whitney, respectivamente. Se consideró estadísticamente significativo un valor de p < 0.05. **Resultados:** Ciento ocho personas respondieron al cuestionario. La edad media fue de 42,8 años (DE +/- 8,5 años) y 53 (49,1%) reportaron mayor carga de trabajo en hospitales públicos, 45 (41,7%) en privados y 10 (9,2%) reportaron la misma carga en hospitales públicos y privados. De los 108, el 63% reportó actividades docentes en sus instituciones. No hubo correlación entre la existencia de actividades docentes y el tipo de hospital (p=0,42). El recurso más disponible fue el uso de la biología molecular (reacción en cadena de la polimerasa) por 73 (67,6%) participantes. El segundo más común fue el uso de aplicaciones de prevención y control de infecciones por 33 (30,6%) participantes. Diecinueve participantes (17,6%) señalaron la ausencia de todos los recursos/equipos. **Conclusiones:** El uso de la biología molecular para investigar muestras microbiológicas fue el recurso/equipo más disponible para los controladores de infecciones de un importante estado brasileño.

Palabras Clave: *Infección Hospitalaria. Programa de Control de Infecciones Hospitalarias. Tecnología Biomédica.*

INTRODUCTION

Healthcare-associated infections (HAIs) are one of the most frequent adverse events that occur in acute-care hospitals. These infections cause significant harm to patients and health systems, including associated increased costs, especially when they are caused by multidrug-resistant organisms.[1] According to the first World Health Organization (WHO) global report on infection prevention and control launched in 2022, 7% (in high-income countries) and 15% (in low- and middle-income countries) of patients in acute-care hospitals, will acquire at least one HAI during their permanence.[2] According to the Centers for Disease Control and Prevention (CDC), one in 31 hospitalized patients will acquire at least one HAI.[3] Furthermore, according to the European Centre for Disease Prevention and Control, from 142,805 patients staying in an ICU for more than two days (patient-based data), 11,787 (8.3%) patients presented with at least one HAI.[4]

Brazil has been implementing measures to mitigate the occurrence of HAIs. Since 1998, reporting of HAI acquired in intensive care units has been mandatory to the Brazilian Health Regulatory Agency (Anvisa). Anvisa updates yearly the diagnostic criteria of infection for the epidemiological surveillance of HAIs and the number of them associated with the invasive devices in hospitals. Data of HAIs were obtained on a voluntary basis reported from hospital participants. In the last update from 2021, the global density of incidence of central venous catheter-associated bloodstream infection was 5.16 in adult intensive care units (ICUs) and 4.85 in pediatric intensive care units (PICUs). In the same report, the global density of incidence of ventilator-associated pneumonia was 13.1 in ICU and 4.64 in PICUs.[5]

New resources and equipment can impact HAI control and prevention.[6] In this perspective, WHO highlighted the role of new technologies in the field of health, in order to provide support in areas such as training and education.[7] Some of these new resources, tools, equipment and technologies aim to influence people's behavior, while others provide direct interference in patient

care, such as the use of molecular biology to improve identification of multiresistant bacteria, automated cleaning systems, antibiotic-impregnated devices and Apps for infection prevention and control.[8,9]

However, further studies need to be carried out to verify the availability of these tools, since they can represent high costs for institutions in a setting of low-middle income countries[6]. Considering these aspects, our aim is to report the availability of nine new technologies for infection controllers of Rio de Janeiro State, Brazil. Recently, new technologies have emerged to improve prevention and control of healthcare-associated infections. Our aim is to verify the availability and use of resources and equipment by infection controllers.

METHODS

We conducted a survey study during August/September 2022 with graduated healthcare workers from Rio de Janeiro State, Brazil that worked as infection control practitioners (ICPs) such as nurses, physicians, or other healthcare professionals.

An invitation was sent to a social media group (WhatsApp®) that included professionals from all over the State. Inclusion criteria was to be a healthcare worker associated to a social media group and work as infection control practitioner. After the participants' agreement, an online questionnaire was sent using google forms®. Each participant received a copy of their answers by email and google forms created a file with all answers compiled. We collected data from two continuous weeks after invitation. We excluded participants with incomplete answers.

Nine resources, tools, and equipment complementary to the WHO's infection core components of prevention and control programs were chosen for analysis: Molecular biology (PCR) for microbiological samples, advanced software for HAI analysis, geospatial mapping for HAI identification/ outbreak control, automated decontamination technologies, use of robots for infection control training, ultraviolet devices for environmental cleaning, antibiotic impregnated devices, apps for HAI prevention and control, and telemedicine.

The objective questions (yes/no/not available) included variables about age, gender, professional category, time (in years) working as ICP, greater workload categorized according to the type of hospital (public or private), presence of formal teaching classes for healthcare students in hospitals and type of resources, tools and equipment used by ICPs. Since the WhatsApp group had 250 participants, we expected to have a sample of at least 100 participants in our survey.

The data was compiled in an Excel spreadsheet. We performed a descriptive analysis and used chi-square test to compare categorical data, t-test to compare means and Mann–Whitney U test for continuous variables. A p value of less than 0.05 was considered statistically significant.

The study was conducted in accordance with the required ethical standards (Resolutions 466/2012 - 510/2016 - 580/2018, of the Ministry of Health of Brazil) and was submitted and approved by the Ethics Committee of the Faculty of Medicine (Universidade Federal Fluminense), under the number 5.563.562 dated from August 4, 2022 and CAAE 58816422.2.0000.5243.

RESULTS

One hundred and eight ICPs participated in the survey. The mean age of participants was 42.8 years (SD +/- 8.5 years). Demographic data of participants are shown in table 1.

Table 1. Conduct of companions and visitors of hospitalized patients under specific precautions from the perspective of infection preventionists participating in the study (n=89) Brazil, 2020.

Variable	N (%)
Age group (years) N=108	
24-30	7 (6.5)
31-40	43 (40.2)
41-50	38 (35.2)
51-60	14 (13.1)
More than 60	6 (5.6)
Gender (N=108)	
Male	15 (13.9)
Female	93 (86.1)
Professional category (N=108)	
Nurse	81 (75)
Physician	26 (24.1)
Microbiologist	1 (0.9)
Time working as IPC (in years) N=108	
Less than 1	5 (4.6)
1-5	29 (26.9)
>5 and <10	28 (25.9)
>10 and <15	25 (23.1)
>15	21 (19.4)

Considering the greater workload of the ICPs according to the hospital type of care, 53/108 (49.1%) worked in public hospitals, while 45/108 (41.7%) in private institutions and 10/108 (9.2%) in both hospitals, with the same workload.

The presence of teaching activities (undergraduate, graduate and specialization programs) in the hospitals of the participant ICPs was cited by 68/108 (63%) while 40/108 (37%) informed the absence of them.

The availability and utilization of resources and equipment by the ICPs are shown in table 2, according to the specific type.

Only two (1.9%) participants reported the availability of all resources and equipment. On the other hand, 19/108 (17.6%) reported no availability of resources/equipment. At least one resource/equipment was available for 25/108 (23.1%) participants, two resources/equipment, at same time, were available and used by 23/108 (21.3%) ICPs, three resources/equipment for 17/108 (15.7%) participants and four resources/equipment for 10/108 (9.3%). One participant didn't know if the new resources/ equipment were available or not.

Table 2. Availability and utilization of resources and equipment by ICPs (Rio de Janeiro State, 2022).

Resources/Equipment	Utilization (%)	Absence of Utilization (%)	Don't know if it's available (%)
Molecular biology (PCR) for microbiological samples	73 (67.6)	32 (29.6)	3 (2.8)
Advanced software for HAI analysis	31 (28.7)	76 (70.4)	1 (0.9)
Geospatial mapping for HAI identification/ outbreak control	10 (9.3)	93 (86.1)	5 (4.6)
Automated decontamination technologies	15 (13.9)	92 (85.2)	1 (0.9)
Use of robots for infection control training	6 (5.6)	100 (92.6)	2 (1.9)
Ultraviolet devices for environmental cleaning	31 (28.7)	76 (70.4)	1 (0.9)
Antibiotic impregnated devices	22 (20.4)	84 (77.8)	2 (1.9)
Apps for HAI prevention and control	33 (30.6)	74 (68.5)	1 (0.9)
Telemedicine	20 (18.5)	85 (78.7)	3 (2.8)

Table 3. Categorization of greater workload of ICPs according to the hospital type of assistance and presence or absence of teaching activities, in units with at least one resource/equipment for infection prevention (Rio de Janeiro State, 2022). N=73.

