



Utrecht University



samhoud

A Safe Pair of Hands

*The positive effect of nudging and boosting
on hand hygiene compliance of nurses*

Master's Thesis

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Research in Public Administration and Organizational Science

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Preface

In his *Maxims and Reflections*, Johann Wolfgang von Goethe wrote: 'Behaviour is a mirror in which everyone shows his image' (translation from 1998). How and why humans act in certain ways rather than others, has always fascinated me. In all honesty, I must admit I have considered studying psychology rather than public administration, but somehow it did not seem right at the time. With the benefit of hindsight, I am lucky: public administration would allow me to combine the fascination with the public domain with psychological insights through the interdisciplinary nature of behavioural public administration.

It is in that spirit that his thesis has been conducted, albeit on a very specific and small element of human behaviour: protocol compliance. Specifically, hand hygiene protocol compliance by hospital nurses. It is, however, an incredibly interesting topic because, frankly, humans do not like protocols. Combine this with a society (and sector!) where everything requires a protocol, and tensions are guaranteed.

I sincerely hope this thesis in some form or way contributes to the scientific understanding of the topics I address and investigate. Besides, this thesis has (hopefully) helped me evolve from a graduate student to a PhD student, allowing me to continue my contribution to science.

Now, this is the part where I thank those I could not have done this without. Stephan, thanks so much for introducing me to this research project and being a fantastic tutor along the way. The door was literally always open and I realise I have been very lucky with that. Joanne, your contribution as a consultant was invaluable: you brought a creativity and pace of work to the project that was very welcome. Also, the employees from &samhoud that helped me design the interventions and result posters: thank you, they look so good! Those that helped me find my way in the hospital, especially Betteco, the infection prevention experts and the ward coordinators: thank you for being so open to my ideas and helping me out all the time! Finally, a big thank you to my friends, fellow students, USG-employees, and last but not least, my parents, for stimulating what I do, being interested in all my stories (or at least faking it) and helping me realise life is more than this thesis. Well, I am about to find that out anyway.

Enjoy reading this thesis and do not hesitate to contact me if you feel the need to!

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Executive Summary

Onder de samenvatting is een Nederlandse vertaling weergegeven.

- Hand hygiene compliance by hospital employees is one of the key measures that can help to improve patient safety in hospitals. At the same time, most studies assessing compliance report employees only comply half of the time!
- This master's thesis develops, executes and analyses a quasi-experimental field study that aims to increase compliance of hospital employees with the hand hygiene protocol, by means of two behavioural interventions.
 - First, nudging is a widespread approach that aims to invoke an individual's reflexive decision making process. However, often the same types of nudge are used. This thesis aims to develop an innovative nudge.
 - Second, this thesis adds a fundamentally different and innovative approach: boosting. Boosting aims to stimulate reflection and learning of actors. By testing both interventions, their distinctive qualities can be assessed.
- The hypotheses for this study suggest both interventions are effective in increasing compliance, yet nudging is likely to have a more immediate and diminishing effect whilst boosting will show the opposite.
- The experiment is executed at a Dutch regional hospital in March-May 2019. The research question that guides the study is: *What is the effect of behavioural nudging and boosting on hand hygiene protocol compliance of hospital employees?*
- For operationalising and developing the interventions, a pre-experimental analysis is conducted in cooperation with healthcare professionals. Next, the experiment adopts a quasi-experimental design in which the interventions are separately tested, including a control group, two pre-tests and two post-tests.
- The results show that boosting and nudging both increase hand hygiene compliance whilst the control group showed no significant effects. Nurses subject to the nudge are 7.5 times as likely to comply in first post-test compared to the pre-test, but only 2.81 times in the second post-test. Contrarily, nurses subject to a boost are 3.74 times as likely to comply in the first post-test and 4.36 times in the second one.
- In conclusion, the experiment is successful. Notwithstanding its methodological limitations, this thesis finally discusses implications and recommends to continue

innovative behavioural experiments, with an interactive development process and employing mixed methods-designs.

Dutch version:

- *De naleving van handhygiëne onder ziekenhuismedewerkers is een van de belangrijkste manieren om de patiëntveiligheid in ziekenhuizen te vergroten. Tegelijkertijd laten veel onderzoeken zien dat medewerkers maar de helft van de tijd daadwerkelijk het protocol volgen.*
- *Deze masterscriptie ontwikkelt, implementeert en analyseert een quasi-experimentele veldstudie die poogt de naleving van het handhygiëne protocol onder ziekenhuismedewerkers te vergroten door middel van twee gedragsinterventies.*
 - *Ten eerste, nudging is een bekende aanpak die probeert het reflexieve besluitvormingsproces van een individu aan te spreken. Echter, vaak worden dezelfde typen nudges gebruikt in interventies. Deze scriptie poogt een innovatieve nudge te ontwikkelen.*
 - *Ten tweede voegt deze scriptie een andere en innovatieve aanpak toe: boosting. Boosting probeert reflectie en het lerend vermogen van actoren te bevorderen. Door beide interventies te testen, kunnen ze vergeleken worden.*
- *De hypotheses voor deze studie zijn dat beide interventies succesvol zijn in het vergroten van de naleving, maar dat nudging meer direct en op korte termijn werkt, terwijl boosting het tegenovergestelde laat zien.*
- *Het experiment wordt uitgevoerd in een Nederlands perifeer ziekenhuis in maart t/m mei 2019. De onderzoeksvraag is: Wat is het effect van nudging en boosting op de naleving van het handhygiëne protocol van ziekenhuismedewerkers?*
- *Om de interventies te ontwikkelen is een pre-experimentele analyse uitgevoerd in samenwerking met ziekenhuismedewerkers. Vervolgens wordt een experiment uitgevoerd met een quasi-experimenteel ontwerp waarbij de interventies apart worden getest. Ook is er een controlegroep, en zijn er twee voormetingen en twee nametingen.*
- *De resultaten laten zien dat boosting en nudging beide de naleving van het protocol vergroten terwijl de controlegroep geen significante resultaten laat zien. De kans dat verpleegkundigen het protocol naleven is 7.5 keer zo groot in de eerste nameting en 2.81 keer zo groot in de tweede. Bij de boost is de kans in de eerste meting 3.64 keer zo groot en in de tweede meting 4.36 keer.*
- *In conclusie, het experiment is succesvol. Hoewel er methodologische beperkingen zijn, kunnen de implicaties besproken worden en zijn er drie belangrijke aanbevelingen: doorgaan met het ontwikkelen van innovatieve experimenten, daarbij gebruikmaken van een interactief ontwikkelingsproces en gemengde methoden toepassen om resultaat te meten.*

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1. Introduction

1.1. Research problem and question

Hand hygiene protocol compliance by hospital employees is one of the key acts improving patient safety in hospitals. Where hospital employees fail to comply, infections are more likely to be transmitted from patient to patient (Pittet *et al.*, 2006). Similarly, studies show improvements in healthcare hand hygiene lead to a reduction in infections and cross-transmission rates (*e.g.* Rosenthal *et al.*, 2005; Carboneau *et al.*, 2010).

Consequently, one may expect compliance towards hand hygiene protocols to be duly noted amongst hospital employees. But it is not. Most studies assessing compliance report rates (the amount of moments in which an employee complied to the protocol divided by the total amount of moments in which an employee should have complied) under 50% (*e.g.* Squires *et al.*, 2013) and the World Health Organisation (WHO) reports an average rate of 38.7%, based on a systematic review (2009), p.5). Worries about hand hygiene compliance are also justified in Dutch context, as the official healthcare inspectorate indicates in their 2017 study on Dutch healthcare infection prevention (Health and Youth Care Inspectorate (IGJ), 2018). At the same time, recent numbers show one in twenty patients in Dutch hospitals suffers from an infection received in the hospital (IGJ, 2018), and in one-fifth of patient deaths in Dutch hospitals, hospital induced infections played a role (Langelaan, 2017).

The Dutch minister of Healthcare consequently emphasised the urgency to improve infection prevention of hospitals and hospital employees (Benschop, 2018). Also, the report of the Dutch inspectorate, titled 'Infection prevention, a matter of behaviour and perseverance', points out that everyday commitment and correct behaviour of healthcare employees is crucial in improving infection prevention (IGJ, 2018).

Yet, why are compliance levels relatively low? And how can this be improved? Answers to these questions are in need of a multidisciplinary approach as they are both a matter of *behaviour*, as well as one of *organisational context* in which behaviour is displayed. Specifically, insights from behavioural sciences with regard to behaviour of (groups of) humans may fuel the development of interventions aimed to influence behaviour, whereas the academic discipline of public administration provides context through understanding of the functioning of public (*i.e.* healthcare) organisations (Grimmelikhuijsen *et al.*, 2017; Sonne Nørgaard, 2018).

Hence, this master's thesis develops, executes and analyses a quasi-experimental field study at a Dutch regional hospital¹ in March-May 2019. This experiment aims to increase compliance of hospital employees with the hand hygiene protocol by using two psychological concepts to fuel behavioural interventions.

First, the concept of *nudging* is a well-known strategy to influence behaviour by changing the decision environment of the actors (Thaler and Sunstein, 2008). Yet, whilst nudging has been applied in hand hygiene compliance, its appliance has been rather one-sided (and mostly focussed on the *efforts* of decisions). In sum, the first thesis goal is to apply an innovative nudge to improve hand hygiene compliance.

Yet the nudging strategy has not been free of criticism. Most importantly, some authors have criticised its inability to have a long-term impact on behaviour (*e.g.* Hertwig, 2017). Hertwig and Grüne-Yanoff (2017) subsequently present an alternative approach towards behavioural change: *boosting*. They suggest, in order to make a long-term impact, an intervention should be directed at enhancing the decision-making process of the actors themselves rather than altering the environment. This is a recent and fundamentally different approach and it has not been applied much yet, let alone in hand hygiene compliance. Thus, this thesis second goal is to present boosting as an innovative approach for long-term impact on hand hygiene compliance.

Finally, a third goal can be added to the former two. To date, very few authors have attempted to test and compare their effects empirically in an experimental setting (Hertwig and Grüne-Yanoff, 2017; Hertwig, 2017; Grüne-Yanoff *et al.*, 2018). By testing both psychological concepts separately in the same field experiment, their distinctive, rather than joint, effects on hand hygiene compliance can be assessed.

The research goals above form this thesis' contributions to the scientific literature. Besides theoretically, it also aims to contribute methodologically. First, recent criticisms of the nudging movement describe endeavours to apply behavioural insights in practice as elite- and expert-driven (John and Stoker, 2019) or as possessed with unjustifiable pretence to be apolitical and objective (Feitsma, 2019). In reaction, this thesis presents an interactive intervention development process that, besides scientific theory, uses another crucial source: the professional wisdom and insights from hospital employees themselves.

¹ In consultation with the hospital, it was jointly decided the hospital would be anonymised in the final version of the thesis.

Second, in addition to observing actual hand hygiene compliance (cf. Erasmus *et al.*, 2010), this thesis employs a pre- and post-test survey to add additional insights into the effectiveness of the behavioural interventions, both by quantitative as well as qualitative measures. Hence, a mixed methods approach is applied to a field experiment.

Finally, at least two practical contributions are made to the hospital in case and healthcare in general. Most importantly, interventions are developed that act as instruments for behavioural change and that contribute to hand hygiene practice in the hospital. Not only are they valuable for the hospital in the years to come, their relevance for other contexts is considerable. For example, other wards, hospitals, and (healthcare) organisations may adapt them.

Similarly, the interactive intervention development process presents the hospital in case with a behavioural scan on factors hindering employees in hand hygiene compliance, which, besides fuelling the experiment, may be considered by hospital managers in other projects as valuable contextual knowledge.

To make these contributions, the following research question guides the study:

What is the effect of behavioural nudging and boosting on hand hygiene protocol compliance of hospital employees?

1.2. Sub-questions

To answer the research question, multiple theoretical and empirical sub-questions have been developed. First, three theoretical questions position this thesis in the literature. The questions discuss hand hygiene compliance, nudging and boosting, and the appliance of the latter in the former.

1. What are the facts and consequences regarding hand hygiene compliance amongst hospital employees?
2. What does it mean to nudge or boost behaviour and what are benefits and drawbacks of both approaches?
3. To what extent have nudging and boosting interventions been applied for hand hygiene compliance and which literature gaps can be identified?

Next, an empirical pre-analysis of the status of hand hygiene compliance in the specific hospital is conducted, which forms the basis for the experiment. This pre-experimental

analysis is conducted by means of short interviews and document analysis. The analysis is included in appendix 1.

4. What hinders employees of the hospital in case in complying with the hand hygiene protocol and what specific types of nudging and boosting seem promising to improve compliance?

Finally, the field experiment, which forms the core of the empirical analysis and contains both quantitative as well as qualitative measures, is executed and evaluated. Its methods are described in chapter 3 and its results in chapter 4.

5. What is the effect of a nudge and a boost on hand hygiene compliance?

2. Theoretical framework

2.1. Hand hygiene compliance

First, the topic of hand hygiene and compliance towards is discussed, guided by the first theoretical question: What are the facts and consequences of hand hygiene compliance amongst healthcare workers?

2.1.1. WHO guidelines

'Patient safety' is one of the many programmes the WHO is concerned with. It is defined as the 'absence of preventable harm to a patient during the process of healthcare and reduction of risk of unnecessary harm associated with healthcare to an acceptable minimum' (WHO, 2019). As part of this programme, the WHO has published guidelines on hand hygiene that are adapted widely and used by hospitals all over the world (WHO, 2011), likewise in the hospital that is the setting of this experiment. (The specific protocol of the hospital in case has been included in appendix 2.) The guidelines define five basic moments during work in healthcare at which healthcare employees have to apply hand hygiene: before touching a patient, before a clean or aseptic procedure, after (risk of) body fluid exposure, after touching a patient, and after touching the surroundings of a patient (WHO, 2009, p.27). In practice, these moments may not be excluding, but together they are considered exhaustive.

2.1.2. Low compliance rates

However, studies on hand hygiene compliance in hospitals show compliance with these hand hygiene guidelines often falls short. Many studies report compliance rates under 50% (Squires *et al.*, 2013; Bischoff *et al.*, 2000; Pittet *et al.*, 1999). The WHO provides a review of studies addressing hand hygiene compliance worldwide, and reports an average baseline rate (rate of compliance before any potential intervention) of 38.7% (WHO, 2009, p.5).

This lack of hand hygiene compliance is also visible in the Dutch context. A 2017 study by the official Health and Youth Care Inspectorate of the Dutch government claims that in many Dutch hospitals infection prevention is substandard, including hand hygiene (IGJ, 2018). While most hospitals improved on a number of regulations in comparison to the investigations in 2013 and 2015, similar shortcomings were noted. A considerable share of the hospitals did

not satisfactorily comply with dress code, disinfection and cleaning, or infection monitoring (varying from 44% to 71%, dependent on the topic). Whilst antibiotics policies and the availability of infection protocols were rated sufficient, facilities for and knowledge of isolation of patients were often insufficient. For hand hygiene, the basic facilities were usually present, but the researchers questioned whether they were actually used correctly and consequently (IGJ, 2018).

What is more, the facts on hospital infections in the Netherlands are worrying. Recent statistics show one in every twenty patients in a Dutch hospitals suffers from an infection that was not present when they entered the hospital, meaning it has been transferred from other patients or employees (IGJ, 2018). Additionally, a 2017 monitor on healthcare related damage in Dutch hospitals claims for 20,4% of the patients who died in the hospital, there were clues that pointed to hospital induced infections (Langelaan, 2017).

2.1.3. Hand hygiene and infections

A causal connection between lack of hand hygiene and an increase in infections makes sense. Pittet *et al.* (2006, p.641) have come up with an evidence-based model that describes the steps for patient-to-patient transmission of certain organisms via the hands of healthcare employees and found evidence present for each of the steps. For example, in one study, all healthcare employees had at least once carried Gram-negative bacilli and two third had carried *Staphylococcus aureus* (e.g. the Methicillin-resistant type: MRSA) at least once (Waters *et al.*, 2004; Maki, 1978; in Pittet *et al.*, 2006, p.643). Also, these organisms were shown to survive when hand hygiene is not applied correctly (or not applied at all), e.g. through quick cleansing, not using alcohol-based gel, or wearing jewellery (Trick *et al.*, 2003; McNeil *et al.*, 2001; in Pittet *et al.*, 2006, p.644).

