



A nudge intervention to improve hand hygiene compliance in the hospital

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Abstract

Hand hygiene among professionals plays a crucial role in preventing healthcare-associated infections, yet poor compliance in hospital settings remains a lasting reason for concern. Nudge theory is an innovative approach to behavioral change first developed in economics and cognitive psychology, and recently spread and discussed in clinical medicine. To assess a combined nudge intervention (localized dispensers, visual reminders, and gain-framed posters) to promote hand hygiene compliance among hospital personnel. A quasi-experimental study including a pre-intervention phase and a post-intervention phase (9 + 9 consecutive months) with 117 professionals overall from three wards in a 350-bed general city hospital. Hand hygiene compliance was measured using direct observations by trained personnel and measurement of alcohol-based hand-rub consumption. Levels of hand hygiene compliance were low in the pre-intervention phase: 11.44% of hand hygiene opportunities prescribed were fulfilled overall. We observed a statistically significant effect of the nudge intervention with an increase to 18.71% ($p < 0.001$) in the post-intervention phase. Improvement was observed in all experimental settings (the three hospital wards). A statistical comparison across three subsequent periods of the post-intervention phase revealed no significant decay of the effect. An assessment of the collected data on alcohol-based hand-rub consumption indirectly confirms the main result in all experimental settings. Behavioral outcomes concerning hand hygiene in the hospital are indeed affected by contextual, nudging factors to a significant extent. If properly devised, nudging measures can provide a sustainable contribution to increase hand hygiene compliance in a hospital setting.

Keywords Hand hygiene · Infection prevention · Nudge · Decision-making

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Background

Hand hygiene among healthcare professionals plays a crucial role in preventing healthcare-associated infections, a leading cause of mortality worldwide. According to the European Centre for disease prevention and control, 6% of patients contracts an infection during their hospital stay in the EU, with figures ranging from 2.3 to 10.8%, and 3.2 million patients are affected by nosocomial infections every year, which are fatal for 37 thousand patients [1].

Randomised studies on the topic are scarce, but the link between hand hygiene (HH) and nosocomial infections is well supported by the evidence [2–4] and healthcare professionals are generally aware of it. Still, data indicate that overall only a minority of hospital staff complies with good practice. For instance, a systematic analysis of 96 empirical studies has shown that median HH compliance rate in

hospital settings is no more than 40% [5], with some studies reporting compliance under 20% [6] or even under 10% [7]. Also, a concerning degree of variation exists. For instance, hand hygiene compliance is lower in the ICUs (30–40%) as compared to other departments. It is lower among physicians (32%) as compared to nurses (48%), and before (21%) rather than after (47%) touching a patient.

From a traditional point of view on human reasoning and behavior, poor hand hygiene compliance in the hospital is a conundrum [8]. Acting rationally and consequentially from their informed beliefs, well-intentioned healthcare professionals—“good” doctors, and nurses [9]—should just act accordingly and regularly sanitise their hands. Why don't they?

An innovative approach to such issues arises from the fields of behavioral economics and experimental psychology. According to nudge theory, “supposedly irrelevant factors” in the decision context can have a substantial impact on people's behavior, which is based on routine heuristic processes rather than careful calculation of consequences [10–12]. Nudges are deliberate and small changes in the environment which exploit such heuristic and automatic processes to promote beneficial outcomes in human decision-making. Interventions of this kind are distinct and complementary to more traditional tools (such as training or incentives), and have brought encouraging results in several domains of healthcare [13–15].

In what follows, we report results from a study assessing nudging as an approach to improve hand hygiene in the hospital.

Methods

Setting, participants, and design

The aim of the study was to evaluate the efficacy of a nudge intervention to improve hand hygiene [HH] compliance rates among healthcare professionals in hospital settings. The study was conducted at San Giovanni Bosco (SGB), a 350-bed general hospital in Turin, Italy, before the global SARS-CoV-2 outbreak (between January 2018 and July 2019). Three wards of this hospital were involved (all personnel for each): a Sub-Intensive Care Unit with 13 beds [SCU]; an Internal Medicine Unit with 28 beds [IMU]; and a General Surgery Unit with 30 beds [GSU].

A total of 117 professionals took part in the study, 42 in SCU (8 physicians, 19 nurses, 15 healthcare workers), 27 in IMU (2 physicians, 15 nurses, 10 healthcare workers), and 48 in GSU (18 physicians, 22 nurses, 8 healthcare workers) (Table 1). Participants were informed that their de-identified data would be used for research, and the study was approved by the management office and the infection control center

Table 1 Description of the study population

	Sub-intensive % (N)	Internal medicine % (N)	General surgery % (N)	Total
Physicians	19 (8)	7 (2)	37 (18)	(28)
Nurses	45 (19)	56 (15)	46 (22)	(56)
Healthcare workers	36 (15)	37 (10)	17 (8)	(33)
Total	(42)	(27)	(48)	

of the hospital. (For the nature of the study—not involving manipulation of information or human biological material—no further approval was required).

