Infectious Diseases

Analysis and Impact of Infection Prevention Procedures in Long-Term Care Facilities

FEDERICO VITI[1], ALESSANDRA CARTOCCI[2], ROBERTO PERINTI[3], GIOVANNI GUARDUCCI[1], NICOLA NANTE[1,4]
[1] Post Graduate School of Public Health, University of Siena, Italy; [2] Department of Medical Sciences, Surgery and Neurosciences, University of Siena, Italy; [3] Department of Technical Health Professions in Rehabilitation and Prevention, Tuscany South-East Local Health Authority, Italy; [4] Department of Molecular Medicine and Development, University of Siena, Italy

Keywords

Infection control • Prevention procedures • Long-term care facilities • Infection risk management

Summary

Background. *Healthcare-associated infections (HAIs) are a significant healthcare complication, with major implications for public health. In the EU/EEA, up to 2.6 million new HAIs cases occur annually, causing significant burdens and economic costs. In Italy, the prevalence of HAIs is rising due to factors like invasive devices, antibiotic resistance, and poor infection control. The aim of this work is to evaluate the effectiveness of HAIs containment practices in long-term care facilities (LTCF).*

Materials and methods. *This cross-sectional study included eight LTCF inspected by Prevention Technicians of the Local Health Authority Tuscany South-East (LHA-TSE) in 2023. The study evaluated non-compliance in procedures for legionellosis prevention, cleaning and disinfection, laundry management, management of pans, HAIs prevention, healthcare tools disinfection, and hairdressing services. Data were analysed using descriptive statistics and the Mann Whitney test to compare infection rates with procedure compliance.*

Results. *In 2023, 606 infections were reported in the eight enrolled LTCF. The most frequent infections were COVID-19 (19.4%), urinary tract infections (16.9%), pharyngitis (15.6%), and influenza-like illness (ILI) (15%). For the "Laundry Procedure," 3 LTCF were compliant and 5 were not, showing a significant relationship with influenza syndromes (p = 0.02) and surgical site infections (p = 0.04). For the "Cleaning Check" procedure, non-compliance was linked to higher fungal infections (p = 0.01) and gastroenteritis (p = 0.04). The "Disinfection of Health Tools procedure showed non-compliance correlated with higher gastroenteritis (p = 0.04) and conjunctivitis (p = 0.01). Gastrointestinal infections from* Clostridium difficile *were linked to non-compliance with "HAIs Procedures Routes" (p = 0.04), "Pans" processes (p = 0.04), and cleanliness in the hairdressing service (p = 0.04). Herpes simplex or Herpes zoster infections were higher in LTCF with non-compliant hairdressing service rooms (p = 0.02). Two legionellosis cases were recorded in LTCF with reported non-compliance in analytical procedures for Legionellosis.*

Conclusions. *Our analysis showed significant correlations between cleanliness procedures and reductions in fungal infections, gastroenteritis, and ear infections. Compliance in laundry procedures was linked to ILI and surgical site infections. Non-compliance in healthcare tools correlated with higher rates of gastroenteritis and conjunctivitis, highlighting the need for stronger practices. The data suggest that effective prevention measures reduce HAIs, though discrepancies in implementation across facilities call for standardization and continuous monitoring.*

Introduction

Healthcare-related infections (HAIs) are caused by bacteria, viruses, or other pathogens. HAIs are the most frequent complications that occur in all healthcare settings (hospitalization facilities, outpatient facilities, local residential facilities, *etc.*) [1-3].

They can be related to endogenous transmission mechanisms, caused by bacteria within the body. Still, more frequently they are related to exogenous transmission events, from person to person or derived from the environment [4-6]. HAIs also represent a public health problem, as they generate additional treatment costs, a reduction in quality of life and an increase in the risk of morbidity and mortality [3-7].

Every year in the European Union and in the European Economic Area up to 2.5 million new cases of HAIs occur, and the most common HAIs are pneumonia, urinary tract infection, surgical site infection, *Clostridium difficile* infection, neonatal sepsis, and primary bloodstream infection. In addition, the burden of HAIs has been estimated at 501 disability-adjusted life years (DALYs) per 100,000 population [8].

The global report published by the World Health Organization highlights that in Europe HAIs cause 16 million additional days of hospitalization, 37,000 directly attributable deaths and 110,000 deaths for which the infection represents a contributory cause. The direct costs of these infections are approximately estimated at around 7 billion Euros [9].

According to the PPS3 (Point Prevalence Survey) report, published in 2022, the Italian prevalence of HAIs is higher than that reported in PPS2, published in 2016/2017, and the European prevalence [10]. The highly specialized hospitals, where the number of beds and days of hospitalization are greater, are probably more at risk since they are more concentrated on fragile patients with high care intensity [10].

With the general aging of the population, long-term

care facilities (LTCFs) are increasingly needed, and those that already exist are crowded. The elderly who are residents in these facilities have an increased risk of contracting HAIs as they are used to share facilities with other residents, to live in a confined environment, to have risky contact with staff, or with improperly performed procedures [11, 12]. However, the results of a 2017 European survey show a higher prevalence of HAIs in acute hospital settings than LTCFs, while the latter need to pay more attention to the phenomena of antimicrobial resistance (AMR) [13].

A 2019 Dutch study demonstrating the decreasing trend of HAIs in LTCFs participating in a national surveillance network implies that surveillance is a valuable addition to current strategies to optimize infection control [11].