Crucially, the WHO (2009) argues at least 20 studies in hospitals have shown that an improvement in hand hygiene is followed by a reduction in infection and cross-transmission rates (p.9). For example, Rosenthal *et al.* (2005, in WHO, 2009) report a reduction in healthcare-associated infection rates from 47.5 on every 1000 patient-days to 27.9, over a period of 21 months. Lastly, Carboneau *et al.* (2010) found an increase in compliance from 65% to 82% to result in a 51% decrease in hospital-acquired cases of MRSA over the period of one year.

2.2. Nudging or boosting behaviour

The second theoretical question discusses the psychological concepts: What does it mean to nudge or boost behaviour and what are benefits and drawbacks of both approaches?

2.2.1. Behavioural public administration

Clearly, amongst its other ongoing challenges, the healthcare sector is struggling with hand hygiene compliance. Studies in healthcare show a continuous need for work optimisation and efficiency (Voyer, 2015), but it can take years to, for example, incorporate new guidelines into a healthcare organisation (IGJ, 2018). Additionally, traditional measures that attempt to influence employee behaviour, for example through rewards and penalties, have often proved ineffective (Crupi *et al.*, 2018). In healthcare, this can be a matter of life and death. At the same time, the autonomy of healthcare professionals should also be considered: imposing too many rules or policies on employees in already stressful environments should rather be avoided (Nagtegaal *et al.*, forthcoming). Consequently, the healthcare sector has increasingly attracted the attention of scholars who study the behaviour of professionals and how to influence it whilst considering issues like autonomy and dignity. Amongst them are those doing so in the field of public administration (Grimmelikhuijsen *et al.*, 2017).

Like in other academic disciplines, psychological insights have been increasingly applied in the discipline of public administration, eventually creating the subdiscipline that was baptised behavioural public administration. These insights enable to study public administration issues at the micro-level of behaviour and attitudes of individuals (Grimmelikhuijsen *et al.*, 2017). Since then, learning from, adapting and applying insights of the behaviour of (groups of) humans has contributed a great deal to the development and practical value of public administration as a discipline (Sonne Nørgaard, 2018). A core business in the behavioural sciences concerns the development and assessment of actual interventions aimed at influencing behaviour. Herein, the concept of *nudging* has had considerable attention, whilst the concept of *boosting* is new and innovative. Yet both insights offer potential for increasing hand hygiene amongst healthcare workers.

2.2.2. Nudging: a definition

One of the behavioural insights that has been applied in public administration is the concept of nudging. Nudging is concerned with influencing 'people's behaviour in a predictable way', yet 'without forbidding any options or significantly changing their economic incentives' (Thaler and Sunstein, 2008, p.6; Sunstein, 2016). Nudging thus refers to changes in the decision environment or choice architecture of actors that influence their behaviour. These changes are fuelled by the psychological understanding of biases and flaws in the bounded rational human decision making, rather than upholding the notion of a full rationality (Thaler *et al.*, 2010; Münscher *et al.*, 2016).

2.2.3. Nudging: a taxonomy

Münscher *et al.* (2016) have, amongst others, developed this notion by presenting a taxonomy for choice architecture techniques (*i.e.* nudges) structured by design rather than underlying cognitive processes. The taxonomy clarifies the different avenues through which human decision making can be nudged.

First, *decision information* targets the way information is presented. It includes the technique of translating information through reframing (*e.g.* 'blood donation prevents deaths' instead of '... saves lives') or simplifying (*e.g.* 'please bring your ID' rather than 'the display of a valid form of civil identification is required'). Also, one could opt to make information visible. This could be either feedback on own behaviour (*e.g.* the amount of taken steps in a day) or external information (*e.g.* which hotels have passed a test guaranteeing a minimum level of quality). Lastly, providing a social reference point is a way of altering the presentation of information. One could refer to a descriptive norm (*e.g.* most people in this hotel shower less than 5 minutes) or an opinion leader (*e.g.* celebrity X always does her taxes on time) (pp.514-516).

Secondly, nudges can be aimed at changing the *decision structure*. First, people are likely to choose any option that is considered default. A nudge can aim to change the choice default by setting the desired choice as a no-action default (*e.g.* green energy as default) or deleting the default, hereby prompting a choice (*e.g.* asking whether to pay cash or by card rather than assuming one of the options). Secondly, the perceived physical or financial efforts that accompany a choice can be altered (*e.g.* placing fruit at eye-level; and asking people to pay a smaller amount of money in parts rather than the whole sum at once). Thirdly, the range or composition of options is changeable (*e.g.* presenting more healthy options for lunch than unhealthy ones). And fourthly, the consequences, either financial or social, can be changed (*e.g.* shops selling plastic bags for a few cents; and confronting people with a charity collection in front of other people (pp.516-519).

The last category of nudges aims to deliver further *decision assistance* to people. It can do so by providing reminders (*e.g.* reminding to vote in elections). Also, the facilitation of self- or public commitment is a form of decision assistance (*e.g.* signing a letter to quit smoking, either privately or in cooperation with other people) (pp.519-520).

Chapter 2.3. discusses to what extent these categories of nudges have been applied and subsequently define an innovative nudge as one of the distinctive qualities of this thesis.

2.2.4. *Nudging: application and discussion*

Since its introduction, nudging has been studied and applied extensively in a great number of disciplines, including nutrition sciences (e.g. Bucher *et al.*, 2016), environmental policy (e.g. Ölander and Thøgersen, 2014), and health policy and sciences (e.g. Marteau *et al.*, 2011). However, parallel to its increasing popularity, nudging has attracted criticisms.

First, behind the concept of nudging lies a philosophy that prefers gentle encouragement above more obtrusive and forceful forms of stimulating behavioural change, like rules and sanctions (Voyer, 2015). Scholars have criticised the principles of this approach for a multiplicity of reasons. Some claim its philosophy is liberal paternalistic: whilst freedom of choice is preserved, behaviour is at the same time affected. They go on to argue it contains ‘an insult’ to the integrity of the individual (Gingerich, 2015, p.1). Still, one could, depending on his or her political principles, also argue that ‘when paternalism would improve welfare, welfarists should support paternalism’ (Sunstein, 2015, p.29).

Others deem nudging to be, at least in some cases, inherently not transparent to those being nudged, for it to work (Hertwig and Grüne-Yanoff, 2017). Sunstein (2014) has argued that nudging can and should always be transparent and open to public scrutiny: influencing is not the same as manipulating or tricking. However, others state the issue of to what extent nudging can be transparent and effective has not been satisfactorily investigated yet and deserves scientific attention in the coming years (Marchiori *et al.*, 2017).

Besides, nudging has become somewhat of an umbrella term, readily encompassing everything related to influencing the decision making of an individual not based on rational cost-benefit analysis (Marchiori *et al.*, 2017). In this spirit, Münscher *et al.* (2016) contrast nudging with alternative measures of education, bans, mandates or economic incentives (p.513). Yet a grey area exists to what can be considered nudging and what is simply educating. Münscher’s *et al.* (2016) taxonomy includes techniques that vary greatly in the extent to which the knowledge or competences of an individual are influenced. For example, whereas changing the choice default supposedly requires no adaption of the individual, a nudging technique like making external information visible can, depending on the execution of the technique, require a lot of interpretation and even resemble an educational measure (Münscher *et al.*, 2016). It is a matter up for discussion whether the latter can still be considered nudging.

2.2.5. *Main criticisms: nudge development and effects*

However, two chief criticisms that fuelled this thesis are not about the philosophical nor descriptive issues. They are about the *development* and the *effect* of a nudge.

First, in 'Nudge, Nudge, Think, Think: Two Strategies for Changing Civic Behaviour', John *et al.* (2009) distinguish between nudging and thinking, when they argue both behavioural economics ('nudging') as well as deliberative democracy ('thinking') should be tools in a governments toolbox for influencing the behaviour of citizens. In contrast to nudging, a thinking strategy aims to stimulate public deliberation. This is crucial, because the legitimacy of governments decisions rest 'on the free flow of discussion and exchange of views in an environment of mutual respect and understanding' (John *et al.*, 2019, p. 364). More recently, the same authors advocated for more engagement of citizens in behavioural policy processes, arguing that emphasising the bounded rationality of individuals and necessity of expert advice is narrow-minded (John and Stoker, 2019).

More scholars have questioned the process of choice architecture, arguing that whilst scientists engaged in developing behavioural interventions may present it as an apolitical and instrumental process, in reality, the concept of 'knowledge brokers' offers better understanding for the inherently political relationship between science and policies (Feitsma, 2019, p.42). In short, behavioural intervention developers are not 'ivory tower'-scientists implementing objective knowledge but actors involved in the inherent political process of knowledge brokerage. Hence, engaging the subjects of a behavioural intervention in the development process increases its legitimacy.

This criticism is addressed in this thesis by presenting an interactive intervention development process, highly involving hospital employees in the experiment.

Second, the *effect* of a nudge is severely criticised for its inability to have an impact in the long term. The effect of a nudge may cease when the nudge is taken away and existing cognitive biases become prevalent again. This is especially the case for choices that are not made on a regular basis. Only nudges that are internalised in a routine may luckily survive the deletion of the nudge (Hertwig, 2017). In a reaction, Sunstein (2014) emphasises nudging is not innovative in its efficacy. People are nudged all the time. Consciously implementing a nudge merely adds to the existing ones. Clearly, nudging does not include increasing someone's competences as such (Hertwig and Grüne-Yanoff, 2017). Nudging makes use of the limitations of decision making and finds ways around it by adapting the decision environment to the decisionmaker rather than teaching the decisionmaker to better understand his or her decision environment.

This criticism is addressed by an alternative approach, described below.

2.2.6. Boosting: a definition

The above calls for alternative approaches addressing the shortcomings of nudging. Hertwig and Grüne-Yanoff (2017) developed a fundamentally different approach and named it boosting. Contrarily to adapting the decision environment to the confined mental state of an individual, boosting aims to enhance the decision-making of an individual. Specifically, its goal is to improve knowledge or competences (Hertwig and Grüne-Yanoff, 2017). Hence, similarly to nudging, boosting admits the bounded rationality of human decision making but deduces different implications from it. It attempts to change skills, knowledge, or decision tools (p.2) in order to solve the misfit between the decision maker and their environment (Hertwig, 2017, p.146).

From the publication dates and subsequent citations, it becomes clear that boosting is a recent and novel approach that still needs to prove its worth. Testing a boosting intervention in a field experiment is therefore very valuable to the assessment of the concept in general and this thesis aims to do just that.

2.2.7. Boosting versus nudging

The difference between nudging and boosting is best captured when picturing the relationship between an individual, its behaviour, and the role of the environment. An individual has possession over a heuristic repertoire (a set of methods to solve problems and deal with situations) of which the person continuously selects heuristics to be used. This leads to behaviour portrayed by an individual, within a certain environment (Grüne-Yanoff *et al.*, 2018, pp.249-250). Whereas a nudge intervenes in the environment of an individual to stimulate a heuristic and influence behaviour, a boost attempts to expand the heuristic repertoire of an individual to change behaviour. Figure 2.1 illustrates this difference.

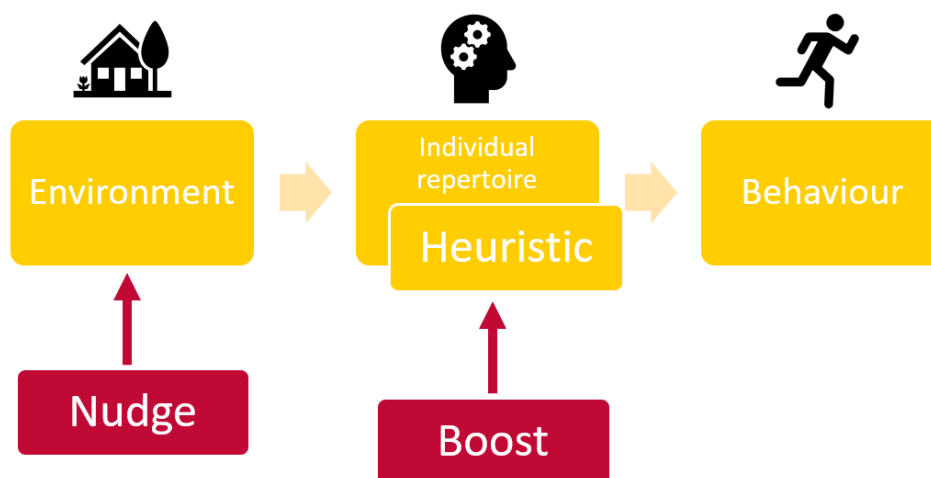


Figure 2.1: Nudging versus boosting. Adapted from Grüne-Yanoff *et al.*, 2018.

Subsequently, the success or failure of a nudge and a boost depends on different things. The success of a nudge depends for a large share on its *trigger stability* (Grüne-Yanoff *et al.*, 2018, p.254). This is the extent to which changes in the environment are able to alter behaviour. Herein, nudging assumes heuristic repertoires of individuals to be more or less similar and does not consider personal competences or attitudes. In contrast, boosting depends heavily on both the motivation of the individual and the teachability of the boost: does an individual want to apply the boost and is he or she able to do so, and at the right moment (Grüne-Yanoff *et al.*, 2018, p.254)?

Next, Hertwig and Grüne-Yanoff (2017) offer an empirical criterion for distinguishing between the two, related to the criticism on the short term focus of nudges: if with the elimination of the intervention the effect on behaviour stops too, the intervention was likely to be a nudge. If the behaviour persists, the intervention was likely to be a boost (pp.980-981). From this follows, not uncontroversially, that nudges resulting into lasting behaviour (*e.g.* routines) are actually boosts. It also shows that, whereas the designer may separate the two in the design of the intervention, he or she should be cautious about to what extent the implementation reflects the intended behavioural intervention. An intended nudge may have resulted in a boost and vice versa².

² The empirical criterion resembles a classic distinction in human decision making: System 1 versus System 2 thinking (Kahneman and Egan, 2011; Sunstein, 2015). Whereas system 1 concerns the fast, effortless, automatic, affective, and nonconscious thought process', system 2 thinking is 'slow, effortful, rule-based, deliberate, and conscious' (Marchiori *et al.*, 2017, p.2). In recent behavioural theories, fast thinking is argued to be often prevalent above slow thinking, which relates to the bounded rationality of individuals (Marchiori *et al.*, 2017). Technically, nudging can be directed at both System 1 and System 2, dependant on whether the nudge is meant to activate automatic decision processes or lead to deliberation (Sunstein, 2015). However, Hertwig and Grüne-Yanoff (2017, p.980) argue in practice nudges are predominantly directed at the former for two reasons. First, debiasing human decision making is considered hard if not impossible (Kahneman, 2011, in Hertwig and Grüne-Yanoff, 2017). Second, System 1 nudges are more cost efficient because they assume human decision making to be stable: this way, relatively small nudges can be directed at a large, homogeneous audience. In contrast, proponents of boosting, like Hertwig and Grüne-Yanoff (2017), do assume System 2 thinking is changeable (let it be noted some scholars may not agree with this distinction in the first place). Consequently, boosting is primarily directed at debiasing or enhancing human decision making (Hertwig, 2017).

Table 2.1 summarises the above argument.

	Nudging	Boosting
Perception of environment	Intervention target	Additional factor
Effect of environment on individual repertoire	Triggering	Informing
Perception of individual repertoire	Almost non-malleable factor	Malleable intervention target
Main success factor	Trigger stability	Motivation and teachability
Main decision making process	Reflexive (system 1)	Reflective (system 2)
Effect of intervention removal	Return to preintervention state	Persistence of postintervention state

Table 2.1: Characteristics of nudging and boosting. Adapted from Grüne-Yanoff *et al.*, 2018; Hertwig and Grüne-Yanoff, 2017.

2.2.8. Boosting: a preliminary taxonomy

What interventions are typical boosts? Hertwig and Grüne-Yanoff (2017) offer a preliminary taxonomy on the competences that can be boosted. First, risk literacy boosts are meant to increase understanding about statistical information. The assumption is that people often misinterpret information about the risks that result from their decisions. Ways to improve risk literacy are using graphical representations (*e.g.* depicting a hundred people and visually marking which of them have a certain illness), eliminate biasing framing effects (*e.g.* using absolute rather than relative numbers) or training in math skills (p.7).

