

# ERASMUS UNIVERSITY ROTTERDAM

Erasmus School of Economics

Master Thesis Economics & Business Economics – Behavioural Economics

*Influencing ICU staff's behaviour: towards more sustainable health care units by nudging via social norms*

Name student: Theo Post

Student ID number: 470907

Supervisor: dr. S.C. van der Zee

Second assessor: prof. dr. K.I.M. Rhode

Date final version: 27-9-2022

## Abstract

Making substantial changes to realise emission reductions is pivotal to avoid any further exacerbation of the already disastrous consequences of climate change. Such change must be implemented in all sectors, including the oftentimes overlooked healthcare sector. This thesis belongs to a project in which the Erasmus Medical Centre Rotterdam (EMC) Intensive Care Unit (ICU) aims to realise a circular ICU by 2030. Achieving that goal requires, inter alia, behavioural change, which can be incentivised via social norms. Individuals may desire to not be the *odd one out*, avoid disapproval (by their peers), enhance social esteem, or may hope to reach efficiency by copying others' behaviour. In this field experiment, social norms are implemented in EMC's ICU department to nudge personnel to use fewer aprons in order to achieve a more sustainable ICU. Social norms were displayed in all ICU rooms near the pile of aprons, whilst apron usage per room was counted two times per day during the experiment. All ICU personnel that worked during the experiment participated. No significant differences are found between the baseline and treatment groups. Possible explanations are associations with budget cuts, the gap between planning and doing, a lack of saliency, habits, a too-distant reference group, context-specific medical restrictions, and insufficient time. Further research is required in the ICU context, in which social norms are customised to take these impeding factors into account.

## Dedication

This master thesis is the cherry on top of a journey that brought me to Rotterdam in the late summer of 2017. Erasmus University played a significant role in understanding my (academic) self and my interests better, eventually leading to a master's programme in behavioural economics: at the crossroads of economics and psychology. By choosing sustainable healthcare as a topic, I envisaged working on a practical goal in a real-world environment. The EMC ICU and its project to realise a fully circular ICU by 2030 proved a great environment for that goal. Conducting an experiment was challenging but satisfying and was only possible thanks to some very helpful people. I want to thank Sophie van der Zee, my supervisor who guided me well and optimistically through the process. Not only did she impart fruitful academic knowledge: consciously or unconsciously she also expanded my set of soft skills. Moreover, I am grateful to Tamarah Verhoog, who wrote a thesis on a similar topic and with whom the experiment was performed: regularly brainstorming and going through the challenges of conducting a natural experiment together was encouraging and inspiring. Furthermore, the experiment has only been made possible by the help and kind support of Jan Carel Diehl, Lobke Hazelaar, Nicole Hunfeld, Lianne Zuyderduin, and especially the ICU's care assistants, with a special expression of appreciation to Anna. Lastly, I am grateful to Jeroen Lammers from Utrecht Medical Centre (UMC) for enabling me to perform a pilot study at the UMC Utrecht's ICU.

*"As a rule, people grossly underestimate the guiding role that others play in personal choices" ~ Robert B Cialdini*

## Abbreviations

---

<b>EMC</b>	Erasmus medical centre Rotterdam
<b>HIPB</b>	Hygiene and infection prevention board (EMC)
<b>ICU</b>	Intensive care unit
<b>LCA</b>	Life cycle assessment
<b>PPE</b>	Personal protective equipment
<b>UMC</b>	University medical centre Utrecht

---

## Contents

Abstract.....	2
Dedication.....	3
Abbreviations.....	3
Introduction.....	5
The potential of nudges.....	7
Considering the particularities of the ICU environment.....	7
Applying social norm nudges.....	8
Theoretical framework.....	9
The origins of social learning.....	10
Social learning via social norms.....	11
Reference groups in social norms.....	13
Formulating social norms.....	14
Incentivising pro-environmental behaviour via social norms.....	15
Implementing social norms in a medical setting.....	16
Methodology.....	17
Experimental design.....	17
Experimental setting.....	18
Sample & Subjects.....	19
Materials.....	20
Designing the social proof statement.....	20
Procedure.....	21
Analysis.....	22
Analysis and Results.....	23
Discussion.....	26
Contextual limitations.....	31
Lessons from the experiment and suggestions for further research.....	31
Conclusion.....	33
References.....	35
Appendix.....	44
A1    Experiences from the field.....	45
A2    Materials used during the experiment.....	46
A3    Ethical approval.....	49
A4    Life cycle assessment of the aprons studied.....	49
A5    Stata commands.....	50

## Introduction

Two-thirds of people worldwide estimate climate change to be a risk to their country (World Risk Poll, 2021). In the Netherlands, a country located below sea level, that number is even higher: three out of four Dutch interviewees indicate that they are concerned about climate change (NOS, 2021). Such concerns are increasingly visible on the global political stage as well. In November 2021, world leaders gathered in Glasgow for the 26<sup>th</sup> United Nations Climate Change Conference. The event was an artefact of international joint efforts to concur upon a comprehensive strategy to prevent the possibly disastrous consequences of failing to tackle climate change (Economist, 2021). In the wake of the conference, the organisation stressed the importance of nations swiftly engaging in thorough policymaking to, amongst others, reduce CO<sub>2</sub> emissions (United Nations, 2021). Congruent with that exhortation, The Netherlands aims to reduce its CO<sub>2</sub> emissions by 49% by 2030 (Rijksoverheid, n.d.). Hence, policies that reduce CO<sub>2</sub> emissions are increasingly important.

Such a reduction in CO<sub>2</sub> emissions can be achieved in various ways, such as by targeting specific sectors (Whalley & Wigle, 2017). One sector that is often overlooked is the healthcare sector: research targeting its environmental sustainability is scarce (MacNeill et al., 2019). Healthcare emissions are nevertheless considerable: if the respective healthcare sectors of Australia, Canada, the United Kingdom, and the United States would constitute a nation, it would globally rank 7<sup>th</sup> in CO<sub>2</sub> emissions (MacNeill et al., 2019). In the OECD countries plus China and India, healthcare accounts for 5% of CO<sub>2</sub> emissions on average, which is similar to the food sector of those countries (Jaccard et al., 2019). Focusing on the Netherlands, the number is even higher: 7% of all Dutch CO<sub>2</sub> emissions are caused by the healthcare sector, comparable to the Dutch aviation sector (Gupta Strategists, 2019). It is therefore important for policymakers to focus on the healthcare sector.

A non-negligible proportion of those healthcare CO<sub>2</sub> emissions are caused by intensive care units (ICUs) in hospitals (De Gruijter, 2021). ICUs are hospital units that provide intensive care for critically ill or injured patients, staffed by specialised personnel, and equipped with devices that allow for continuous monitoring of patients' health and the provision of life support (Merriam-Webster, n.d.). The intensity and complexity of healthcare as provided in ICUs bring the sector on top of the most resource-intensive departments of hospitals, as products such as caterers, gloves, and syringes are used up in vast quantities (Honkoop, 2022). The considerable role that ICUs play in healthcare emissions makes a specialised focus on the sector essential for any healthcare emissions policymaking.

Until recently, sustainable ICUs were uncharted territory: only one study provided calculations that estimate an ICU patient's daily CO<sub>2</sub> emissions at about 178 KG, equivalent to the daily footprint of 3.5 Americans (Bein et al., 2021). The Erasmus Medical Centre Rotterdam (EMC) ICU

was therefore one of the first hospitals where a comprehensive calculation of the ICU's waste production was performed. Resulting, it was found that roughly seven bags of waste per patient per day account for 250.000 kilos of waste per year for effectively thirty ICU rooms (Marmelstein, 2021). Given the aforementioned size of the (sub)sector and the relative absence of policies that decrease the amount of waste and energy consumption, implementing such policies in ICUs could make a valuable contribution toward achieving the respective national climate goals by reducing healthcare emissions (Bein et al., 2021).

In 2021, a consortium project was launched in metropolitan Rotterdam, the Netherlands, by two universities and a hospital (Zorg voor klimaat, 2021). The project envisaged transforming the EMC ICU into a fully circular hospital department by 2030. Circularity entails curtailing the loss of raw materials whilst emphasis is placed on the restorative use of resources (Geisendorf & Pietrulla, 2018). This thesis falls under the umbrella of the project, which focuses on realising a more sustainable EMC ICU department by 2030.

An effective way to become more sustainable is reducing ICU emissions, which can be achieved in several ways. A non-exhaustive enumeration is provided: First, policies could focus on the technical side: by replacing materials used with less polluting ones and applying more economical technicalities, waste could be reduced (Bilec et al., 2015). Second, in addition to the nature of the materials used, emphasis can be placed on the way materials are used. By benefiting from medical best practices and innovative methods, less resource-intensive treatments could be introduced (Bilec et al., 2015). Those first two options focus on the technicalities of materials and operations. Altering materials used requires redesigning (medical) procedures, which are restricted by various barriers. Alternatively, policymakers could focus on behavioural change. Within that behavioural scope, a third focus area for reducing ICU emissions could be limiting the number of ICU patients' interventions in underlying behaviours such as smoking or traffic behaviour; behavioural change focusing on prevention (Beadle et al., 1993). Finally, behavioural change could be realised during medical treatment: existing knowledge about more sustainable decision-making (such as using fewer materials) that does not endanger patient safety could be capitalised on to steer behaviour. In that way, the current use and waste of materials could be influenced (Schubert, 2017). The first three categories require, amongst others, extensively redesigning processes, intensive retraining of personnel, or nationwide interventions. Those requirements are costly, time-consuming, and potentially politically unfeasible. By contrast, the fourth category can be effectuated by minor interventions: nudges.

## The potential of nudges

A nudge is an aspect of choice architecture that steers an individual's behaviour in a predictable direction without removing options or significantly changing incentives. Such an intervention should be uncostly and uncomplicated to avoid (Leonard et al., 2008). If designed well, nudges can increase pro-environmental behaviour. Well-designed nudges can be more powerful than other (technical) interventions (Schubert, 2017). Nudges can therefore be an efficient route towards increasing ICU sustainability. Characteristics such as time- and cost-effectiveness enhance the probability that a successful intervention is executable in other hospitals and countries as well, stressing the social relevance of nudges.

However, nudges occur in many varieties. It is therefore of key importance to seek the most effective and appropriate nudge(s), considering the barriers to the effectiveness of nudges in the ICU context. Although exact data is unavailable due to privacy reasons, most staff members have been in healthcare for a substantial number of years. Consequently, their behaviour will partly be based on habits that are harder to change since *old habits die hard* (Raymaekers, 2019). To avoid infections in the delicate ICU environment, strict patient safety protocols apply. Any policy changes need to be granted permission from the hospital's hygiene and infection prevention board (HIPB). The HIPB focuses on both patients' and personnel's safety. In addition to the HIPB's factual judgement on policy changes, individual staff members should also be convinced that changes do not increase patients' or their risks of infections: their perception is not necessarily linked to actual risks. Last, the department is characterised by stressful high-pressure dynamics, making any interventions that add to the workload rather unfeasible and undesirable (Donchin & Seagull, 2002). Although a variety of nudges are potentially applicable, the contextual barriers of the ICU should all be considered when designing a nudge.<sup>1</sup>

## Considering the particularities of the ICU environment

The ICU's activities require a functional working climate that any nudge should affect as little as possible. First, all rooms are equipped with heating, illumination, respiratory equipment, and monitoring screens (Malone, 2002). The severe physical condition of patients requires goldilocks conditions to minimise risks; making changes to one of those categories is consequently undesirable. Second, ICU waste generation is substantial. An intuitive intervention to increase circularity is implementing and/or incentivising waste separation (Brooks & Windfeld, 2015). However, the particularities of the department currently require all waste to be burnt, thwarting waste separation initiatives (De Gruijter, 2021). Third, the personnel's activities entail using many materials. Some materials require regular replacement for medical reasons, like catheters, syringes, etc. (Maki et al.,

---

<sup>1</sup> More in-depth details are provided in the methodology section.

1991). Using less of those materials can increase medical risks, such as infections, making it undesirable to tinker with the category. Finally, several materials are less related to managing medical risks and more related to the staff's preferences. Examples of those are excessive use of aprons and gloves, or (costly) urine mats being used to temporarily pose other utensils on (De Gruijter, 2021). That latter category can be considered low-hanging fruit: decreasing the usage of such materials is the most feasible course of action, both reglementary, financially, and timewise.

