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Research paper

Hand hygiene compliance and behavioural determinants in a paediatric intensive care unit: An observational study

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ABSTRACT

Background: Hand hygiene is considered the single most effective means of reducing healthcare-associated infections, but improving and sustaining hand hygiene compliance remains a great challenge.
Objectives: To compare hand hygiene compliance before and after interventions to promote adherence in a paediatric intensive care unit (PICU) and to identify predictors of intention to perform the behaviour "hand hygiene during patient care in the PICU".
Methods: A before and after study was conducted in three phases. Based on the World Health Organization guideline for hand hygiene compliance monitoring, 1261 hand hygiene opportunities were directly observed during routine patient care by two observers simultaneously, in a nine-bed PICU in Brazil, before and after infrastructure and educational interventions. To identify predictors of healthcare professionals' intention to perform the behaviour hand hygiene during patient care, a data collection instrument was designed based on the Theory of Planned Behaviour. Statistical analyses were undertaken using Chi-square test or the Fisher's exact test and regression analysis. A significance level of 5% ($p < 0.05$) was applied to all analyses.
Results: The hand hygiene compliance rate increased significantly from 27.3% in the "pre-intervention phase" to 33.1% in "phase 1—post-intervention," to 37.0% in "phase 2—post-intervention" ($p = .010$). Perceived social pressure ($p = .026$) was a determinant factor of intention to perform the behaviour.
Conclusions: Hand hygiene compliance raised significantly after infrastructure, educational, and performance feedback interventions. However, despite the significant effect of the implemented interventions, the overall hand hygiene compliance rate was low. Perceived social pressure characterised a determinant factor of intention to perform the behaviour "hand hygiene during patient care in the PICU", reinforcing the need for behaviour determinants analysis when designing promotional interventions.

1. Introduction

Hand hygiene is the single most effective intervention to reduce healthcare-associated infections, a frequent adverse event in intensive care units (ICUs) and a major global challenge.[1–3] Hand hygiene prevents endogenous and exogenous infections, cross-transmission of potential pathogens between patients, and environment contamination.[4]

Despite evidence on hand hygiene best practices, the adoption of the recommended practices in clinical settings is not consistently observed, and hand hygiene adherence among healthcare professionals is described as unacceptably low worldwide.[2–6] Improving and sustaining compliance remains a great challenge, and numerous studies describe a range of factors that influence hand hygiene behaviour, including professional role, clinical setting, cultural factors, and workload.[7–10]

Knowledge derived from the social sciences can provide support to the assessment of key determinants of hand hygiene behaviour

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among healthcare professionals.[9] The use of multiple interventions has been recognised and recommended as an effective strategy for stimulating behavioural changes in multifaceted and complex environments. As part of the World Health Organization (WHO) *Save Lives: Clean Your Hands* initiative, the WHO *Multimodal Hand Hygiene Improvement Strategy* was developed.[11] This is a conceptual framework with five key components: (i) system change; (ii) staff training; (iii) monitoring of hand hygiene indicators and performance feedback; (iv) reminders in the workplace; and (v) improvement of the institutional patient safety climate.[1,11]

The aims of this study were to compare hand hygiene compliance before and after interventions to promote adherence in a paediatric intensive care unit (PICU) in Brazil and to identify predictors of intention to perform the behaviour "hand hygiene during patient care in the PICU".

2. Method

A before and after study for hand hygiene compliance monitoring was conducted in a nine-bed PICU at a 700-bed tertiary care university hospital in São Paulo, Brazil. Approval from the institution's Research Ethics Committee and informed consent from healthcare workers were obtained.