The study used a quasi-experimental design including two phases: a pre-intervention phase (from 15th January 2018 to 15th October 2018) and a post-intervention phase (from 16th October 2018 to 15th July 2019). During the pre-intervention phase, baseline measurements of HH compliance rates among healthcare professionals were collected. No nudge intervention was performed at this stage. At the beginning of the post-intervention phase, intervention activities were performed, and observations continued during the whole time-window.

Intervention

At the beginning of the study (base-line, no intervention), sanitizer dispensers were mounted on the wall close to each room entrance of the three wards. Instruction charts depicting steps of correct handwashing procedures were placed in close proximity to each washstand and dispenser.

Our nudge intervention had three components. First, at the beginning of the intervention period, we placed additional antiseptic sanitizer dispensers at the foot of each patient's bed. The dispensers were attached to the bed footboard by means of plastic supports. It has been observed that the placement of the dispensers at the bedside of every patient, where professionals spend much of their working time, has a significant role in improving HH compliance [16] for human agents perform more easily procedural steps that are not functionally isolated from the main course of action (like going back to the room entrance to wash one's hands while interacting with a patient).

Second, we placed brightly colored visual reminders on the footboard of each patient's bed in close proximity to the additional dispensers. The use of visual cues located right above the dispensers has been associated with increased compliance [17], probably because the cognitive efficacy of memory aids and reminders is maximum when in close proximity to where the action has to be performed. In our study, reminders were grey and bright yellow sticks

depicting stylized hands and reporting the slogan “Wash your hands!” (Fig. 1).

Finally, we hung permanent posters promoting hand hygiene in easily visible places within the three wards. The posters were located in areas exclusively used by healthcare professionals, such as the Infirmary. A gain-framed message focusing on the benefits of HH compliance (“40% more handwashing, 40% less infections”) was displayed in the poster (Fig. 2). It has been shown that poster campaigns with messages focusing on the advantages of HH rather than the risks of noncompliance are particularly effective among professionals [18], for messages that are framed to emphasize gains appear to be more persuasive in encouraging prevention behaviour than loss-framed appeals [19].

No further intervention was adopted in the study.

Measurement

HH compliance was measured using direct observations by trained personnel and measurement of alcohol-based hand-rub consumption.

Direct observation is regularly used and is currently considered the gold standard for monitoring HH compliance in a hospital setting [20]. The main advantage of this



Fig. 1 Additional dispenser at the foot of patient’s bed and visual reminder



Fig. 2 Poster promoting hand hygiene

method is that it provides detailed information about who is performing handwashing and at what moment. In our study, each observation period lasted 20 min (± 10). All personnel working in the three wards were observed and the type of professional (physicians, nurses, or healthcare worker) was recorded. Compliance during each of the five moments for HH [21] was checked:

- Moment 1: before touching a patient
- Moment 2: before clean/aseptic procedures
- Moment 3: after body fluid exposure/risk
- Moment 4: after touching a patient
- Moment 5: after touching the patient surroundings

Failure to wash hands during any of these moments was coded as noncompliance. The compliance rate was then quantified by calculating the sum of actual handwashing moments divided by the sum of all prescribed handwashing moments, or HH opportunities (e.g., compliance $2/5 \times 100 = 40\%$). Healthcare professionals at the SBG Hospital are used to be observed for training or research, countering the risk of the Hawthorne effect [22]. Furthermore, observations went on regularly through both the pre-intervention and post-intervention phases. Therefore,

hypothetical confounds due to observation biases must have been balanced across experimental conditions.

Compliance was also measured by calculating the amount of hydroalcoholic solution consumed by the three wards during the two phases of the experiment. This is an indirect measure that provides less detailed information about HH procedures as compared to direct observation, but it is very efficient and virtually immune to observation bias. Methods based on alcohol-based handrub consumption are standardly used to quantify HH compliance in the hospital [20]. In our study, consumption was calculated by dividing the total amount of solution (measured in millilitres) delivered to each ward from the hospital central pharmacy by the number of patients' hospitalization days [ml / patient days].

Statistical analysis

Statistical analyses were performed using STATA 13 Software (Stata Corp., College Station, TX, 2011). A descriptive analysis was performed for all the categorical variables, expressed in frequencies and percentages. Chi-squared tests and Fisher's Exact Tests were computed for all independent variables to assess differences between groups concerning handwashing. Potential predictors of handwashing (dichotomous outcome: yes/no) were assessed through a multivariate analysis. A model of logistic regression for handwashing was developed with gender, ward, professional role, and study intervention as independent variables. For all analyses, results were considered statistically significant when the *p* value obtained with the hypothesis tests was lower than 0.05.