Greater workload of Infection Control Practitioners	Presence of teaching activities	Absence of teaching activities	Total	P value
Public hospitals	24	8	32	0.42
Private hospitals	21	14	35	
Half public/half private	4	2	6	
Total	49	24	73	

In table 3, we categorized availability and use of at least one resource/equipment, according to the type of assistance and presence or not of teaching activities.

DISCUSSION

Healthcare-associated infection prevention and control remains a global challenge and since 2016, eight core components for infection prevention and control (IPC) were summarized and published by the WHO to be implemented in all countries and healthcare facilities. Although new resources/equipment were not formally included as core component, they could be inserted as multimodal strategies in this item.[7]

Considering the necessity of research about this topic, in our report, we described availability and use of resources, tools and equipment by ICPs in hospitals from Rio de Janeiro State, Brazil.

In this survey, most of the responders were nurses, aged between 31 and 50 years, which is similar to the findings of a large survey conducted in the USA and in another study conducted in Santa Catarina State, Brazil. The study reflects the reality that most of the infection controllers are nurses.[10,11] When we evaluated time (in years) of professionals working as ICP, most of them had more than five years in this area, which was similar to the results of the surveys conducted in the USA and countries of the Middle East.[10,12]

In Brazil, the healthcare system is based on a public service available for all Brazilian citizens (Brazilian National Health System- SUS) and complementary private services.[13] Reflecting this healthcare system, where SUS is the main place for healthcare in Brazil, most of the res-

ponders worked as ICP in public services. Interestingly, almost 10% of volunteers had the same workload both in public and private services.

We analyzed nine complementary resources and equipment that could help ICPs in preventing and avoiding HAI. The most commonly cited resources/equipment available was molecular biology (PCR) for microbiological samples identification. Despite molecular biology not being a new technique, its use for prevention and control of HAIs is not easy to implement in all healthcare facilities.[14,15] Even with this difficulty, almost two thirds of ICPs reported availability of this resource. The second most cited was the use of Apps for HAI prevention and control and although this resource could be easily accessed by all mobile devices, quality and relevance of existing Apps could be improved.[16]

Other resources/equipment such as advanced software for HAI analysis, geospatial mapping for HAI identification/ outbreak control, automated decontamination technologies, use of robots for infection control training, ultraviolet devices for environmental cleaning, antibiotic impregnated devices and telemedicine were cited by less than 30% of the responders. To our knowledge this manuscript is the first one to describe availability of different resources/equipment to help ICPs in HAI prevention in Brazil.

Two or more resources/equipment were available simultaneously to a small proportion of ICPs (less than 25%), showing the reality of access to new resources/equipment to prevent HAI in a developing country. In a meeting with 42 experts in infection prevention and control, a question about how can technology help to overcome challenges in infection prevention and control (IPC) and to prevent HAI and emerging antimicrobial resistance, identified four potential domains: 1) role and

potential contribution of microbiome research; 2) whole genome sequencing; 3) effectiveness and benefit of antimicrobial environmental surfaces; and 4) future research in hand hygiene.[17] Since then, no new clinical trials have identified the true impact of new resources/equipment used at the same time to prevent HAIs in "real-world".

As expected, resources and equipment were available more frequently in hospitals (both public and private) with teaching activities when compared with hospitals with absence of teaching activities, although there was no statistical significance. Presence of teaching activities in hospitals help to improve infection control practices and adherence to protocols in order to avoid infections.[18] With regards to clinical practice, this study aims to show the need for the acquisition of new technologies by the managers of healthcare institutions, in order to improve the prevention and control of HAIs.

The current manuscript has some limitations such as to have been conducted in one state of Brazil, which could reflect a regional reality. Considering that Rio de Janeiro State is one of the most developed states of Brazil, probably similar results could be found in other regions of the country. Another limitation of the study was to be carried out during the COVID-19 pandemic, which may have had an impact in hospitals regarding the limitations of acquiring new tools and equipment.

In conclusion, molecular biology (PCR) for microbiological samples research was the most common resource/equipment available for infection controllers in a middle-income state of Brazil, available for almost three quarters of the participants.

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AUTHOR'S CONTRIBUTIONS

Pérola Figueiredo Veríssimo and **André Ricardo Araujo da Silva** contributed to the article conception and design, data analysis and interpretation, and writing of the manuscript.

All authors approved the article's final version to be published and are responsible for all the aspects of the study, including the assurance of its accuracy and integrity.

Revista de Epidemiologia e Controle de Infecção

ORIGINAL ARTICLE

Impact of COVID-19 on the registration of tegumentary leishmaniasis cases in Maranhão, Brazil

Impacto da COVID-19 no registro de casos de leishmaniose tegumentar no Maranhão, Brasil

Impacto de la COVID-19 en el registro de casos de leishmaniasis tegumentaria en Maranhão, Brasil

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ABSTRACT

Background and Objectives: Elucidating the potential impact of COVID-19 on surveillance interventions and programs, such as the tegumentary leishmaniasis one, during the first year of the pandemic can help understand its consequences for notification systems, which can inform immediate public policy and health education actions, as well as highlight the need to implement new strategies to strengthen epidemiological surveillance services. The objective of the present study was to analyze the possible impact of the COVID-19 pandemic on the number of cases of tegumentary leishmaniasis in Maranhão, Brazil. **Methods:** Ecological study of confirmed cases of tegumentary leishmaniasis in the period from January 2015 to December 2020. Data were obtained from the Brazilian Information System for Notifiable Diseases. The P-score metrics were used to evaluate the possible underreporting of tegumentary leishmaniasis. **Results:** In the period from 2015 to 2020, 7,886 new cases of the disease were registered. For the year 2020, 1,346 cases were expected, but 1,158 were notified, which represented a decrease of 13.94%. The regional health centers of São Luís, São João dos Patos, and Presidente Dutra showed the greatest drops in possible expected new cases. **Conclusion:** The challenges in diagnosing tegumentary leishmaniasis cases seem to have intensified in the context of COVID-19 in Maranhão, which signals an important alert for health services and managers.

Keywords: Epidemiology. Neglected Diseases. Coronavirus. Health Services.

RESUMO

Justificativa e Objetivos: O potencial impacto da COVID-19 nas intervenções e nos programas de vigilância, como a *leishmaniose* tegumentar, durante o primeiro ano da pandemia, auxilia no entendimento das consequências da pandemia nos sistemas de notificação, com o intuito de subsidiar ações imediatas de políticas públicas e educação em saúde, além de evidenciar a necessidade de implementação de novas estratégias de fortalecimento dos serviços de vigilância epidemiológica. Este estudo teve como objetivo analisar o possível impacto da pandemia da COVID-19

no número de registros de casos de *leishmaniose* tegumentar no Maranhão, Brasil. **Métodos:** Trata-se de um estudo ecológico dos casos confirmados de *leishmaniose* tegumentar no período de janeiro de 2015 a dezembro de 2020. Os dados foram obtidos do Sistema de Informação de Agravos de Notificação. A métrica *P-score* foi utilizada para avaliar os possíveis subregistros de *leishmaniose* tegumentar. **Resultados:** No período de 2015 a 2020, foram registrados 7.886 casos novos da doença. Para o ano de 2020, eram esperados 1.346 casos, porém 1.158 foram notificados, o que representa uma diminuição de 13,94%. As regionais de saúde de São Luís, São João dos Patos e Presidente Dutra apresentam as maiores quedas de possíveis novos casos esperados. **Conclusão:** Os desafios no diagnóstico dos casos de *leishmaniose* tegumentar parecem ter se intensificado no contexto da COVID-19 no Maranhão, o que sinaliza um alerta importante para os serviços de saúde e gestores.

Descritores: Epidemiologia. Doenças negligenciadas. Coronavírus. Serviços de Saúde.