Much of that latter category revolves around personal protective equipment. Personnel were expected to wear a plastic apron when performing (medical) acts that involve any contact with (non-infectious) patients. By mid-2022, the hospital's HIPB had decided in favour of alleviating the rules as no increase in medical risks was at stake: aprons were only to be worn when actions involved contact with body fluids (blood, exudate, urine etc.). That policy change provided several advantageous conditions that facilitated an experiment. First, the correct implementation of that policy change contributes to decreasing CO<sub>2</sub> emissions. Using fewer aprons implies wasting fewer materials, moving towards the goal of a circular ICU. A brief estimation of the environmental impact of reducing apron usage is provided in Appendix A4. Second, apron usage is one of the few areas in which using different and/or fewer materials is permitted by the HIPB; other interventions are restricted by various limitations, especially in the short term. Third, nudging personnel towards using fewer aprons can be implemented with minimal costs and does not necessarily require time-intensive action such as retraining. Minimising costs contributes to the issue of increasing healthcare expenses, as *greener* practices in hospital environments tend to be more cost-efficient (Riedel, 2011). Finally, even if production is not decreased in the short run, reducing the unnecessary usage of materials will allow for a bigger share of manufactured materials to be sent to regions that suffer from a shortage of medical supplies (Kekana et al., 2017).

Nudges need not be designed from scratch, as a myriad of experiments concerning nudges have been conducted over the last decades (Leonard et al., 2008). Three powerful nudge categories cannot be applied due to limitations: defaults or limiting choices are not applicable. Also, manipulating the choice environment by a placement intervention, where the aprons would be placed in a different location, is not feasible as hindering the personnel's work is undesirable. A powerful nudge that is not hindered by contextual restrictions concerns social comparison, which is chosen for its relatively strong effects and practical feasibility in an ICU context (Hummel & Maedche, 2019).

#### Applying social norm nudges

Social comparison describes individuals comparing their behaviour with peers' behaviour, (sub)consciously checking for modifiable discrepancies with other members. Of the various reasons hypothesised to explain the phenomenon, self-evaluation, learning new skills, and protecting one's



self-esteem are provided as the most important (Buunk et al., 2010). It especially occurs in the workplace, where an individual's behaviour is generally influenced by the group (Ajzen, 1996). In the specific, high-pressure dynamics environment of ICUs, social comparison mechanisms play an important role. Stressful situations or situations of doubt frequently occur, triggering individuals to rely on colleagues (Donchin & Seagull, 2002).

Considering the majority's behaviour (and indirectly decisions) can prove a valuable heuristic to learn what is perceived as normal (Leach & Vliek, 2008). The (potentially costly) fear to be the *odd one out* has provided humans with a strong sensitivity for and a tendency to conform to the norms of the group (Laland & Morgan, 2012). Social norm nudges are based on such social comparison. Hotel visitors that were confronted with a social norm that informed them about other visitors engaging in re-using behaviour, showed significant re-using rate increases (Cialdini, 2005). Such social norms are more effective when people can identify themselves with the reference group (Cialdini et al., 2008). The instrumentalisation of social norms is widely supported, both in research and in practical marketing applications (Amblee & Bui, 2011). In sum, social norm nudges can change behaviour.

Social norms are strongest when individuals experience a moment of doubt or uncertainty regarding a choice (Benjamins et al., 2020). The implementation of a new apron policy in the ICU department might induce such uncertainty. The location of the piles of aprons in the patient's rooms allows for displaying social norm nudges in the direct choice environment. The expectation is for a social norm treatment to nudge the personnel's habits towards using fewer aprons (H1). This leads to the main research question:

*Can a social norm nudge incentivise an ICU department's personnel towards using fewer aprons?*

This thesis will shed a light on whether earlier studies that successfully instrumentalised social norms to reduce littering, boost towel re-use, reduce energy consumption, or reduce the number of plastic bags used can be replicated in a different context, i.e., pro-environmental behaviour measured by apron usage by ICU personnel in a large academic hospital in the Netherlands, in the context of a field study (Abrahamse et al., 2013).

## Theoretical framework

This thesis is part of a project that envisages the realisation of a circular Erasmus Medical Centre Rotterdam (EMC) intensive care unit (ICU) by 2030. A variety of routes can lead to the desired energy and material savings, moving towards the desired circularity. When considering restrictions in finances, time, and especially reglementary restrictions, a behavioural nudge that disincentivises the

excessive use of materials is the most promising approach to change human behaviour. Focusing on behaviour considers that human behaviour is an important contributor to emissions; reducing emissions requires changing human behaviour.

Several studies have attempted to rank the most effective nudges within a multifaceted set of nudges (Banerjee et al., 2021). In a comparative study of nudges, defaults were recognised as inducing the biggest effect size (Congiu & Moscati, 2022). Defaults entail setting the choice architect's desired choice as a standard choice, requiring (a minor) effort to deviate from the default (Ghesla et al., 2019). Although the situation in which aprons should be used changes, no difference or possibility for implementing an alteration in standard choice is feasible as it is up to personnel whether to follow the policy. The second most impactful nudge, simplification of options, is neither possible, as the number of options cannot be reduced (John, 2018). The third most powerful nudge, altering the attractiveness of choices by changing the amount of effort required, could be implemented by placing the aprons somewhere in the room where it takes more effort to grab them (Ensaff, 2021). While this nudge is potentially effective in reducing apron usage, such an increase in effort exerted by personnel is, however, not desirable due to the pressure and time restrictions that are already imposed on them. The fourth category for which ICU departments prove a promising environment is social norm nudges, which are chosen for their power and contextual applicability. Therefore, this section will focus on the background and best practices of social norms, providing a framework that is applied to design the optimal social norm for the experiment.

### The origins of social learning

Understanding social norms requires grasping the underlying concepts. A plethora of scientists have conducted research to explain why humans have outperformed all other animals in (technological) development (Chapman & Huffman, 2018). One explanation that is often given mentions cultural, and social learning: the ability to preserve knowledge by communicating it to other humans and new generations (Schaik, 2010). In prehistorical times when food was regularly scarce, it might have been tempting to eat just any plant, in dire need of energy. Due to the omnipresence of a myriad of poisonous plants, it would nevertheless have been a disastrous strategy to base all knowledge on individual experiences. Thus, social learning proved a more successful game plan that equipped humans with accumulated shared knowledge: trusting others instead of one's observations (Eastwick, 2016).

In addition to norms that protected individuals, humans are programmed to follow the behaviour of the group. Deviating could be punished by banishment, whilst becoming a lone wolf *de facto* equated to a death sentence (Laland & Morgan, 2012). Complying with in-group behaviour

allows for the preservation of the steady state, maintaining order, and avoiding conflicts. Humans' current emotional response to being alone or not being liked is grounded in such evolutionary reasons. The negative feelings resulting from that emotional response are not only subjective: parts of the brain that are related to experiencing physical pain are activated when (fear of) social rejection is experienced (Berman et al., 2011). In sum, humans avoid being the *odd one out*.

Along with lifesaving strategies and not losing one's position in the group, social learning finds its origins in efficiency: if behaviour is very common, it must be sensible. Via shortcuts, humans use heuristics to process information quickly, simplifying decision-making (Griffiths et al., 2021). Why reinvent the wheel if you could stand on the shoulders of giants? In behavioural economics, a related distinction between modes of thinking has been proposed: quick, short-run, intuitive, automated, and instantaneous heuristics that require minor effort (system one) versus more profound, conscious, logical, and deep considerations (system two). Whilst tasks that come naturally or frequently executed tasks require minor effort and are performed subconsciously, unexpected, or rather demanding situations require active thinking. Although the theory has been erroneously oversimplified into assuming different parts of the brain are linked to the modes of thinking and operate independently, the concept still provides theoretical value in understanding the *modus operandi* that affects susceptibility to nudges. According to the distinction between systems one and two and in line with the efficiency argument, most social nudges work via system one (Kahneman, 2011). The efficiency argument is linked to survival but is recognised as a separate pillar: the world is simply too vast to contemplate everything.

The phenomenon of social learning is not limited to the prehistoric times in which it originated: although the role of lifesaving strategies has decreased, not being banned from the group and efficiency remain desired applications in modern settings. Before the 1930s, grocery store customers purchased limited quantities because stores only offered small shopping baskets. A grocery store chain owner introduced the first self-made shopping carts, allowing customers to buy bigger quantities in 1936 (Grandclement, 2006). Due to an alleged lack of interest in the carts by customers, their uptake was limited. Consequently, models were hired to walk around with the carts. By making it look like others did something, that farce became a reality: by making shopping carts look common they became popular (Cochoy, 2019).

#### Social learning via social norms

The shopping cart example evolves around social learning via social norms: group-based standards or rules regarding appropriate attitudes and behaviours (Cheng et al., 2012). When individuals learn that most people prefer a specific brand or avoid a certain meal, they perceive social

norms. Such norms provide information on effective or adaptive behaviour and can be communicated via revealed (group) preferences. Individuals that someone admires or identifies with, can also set social norms. Celebrity endorsements have become a classic marketing tool that generally leads to an increase in the desired behaviour (Keel & Natarajan, 2012). In addition to real-life behaviour, such norms can be communicated via statements on posters, stickers, and other means. In summary, social norms function via different routes.

When norms are successfully implemented, not only the desired behavioural change might occur. A normative message does not only focus an individual's attention on a specific behaviour: it can activate (related) personal goals and lead to acting in a desired way in the entire situational context. An individual's goals can be triggered, activating related relevant behaviours (Keizer et al., 2008). Moreover, others' behaviour could potentially be affected as well: positive spillovers (Hamann et al., 2013).

Despite the various applications of social norm nudges and their spillovers, individuals do not seem able or willing to recognise the importance they attach to others' behaviour. In an experiment, a confederate street musician was set up in a busy area. The musician only received money from one individual in the baseline condition. In the intervention condition, a confederate made the first contribution, leading to numerous additional contributions. None of the subjects attributed their behaviour to the influence of witnessing the confederate contribute (Cialdini, 2005). In another experiment where people were asked for their motives behind saving energy, others' behaviour was systematically selected as being the least impactful. Nevertheless, energy-saving efforts correlated twice as high with the conviction that others were saving energy as any of the other previously indicated reasons. Individuals seem oblivious to their susceptibility to social norms (Cialdini, 2007).

Not all social norms, albeit via revealed preferences or statements, reap similar effects: their design and the context in which they are perceived are impactful. Social norm nudges work better in case of uncertainty or conflicting interests. Imagine the situation of being in a grocery store and seeing cans of soda – or any other product – in an untouched multipack. In such moments, it is not always clear whether customers can buy a single can: uncertainty. A store owner could set norms by cutting the packaging and taking a can out, guiding customers during their moment of uncertainty. In situations with comparable levels of uncertainty, guidance could also be given via social norms: when information concerning the majority's behaviour or others' behaviour is witnessed, such information could (substantially) influence an individual's decisions (Benjamins et al., 2020). Nevertheless, social norms can also influence behaviour in absence of uncertainty. In the aftermath of the horrors of the second world war, a – by now – famous experiment was conducted, demonstrating how strong the

effects of social conformity on people's decision-making can be. Subjects went through several trials in which all other participants – unknowingly to the participant – were confederates. Whilst sitting together at a table, each person had to answer the same question out loud, for example 'which of the two lines is longest'? Confederates deliberately gave incorrect responses to influence participants. While the answers to the questions asked were obvious, 36.8% of subjects eventually joined the (clearly incorrect) majority's opinion. Despite knowing that it was virtually impossible to convincingly make that judgement, many subjects demonstrated a strong willingness to conform to groupthink (Asch, 1951). Consequently, social norms might be stronger than individual morals, even in full certainty.

#### Reference groups in social norms

In addition to the moment in which people are confronted, the constellation of reference groups is rather decisive for the effectiveness of social norm nudges. Reference groups are the individuals that a social norm refers to. Identifying with the reference group is important: in an experiment regarding the effect of laughter tracks, people were more likely to enjoy a clip when they believed it was taken from an audience they identified with (Both et al., 2005).