Second, uncertainty management boosts are meant to increase the quality of decision making in uncertainty by, for example, introducing decision trees or procedures (*e.g.* financial rule-of-thumb trainings, cf. Drexler *et al.*, 2014), or teaching people to make use of collective intelligence (Hertwig and Grüne-Yanoff, 2017, p.7) ('the ability of groups to outperform individual decision makers when solving complex cognitive problems' (Kurvers *et al.*, 2016, p.8777)).

Third, motivational boosts are meant to enable people to autonomously alter their own motivation or self-control by, amongst others, expressive writing (a therapeutic tool developed in psychology, in Lepore and Smyth, 2002) or training in attention or self-control (Hertwig and Grüne-Yanoff, 2017, p.7) (cf. social mind theories about *e.g.* learning to alter the choice

situation, or change the psychological meaning of the choice options, in Fishbach and Shen, 2014).

2.2.9. *Boosting: application and discussion*

As pointed out, the concept of boosting has been developed quite recently and it has not been applied much yet. Amongst other applications, boosting has been used to advance the decision abilities of parents towards food choices for their children (Dallacker, 2018) and to foster responsible gambling (Hassanniakalager and Newall, 2018). Furthermore, Reijula *et al.* (2018) have argued that besides nudging and boosting, attention should be paid to the design of mechanisms and social norms (p.99).

A first ethical advantage of boosting is the necessity of transparency and subject cooperation of the intervention. Boosts appeal to the responsibility of the individuals involved, whereas nudges can simply work without the explicit blessing of the individual involved (Hertwig, 2017; Sunstein, 2015). Additionally, boosts are expected to have a larger effect in the long run, for they change the individual rather than the environment. By definition, the effect should last whilst the intervention is removed (Hertwig, 2017). This may be preferable when choosing an intervention.

A potential disadvantage is that an individual ought to possess a minimum of cognitive ability or motivation for a boost to be effective. Put differently, if someone does not want to cooperate or simply is not able to, the boost will not work. In contrast, a nudge does not require the same abilities or motivations (compare *e.g.* the mental or motivational effort for a change in the default to any kind of boost) (Hertwig, 2017, pp.150-151).

Secondly, the results of a boost may not immediately be visible and the implementation may take some more time. Depending on the severity of the boost, people may require more instruction and practicing before they are able to act accordingly (Hertwig, 2017). This last issue should be considered when comparing the effect of a boosting intervention on compliance to that of a nudging intervention.

2.3. Nudging and boosting in hand hygiene

The third theoretical question assesses the application of the psychological concepts in hand hygiene: To what extent have nudging and boosting interventions been applied in hand hygiene compliance and which literature gaps can be identified?

2.3.1. Field experiments

One of the key strands of behavioural research in healthcare has centred around applying nudges in healthcare settings to alter behaviour of employees, patients and/or visitors (Nagtegaal *et al.*, forthcoming). The enterprise of developing and testing nudges is mainly guided by one specific research method: the field experiment (Grimmelikhuijsen *et al.*, 2017). One of the nudging-fathers already proclaimed: 'experimentation, with careful controls, is a primary goal of the nudge enterprise' (Sunstein, 2014, p.585). In investigating the effect of behavioural interventions, conducting a field experiment is effective, as it allows the researcher to add the variable in an intervention in a real world setting and subsequently test its effects. This way, one decreases chances of endogeneity and simultaneity and increases the quality of the causal claim being made (Margetts, 2011; Bouwman and Grimmelikhuijsen, 2015).

Next, the literature on nudging, boosting and hand hygiene compliance show some knowledge gaps that this thesis aims to address.

2.3.2. Nudging lacks variation

First, the lack of variation in nudging interventions is a gap in the literature that is addressed in this thesis. Recently, Nagtegaal *et al.* (forthcoming) have conducted an elaborate systematic review of nudging experiments in healthcare in relation to evidence-based medicine, consisting of 100 publications in 64 journals up till May 2018. The analysed nudges represented all categories defined by Münscher *et al.* (2016), and were mostly directed at changing prescribing (30%, of *e.g.* antibiotics), laboratory tests or image ordering (26%), and hand hygiene (18%) (Nagtegaal *et al.*, forthcoming, p.12). Within the hand hygiene experiments, a large number (36%) of the nudges were categorised in the changing option-related efforts-category (*e.g.* changing dispenser location). At the same time, none used the approaches of visibility of information, reminders or defaults (Nagtegaal *et al.*, forthcoming, p.14). Finally, 77% of all hand hygiene interventions showed positive effects, which made it the most successful behavioural target in the study (p.19). Hence, variation in nudging interventions regarding hand hygiene has been quite limited, yet the interventions were often successful.

2.3.3. No boosting experiments

Secondly, the lack of boosting experiments in hand hygiene is another gap in the literature that this thesis addresses. In contrast to nudging, the concept of boosting, being less familiar and relatively new in the academic literature, has sparked less attention of field experimenters. A

search for articles (February 2019) that mention boosting and hand hygiene leads to some results, but they do not use boosting in a ‘Hertwig and Grüne-Yanoffian’ sense (2017).

2.3.4. Messy interventions

Finally, there is a third theoretical gap: there is limited knowledge about the distinctive qualities of different (types of) interventions, because of the messiness of the interventions. This becomes especially clear when analysing articles that do not explicitly mention nudging or boosting but do present hand hygiene compliance interventions. A WHO report on hand hygiene (2009) provides an overview of studies on effective interventions to improve hand hygiene, in which 42 studies are presented. Whilst nudging is not mentioned specifically, many of the interventions use posters, feedback, reminders or alternative hand hygiene materials and could hence be classified as nudges. For example, Preston *et al.* (1981, in WHO, 2009) altered sink locations which led to an increase in hand hygiene of 14%. This could be categorised as decreasing the physical effort (Münscher *et al.*, 2016).

Besides nudging, 11 studies mention they include a form of education (*e.g.* Bischoff *et al.*, 2000). Educational interventions slightly resemble boosts in the sense that they address individual learning (however, as discussed, boosts are argued to differ conceptually from ‘plain’ education). However, it is hard to assess which (types of) interventions are more effective since most studies use multiple interventions at the same time. In that sense, the interventions are messy (or: multifaceted). For example, Raju and Kobler (1991, in WHO, 2009) use both feedback mechanisms as well as dissemination of relevant literature and manage to increase compliance from 28 to 63%. This limits claims about the specific success of each of the interventions.

2.4. Conclusion and hypotheses

In sum, this thesis aims to address the multiple gaps in the literature. First, whereas nudging has been increasingly applied in healthcare, its application has been limited to a selection of subtypes. Hence, the first research gap that needs attention is to find an innovative way of developing and applying a nudge concerning hand hygiene and assess its effect on compliance.

However, nudging is also criticised for its short-term focus. Hence, secondly, with boosting, an additional behavioural intervention has been presented. Since very few studies have applied boosting in field experiments, let alone in healthcare or hand hygiene, the second research aim is to design a boosting intervention and assess it on its merits.

A third aim, related to the other two, is to test both intervention separately from each other, in order to assess their distinctive qualities rather than using multifaceted, messy interventions.

Four main hypotheses are deduced from the literature study to guide the empirical work. First, both a nudging intervention as well as a boosting intervention are expected to significantly and positively influence the level of hand hygiene compliance.

H1: Compared to the control group and pre-tests, the ward subject to a nudging intervention will have higher levels of in hand hygiene compliance.

H2: Compared to the control group and pre-tests, the ward subject to a boosting intervention will have higher levels of hand hygiene compliance.

Second, differences over time in compliance between the two interventions are likely. On the one hand, nudging has received criticism for its short term focus, hence the effect may be immediate yet decreasing in the long term, especially when the intervention is removed. On the other hand, it is argued boosting is more effective in the long term, yet its claim on changing reflective rather than reflexive thinking may result in a smaller immediate effect.

H3: The nudging intervention is likely to have a more immediate effect but decrease over time.

H4: The boosting intervention is likely to have a less immediate effect but increase over time.

3. Methods

3.1. Experimental setup

3.1.1. Setting

The experiment takes place in a regional (non-academic) hospital in a large Dutch city, in April 2019. The hospital has over 300 beds and roughly 2000 employees, medical specialists and volunteers, and delivers healthcare in a variety of specialisms and wards. In the hospital ranking of the *Algemeen Dagblad* (AD), the hospital has a mid-range score in the 'Hospital top 100' of 2018, whereas the *Elsevier* ranking categorises the hospital quality as lower than the average hospital quality in the Netherlands for 2018 (to the contrary, in 2017, the hospital was regarded to be of higher quality than average) (Algemeen Dagblad, 2019; Elsevier, 2019).

3.1.2. Participants

Within the hospital, three wards are picked to participate in the experiment and form three experimental groups. The amount of three is the minimum needed to be able to implement two separate interventions (a nudge and a boost) and include a control group. Hospital wards are so-called higher order experimental units that consist out of a number of individuals (Shadish *et al.*, 2002, p.253). Choosing units on a lower level (*e.g.* teams or individuals) would increase the chance of treatment diffusion, whereas wards operate relatively independent (Shadish *et al.*, 2002, p.81). The wards are described in table 3.1.

The employees that this experiment focuses on are nurses. They are chosen because they form the largest share of employees providing daily care to the patients in the hospital. Second, type of job can be a factor in compliance (*e.g.* Squires *et al.*, 2013), so to effectively assess an intervention, it makes sense to keep the type of employee consistent. For the intervention, all nurses in the wards are targeted.

	Ward 1	Ward 2	Ward 3
Discipline	MDL (stomach, intestines and liver care)	Day treatment (Brief procedures)	Orthopedics (support or movement care)
Number of beds	17	39*	18
Number of nurses	20	26	13
Placement of dispensers	<i>Alcohol dispensers are placed at the entrance, near sinks, at beds and in hallways. Soap dispensers are placed near sinks.</i>		

Table 3.1: Experimental wards. *This ward has 2 sub-wards, each sub-ward is similar in size to ward 1 or 3.

3.1.3. Design

This experiment is not a randomised control trial (RCT), because it lacks randomisation of treatments. Within the hospital, there are just over 20 (clinical) wards that vary in type of care, type of employees, size, et cetera. Random selection of a small number in a small sample is ineffective and will risk the three wards to be inherently different (Shadish *et al.*, 2002, p.255). Due to practical limitations, including more wards in the experiment is not possible. Also, randomisation on individual level is not possible since the nature of the work and design of the wards will make treatment diffusion likely (Shadish *et al.*, 2002, p.81), which leads to interference of experimental units (Gerber and Green, 2012).

Instead, the experiment adopts a quasi-experimental design with control group, pre- and post-tests (Shadish *et al.*, 2002, p.137). Not using random assignment jeopardises to some extent the comparison between the groups because the differences between them include an inherent selection bias (Gerber and Green, 2012, p.38).

To validate this design, other strategies for reducing alternative explanations have to be applied (Shadish *et al.*, 2002, p.105). The first strategy is to select wards based on their similarities on a number of characteristics, and include a control group. The three wards are relatively similar because they all provide non-intensive care to a large variety of patients. Contrarily, in a surgical or intensive care ward, for example, employees will be more pressed to apply hygiene protocols due to the nature of the care provided and the state of the patients (Hugonnet *et al.*, 2002). Similarly, special groups of patients (like children or elderly) may influence compliance (Eveillard *et al.*, 2012). The chosen wards do differ in size (ward 2 is larger than ward 1 and 3), but this should not complicate the findings. Besides pre-intervention characteristics, the measurements include a number of background characteristics of

individual nurses within the wards, that act as control variables and enable further comparison between the wards.

The second avenue chosen is to include a design feature that reduces alternative explanations. To decrease threats to internal validity due to potential inherent differences between the groups, a double pre-test is conducted (Shadish *et al.*, 2002, p.145).

3.1.4. Procedure

The research procedure is organised as depicted in table 3.2. A few months before the experiment, interviews are held with nurses and ward managers to identify behavioural problems, causes and potential solutions (its methods and results are described in appendix 1). After that, the interventions are developed and each ward is linked with an intervention.

Next, the experiment is executed. Pre-tests are done to establish a baseline. Using Qualtrics XM, a survey is sent out to all nurses in the wards, two weeks before two rounds of observations are conducted in every ward, a week apart. Then, the interventions are implemented, after which the post-tests begin. Similar to the pre-tests, two rounds of observations are conducted, the one a week after the other. In between, the intervention is removed. This is done to assess the assumptions in hypotheses 3 and 4. Finally, a post-test survey is sent out.

Phase	Action	Period
Development (empirical sub-question 1)	Interviews and document analysis	December 2018
	Intervention development	January - March 2019
Execution (empirical sub-question 2)	Survey 1	March 18 - April 2, 2019
	Pre-test 1	April 2-3, 2019
	Pre-test 2	April 11-12, 2019
	Intervention implementation	April 23, 2019
	Post-test 1	April 25, 2019
	Intervention removal	April 30, 2019
	Post-test 2	May 1, 2019
	Survey 2	May 2-11, 2019

Table 3.2: Research procedure. (Experiment is highlighted.)

The process of pre-test interviews and intervention developing is further explained under 3.2. The process of pre- and post-test measuring through observations and a survey is discussed under 3.3.

3.2. Interventions

The three wards are each attributed to either the nudging intervention, the boosting intervention or the control group. Table 3.3 shows the non-purposive distribution, meaning each ward has equal chances to end up with one of the interventions.

	Intervention
Ward 1 (MDL)	Nudging
Ward 2 (Day treatment)	Boosting
Ward 3 (Orthopedics)	Control group

Table 3.3: Intervention allocation.

Next, the interventions are specified. As shown in figure 3.1, the theoretical framework fuels the type of behavioural interventions, namely the approaches of nudging and boosting. However, both theoretical approaches have taxonomies with various subtypes. To be able to choose suitable subtypes that are applicable in the empirical context, an experimental pre-study is conducted to systematically assess the behavioural problems present in the wards, following a framework suggested by Michie *et al.* (2011) and further revised by Münscher *et al.* (2016, p.512). In interviews, healthcare workers are asked to identify and explain problems and come up with solutions. Also, relevant documents are analysed. A description of the systematic approach and the results of the pre-test interviews is presented in appendix 1. The specific approaches that are chosen, are *reframing* (a type of nudging) and *increasing risk literacy* (a type of boosting). The main results from the experimental pre-study are further described below.

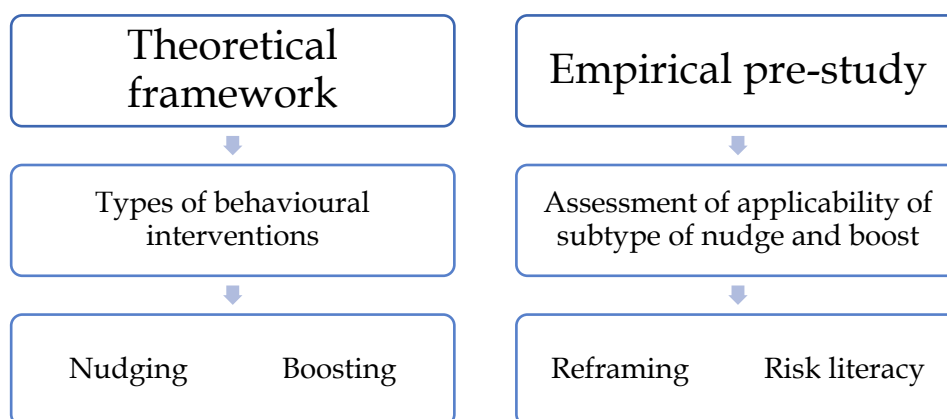


Figure 3.1: Theory and empirical pre-study.

3.2.1. Nudging intervention: Reframing

As defined in appendix 1, the nudge should address the negative perception of the hand hygiene protocol. A nudge type that aims to change perceptions can be found under the

category of decision information. This category aims to alter the presentation of information. Specifically, the subtype of reframing aims to translate information by, for example, redefining crucial messages from a negative perspective to a positive one (Münscher *et al.*, 2016).

In this specific case, the intervention aims to *nudge* nurses to comply with the hand hygiene protocol. Following the reframing-logic, it can do so by *reframing* the hand hygiene protocol from an extra burden (how it is often perceived, a negative frame) to a moment of care for the patient (a positive frame) (Münscher *et al.*, 2016, pp.514-515). Whilst no new information is unfolded to the nurses, their decision environment is influenced by presenting the same protocol in a different light.