RESUMEN

Justificación y Objetivos: El posible impacto de la COVID-19 en las intervenciones y programas de vigilancia, como el de la leishmaniasis tegumentaria, durante el primer año de la pandemia, ayuda a comprender las consecuencias de la pandemia en los sistemas de notificación, con el fin de subsidiar las acciones inmediatas de política pública y educación para la salud, además de resaltar la necesidad de implementar nuevas estrategias para fortalecer los servicios de vigilancia epidemiológica. Este estudio tuvo como objetivo analizar el posible impacto de la pandemia de COVID-19 en el número de registros de casos de leishmaniasis tegumentaria en Maranhão, Brasil. **Métodos:** Se trata de un estudio ecológico de los casos confirmados de leishmaniasis tegumentaria desde enero de 2015 hasta diciembre de 2020. Los datos se obtuvieron del Sistema de Información de Enfermedades de Declaración Obligatoria. Se utilizó la métrica P-score para evaluar los posibles subregistros de leishmaniasis tegumentaria. **Resultados:** Entre 2015 y 2020, se registraron 7.886 nuevos casos de la enfermedad. Para 2020 se esperaban 1.346 casos, pero se notificaron 1.158, lo que representa una disminución del 13,94%. Los centros regionales de salud de São Luís, São João dos Patos y Presidente Dutra presentaron las mayores caídas en los posibles nuevos casos esperados. **Conclusión:** Los desafíos en el diagnóstico de los casos de leishmaniasis tegumentaria parecen haberse intensificado en el contexto de la COVID-19 en Maranhão, lo que señala una alerta importante para los servicios y gestores de salud.

Palabras Clave: Epidemiología. Enfermedades Desatendidas. Coronavirus. Servicios de Salud.

INTRODUCTION

Between December 18 and 29, 2019, five atypical pneumonia cases were reported in inpatients in the city of Wuhan, China.[1,2] On December 30, 2019, these cases were notified at the World Health Organization (WHO). On January 7, 2020, a new type of coronavirus (CoV) was isolated. At that time, it was designated 2019-nCoV, a term subsequently changed by WHO to severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), responsible for the coronavirus disease-2019 (COVID-19).[3,4]

The COVID-19 pandemic exposed the inequalities in access to health services all over the world.[5] Turning attention to this health issue affected care measures to prevent and treat other pathologies, such as tegumentary leishmaniasis (TL), which delayed its timely diagnosis and led to an increase in disabling and severe complications, especially in vulnerable populations.[6,7]

In South America, the first reported cases of COVID-19 occurred in Brazil, which was one of the countries most affected by the disease, with over 7,716,184 cases and around 195,725 deaths in 2020.[8] In this period, attention was focused on and adjusted to fighting this pandemic. In the Brazilian state of Maranhão, the efforts to prevent a growth in the number of cases of this disease caused the authorities to declare a state of emergency, which made it possible to implement several measures, including increasing the number of hospital beds specifically for patients with this infection in intensive care units and wards, concert and lesson cancellations, as well as restrictions in interstate transportation. This quick response to the increase in COVID-19 cases may have originated gaps in access to health services by patients with TL.[9] The objective of the present study was analyzing the possible impact of COVID-19 on the number of reported TL cases in Maranhão, Brazil.

METHODS

Study area

Maranhão is located in the Brazilian Northeast Region. The state has an area of 333,367 km², an estimated population in 2020 of 7,114,598 people, and a demographic density of 19.81 people per km². It is bordered to the west by Pará, to the southwest by Tocantins, to the north by the Atlantic Ocean, and the southeast and east by Piauí.[10]

The state is divided into 19 health regions (São Luís, Chapadinha, Itapecuru, Rosário, Timon, Pinheiro, Viana, Açailândia, Imperatriz, Barra do Corda, Presidente Dutra, São João dos Patos, Bacabal, Codó, Pedreiras, Santa Inês, Zé Doca, Balsas, and Caxias), delimited based on municipalities, population, and demographic density, for the
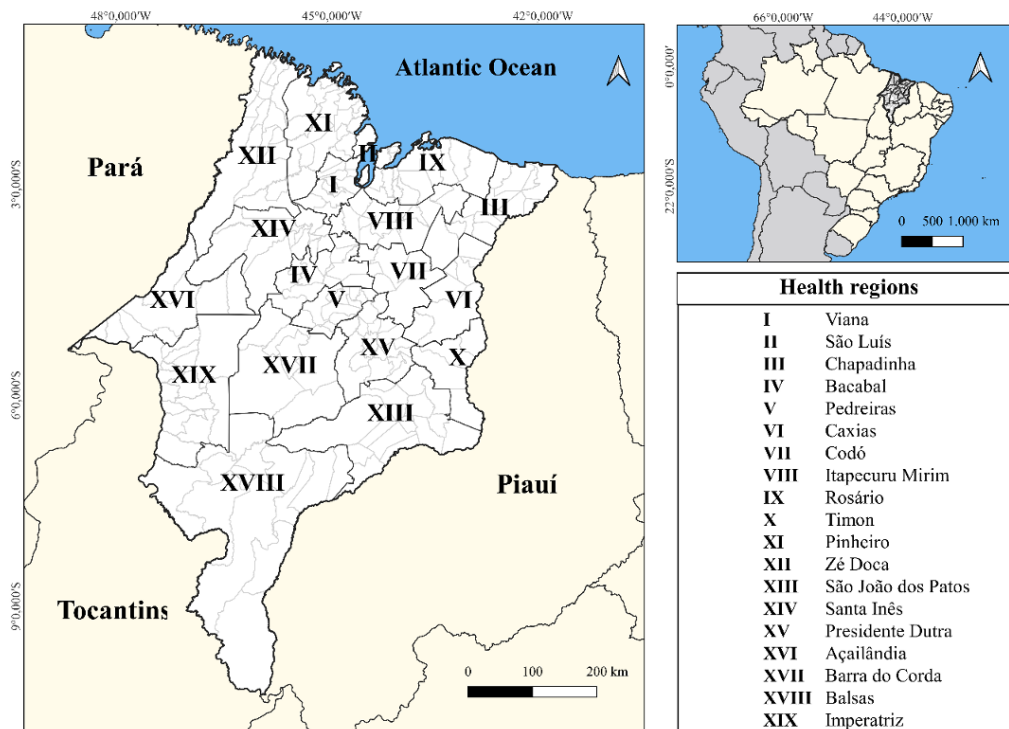
Figure 1. Map of Maranhão and its health regions.

provision of actions and minimum services in each area (Figure 1).[11]

Study type

This was an ecological study that analyzed confirmed TL cases and incidence rates in Maranhão and its health regions between January 2015 and December 2020.

Data source

The data on confirmed new TL cases included in the present study were obtained at the Brazilian Information System for Notifiable Diseases (Sinan, as per its acronym in Portuguese) using the digital platform of the Informatics Department of the Brazilian Unified Health System (Datasus, as per its abbreviation in Portuguese), which is part of the Ministry of Health, on December 5, 2021. The accessed item was "Notifiable diseases", followed by "2007 onwards", via TabNet, a tabulation tool.[12] COVID-19 cases confirmed in 2020 were obtained directly from the CORONAVÍRUS BRASIL panel, updated by the Health Surveillance Secretariat.[8] Confirmed cases in patients who did not live in Maranhão were excluded. The estimated population was obtained from projections for all the years from 2015 to 2020 by the Brazilian Institute of Geography and Statistics.

Data analysis

Data were analyzed by using the P-score metric, which was originally developed to assess mortality increase. However, it proved useful for identifying the underreporting of events in public health.[13] P-score is de-

fined as the percentage difference between the reported number of cases or incidence and the expected number of cases or incidence divided by the reported number of cases or incidence, which is then multiplied by 100. The expected value was considered the average in the period from 2015 to 2019, previous to the COVID-19 pandemic. Incidence was obtained by dividing the number of annual cases in Maranhão or its health regions by the number of people and then multiplying the value by 100,000. The results were expressed as positive and negative percentage values, which indicated increase and reduction, respectively. Office Excel software (Microsoft Corporation) version 2016 was used to treat the data.

Ethical aspects

The present study used secondary aggregate data, with no identification of any patients. Therefore, the proposal did not require approval by a research ethics committee. The study was conducted in accordance with the ethical standards imposed by Ministry of Health Resolutions 466/2012, 510/2016, and 580/2018. The principles of the Declaration of Helsinki were also observed.