When referring, the distinction between provincial and global social norms is made. Provincial social norms focus on the specifics of a situation: the reference group consists of, e.g., people that stayed in the same room or hotel. Global social norms are more abstract, focusing on more general reference groups, like people in the same region or country. Although provincial norms do not provide extra valuable information in the experiment's context of re-using a towel, the distinction seemed to matter to subjects. Standard environmental messages led to a 40% re-use percentage, whilst the provincial social norm led to a re-use percentage of 49.3%. The global social norm – focusing on one's identity as a hotel guest -, led to a re-use rate of 43.5%, underlining the advantages of provincial as compared to global social norms (Cialdini et al., 2008). In a 2013 field experiment, random households were asked to paste no-ads stickers on their mailboxes. In neighbourhoods where a subset of households was actively asked to put the stickers on their mailboxes, leading to higher visibility of the provincial social norm, the rate of individuals that received a sticker without context that pasted the stickers on their mailboxes was significantly higher (Hamann et al., 2013).

Besides the distinction between provincial and global norms, shared identity and contextual similarity can be distinguished. Identity depends on the group people identify with, such as Europeans, males, or hockey fans (Hogg, 2003). If the idea can be primed that someone is alike, similar behaviour becomes more likely: social influences that used peer behaviour in group discussions proved the most effective nudge in decreasing smoking rates (Johnson et al., 1987). Identifying with a group does not purely depend on static identities. Contextual similarity is the overlap that individuals share with a

reference group based on the particular environment, situation, or circumstances that most closely match one's own, rather than personal characteristics (Campos et al., 2019; Burnkrant & Cousineau, 1975). In the towel example, such a context would be being a customer of the same shop as the reference group. Whilst both provincial social norms and contextual similarity focus on a specific context, the former focuses on an act whilst the latter describes a temporary identity such as a supermarket customer. Finding a reference group that people identify with is important: sharing attributes with others increases the probability that individuals are willing to follow others' behaviour (Carli et al., 1991). The strength of an individual's adherence to a social group is linked to the perceived importance of the group to one's view of self or social identity (Hogg et al., 1999). Consequently, someone who is more connected to her identity as a woman than her identity as an American will be more susceptible to social norms that refer to women's behaviour.

#### Formulating social norms

Once the reference group is determined, the wording of the norm can also occur in different forms. A distinction can be made between prescriptive, what others do or approve of, and proscriptive, what others do not do or disapprove of (Cialdini et al., 2011). Additionally, injunctive and descriptive norms are distinguished. Injunctive norms state what others approve or disapprove of, incentivising actions via social rewards or punishments. Descriptive norms describe others' revealed behaviour, portraying what behaviour is probably effective or adaptive (Cheng et al., 2012). The former norms are mostly moralistic, the latter is more neutral and factual. No structural significant differences in strength between descriptive and injunctive norms have been found, implying that various contexts allow for the most efficient norm variant to be chosen. Whereas surveys often lead to a majority morally supporting a type of pro-environmental behaviour allowing choice architects to formulate an injunctive norm, it is hard to formulate a descriptive norm as most people do not necessarily already engage in the desired behaviour. By first convincing individuals to engage in a certain behaviour via an injunctive norm and subsequently using that altered behaviour to constitute a descriptive norm, the power of both can be leveraged (Abrahamse et al., 2013).

Combining norms or displaying descriptive and injunctive norms simultaneously or separately has been tried with mixed success (Smith & Louis, 2008). The probability of a certain behaviour occurring is highest when individuals are convinced the behaviour is commonly approved and exerted similarly by others, i.e., an alignment of descriptive and injunctive norms (Smith & Louis, 2008). A combined descriptive and injunctive norm was, consequently, more effective than one of the two norms presented separately (Khazian et al., 2008). Alignment is important, as contradictory descriptive and injunctive norms decreased nudge effects (Cheng et al., 2012).

## Incentivising pro-environmental behaviour via social norms

Thus far, the reasons why social norms affect humans have been discussed. Moreover, the importance of selecting an appropriate reference group and the different formulations that can be used to formulate convincing norms were mentioned. Although social norms apply to various fields, using social norms to incentivise pro-environmental behaviour has received special attention. Pro-environmental behaviour, such as using fewer aprons, is defined as behaviour that benefits the environment by altering the availability of energy and materials or advantageously changing the characteristics of ecosystems (Abrahamse et al., 2013). Pro-environmental behaviour is normally linked to benefits for the environment or other individuals, whereas the individual engaging in such behaviour does not necessarily receive any benefit. Influencing ICU personnel such that fewer materials are wasted is a direct example of incentivising pro-environmental behaviour. This section will discuss the application of social norms to contexts where *greener* practices were endeavoured, as such contexts can be compared to the ICU context.

On average, social norm interventions reduce energy consumption by 2% (Asensio et al., 2013). Neurologically, such results are not unexplainable: prosocial behaviour and the enforcement of norms are linked with an increase in reward circuit brain activity (Camerer & Fehr, 2007). Formulating social norms to increase pro-environmental behaviour requires caution, to avoid any adverse effects. In 2006, National Park officials wanted to reduce stealing behaviour and did so by implementing signs that informed visitors about the (high) prevalence of stealing wood. Such a solution normalises behaviour and therefore tends to backfire. Individuals' guilt decreases and the undesired behaviour increases: the boomerang effect (Barrett et al., 2006). National Park visitors that passed a sign that depicted a lone thief were less likely to steal (1.67%) than those who passed a sign depicting three thieves in action (7.92%; Cialdini, 2003). To avoid the boomerang effect, choice architects should only mention the subset of people engaging in the desired behaviour if that percentage is noteworthy and avoid mentioning widespread undesired behaviour (Cialdini, 2003).

In a study in which energy savings were targeted, individuals received several door-hangers. The door-hangers stating that saving energy was common in the neighbourhood reaped the highest energy savings (Schultz, 1999). The idea that individuals navigate on their observations of others' behaviour has also been recognised with littering. Littering occurs more frequently in already littered environments, especially when confederates visibly littered the environment, although findings in this area are mixed (Cialdini et al., 1990; Krauss et al., 1978). In a waste recycling experiment, subjects were provided with recyclable waste boxes that were to be put outside. A higher rate of perceived recycling behaviour among neighbours predicted an individual's recycling behaviour (Lyons et al., 2010). In another experiment, researchers aimed to decrease hotel towel usage. Classic suasion

messages focused on helping the environment, future generations, or the hotel. When the message was replaced by an appeal to join one's fellow citizens in using one's towel more than once, the re-use rate increased by an average of 28.4%, as compared to the original messages (Cialdini, 2005). Whilst all these experiments were conducted in the United States, comparable results were found in Europe, contributing to the idea that social norms regarding environmental behaviour can be effective across contexts and cultures (Loew et al., 2014). In sum, social norms can be an effective tool to incentivise individuals to use fewer materials or energy, which may also apply to ICU environments.

#### Implementing social norms in a medical setting

Social norms have not yet been applied to medical (and ICU) environments. Nevertheless, previous research provides valuable lessons for a fruitful ICU application. In summary, the underlying principle of individuals avoiding the discomfort that stems from being the *odd one out* applies to all human groups (Berman et al., 2011). The underlying principle of efficiency especially applies to a stressful, ICU working environment (Griffiths et al., 2021). The desired behaviour, using fewer aprons, could be made popular by making it seem common (Cochoy, 2019). Making a behaviour (seem) popular does not require revealed preferences via behaviour: messages such as statements can equally convey the norm (Cheng et al., 2012). Apart from the targeted behaviour of using fewer aprons, social norms can reap positive spillovers to other pro-environmental behaviours (Hamann et al., 2013). Peers with morals that denounce using fewer aprons might still succumb to the group's (indirect) peer pressure (Asch, 1951). Implementing social norm nudges will generally be subtle, as individuals are unaware of their susceptibility (Cialdini, 2007). The implementation of a new apron policy potentially induces uncertainty, which is important for social norm efficiency (Benjamins et al., 2020). Consequently, there are multiple reasons to assume social norms may be effective in ICUs.

Designing a social norm nudge for an ICU environment requires diligence. Subjects should be able to identify with the reference group. Norms should convey a situation that resembles the context of ICU personnel, preferably provincial social norms (Cialdini et al., 2008). Provincial social norms are linked to perceived similarity: in addition to identifying with the reference group via objective characteristics such as occupation, the reference group should be able to activate a feeling of perceived similarity (Hogg, 2003). As combined descriptive and injunctive norms are most effective, the wording of social norm nudges applied to ICU environments should ideally be a combination of both (Smith & Louis, 2008).

Researchers have applied social norm nudges to incentivise pro-environmental behaviour such as using less energy, decreasing littering, increasing recycling, and promoting towel re-use (Abrahamse et al., 2013; Cialdini, 2005; Cialdini et al., 1990; Lyons et al., 2010; Schultz, 1999). These positive nudge effects share a neurological denominator: pro-environmental behaviour induces



increased reward circuit brain activity (Camerer & Fehr, 2007). Designing social norms to decrease apron usage should only mention a reference group's behaviour if that percentage is noteworthy and describes a majority that engages in the desired behaviour, to avoid triggering the boomerang effect (Barrett et al., 2006; Cialdini, 2003).

Medical settings share several characteristics with environments in which these pro-environmental nudges were applied: countless daily micro-decisions lead to considerable waste generation. If the lessons from previous research are considered, it is expected for a social norm treatment to nudge the personnel's habits towards using fewer aprons (H1). This leads to the main research question:

*Can a social norm nudge incentivise an ICU department's personnel towards using fewer aprons?*

## Methodology

It was tested whether the implementation of a social norm nudge via stickers led to a decrease in apron usage by medical personnel (H1). To provide an answer to that research question, an experiment was conducted in the micro-economic system of the Erasmus Medical Centre Rotterdam's (EMC) intensive care unit (ICU) department from 5 to 25 July 2022. The experiment was ethically approved by the Erasmus University Rotterdam Internal Review Board (Appendix A3, reference number ETH2122-0751).

### Experimental design

A field experiment was conducted at the EMC's ICU, to test whether the implementation of a social norm nudge led to a decrease in apron usage per room. Apron usage per room per eight-hour day shift was counted in a baseline and treatment condition. In general, all rooms are worked in by different nurses and doctors per shift. All staff members work in units, to which they are randomly assigned once they start working at the ICU. Which staff members work in which room can change from day to day. Each observation was therefore generated by data based on apron usage of a random set of employees. The experiment took place during the holiday season, which meant that many subjects only participated in (a part of) either the baseline or treatment period. The experiment is consequently considered a between-subjects design. Nevertheless, that decision is debatable as certain staff members indirectly provided data in both conditions.

In the experiment, the categorical independent variable was Nudge, with two conditions: pre-nudge and nudge. In the control condition, apart from neutral information concerning the new policy, no methods of persuasion were used. Subjects were only informed via posters near the patient room

doors and in the canteen that the policy had changed. In the nudge condition, stickers containing a social norm were put above all piles of aprons in the patient's rooms and displayed in the canteen. The continuous dependent variable was Apron usage (per room). The variable was measured two times per day throughout the treatment period. Aprons were counted in the same order of rooms in the morning as in the afternoon, ensuring that every observation is approximately based on the same number of hours. Again, Apron usage is considered a between-subjects variable, which is debatable. Because staff throughout the department were in regular contact, no simultaneous treatments could be conducted. Hence, a before-and-after study was conducted to avoid confounding the results.

#### Experimental setting

The ICU is the hospital department where patients in severe conditions that require acute and intensive care are hospitalised. Generally, these patients are weakened to the extent that vital functions such as breathing require respiratory equipment, which makes ICU caretaking demanding. To be able to function in that special high-pressure context, the department's staff is specially trained. The department consists of four units, A, B, C, and D. Units A & B share a canteen and sub-management, just like units C & D. Only units C & D were available due to another experiment that was conducted in units A & B. Each unit contains ten rooms, leading to a total capacity of forty patients. Nevertheless, due to personnel shortages, only three-quarters of those rooms can be occupied by patients.



**Figure 1:** Medical workwear in the ICU environment. Aprons that are to be worn when performing medical acts with patients are depicted.

The practice of the (medical) acts that constitute the bulk of the daily work varies from short talks with patients and replacing band-aids to resuscitating them. Independent of the nature of a task, personal protective equipment (PPE) is worn, depending on the occasion. Except for when dealing with infectious or patients at high infection risk, personnel were expected to wear a (plastic) apron mostly covering their trunk and upper arms when in contact with patients (Figure 1).

<b>Apron policy non-isolation patients</b>	<b>Policy outline</b>
Old (pre-baseline situation)	Apron to be worn at all patient contacts, turning patients over, feeding them, washing them, etc.
New (baseline-onwards)	Apron only to be worn when in contact with excreta: blood, wound fluids, urine, etc.