This message is communicated through a poster and a flyer (for this intervention, the poster and the flyer are identical). The material is presented at team meetings, placed at a number of highly visible places in the ward and sent to all employees by email. Its main slogan, 'In good hands', relates hand hygiene to caring for patients. Next, two lines of texts are displayed: 'Good care for your patient starts with clean hands', and 'With the hand hygiene moments below, you contribute to this. The five hand hygiene moments are displayed below these lines. The material is designed to attract attention but also comply to the corporate identity of the hospital. The material is included in appendix 3.

3.2.2. *Boosting intervention: Risk literacy*

As defined in appendix 1, the boost should increase the urgency and relevance of the hand hygiene protocol. A boost type that appears especially useful concern the risk literacy boosts. It suggests people make wrong decisions (*e.g.* not complying to the hand hygiene protocol) because they misunderstand information about the risks (*e.g.* the chances of patients getting infections due to non-compliance and the severity of infections).

Hence, this intervention aims to *boost* nurses' decision-making of compliance with the hand hygiene protocol by increasing their risk literacy (Hertwig and Grüne-Yanoff, 2017, p.7). To that aim, the boost unfolds information about the commonality of hospital infections and the role of hand hygiene of hospital employees herein that aims to enable them to better weigh the risk of non-compliance. The information is presented using absolute rather than relative numbers to eliminate biasing framing effects (Hertwig and Grüne-Yanoff, 2017, p.7).

The message is communicated through a flyer and a poster. The material is distributed at team meetings, placed at highly visible places and sent along with an email from the ward manager. The main slogan is 'Prevent infections', referring to the risk of infections when hand hygiene is not applied. Next, the poster reads 'good hand hygiene prevents infections', after

which, similarly to the other intervention, the hand hygiene moments are referred to and displayed.

The flyer's frontpage is almost identical to the poster. In addition, the back provides absolute numbers on infections which are supposed to increase risk literacy. It reads as follows: 'Did you know?' '1 in 20 hospital patients receives a hospital infection.' 'Good hand hygiene from healthcare employees is the most effective way to prevent infections.' 'Research shows that in two American hospitals, the amount of cases with MRSA-infections halved after healthcare employees applied more hand hygiene.' The first line is based on the IGJ-report (2018), the second on Pittet *et al.* (2006). The third line refers to the study by Carboneau *et al.* (2010). Again, the material is designed to attract attention but also comply to the corporate identity of the hospital. The material is included in appendix 3.

3.2.3. Control group

The third ward receives no intervention and functions as a control group: an experimental unit where circumstances in the pre- and post-tests are supposed to be similar (Shadish *et al.*, 2002, p.103). By adding a control group, an (inherently limited) attempt at predicting the counterfactual (what would have happened without the treatment) is made (Shadish *et al.*, 2002, pp.5-6).

3.3. Measurements

In the literature, several approaches have been used to measure compliance with hand hygiene. Some measure the use of alcohol or soap by weighing the dispensers (*e.g.* Li *et al.*, 2019) or using electronic dispensers that record use (*e.g.* Caris *et al.*, 2018; Kwok *et al.*, 2016). A clear benefit of the latter approach becomes clear from the results of the study: the difference in compliance between points of time can be analysed. Caris *et al.* (2018) find nurses are more likely to comply during doctor rounds. Another approach is to observe hand hygiene compliance (*e.g.* Erasmus *et al.*, 2010; King *et al.*, 2016). Erasmus *et al.* (2010) individually observed a number of nurses for thirty minutes each at the same point of time, and did so before and after the intervention. This approach enabled them to specify the compliance to the several moments of hand hygiene as defined by the WHO (p.162).

In this study, compliance with the hand hygiene protocol is measured in multiple ways. First, actual compliance is measured by quantitative observations. Secondly, perceived compliance as well as other quantitative and qualitative perceptions are measured by means of a survey. Finally, qualitative fieldnotes are employed during the quantitative observations. The quantitative observations form the main measure of compliance, yet the survey and

fieldnotes are included because they may provide valuable additional explanations. This is a form of data triangulation. Employing quantitative as well as qualitative methods means this thesis uses a mixed methods-approach (Bryman, 2012). Below, the measurements are described in more detail.

3.3.1. Observations

As depicted in table 3.2, there are four observation rounds: two before and two after the intervention. For each observation round, each of the wards is observed for roughly 1.5-2 hours within two days. During this time, multiple nurses are individually observed. During the close observation, every potential moment of hand hygiene is noted by means of a score depicting which of the five moments of hand hygiene it is. (The protocol with the five moments is included in appendix 2.) After noting the potential moment, the reaction of the nurse is noted: is hand hygiene applied by means of alcohol, water and soap, or not applied at all? This approach is largely adapted from Erasmus *et al.* (2010). An example of the scoring sheet is included in appendix 4.

Hence, every observation session results in a percentage that depicts the number of hand hygiene moments where hand hygiene is applied, divided by the total amount of hand hygiene moments. All observations are executed by the author of this thesis. Simultaneously to the observations, field notes are used to record any additional comments or striking features (Bryman, 2012). To be able to conduct these observations, the author has attended a day of hand hygiene observation training at a different hospital. These trainings are given by infection prevention experts and nurses.

3.3.2. Surveys

The key concept in the pre- and post-test surveys is perceived compliance (the other survey elements are discussed below, for a full overview of the surveys see appendix 5). The measurement is adapted from Erasmus (2012) and asks nurses to estimate their appliance of hand hygiene per hand hygiene moment on a 7-point scale ranging from 'never' to 'always'. The surveys are also used to measure a number of other concepts, that are discussed below in the order they are presented in the pre-test survey.

First, a number of nurses' perceptions of the protocol are tested: the extent to which they think the protocol is useful, executable and pleasant (partially adapted from Erasmus, 2012). In the pre-test survey, they are also given opportunity to explain their answer and add ideas that could improve their perception. In contrast, in the post-test survey they are asked

whether they noticed the extra attention to the protocol in the past weeks and what they thought of it.

Second, nurses' knowledge of the protocol is tested by asking them to name the five moments and name the absorption time of the alcohol fluid (only in the pre-test survey).

Third, their perception of the consequences of non-compliance is measured in both the pre-and post-test survey by letting them estimate the probability of an infection in their ward due to non-compliance with the hand hygiene protocol, and the severity of the consequences of an infection on a 7-point scale (partially adapted from Erasmus, 2012).

Fourth, the relationship of the protocol and attitude of peers is addressed in both the pre-and post-test survey by asking three questions on whether they perceive peers to comply, whether they feel pressure to comply, and whether colleagues are supportive towards complying (5-point Likert scale, adapted from Erasmus, 2012).

Finally, background characteristics are asked (gender, job function, ward, age) and participants are encouraged to leave any remaining comments.

3.4. Analyses

First, quantitative analysis of the observational and survey data is conducted using IBM SPSS Statistics Version 25. Using the functions Descriptives, Frequencies and Crosstabs, descriptive statistics like frequencies, means and standard deviations are calculated.

Next, the statistical significance of the observations is assessed using Generalised Estimating Equations (GEE). GEE provide, in short, a semi-parametric way to longitudinally analyse correlated data (Zeger *et al.*, 1988; Hanley *et al.*, 2003; Ballinger, 2004). GEE are suitable for binary dependent variables (in this case: compliance) and categorical independent variables (in this case: the pre- and post-tests, with the first pre-test as reference) (Hanley *et al.*, 2003). The model assumes independence of observations between subjects, however, in contrast to logistic regression analysis and GLMs, it allows for the data to be dependent within subjects (IBM, 2013; Field, 2013). Because dependence within subjects is likely for a repeated measures design like this one (measuring compliance over time), this makes logistic regression an ill-fitting candidate for the analysis. Hence, in these circumstances GEE are found to provide closer approximations of population averages (Hubbard *et al.*, 2010). This thesis uses the GEE-approach to estimate the statistical significance of the observational results. Additionally, for comparative purposes, logistic regressions are conducted and added in an appendix.

Besides, a qualitative analysis of the qualitative survey elements and the field notes is presented. The qualitative analysis is used for the open questions where nurses can leave comments. Through thematic analysis, categories of perceptions are identified, analysed and presented (Bryman, 2012, pp. 578-580). Field notes are qualitative observations or reflections, and they written down quickly during the quantitative observations and subsequently included in a field notes table in more detail on the same day (Bryman, 2012, pp. 447-452).

3.5. Ethics and research quality

This section discusses some potential ethical or research quality issues that may accompany the study as described above, along with the solutions that are raised to counter potential risks.

3.5.1. Preregistration

A general erroneous practice in research is 'mistaking generation of post-dictions with testing of predictions' (Nosek *et al.*, 2018, p.2600). *I.e.* hypotheses must be formulated beforehand to assess the results and should not adapted to the results. To prove this is done in this experiment, the research question and hypotheses are submitted to an online registry (The Evidence in Governance and Politics registry (EGAP), accessible via <http://egap.org/design-registrations>), prior to execution of the experiment. The registration number is 20190313AA.

3.5.2. Informed consent, deception, invasiveness and opt-out

Next, as with many experiments, the issues of consent, deception, invasiveness and opt-out are important to discuss. First, for participation in the experiment, participants are not asked to sign an informed consent. Second, there is a small element of deception regarding the withholding of information about the experiment. Nurses are informed that the survey and the observations are conducted for an inter-hospital program on the compliance with several protocols, amongst which hand hygiene. They are not told that the goal is to assess whether the interventions of nudging and boosting affect compliance. Third, the observations and interventions to some extent invade their professional territory. Fourth, besides the survey, they are not able to opt out of the experiment.

The maintained level of secrecy is however necessary and common amongst field experiments in hand hygiene (compare Erasmus *et al.*, 2010). Informing nurses beforehand about the goals may influence their compliance and introduce a bias. Also, it is unlikely that any of these issues influences the nurses in any negative manner.

A number of measures are taken to strengthen ethical soundness. First, explicit permission has been asked and received from the chair of the general board of the hospital, the chair of the

scientific committee of the hospital, the infection prevention department of the hospital, and the three ward managers of the participating wards. Second, in all stages of the experiment, a policy officer of the hospital is involved to give advice. Third, nurses that participate in the survey are given the opportunity to contact the researcher with any questions they may have. In answering the questions, the researcher is careful not to convey crucial information, but at the same time this opportunity functions as a safety valve that may inform about any worries or confusion amongst nurses. In that case, responsible action needs to be taken. Fourth, all participants are debriefed after the experiment has finished, in which disclosure of the experiment, its goal and its results is given.

3.5.3. Intervention burden

Intervening in the real world is a risk and it must be carefully considered whether any perverse effects are possible or whether the intervention forms an unacceptable burden for the participants. Especially in healthcare, the existence of these effects may be a reason to terminate the experiment. The ethical committee of Utrecht University maintains a number of criteria to assess the burden: it must be considered whether the intervention is potentially physically or emotionally damaging, and whether it includes new procedures or procedures that are clearly out of the scope of the participants. Arguably, the intervention in this experiment, which is limited to a change in communication strategy, places almost no burden on the participants and there is no reason to expect unacceptable burdens or perverse effects due to the interventions. (Consequently, no official ethical approval has been deemed necessary to carry out the experiment, taking into account the nature of the experiment and the additional measures taken.)

3.5.4. Data and researcher triangulation

Another issue is whether evidence is singular or whether multiple procedures are used to improve soundness of the results by *triangulating* between them (Bryman, 2012). In this experiment, data triangulation takes place because of the double measurement and using mixed methods for this: observations and a survey. Observations unveil actual compliance but may be oblivious to factors influencing compliance that can be addressed in the survey. On the other hand, a survey contains mainly reported measures and may thus be subject to self-reporting bias (e.g. Randall and Fernandes, 1991).

An additional form of triangulation is to employ multiple researchers. Whilst this is not feasible in this experiment for practical reasons, a number of checks are built in to limit researcher bias. Besides the mentioned policy officer, an academic mentor and a mentor from

a large consultancy company with experience on behavioural interventions are involved in all stages of the research, through regular meetings and email.

3.5.5. Data encryption, use and storage

The data gathered in the experiment partially contain personal and sensitive data: some of the questions concern personal characteristics and the small amount of nurses in the wards makes them traceable when all the dots are connected. Therefore, measures are taken to protect the data. The data are stored on a Utrecht University data solution (Yoda). Also, the researcher is the only person authorised to edit or share the data. Finally, data is only presented at aggregate level to guarantee participant anonymity.

4. Results

This chapter answers the question: What is the effect of a nudge and a boost on hand hygiene compliance? It contains the results from the observations and the surveys. Also, attention is devoted to the qualitative elements in both methods.

4.1. Observations

4.1.1. Descriptive statistics

First, table 4.1 presents the number of observed potential hand hygiene moments per ward, per round, and the totals. In total, 348 moments of potential hand hygiene compliance are observed.

	Pre-test 1	Pre-test 2	Post-test 1	Post-test 2	Total
Ward 1 (N)*	31	32	18	24	105
Ward 2 (B)	46	50	31	25	152
Ward 3 (C)	21	25	27	18	91
Total	98	107	76	67	348

Table 4.1: Number of observed potential hand hygiene moments. *In this chapter, the letter behind the ward refers to the received treatment: N = nudge, B = boost, C = control group.

Next, table 4.2 presents the absolute numbers for the use of alcohol or soap or missed compliance before and after the intervention and per ward. Remarkably, nurses use far more alcohol than soap when applying hand hygiene (89% of all cases). Most importantly, when comparing before-and after-intervention scores, compliance seems to have increased. This appears to be especially the case for the two wards that received the intervention.

	Before intervention			After intervention		
	Alcohol	Soap	Miss	Alcohol	Soap	Miss
Ward 1 (N)	30	3	30	29	5	8
Ward 2 (B)	46	4	46	33	11	12
Ward 3 (C)	22	1	23	26	0	19
Total	98	8	99	88	16	39

Table 4.2: Alcohol, soap or miss. Per ward for rounds 1 and 2, and 3 and 4 combined.

In figure 4.1, the compliance scores (*i.e.* the ratio of moments of actual compliance and potential moments. For example, when four potential moments have been observed and in two of them the nurse applied hand hygiene, this leads to a score of 50%.) per ward and per round are presented, including confidence intervals³. Notably, ward 1 and 2 show more or less comparable (yet slightly increasing) scores for the two pre-tests. Next, they receive an intervention and subsequently show a large increase in compliance in post-test 1. Especially ward 1 increases dramatically. In post-test 2, after intervention removal, ward 2 increases again, whilst ward 1 shows a decrease. Meanwhile, the control group shows a decrease in pre-test 2 and more or less similar scores in the other rounds.

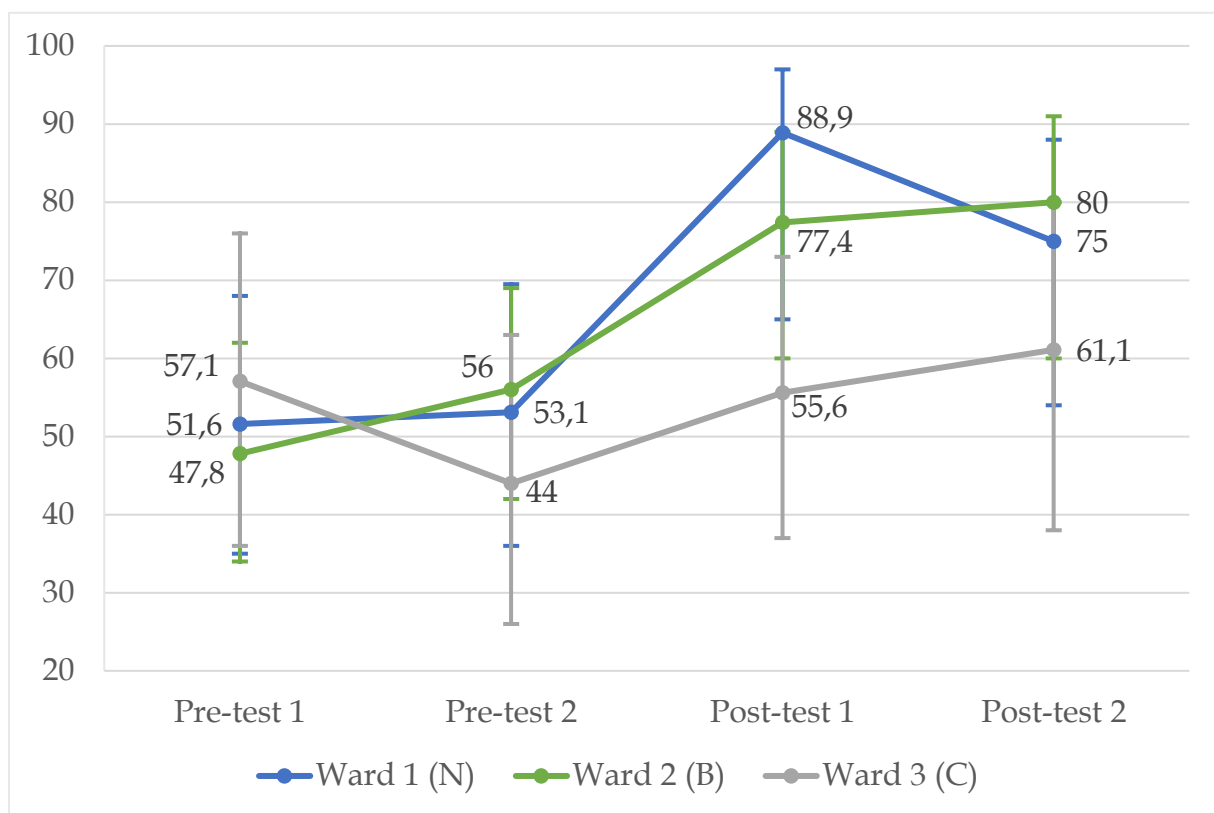


Figure 4.1: Compliance scores for hand hygiene in %. Confidence intervals in % with 95% confidence intervals.