The measures reported were the hand hygiene opportunities. A hand hygiene opportunity was defined as the moment during care activities that hand hygiene is necessary to interrupt germ transmission: before patient contact (indication 1), before clean/aseptic task (indication 2), after body fluid exposure risk (indication 3), after patient contact (indication 4), and after touching patient surroundings (indication 5).[1,11,12]

A sample of 378 hand hygiene opportunities per study moment, before and after two interventions periods (1134), was previously calculated for a statistical power of 80% with a confidence level of 95%. At the end of the data collection, a total of 1261 hand hygiene opportunities were analysed. Hand hygiene compliance was calculated by the number of observed hand hygiene episodes per number of hand hygiene opportunities.[11,12]

Hand hygiene opportunities were observed by two trained nurses to conduct unobtrusive sessions, and PICU staff were aware of the monitoring.[13] The observation sessions lasted 1 h. Observation and intervention phases are presented in Fig. 1.

To stimulate behavioural changes to hand hygiene improvement, a multimodal strategy based on WHO recommendations was implemented with five key components: (i) system change; (ii) staff training; (iii) monitoring of hand hygiene indicators and performance feedback; (iv) reminders in the workplace; and (v) improvement of the institutional patient safety climate.

Before the intervention, baseline data on hand hygiene compliance rates and infrastructure were collected in the 6 months preceding the intervention. An intervention was then implemented which consisted of system changes, staff training, and education. Conventional sinks were replaced by four large sinks with sensor-activated taps, wall-mounted soap and alcohol dispensers changed and repositioned at the point of care, alcohol containers with a pump were placed at the head and end of each bed, and individual portable dispensers of alcohol-based hand rub solution were distributed to healthcare professionals. During this period, hand hygiene knowledge was assessed before the first education session was carried out. Following the intervention period, observations were conducted.

A second intervention was then implemented which inducted administration of an instrument to identify predictors of intention to perform hand hygiene. A second education session was also held. The study aims were reinforced, and the results feedback is presented to PICU staff including medical and nursing leaders. At this time an institutional safety climate initiative and a mobilisation campaign entitled "Clean hands save lives. I do!" were launched as motivating factor. A pin with the campaign symbol was distributed to healthcare professionals. Posters were displayed showing hand hygiene indication concepts. Therefore, as suggest by WHO, we implemented training and education, observation, and feedback with reminders in the workplace.

Weekly performance feedback was provided to the PICU staff during the three observation phases with special emphasis on hand hygiene indications with lower adherence and on specific fault points identified by the observers. During the study, healthcare professionals interacted anonymously with the observers through a writing board available at the unit.

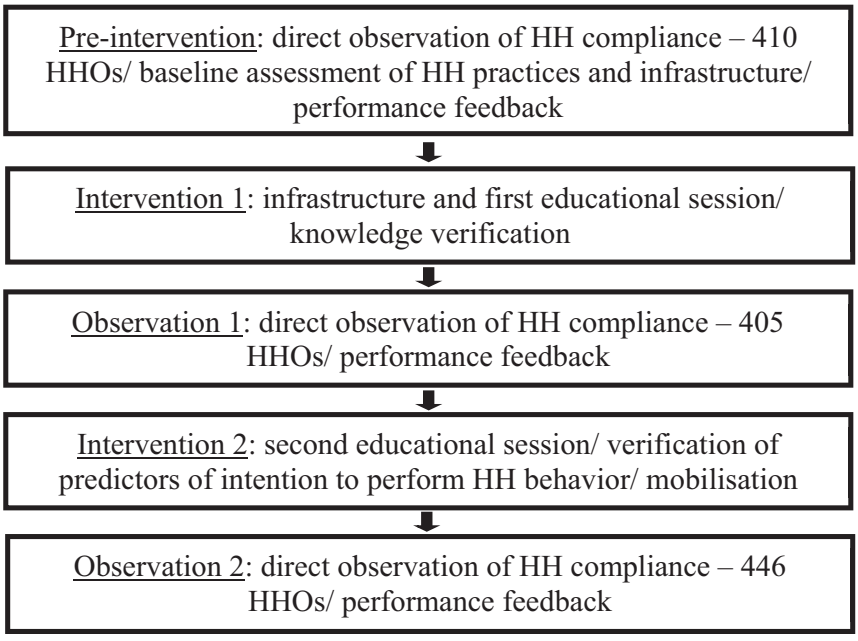

Fig. 1. Description of the study phases. HH - hand hygiene and HHO - hand hygiene opportunity.