**Table 1:** *Policy overview apron usage*

The rules of the department are strictly guided by the hospital’s hygiene and infection prevention board. In spring 2022, the board decided that it was justifiable, considering patients’ and personnel’s safety, for an apron usage policy change to be implemented to use fewer aprons (Table 1). Consequently, a myriad of acts that were previously guided by the strong recommendation to wear an apron such as helping to dress or turning over a patient no longer required personnel to do so. The implementation of that new apron policy forms the basis of the experiment. Instead of merely communicating the new policy via the traditional routes, the policy change was utilised to conduct a natural experiment.

#### Sample & Subjects

A power calculation was performed, based on a 5% significance level, a desired (medium) effect size of 0.5 and a power of 80%. The test led to a minimum number of 67 observations for each treatment condition. These parameters used for the power calculation were based on previous research that involved nudging interventions (De la Hunty & Trafford, 2021; DellaVigna & Linos, 2022; Erjavec et al., 2021).

All medical employees who worked in units C and D of the EMC ICU during the period of data collection indirectly participated in generating apron usage data per room by simply using aprons. No subjects were recruited due to the experiment’s nature of field study. The staff consists of nurses (about one nurse per patient per eight-hour shift, four full-time nursing jobs per occupied room per day) and doctors (that on average make two patient rounds across the rooms per day), making for a total of 240 medical staff members. The earlier observation period showed the personnel’s regular activities in the corner of the patient’s room where the aprons (and other equipment) were located and the social norm stickers were displayed. Therefore, the total number of subjects that saw the stickers presumably approached the total number of medical staff working at units C & D during the treatment.

In hospitals, employees’ privacy is considered pivotal. Therefore, no information about ICU personnel was gathered: only room apron usage was measured. The experimenter’s occasional

observations and data from the pilot study held in a comparable environment in Utrecht indicate that over 80% of the subjects were females.

As the PPE policy did not change for isolation rooms, these rooms were excluded from the experiment. Moreover, it regularly happens that ICU rooms accommodate a hospitalised patient in the morning whilst being empty in the afternoon or vice versa. On such occasions, the observation was deleted from the dataset, as observations can only be compared when they are based on a similar number of hours.

## Materials

At the start of the baseline period, the new policy of using fewer aprons was communicated via updated posters next to the patient room doors and a text in the newsletter (Appendix A2). After the baseline period, stickers with a social norm were put on in-room hand soap containers, which were situated just above the pile of aprons where personnel would normally grab an apron. Moreover, the same social norm was displayed on a screen in the canteen, between several general announcements on a continuous display.

## Designing the social proof statement

In economic experiments, deception is rather unusual and frowned upon. Therefore, the social norm that was displayed needed to be based on actual data. To avoid influencing the EMC ICU subjects, the data for the social proof statement were gathered in the ICU of a different (academic) hospital: Utrecht Medical Centre (UMC). Utrecht is located in the same Randstad region of the Netherlands as the EMC where the main experiment was conducted. The hospital was chosen due to its relative proximity to and similarity as an academic hospital. In a (digital) pilot study, UMC employees (N=32), were shown the following question:

*Imagine the following scenario: An ICU department, such as the UMC Utrecht, introduces a new policy for protective clothing. You are given the choice between more sustainable clothing (washable gowns, shorter aprons, or fewer aprons) and less sustainable clothing (plastic gowns, longer aprons, or more aprons). Which category of protective clothing would you choose (in most cases)?*

Gowns, although not considered in this experiment, are medical workwear that employees wear throughout the day. Gowns were also included in the scenario to enable subjects to consider the broader topic of workwear. The scenario was followed by a multiple-choice question that provided three options:

- 1 The more sustainable clothing
- 2) The less sustainable clothing

- 3) Other, i.e.

81% of respondents indicated (three indirectly via option 3) to be in favour of using more sustainable clothing. How does that statistic transform into a social norm? In social norms, a distinction can be made between injunctive and descriptive norms. Injunctive norms state what others approve or disapprove of whilst descriptive norms describe others' behaviour (Cheng et al., 2012). A combination of both tends to be more effective than one of the two norms presented separately (Khazian et al., 2008). The social norm that was derived from the pilot study was phrased in such a way that it was congruent with the results but could be interpreted as a description of others' behaviour as well as others' opinions, a combined norm:

*81% of intensive care staff in a similar hospital (UMC) prefer the sustainable option: only wearing an apron when required. Join them and limit your apron use.*

The resulting materials used in the experiment are depicted in Appendix A2.

#### Procedure

Before the treatment phase, stickers were designed and printed. Once the daily counting of aprons started, the experimenter received medical gowns to be more inconspicuous for staff and patients. One day before the experiment started, a general announcement of the new apron policy was disseminated via the newsletter and posters. The treatment intervention was performed in the early morning just before the day shift personnel arrived, to avoid any association between the experimenter and the stickers. After the treatment period had ended, all stickers were removed. The variable was counted twice per day by the experimenter, just before the start (07:30) and end (16:00) of the day shift. Counting took place by hand and was intentionally made inconspicuous by simultaneously executing the task of replenishing the pile of aprons to not raise any suspicions from personnel.

Because the research conducted took place in a natural setting, subjects did not consent to participate. Subconsciously participating in an experiment can have (adverse) consequences: experiments might cause confusion, induce unintended harm, and (permanently) change subjects' ideas. Debriefing targets those consequences by informing subjects afterwards, out of respect. Debriefing is important to maintain scientific integrity and institutional credibility (Hatemi & McDermott, 2020). The debriefing statement has been included in Appendix A2. Consequently, after the experiment had ended, in August 2022, the subjects were debriefed via the department's newsletter. The text has been included in Appendix A2.

## Analysis

The data contains two variables; the continuous dependent variable Apron usage was influenced by the categorical independent variable with two conditions (pre-nudge and nudge): Nudge. Apron usage was counted per room per day shift, the generated data were therefore based on multiple staff members working in the same room. A before-and-after study normally implies a within-subjects design. Nevertheless, the staff members using a room differed from day to day. Moreover, due to the holiday season, there were substantial changes in staff from week to week, implying that the pre-nudge and nudge room data was based on varying populations. Consequently, the design is considered a between-subjects design, as apron usage between rooms was compared. It should be noted that the experiment setting did not reveal a clear between-subjects design, an important consideration that should be given thought to when interpreting the results.

The assumptions of parametric tests are not met. One of the assumptions states that the observations are drawn from a normally distributed population, whereas the underlying distribution is unknown. The central limit theorem states that a sufficiently large sample size leads to the sample approximating a normal distribution. Although some statisticians state a sample size of thirty could be sufficient, the ten per-cent condition states that a sample should not be larger than 10 per-cent of the population. That number is surpassed. Therefore, a non-parametric test is chosen.

As the experiment consists of two samples, a two-sample test is selected. If the experiment would be considered a within-subjects design, a Wilcoxon Matched-Pairs test would be preferable. Such a test is not possible because data to match observations has not been recorded, mostly due to privacy restrictions. Moreover, different people work in the same room during a shift, rendering such individual observations impossible. Because of the differences in the groups that constituted the room's apron usage data, a between-subjects design was chosen. Consequently, a Mann-Whitney U test was applied to determine whether the two samples stem from the same population. The test looks at the sum of the ranks of the observations, which should be similar if both groups are similar. Moreover, a two-tailed is performed. Although the expected effect is only negative, a decrease in Apron usage, it cannot be ruled out that a positive treatment effect occurred. For such a two-tailed Mann-Whitney U test, data is minimally required on the ordinal level. Given that Apron usage is a continuous variable, that assumption is met.

Furthermore, independence should hold. Within the broader group of EMC ICU personnel, all new staff members are randomly assigned to one of the units: it can be assumed that those working for C & D do not systematically differ from other employees. Because of the before-and-after design, results for individual rooms are not independent: there are generated by personnel whose approach towards aprons in the neutral condition is already influenced by their characteristics and convictions,

which relates to their susceptibility to the nudge. Multiple subjects participated in both the pre-nudge and nudge conditions, influencing room apron usage data. Susceptibility to the social norm in the nudge condition is influenced by opinions in the baseline period. Although within-subject independence is improbable, between subjects the observations should be independent. Normally, wearing aprons boils down to an individual decision that is mostly made alone where the influence of others is negligible. On the other hand, one cannot rule out the possibility of personnel discussing the new policy among themselves and influencing each other. In the decision on whether Mann-Whitney U can be applied, such interactions are assumed to be minimal and considered noise. However, it should be stated that the latter assumption is not backed up. More information on experiences from the field experiment and subjects' behaviour is provided in Appendix A1.

## Analysis and Results

Counting took place from 5 to 25 July on two occasions daily: just before and slightly after the eight-hour day shift (around 07:30 and 16:00). Counting took place to determine how many aprons were used within one room during a day shift. Due to the nature of the department, the length of stay of intensive care unit patients can vary from some hours to multiple months, with most patients staying relatively short. Rooms that were occupied in the morning but empty in the afternoon were removed from the counting because such rooms did not guarantee a full day shift of nursing. Apron usage per room varied from zero to twenty-one. In Table 2, summary statistics on the experiment are provided. The baseline phase of the experiment was discontinued due to time restrictions after the number of 67 observations was reached, after nine days. The number of 67 observations is derived from the power calculation. The treatment phase took twelve days and led to a total of 72 observations. The median for both periods is five, whilst the mean is a little higher at 5.69 for the baseline period and 5.85 for the treatment period. The statistics provide a first insight into the results of the experiment. Surprisingly, the treatment group shows a slightly higher mean.

<b>Nudge status</b>	<b>Pre-nudge period</b>	<b>Nudge period</b>
Number of eight-hour day shift room observations	67	72
Apron usage, mean	5.69	5.85
Apron usage, median	5	5
Standard deviation	3.41	3.36

**Table 2:** Summary statistics experiment

To determine whether the baseline and treatment groups were statistically different, a Mann-Whitney U analysis was conducted. The test's null hypothesis of the group's medians being equal cannot be rejected at a 5% significance level (Table 3). The distributions in the baseline and treatment groups did not differ significantly. The Stata commands used to obtain the results can be found in Appendix A5.

<b>Nudge status (independent variable)</b>	<b>Observations</b>	<b>Rank sum</b>	<b>Expected</b>
Pre-nudge	67	4631.5	4690
Nudge	72	5098.5	5040
Combined	139	9730	9730
Adjusted variance	55570.43		
H0: Apron usage pre-nudge condition = Apron usage nudge condition			
Z-value = -0.25	P-value = 0.81	Effect size = 0.00	

**Table 3:** Results of the Mann-Whitney U test

It was mentioned that the baseline period lasted for nine days, whilst the treatment period lasted for twelve days. Although the original intention was for both periods to be equally lengthy, it was decided otherwise for two reasons. Whilst it required nine days to obtain 67 observations in the baseline condition, a higher number of observations was interrupted by changes in room occupation during the treatment period. Such differences between days occur randomly and can be explained by, inter alia, health conditions improving, operations, or death. The baseline period not initially being extended to avoid the risk of dissimilarity between the periods can be explained by time limitations on the experimenter's side. However, this comes as a risk: nudges can be susceptible to time-effects (Congiu & Moscati, 2022). Robustness checks provide information on the validity of test results when (small) alterations are made to variables. Consequently, as a robustness check, another Mann-Whitney U test was run with the same nine days of baseline observations, whilst for the treatment, only the first nine days were taken. As depicted in Table 4, no significant differences between the two groups are found.

<b>Treatment status (independent variable)</b>	<b>Observations</b>	<b>Rank sum</b>	<b>Expected</b>
Baseline	67	4097	4254.5



Treatment	59	3904	3746.5
Combined	126	8001	8001
Adjusted variance	41361.68		
H0: Apron usage baseline condition = Apron usage treatment condition			
Z-value = -0.77	P-value = 0.44	Effect size = 0.01	

**Table 4:** Results of the Mann-Whitney U test where the baseline period is compared to the first nine days of the treatment period

## Discussion

In light of a project in the Dutch province of South Holland, this thesis project aims to contribute to the project's goal of realising a fully circular Erasmus Medical Centre Rotterdam (EMC) intensive care unit (ICU) by 2030. A circular ICU requires decreasing emissions and reducing material usage on an extensive scale. Because of positive results in previous research, low implementation barriers, and the simplicity with which such an intervention can be applied in other (medical) settings, a nudge intervention was implemented. Nudging and circularity are deeply connected: emissions and waste are mainly caused by human behaviour. Hence, reducing emissions and waste requires changing human behaviour. Inspired by experiments in which pro-environmental behaviour was stimulated via social norms, an experiment was conducted in the ICU.