Additionally, table 4.3 presents compliance scores before and after the intervention per hand hygiene moment (1 through 5). The percentages are calculated per ward and additionally, a weighted average is presented. For most moments, compliance increases, yet notably, even

³ These are deduced from the GEE-procedures in table 4.5 and presented before the actual analyses for conciseness purposes. GEE-procedures allow for estimating the marginal means of compliance scores. These show an approximation of the true population mean, however, they must be interpreted with some caution due to absence of randomisation (O'Brien and Yi, 2016).

after the intervention the scores for hand hygiene moments 1, 2 and 5 remain relatively low for at least one of the intervention wards. At the same time, hand hygiene moment 3 and 4 show consistently increased compliance for both intervention wards. However, conclusions are limited, since in some cases $n < 5$ (this is especially the case for moment 2).

	Before intervention					After intervention				
	1	2	3	4	5	1	2	3	4	5
Ward 1 (N)	35.7	14.3	77.8	60.0	50.0	40.0	100.0*	100.0	81.8	100.0
Ward 2 (B)	33.3	5.9	72.0	77.8	40.0	50.0	75.0*	90.9	93.3	33.3*
Ward 3 (C)	46.7	0.0*	50.0	76.9	30.0	54.5	50.0*	56.3	72.7	40.0
W.Av.	39.0	7.7	71.4	74.0	41.0	48.5	71.4	83.0	83.8	61.5

Table 4.3: Compliance scores before and after per hand hygiene moment. In % (rounds 1 and 2, and 3 and 4 taken together to increase chance of $n > 5$). An asterisk (*) marks percentages with $n < 5$).

4.1.2. Generalised estimating equations

Next, table 4.4 presents the results of the generalised estimating equations (GEE)⁴. This full model includes main effects and interactions for wards and measurement rounds. Ward 3 and Pre-test 1 are reference categories.

⁴ For reasons explained in 3.4, logistic regression analysis does not fit the data well due to absence of independence of observations. Still, conducting logistic regression analysis for the three wards yielded exactly the same results as the generalised estimating equations, showing the results of the GEE are likely to be robust. The results for the logistic regression analyses are included in appendix 6.

Dependent variable: compliance		
	B (SE)	p
Ward 1 (N)	-0.22 (0.57)	0.70
Ward 2 (B)	-0.38 (0.53)	0.48
Pre-test 2	-0.53 (0.60)	0.38
Post-test 1	-0.07 (0.59)	0.91
Post-test 2	0.16 (0.65)	0.80
Ward 1*Pre-test 2	0.59 (0.78)	0.45
Ward 1*Post-test 1	2.08** (1.02)	0.04
Ward 1*Post-test 2	0.87 (0.88)	0.33
Ward 2*Pre-test 2	0.86 (0.72)	0.24
Ward 2*Post-test 1	1.38* (0.78)	0.08
Ward 2*Post-test 2	1.31 (0.87)	0.14
Constant	0.29 (0.44)	0.51
<u>Model effects</u>		
Ward	$\chi^2 (2) = 4.81, p < 0.1$	
Measurement round	$\chi^2 (3) = 15.61, p < 0.01$	
Ward*Measurement round	$\chi^2 (6) = 6.01, p > 0.1$	
N	348	

Table 4.4: Coefficients, standard errors, p-values and model effects of Generalised Estimating Equations. * = $p < 0.1$, ** = $p < 0.05$. Pre-test 1 and ward 3 are taken as reference categories.

The model shows the interactions of the intervention wards with post-test 1 are significant. The effect for ward 1 is stronger than the effect for ward 2. It appears the interventions have a direct, significant effect, but the effects after intervention removal (post-test 2) are more unclear. Here, the effect for ward 1 is not at all significant but the effect for ward 2 is nearly significant. However, possibly, the amount of factors in the model compared to the used data contribute to a model having too little power (also, the interaction model effect is insignificant).

Therefore, as additional analysis, three separate GEE's⁵ are conducted so that the statistical analysis treats every ward as its own experiment. This decreases the amount of factors in the model. Pre-test 1 is taken as reference category.

⁵ Similarly to the full model, logistic regression analyses for these models have also been included in appendix 6.

The analyses in table 4.5 show significant results for all post-tests in wards 1 and 2. For ward 1, post-test 2 is significant at .1 level. The other post-tests for ward 1 and 2 are significant at .05 level. In contrast, the pre-tests for ward 1 and 2 and all tests for ward 3 are not significant. Comparing table 4.4 and 4.5, coefficients have not changed (subtracting ward 3 coefficients from the coefficients of the other wards results in the interaction coefficients for these wards, except for some rounding differences).

For interpretative purposes, odd ratios (OR) are calculated and presented⁶ (these are the exponentials of the coefficients, and represent the odds of being compliant to the protocol). They show nurses in ward 1 are 7.5 times as likely to comply in post-test 1 as they were in pre-test 1 (2.81 times in post-test 2), and nurses in ward 2 are 3.74 times as likely to comply in post-test 1 as they were in pre-test 1 (4.36 times in post-test 2).

Dependent variable: compliance									
	Ward 1 (N)			Ward 2 (B)			Ward 3 (C)		
	B (SE)	p	OR	B (SE)	p	OR	B (SE)	p	OR
Pre-test 2	0.06 (0.50)	0.90	1.06	0.33 (0.41)	0.42	1.39	-0.53 (0.60)	0.38	0.59
Post-test 1	2.02** (0.83)	0.02	7.50	1.32** (0.52)	0.01	3.74	-0.07 (0.59)	0.91	0.94
Post-test 2	1.03* (0.59)	0.08	2.81	1.47** (0.58)	0.01	4.36	0.16 (0.65)	0.80	1.18
Constant	0.07 (0.36)	0.86		-0.09 (0.30)	0.77		0.29 (0.44)	0.51	
Model	$\chi^2(3) = 8.60, p < 0.05$			$\chi^2(3) = 10.65, p < 0.05$			$\chi^2(3) = 1.47, p > 0.1$		
N	105			152			91		

Table 4.5: Coefficients, standard errors, p-values, odd ratios and model effects of Generalised Estimating Equations for all wards. * = $p < 0.1$, ** = $p < 0.05$. Pre-test 1 is taken as reference category.

4.2. Surveys

Complementary to the results of the observations, the wards are surveyed twice to gain more understanding of the perceptions of the nurses. Response rates for wards 1 and 2 lie between 25 and 42,3%. Unfortunately, for ward 3 (control group), in the post-survey, only one nurse responds. Hence, for ward 3, only the results of the pre-survey are presented. They function as a gauge of ward comparability. Because wards 1 and 2 do have sufficient participants for

⁶ SPSS does not calculate the explained variance for GEE's. The logistic regression analyses in appendix 6 do provide Nagelkerke R^2 's. For the full model logistic regression, this is $R^2=0.10$. For the partial models, the scores are 0.13, 0.10 and 0.02 for ward 1, 2 and 3 respectively.

both surveys, this analysis mainly focuses on similarities and differences between the two intervention wards. Information on number of participants, response rates per ward and background characteristics is presented in appendix 6.

First, participants were asked to estimate their own compliance to the hand hygiene protocol. Table 4.6 shows the results.

	Pre	Post
Ward 1 (N)	5.03 (0.82)	5.80 (0.66)
Ward 2 (B)	5.66 (0.70)	5.71 (0.65)
Ward 3 (C)	5.57 (0.75)	-

Table 4.6: Mean perceived compliance per ward. (Standard deviations between brackets. On a scale from 1 to 7, with 1: never, and 7: always)

Figure 4.2 compares the perceived compliance with actual compliance measured in the observations. Notably, in the pre-test nurses in all wards highly overestimate their hand hygiene compliance. In contrast, estimations become surprisingly more accurate after the intervention. Additionally, the nudging intervention in ward 1 seems to more strongly influence perceived compliance, whereas the nurses subject to a boosting intervention in ward 2 retain their (high) perception of compliance.

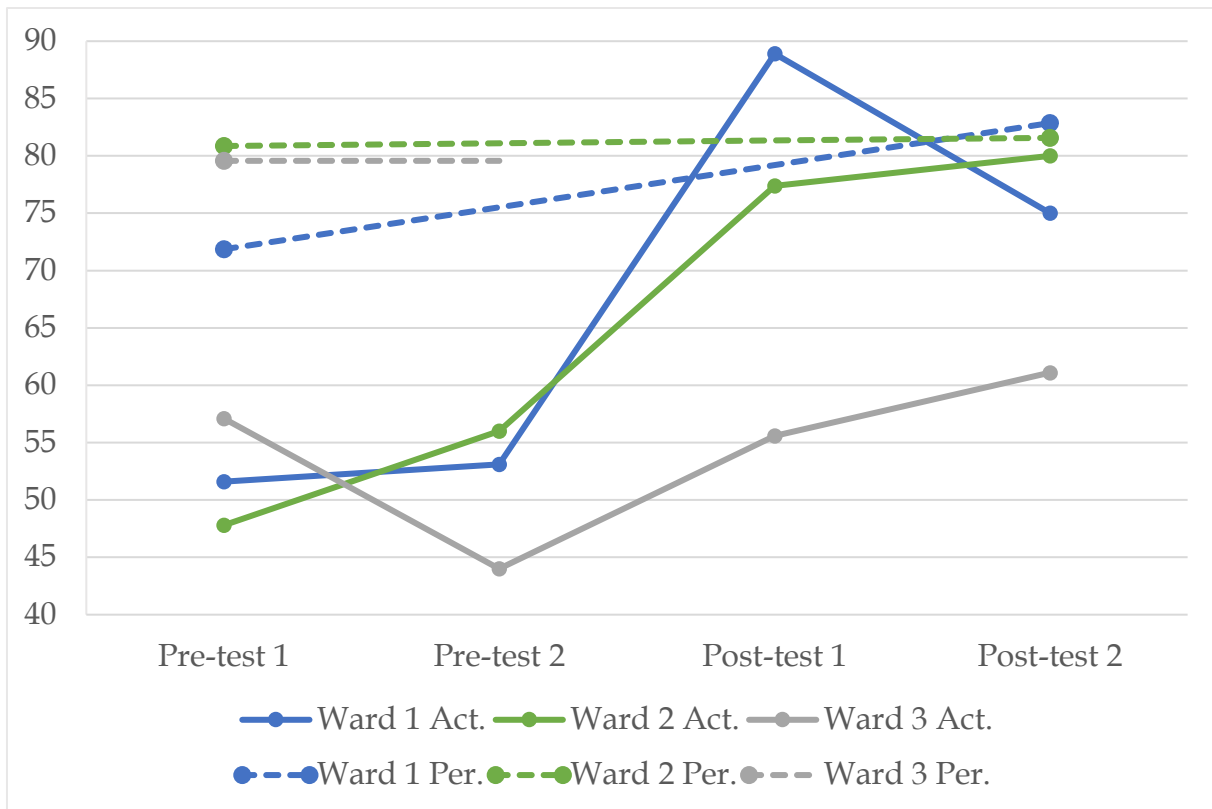


Figure 4.2: Perceived versus actual compliance. The perceived compliance-scores have been converted to percentages.

Finally, multiple questions related to the perceptions of nurses towards the protocol are asked. They are presented in table 4.7. In general, no exceptional differences were found between intervention wards and the control group in the first survey.

When zooming in on pre- and post-experimental perceptions of the protocol in general for the two intervention wards, mixed results are visible. For ward 1, after a positive reframing intervention, usefulness and pleasantness increase but executability does not. For ward 2, all three slightly decrease, but, notably, pre-experimental scores for ward 2 are much higher than those for ward 1.

Next, whereas the perceived probability of infections in the ward decreases for ward 1, it increases for ward 2. Nurses in ward 2 perceive the severity of infections slightly higher after the intervention whilst for nurses in ward 1 it is more or less equal. The increases in ward 2 make sense, considering they received the risk literacy intervention. However, in ward 1, these scores were already high.

Lastly, nurses' perceptions of peer compliance slightly increase for ward 2 and stay more or less similar for ward 1. Yet interestingly, the nurses in both wards experience more peer pressure and more peer support to comply to the hand hygiene protocol, after the intervention.

	Ward 1 (N)		Ward 2 (B)		Ward 3 (C)
	Pre	Post	Pre	Post	Pre
<i>Perceptions</i>	<i>1: not at all ..., 7: very ...</i>				
Usefulness	5.75 (1.75)	6.40 (1.34)	6.57 (0.79)	6.27 (1.10)	6.83 (0.41)
Executability	4.50 (1.85)	4.00 (2.00)	5.00 (0.58)	4.09 (1.38)	5.17 (0.41)
Pleasantness	4.50 (1.93)	5.20 (1.48)	5.14 (0.69)	4.91 (1.22)	5.33 (0.52)
<i>Infections</i>	<i>1: very improbable / minor , 7: very probable / very severe</i>				
Probability	3.63 (1.69)	3.60 (2.41)	3.00 (1.41)	3.18 (1.72)	3.17 (1.47)
Severity	5.75 (1.28)	5.80 (0.84)	5.14 (1.86)	5.55 (1.29)	5.83 (0.75)
<i>Peers</i>	<i>1: totally disagree, 5: totally agree</i>				
Compliance	2.75 (0.71)	2.80 (1.10)	2.43 (0.54)	2.73 (0.91)	2.33 (1.03)
Pressure	2.50 (1.20)	3.00 (1.00)	2.43 (0.79)	3.09 (1.04)	2.33 (0.52)
Support	2.89 (0.84)	3.40 (0.89)	3.29 (1.25)	3.73 (0.65)	3.33 (0.52)

Table 4.7: Means. (Standard deviations between brackets; Differences of more than .1 are coloured red when negative and green when positive.)

4.3. Qualitative analysis

The next section discusses the qualitative elements in the experiment, divided in four parts: nurses' perceptions of the hand hygiene protocol before the experiment⁷, their protocol knowledge before the experiment (both assessed in the pre-survey), the field notes during the observations, and nurses' opinions about the attention to hand hygiene in the post-survey.

4.3.1. Pre-experimental protocol perceptions

First, after ranking the protocol on usefulness, executability and pleasantness, the nurses are asked to elaborate on their answers. Multiple types of answers are given by 17 nurses. 3 nurses give a solely positive comment on the relevance of hand hygiene. One of them says: 'the protocol is pictured and explained well, and therefore easily executable'.

Next, 5 nurses give a mixed reply, emphasising both the relevance as well as issues that were problematic. 2 of the 5 mention being busy as interfering with hand hygiene compliance. One acknowledges hands as a 'source of contamination' but points out there is too little attention to, and cleaning of, alternative sources like toilets. 3 of the 5 nurses mention

⁷ Please mind, these are the perceptions collected in the pre-experimental survey, not the perceptions collected in the pre-study interviews used to design the interventions.

impracticalities in complying, like touching the environment of another patient on accident and not really considering to disinfect before continuing with the patient they were treating.