Among the main factors contributing to the increase of HAIs, there is the use of invasive medical devices such as venous catheters, urinary catheters, and ventilators, as well as the extensive use of antibiotics, which has promoted the spread of multidrug-resistant organisms [14, 15]. However, the poor application of environmental hygiene and infection prevention and control measures in healthcare settings cannot be underestimated [16]. Environmental monitoring confirms the persistence of contamination of objects, equipment, and beds placed in rooms of colonized/infected patients [17].

Frequent cleaning of high-touch surfaces is crucial to prevent the spread of infections, while regular cleaning and disinfection of the patient's environment can reduce the contamination and the risk of HAIs [18, 19].

The Italian Regulatory System, which regulates the organization of LTCFs, requires documented procedures for cleaning, waste treatment, laundry/wardrobe management, prevention of water-borne diseases through the internal water network and specific protocols for infectious diseases [20, 21].

These procedures must therefore describe the most suitable methods to carry out the operations and/or the necessary prevention measures to be adopted to contain infections [22].

For these reasons, this work has the aim of investigating the methods of drafting the procedures for the containment of HAIs and of correlating the presence and the compliance to these procedures with the incidence of HAIs LTCFs.

Material and methods

Study population

This is a cross-sectional study conducted in Tuscany (Italy) in 2023. The structures included in the study were monitored by Prevention Technicians of the Public Hygiene and Nutrition Unit of the Local Health Authority Tuscany South-East (LHA-TSE). The included structures were eight. One out of 8 has 325 beds, six have between 40 and 60 beds, one 20 beds.

The population is constituted by frail elderly individuals with chronic conditions and physical and/or cognitive disabilities. These are individuals who are either fully dependent or have a mild level of independence.

This type of control is carried out according to the criteria adopted with the General Director's Resolution no. 546 of 16/05/202312 with which specific check lists for supervisory activities were approved.

Infections evaluated

Each LTCF included in the study received a form for the collection of cases of HAIs diagnosed in its structure in 2023 [23]. The types of infections to be included in the study were extrapolated from the pilot study carried out by University of Turin with the support of the Italian National Institute of Health and the Ministry of Health in 2023 [24].

The list included: urinary tract infections, pharyngitis, Influenza-Like-Illness (ILI), pneumonia, Legionellosis, other lower respiratory tract infections (RTI), COVID-19, surgical site infections, skin infections (cellulitis, soft tissue, wound infection), scabies, *Herpes* simplex or *Herpes* zoster, fungal infection, gastroenteritis, *Clostridium difficile* infection, conjunctivitis, ear infections, sinusitis, oral Infections or Candidiasis, blood infections, Fever of unknown origin (FUO).

Presence and compliance of procedures

The procedures considered in this study are categorized into the following macro areas: prevention of Legionella, cleaning and disinfection of the premises, laundry management, management of pans, procedures for the prevention of HAIs, disinfection of healthcare instruments, and management of the hairdressing service. Each macro area includes specific items, and for each item the Environmental Health and Safety Technicians assess the compliance or non-compliance, as well as the presence or absence of the procedures. For a detailed description of these procedures, see Supplementary Material 1, where each macro area is further described.

For the prevention of legionellosis, reference was made to the 2015 guidelines of the Italian Ministry of Health and to the report of the Italian National Institute of Health "ISTISAN 22/32" where the standards for quality of water in priority buildings were descripted in order to identify the critical points [25, 26].

For the cleaning and disinfection procedures of the premises, reference was made to the guidelines produced by National Association of Hospital Management Physicians (ANMDO) [27].

Statistical analysis

A preliminary descriptive an analysis was conducted. The absolute frequency and percentages to summarize the qualitative variables and median and interquartile range for the quantitative ones were performed.

The number of infections with the compliance at procedures, through the Mann Whitney test was compared. Statistical comparisons were performed only for infections with at least 10 cases. Statistical tests were considered significant with a p-value < 0.05. The analyses were carried out with STATA version 13.0.

Results

Figure 1 shows the 606 infections reported in the eight enrolled structures in 2023. In particular, 118 cases of COVID-19 (19.5), 103 urinary tract infections (17.0%), 95 pharyngitis (15.7%), 91 Influenza-Like-illness (15.1%), 54 Pneumonia (8.9%), 40 fungal infection (6.6%), 32 Conjunctivitis (5.3%), 15 oral infections or Candidiasis (2.5%), 14 skin infections (2.3%), 13 Gastroenteritis (2.1%), 11 Scabies (1.8%), 6 infection of *Herpes* simplex or *Herpes* zoster (1.0%), 5 ear infections (0.8%), 3 *Clostridium difficile* infection (0.5%), 2 cases of legionnaires' disease (0.3), 2 other lower respiratory tract infections (RTI) (0.3%), 2 surgical site infections (0.3). Excluding SARS-CoV-2, the three more prevalent infections were urinary tract infections, pharyngitis, and ILI.

Table I shows the Distribution of infections according to presence and compliance to laundry procedures. In particular, 5 structures of 8 did not have a laundry procedure and 6 were non-compliant to guidelines (Failure to identify dirty clean paths; Failure to label guests' clothing.

Lack of instructions in the procedure on the collection, handling and washing of clothes from infected subjects). Structures with laundry procedures had a significantly lower prevalence of ILI than the structures that had not laundry procedures ($p < 0.05$,0 [0-2] *vs* 30 [13-40]).