Social norm nudges inform subjects about behaviour that others, a reference group, either engage in, approve of, or both simultaneously. A pilot study among ICU personnel in a comparable academic hospital generated data to formulate a social norm. Baseline experiment data were gathered, after which all non-isolation ICU rooms and the canteen were equipped with a sticker depicting the social norm to nudge personnel towards using fewer aprons. Apron usage per room was counted before and after the eight-hour day shift during the pre-and post-intervention periods. The latter period lasted for twelve, instead of nine days. The difference in length of the periods is explained by a decrease in useful observations, presumably due to random daily ICU practice, which required to continue counting observations for a longer treatment period.

Although the literature-based expectation was for the social norm treatment to nudge the personnel towards using fewer aprons, no such results were found: apron usage remained approximately unchanged, a little less than six aprons per room were used per eight-hour shift for both periods. The absence of any reduction in apron usage is not in line with experiments where such norms led to a decreased use of other consumables like towels (Cialdini et al., 2008). The assumption of individuals being susceptible to a reference group behaving pro-environmental was theorised in a variety of experiments: from theft avoidance to no-ads-stickers, and from littering to recycling (Cialdini, 2003; Cialdini et al., 1990; Hamann et al., 2013; Lyons et al., 2010).

Multiple reasons could explain the experiment's unexpected results. Nudges work better in case of uncertainty or conflicting interests. The implementation of a new apron policy was considered as potentially inducing uncertainty, consequently allowing for new habit formation (Benjamins et al., 2020). However, the presence of uncertainty might have been an overestimation. Although data are unavailable, it can be assumed that the average subject had substantial experience in the field, which implies multiple years of wearing aprons. It could be that staff members felt relatively certain about

wearing aprons due to being experienced, inducing relatively unaffected apron usage decisions (Benjamins et al., 2020).

How do these difficulties in changing habits relate to intentions? According to the EMC ICU's management and a series of interviews and focus groups conducted within the same project, ICU employees were willing to engage in more pro-environmental behaviour (Maanicus, 2022). In practice, such intentions did not show. That discrepancy might be attributable to the intention-behaviour gap when behaviour and indicated willingness (intention) contradict. The intention-behaviour gap exists under a delay between formulating intentions and acting upon them at a later moment. The phenomenon of hyperbolic discounting helps to explain the concept: individuals attribute more value to the present than the future, which makes it easier to intend effort-requiring behaviour in the future (Rohde, 2010; Sniehotta et al., 2005). Once that future arrives, the costs of the required effort are higher than previously estimated. Consequently, individuals engage in planned behaviour less frequent than previously planned. Barriers such as rethinking habits, fear of medical consequences, or fear of staining workwear could have impeded change (Cawcutt et al., 2020). Moreover, the experiment might have focused too much on the short run: habit formation can take time, especially if the habit that one tries to change has not changed for years (Henry et al., 2010).

Among the barrier that might have rendered the perceived costs too high, fear should not be underestimated. Throughout the COVID-19 pandemic, hospitals went through an unprecedented phase in modern times: while the hospital was overcrowded, illness rates among personnel were higher than ever. Amid widespread fear of the new pandemic, patients in the most threatening conditions were brought to the ICU (Jung & Park, 2021). Such patients were very contagious, whilst long-run consequences were unknown. Although the experiment was conducted in a context where the pandemic's intensity had decreased, the aftermath was certainly hard felt. Perceived fear is influenced by factual knowledge. Although the hygiene and infection prevention board (HIPB) indicated that only wearing aprons when excreta were involved was safe for both patients and personnel, staff members might have still feared the consequences of now wearing aprons.

Thus far, explanations for the absence of the expected treatment effect were sought in factors that do not directly involve the design of the social norm nudge. A pilot study was conducted in Utrecht Medical Centre to formulate a norm based on other ICU personnel's opinions. That reference group was chosen for several reasons. First, forming such as statement with data from the most direct reference group, i.e., EMC ICU colleagues, would influence participants themselves because that would already make them think about apron usage, inducing biased results. Second, the hospital in Utrecht is also an academic hospital, of which only a select number exist in the Netherlands, indicating

similarity. The city is a better comparison to Rotterdam than other cities in the Randstad region; Other academic hospitals in the region share fewer similarities: Leiden is a significantly smaller city, whereas the relationship between Rotterdam and Amsterdam tends to be experienced through a certain animosity, which might endanger the willingness or ability to identify with the reference group. Other academic hospitals are even further away from Rotterdam, in less urbanised areas. The trade-off that led to using a non-EMC reference group entailed the advantage of not influencing employees prior to the experiment. Nevertheless, Utrecht remains a different city and the probability that EMC ICU personnel will have contacts in the city and especially in the hospital is small. Therefore, personnel might not have identified with the reference group, inducing the absence of the expected treatment effect (Carli et al., 1991).

As well as referring to a reference group that subjects can identify with, the wording and implications of social norms should be salient to subjects. In the experiment, policy change information was communicated in the department's newsletter and via new posters. The update stated that aprons were only to be worn when working with excreta. The stickers did not directly mention that policy: they insisted on '...limiting apron usage, as ICU personnel in Utrecht intended and approved of...'. Possibly, the link between the new policy and the message on the stickers was not salient enough, leading to disappointing effects. It could be that a more direct inclusion of the new policy such as explicitly mentioning excreta, could have increased saliency and consequently the treatment effect (Noggle, 2018). The policy change might not have sufficiently reached the personnel, implying inadequate communication could have influenced the results (Cawcutt et al., 2020).

Notwithstanding the importance of norm salience, norm effectiveness can be linked to accountability: feeling and being held accountable for behaviour. Some individuals engage in pro-environmental behaviour to enhance social status and prestige: virtue signalling. Social norms can leverage that mechanism: to avoid losing status, people engage in certain behaviour. By the absence of visibility of apron usage statistics per employee and therefore accountability, a part of the motivation for some individuals to engage in pro-environmental behaviour might have disappeared. Although most subjects were presumably unaware of the apron counting, the (unknown) percentage of subjects that realised would be aware that no link to personal identity was made as multiple staff members used the same room. Therefore, the social rewards that may be reaped from signalling pro-environmental behaviour were absent, decreasing incentives (De Groot & Thøgersen, 2018).

Independent of the design of the norm, the personnel's willingness to engage in pro-environmental behaviour might have been thwarted by long-run national developments. The Netherlands has seen several waves of spending cuts in healthcare (Herderschee, 2021). Spending

cuts in healthcare tend to lead to anger and frustration among personnel (Bone, 2002). An analysis of cutbacks in hospital settings, in which personnel were interviewed, concluded that the work atmosphere can be negatively impacted by cutbacks (Arnetz et al., 2003). The association between using fewer aprons and cutbacks is not an uncommon one to make. Therefore, personal negative associations with such policies might have discentivised personnel from adhering to the desired behavioural change.

Other particularities of the Dutch experimental context might play a role as well. The Netherlands scores relatively high on individualism in the Hofstede database (80 out of 100). Although the Netherlands scores lower than the United States (91), it is relatively comparable to the United States (Hofstede, 2022). In a comparison study, social norms had a bigger effect in the Polish, relatively collectivist context, as compared to the American, relatively individualistic context (Barrett et al., 1999). On the other hand, the level of Stateside individualism did not lead to the absence of any treatment effect. Cultural differences could therefore explain a relatively small impact, but the absence of any treatment effect is improbable.

Thus far, several explanations have hypothesised why the treatment was not correctly conveyed, or why pre-existing factors could have interfered. No distinction was made between the baseline and treatment period. When a clean experiment is conducted, the risk of causal interference is significantly reduced. When behaviour in two identical situations is compared, but only one variable is changed in one situation, no confounding effects should occur. There are valid reasons to assume the absence of such confounding effects. The personnel that contributed to the room data were randomly assigned to units by the hospital. Both the baseline and treatment periods took place in the same period. Moreover, the COVID-19 situation did not significantly change, and therefore the number of mandatorily isolated patients did not substantially change. Nevertheless, not all variables were controlled. It could be that external, confounding effects occurred that influenced the treatment effect (Kallus et al., 2018).

Confounding effects can bias the results. The Mann-Whitney U test that was applied requires independence to hold, which also decreases the risk of biased results. Given the before-and-after design, independence within subjects does not hold. Independence between subjects implies the absence of subjects mutually influencing each other. In Appendix A1, the personnel's responses to the treatment are discussed. Some examples include 'group leaders' openly questioning the new policy among their colleagues, whilst others occasionally removed social norm stickers which had to be put back. The risk that such, and multiple unobserved interactions led to subjects influencing each other cannot be ruled out. Negative behaviours such as sabotage by in-group members can set a social norm,

leading to other in-group members following that behaviour (Ariely et al., 2009). Subjects that intentionally hinder the experiment pose a high risk of biasing results and threatening the assumption of independence. The chosen methodology is therefore dependent on an assumption that cannot be guaranteed. That limitation could not be countered by applying other statistical tests, as all statistical tests require independence.

Another factor that might explain the absence of a treatment effect concerns the difference in length between the baseline and treatment periods. Counting was discontinued after 67 observations during the baseline period due to time restrictions. During the baseline period, the number of usable observations decreased, explaining the need to count some extra days. The decrease presumably happened due to, among others, a higher rate of patients being discharged from the ICU. Such differences introduce time-effect risks, as a nudge's effect can change over time (Congiu & Moscati, 2022). Whilst some authors consider the effects of nudges, especially those focusing on the intuitive 'system one' to remain consistent, others assume increasing or decreasing time-effects. In case the latter presumption applies in this experiment, comparing an observation period of nine to twelve days introduces a time effect that biases results (Congiu & Moscati, 2022). The risk of such confounding variables is inherent to before-and-after study designs but could have been avoided by generating data in a timeframe without time-limits. Nevertheless, a Mann-Whitney U test with only the observations from the first nine baseline and treatment days was conducted to check for bias due to comparing periods of different lengths. The test did not indicate different results from the initial test, indicating the difference in the length of periods does not explain the absence of a treatment effect. Still, in the scope of time-effects, the periods could have been too short: nudges can require time to take effect (De Ridder et al., 2018).

The experiment departed from the assumption that personnel wore new aprons at every patient contact, based on a day's observations at the ICU. Although observations mostly confirmed that assumption, a few performed (medical) acts (turning over a patient and replacing auxiliary equipment) without wearing one. When mentioning the subject between the lines, one employee indicated *'it would be a great leap forward if all employees would wear aprons when required'*. If the observations of that one employee would be representative, the experiment might have induced the opposite effect of its hypothesis: the social norm nudge might have served as a reminder to frequently wear aprons. Nevertheless, several others stated that most employees wore aprons on most occasions. From that starting point, it was assumed that before the implementation of the new policy the average employee wore aprons for every medical act. It could nevertheless be that such an assumption was incongruent with reality and that the observation period was insufficient.

Although the exact uptake of aprons before the implementation of the new policy is unknown, the assumption of sixteen aprons per day was provided based on procurement data. The results from this experiment were based on an eight-hour day shift. With three shifts per day, the results are in line with sixteen aprons per day. That would assume that the baseline policy nor treatment led to a decrease in apron usage. Nevertheless, the procurement-based estimation was based on twenty-four hours, whereas practice shows substantially less care takes place in the evening and night hours. Therefore, a bigger share than sixteen hours should be attributable to the day shift. Did the initial baseline policy change already lead to a decrease in apron usage? Such information is unknown. The uncertainty regarding these matters provides an extra reason for the Mann-Whitney U test having been conducted as a two-tailed test. In sum, a variety of reasons provide possible explanations for the absence of the expected treatment effect.

#### Contextual limitations

An important limitation to conducting research in the EMC ICU environment concerns privacy. Due to strict protection of privacy, data on the personal level cannot (easily) be gathered. In the current methodology, the differences between the baseline and treatment groups were considered substantial due to holiday season-induced changes in the constellation. Subsequently, the design was considered a between-subjects design. Nevertheless, that choice is debatable. A substantial share of personnel that indirectly provided apron usage data per room participated in both periods. Consequently, it cannot be stated that the experiment at hand constituted a clear between-subjects design. Outside of the holiday season, the two groups would almost be identical, which points further towards a within-subjects design. Such a design would fit the usage of a Wilcoxon Matched-Pairs test. However, conducting that test would be difficult as gathering the subject's data to create pairs is out of scope in the ICU. The impossibility to use personalised data disallows applying parametric tests, as the underlying distribution of the population cannot be retrieved. Although the applied Mann-Whitney U test is not hindered by that condition, an important limitation of the test concerns its power: compared to parametric alternatives, the test is less powerful. Consequently, any differences between groups are less likely to be found.