Finally, 9 nurses give a solely negative reply. Most nurses consider strict compliance to be impossible due to time constraints and the sheer quantity of hand hygiene moments. 3 out of 9 nurses wonder what the consequences of strict compliance would be for their skin flora. As one puts it: ‘if you do it like you are supposed to, you won’t have any skin left’.

8 nurses respond to the question to leave ideas for improving the protocol. Two advocate for more awareness of the relevance of hand hygiene, *e.g.* through ‘short movies’. One questions the functioning of the regular posters and trainings. Also, two nurses argue for better availability of hand alcohol, for example through personal bottles nurses carry with them, or by not placing the alcohol dispensers at the foot end of beds but at the side or headboard. Finally, one nurse wonders whether the hand hygiene moments could be decreased without decreasing safety.

4.3.2. Pre-experimental protocol knowledge

In the pre-test survey, nurses are asked to name all 5 hand hygiene moments. As specific formulations may differ, the results have to be qualitatively analysed to decide whether the nurses are correct or not. Table 4.8 shows the scores. Clearly, most nurses are well aware of the five moments of hand hygiene (or have looked it up whilst responding to the survey).

Hand hygiene knowledge score:	Number of nurses:
5 moments	15
4 moments	3
3 moments	2
2 moments	1
1 moment	-

Table 4.8: Scores hand hygiene moment knowledge.

Besides, nurses are asked whether they knew the exposure time of the hand alcohol. The correct answer as presented in the protocol is 30 seconds. 19 nurses give this answer. One thinks the time is 60 seconds and the last one answers with 20 seconds.

4.3.3. Field notes during observations

During the observations, in four rounds and in three wards, field notes are used to keep track of issues that spark attention during the observation but are not part of the observed behaviour. The field notes are presented in appendix 7. A few remarkable issues are worth

mentioning. First, on the first day in ward 1, a lot of beds do not have dispensers attached to them. In contrast, the dispensers are present on the next day, which is most likely caused by the awareness of the ward coordinator. Secondly, the protocol is not always understood well, for example: a number of times nurses apply double hygiene. They wash their hands with water and soap and apply alcohol afterwards. This is not useful nor advised by the infection prevention department. Also, some nurses assume wearing gloves counts as disinfection, use a lot of alcohol liquid or perform very quick disinfection procedures. Finally, most of the times reactions to the presence of the observant are positive, however, some nurses take the opportunity to complain about the hand hygiene protocol or work pressure or are clearly not very amused with the presence of the observant.

4.3.4. Opinion about hand hygiene attention

First, in the post-experimental survey, nurses are asked whether they notice the extra attention to the hand hygiene protocol. All 16 nurses respond they do.

Second, nurses are enabled to leave a response to what they think of the extra attention. For ward 1 (nudging intervention), 3 nurses are solely positive. One of them argues the new flyers and posters draw attention and 'this way you talk about it with your colleagues again'. One nurse is positive but at the same time thinks it is slightly exaggerated to draw so much attention to it: 'how much more can we do?'. The last nurse responds with 'exaggerated'.

For ward 2 (boosting intervention), 8 nurses are solely positive. One of them thinks the intervention is 'unforced' and 'not heavy'. Another one says: 'I realise that through the extra attention regarding the topic, I get more aware of my actions regarding hand hygiene'. 2 nurses give a mixed response, saying 'it is a lot, but it is necessary, apparently', and that 'over-disinfecting' should be avoided. A last nurse responds with 'overwhelming'.

4.4. Conclusion

In conclusion, all hypotheses are either partially or fully supported (table 4.9). Hypotheses 1 and 2 are fully supported. Both interventions significantly affect nurses compliance with the hand hygiene protocol whereas the control group scores remain insignificant. This is visible in all analyses.

Hypotheses 3 and 4 defined a difference in effect development over time. To support this, the data should have shown a decrease for ward 1 and an increase for ward 2 in post-test 2. For ward 1, this decrease is visible yet differs in statistical significance between the full model GEE and the partial GEE. For ward 2, there are some contrasting results where the effect is not visible in the full model GEE but visible in the partial GEE. Hence, based on the partial

GEE's (that were used to address statistical shortcomings in the full model), hypotheses 3 and 4 are supported. Yet, to account for the full model results, some caution should be exercised: hypothesis 4 is therefore only partially supported.

Hypothesis	Finding
H1: Compared to the control group and pre-tests, the ward subject to a nudging intervention will have higher levels of in hand hygiene compliance.	Supported
H2: Compared to the control group and pre-tests, the ward subject to a boosting intervention will have higher levels of hand hygiene compliance.	Supported
H3: The nudging intervention is likely to have a more immediate effect but decrease over time.	Supported
H4: The boosting intervention is likely to have a less immediate effect but increase over time.	Partially supported

Table 4.9: Hypotheses

Besides, these are the most important additional results:

- Hand hygiene moments 1, 2 and 5 have lower scores than 3 and 4, both before and after the intervention.
- Before the intervention, nurses highly overestimate their hand hygiene compliance. Interestingly, after the intervention, reported compliance is a lot closer to actual compliance.
- The interventions have mixed effects on nurses' perceptions. Nurses subject to the reframing intervention report higher pleasantness and usefulness but lower executability. Nurses subject to the risk literacy intervention report higher infection probability and severity perceptions but lower protocol perceptions (pleasantness, usefulness, executability). Notably, after the intervention, in both wards nurses experience more peer pressure as well as more peer support to comply to protocol.
- 9 out of 17 nurses leave a negative comment about the protocol, before the interventions.
- 15 out of 21 nurses know all 5 hand hygiene moments, even before the interventions.
- 11 out of 16 nurses leave a positive comment about the interventions.

5. Conclusion and discussion

5.1. Nudging and boosting hand hygiene compliance

The research question of this thesis is: *what is the effect of behavioural nudging and boosting on hand hygiene protocol compliance of hospital employees?* To that aim, this master's thesis develops, executes and analyses a quasi-experimental field study that aims to increase compliance of hospital employees with the hand hygiene protocol, by means of nudging and boosting. The experiment takes place in a Dutch regional hospital in March-May 2019. The results show that both a nudging intervention that aims to reframe the protocol from a negative to a positive frame, as well as a boosting intervention that aims to increase risk literacy of nurses through providing information about infections, lead to significantly higher compliance with the hand hygiene protocol compared to pre-intervention levels, whereas the control group does not show significant differences. The nudging intervention shows a higher direct effect on compliance compared to the boosting intervention but this effect decreases in a second post-test measurement, a week later. The boosting intervention shows a lower direct effect on compliance compared to the nudging intervention, but this effect increases in a (partial) second post-test measurement.

The remainder of this chapter first discusses methodological limitations this study has, before turning to its implications for theory and recommendations.

5.2. Methodological limitations

Notwithstanding the effort put into maintaining ethical and research quality standards (chapter 3.5), this thesis has some limitations. These limitations are discussed below, and accompanied by either ways in which this study tried to tackle these issues or ways in which future studies could.

First, some points on the interventions are discussed. Regarding the operationalisation of the boost, one could wonder to which extent it reflected an typical boost. Specifically, the boost could trigger reflexive rather than reflective thinking, because posters and flyers may not be ideal ways of communicating large amounts of new information for reflection (Grüne-Yanoff *et al.*, 2018; Hertwig and Grüne-Yanoff, 2017). In that case, the treatment effect is potentially

biased by violating excludability, *i.e.* the exclusion of other variables in the causal process (Gerber and Green, 2012). However, nurses subject to a boosting intervention do report more awareness of the probability and severity of infections, which makes it likely the intervention triggered reflection.

Additionally, it is possible not all nurses receive exactly the same treatment: intervention implementation and removal may differ based on working hours, frequency of reading mail or basic ability to notify the posters and flyers. However, all nurses that receive a treatment do point out that they notice the increase in attention regarding the hand hygiene protocol, which is a proxy that the implementation is successful.

Also, whilst the interventions are conceptually distinctive, in the execution they are still quite multifaceted. They employ multiple communication strategies at the same time (posters, flyers, emails). Hereby, effectiveness could be increased, but so is the messiness of the intervention. Consequently, the specific role of all the strategies in increasing hand hygiene compliance may be unclear. This concerns, however, methodological messiness rather than theoretical messiness: this experiment uses multiple ways to implement one concept. Still, future studies may select one of the strategies or pay more attention to distinguishing between practical communication strategies.

Second, the experimental design deserves attention. Being limited by time and non-randomisation constraints, the experiment may be somewhat underpowered to assess especially the last hypotheses on the long term differences between nudging and boosting after intervention removal. First, the role of ward characteristics cannot entirely be ruled out. However, since there are no large differences in pre-test compliance, this makes large between-ward differences unlikely. Hence, non-randomisation does not seem to be a major problem. Second, conducting a second measurement round only a week after the first is a conservative interpretation of long term effects measurement. Future studies may consider longer timelines, although the maintained timeline of a number of weeks is not unusual in these types of experiments (compare *e.g.* Erasmus *et al.*, 2010). Also, this experiment shows a week is long enough to spot preliminary differences.

Third, measurement issues may be raised. The observations are potentially biased by a number of factors. First, nurses may be influenced by the presence of the observant. However, multiple measures are taken to minimise the influence, including not explicitly mentioning hand hygiene as the focus of the observations and observing the nurses for a longer period of time so that nurses' consciousness of the observer would diminish (Erasmus *et al.*, 2010). Still,

obviously, over time nurses start to realise what the observations were for. They may also be influenced by the survey that is sent out in advance. Yet, these effects are controlled for by adding a control group that was sent the same survey.

A final crucial measurement issue concerns observer bias. All the observations are conducted by the researcher himself. No other observants were available with the limited funding and possibilities of this master's thesis. Hence, there is no observant triangulation. Instead, the solution this thesis presents is using surveys, which acts as a form of data triangulation (Bryman, 2012).

5.3. Implications for theory

Since multiple strands of literature are related to this study, there are implications for hand hygiene compliance literature, behavioural public administration literature in general and on nudging and boosting specifically.

First, this study adds to the (hand hygiene) compliance literature by introducing and testing two instruments that can be used to increase compliance: a reframing nudge and a risk literacy boost. Besides, it shows that the behavioural approach of boosting in general is worthwhile to add to the repertoire of behavioural interventions in hand hygiene compliance. Finally, this thesis argues that many hand hygiene interventions are multifaceted, and do include some form of nudging and boosting but that these forms should be tested explicitly and separately to learn more about the distinctive approaches. Hence, it is a fruitful avenue of research to further assess their differences and similarities, and study in what contexts, for which actors and for which types of behaviour one approach is more suitable than the other.

Second, regarding the behavioural public administration-venture in general, this study firstly corroborates its principles that behavioural approaches towards solving work-related quests form a valid alternative to more traditional (*e.g.* formal) measures that have often been proved ineffective or at least slow (Crupi *et al.*, 2018; IGJ, 2018). What this study specifically contributes is, hopefully, an incentive to continue looking for new approaches, and optimising existing ones, to study and influence behaviour of professionals. One may wonder to what extent settling down in existing approaches and only experimenting with interventions that have already proved to be effective (as Nagtegaal *et al.*, forthcoming pointed out), is still experimental. Please mind, this argument is obviously not meant to the detriment of the very relevant endeavour of replicating and extending existing studies.

Another issue that should be mentioned is that this thesis tries to address recent criticism from scholars towards the way behavioural public administration presents and

organises its process of choice architecture development. It agrees that solely relying on expert advice, which implies individuals' bounded rationality is not quite useful, is a narrow-minded state of mind (John and Stoker, 2019) and that scholars should not underestimate the inherent political nature of behavioural intervention development (Feitsma, 2019). In reaction, this thesis adapts an interactive intervention development process, that includes an extensive pre-study which allows employees on all levels to voice their opinions, feelings and suggestions. Similarly, during the research process, the researcher keeps in touch with some of the employees, without revealing the actual nature of the experiment. As a result, the interventions are broadly supported by the organisation, which likely contributes to their effectiveness.

Finally, this thesis contributes to the debate of nudging and boosting. It adds to the repertoire of nudges by presenting the reframing nudge as an effective intervention, and it also presents boosting as a valid alternative approach for existing behavioural interventions. The extent to which these results are generalisable to other contexts is limited in field experiments but this does not hinder some extent of theoretical generalisation (Shadish *et al.*, 2002). Crucially, this thesis presents preliminary evidence that boosts and nudges really have different effects and may indeed follow different (*i.e.* reflective versus reflexive) decision making processes. The insights deserves further attention and testing, and are potentially very valuable. They imply that it is not unfeasible to design reflective interventions that are effective: whilst an individual may be bounded rational, appealing to or even increasing the rationality present is not a lost battle, and a researcher who aims to change behaviour does not only have to resort to indirectly influencing individuals through their environment. Next, it may be worthwhile to theorise when to use the one rather than the other, and to investigate to what extent their distinctive characteristics are really distinct, or rather malleable (as portrayed in table 2.1).

5.4. Recommendations

Based on the former, these are the most important recommendations.

- It should be the continuous aspiration of scholars to look for new and innovative approaches to behavioural interventions. In this case, the above results about a reframing nudge and risk literacy boost provoke a lot of questions worth investigating. Understanding more about the fundamentally distinctive nature and effectiveness of nudging and boosting could further stimulate experimentation in behavioural public administration. Hence, addressing this may just be one of the ways forward for the discipline.

- This thesis has presented an interactive process of intervention design, interweaving scientific concepts with professional wisdom to develop interventions that have most potential in being theoretically sound, effective and widely supported. An approach like this is highly recommended above an elite-driven process that may use scientific objectivity as shield but risks losing credibility and societal support.
- Combining quantitative with qualitative data in a mixed methods-approach results in a more comprehensive understanding of intervention effects. Besides observations to assess actual behaviour, testing how employees estimate their behaviour as well as asking them about their honest opinions and perceptions is very valuable. Also, this approach is an effective form of data triangulation.

Additionally, some recommendations to improve hospital hand hygiene compliance that came up during the research process have been included in appendix 7.

5.5. Final remarks

Ultimately, this thesis has hopefully contributed to understanding and improving compliance of hospital employees with the hand hygiene protocol, by means of both nudging and boosting. The relevance of hand hygiene compliance by hospital employees may seem beyond a doubt, since it is one of the key measures improving patient safety in hospitals. However, compliance of nurses and other healthcare workers in their often hectic daily jobs is a matter of 'behaviour and perseverance' (IGJ, 2018), and wherever great strides are made for the sake of patients' health and safety, this should not go unnoticed. Yet, only then can one really claim to be and have 'a safe pair of hands'.

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7. Appendices

Appendix 1: Pre-experimental analysis

This section answers the question: What hinders employees of the hospital in case in complying with the hand hygiene protocol and what specific types of nudging and boosting seem promising to improve compliance?

A1.1 Methods

Before designing the experiment, exploratory, semi-structured interviews are organised with hospital employees (Bryman, 2012). A total of 11 interviews are executed, of which three with the ward heads, seven with nurses or head nurses, and one with someone from the infection prevention department. The interviews are recorded in order to make interview summaries and extract the key issues. Additionally, documents are requested and analysed. Tables A1.1 and A1.2 describe respectively the characteristics of the interviews and of the documents.

Interview number (chronologically)	Interviewee	Ward
1	Nurse (healthcare coordinator*)	MDL
2	Nurse	MDL
3	Nurse	MDL
4	Ward manager	MDL
5	Ward manager	Orthopedics
6	Infection prevention specialist	-
7	Ward manager	Day treatment
8	Nurse (healthcare coordinator)	Day treatment
9	Nurse	Day treatment
10	Nurse (healthcare coordinator)	Orthopedics
11	Nurse	Orthopedics

Table A1.1: Interviews. *Healthcare coordinators are nurses who direct the other nurses in the ward on a daily basis.

Document number	Document description
1	Report measurement round 1 – November 2014
2	Report measurement round 2 – July 2015
3	Report measurement round 3 – December 2015
4	Report measurement round 4 – June 2016
5	Report measurement round 5 – December 2016
6	Report measurement round 6 – December 2017
7	Report measurement round 7 – July 2018
8	Report measurement round 8 – November 2018
9	Hand hygiene protocol
10	Organisation chart
11	Cluster layout clinics

Table A1.2: Documents.