Similar results were obtained for the compliance to the laundry guidelines. A significant difference was observed in ILI cases ($p = 0.04$), non-compliant structures had significantly higher rate of ILI (35 [30-40] *vs* 1 [0-6]), and in pneumonia cases, non-compliant structures had significantly higher rate of cases (18 [8-28] *vs* 3 [0-5], $p = 0.04$). Significantly higher presence of non-COVID infections was also observed in structures without laundry procedures ($p = 0.02$, 109 [98-125] *vs* 20 [14-24]) and non-compliant to guidelines ($p = 0.04$, 117 [109-125] *vs* 22 [14-94]).

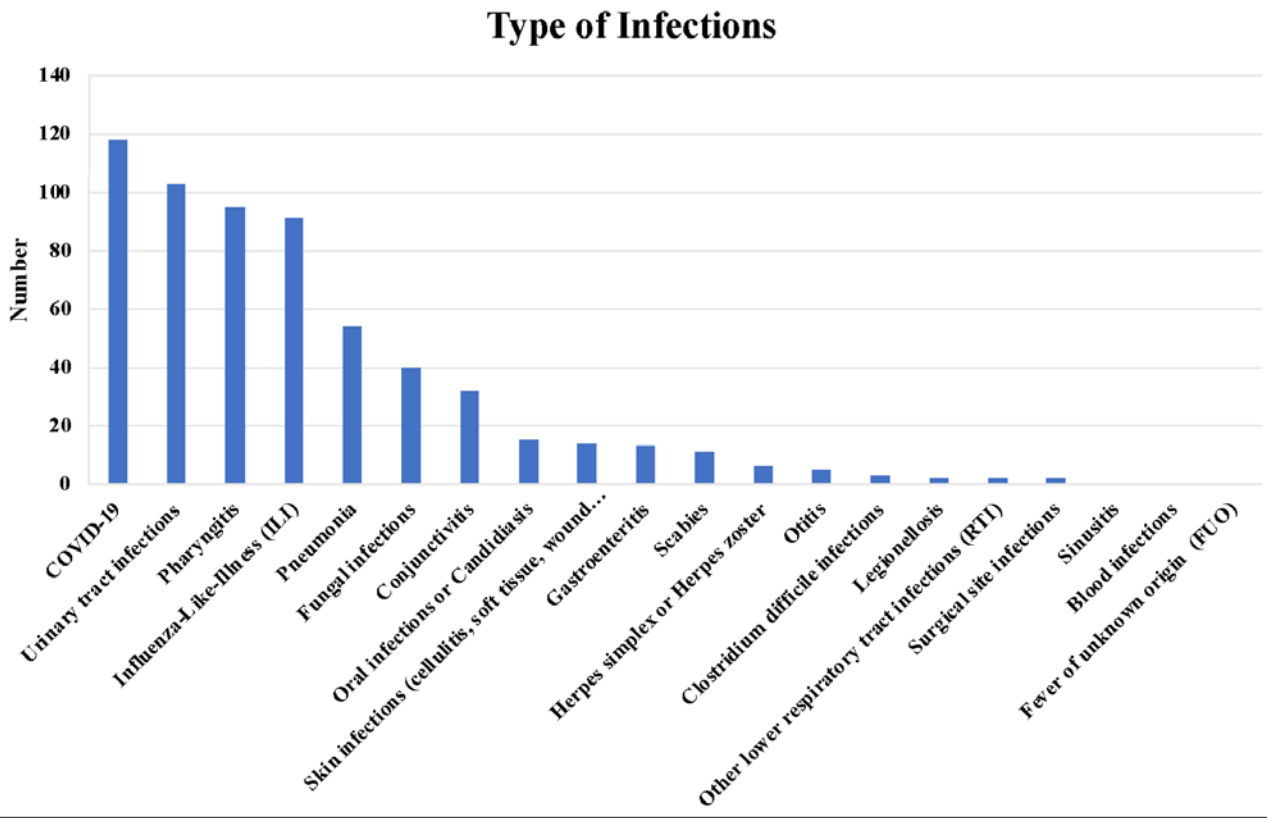
Distribution of infections according to adequacy hairdressing service room were shown in Table II. The rooms set up for the hairdressing service were found to be adequate in 2 structures and not in 6. Non-compliant structures, for professional and/or authorization requirements of the hairdresser compliant with regional legislation and with unavailability of equipment or products for thermal or chemical disinfection of hairdresser's tools, seem to correlate with a greater number of urinary tract infections ($p = 0.04$, 27 [20-34] *vs* 7.5 [2-15]). The same was found for the conjunctivae ($p = 0.03$, 12 [11-13] *vs* 0 [0-3]).

Table III shows the distribution of infections according to the item "Cleaning process verification system" of the macro area "Cleaning and disinfection process of the premises" an "Disinfection of healthcare tools" like:

Urinary and respiratory devices: catheters, syringes, urinary probes, respiratory suction devices

Vital sign monitoring devices: thermometers, blood

Fig. 1. Distribution of most frequent infections according to procedures.