To identify predictors of healthcare professionals' intention to perform the behaviour "hand hygiene during patient care in the PICU," a data collection instrument was designed based on the Theory of Planned Behaviour (TPB).[14]

This theory suggests that intention is the best single predictor of behaviour and represents readiness to perform the behaviour. Intention is based on a particular combination of attitudinal, normative, and control considerations. The authors define "attitude" as a latent disposition or tendency to express a behaviour with some favourableness or unfavourableness degree. Norms are defined as "perceived social pressure" and refer to what is acceptable or permissible in a group or society. Control is "perceived behavioural control" which is defined as the extent to which people believe that they have control over the behaviour performance. The relative importance of the different predictors can vary from one population to another. By identifying determinants that discriminate individuals who perform or not, the behaviour of interest can support the design of properly targeted interventions.[14]

The data collection instrument comprised demographic characteristics and TPB constructs: intention (five items), attitude (six items), perceived social pressure (six items), and perceived behavioural control (six items). Attitude was measured by means of six semantic differential scales constructed with bipolar adjectives, with scores ranging from one to seven. The other constructs were measured by seven-point Likert scales, and the healthcare professionals were asked to indicate their opinion or judgement on the questions or assertions presented. Each construct was considered as an independent variable, and scores were obtained by the arithmetic mean of the items composing the construct. Additionally, an item related to healthcare professionals' self-report of compliance was included. To validate this instrument, we used Delphi technique with three judges with doctoral degree and scientific production on the TPB. Level of agreement between panel members was set at 80%. Based on the recommendations of the theoretical model and of studies using the TPB, the final version of the instrument was applied to 29 healthcare workers outside the PICU for internal consistency analysis. Cronbach's α coefficient was calculated for each construct and scores of all items were equal or higher to 0.75 (Cronbach's α coefficient: intention 0.84; attitude 0.77; perceived social pressure 0.75; perceived behavioural control 0.77). The final instrument is presented in Fig. 2.

The chi-square test or the Fisher's exact test was applied to the statistical analyses to compare categorical variables. Regression analysis was used to estimate the relationships among TPB determinant constructs and the intention to perform the behaviour. A significance level of 5% ($p < 0.05$) was applied to all analyses. (See Fig. 3).

3. Results

A total of 1261 hand hygiene opportunities were verified during 32.45 h of observation, comprising 410 hand hygiene opportunities in the "pre-intervention," 405 during "observation 1," and 446 in "observation 2". Thirty-two observation sessions were carried out with an average duration of 61.7 min. The average number of hand hygiene opportunities per hour of observation was 38.9.

The compliance rate of healthcare professionals for hand hygiene practices increased significantly from 27.3% ($n = 112$) in the "pre-intervention" to 33.1% ($n = 134$) in "observation 1," to 37.0% ($n = 165$) in "observation 2" ($p = .010$). A substantial increase was also observed for the use of alcoholic solution (pre-intervention: 3.6%; observation 1: 41.8%; observation 2: 37.0%; $p = .001$).

The 1261 HHOs represented 1441 indications for the procedure, because sometimes one HHO had two or more indications due to simultaneous reasons for the hand hygiene. Indications "before patient contact" and "after patient contact" were the most frequently observed. The overall mean compliance rate was higher for indication "after patient contact" ($p < .001$) (Table 1). Significant differences in adherence related to the study phases were identified in indications "after patient contact" ($p = .005$) and "after touching patient surroundings" ($p = .005$) (Table 2). Global compliance was higher during morning shifts ($p < .001$) (Table 1), although no differences related to working shift were verified during the intervention periods ($p = .445$).