RESULTS

Between 2015 and 2020, 7,886 new TL cases were reported in Maranhão, of which 72.9% (5,747) occurred in the male population. For 2020, 1,346 new cases were expected (18.9 per 100 thousand people). However, the actual number was 1,158 (16.3 per 100 thousand people). This meant a reduction of 13.94% in the number of new cases and 14.57% in incidence. The highest drop in the
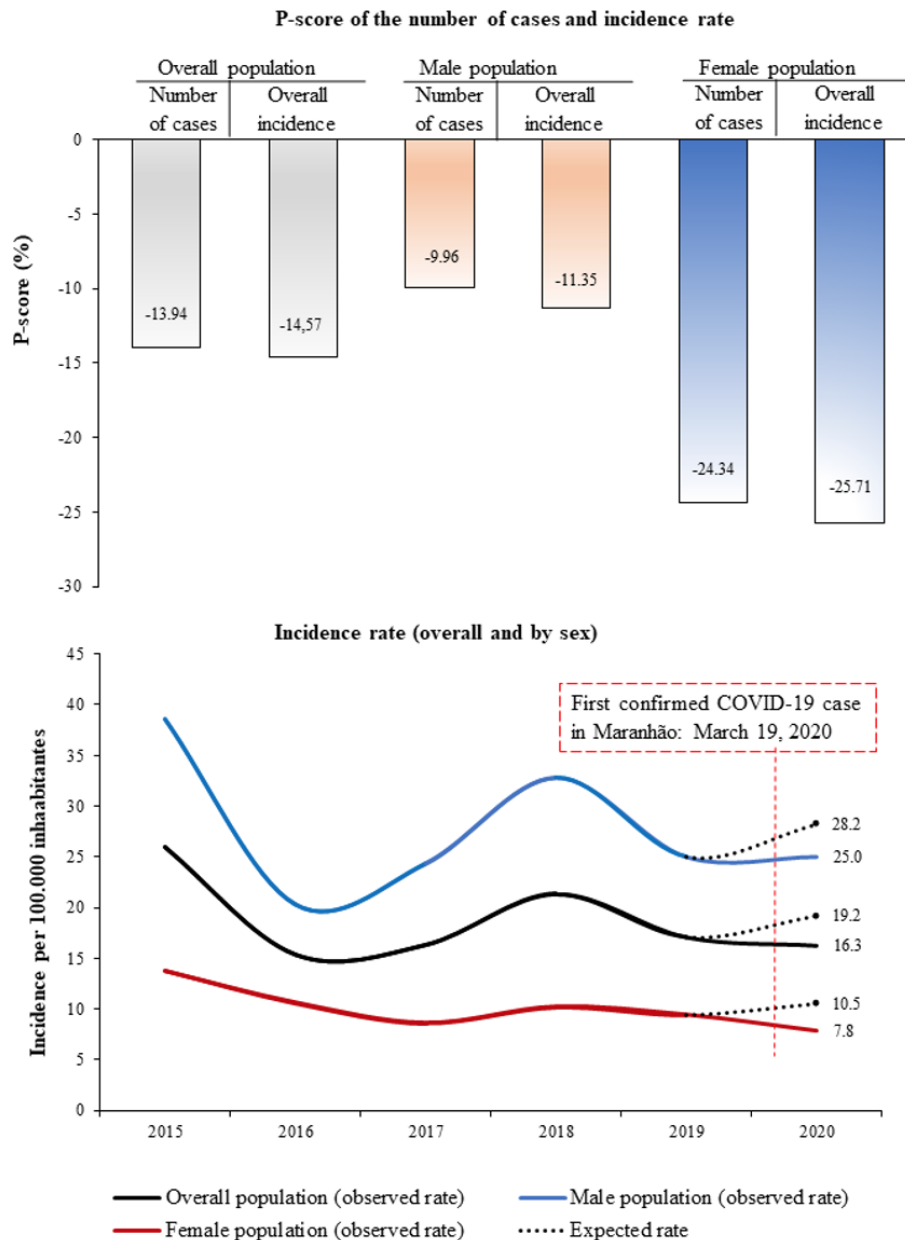
Figure 2. P-score and incidence rate (overall and by sex) of tegumentary leishmaniasis in Maranhão, Brazil, 2015-2020.

number of new cases was observed in women (-24.34%). The probable number of undiagnosed cases for 2020 was 188 (Figure 2).

Analysis of the absolute numbers of the health regions indicated that São Luís (-69.63%), São João dos Patos (-54.02%), Presidente Dutra (-45.95%), and Codó (-41.56%) showed a decrease in the number of reported new cases. The health region of Viana experienced an 80% increase in the number of reported cases in comparison with the expected number for the same period (Figure 3).

Seven health regions (Açailândia, Bacabal, Pedreiras, Rosário, Santa Inês, Timon, and Viana) had an increase in the number of reported TL cases over the pandemic year of COVID-19 (2020) in comparison with the pre-pandemic period examined in the present study (2015-2019). Analysis of TL incidence in 2020 showed that the health regions most affected by this disease were Açailândia, Rosário, and Zé Doca (Table 1).
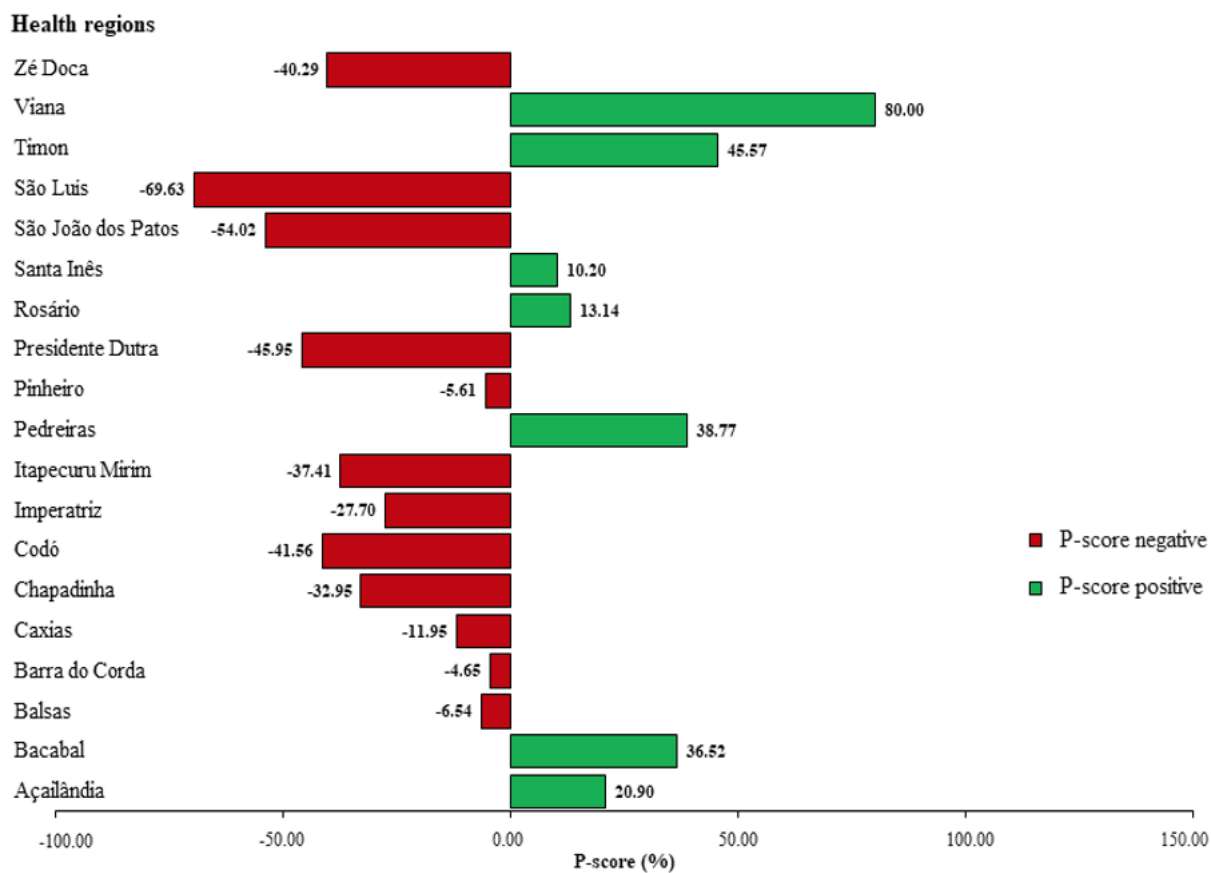
Figure 3. P-score for the absolute number of cases of tegumentary leishmaniasis by health region in Maranhão, Brazil, 2020.

Table 1. Difference between the average number of cases of tegumentary leishmaniasis in Maranhão in 2015-2019 and 2020.