Tab. I. Distribution of infections according to compliance of laundry procedures

	Presence of laundry procedures			Compliance to laundry guidelines		
Compliant	Yes N = 3	No N = 5	p	Yes N = 2	No N = 6	p
Infections	Median [IQR]			Median [IQR]		
Urinary tract infections	6 [2-15]	16 [9-34]	0.17	7.5 [2-15]	25 [16-34]	0.09
Pharyngitis	0 [0-6]	20 [14-30]	0.09	3 [0-20]	22 [14-30]	0.17
Influenza syndrome	0 [0-2]	30 [13-40]	0.02	1 [0-6]	35 [30-40]	0.04
Pneumonia	1 [0-5]	8 [5-28]	0.07	3 [0-5]	18 [8-28]	0.04
Fungal infection	0 [0-2]	1 [0-34]	0.52	1 [0-3]	0.5 [0-1]	0.59
Conjunctivitis	0 [0-3]	5 [0-11]	0.52	1.5 [0-5]	5.5 [0-11]	0.85
Oral infections	0 [0-0]	2 [0-3]	0.39	0 [0-3]	1 [0-2]	1.00
Skin Infection	2 [0-3]	2 [0-4]	0.75	2.5 [0-3]	1 [0-2]	0.38
Gastroenteritis	0 [0-0]	2 [0-10]	0.12	0 [0-1]	5 [0-10]	0.44
Scabies	0 [0-0]	0 [0-0]	0.43	0 [0-0]	0 [0-0]	0.56
Tot. NON COVID-19 infection	20 [14-24]	109 [98-125]	0.02	22 [14-94]	117 [109-125]	0.04

Tab. II. Distribution of infections according to compliance to the hairdressing service room procedures.

	Compliance to the hairdressing service room guidelines		
Compliant	Yes N = 2	No N = 6	p
Infections	Median [IQR]		
Urinary tract infections	7.5[2-15]	27 [20-34]	0.04
Pharyngitis	3 [0-20]	19.5 [14-25]	0.30
Influenza syndrome	1 [0-13]	23 [6-40]	0.17
Pneumonia	3 [0-5]	7.5 [7-8]	0.17
Fungal infections	0 [0-2]	2 [1-3]	0.28
Conjunctivitis	0 [0-3]	12 [11-13]	0.03
Oral infections	0 [0-2]	5 [0-10]	0.44
Skin infections	2 [0-3]	1.5 [0-3]	0.86
Gastroenteritis	0 [0-0]	5.5 [1-10]	0.05
Scabies	0 [0-0]	0 [0-0]	0.56
Tot. NON COVID-19 infection	22 [14-98]	109.5 [94-125]	0.18

pressure cuffs, stethoscopes, pulse oximeters, digital thermometers.

Four structures had failure to adopt a cleaning process verification system and the fungal infections and gastroenteritis are significantly more present in this structure (fungal infections p = 0.01, 2.5 [1.5-18.5] *vs* 0 [0-0]) (gastroenteritis p = 0.04, 1.5 [0.5-6] *vs* 0 [0-0]).

The "Disinfection of health instruments " procedure was found non-compliant in 4 structures due to unavailability of equipment or products for thermal or chemical disinfection of medical instruments.

Non-compliance is correlated with a greater number of gastroenteritis (p = 0.04, 1.5 [0.5-6] *vs* 0 [0-0]). Same thing for conjunctivitis (p = 0.01, 8 [4-12] *vs* 0 [0-0]).

Regarding infections with low incidence (< 5 cases), we found 3 cases of gastrointestinal infections from *Clostridium difficile* in two structures. One structure was not compliant with the identification of horizontal and vertical accesses and routes, structurally and/or functionally distinct, both for people (guests, healthcare workers, GPs, suppliers) and for goods and materials (separation of dirty/clean routes for food, linen, waste) and the other to non-application of physical or chemical disinfection system for the reconditioning of bedpans.

Still regarding infections with few cases, we have recorded two cases of surgical site infection in two facilities, one of which showed no compliance in laundry procedures.

Finally, regarding the two cases of legionellosis, they were recorded in 2 structures where a "Failure to adopt corrective measures following analytical non-conformities detected in self-monitoring" had been reported.

Discussion

Awareness of the importance of basic hospital hygiene is therefore of fundamental importance, together with formal monitoring, feedback to cleaners and surveillance of the main environmental pathogens [16].

Based on the results obtained from the cross-sectional study conducted to evaluate the prevalence and relationships between infection prevention practices and their incidence in some LTCF, some significant conclusions emerge.

As regards the prevalence of infections, the most frequent in the year 2023 were those from SARS-CoV-2, followed by urinary tract infections, pharyngitis, influenza syndromes and pneumonia. Results in line with those obtained from the 2022 report "Prevalence study on healthcare-related infections and the use of antibiotics in non-hospital social and healthcare facilities", which recorded a predominantly respiratory (40.6%) and urinary localization (28.1%) [10]. These results reflect the importance of specific preventive strategies for these pathologies.

Tab. III. Distribution of infections according to cleaning process verification system and compliance to the disinfection of healthcare instruments procedures.

	Cleaning process verification system			Compliance to the disinfection of healthcare instruments		
Compliant	Yes N = 4	No N = 4	p	Yes N = 4	No N = 4	p
Infections	Median [IQR]			Median [IQR]		
Urinary tract infections	10.5[4-15.5]	14.5[5-27]	0.56	8.5 [1.5-15.5]	14.5 [7.5-27]	0.24
Pharyngitis	3[0-18]	17[7-22.5]	0.55	0 [0-15]	17 [10-22.5]	0.23
Influenza syndrome	1[0-16]	9.5[3-26.5]	0.37	0 [0-15]	9.5 [4-26.5]	0.13
Pneumonia	3[0.5-26.5]	6[2.5-7.5]	0.77	3 [0.5-16.5]	6 [2.5-7.5]	0.77
Fungal infection	0[0-0]	2.5[1.5-18.5]	0.01	0 [0-1]	2 [0.5-18.5]	0.16
Conjunctivitis	0[0-1.5]	8[2.5-12]	0.09	0 [0-0]	8 [4-12]	0.01
Oral infections	0[0-1]	1.5[0-6.5]	0.32	0 [0-1]	1.5 [0-6.5]	0.32
Skin infections	2[1-2.5]	1.5[0-3.5]	0.88	1 [0-2]	3 [1.5-3.5]	0.13
Gastroenteritis	0[0-0]	1.5[0.5-6]	0.04	0 [0-0]	1.5 [0.5-6]	0.04
Scabies	0[0-5.5]	0[0-0]	0.31	0 [0-5.5]	0 [0-0]	0.31
Tot. NON COVID-19 infection	22[17-66.5]	96[49-111.5]	0.56	19[9-66.5]	96[57-111.5]	0.24