Nursing technicians had the greatest number of opportunities for hand hygiene ($n = 628$) and the lowest global adherence rate (Table 1). Significant improvement ($p < .001$) in hand hygiene compliance during the study phases was associated only with this professional category (Table 2). A decrease in hand hygiene adherence and the lowest overall rate was observed among resident physicians. Compliance among nurses showed an increasing trend. Unexpectedly, adherence was lower for patients under contact precautions ($p = .057$) when compared to the overall rate (Table 1), and the implemented interventions did not influence this variable ($p = .500$).

Use of gloves was observed in 41.5% of the 1261 hand hygiene opportunities. Global adherence was higher for glove use but not statistically significant ($p = .199$) (Table 1). Despite the increase in hand hygiene performance during the study, there was a significant decrease in the compliance rate when the procedure was related to glove use ($p < .001$; Table 2). The compliance rate was similar when the occurrence of only one or two or more indications for the procedure was compared ($p = .773$; Table 1). Data analysis of the study phases showed an increase in adherence related to one indication per hand hygiene opportunity ($p = .001$; Table 2).

Care activities classified as "direct patient contact" were related to a greater number of hand hygiene opportunities and to higher overall compliance ($p < .001$; Table 1). The category "invasive procedure" was the second most frequent and was associated with a low adherence rate (Table 1). Hand hygiene rate stratified by care activity and study phase evidenced significant variations for "direct patient contact" ($p = .016$) and "contact with inanimate surfaces and objects" ($p < .001$) (Table 2).

A total of 38 (63.3%) PICU healthcare workers answered the TPB instrument. In 21 of the 23 items related to the constructs, mean values greater than or equal to 5.0 were identified, showing a predisposition of the group to perform "hand hygiene during patient care in the PICU" (Table 3). Multivariate regression analysis revealed that perceived social pressure ($p = .026$) characterised a determinant factor of intention to perform the behaviour, unlike the other variables (attitude $p = .452$; perceived behaviour control $p = .540$).

The mean score of self-report of compliance was 6.36 (standard deviation = 0.85) indicating that healthcare professionals always perform hand hygiene during patient care in the PICU. This result contradicts the compliance rates observed during the study phases.

4. Discussion

Compliance with hand hygiene practices among healthcare professionals has historically been lower than expected and recommended. Reasons for suboptimal practices are multiple and vary according to the setting and available resources.[15,16] Therefore, designing interventions to improve and sustain rates and identifying the reasons for low adherence were stated as research priorities.[17,18]

A significant increase in hand hygiene compliance was verified after the implementation of a set of infrastructure and educational interventions. The highest observed score in this study was lower

Intention
I am committed to doing hand hygiene during patient care in the PICU. (true – false)
I plan to do hand hygiene during patient care in the PICU. (definitely not – definitely yes)
I intend to do hand hygiene during patient care in the PICU. (strongly disagree – strongly agree)
The likelihood that you do hand hygiene during patient care in the PICU is: (extremely unlikely – extremely likely).
I am willing to do hand hygiene during patient care in the PICU. (strongly disagree – strongly agree).
Attitude
For me doing hand hygiene during patient care in the PICU is:
very unimportant – very important
very unpleasant – very pleasant
very harmful – very beneficial
very annoying – very enjoyable
very bad – very good
totally unnecessary – totally necessary
Perceived social pressure
People who are important to me think I (definitely should not - definitely should) do hand hygiene during patient care in the PICU.
People who are important to me expect me to do hand hygiene during patient care in the PICU. (strongly disagree – strongly disagree).
I feel there is a social pressure for me to do hand hygiene during patient care in the PICU.
People I respect and admire professionally (strongly approve – strongly disapprove) of me doing HH during patient care in the PICU.
Most people of my professional category do hand hygiene during patient care in the PICU. (never – always)
Most people I respect and admire professionally (never – always) do hand hygiene during patient care in the PICU.
Perceived behavioral control
For me, hand hygiene during patient care in the PICU is: very difficult – very easy.
About your ability to hand hygiene during patient care in the PICU, you feel: very safe – very unsafe.
I am sure that if I wanted to I would be able to do hand hygiene during patient care in the PICU. (strongly disagree – strongly disagree)
The decision to do hand hygiene during patient care in the PICU is under my control. (strongly disagree – strongly disagree)
Do hand hygiene during patient care in the PICU depends only on me. (strongly disagree – strongly disagree)
How much control do you believe to have upon hand hygiene behavior during patient care in the PICU? (no control – total control)
Behavior self-report
Do you do hand hygiene during patient care in the PICU? (never – always)

