

## 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*

<https://doi.org/10.17058/reci.v13i3.18255>

Received: 14/03/2023

Accepted: 22/05/2023

Available online: 08/09/2023

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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-three 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-

Rev. Epidemiol. Controle Infecç. Santa Cruz do Sul, 2023 Jul-Set;13(3):158-163. [ISSN 2238-3360]

Please cite this article as: Figueiredo Veríssimo P, Araujo da Silva AR. Disponibilidade de recursos e equipamentos complementares para uso na prevenção de infecções relacionadas à assistência à saúde. Rev Epidemiol Control Infect [Internet]. 11º de novembro de 2023 [citado 20º de novembro de 2023];13(3). Disponível em: <https://online.unisc.br/seer/index.php/epidemiologia/article/view/18255>



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.<sup>1</sup> 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.<sup>2</sup> According to the Centers for Disease Control and Prevention (CDC), one in 31 hospitalized patients will acquire at least one HAI.<sup>3</sup> 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.<sup>4</sup>

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.<sup>5</sup>

New resources and equipment can impact HAI control and prevention.<sup>6</sup> 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.<sup>7</sup> 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.<sup>8,9</sup>

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<sup>6</sup>. 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.<sup>7</sup>

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.<sup>10,11</sup> 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.<sup>10,12</sup>

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.<sup>13</sup> 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.<sup>14,15</sup> 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.<sup>16</sup>

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.<sup>17</sup> 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.<sup>18</sup> 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.

## ACKNOWLEDGMENTS

To Debora Otero Britto Passos Pinheiro, coordinator of the social media group of infection controllers from Rio de Janeiro State, Brazil.

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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.