The analysis highlighted significant correlations between some prevention procedures and the incidence of specific infections. The presence of cleanliness verification procedures has been associated with a reduction of the number of fungal infections, ear infection and gastroenteritis. For the latter, although it has been observed that cleanup alone may not be able to prevent an outbreak, it is critical to reducing its impact [28]. In addition, the surveillance of fungal infection is crucial, in fact this one are increasingly common problems in inpatient settings, and episodes of infection with new and rare species of fungi are becoming more frequent [29, 30].

Similarly, the presence of compliant procedures in laundries is correlated with a lower prevalence of flu syndromes and surgical site infections. However, data are limited regarding the association between tissue characteristics and the risk of surgical site infection [31]. Regular cleaning and disinfection of all laundry areas is necessary to prevent recontamination of washed textiles during post-wash handling processes [32]. This is especially important in healthcare laundry, where textiles meet vulnerable patients and antibiotic-resistant microorganisms are increasingly prevalent. However, there are currently no international standards for validating and monitoring the effectiveness of industrial laundering processes [33]. Alternatively, they might consider using disposable materials where possible and cost allowing [31].

Although further studies are needed, a 2022 systematic review demonstrates a strong relationship between interventions to improve healthcare environmental hygiene and the reduction of both environmental bacterial load and colonization of patients or HAIs [34]. The need to improve specific procedures appears evident, some areas have emerged as critical points that require particular attention. For example, non-compliance in the disinfection of healthcare tools is associated with an increase in gastroenteritis and conjunctivitis, suggesting the need to strengthen these practices. In fact, these two infections are often caused by viruses that can be acquired from healthcare tools [35, 36]. Since their effective disinfection and sterilization plays a key role in preventing morbidity and mortality due to infectious diseases [37].

The importance of the adequacy of procedures in additional services also emerged. Additional services, such as hairstyling services, also require specific procedures to ensure user safety. Lack of local adjustments and instrument cleaning may be related to increased infections; in fact, hairdressing services can be a possible source of cross-contamination [38]. It is therefore necessary to increase awareness about the potential transmission of infections through common tools and products used in hairdressing and cosmetic services [39].

Regarding the 3 cases of *Clostridium difficile*, living in a LTCF is a risk factor for colonization by multi-resistant bacteria. In fact, several characteristics of this bacterium favour environmental survival and transmission of this pathogen. These include the prolonged survival of spores in the environment, frequent environmental contamination, and continued environmental contamination despite relative resistance to germicides [40]. In particular, the presence of common areas and multi-bedrooms, where hygiene procedures are not always respected, could have an impact on the risk of transmission [41]. The two cases of legionellosis, associated with structures where "non-conformity of analytical procedures for legionellosis" was detected, raise concerns about the effectiveness of monitoring and control systems for legionella. This highlights the need to ensure that all structures strictly adhere to established guidelines for the prevention of legionella, as emphasized by several studies showing that effective water management can drastically reduce the incidence of legionellosis [42]. Certainly, the complexity and organizational heterogeneity of prevention services and insufficient coordination between different levels of territorial competence do not act as factors that do not promote infection prevention [9].

Finally, it is important that the different cleaning methods available are used in a complementary way because each one analyses and quantifies different aspects of the operations necessary to achieve adequate environmental cleanliness [43]. All of this is essential to reduce the risk of infection as much as possible.

Limitations

Although the study provides valuable information on the effectiveness of infection prevention procedures, it has some limitations, such as, self-reported number of infections. In addition, the LTCFs that decided to participate in this study are few. Hence the need to confirm the results with a larger sample size.

Conclusions

Our study seems to suggest the effectiveness of prevention measures and a positive impact of their implementation, highlighting a significant reduction in HAIs. This data can be interpreted as an encouraging sign, indicating that sanitation practices are tangibly contributing to improving patient and staff safety in LTCF.

However, the discrepancies observed between different LTCF raise interesting questions regarding the consistency in the implementation of prevention practices. There may be significant variations in the resources available, the protocols followed and the adequacy of staff training, which could influence the results obtained. This raises the need for standardization and continuous monitoring of prevention practices.

Finally, it seems clear that there are still numerous challenges to face to guarantee a uniform level of safety in LTCF. The development of more effective and sustainable strategies for infection prevention will require a continuous commitment to monitoring and updating practices to ensure a safe environment for patients and operators themselves. Adopting a proactive and collaborative approach, involving all stakeholders, is essential to address emerging challenges and to consolidate the progress achieved, in order to ensure high standards of safety and care in LTCF.

The future of infection control lies in the adoption of advanced technologies, the integration of infection control into patient safety initiatives, the promotion of collaboration and the empowerment of patients.

Conflict of Interest statement

The Authors declare that there is no conflict of interest.