Fig. 2. Theory of Planned Behaviour instrument and assessment of internal consistency. PICU = paediatric intensive care unit.

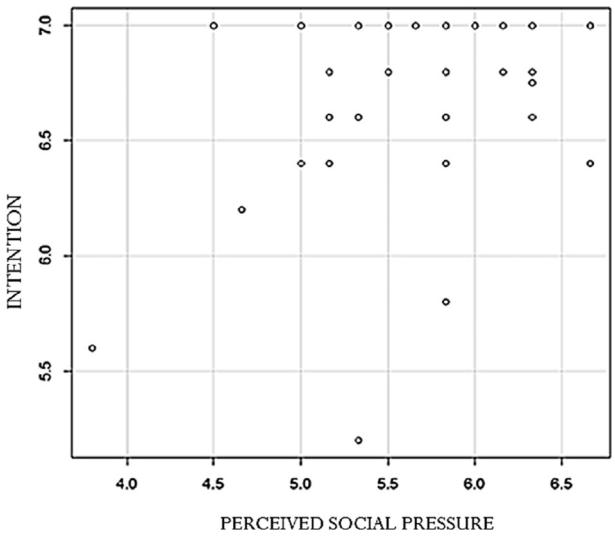

Fig. 3. Dispersion graph of relation between intention and perceived social pressure.

Table 1
Overall analysis of compliance rate of hand hygiene in a PICU.

Characteristics	Yes	No	Compliance (%)	p value
Indication				
Before patient contact	124	249	33.2	<.001
Before clean/aseptic task	52	196	21.0	
After body fluid exposure risk	68	169	28.7	
After patient contact	161	162	49.8	
After contact with patient surroundings	70	190	26.9	
Healthcare worker category				
Nursing technicians	169	459	26.9	<.001
Nurses	84	123	40.6	
Resident physicians	56	126	30.8	
Therapists	66	114	36.7	
Other	36	28	56.3	
Work shift				
Morning	164	253	39.9	<.001
Afternoon	131	281	31.8	
Night	116	316	26.9	
Contact precaution	158	378	29.5	.057
Glove use	181	342	34.6	.199
Number of indications per HHO				
1 indication	350	729	32.4	.773
≥2 indications	61	121	33.5	
Care activities				
Direct patient contact	226	327	40.9	<.001
Invasive procedure	115	322	26.3	
Contact with inanimate surfaces and objects	61	184	24.9	
Contact with body fluids or excretions	9	17	34.6	

PICU = paediatric intensive care unit.

than average scores from the literature and similar to that identified in low- and middle-income countries.[3,19–21]

An observational study conducted to assess the compliance of hand hygiene of healthcare workers in a neonatal and PICU in a tertiary university hospital in Istanbul identified 704 hand hygiene opportunities during the observation period with an overall compliance of 37.0%.[22] Another observational study performed in four PICU from a paediatric teaching hospital found a total of 1227 hand hygiene opportunities with 56.64% compliance. The surgical PICU had the lower compliance (39.2%).[23]

Our PICU is characterised by seriously ill patients demanding intense direct assistance at a large public university hospital, a referral centre for high complexity care, with a high turnover of healthcare professionals in training process. At the time of data collection, promoting hand hygiene was not a unit priority, despite the extensive worldwide mobilisation on the topic.