Results

As far as the direct observation method is concerned, a total of 2563 HH opportunities were observed, 1756 during the pre-intervention phase (508 in SCU, 591 in IMU, 657 in GSU), and 807 in the post-intervention phase (191 in SCU, 256 in IMU, 360 in GSU). In general, we observed that overall compliance across hospital professionals was poor, close to the lower ends of the distribution of compliance levels observed in previous studies (reporting a range 4–100%) [5]. In addition, we observed significant differences in the level of compliance among the three wards included in the study. Over the whole observation period, the highest level of compliance was measured in SCU (26.18%), with significantly lower levels in IMU (9.24%) and GSU (8.86%). Nurses among all three wards were generally more compliant (15.83%) as compared to both healthcare workers (12.15%) and physicians (11.3%) (Table 2).

We observed a statistically significant effect of the nudge intervention on HH compliance. In general, compliance enhanced from 11.45% in the pre-intervention

Table 2 Description of the stratified sample for handwashing

	Hand washing		<i>P</i> value
	Yes % (<i>N</i>)	No % (<i>N</i>)	
Ward			
Sub-intensive	26.18 (183)	73.82 (516)	<0.001
Internal medicine	8.85 (75)	91.15 (772)	
General surgery	9.24 (94)	90.76 (923)	
Professional role			
Physician	11.30 (85)	88.70 (667)	0.024
Nurse	15.83 (202)	84.17 (1074)	
Healthcare worker	12.15 (65)	87.85 (470)	
Study intervention			
Pre-intervention	11.45 (201)	88.55 (1555)	<0.001
Post-intervention	18.71 (151)	81.29 (656)	

phase to 18.71% (*p* < 0.001) in the post-intervention phase (Table 2). Improvement was observed in all experimental settings. In SCU, the handwashing opportunities actually taken among all categories of professionals increased from 23.62 to 32.98% (*p* = 0.009), respectively, from pre- to post-intervention. In IMU, the handwashing opportunities actually taken among all categories of professionals increased from 5.41 to 16.80% (*p* < 0.001). In GSU, the handwashing opportunities actually taken among all categories of professionals increased from 7.46 to 12.50% (*p* = 0.006). Interestingly, improvement in compliance was greater in the phases following the interaction with the patient (moments 3, 4, and 5), with an increase from 10.92 to 20.29% (*p* < 0.001), as compared to the phases preceding the interaction with the patient (moments 1 and 2), with an increase from 12.3 to 16.21% (*p* = 0.073). Among all five moments for HH, the greatest improvements were observed during moment 4 (from 12.76 to 24.32%, *p* < 0.001) and moment 5 (from 8.09 to 17.11%, *p* = 0.007). A statistical comparison of HH compliance across three subsequent periods of the post-intervention phase (months 1–3 vs. 4–6 vs. 7–9) revealed no significant difference.

The following factors were significant predictors of handwashing in the multivariate analysis: ward (for IMU vs. SCU, OR = 0.25, 95%CI 0.19–0.34, *p* < 0.001; for GSU vs. SCU, OR = 0.27, 95%CI 0.20–0.35, *p* < 0.001); professional role (for nurse vs. physician, OR = 1.63, 95%CI 1.20–2.21, *p* = 0.002); and study intervention (for pre- vs. post, OR = 1.98, 95%CI 1.56–2.51, *p* < 0.001) (Table 3).

An assessment of the collected data on alcohol-based hand-rub consumption indirectly confirms the improvement of HH compliance after intervention in all experimental settings. Consumption increases from 35.2 to 36.4 ml/patient days in SCU, from 7.8 to 10.6 ml/patient days in IMU, and from 14.8 to 19.4 ml/patient days in GSU.

Table 3 Potential predictors of handwashing

	Handwashing	
	OR (95% CI)	<i>p</i> value
Gender		
Male	1	–
Female	0.81 (0.62–1.06)	0.133
Ward		
Sub-intensive	1	–
Internal medicine	0.25 (0.19–0.34)	<0.001
General surgery	0.27 (0.20–0.35)	<0.001
Professional role		
Physician	1	–
Nurse	1.63 (1.20–2.21)	0.002
Healthcare worker	1.38 (0.96–1.98)	0.081
Study intervention		
Pre-intervention	1	–
Post-intervention	1.98 (1.56–2.51)	<0.001