Authors' contributions

Conceptualization: RP, GG, NN; Methodology: FV, AC, GG; formal analysis: AC; data Curation: FV, RP; Writing, original draft preparation: FV, RP, GG; Writing, review and editing: FV, AC, RP, GG, NN; Visualization: FV; Supervision: NN; Project administration: FV, GG. All authors approved the final version of the manuscript.

References

[1] Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, Lynfield R, Maloney M, McAllister-Hollod L, Nadle J, Ray SM, Thompson DL, Wilson LE, Fridkin SK; Emerging Infections Program Healthcare-Associated Infections and Antimicrobial Use Prevalence Survey Team. Multistate point-prevalence survey of health care-associated infections. N Engl J Med 2014;370:1198-208. https://doi.org/10.1056/NEJMx210023.

[2] Allegranzi B, Bagheri Nejad S, Combescure C, Graafmans W, Attar H, Donaldson L, Pittet D. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. Lancet 2011;377:228-41. https://doi.org/10.1016/S0140-673661458-4.

[3] Cassini A, Plachouras D, Eckmanns T, Abu Sin M, Blank HP, Ducomble T, Haller S, Harder T, Klingeberg A, Sixtensson M, Velasco E, Weiß B, Kramarz P, Monnet DL, Kretzschmar ME, Suetens C. Burden of Six Healthcare-Associated Infections on European Population Health: Estimating Incidence-Based Disability-Adjusted Life Years through a Population Prevalence-Based Modelling Study. PLoS Med 2016;13:e1002150. https://doi.org/10.1371/journal.pmed.1002150.

[4] Vincent JL, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, Moreno R, Lipman J, Gomersall C, Sakr Y, Reinhart K; EPIC II Group of Investigators. International study of the prevalence and outcomes of infection in intensive care units. JAMA 2009;302:2323-9. https://doi.org/10.1001/jama.2009.1754.

[5] Klevens RM, Edwards JR, Richards CL Jr, Horan TC, Gaynes RP, Pollock DA, Cardo DM/. Estimating health care-associated infections and deaths in U.S. hospitals, 2002. Public Health Rep 2007;122:160-6. https://doi.org/10.1177/003335490712200205.

[6] Stone PW, Mooney-Kane C, Larson EL, Horan T, Glance LG, Zwanziger J, Dick AW. Nurse working conditions and patient safety outcomes. Med Care 2007;45:571-8. https://doi.org/10.1097/MLR.0b013e3180383667.

[7] Arefian H, Hagel S, Heublein S, Rissner F, Scherag A, Brunkhorst FM, Baldessarini RJ, Hartmann M. Extra length of stay and costs because of health care-associated infections at a German university hospital. Am J Infect Control 2016;44:160-6. https://doi.org/10.1016/j.ajic.2015.09.005.

[8] Ministero della Salute. Piano nazionale della Prevenzione 2020-2025. Available at: https://www.salute.gov.it/portale/prevenzione/dettaglioContenutiPrevenzione.jsp?id=5772&area=prevenzione&menu=vuoto (Accessed on: 08/08/2024).

[9] World Health Organization 2022, Global report on infection prevention and control. Available at: https://iris.who.int/bitstream/handle/10665/354489/9789240051164-eng.pdf?sequence=1 (Accessed on: 10/08/2024).

[10] National Point Prevalence Survey (PPS-3) of Healthcare Associated Infections (HAI) and Antibiotic Use in Acute Care Hospitals. Available at: https://www.epicentro.iss.it/sorveglianza-ica/pdf/Summary%20report%20PPS3.pdf (Accessed on: 12/08/2024).

[11] Haenen APJ, Verhoef LP, Beckers A, Gijsbers EF, Alblas J, Huis A, Hulscher M, de Greeff SC. Surveillance of infections in long-term care facilities (LTCFs): The impact of participation during multiple years on health care-associated infection incidence. Epidemiol Infect 2019;147:e266. https://doi.org/10.1017/S0950268819001328.

[12] Tesini BL, Dumyati G. Health Care-Associated Infections in Older Adults: Epidemiology and Prevention. Infect Dis

Clin North Am 2023;37:65-86. https://doi.org/10.1016/j.idc.2022.11.004.

[13] Suetens C, Latour K, Kärki T, Ricchizzi E, Kinross P, Moro ML, Jans B, Hopkins S, Hansen S, Lyytikäinen O, Reilly J, Deptula A, Zingg W, Plachouras D, Monnet DL; Healthcare-Associated Infections Prevalence Study Group. Prevalence of healthcare-associated infections, estimated incidence and composite antimicrobial resistance index in acute care hospitals and long-term care facilities: results from two European point prevalence surveys, 2016 to 2017. Euro Surveill 2018;23:1800516. https://doi.org/10.2807/1560-7917.ES.2018.23.47.181122e1.

[14] Weiner LM, Webb AK, Limbago B, Dudeck MA, Patel J, Kallen AJ, Edwards JR, Sievert DM. Antimicrobial-Resistant Pathogens Associated With Healthcare-Associated Infections: Summary of Data Reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2011-2014. Infect Control Hosp Epidemiol 2016;37:1288-301. https://doi.org/10.1017/ice.2016.174.

[15] Messina G, Ceriale E, Lenzi D, Burgassi S, Azzolini E, Manzi P. Environmental contaminants in hospital settings and progress in disinfecting techniques. Biomed Res Int 2013;2013:429780. https://doi.org/10.1155/2013/429780.