Health regions	2015-2019 (n)	2020 (n)	Difference (n)	%	Incidence per 100,000 people (2020)
Açailândia	116	139	23	54.51	46.37
Bacabal	55	77	22	58.33	28.54
Balsas	21	20	-1	48.78	8.77
Barra do Corda	46	39	-7	45.88	16.61
Caxias	28	27	-1	49.09	8.79
Chapadinha	92	60	-32	39.47	15.74
Codó	30	17	-13	36.17	5.47
Imperatriz	98	72	-26	42.35	13.21
Itapecuru Mirim	129	84	-45	39.44	21.65
Pedreiras	44	63	19	58.88	28.75
Pinheiro	75	74	-1	49.66	18.53
Presidente Dutra	36	19	-17	34.55	6.52
Rosário	121	135	14	52.73	44.48
Santa Inês	116	130	14	52.85	32.85
São João dos Patos	50	19	-31	27.54	7.69
São Luís	57	24	-33	29.63	1.64
Timon	12	24	12	66.67	9.55
Viana	5	8	3	61.54	2.91
Zé Doca	203	122	-81	37.54	40.25

DISCUSSION

The data on reported TL cases showed a higher predominance of new cases in men and a remarkable reduction in disease reporting over 2020, especially in the health regions in the north and south areas of Maranhão. The COVID-19 pandemic interfered with the timely diagnosis of other infectious diseases all over the world in 2020, especially those caused by vectors, such as dengue fever, malaria, and leishmaniases (both visceral and tegumentary).[14,15,16] Maranhão had its first COVID-19 report on March 19, 2020, and was one of the first Brazilian states to implement lockdown and social distancing measures.[17,18]

Social restraints and isolation as a response to the increase in COVID-19 cases were a considerable logistic challenge to health surveillance services and impacted the underreporting of other infectious diseases, including TL.[19] With the pandemic dissemination, the P-score metric became an important analysis tool that helps elucidate the consequences of COVID-19 for health services, since it allows a comparison of a certain disease status between municipalities, states, and countries.[20]

The female gender showed the highest potential drop in a number of reported new cases, and the male gender had the highest TL incidence. Tropical vector-borne diseases, such as TL, tend to afflict certain groups in situations of social vulnerability, that is, more susceptible to poverty.[21] COVID-19 unevenly affects poorer men and women, increasing existing inequalities.[22] Maranhão is considered the poorest state in Brazil.[23] Therefore, neglecting the impact of sexual differences in health records can reinforce healthcare inequalities and reduce the efficacy of interventions.[24,25]

It is important to emphasize that permanent disfiguring scars, which occur when diagnosis is not timely, cause lifelong stigma and decrease quality of life. They are more harmful to women in situations of social vulnerability.[26]

Disease underreporting already existed before the COVID-19 pandemic. Dealing with this problem involves a complex process of getting to understand the coverage level of health surveillance services, as well as aspects related to management, interaction with healthcare teams, factors inherent in the identification of suspected cases, and timely diagnosis.[27]

Maranhão has a high TL burden, and the management of the disabilities and deformities caused by this disease is always an urgent matter.[28] An absent or delayed diagnosis means reinforcing its stigma as a neglected tropical disease. In a context in which attention was focused on COVID-19, an assessment of the actual impact of TL control measures can be designed by analyzing reported new cases, with special emphasis on the detection delay period.[29]

The present study had limitations inherent in the use of secondary data, which is subject to incompleteness, transcription errors, and duplicity. P-score quality depends on the accuracy of the available data.[30] However, it is important to stress the continuous updating of Sinan over the past years, which helped consolidate this system as the most important source of information/decision-making/action related to diseases in Brazil.[31]

Dealing with the COVID-19 pandemic was a challenge regarding reporting of new TL cases in Maranhão, mainly in the health regions of São Luís and São João dos Patos. In this context, it is important that health services, once back to their routine activities, be encouraged to intensify actions oriented toward TL prevention, active screening, diagnosis, and treatment.

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AUTHOR CONTRIBUTIONS

Romário de Sousa Oliveira and **Valéria Cristina Soares Pinheiro** contributed to the study design as well as manuscript writing and critical review, and **Karen Brayner Andrade Pimentel** and **Maria Edileuza Soares Moura** contributed to data analysis and interpretation, and manuscript writing.

All the authors approved the final version of the manuscript and are responsible for all of its aspects, including accuracy and integrity assurance.

Revista de Epidemiologia e Controle de Infecção

REVIEW ARTICLE

Digital health for treatment adherence in people with tuberculosis: a systematic review

Saúde digital para a adesão ao tratamento da pessoa com tuberculose: uma revisão sistemática

Salud digital para la adherencia al tratamiento en personas con tuberculosis: una revisión sistemática

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ABSTRACT

Justifications and Objectives: the use of digital health, among people diagnosed with tuberculosis, can be an effective strategy, combined with health services, to increase adherence to treatment and impact the disease's epidemiological data in the country. As this topic has been widely discussed and improved in recent years, it is necessary to further investigate the research available on scientific bases. The objective of this study was to describe the use of digital health technologies to assist with adherence to tuberculosis treatment. **Methods:** this is a systematic literature review with a rapid review approach, following the PRISMA guidelines and the Cochrane guide. Evidence quality was assessed using the Mixed Methods Appraisal Tool. The studies were identified in PubMed, VHL, CINAHL, Cochrane Trial, SciELO, Scopus and Embase. Experimental, quasi-experimental studies and clinical trials were included, without language restrictions, published between 2020 and 2022. **Content:** nine studies were selected, which demonstrated that the implementation of digital technologies improved adherence rates to medication treatment and cure rates. Applications use strategies such as synchronous and asynchronous video, voice calls and text messages. Among the studies, only two technology/application names were mentioned. **Conclusion:** digital technologies have had a positive impact on the treatment of people diagnosed with tuberculosis.

Keywords: Telemedicine; Tuberculosis; Treatment Adherence and Compliance; Systematic Review.

RESUMO

Justificativas e Objetivos: a utilização da saúde digital, junto às pessoas diagnosticadas com a tuberculose, pode ser uma estratégia eficaz, aliada dos serviços de saúde, para aumentar a adesão ao tratamento e impactar os dados epidemiológicos da doença no país. Como esse tema tem sido amplamente discutido e aprimorado nos últimos anos, é necessário investigar mais a fundo as pesquisas disponíveis nas bases científicas. O objetivo deste estudo foi descrever o uso de tecnologias em saúde digital para auxiliar na adesão ao tratamento da tuberculose. **Método:**

trata-se de revisão sistemática da literatura com abordagem de revisão rápida, seguindo as diretrizes do PRISMA e o guia da Cochrane. A qualidade das evidências foi realizada utilizando a ferramenta *Mixed Methods Appraisal Tool*. Os estudos foram identificados nas bases de dados PubMed, BVS, CINAHL, Cochrane Trial, SciELO, Scopus e Embase. Foram incluídos estudos experimentais, quase-experimentais e ensaios clínicos, sem restrição de idioma, publicados entre 2020 e 2022. **Conteúdo:** foram selecionados nove estudos, que demonstraram que a implementação de tecnologias digitais melhorou as taxas de adesão ao tratamento medicamentoso e as taxas de cura. Os aplicativos utilizam estratégias como vídeo síncrono e assíncrono, chamadas de voz e mensagens de texto. Entre os estudos, apenas dois nomes de tecnologia/aplicativo foram mencionados. **Conclusão:** as tecnologias digitais têm impactado de forma positiva no tratamento das pessoas com diagnóstico de tuberculose.

Descritores: Telemedicina. Tuberculose. Cooperação e Adesão ao Tratamento. Revisão Sistemática.

RESUMEN

Justificaciones y objetivos: el uso de la salud digital entre las personas diagnosticadas con tuberculosis puede ser una estrategia eficaz y aliada de los servicios de salud para aumentar la adherencia al tratamiento e impactar los datos epidemiológicos de la enfermedad en el país. 3. **Método:** se realizó una revisión sistemática de la literatura con un enfoque de revisión rápida, siguiendo las pautas de PRISMA y la guía de Cochrane. La calidad de la evidencia se evaluó utilizando la herramienta *Mixed Methods Appraisal Tool*. Los estudios se identificaron en las siguientes bases de datos: PubMed, BVS, CINAHL, Cochrane Trial, SciELO, Scopus y Embase. Se incluyeron estudios experimentales, cuasiexperimentales y ensayos clínicos, sin restricciones de idioma, publicados entre 2020 y 2022. **Contenido:** se seleccionaron nueve estudios que demostraron que la implementación de tecnologías digitales mejoró las tasas de adherencia al tratamiento con medicamentos y las tasas de curación. Las aplicaciones utilizan estrategias como video sincrónico y asincrónico, llamadas de voz y mensajes de texto. Entre los estudios, sólo se mencionaron dos nombres de tecnologías/aplicaciones. Conclusión: las tecnologías digitales han tenido un impacto positivo en el tratamiento de personas diagnosticadas con tuberculosis.