#### Lessons from the experiment and suggestions for further research

Implications that follow from the experiment can be based on the absence of a treatment effect whilst assuming a fully clean design, leading to the implication that the EMC ICU personnel were not susceptible to social norms. Whether that conclusion holds for other departments and hospitals or beyond the Dutch context remains unknown: factors such as willingness to engage in pro-environmental behaviour and susceptibility to norms may differ per hospital and region. Work floors or departments where people are less experienced might be more susceptible to social norms, as for

ICU departments in less individualistic countries or regions. Alternatively, one can assume limitations to the design to have caused the absence, leading to implications in line with the hypothesis and theoretical framework. The various explanations for the absence of the expected effect make the latter more probable.

Many of the provided explanations are accompanied by a dichotomy that is specific to ICUs: the dilemma of factual and perceived hygiene safety versus sustainability. The particularities of an ICU environment are guided by strict control of hygiene and medical guidelines, typically outlined by the HIPB. The size of healthcare emissions is considerable. The lessons from conducting an experiment in an ICU environment anecdotally underline those statistics: an average ICU patient accounts for seven bags of waste per day. Infected patients increase that number: when an infected patient is released (for various reasons), all consumables and medical products in that room are burnt to prevent risks. Such procedures are not futile, as they decrease infection risks with potentially detrimental consequences. Reducing emissions consequently requires rethinking these procedures while limiting adverse health effects.

Once intended changes are accepted by the HIPD bottleneck, this experiment provides lessons for the design of any future social norm nudge intervention in the ICU context. The practice of nursing proved to oftentimes be an individual task. Individuals are more likely to make a pro-environmental choice if choices are publicly visible (Asensio et al., 2013). Introducing mechanisms such as dynamic posters that make personnel's choices more visible and therefore more salient could increase pro-environmental behaviour (Asensio et al., 2013). When introducing such visible comparisons, researchers should nevertheless be careful: the use of social norms has been shown to entail a boomerang effect for some individuals who learn that they outperform the norm: the baby should not be thrown away with the bathwater (Allcott & Rogers, 2014). Additionally, no ICU patient is the same. Taking care of one patient might require substantially more use of aprons than of another patient, making (visible) comparisons between individuals undesirable.

Alternatively, an even closer reference group could be used. Possibly, that UMC reference group was too distant for EMC ICU personnel to identify with (Campos et al., 2019). Conducting an experiment in which a reference group from the same hospital, such as a comparable department is used might be a more effective nudge. Are ICU staff members more susceptible to being compared to fellow ICU staff members, medical personnel, gender, or inhabitants of the same region? Further research could provide answers to the required specifics of such a reference group.

In absence of the successful implementation of social norms, focusing on individual morals could be a valuable intervention too. Applying normative personal statements such as 'do you care



about' might be more effective, especially in the ICU context where uncertainty is low because staff members receive intensive training (Bolderdijk et al., 2013). Moreover, the Netherlands are characterised by a relatively high level of individualism (Hofstede, 2022). Applying such normative personal statements could therefore foster relatively strong effects in the Dutch context.

This experiment departed from the assumption that on average, sixteen aprons per ICU room per 24 hours were used. In the baseline and treatment periods, the eight-hour day shift resulted in an apron usage statistic that corresponded to approximately one-third of that number. More acts are performed during the day than at night when patients tend to sleep. Therefore, a higher proportion than one-third of daily apron usage should be attributable to the day shift. That assumption would indicate the effectiveness of the baseline policy, rather than the treatment nudge. Further research could count the number of aprons per 24-hour period to determine whether the sixteen per day statistic still holds or has decreased.

Last, the effect of descriptive social norms does not show differences between males and females, but injunctive social norms have stronger effects on women. In this experiment, a mixed descriptive and injunctive norm was applied. Further research could focus on whether that discrepancy holds in the typically female-dominated medical world: possibly, implementing purely injunctive norms could reap stronger effects (Trelohan, 2022).

## Conclusion

Observations about the considerable amount of waste that the EMC ICU department generated throughout the height of the COVID-19 pandemic inspired the management to gather more information on the magnitude of the department's waste production. It was concluded that the observations were not merely incidental but in line with the ICU's characteristic of being a heavy consumer of energy and materials. The near absence of pro-environmental policies propelled a project that endeavoured to establish a fully circular ICU by 2030. This thesis was written in light of that ambition. The hygiene and infection prevention board's decision to allow a more lenient apron usage policy allowed for the conduct of an experiment. Previously, ICU personnel were expected to wear an apron at every patient contact. The new policy required them to only wear an apron whilst in contact with excreta. In a variety of experiments, pro-environmental behaviour was successfully incentivised via social norms. Social norms are informative messages in which commonly exerted or (dis)approved behaviours are mentioned. The success of the nudge has been linked to an evolutionary traceable human tendency to adhere to the group, both fostering efficiency and group inclusion. During a baseline period, apron usage was observed while the new policy had been communicated via the

department's newsletter and posters. Subsequently, a social norm nudge was displayed in every patient room near the pile of aprons and on an informative screen in the canteen. The goal of this nudge was to reduce apron usage. To determine the effect of the nudge, the number of aprons used per room was counted twice, at the beginning and the end of the day shift for a period of twenty-five days. Contradictory to expectations, no significant differences were found between the baseline and the treatment periods. A little less than six aprons were used per day shift in both the baseline and treatment periods, on average. Several reasons can be assigned to account for the difference between previous experiments in which pro-environmental behaviour increased and the experiment at hand. Social norms depend on the extent to which an individual identifies with the reference group. The reference group used (ICU employees from another hospital) might have been too distant. Also, social norms tend to be more effective in case of uncertainty. ICU personnel might have been relatively certain of whether to wear an apron due to, on average, substantial experience in the field, leading to habits that were hard to break. Such habits might have been based on (unjustified) fears of context-specific medical risks, such as infection, of which the absence was not clearly communicated. Moreover, some subjects demonstrated a strong resistance to changing their behaviour. Such resistance could not only have impacted their behaviour but could also have cross-influenced initially neutral colleagues. The practical implications of the research depend on the validity of the results, as they contradict earlier research: was the absence of a treatment effect caused by limitations or are social norm nudges simply less applicable to ICU environments? Due to the absence of a change in apron usage, it could be assumed that the Rotterdam ICU context and presumably other ICU and/or medical contexts are relatively insensitive to social norms that incentivise pro-environmental behaviour. On the other hand, a closer reference group, more salient norm, and clearer explanation of the advantages of using fewer aprons might have led to an effect. Further research is recommended to clarify whether those latter factors have impeded the social norm from bearing effect.

## References

### Books

- Ajzen, I. (1996). *Social psychology: Handbook of basic principles* (297-325). New York: The Guilford Press.
- Buunk, A. P., Dijkstra, P., & Gibbons, F. X. (2010). *Social comparison theory*. New York: The Guilford Press.
- De Groot, J. I., & Thøgersen, J. (2018). *Environmental psychology: An introduction* (167-178). New York: John Wiley & Sons.
- Gneezy, U., & List, J. (2014). *The why axis: Hidden motives and the undiscovered economics of everyday life*. New York: Random House.
- Hogg, M. A. (2003). *Social identity* (462–479). New York: The Guilford Press.
- Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar, Straus and Giroux.

### Newspaper articles

- De Gruijter, W. (2021, September 15). Een doos handschoenen en 8 incontinentiematjes per patient per dag: het ziekenhuis gaat zijn afvalberg te lijf. *Volkskrant*.  
<https://www.volkskrant.nl/wetenschap/een-doos-handschoenen-en-8-incontinentiematjes-per-patient-per-dag-het-ziekenhuis-gaat-zijn-afvalberg-te-lijf~b59d5b5d/>
- Economist. (2021, November 11). What happened at COP26? *The Economist*.  
<https://www.economist.com/international/2021/11/11/what-happened-at-cop26>
- Herderschee, G. (2021, December 16). Oppositie woedend over bezuinigingen op de zorg, maar staan die eigenlijk wel in het regeerakkoord? *Volkskrant*.  
<https://www.volkskrant.nl/nieuws-achtergrond/oppositie-woedend-over-bezuinigingen-op-de-zorg-maar-staan-die-eigenlijk-wel-in-het-regeerakkoord~b062ee8a/>
- Marmelstein, S. (2021). De intensive care gaat circulair. *Amazing Erasmus MC*.  
<https://amazingerasmusmc.nl/maatschappelijke-gezondheidszorg/de-intensive-care-gaat-circulair/>
- NOS. (2021, November 1). Meeste Nederlanders bezorgd over klimaatverandering, weinig vertrouwen in top. *Nederlandse Omroep Stichting*.  
<https://nos.nl/collectie/13871/artikel/2403922-meeste-nederlanders-bezorgd-over-klimaatverandering-weinig-vertrouwen-in-top>

## Other sources

Gupta Strategists. (2019). *Een stuur voor de transitie naar duurzame gezondheidszorg. Kwantificering van de CO2-uitstoot en maatregelen voor verduurzaming.*

[https://strategists.nl/storage/files/1920\\_Studie\\_Duurzame\\_Gezondheidszorg\\_DIGITAL\\_DEF.pdf](https://strategists.nl/storage/files/1920_Studie_Duurzame_Gezondheidszorg_DIGITAL_DEF.pdf)

Hofstede insights. (2022). *The Netherlands.*

<https://www.hofstede-insights.com/country/the-netherlands/>

Lloyd's Register Foundation. (2021). *World Risk Poll* [infographic].

<https://wrp.lrfoundation.org.uk/infographics-2021/>

Maanicus, M. (2022). *Sustainable intensive care: identifying motivators and barriers to sustainable behavior among intensive care employees.* Erasmus University

Merriam-Webster. (n.d.). *Intensive care unit.* In Merriam Webster dictionary. Retrieved April 14, 2022, from

<https://www.merriam-webster.com/dictionary/intensive%20care%20unit>

Rijksoverheid (2022). *Klimaatbeleid.*

<https://www.rijksoverheid.nl/onderwerpen/klimaatverandering/klimaatbeleid>

United Nations. (2021, November 15). *COP26: Together for our planet.* [Press release].

<https://www.un.org/en/climatechange/cop26>

Zorg voor klimaat. (2021). *De circulaire IC.* <https://www.zorgvoorklimaat.nl/nieuws/de-circulaire-ic/>

## Journal articles

Abrahamse, W., De Groot, J., & Jones, K. (2013). Persuasive Normative Messages: The Influence of Injunctive and Personal Norms on Using Free Plastic Bags. *Sustainability, 5*(5), 1829–

1844. <https://www.doi.org/10.3390/su5051829>

Allcott, H., & Rogers, T. (2014). The short-run and long-run effects of behavioral interventions: Experimental evidence from energy conservation. *American Economic Review, 104*(10), 3003-37.