[16] Dancer SJ. Controlling hospital-acquired infection: focus on the role of the environment and new technologies for decontamination. Clin Microbiol Rev 2014;27:665-90. https://doi.org/10.1128/CMR.00020-14.

[17] Lemmen SW, Häfner H, Zolldann D, Stanzel S, Lütticken R. Distribution of multi-resistant Gram-negative versus Gram-positive bacteria in the hospital inanimate environment. J Hosp Infect 2004;56:191-7. https://doi.org/10.1016/j.jhin.2003.12.004.

[18] Spruce L, Wood A. Back to basics: environmental cleaning. AORN J 2014;100:54-61; quiz 62-4. https://doi.org/10.1016/j.aorn.2014.02.018. Erratum in: AORN J. 2014;100:331.

[19] Comar M, D'Accolti M, Cason C, Soffritti I, Campisciano G, Lanzoni L, Bisi M, Volta A, Mazzacane S, Caselli E. Introduction of NGS. ES-HCAI 2019;7:708. https://doi.org/10.3390/microorganisms7120708.

[20] Istituto Superiore di Sanità. (2017). ISS COVID-19 Report No. 5/2020-Interim recommendations on the sanitization of non-healthcare facilities in the current COVID-19 emergency: surfaces, indoor environments and clothing. Istituto Superiore di Sanità. Available at: https://www.iss.it/documents/20126/0/Rapporto+ISS+COVID-19+n.+5_2020+Sanificazione.pdf (Accessed on: 22/08/2024).

[21] Tuscany Region. (2018). Guidelines for the prevention and control of healthcare-associated infections (HAI). Regione Toscana. Available at: https://www.regione.toscana.it/documents/10180/147124/Linee+di+indirizzo+ICA/639eb4bb-ef0e-448c-9b06-8c3fcf2731a0 (Accessed on: 20/08/2024).

[22] Haque M, McKimm J, Sartelli M, Dhingra S, Labricciosa FM, Islam S, Jahan D, Nusrat T, Chowdhury TS, Coccolini F, Iskandar K, Catena F, Charan J. Strategies to Prevent Healthcare-Associated Infections: a Narrative Overview. Risk Manag Healthc Policy 2020;13:1765-80. https://doi.org/10.2147/RMHP.S269315.

[23] European Union, European Centre for Disease Prevention and Control. Available at: https://www.ecdc.europa.eu/en/publications-data/protocol-point-prevalence-surveys-healthcare-associated-infections-4-0 (Accessed on: 13/01/2025).

[24] Istituto Superiore di Sanità, Prevalence study on healthcare-associated infections and antibiotic use in out-of-hospital 2022. Available: https://www.epicentro.iss.it/sorveglianza-ica/pdf/REPORT%20HALT%20PILOTA%202022.pdf (Accessed on: 10/08/2024).

[25] Ministero della Salute. Piano nazionale della Prevenzione 2020-2025. Available at: https://www.salute.gov.it/portale/prevenzione/dettaglioContenutiPrevenzione.jsp?id=5772&area=prevenzione&menu=vuoto (Accessed on: 08/08/2024).

[26] ISTISAN Report 22/32-Guidelines for the assessment and management of the risk for water safety in internal distribution systems of priority and non-priority buildings and in certain ships pursuant to Directive (EU) 2020/2184. Ad hoc working group on water safety in internal water distribution systems of buildings and certain ships. Available at: https://www.iss.it/-/rapporto-istisan-22/32-linee-guida-per-la-valutazione-e-la-gestione-del-rischio-per-la-sicurezza-dell-acqua-nei-sistemi-di-distribuzione-interni-degli-edifici-prioritari-e-non-prioritari-e-in-talune-navi-ai-sensi-della-direttiva-ue-2020/2184 (Accessed on: 22/08/2024).

[27] National Association of Hospital Directors Doctors-Guideline on the evaluation of the environmental sanitation process in hospital and territorial facilities for the control of healthcare-related infections, 2019. Available at: https://www.sicp.it/wp-content/uploads/2020/03/ANMDO-linee-indirizzo-sanificazione-ambientale-ospedale-territorio-ICA-settembre-20_cprd.pdf (Accessed on: 28/08/2024).

[28] Vivancos R, Trainor E, Oyinloye A, Keenan A. Factors affecting prevention and control of viral gastroenteritis outbreaks in care homes. J Hosp Infect 2012;82:129-32. https://doi.org/10.1016/j.jhin.2012.07.003.

[29] Troiano G, Nante N. Emerging fungal infections: focus on Saksenaea Erythrospora. J Prev Med Hyg 2021;62:E382-E385. doi: 10.15167/2421-4248/jpmh2021.62.2.1953.

[30] Troiano G, Sacco C, Donato R, Pini G, Niccolini F, Nante N. Demolition activities in a healthcare facility: results from a fungal surveillance after extraordinary preventive measures. Public Health 2019;175:145-7. https://doi.org/10.1016/j.puhe.2019.07.012.

[31] Sehulster L, Chinn RY; CDC; HICPAC. Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). MMWR Recomm Rep 2003;52(RR-10):1-42.

[32] Mitchell A, Spencer M, Edmiston C Jr. Role of healthcare apparel and other healthcare textiles in the transmission of pathogens: a review of the literature. J Hosp Infect 2015;90:285-92. https://doi.org/10.1016/j.jhin.2015.02.017.

[33] Owen L, Cayrou C, Page G, Grootveld M, Laird K. Development of a Standardised International Protocol for Evaluation of the Disinfection Efficacy of Healthcare Laundry Wash Processes. Applied Microbiology 2024;4:194-214. https://doi.org/10.3390/applmicrobiol4010014.