Palabras clave: Telemedicina; Tuberculosis; Cumplimiento y Adherencia al Tratamiento; Revisión Sistemática.

INTRODUCTION

Tuberculosis (TB) is a serious global public health problem, affecting vulnerable countries and groups, with an estimated 1/3 of the world's population infected by *Mycobacterium tuberculosis*. To combat the disease, the World Health Organization (WHO) launched the End TB Strategy, based on three pillars: person-centered care; integrated and robust health systems covered by social protection programs; and research and innovation.[1,2]

According to the WHO report released in 2021, in Brazil, only 71% of people diagnosed with TB complete treatment, a rate below the goal established by the WHO of at least 85%.[3] Several factors can influence the decision-making of people with TB, such as socioeconomic aspects, access to health services, social protection actions and lack of information or knowledge about the disease.[4]

TB treatment typically requires daily supervision and use of a combination of medications, which can cause adverse reactions and negatively affect the treatment experience. This can lead to non-adherence or abandonment of treatment.[4,5] Therefore, care focused on sick individuals' well-being, as recommended by person-centered care, is essential for supporting and ensuring the completion of TB treatment.[4]

The introduction of Directly Observed Treatment Short Course (DOTS) substantially increased cure rates and reduced dropouts, being considered a blueprint strategy.[4-6] However, a study developed in 2020 estima-tes that physical distancing measures contribute to an increase in 6.3 million additional cases of TB between the years 2020 and 2025, in addition to 1.4 million deaths from TB due to the reduction in coverage of TB DOTS strategy.[7]

Even before the COVID-19 pandemic, Video Directly Observed Treatment (VDOT) was already encouraged as an alternative to traditional DOTS, since digital resources are viable and have long reach, minimizing barriers cultural, organizational, economic and geographic issues faced by people with TB.[8,9]

The WHO supports a configuration of the strategy based on digital health, person-centered care and Unique Therapeutic Projects. However, this recommendation still needs to be thoroughly assessed against the strengths of evidence available for advanced DOTS in digital health. Although a systematic review has been observed in the literature, many other studies may have been produced, and a new analysis with more evidence is needed.[10-11] Considering the above, the study aims to describe the use of digital health technologies to assist with adherence to TB treatment through a systematic literature review with a rapid review approach.

METHODS

This is a systematic literature review with a rapid review approach registered in PROSPERO under number

CRD42022364841. The review was conducted according to the Cochrane Handbook for Systematic Reviews of Interventions methodological items, in addition to using the Guidance from the Cochrane Rapid Reviews Methods Group of 2020. The presentation of results was reported in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[12,13]

Studies without language restrictions were included, published between January 1, 2020 and September 15, 2022. The time frame was carried out following the rapid review methodology developed by Cochrane, in cases where there is a need for a rapid synthesis of evidence. This approach simplifies systematic review components, such as limiting search time. Furthermore, the time frame was carried out to identify which technologies are the most recent and which remain up to date.[13]

Quantitative, experimental, quasi-experimental studies and clinical trials were included. The study population was made up of people aged 18 years or over, with all types of TB (pulmonary, extrapulmonary TB, latent TB, active TB, sensitive TB or extrapulmonary TB), as proven by the study analyzed. Technologies included were smartphone apps, synchronous and/or asynchronous videos, phone reminders, ingestible sensors, SMS (Short Message Service) reminders, and other digital health interventions that aim to improve medication adherence and TB treatment outcomes.

The primary outcome was medication adherence, i.e., treatment completion, adherence rate and missed doses. Adherence can be measured through the patient's medical record and/or self-report on the device, through asynchronous or synchronous video, responding to phone calls and SMS text messages. There is no "gold standard" in the literature to measure adherence behavior, as there are a variety of strategies used.[14]

Studies were included, within the eligibility aspects, to address the following question: what is the evidence of use of telemedicine in adherence to TB treatment? The question was formulated following the PIO acronym structure (P = Population, I = Intervention or exposure, O = Outcome) (Chart 1).[15]

The following databases were used for the research: US National Library of Medicine (PubMed); Virtual Health Library (VHL); Cumulative Index to Nursing and Allied Health Literature (CINAHL); Cochrane Trial; Scientific Electronic Library Online (SciELO); Scopus; and Embase.

The search strategies were developed in collaboration with a specialized librarian, using the Boolean operators AND and OR in combination with the Medical Subject Headings (MeSH), Health Sciences Descriptors (DeCS) and Emtree Terms descriptors, in accordance with each database. The general strategy included the descriptors "Tuberculosis" AND "Telemedicine" AND "Treatment Adherence", combined with keywords.

Throughout the text, the term used was "digital health", but in the search term, it was replaced by the synonym "telemedicine", as it is a descriptor considered more appropriate to cover the broad search in databases.[12] It is important to highlight that access to the electronic databases was carried out through the content services (Proxy) of *the Universidade de São Paulo* (USP) - *Campus* Ribeirão Preto via USP's VPN (Virtual Private Network).

Retrieved records were imported into the Rayyan® software,[16] and duplicate records were eliminated. The remaining records were grouped according to titles and abstracts to identify potentially eligible studies. During screening, 24 studies could not be read in full, as they were absent from online platforms, only having their abstracts. E-mails were sent to the authors requesting full access to the article, but there was no response until the completion of this study.

Records' titles and abstracts were assessed by two independent reviewers (AFT, RVSS) and a third reviewer (JSTA) who arbitrated any disagreements. Potentially eligible records were read in full by two independent reviewers (AFT, RVSS), again, with third reviewer (JSTA) refereeing. The study selection process was outlined according to the PRISMA diagram.[12]

Data were collected independently by two reviewers (AFT, RVSS), and all disagreements were discussed by the team until a consensus was reached. A standardized extraction form based on the Cochrane Consumer and Communication Review Group Data Extraction Template (2015) was used. The information extracted included: 1) author; 2) year of publication; 3) country of publication; 4) study design; 5) study objective; 6) sample characteristics; and 7) results.

The Mixed Methods Appraisal Tool (MMAT) assesses according to the percentage of development of each domain, using the descriptor "*", which is equivalent to 25%, with the maximum quality score with 100% development expressed by the descriptor "****". Based on the results found, study quality was classified as "high quality" evidence (100% = "****"), "moderate quality" (75% = "***"); and "low quality" (< 50% = "**"; "*").[17]

According to Resolutions 466/2012 and 510/2016, "all research involving human beings must be assessed

Chart 1. Components of research question according to the acronym "PIO" (P = Population, I = Intervention or exposure, O = Outcome).

Description	Acronym	Search components	Descriptors and keywords
Population	P	Adults diagnosed with TB	Patients AND Tuberculosis OR Mycobacterium tuberculosis
Intervention	I	Telemedicine	Telemedicine OR Connected Health OR Digital Health OR Health Tele-Services OR Mobile Health
Outcome	O	Adherence to TB treatment	Treatment Adherence and Compliance OR Adherence, Therapeutic OR Adherence, Treatment OR Therapeutic Adherence OR Therapeutic Adherence and Compliance

by a Research Ethics Committee (REC)", even those that use secondary data, through the CEP-CONEP System. However, if the research uses only public domain data without identifying the participants or if it is a bibliographic review without the involvement of human beings, it does not need to be approved by REC-CONEP. Therefore, as this study uses public domain data, it was not necessary to submit it for REC assessment.