<https://doi.org/10.1257/aer.104.10.3003>

Amblee, N., & Bui, T. (2011). Harnessing the influence of social proof in online shopping: The effect of electronic word of mouth on sales of digital microproducts. *International journal of electronic commerce, 16*(2), 91-114. <https://doi.org/10.2753/JEC1086-4415160205>

- Ariely, D., Ayal, S., & Gino, F. (2009). Contagion and differentiation in unethical behavior: The effect of one bad apple on the barrel. *Psychological science*, 20(3), 393-398.  
<https://doi.org/10.1111/j.1467-9280.2009.0230>
- Arnetz, B., Brown, C., & Petersson, O. (2003). Downsizing within a hospital: cutting care or just costs?. *Social Science & Medicine*, 57(9), 1539-1546. [https://doi.org/10.1016/S0277-9536\(02\)00556-7](https://doi.org/10.1016/S0277-9536(02)00556-7)
- Asch, S. E. (1951). Effects of group pressure upon the modification and distortion of judgments. *Organizational influence processes*, 58, 295-303.  
<https://doi.org/10.1525/9780520313514-017>
- Asensio, O. I., Delmas, M. A., & Fischlein, M. (2013). Information strategies and energy conservation behavior: A meta-analysis of experimental studies from 1975 to 2012. *Energy Policy*, 61, 729-739.  
<https://doi.org/10.1016/j.enpol.2013.05.109>
- Banerjee, A., Chandrasekhar, A. G., Dalpath, S., Duflo, E., Floretta, J., Jackson, M. O., & Shrestha, M. (2021). Selecting the most effective nudge: Evidence from a large-scale experiment on immunization (No. w28726). *National Bureau of Economic Research*. <https://doi.org/10.3386/w28726>
- Barrett, D. W., Butner, J., Cialdini, R. B., Gornik-Durose, M., & Wosinska, W. (1999). Compliance with a request in two cultures: The differential influence of social proof and commitment/consistency on collectivists and individualists. *Personality and Social Psychology Bulletin*, 25(10), 1242-1253.  
<https://doi.org/10.1177/0146167299258006>
- Barrett, D. W., Cialdini, R. B., Demaine, L. J., Rhoads, K., Sagarin, B. J. & Winter, P. L. (2006). Managing social norms for persuasive impact. *Social influence*, 1(1), 3-15.  
<https://doi.org/10.1080/15534510500181459>
- Beadle, C. E., Cooper, P. P., England, M. J., Fries, J. F., Greaves, R. F., & Koop, C. E. (1993). Reducing health care costs by reducing the need and demand for medical services. *New England Journal of Medicine*, 329(5), 321-325. <https://doi.10.1056/NEJM199307293290506>
- Bein, T., Koch, S., & Schulz, C. (2021). What's new in intensive care: environmental sustainability. *Intensive Care Medicine*, 47(8), 903-905. <https://doi.org/10.1007/s00134-021-06455-6>
- Benjamins, J. S., De Ridder, D. T., Kroese, F. M., & Venema, T. A. (2020). When in doubt, follow the crowd? Responsiveness to social proof nudges in the absence of clear preferences. *Frontiers in psychology*, 11, 1385. <https://doi.org/10.3389/fpsyg.2020.01385>

- Berman, M. G., Kross, E., Mischel, W., Smith, E. E., & Wager, T. D. (2011). Social rejection shares somatosensory representations with physical pain. *Proceedings of the National Academy of Sciences*, 108(15), 6270-6275. <https://doi.org/10.1073/pnas.110269310>
- Bhutta, M. F., Reed, M., & Rizan, C. (2021). Environmental impact of personal protective equipment distributed for use by health and social care services in England in the first six months of the COVID-19 pandemic. *Journal of the Royal Society of Medicine*, 114(5), 250-263. <https://doi.org/10.1177/01410768211001583>
- Bilec, M. M., Campion, N., Landis, A. E., Swanzy, L., Thiel, C. L., & Woods, N. C. (2015). Sustainable healthcare and environmental life-cycle impacts of disposable supplies: a focus on disposable custom packs. *Journal of Cleaner Production*, 94, 46-55. <https://doi.org/10.1016/j.jclepro.2015.01.076>
- Bilec, M. M., Eckelman, M., Guido, R., Huddleston, M., Landis, A. E., Sherman, J., & Thiel, C. L. (2015). Environmental impacts of surgical procedures: life cycle assessment of hysterectomy in the United States. *Environmental science & technology*, 49(3), 1779-1786. <https://doi.org/10.1021/es504719g>
- Bolderdijk, J. W., Geller, E. S., Lehman, P. K., Steg, L., & Postmes, T. (2013). Comparing the effectiveness of monetary versus moral motives in environmental campaigning. *Nature Climate Change*, 3(4), 413-416. <https://doi.org/10.1038/nclimate1767>
- Bone, D. (2002). Dilemmas of emotion work in nursing under market-driven health care. *International Journal of Public Sector Management*. <https://www.doi.org/10.1108/09513550210419564>
- Brooks, M. S. L., & Windfeld, E. S. (2015). Medical waste management—A review. *Journal of environmental management*, 163, 98-108. <https://doi.org/10.1016/j.jenvman.2015.08.013>
- Burnkrant, R. E., & Cousineau, A. (1975). Informational and normative social influence in buyer behavior. *Journal of Consumer research*, 2(3), 206-215. <https://doi.org/10.1086/208633>
- Camerer, C. F., & Fehr, E. (2007). Social neuroeconomics: the neural circuitry of social preferences. *Trends in cognitive sciences*, 11(10), 419-427. <https://doi.org/10.1016/j.tics.2007.09.002>
- Campos, P., Caraban, A., Gonçalves, D., & Karapanos, E. (2019). 23 ways to nudge: A review of technology-mediated nudging in human-computer interaction. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (pp. 1-15). <https://doi.org/10.1145/3290605.3300733>
- Carli, L. L., Ganley, R., & Pierce-Otay, A. (1991). Similarity and satisfaction in roommate relationships. *Personality and Social Psychology Bulletin*, 17(4), 419-426. <https://doi.org/10.1177/0146167291174010>

- Cawcutt, K. A., Rupp, M. E., & Starlin, R. (2020). Fighting fear in healthcare workers during the COVID-19 pandemic. *Infection Control & Hospital Epidemiology*, 41(10), 1192-1193.  
<https://doi.org/10.1017/ice.2020.315>
- Chapman, C. A., & Huffman, M. A. (2018). Why do we want to think humans are different? *Animal Sentience*, 3(23), 1. <https://doi.org/10.51291/2377-7478.1358>
- Cheng, X., Clarke, M. R., Greenaway, K. H., Louis, W. R., Smith, J. R., & Terry, D. J. (2012). Congruent or conflicted? The impact of injunctive and descriptive norms on environmental intentions. *Journal of environmental psychology*, 32(4), 353-361. <https://doi.org/10.1016/j.jenvp.2012.06.001>
- Cialdini, R. B. (2003). Crafting normative messages to protect the environment. *Current Directions in Psychological Science*, 12, 105–109. <https://doi.org/10.1111/1467-8721.01242>
- Cialdini, R. B. (2005). Basic Social Influence Is Underestimated. *Psychological Inquiry*, 16:4, 158-161.  
[https://doi.org/10.1207/s15327965pli1604\\_03](https://doi.org/10.1207/s15327965pli1604_03)
- Cialdini, R. (2005). Don't throw in the towel: Use social influence research. *APS Observer*, 18. DOI: unknown.
- Cialdini, R. B. (2007). Descriptive Social Norms as Underappreciated Sources of Social Control. *Psychometrika* 72, 263 (2007). <https://doi.org/10.1007/s11336-006-1560-6>
- Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008). A room with a viewpoint: Using social norms to motivate environmental conservation in hotels. *Journal of consumer Research*, 35(3), 472-482.  
<https://doi.org/10.1086/586910>
- Cialdini, R. B., Jacobson, R. P., & Mortensen, C. R. (2011). Bodies obliged and unbound: Differentiated response tendencies for injunctive and descriptive social norms. *Journal of Personality and Social Psychology*, 100(3), 433–448. <https://doi.org/10.1037/a0021470>
- Cialdini, R. B., Kallgren, C. A., & Reno, R. R. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, 58(6), 1015–1026. <https://doi.org/10.1037/0022-3514.58.6.1015>
- Cochoy, F. (2009). Driving a shopping cart from STS to business, and the other way round: On the introduction of shopping carts in American grocery stores (1936—1959). *Organization*, 16(1), 31-55.  
<https://doi.org/10.1177/1350508408098921>
- Congiu, L., & Moscati, I. (2022). A review of nudges: Definitions, justifications, effectiveness. *Journal of Economic Surveys*, 36(1), 188-213. <https://doi.org/10.1111/joes.12453>

- De la Hunty, A., & Trafford, E. P. (2021). A gentle nudge: Can choice architecture play a role in retailers' efforts to promote healthier choices? *Nutrition Bulletin*, 46(1), 98-109.  
<https://doi.org/10.1111/nbu.12484>
- DellaVigna, S., & Linos, E. (2022). RCTs to scale: Comprehensive evidence from two nudge units. *Econometrica*, 90(1), 81-116. <https://doi.org/10.3982/ECTA18709>
- Dennis, J. S., Harding, K. G., Harrison, S. T. L., & Von Blottnitz, H. (2007). Environmental analysis of plastic production processes: Comparing petroleum-based polypropylene and polyethylene with biologically-based poly- $\beta$ -hydroxybutyric acid using life cycle analysis. *Journal of biotechnology*, 130(1), 57-66. <https://doi.org/10.1016/j.jbiotec.2007.02.012>
- De Ridder, D. T., Kroese, F. M., & Venema, T. A. (2018). I'm still standing: A longitudinal study on the effect of a default nudge. *Psychology & Health*, 33(5), 669-681.  
<https://doi.org/10.1080/08870446.2017.1385786>
- Donchin, Y., & Seagull, F. J. (2002). The hostile environment of the intensive care unit. *Current opinion in critical care*, 8(4), 316-320. <https://doi.org/10.1097/00075198-200208000-00008>
- Feldman, D. C. & Ng, T. W. (2012). Evaluating six common stereotypes about older workers with meta-analytical data. *Personnel psychology*, 65(4), 821-858. <https://doi.org/10.1111/peps.12003>
- Eastwick, P. W. (2016). The emerging integration of close relationships research and evolutionary psychology. *Current Directions in Psychological Science*, 25(3), 183-190.  
<https://doi.org/10.1177/0963721416641048>
- Ensaaff, H. (2021). A nudge in the right direction: the role of food choice architecture in changing populations' diets. *Proceedings of the Nutrition Society*, 80(2), 195-206.  
<https://doi.org/10.1017/S002966512000798>
- Erjavec, M., Marcano-Olivier, M., Viktor, S., & Williams, S. (2021). Nudge with caution: targeting fruit and vegetable consumption in primary schools. *European Journal of Clinical Nutrition*, 75(4), 724-727.  
<https://doi.org/10.1038/s41430-020-00772-7>
- Geisendorf, S., & Pietrulla, F. (2018). The circular economy and circular economic concepts—a literature analysis and redefinition. *Thunderbird International Business Review*, 60(5), 771-782.  
<https://doi.org/10.1002/tie.21924>
- Ghesla, C., Grieder, M., & Schmitz, J. (2019). Nudge for good? Choice defaults and spillover effects. *Frontiers in psychology*, 10, 178. <https://doi.org/10.3389/fpsyg.2019.00178>



- Grandclément, C. (2006). Wheeling food products around the store... and away: the invention of the shopping cart, 1936-1953. *Halsh Open Science*, 00122292v2. DOI: unknown.
- Griffing, E., Overcash, M., & Vozzola, E. (2018). Environmental considerations in the selection of isolation gowns: A life cycle assessment of reusable and disposable alternatives. *American journal of infection control*, 46(8), 881-886. <https://doi.org/10.1016/j.ajic.2018.02.002>
- Griffiths, T. L., Krafft, P. M., Shmueli, E., & Tenenbaum, J. B. (2021). Bayesian collective learning emerges from heuristic social learning. *Cognition*, 212, 104469. <https://doi.org/10.1016/j.cognition.2020.104469>
- Hamann, K., Loeschinger, D. C., Neubert, S., & Reese, G. (2013). Sticker in the box! Object-person distance and descriptive norms as means to reduce waste. *Ecopsychology*, 5(2), 146-148. <https://doi.org/10.1089/eco.2012.0075>
- Hatemi, P. K. & McDermott, R. (2020). Ethics in field experimentation: A call to establish new standards to protect the public from unwanted manipulation and real harms. *Proceedings of the National Academy of Sciences*, 117(48), 30014-30021. <https://doi.org/10.1073/pnas.2012021117>
- Henry, W. W., Lally, P., Potts, C., Van Jaarsveld, C. H. M., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. *European journal of social psychology*, 40(6), 998–1009. <https://doi.org/10.1002/ejsp.674>
- Hogg, M. A., Terry, D. J., & White, K. M. (1999). The theory of planned behaviour: self-identity, social identity and group norms. *British journal of social psychology*, 38(3), 225-244. <https://doi.org/10.1348/014466699164149>
- Honkoop, M. (2022). Reducing the environmental impact of syringes in the Intensive Care Unit. DOI: unknown.
- Hummel, D., & Maedche, A. (2019). How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies. *Journal of Behavioral and Experimental Economics*, 80(), 47–58. <https://doi.org/10.1016/j.socec.2019.03.005>
- Jaccard, I. S., Pichler, P. P., Weisz, H., & Weisz, U. (2019). International comparison of health care carbon footprints. *Environmental research letters*, 14(6), 064004. <https://doi.org/10.1088/1748-9326/ab19e1>