Discussion

Several studies have reported potential benefits of diverse strategies to improve HH compliance [23]. Yet, most of these studies have relied mainly on traditional tools, used either in isolation or in combination, such as education and training [24, 25], audit and feedback [26, 27], incentives [28], or the introduction of new devices [29]. Such interventions reflect a standard conception of human rationality [8, 12], according to which behavioral change requires providing new information that alter beliefs (e.g., by education or training), modifying the relevant incentives (reward and penalties), assisting planning or removing potential disturbing factors (e.g., stress or fatigue) by means of some technological amelioration. Although often effective, traditional interventions are typically costly and comparatively difficult to implement. Only few studies have assessed the efficacy of milder interventions based on specific behavioral insights to promote good HH practice [30, 31]. In this work, we have addressed HH compliance by healthcare professionals in the hospital using a combined nudge intervention (localized dispensers, visual reminders, and gain-framed posters). Overall, HH compliance remained low in our study, but the increase achieved was 63% in relative terms, thus confirming the key tenet of nudge theory: behavioral outcomes concerning HH in the hospital are indeed affected by contextual, “supposedly irrelevant” factors to a significant extent. Validation of this approach can be extended beyond the specific nature of our intervention. For example, behavioral insights, if properly developed, might help us exploit so-called availability heuristic and look at the “availability cascade” [32, 33] generated by the SARS-CoV-2 pandemic as an

opportunity to sustain more stringent HH protocols even after the emergency has hopefully gone.

In several respects, the remarkable variability of HH figures was well represented in our data. Differences among the three wards involved is partly explained by differences in physical arrangement, location of patients (open space vs. separate rooms), and personnel/patients ratios. A higher level of compliance among nurses than among physicians was confirmed. The pattern of HH compliance before vs. after interaction with the patient also deserves comment. Notably, we did not observe the base-line imbalance in favour of HH after interaction that usually prevails. Still, the increase in compliance was greater after rather than before interaction with the patient. In fact, the practical similarity of pre- vs. post-interaction HH should not obscure the possibility of their different psychological representation and behavioural determinants. Lack of hand hygiene before clinical interaction is particularly detrimental for patients’ protection, while protection of the individual professional is more strongly associated with HH after interaction. As a consequence, more tailored measures may be to target each kind of behavior more effectively.

Methodologically, a limitation of our study is that it does not assess the efficacy of the implemented strategies in improving “harder” outcomes such as infection rates and colonization rates. Another limitation is that the design did not allow us to disentangle the contribution of each distinct element of our intervention (dispensers vs. visual reminders vs. gain-framed posters). This is an important issue, as already emphasized in the literature [23]. The effect detected in our work must be taken as a basis for further inquiry if a more fine-grained assessment is sought for in this respect.

For nudges that are shown to be effective, a non-trivial challenge has to do with long-terms prospects. In fact, a successful behavioral intervention may fail to become useful in practice for at least two reasons, namely, (i) a decay after the intervention is discontinued, and (ii) a decrease of the impact while the intervention is still in force. In this perspective, two tentatively positive remarks emerge from our work. First, measures that proved useful in our study also feature a good level of sustainability over time—they are consistent, in particular, with a long-term arrangement to be realistically implemented under the guidance of an infection control unit in many hospital settings. And second, the observed increase in HH compliance remained essentially stable over the whole 9-month period of intervention.

Conclusion

In ordinary circumstances—like those in which our study has taken place, before the global SARS-CoV-2 outbreak—getting healthcare professionals to wash their hands regularly

and appropriately is hard. Surprisingly hard, one could say, for most hospital personnel are generally informed and concerned about infection control and prevention. Apparently, even in convenient conditions of information and incentives, people may still fail to pursue beneficial actions, because choices do not usually arise as the logical consequences of stable preferences and beliefs. As shown by contemporary cognitive science, behavior is largely driven by heuristic processes, instead, which can be systematically biased and highly context-sensitive [34]. This is not necessarily bad news, though. Insights into the quirks and limitations of human rationality can help us improve decision outcomes by the design of suitable nudges, non-coercive and typically small changes of the choice context that exploits inherent tendencies of agents in order to promote desirable outcomes. Our results indicate that nudging can contribute to increase hand hygiene compliance in a hospital setting. Nudges are not meant to displace more traditional tools to promote beneficial behavior (training, regulations), but to combine with them. As a decision environment entirely free from nudging factors can hardly ever exist in healthcare (e.g., sanitizer dispensers have to be located somewhere), explicit and careful consideration of how such factors can eventually affect clinical outcomes is a cost-effective opportunity for improvement.

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Declarations

Conflict of interest The authors have no conflicts of interest to report.

Ethics approval and consent to participate Participants of this study were informed that their de-identified data would be used for research, and the study was approved by the management office and the infection control center of the hospital. (For the nature of the study—not involving manipulation of information or human biological material—no further approval was required).

Consent to publication Not applicable.

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