RESULTS

In literature, a total of 300 articles were found in the searched databases, of which 157 articles were excluded after selection, as they were duplicates, based on the detection of Rayyan®.[16] After exclusion, 149 articles remained for analysis. After reading titles, abstracts and reading in full, only 9 eligible articles were identified (Figure 1).
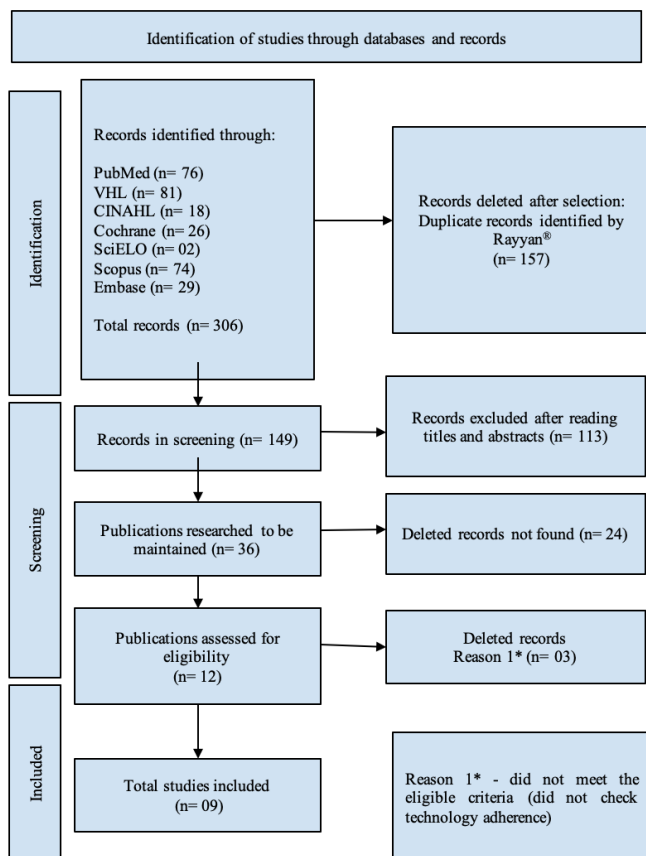

Figure 1. PRISMA 2020[12] flow diagram for new systematic reviews that included only database and record searches.

As shown in Chart 2, of the studies included, three[18-20] studies (33.3%) were carried out is America (North and South America), five,[21-25] (55.5%) in Asia, and one,[26] (11.1%) in Africa. The countries where the studies

were carried out were: one[17] (11.1%) in Peru; two[21,24] (22.2%) in China; one[22] (11.1%) in Saudi Arabia; two[19-20] (22.2%) in the United States of America; one[26] (11.1%) in Ethiopia; and two[23-25] (22.2%) in India. Regarding design, five[20-22, 25,26] studies (55.5%) were defined as clinical trials; two[23-24] studies (22.2%) were quasi-experimental clinical trials; one[18] studies (11.1%) were descriptive; and one[19] study (11.1%) was a prospective cohort. The publication period of each study covered 2020 to 2022, with two[24-25] studies (22.2%) published in 2020, four[20,22-23,26] studies (44.4%) published in 2021 and three[18-19,21] studies (33.3%) published in 2021.

Six[19-23,26] studies (66.6%) used text messages (applications) and SMS as strategies; and three[19-21] studies (33.3%) presented the name of the technological application used in the study, namely WeChat® and Emocha Mobile Health®. Six[18-21,24,25] studies (66.6%) used videos ranging between synchronous and asynchronous; two[22,26] studies (22.2%) used only SMS; and one[23] studies (11.1%) used voice calls. The majority[20-26] of study participants were men (77.7%) aged 18 or over (77.7%).

The sample size of studies[18,25] varied between 10 and 405 participants with a confirmed diagnosis of TB. Samples were collected differently across studies, with participants divided into control and intervention groups. However, there were also studies in which participants, as in previous studies, were divided into two groups, control and intervention, with the difference that the sample of participants in the control group was collected from retrospective data. In both situations, the intervention concerned the use of digital health. Video and SMS technologies gained prominence in studies, being the most used strategies both together and separately.

Among the studies, the samples were diverse, as were the approaches and sample characteristics. Participants were found who received TB treatment for the first time or who had previously received treatment (retreatments). People with TB were classified as having pulmonary TB, extrapulmonary TB, or both.

Regarding objectives, five[18-20,23,26] studies (55.5%) verified adherence to treatment by controlling missed doses; three[22,24,25] studies (33.3%) analyzed adherence to treatment through completion of drug treatment (cure); and one[20] article (11.1%) demonstrated that, even with a higher percentage of doses not ingested in the technological intervention, there was an increase in treatment completion rates.

The studies had similar objectives related to the following categories: assess and compare adherence to treatment using digital health compared to conventional treatment in people diagnosed with TB; describe the characteristics of VDOT implementation; and assess the cost-benefit of applying technology in the treatment of people with TB.

The quality and evidence of studies were assessed using MMAT[17], as described in Table 1. Among the randomized controlled studies, four[21,22,24-25] were suspected of high quality, except for one[26] study, which did not report blinding sample allocation. Among the non-randomized

Chart 2. Characteristics of studies included in the review according to author, year, country, study design, study objective, population and results (2020 – 2022).

Author	Year	Country	Study design	Study objective	Population	Results
Peinado[18]	2022	Peru	Descriptive quantitative	Describe the characteristics of implementing video treatment (VDOT) in people with TB.	10 participants diagnosed with pulmonary TB, 7 participants being women and aged between 24 and 39 years.	Using recorded video calls made with commercial software, 100% treatment adherence was achieved, measured by observed doses.
Bao[21]	2022	China	Controlled, randomized, triple-blind	Explore a baseline mHealth intervention in participants with TB to increase their self-care capacity.	112 participants diagnosed with pulmonary TB. Of the total participants, 59% in the intervention group and 53% in the control group. 57.1% were men, aged between 18 and 30 years old and only 6.3% were over 60 years old.	Using WeChat®/videos and text messages, adherence in the intervention group increased with daily medication reminders, and adherence in the control group decreased over time by discontinuing the medication.
Al-Sahafi[22]	2021	Saudi Arabia	Controlled, randomized, triple-blind	Compare the approach of people with TB with those undergoing DOTS and VDOT unit treatment.	221 participants. Study participants were 34 years old. The majority of participants were male (66.5%). Pulmonary TB was the majority of cases (80%), and were divided into 97 in the intervention group and 76 in the control group.	Using SMS, it was found that the group that used the technology showed greater adherence to treatment, since the relative risk of treatment success rate among the intervention group was 1.27 times greater than the control group.
Bachina[19]	2022	USA	Prospective cohort	Assess the use of VDOT compared to treatment adherence between VDOT and in-person DOTS, and understand the impact of COVID-19 on adherence to TB treatment and technology adoption.	46 participants, the majority diagnosed with pulmonary TB. The average age was 41 years, with the majority being women and not born in the USA. They received treatment during the post-COVID-19 period.	Using Emocha Mobile Health®/video and SMS, verified adherence (proportion of doses observed) was significantly higher when using VDOT (average of 81%,) compared to in-person DOT (average of 54.5%, SD 10.9; P = 0.001).
Perry[20]	2021	USA	Pragmatic quantitative	Estimate the proportion of doses prescribed with administration verified by VDOT vs. DOTS in person.	163 participants, most diagnosed with pulmonary TB. Of the total participants, 61% were men, aged 52 years old, with the majority not born in the US.	Using Emocha Mobile Health®/video and SMS, it was found that, despite the DOT showing fewer wasted doses than the use of VDOT, treatment completion was higher in the group that received the app intervention, 96% to 90%, DOT strategy.
Gashu[26]	2021	Ethiopia	Controlled, randomized, double-blind	Assess the effect of the telephone reminder system on adherence to TB treatment.	306 participants, the majority diagnosed with pulmonary TB. In the intervention group, it was 55.3%, and in the control group, 48.7%. All were men aged between 18 and 29 years old.	Using SMS (text messaging and graphics for illiterates), it was found that adherence to treatment was 79% in the intervention and 66.4% in the control groups.
Santra[23]	2021	India	Quasi-experimental	Assess the mHealth package on medication adherence of people with TB through DOTS.	220 participants, divided into intervention and control groups. Of the total, the majority were men and over 18 years old.	Using text messages and voice calls, it was found that the group that received daily intervention increased adherence to 96.4% at the end (post-intervention) (P = 0.004)
Guo, X[24]	2020	China	Quasi-experimental	Assess acceptance of VOT for TB management.	393 participants diagnosed with pulmonary TB. There were 158 participants in the retrospective DOTS group and 235 in the VOT group, in both the majority were men, between 25 and 44 years old.	Using our own APP (video), it was found that all people were cured without recurrences.
Guo, P[25]	2020	Índia	Controlled, randomized, prospective	Assess the clinical benefit and cost-effectiveness of video therapy (VDOT) compared to the DOTS service.	405 participants diagnosed with pulmonary TB for the first time. Of the total, 203 went to VDOT and 202 to DOTS. The age ranged between 18 and 89 years old, with the majority being men.	Using an asynchronous video app, treatment completion rates were 96.1% with VDOT and 94.6% with DOTS.

quantitative studies, two[23-24] studies were considered to be of high quality, while one[20] studies were considered to be of moderate quality. Two[20,24] studies have shown inconsistencies in sample selection (selection bias), inconsistencies in the measurements used (measurement bias) and confounding factors related to the sample conduct. The quantitative descriptive studies[18-19] were classified as suspect of moderate quality, due to weaknesses in sampling strategy that was not relevant to address the quantitative research question as well as the sample size that was not representative of the population.