Goal of the interviews and document analysis is to create a behavioural scan that enables to identify solutions (&Samhoud, 2018). This is done following a four-step model defined by Michie *et al.* (2011) and further developed by Münscher *et al.* (2016, p.512):

‘Step 1. Define behavioral problem and target behavior;

Step 2. Analyze applicability of choice architecture framework;

Step 3. Check for behavioral bottlenecks; and

Step 4. Build hypotheses on promising choice architecture interventions’.

To guide the analysis, Michie *et al.* (2011) identify three determinants of behaviour. These three factors originate from both a consensus of behavioural theorists as well as United States of America’s criminal law on constitutional elements of behaviour: capability, opportunity, and motivation. First, capability concerns someone’s psychological and physical capacities (including knowledge and skills). Second, opportunity is about external physical or social factors that influence (or even enable or disable) behaviour. Lastly, motivation describes mental processes that steer behaviour (either automatic processes like habits and emotions, or reflective processes through rational thinking) (Michie *et al.*, 2011, p.3).

In their review on choice architecture, Münscher *et al.* (2016) suggest using these three determinants to assess why people (fail to) portray certain behaviour and consequently apply the choice architecture interventions that may lead to compliance. To illustrate how these factors may influence compliance: information crucial for compliance can be incomprehensible

to someone (capability), someone may not be able to comply because the option is snowed under non-compliant alternatives (opportunity), or someone does not feel like complying (motivation). A behavioural intervention can be directed at one or more of them.

Hence, these are the most crucial questions to be answered in the pre-experimental analysis:

- 1a. What is the current state of compliance with the hand hygiene protocol?
- 1b. What is the ideal state of compliance with hand hygiene protocols?
2. What kind of behavioural change is needed?
3. What behavioural bottlenecks hinder hospital employees in complying with hand hygiene protocols?
4. What interventions might offer a solution to this problem?

A1.2 Analysis

1a. What is the current state of compliance with the hand hygiene protocol?

First, the hand hygiene protocol of the hospital has been included in appendix 1. It consists of three main elements: whether hand hygiene should be applied with water and soap or alcohol, at which moments hand hygiene should be applied, and via which procedure hand hygiene should be applied.

In 2014, a collaboration of multiple Dutch hospitals initiated a hygiene programme. Its goal was to structurally improve compliance with dress codes and hand hygiene. Amongst other interventions, it did so by measuring the levels of compliance within the hospitals and comparing them to each other. Since its initiation and in the period 2014-2018, eight measurement rounds have been conducted roughly every half a year.

The results of these rounds for the hospital are presented (table A1.3) as they provide an exquisite first picture of pre-experimental levels of compliance with hand hygiene. The scores on each hand hygiene moment were not available for the first two rounds.

Round number	% of total compliance with hand hygiene protocol for the experiment-hospital	% of total compliance for all hospitals	Scores for the experiment-hospital on each of the five hand hygiene moments				
			1	2	3	4	5
1	43	43,4	x	x	x	x	x
2	46,3	43,9	x	x	x	x	x
3	48,8	41,5	26,9	12,5	34,9	64,5	64,8
4	54,8	54,2	40,5	34,5	54,1	73,2	63,6
5	51	52,2	36,4	40	60,7	59,6	51,8
6	58,2	60,3	30,9	29,6	52,9	75,9	75,4
7	59,6	57,7	33,3	29,6	55,3	74,6	77,9
8	55,6	60,5	33,3	39,1	63,6	76,2	61,6

Table A1.3: Results hand hygiene programme. The five moments for hand hygiene are: before patient contact (1), before a procedure (2), after contact with bodily fluids (3), after patient contact (4), after contact with patient environment (5).

The results show an increase in compliance from around 45% to almost 60% for the experiment-hospital. However, the last round shows a drop in compliance. Additionally, hand hygiene moments 1 and 2 still show low compliance, remaining under 40%.

1b. What is the ideal state of compliance with hand hygiene protocols?

Before the project, the goal for hand hygiene was defined as follows: Employees apply the five WHO-moments of hand hygiene correctly. Hence, the ultimate goal is a 100%-compliance.

2. What kind of behavioural change is needed?

Münscher *et al.* (2016) argue a choice architecture intervention may not be applicable if the root of the problem is found elsewhere rather than in behaviour. In this case, the problem could for example be that employees knowingly oppose the hand hygiene protocol because they do not agree with it. Alternatively, external factors may force their non-compliance. In the interviews, resistance was a minor theme and external factors identified were never sole forces of non-compliance. This means choice architecture is arguably a good fit for this study.

3. What behavioural bottlenecks hinder hospital employees in complying with hand hygiene protocols?

From the interviews, two factors concerning *capability* (Michie *et al.*, 2011) are identified.

1. Lack of knowledge about hand hygiene protocol.

Whilst some interviewees argue everyone knows about the hand hygiene protocol and one goes on to say that it is basically in their DNA, most of the interviewees asked about the five moments of hand hygiene could not mention them all. Similarly, different answers were given to how long the hand hygiene procedure should take and what steps had to be taken.

2. Pluriform background of employees.

One ward head says that the background of employees, some were transferred from another hospital, influences their understanding of the protocol. Similarly, one nurse says she read the protocol at the hospital she worked earlier, yet she had not seen the protocol used in this hospital.

Second, four factors considering *opportunity* seem to play a role (Michie *et al.*, 2011).

3. Work pressure.

Almost every interviewee mentions work pressure as one of the main reasons for non-compliance. They simply find themselves not having enough time to fully comply.

4. Lack of peer addressing (social pressure).

When asked if they addressed peers on non-compliant behaviour, most interviewees said they did not. They said it was hard, that they did not really pay attention to peer mistakes, or that they did not want to come across as know-it-all. Some argued they did, but only for matters they considered of direct effect for the patient (*e.g.* when a colleague was about to give the wrong medicine).

5. Unavailability of alcohol rub.

A few nurses state that the alcohol rub may sometimes be unavailable due to empty dispensers. However, others argue this is a weak excuse: dispensers are attached to every bed in a ward, and there is always one close by.

6. Overdose of information.

A nurse mentions that whilst the hand hygiene protocols are clearly shown at the wards, they depict too much information and that people generally do not read them.

Lastly, six factors that address *motivation* (Michie *et al.*, 2011) are identified.

7. Invisibility of effects.

The direct urgency for hand hygiene is often absent, according to a few nurses. Most of the times, hand hygiene non-compliance does not lead to an infection. Similarly, most of the

times there are no infections sweeping the hospital wards. One nurse wonders whether the protocol has really improved patient safety. Additionally, even when a non-compliance leads to an infection, a ward head argues it is unlikely that nurses will hear about that infection or link it to their hand hygiene behaviour.

8. Negative perception of hand hygiene procedure.

Multiple nurses point out the prescribed 30 seconds for hand hygiene are simply unrealistic in their working environment. Yet, and this has not been communicated, the infection prevention department of the hospital suggests 20 seconds is sufficient to dry the liquid.

9. Feeling no need for hygiene.

A ward head explains it is likely nurses forget to apply hand hygiene before contact with a patient since their own need for hygiene is mostly experienced after patient contact.

10. Distraction.

Three nurses point out that they often get distracted when working in the ward. The multiplicity and intertwinement of their tasks makes it hard to remember hand hygiene moments.

11. Easiness.

A ward head argues some employees simply become too easy-going in following the protocols.

12. Non-involvement.

A nurse points out she feels not involved in the creation of protocols since nobody asked her anything.

4. What interventions might offer a solution to this problem?

On the one hand, there seem to be a number of issues concerning perceptions of the protocol that influence nurses' behaviour: the procedure is long and complicated, it is hard to remember before patient contact, distraction is easy, et cetera. Consequently, a nudging intervention could attempt to influence the negative perception of the hand hygiene protocol. This could be done through attempting to *reframe* the hand hygiene protocol. This approach has not been applied much in hand hygiene nudging interventions (Nagtegaal *et al.*, forthcoming). The message that should come across, rather than the protocol being an extra burden to the

workflow of the nurse, is that hand hygiene moment is a moment of care for the patient (Münscher *et al.*, 2016, p.514-515).

On the other hand, employees lack specific knowledge about the hand hygiene protocol, which influences their behaviour. The specifications of the protocol are not always remembered, and crucially, the urgency and relevance of hand hygiene is somewhat doubted. Interestingly, one of the types of boosts delivers a suitable intervention for this issue. Specifically, the boosting intervention can attempt to boost nurses' decision-making of compliance with the hand hygiene protocol by increasing their *risk literacy* (Hertwig and Grüne-Yanoff, 2017, p.7). The boost unfolds new information about the commonality of hospital infections and the role of hand hygiene of hospital employees herein that aims to enable them to better weigh the risk of non-compliance.

Appendix 2: Hand hygiene protocol (in Dutch)

Image A2.1: Page 1 of hand hygiene protocol. The black squares are used to cover the hospital's logo.

Deze afdruk is alleen geldig op 06-12-2018

Handhygiëne medewerkers

Versie: 1 **Controledatum: 08-06-2019**
Document ID: 020668 **Publicatiedatum: 14-10-2013**

Trefwoord
handhygiëne, hand hygiëne, handen wassen, handen desinfecteren, handdesinfectie, handreiniging

Type document
Procedure / werkinstructie

Doel
Het op de juiste wijze en op de juiste momenten uitvoeren van handreiniging of handdesinfectie

Toepassingsgebied
Alle medewerkers van het [redacted] ziekenhuis

Bevoegde functionaris
Alle medewerkers van het [redacted] ziekenhuis

Definitie/afkorting
Medewerker [redacted] ziekenhuis: alle medewerkers in loondienst, medisch specialisten, verloskundigen, uitzendkrachten, stagiaires, medewerkers met een detacheringovereenkomst, vrijwilligers, externe "gasten" die patiëntcontact, doch geen dienstverband met het [redacted] Ziekenhuis hebben (bijvoorbeeld: "gastspecialisten" en medewerkers van leveranciers).

Werkwijze

Algemeen:
Ringen, polshorloges, armbanden, lange mouwen, kunst- en gelnagels, nagellak en braces, staan een effectieve handreiniging of -desinfectie in de weg en zijn derhalve niet toegestaan te dragen

1. Reiniging of desinfectie

- Wanneer de handen zichtbaar zijn verontreinigd of plakkerig aanvoelen, dienen ze altijd gewassen te worden met water en zeep;
- Bij niet-zichtbaar verontreinigde handen heeft desinfectie van de handen met een handalcohol de voorkeur boven wassen met water en zeep vanwege hogere kiemreductie, huidvriendelijkheid en tijdsinst.

Handreiniging met water en zeep	Handdesinfectie met handalcohol
- bij zichtbaar vuil - bij plakkerig aanvoelen - na toiletbezoek - na neus snuiten en hoesten	- Pas bij niet-zichtbaar verontreinigde handen bij voorkeur handdesinfectie met handalcohol toe - Pas altijd handdesinfectie toe voorafgaand aan het uitvoeren van schone of aseptische werkzaamheden

Deze afdruk is alleen geldig op 06-12-2018

2. Momenten van handhygiëne

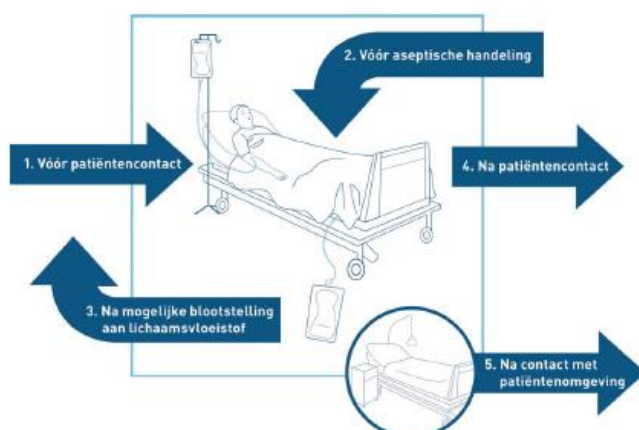
Pas handhygiëne toe op de volgende 5 momenten bij patiëntgebonden werkzaamheden (Zie figuur 1)

1. Voor handcontact met de patiënt
2. Direct voor het uitvoeren van schone en/ of aseptische handelingen (ook bij gebruik van handschoenen*)
3. Na mogelijk handcontact met lichaamsvloeistoffen (ook bij gebruik van handschoenen*)
4. Na ieder handcontact met een patiënt en op het moment dat u de patiënt verlaat (ook bij gebruik van handschoenen*)
5. Na ieder handcontact met de directe omgeving van de patiënt (bed opmaken/ verschonen etc.) ook wanneer daarbij geen handcontact met de patiënt is geweest (ook bij gebruik van handschoenen*)

*Gebruik handschoenen

Indicaties voor het dragen van handschoenen:

- Handschoenen worden altijd gedragen wanneer de handen in contact komen of kunnen komen met bloed, lichaamsvochten, excreta, slijmvliezen, niet-intacte huid, of verpleeg- en behandelmaterialen die hiermee in aanraking zijn geweest.
- Handschoenen worden steeds eenmalig en uitsluitend patiëntgebonden gebruikt.
- Wanneer handelingen in volgorde van vuil naar schoon plaatsvinden, is het noodzakelijk om de handschoenen tussendoor te vervangen.
- Handschoenen mogen tijdens het dragen niet in contact komen met omgevingsmaterialen zoals telefoons, deurknoppen, apparatuur, toetsenborden, patiëntendossiers, schrijfgerei etc.
- Na het uittrekken van handschoenen dient altijd een vorm van handhygiëne toegepast te worden!



3. Uitvoering

3.1 Handreiniging

- Open de kraan met de elleboog;
- Maak de handen nat uit een flink stromende kraan en voorzie de handen van een pompje zeep uit de dispenser zonder daarbij het tuitje van de dispenser aan te raken;
- Wrijf de handen gedurende 10 seconden goed over elkaar, waarbij vingertoppen, duimen en gebieden tussen de vingers en de polsen goed ingewreven moeten worden (zie figuur 1);
- Spoel de handen goed af;
- Sluit de kraan met de elleboog;

Deze afdruk is alleen geldig op 06-12-2018

- Droog de handen, polsen en huis tussen de vingers goed af met papieren handdoekjes en deponeer deze na gebruik in de daarvoor bestemde afvalbak.

3.2 Handdesinfectie

- Breng uit de dispenser een pompje handalcohol aan op de droge handen zonder daarbij het tuitje van de dispenser aan te raken;

- Wrijf de handen gedurende 30 seconden (=inwerktijd) zorgvuldig over elkaar, tot ze droog zijn. Ook de vingertoppen, duimen, gebieden tussen de vingers en de polsen moeten grondig ingewreven worden (zie figuur 1);

- Bij niet of onvoldoende droging van de alcohol is het effect minder en bestaat bij aansluitend gebruik van handschoenen kans op huidirritatie.



Figuur 1: Techniek handreiniging en -desinfectie

Aandachtspunten

- Flacons voor zeep en handalcohol mogen nooit worden bijgevuld; vervang altijd de gehele flacon.
- Lotions en crèmes worden gebruikt om het uitdrogen van de huid tegen te gaan; gebruik alleen lotions en crèmes uit tubes of disposable flacons (geen potjes!).

Gerelateerde documenten

WIP-richtlijn: "Handhygiene medewerkers"
[Kledinovoorschriften en hygiëne regels](#)

Inhoudsverantwoordelijke

Afdeling Infectiepreventie

Appendix 3: Interventions

The black squares are used to cover the hospital's logo.

Image A3.1: Poster 1: nudge.



In goede handen.

Goede zorg voor je patiënt begint met schone handen.

Met onderstaande handwasmomenten draag je hier aan bij.

- vóór patiëntcontact
- vóór schone handeling
- na mogelijke blootstelling aan lichaamsvloeistof
- na patiëntcontact
- na contact met patiëntomgeving

Vragen of opmerkingen? Neem contact op met onze afdeling Infectiepreventie!

Image A3.2: Poster 2: boost.



Voorkom infecties.

Goede handhygiëne voorkomt infecties.

Met onderstaande handwasmomenten draag je hieraan bij.

-  vóór patiëntcontact
-  vóór schone handeling
-  na mogelijke blootstelling aan lichaamsvloeistof
-  na patiëntcontact
-  na contact met patiëntomgeving

Vragen of opmerkingen? Neem contact op met onze afdeling Infectiepreventie!