A mean of 38.9 hand hygiene opportunities per hour of observation characterises a high demand for the procedure. Other observational studies show an association between lower adherence and greater frequency of hand hygiene opportunities.[24–26]

As in other studies, there was significant increase in the use of alcohol-based solution.[27–29] We attribute this finding to educational, infrastructure, and process interventions, promoting the resource availability at the point of care and to the emphasis on results feedback to the PICU team.

Compliance differed depending on the five moments. Higher levels were verified “after touching a patient,” confirming the already observed tendency of instinctive self protection from contamination.[30] Researchers suggest that indications at higher risk of being neglected are those that prevent transmission of pathogens to the patient (before touching a patient and before clean/aseptic procedure).[15]

The large number of hand hygiene opportunities among nursing technicians (professionals with 2 years of formal nursing education working under the supervision of a registered nurse) reveals their prevalent role in direct patient care in the PICU; a peculiar characteristic of nursing practice in Brazil. At the same time, the significant increase in their hand hygiene performance shows the effectiveness of the intervention with this group.

We observed that contact precautions did not represent a factor for higher hand hygiene compliance as reported by other authors. The high frequency of glove usage did not correlate with hand hygiene adherence. There was a significant decrease in compliance rate related to wearing gloves after the intervention. Similarly, other studies showed contradictory findings related to this association, and the reasons were not evident. It is suggested that these behaviours are determined by different predictors and further investigation is needed for appropriate interventions.[31–33]

Table 2
Compliance rate of hand hygiene in a PICU according to study phases.

Characteristics	Hand hygiene									p value
	Pre-intervention			Observation 1			Observation 2			
	Yes	No	Compliance (%)	Yes	No	Compliance (%)	Yes	No	Compliance (%)	
Indications										
After patient contact	50	46	52.1	38	64	37.3	73	52	58.4	.005
After contact with patient surroundings	24	103	18.9	29	44	39.7	17	49	25.8	
Healthcare professional category										
Nursing technician	50	202	19.8	35	115	23.3	84	142	37.2	<.001
Glove use	72	40	64.3	46	88	34.3	63	102	38.2	<.001
Care activities										
Direct patient contact	59	84	41.3	56	116	32.6	111	127	46.6	.016
Contact with inanimate surfaces and objects	16	92	14.8	30	43	41.1	15	49	23.4	<.001

PICU = paediatric intensive care unit.

Table 3
Description of the constructs of the Theory of Planned Behaviour.

Constructs	Mean	SD
Intention		
I am committed to doing hand hygiene during patient care in the PICU. (true—false)	6,81	0,45
I plan to do hand hygiene during patient care in the PICU. (definitely not—definitely yes)	6,89	0,31
I intend to do hand hygiene during patient care in the PICU. (strongly disagree—strongly agree)	6,78	0,84
The likelihood that you do hand hygiene during patient care in the PICU is: (extremely unlikely—extremely likely).	6,28	1,06
I am willing to do hand hygiene during patient care in the PICU. (strongly disagree—strongly agree).	6,78	0,74
Total score	6,78	0,24
Attitude		
For me doing hand hygiene during patient care in the PICU is: very unimportant—very important	6,97	0,16
very unpleasant—very pleasant	5,78	1,63
very harmful—very beneficial	6,60	1,15
very annoying—very enjoyable	5,63	1,60
very bad—very good	6,29	1,26
totally unnecessary—totally necessary	6,73	1,08
Total score	6,33	0,53
Perceived social pressure		
People who are important to me think I (definitely should not—definitely should) do hand hygiene during patient care in the PICU.	6,91	0,27
People who are important to me expect me to do hand hygiene during patient care in the PICU. (strongly disagree—strongly disagree).	6,50	1,13
I feel there is a social pressure for me to do hand hygiene during patient care in the PICU.	4,10	2,10
People I respect and admire professionally (strongly approve—strongly disapprove) of me doing hand hygiene during patient care in the PICU.	6,50	0,95
Most people of my professional category do hand hygiene during patient care in the PICU. (never—always)	4,76	1,42
Most people I respect and admire professionally (never—always) do hand hygiene during patient care in the PICU.	5,50	1,10
Total score	5,71	1,16
Perceived behavioural control		
For me, hand hygiene during patient care in the PICU is: very difficult—very easy.	6,05	1,31
About your ability to hand hygiene during patient care in the PICU, you feel: very safe—very unsafe.	6,56	0,72
I am sure that if I wanted to I would be able to do hand hygiene during patient care in the PICU. (strongly disagree—strongly disagree)	6,13	1,37
The decision to do hand hygiene during patient care in the PICU is under my control. (strongly disagree—strongly disagree)	6,34	1,14
Do hand hygiene during patient care in the PICU depends only on me. (strongly disagree—strongly disagree)	5,00	2,16
How much control do you believe to have upon hand hygiene behaviour during patient care in the PICU? (no control—total control)	5,92	0,96
Total score	6,00	0,53