[34] Peters A, Schmid MN, Parneix P, Lebowitz D, de Kraker M, Sauser J, Zingg W, Pittet D. Impact of environmental hygiene interventions on healthcare-associated infections and patient colonization: a systematic review. Antimicrob Resist Infect Control 2022;11:38. https://doi.org/10.1186/s13756-022-01075-1.

[35] Gordon NC. Infection control for safety and quality. Community Eye Health 2021;34:5-7.

[36] R. Orenstein. Gastroenteritis, Viral Encyclopedia of Gastroenterology 2019:652-7. https://doi.org/10.1016/B978-0-12-801238-3.65973-1.

[37] Garvey M. Medical Device-Associated Healthcare Infections: Sterilization and the Potential of Novel Biological Approaches to Ensure Patient Safety. Int J Mol Sci 2023;25:201.https://doi.org/10.3390/ijms25010201.

[38] Ruddy M, Cummins M, Drabu Y. Hospital hairdresser as a potential source of cross-infection with MRSA. J Hosp Infect 2001;49:225-7. https://doi.org/10.1053/jhin.2001.1065.

[39] Alharbi NM, Alhashim HM. Beauty Salons are Key Potential Sources of Disease Spread. Infect Drug Resist 2021;14:1247-53. https://doi.org/10.2147/IDR.S303461.

[40] Weber DJ, Anderson DJ, Sexton DJ, Rutala WA. Role of the environment in the transmission of Clostridium difficile in health care facilities. Am J Infect Control 2013;41:S105-10. https://doi.org/10.1016/j.ajic.2012.12.009.

[41] Rodríguez-Villodres Á, Martín-Gandul C, Peñalva G, Guisado-Gil AB, Crespo-Rivas JC, Pachón-Ibáñez ME, Lepe JA, Cisneros JM. Prevalence and Risk Factors for Multidrug-Resistant Organisms Colonization in Long-Term Care Facilities Around the World: A Review. Antibiotics (Basel). 2021;10:680. https://doi.org/10.3390/antibiotics10060680.

[42] Gamage SD, Ambrose M, Kralovic SM, Roselle GA. Water Safety and Legionella in Health Care: Priorities, Policy, and Practice. Infect Dis Clin North Am 2016;30:689-712. https://doi.org/10.1016/j.idc.2016.04.004.

[43] Fattorini M, Ceriale E, Nante N, Lenzi D, Manzi P, Basagni C, Messina G. Use of a fluorescent marker for assessing hospital bathroom cleanliness. Am J Infect Control 2016;44:1066-8. https://doi.org/10.1016/j.ajic.2016.03.030.

Received on September 16, 2024. Accepted on January 14, 2025.

Correspondence: Giovanni Guarducci, Post Graduate School of Public Health, University of Siena, Via Aldo Moro 2, 53100 Siena, Italy. E-mail: giovanni.guarducc@student.unisi.it

How to cite this article: Viti F, Cartocci A, Perinti R, Guarducci G, Nante N. Analysis and Impact of Infection Prevention Procedures in Long-Term Care Facilities. J Prev Med Hyg 2025;66:E75-E83. https://doi.org/10.15167/2421-4248/jpmh2025.66.1.3392

Supplementary material

Tab. S1. Description of the procedures.

Procedure	Non-compliance
Legionellosis	Lack of risk assessment document
	Failure to appoint a risk management officer
	DVR containing the description of environmental and plant characteristics that do not correspond to those existing in the structure
	Failure to implement the prevention measures provided for in the DVR
	Failure to adopt corrective measures following analytical non-conformities detected in self-monitoring
	No sampling plan in DVR
Cleaning and disinfection of premises	Lack of procedure for cleaning and disinfecting the premises
	Failure to identify the person responsible for cleaning
	Failure to divide environments into risk areas
	Generic procedure without definition of frequencies, equipment and cleaning products
	Lack of training and education for cleaning staff
	Using cloths without colour coding
	Inadequate reconditioning of cloths and rags
	Failure to adopt a cleaning process verification system
	Failure to adopt a performance verification system
Laundry	Lack of procedure for managing the laundry washing process
	Failure to identify dirty clean paths
	Failure to label guests' clothing
	Lack of instructions in the procedure on the collection, handling and washing of clothes from infected subjects
Pans	Lack of procedure for reconditioning of pans
	Failure to apply a physical or chemical disinfection system for the reconditioning of bedpans
Generic hais procedure	Lack of procedure for the management of healthcare-associated infections
	Failure to identify accesses and horizontal and vertical routes, structurally and/or functionally distinct, both for people (guests, healthcare workers, GPs, suppliers) and for goods and materials (separation of dirty/clean routes for food, laundry, waste)
	Failure to prepare a plan for the management of cases or outbreaks of infectious diseases that require isolation
	Lack of training/education of operators for the application of HAIs management procedures
Disinfection of healthcare instruments	Lack of procedure for disinfection of medical instruments
	Unavailability of equipment or products for thermal or chemical disinfection of medical instruments
Hairdresser service	Lack of procedure for managing the hairdressing service
	Professional and/or authorization requirements of the hairdresser not compliant with regional legislation
	Unavailability of equipment or products for thermal or chemical disinfection of hairdresser's tools

Procedure compliance is defined as the presence of the procedure in conjunction with compliance with additional parameters. In the manuscript was evaluated the compliance/non-compliance and presence/absence of the procedure.