DISCUSSION

This study aimed to describe the use of digital health technologies to assist with adherence to TB treatment. It was observed that technologies, such as reminders via SMS, synchronous and asynchronous videos, and voice calls, are resources that can effectively contribute to TB treatment, increasing medication adherence rates and, consequently, improving disease cure rates.

In the systematic review, the technological strategies used in the interventions included automatic text messages to remind users of appointments and medi-

Table 1. Assessment of quality of evidence of included studies according to MMAT (2020-2022).

Design	Rating criteria				
Randomly controlled quantitative (trials)	**Randomization, sequence generation**	**Allocation concealment**	**Complete outcome data (80% or more)?**	**Low withdrawal/ dropout (below 20%)?**	**Comments**
Bao, 2022	****	****	****	****	High quality is suspected
Al-Sahafi, 2021	****	****	****	****	High quality is suspected
Gashu, 2021	****	****	****	****	High quality is suspected
Guo P, 2020	****	*	****	****	High quality is suspected
Non-randomized quantitative	**Minimum selection bias**	**Appropriate measures**	**Comparable study groups or differences represented by these groups**	**Outcome data 80% or greater, response rate 60% or greater, or acceptable rate of follow-up**	**Comments**
Santra, 2021	****	****	****	****	High quality is suspected
Guo X, 2020	**	**	***	****	High quality is suspected
Perry, 2021	*	*	*	***	Moderate quality is suspected
Quantitative descriptive	**Sampling strategy relevant to the research question**	**Representative sample of the population**	**Appropriate measures**	**Response rates equal to or greater than 60%**	**Comments**
Peinado, 2022	*	*	****	****	Moderate quality is suspected
Bachina, 2021	*	*	****	****	Moderate quality is suspected

Scores ranging from 25% (*)-one criteria met- to 100% (****)-all criteria met.

cation times as well as motivating phrases. Conversation channels were also used to answer questions about the side effects of medications, voice calls with healthcare professionals and asynchronous videos to observe medication taking. These strategies are aligned with what the literature demonstrates about the use of technologies.[28-29]

Medication self-management is a fear of many health professionals, who are resistant to adopting technologies within health services. However, the results of Perry's study[20] contradict these concerns, since, even with a higher incidence of missed doses using the combined SMS and video strategy, cure rates in the intervention group were better in relation to treatment completion. Likewise, the study by Bachina[19] showed different results, with greater medication adherence in the technological intervention group that used the same strategy. This indicates that the same technology can present different results depending on the context.

Technologies contain resources that can be considered a strategic approach to overcome nonadherence to TB treatment, which is one of the main predictors of resistant forms of the disease and treatment relapse. These factors make the process of healing and containing the disease difficult, damaging people's quality of life.[31]

However, the use of technological resources has shown significant results in the persistence of drug treatment, with all articles demonstrating that adherence was equal or better than in the control group that used DOT, as in Bao's article,[21] in which the DOT group has a tendency to gradually stop monitoring until abandoning it completely.

Several factors can influence the decision-making of people with TB, such as socioeconomic factors, access to health services, social protection actions and lack of information or knowledge about the disease.[5] In this sense, technology can also be a resource to assist in the decision-making process of a person diagnosed with TB to adhere to treatment. It was observed that, whenever there was an option to choose between the approach with digital technology or traditional DOT, the preference was for the technological approach. Furthermore, an important factor in choosing VDOT was the optimization of time, avoiding waiting for care and/or transportation when traveling to the reference health unit to receive DOTS.

The technologies used in the studies were mainly synchronous VDOT, with only one study, which used asynchronous videos and SMS. VDOT has been shown

to be a viable approach to supporting TB medication adherence, even in situations where the Internet is not regularly available.This approach allows for person-centered care as well as safety, as it allows visualization of medication intake through recordings, allowing the professional to guide the correct form of administration, as recommended by DOT, but remotely.[28,29]

Although strategies that use only SMS do not demonstrate in the literature that they increase adherence compared to traditional treatment, it is a strategy that has important functions, such as scheduling appointments, remembering medication times and appointments already scheduled as well as signaling problems, if they arise, from adverse effects to delays.Another advantage is its simplicity, low cost and popularity, as it is available on all cell phones.[28,29]

In the study by Guo *et al*. (2020),[25] the strategy used was SMS, and graphics and images were sent in these messages, in order to also include illiterate people. Inclusion strategies are extremely important, given that TB is a disease that mostly affects people in socially vulnerable situations, and is associated with low education.[28,29]

Three[18,23,26] studies (33.3%) included in the review originate from countries considered emerging and developing, which demonstrates an interest on the part of low-income countries in implementing digital health as a strategy to overcome access barriers to health services, improving quality of care provision and advancing improvements in health indicators, as recommended by the End TB Strategy.[1,28]

It should be noted that, among the studies found in the literature review, developed countries, such as the United States of America and China, also demonstrated that they seek to understand the adoption of digital technology in TB treatment, thus aiming to better serve the population with TB.[1,29]

Some studies[24,25] have shown that the use of digital technologies significantly reduced transportation costs for users, since in these countries the health service does not offer free transportation or tickets.[30] In a scenario of global economic crisis, further aggravated by the COVID-19 pandemic, where social inequalities have become even more exacerbated, the use of digital resources to monitor cases becomes essential. Therefore, the use of digital technologies for the sustainability of DOT is considered a valid, safe and effective strategy, bringing several benefits to both users and the health service, highlighting cost reduction and time optimization for professionals and people with TB.[30]

It is noteworthy that only three studies described in detail which technologies were being applied, using Emocha Mobile Health®.[19,20] and WeChat®.[21] The technology used in each study was little discussed, which raises an important gap in knowledge, as better exploring available technologies and relying on examples and experience reports can help managers define strategies and devices to ensure quality of care and adherence to treatment.

The plurality of approaches that technology allows us to explore is wide, and studies show that, in general, technologies are a way of bringing users and health professionals closer together and considering people with TB, considering their autonomy, believing that they want to be treated. This involves working with mutual responsibility and making them the protagonist of their treatment.[1,2,28,29]

Despite the great potential for adherence to medications and achieving a cure outcome, scientific evidence is still limited, and there is a need for further investigations as well as more assertive criteria. Furthermore, it is important to define the names of the applications used and assess the cost of implementing the technology. It is also noteworthy that the grouping of heterogeneous studies did not allow for a qualitative synthesis.

Digital health is not intended to replace conventional treatment, and it is crucial that the strategy used in treatment is centered on people with TB, respecting their needs and, above all, their preferences. The use of digital health among people diagnosed with TB can be a great complementary strategy to health services, with the aim of increasing adherence to treatment and impacting the disease's epidemiological data in the country.[28-29]

CONCLUSION

The use of health technologies as well as conventional treatment appears to be complementary and fundamental for TB control, based on the evidence found in the study countries. It is important to give greater visibility and encouragement to social issues related to understanding the particularities of each person living with the disease, aiming to contemplate and complete treatment.

The systematic review highlighted the relevance of using digital health for TB treatment and its contribution to improving adherence. These results are aligned with the Sustainable Development Goals of the 2030 agenda, especially goal 3.3, which seeks to promote person-centered care rather than just controlling them.

Digital health involves strengthening the bond, the use of an intercultural language, co-responsibility and individuals' leading role in their health-disease process. Digital health does not consist of robotization and mechanization of care, but rather the complementation of the essential basis of care, which is based on human relationships.

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AUTHORS' CONTRIBUTIONS

Ariela Fehr Tártaro and **Ricardo Alexandre Arcêncio** contributed to study conception and design, analysis and interpretation of results, manuscript content writing and critical review.

Ruan Victor dos Santos Silva and **Juliana Soares Tenório de Araújo** contributed to data analysis and interpretation, manuscript content writing and critical review.

Antônio Carlos Vieira Ramos, **Thaís Zamboni Berra**, **Yan Mathias Alves**, **Maria do Socorro Nantua Evangelista** and **Miguel Angel Fuentealba-Torres** contributed to study conception and design, manuscript content writing and critical review. All authors approved the final version to be published and are responsible for all aspects of this work, including ensuring its accuracy and integrity.