PICU = paediatric intensive care unit; SD = standard deviation.

Perceived social pressure, one of the three intermediate variables that determine the intention to comply with the behaviour, refers to people's belief that individuals or groups important to them would approve or disapprove of them performing the behaviour and that these referents themselves would perform or would not perform this behaviour. The more it is perceived that significant others endorse the behaviour, the greater the intention to engage in it.[14]

Analogous to our results, the impact of role models in hand hygiene adherence has been shown in other studies and strongly influences hand hygiene behaviour.[9,34] Specialists argue that healthcare professionals seem much more driven by normative beliefs and that the reasons for performing a highly repetitive task, such as hand hygiene, become less important than the related practical issues and the model of their peers.[35] Social influence should be targeted in combination with other determinants (infrastructure, knowledge, feedback, and local reminder) to achieve larger and more sustained behaviour change.

The main study limitation identified was the potential influence of the presence of an observer on hand hygiene compliance. However, covert monitoring is not recommended in conjunction with promotional interventions because it can induce mistrust. To mitigate the bias, observers frequented the PICU regularly and sought to conduct unobtrusive observation sessions.

5. Conclusions

Hand hygiene compliance raised significantly after infrastructure, educational, and performance feedback interventions. However, despite the significant effect of the implemented interventions, the overall hand hygiene compliance rate (37.0%) was low.

Our data related to hand hygiene practices in a high specificity environment confirm the already reported importance of permanent reinforcement of concepts related to hand hygiene and of the availability of alcohol-based solution at the point of care as key elements for a sustained practice improvement.

Perceived social pressure characterised a determinant factor of intention to perform the behaviour “hand hygiene during patient care in the PICU,” reinforcing the need for behaviour determinants analysis when designing promotional interventions.

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Author contribution

Aline S C Belela-Anacleto made substantial contributions to the following: (i) the design of the work, the acquisition, analysis, and interpretation of data for the work, (ii) draughting the article or revising it critically for important intellectual content, (iii) final approval of the version to be submitted, and (iv) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Denise M. Kusahara made substantial contributions to the following: (i) acquisition, analysis, and interpretation of data for the work, (ii) draughting the article or revising it critically for important intellectual content, (iii) final approval of the version to be submitted, and (iv) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Maria Angélica S. Peterlini made substantial contributions to the following: (i) the design of the work and interpretation of data for the work, (ii) revising the article critically for important intellectual content, (iii) final

approval of the version to be submitted, and (iv) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Mavilde L. G. Pedreira made substantial contributions to the following: (i) the design of the work, analysis, and interpretation of data for the work, (ii) revising the article critically for important intellectual content, (iii) final approval of the version to be submitted, and (iv) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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