Images A3.3 and A3.4: Boost flyer frontside and Boost flyer backside.

Voorkom infecties.



Goede handhygiëne voorkomt infecties.

Vragen of opmerkingen? Neem contact op met onze afdeling Infectiepreventie!

Wist je dat?

1 op de 20 ziekenhuispatiënten loopt een ziekenhuisinfectie op.

Onderzoek laat zien dat in twee Amerikaanse ziekenhuizen het aantal gevallen met MRSA-infecties halveerde nadat zorgmedewerkers meer handhygiëne toepasten.

Goede handhygiëne van zorgmedewerkers is de meest effectieve manier om infecties te voorkomen.

Goede handhygiëne voorkomt infecties.

Met onderstaande handwasmomenten draag je hieraan bij.

-  vóór patiëntcontact
-  vóór schone handeling
-  na mogelijke blootstelling aan lichaamsvloeistof
-  na patiëntcontact
-  na contact met patiëntomgeving

Vragen of opmerkingen? Neem contact op met onze afdeling Infectiepreventie!

Appendix 4: Observations scoring sheet

Image A4.1: Scoring sheet.

Hand Hygiene observation - Data collection form.

Organisation:

Depart/Ward:

Date:

Auditor: Session No.:

Start Time: Finish Time:

Duration of Session: mins

FIVE MOMENTS FOR HAND HYGIENE

1. Before touching a patient
2. Before a procedure
3. After a procedure or body fluid exposure risk
4. After touching a patient
5. After touching a patient's surroundings

Notes

Hcw	Moment	Action	Glove	Hcw	Moment	Action	Glove	Hcw	Moment	Action	Glove
<input type="checkbox"/>	1	<input type="checkbox"/> 1. Rub	<input type="checkbox"/> 1. On	<input type="checkbox"/>	1	<input type="checkbox"/> 1. Rub	<input type="checkbox"/> 1. On	<input type="checkbox"/>	1	<input type="checkbox"/> 1. Rub	<input type="checkbox"/> 1. On
<input type="checkbox"/>	2	<input type="checkbox"/> 2. Wash	<input type="checkbox"/> 2. Off	<input type="checkbox"/>	2	<input type="checkbox"/> 2. Wash	<input type="checkbox"/> 2. Off	<input type="checkbox"/>	2	<input type="checkbox"/> 2. Wash	<input type="checkbox"/> 2. Off
<input type="checkbox"/>	3	<input type="checkbox"/> 3. Missed	<input type="checkbox"/> 3. Cont.	<input type="checkbox"/>	3	<input type="checkbox"/> 3. Missed	<input type="checkbox"/> 3. Cont.	<input type="checkbox"/>	3	<input type="checkbox"/> 3. Missed	<input type="checkbox"/> 3. Cont.
<input type="checkbox"/>	4			<input type="checkbox"/>	4			<input type="checkbox"/>	4		
<input type="checkbox"/>	5			<input type="checkbox"/>	5			<input type="checkbox"/>	5		

Total Correct Moments:
Total Moments:

Appendix 5: Pre- and post-experimental survey (in Dutch)

Below, the pre-experimental survey is presented. The post-experimental survey is identical to the pre-experimental survey except it misses question 4, 4b, 5 and 6, and adds two extra questions.

A5.1. Extra post-experimental survey questions

1. Is de recente aandacht voor het handhygiëne protocol u opgevallen?

- Ja (1)
- Nee (2)

If: Is de recente aandacht voor het handhygiëne protocol u opgevallen? = Ja

2. Wat vindt u van de manier waarop afgelopen tijd aandacht is besteed aan het handhygiëne protocol?

A5.2. Pre-experimental survey

XXX Ziekenhuis Handhygiëne vragenlijst

0. Beste medewerker van het XXX Ziekenhuis,

Hartelijk dank dat u deze korte vragenlijst in wilt vullen! Hieronder informeren we u over het onderzoek.

Over het onderzoek

U wordt in deze vragenlijst gevraagd naar o.a. kennis en beeld van het handhygiëne protocol in het XXX Ziekenhuis.

Deelname

Deelname kost een paar minuten. Uw deelname is uiteraard geheel vrijwillig.

Publicatie

De resultaten kunnen gebruikt worden voor een (wetenschappelijk) artikel of rapport. We gaan vertrouwelijk om met de resultaten. Gepubliceerde resultaten zullen nooit herleidbaar zijn tot individuen.

Data

We vragen niet naar uw persoonsgegevens, alleen naar wat algemene gegevens zoals leeftijd en functie. We houden ons verder aan de huidige wet- en regelgeving op het gebied van privacy.

Contact

Als u nog vragen heeft, kunt u die stellen aan uw teamleider. Ook kunt u mailen naar de student die deze vragenlijst begeleidt via h.vanroekel@uu.nl.

Bent u voldoende geïnformeerd en gaat u akkoord met bovenstaande?

- Ja, ik ga akkoord (1)
- Nee, ik ga niet akkoord (2)

1. Hoe nuttig is het handhygiëne protocol volgens u?

- 1: Helemaal niet nuttig (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- 7: Heel nuttig (7)

2. Hoe uitvoerbaar is het handhygiëne protocol volgens u?

- 1: Helemaal niet uitvoerbaar (1)
- 2 (2)
- 3 (3)

- 4 (4)
- 5 (5)
- 6 (6)
- 7: Heel uitvoerbaar (7)

3 Hoe prettig is het handhygiëne protocol volgens u?

- 1: Helemaal niet prettig (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- 7: Heel prettig (7)

4 Wilt u bovenstaande vragen nog uitleggen?

4b Heeft u ideeën hoe het protocol nuttiger / meer uitvoerbaar / prettiger zou kunnen zijn?

5 Kunt u de vijf momenten van handhygiëne benoemen? Dit is niet om u te controleren, maar om te kijken of het XXX Ziekenhuis er in slaagt het protocol bekendheid te geven.

Moment 1: (1) _____

Moment 2: (2) _____

Moment 3: (3) _____

Moment 4: (4) _____

Moment 5: (5) _____

6 Wat is volgens u de inwerktijd (in seconden) van de handalcohol?

0 10 20 30 40 50 60 70 80 90 100

Sleep de balk naar de juiste hoeveelheid seconden: ()	
---	---

7 Probeer de volgende vraag eerlijk te beantwoorden. Hoe vaak past u, denkt u, handhygiëne toe...

	1: Nooit (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7: Altijd (7)
... voor contact met de patiënt? (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... direct voor het uitvoeren van schone en/of aseptische handelingen? (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... na mogelijk contact met lichaamsvloeistoffen? (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... na contact met de patiënt? (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... na contact met de patiëntomgeving? (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8 Hoe waarschijnlijk is het dat een patiënt op uw afdeling een infectie krijgt omdat u zich niet aan het handhygiëne protocol houdt?

- 1: Heel onwaarschijnlijk (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- 7: Heel waarschijnlijk (7)

9 Hoe ernstig schat u de gevolgen in als een patiënt een infectie krijgt?

- 1: Helemaal niet ernstig (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7: Heel ernstig (7)

10 Geef bij de volgende stellingen aan of u het eens of oneens bent:

	Zeer oneens (1)	Oneens (2)	Neutraal (3)	Eens (4)	Zeer eens (5)
Mijn collega's houden zich altijd aan het handhygiëne protocol. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ik voel druk vanuit collega's om me aan het handhygiëne protocol te houden. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Op mijn afdeling steunen collega's elkaar in het volgen van het handhygiëne protocol. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11 Tot slot wat vragen over u zelf.

Wat is uw geslacht?

- Man (1)
- Vrouw (2)
- Wil ik liever niet zeggen (3)

12 Wat is uw functie?

- Zorghulp / Helpende (1)
- Verzorgende IG (2)
- Verpleegkundige MBO-V (3)
- Verpleegkundige HBO-V (4)
- Verpleegkundig specialist WO (5)
- Polikliniek medewerker (6)
- Basisarts / ANIOS / AIOS (7)
- Medisch specialist (8)
- Facilitaire functie / Voedingsassistente (9)
- Anders, namelijk (10) _____

13 Op welke afdeling werkt u?

▼ Long (1) ... SEH (21)

14 Wat is uw leeftijd?

15 Dit is het einde van de vragenlijst. Bedankt voor uw tijd!
Wilt u nog iets kwijt over het handhygiëne protocol en de naleving ervan in het XXX
Ziekenhuis? Hieronder kan dat.
Klik op de knop rechtsonder om de vragenlijst af te sluiten.

Appendix 6: Additional analyses

A6.1. Logistic regression analyses

Dependent variable: compliance	
	B(SE)
Ward 1	-0.22 (0.57)
Ward 2	-0.38 (0.53)
Pre-test 2	-0.53 (0.60)
Post-test 1	-0.07 (0.59)
Post-test 2	0.16 (0.65)
Ward 1*Pre-test 2	0.59 (0.78)
Ward 1*Post-test 1	2.08** (1.02)
Ward 1*Post-test 2	0.87 (0.88)
Ward 2*Pre-test 1	0.86 (0.73)
Ward 2*Post-test 1	1.38* (0.79)
Ward 2*Post-test 2	1.31 (0.88)
Constant	0.29 (0.44)
N	348

Table A6.1: Logistic regression for wards and measurement rounds with interaction terms. * = $p < 0.1$, ** = $p < 0.05$. Nagelkerke R^2 : 0.10. Model $\chi^2(11) = 26.15$, $p < 0.01$.

Dependent variable: compliance				
	B(SE)	95% CI for Odds Ratio		
		Lower	Odds	Upper
Pre-test 2	0.06 (0.51)	0.40	1.06	2.86
Post-test 1	2.02** (0.83)	1.47	7.50	38.28
Post-test 2	1.03* (0.59)	0.88	2.81	8.99
Constant	0.07 (0.36)			
N	105			

Table A6.2: Logistic regression for ward 1. * = $p < 0.1$, ** = $p < 0.05$. Nagelkerke R^2 : 0.13. Model $\chi^2(3) = 10.72$, $p < 0.05$.

Dependent variable: compliance				
	B(SE)	95% CI for Odds Ratio		
		Lower	Odds	Upper
Pre-test 2	0.33 (0.41)	0.62	1.39	3.10
Post-test 1	1.32** (0.52)	1.35	3.74	10.38
Post-test 2	1.47** (0.58)	1.40	4.36	13.62
Constant	-0.09 (0.30)			
N	152			

Table A6.3: Logistic regression for ward 2. ** = $p < 0.05$. Nagelkerke R^2 : 0.10. Model $\chi^2(3) = 11.70$, $p < 0.01$.

Dependent variable: compliance				
	B(SE)	95% CI for Odds Ratio		
		Lower	Odds	Upper
Pre-test 2	-0.53 (0.60)	0.18	0.59	1.90
Post-test 1	-0.07 (0.59)	0.30	0.94	2.96
Post-test 2	0.16 (0.65)	0.33	1.18	4.25
Constant	0.29 (0.44)			
N	91			

Table A6.4: Logistic regression for ward 3. Nagelkerke R^2 : 0.02. Model $\chi^2(3) = 1.48$, $p > 0.1$.

A6.2. Number of participants, response rates and background characteristics

Table A6.5 shows the number of participants and the response rate for the surveys.

	Pre-survey	Post-survey
Ward 1 (N)	8 (40%)	5 (25%)
Ward 2 (B)	7 (26,9%)	11 (42,3%)
Ward 3 (C)	6 (46,2%)	-
Total	21	16

Table A6.5: Number of survey participants that completed the survey. (Response rates between brackets).

Next, background characteristics of the participants are presented in table A6.6. Notably, most participants are female. Also, most nurses have a degree on MBO-level (secondary vocational education), but there are some nurses with an HBO-degree (higher professional education) and some student nurses too. Finally, the average age lies around 35-45 but shows large standard deviations.

	Ward 1 (N)		Ward 2 (B)			Ward 3 (C)
	Pre	Post	Pre	Post	Pre	
Gender (M; V; No answer)	1 7	1 4	1 6	1 9 1	0 6	
Job function (Nurse MBO; Nurse HBO; Student nurse)	3 2 3	5	7	11	3 3	
Age	34.00 (15.81)	40.00 (12.65)	39.43 (7.96)	45.00 (10.11)	42.67 (14.24)	

Table A6.6: Gender, job function and age. (Standard deviations between brackets.)

Appendix 7: Field notes

A7.1. Field notes

Ward	Round	Field note
1	1	<p>The first time, there are a lot of beds without alcohol dispensers. The second time in the first round, most beds have dispensers!</p> <p>There is a good atmosphere in the ward.</p> <p>A nurses advices to observe between 7-9AM, which are the busiest times.</p>
2	1	<p>At first, nurses are extra alert because the coordinator presents me as hygiene observant.</p> <p>At one point, a nurse is the only one present at the ward, which becomes an issue when the phone rings during patient treatment.</p> <p>Most beds have alcohol dispensers.</p> <p>Multiple times, nurses apply double hygiene: alcohol and soap.</p> <p>Nurses use a lot of gloves.</p> <p>Some nurses (esp. oncology) use gloves without alcohol beforehand.</p> <p>Some nurses use alcohol quickly and not thoroughly.</p>
3	1	<p>All beds have dispensers.</p> <p>Nurses tend to use a lot of alcohol when disinfecting (multiple pumps).</p> <p>Some minor resistance against the observations and critique towards the protocol is uttered by a nurse.</p> <p>A nurse proposes to observe at earlier times (8AM), when at the time of observations, not much is happening.</p>
1	2	<p>The coordinator in the ward subtly informs the nurses that observations are being conducted.</p> <p>A lot of nurses are present.</p>
2	2	<p>Nurses use a lot of alcohol when disinfecting (multiple pumps).</p> <p>A nurse applies double hygiene (soap and alcohol)</p> <p>Clearly, focusing on one nurse for 20-30 minutes does not work, it is more effective to follow nurses when busy with patients and hop to the next when the former leaves the ward / goes on to do computer work.</p> <p>Nurses perform quick disinfections.</p> <p>Quite a busy time in the ward.</p>

3	2	Again a conversation with a nurse who argues '100% hygiene is utopia', and 'we don't have any skin left whilst the machines do not get cleaned often'. Some alcohol dispensers are empty.
1	3	Notably, nurses are very alert, which seems to be promising for the results.
2	3	Contrast in compliance between oncology day treatment and regular day treatment. In the infusion room, one poster is removed without my knowledge.
3	3	-
1	4	A lot of nurses present and not much stress.
2	4	A nurse applies double hygiene (alcohol and soap). Not a lot of patients so quite relaxed.
3	4	The coordinator seems to not like my presence, complains about shortage of personnel, stresses out about hand hygiene. At the same time, compliance seems to go quite well which makes me wonder what the deal is.

A7.2. Field note-inspired recommendations

Along the way, these were some of the avenues noted that could help improve hospital hand hygiene compliance:

- The interventions have shown to be successful in increasing hand hygiene compliance and can be used by other wards and hospitals. Yet, to make lasting impact, rather than one-off events, hand hygiene attention should be structuralised into a hospital's agenda by, for example, devoting one month a year to hand hygiene compliance.
- Peer support and pressure are important elements of hand hygiene compliance. They can be increased by, for example, appointing one or a few hand hygiene representatives amongst nurses or other healthcare workers. They could receive extra training, stimulate others to comply to the protocol, and answer questions that may come up.
- Peer observations with semi-direct feedback can be a successful way to stimulate compliance. Receiving feedback on the spot after a (series of) non-compliant moment may be more effective than learning about the general scores a few weeks later.

- Inconsistencies in general hospital hygiene detract from the legitimacy of the hand hygiene protocol. Nurses wonder why they should wash their hands when materials (*e.g.* medicine boxes, drawers, employee passes, scissors, blood pressure straps) are scarcely cleaned. This should be addressed.
- Protocols should be unambiguous and transparent. Discussion remains about the necessity of the 30-second rule in alcohol appliance, that is seen by infection prevention as a precaution (20 seconds is most likely enough to dry the alcohol). Hence, nurses view the 30-second rule as both unnecessary as well as unrealistic. Another issue nurses struggle with is the use of gloves (when to use them and the fact that they do not prevent bacteria from spreading). Finally, some nurses apply double hygiene, using both alcohol and soap.

Appendix 8: Interventions on location

Images A8.1 and A8.2: Interventions I and II. The black squares are used to cover the hospital's logo.