- John, P. C. H. (2018). How best to nudge taxpayers? The impact of message simplification and descriptive social norms on payment rates in a central London local authority. *Journal of Behavioral Public Administration*, 1(1), 1-11. <https://doi.org/10.30636/jbpa.11.10>
- Johnson, C. A., Luepker, R. V., Murray, D. M., & Richards, P. S. (1987). The prevention of cigarette smoking in children: two-and three-year follow-up comparisons of four prevention strategies. *Journal of behavioral medicine*, 10(6), 595-611. <https://doi.org/10.1007/BF00846657>
- Jung, J., & Park, B. M. (2021). Effects of the Resilience of Nurses in Long-Term Care Hospitals during on Job Stress COVID-19 Pandemic: Mediating Effects of Nursing Professionalism. *International Journal of Environmental Research and Public Health*, 18(19), 10327. <https://doi.org/10.3390/ijerph181910327>
- Kallus, N., Puli, A. M., & Shalit, U. (2018). Removing hidden confounding by experimental grounding. *Advances in neural information processing systems*, 31. <https://doi.org/10.48550/arXiv.1810.11646>
- Keizer, K., Lindenberg, S., & Steg, L. (2008). The spreading of disorder. *Science*, 322(5908), 1681-1685. <https://doi.org/10.1126/science.1161405>
- Keel, A., & Natarajan, R. (2012). Celebrity endorsements and beyond: New avenues for celebrity branding. *Psychology & marketing*, 29(9), 690-703. <https://doi.org/10.1002/mar.20555>
- Kekana, M. P., Matlala, S. F., & Moyimane, M. B. (2017). Experiences of nurses on the critical shortage of medical equipment at a rural district hospital in South Africa: a qualitative study. *Pan African Medical Journal*, 28(1), 157-157. <https://www.doi.org/10.11604/pamj.2017.28.100.11641>
- Khazian, A. M., Schultz, W. P., & Zaleski, A. C. (2008). Using normative social influence to promote conservation among hotel guests. *Social influence*, 3(1), 4-23. <https://doi.org/10.1080/15534510701755614>
- Krauss, R. M., Freedman, J. L., & Whitcup, M. (1978). Field and laboratory studies of littering. *Journal of Experimental Social Psychology*, 14(1), 109-122. [https://doi.org/10.1016/0022-1031\(78\)90064-1](https://doi.org/10.1016/0022-1031(78)90064-1)
- Laland, K. N., & Morgan, T. J. H. (2012). The biological bases of conformity. *Frontiers in neuroscience*, 6, 87. <https://doi.org/10.3389/fnins.2012.00087>
- Leach, C. W., & Vliek, M. L. (2008). Group membership as a 'frame of reference' for interpersonal comparison. *Social and Personality Psychology Compass*, 2(1), 539-554. <https://doi.org/10.1111/j.1751-9004.2007.00058.x>

- Leonard, T.C., Thaler, R. H., & Sunstein, C. (2008). Nudge: Improving decisions about health, wealth, and happiness. *Const Polit Econ* 19, 356–360 (2008). <https://doi.org/10.1007/s10602-008-9056-2>
- Loew, K., Reese, G., & Steffgen, G. (2014). A towel less: Social norms enhance pro-environmental behavior in hotels. *The Journal of Social Psychology*, 154(2), 97-100.  
<https://doi.org/10.1080/00224545.2013.855623>
- Luszczynska, A., Scholz, U., & Schwarzer, R. (2005). The general self-efficacy scale: multicultural validation studies. *The Journal of psychology*, 139(5), 439-457. <https://doi.org/10.3200/JRLP.139.5.439-457>
- Lyons, E., Nigbur, D., & Uzzell, D. (2010). Attitudes, norms, identity and environmental behaviour: Using an expanded theory of planned behaviour to predict participation in a kerbside recycling programme. *British journal of social psychology*, 49(2), 259-284.  
<https://doi.org/10.1348/014466609X449395>
- MacNeill, A., Sherman, J. D., & Thiel, C. (2019). Reducing Pollution From the Health Care Industry. *JAMA*, 322(11), 1043. <https://doi.org/10.1001/jama.2019.10823>
- Maki, D. G., McCormick, R. D., Mermel, L. A., & Springman, S. R. (1991). The pathogenesis and epidemiology of catheter-related infection with pulmonary artery Swan-Ganz catheters: a prospective study utilizing molecular subtyping. *The American journal of medicine*, 91(3), S197-S205.  
[https://doi.org/10.1016/0002-9343\(91\)90369-9](https://doi.org/10.1016/0002-9343(91)90369-9)
- Malone, A. M. (2002). Methods of assessing energy expenditure in the intensive care unit. *Nutrition in clinical practice*, 17(1), 21-28. <https://doi.org/10.1177/011542650201700121>
- McGuigan, M., McNally, S., & Wyness, G. (2016). Student awareness of costs and benefits of educational decisions: Effects of an information campaign. *Journal of Human Capital*, 10(4), 482-519.  
<https://doi.org/10.2139/ssrn.2520771>
- McKenzie-Mohr, D., & Schultz, P. W. (2014). Choosing effective behavior change tools. *Social Marketing Quarterly*, 20(1), 35-46. <https://doi.org/10.1177/1524500413519257>
- Noggle, R. (2018). Manipulation, salience, and nudges. *Bioethics*, 32(3), 164-170.  
<https://doi.org/10.1111/bioe.12421>
- Raymaekers, P. (2019). Old habits die hard. Evaluating the long-term effectiveness of nudging as a policy tool. In *WINK Nudging and Beyond Conference 2019*. DOI: unknown.
- Riedel, L. M. (2011). Environmental and financial impact of a hospital recycling program. *AANA journal*, 79(4). [https://doi.org/10.1016/s0921-3449\(97\)00031-1](https://doi.org/10.1016/s0921-3449(97)00031-1)

- Rohde, K.I.M. The hyperbolic factor: A measure of time inconsistency. *Journal of Risk and Uncertainty*, 41, 125–140 (2010). <https://doi.org/10.1007/s11166-010-9100-2>
- Schaik, C. P. V. (2010). Social learning and culture in animals. *Animal behaviour: Evolution and mechanisms* (pp. 623-653). Springer, Berlin, Heidelberg. [https://doi.org/10.1007/978-3-642-02624-9\\_20](https://doi.org/10.1007/978-3-642-02624-9_20)
- Schubert, C. (2017). Exploring the (behavioural) political economy of nudging. *Journal of Institutional Economics*, 13(3), 499-522. <https://doi.org/10.1017/S1744137416000448>
- Schubert, C. (2017). Green nudges: Do they work? Are they ethical? *Ecological economics*, 132), 329-342. <https://doi.org/10.1016/j.ecolecon.2016.11.009>
- Schultz, P. W. (1999). Changing behavior with normative feedback interventions: A field experiment on curbside recycling. *Basic and applied social psychology*, 21(1), 25-36. [https://doi.org/10.1207/s15324834basp2101\\_3](https://doi.org/10.1207/s15324834basp2101_3)
- Smith, J. R., & Louis, W. R. (2008). Do as we say and as we do: The interplay of descriptive and injunctive group norms in the attitude–behaviour relationship. *British Journal of Social Psychology*, 47(4), 647-666. <https://doi.org/10.1348/014466607X269748>
- Sniehotta, F. F., Scholz, U., & Schwarzer, R. (2005). Bridging the intention–behaviour gap: Planning, self-efficacy, and action control in the adoption and maintenance of physical exercise. *Psychology & health*, 20(2), 143-160. <https://doi.org/10.1080/08870440512331317670>
- Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of environmental psychology*, 29(3), 309-317. <https://doi.org/10.1016/j.jenvp.2008.10.004>
- Trelohan, M. (2022). Do women engage in pro-environmental behaviours in the public sphere due to social expectations? The Effects of social norm-based persuasive messages. *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations*, 33(1), 134-148. <https://doi.org/10.1007/s11266-020-00303-9>
- Whalley, J., & Wigle, R. (2017). Cutting CO2 emissions: The effects of alternative policy approaches. *International Trade and the Environment*, 511–526. <https://doi.org/10.4324/9781315201986-33>

## Appendix

## A1 Experiences from the field

During the experiment's initial phase, contacts in the hospital consisted of people from the management or doctors that participated in the *green team*. Their initial estimations on the staff's attitudes about changing habits towards more pro-environmental behaviour stated that a widespread sentiment of willingness to change was prevalent. In a master's thesis that was written before this experiment, several interviewed employees indicated a similar willingness to change their behaviour (Maanicus, 2020). Via the department's newsletter, it was announced that I would be helping the care assistants for some weeks with replenishing aprons. Officially, the staff was not informed about the experiment or the counting of aprons. Unavoidably, it occasionally happened that personnel entered patients' rooms while the counting was ongoing. When questions were asked in such instances, it was replied that the management wanted to gather data about apron usage for undetermined reasons.

Albeit via sticking the nudge stickers on, the experimenter's presence, or a few observations on the ongoing counting by staff members, throughout the experiment awareness rose among the personnel. Whereas some, mainly younger nurses, inquired positively and outed their support for the (perceived) goal of the nudge, a few – mainly older – nurses exhibited highly sceptical behaviour. One nurse indicated to have repeatedly removed the stickers, stating their presence to be nonsense. In that specific instance, the stickers were quickly put back and the observation for the day was deleted from the dataset. Moreover, the nurse shared a strong antipathy against the idea of the management imposing a certain line of behaviour or working method. In other settings, during the coffee break, other (older) nurses would repeatedly ask sceptical questions as the experimenter passed by, a few of them explicitly stressing their thoughts on the futility of the policy and stickers. On such occasions, numerous other staff members would witness the interaction, also on their coffee break, without responding. Also, the latter interactions were repeatedly initiated by the same persons, mostly in group settings. That implies a strong incentive for a few, older, nurses, presumably group leaders, to keep denouncing the new policy.

These experiences show that the practical implementation of a policy change, and with that the implementation of nudges, can be impeded by the local context. On the one hand, it could be that the use of social proof and the comparison to a different hospital led to increased antipathy. On the other hand, much of the frustration was already outed in the baseline pre-treatment phase. In addition to that, these anecdotal observations were not substantially less in units A & B where a different, non-social norms treatment was implemented. The main characteristic of the subjects that expressed scepticism was age, being relatively older than the average staff member. Such patterns

might be caused by a decreased willingness to change practices. Nevertheless, in a meta-analytical study on elderly workers, no evidence was found for that assumption (Feldman & Ng, 2012).

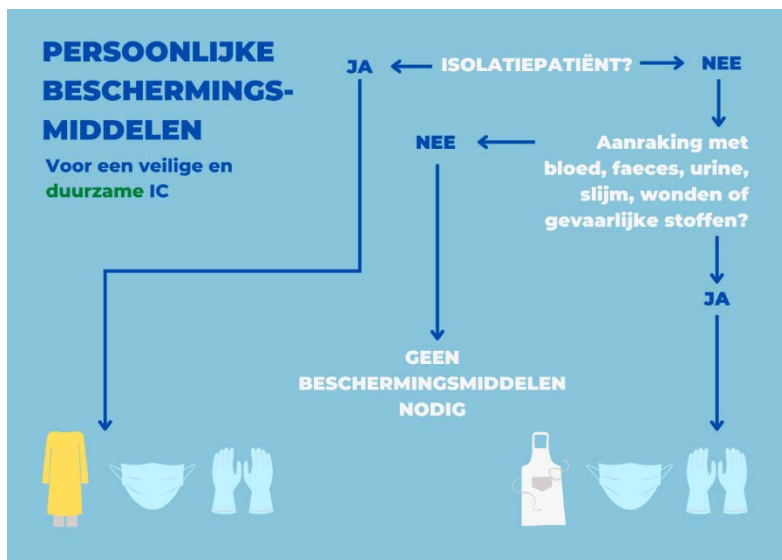
## A2 Materials used during the experiment

The following wording was communicated in the newsletter:

.....From 5 July 2022, the policy of using gloves and isolation coats for non-isolated patients will change. This will be changed to be in line with the policy in the rest of the hospital and to be more sustainable. What will change?

From now on, only wear a white apron for activities involving contact with blood, faeces, urine, mucus, wounds, or hazardous substances. The policy for isolation patients will not change.....

**In addition to the text in the newsletter, the following poster was displayed, which explains the route that leads to the decision on what personal protective equipments (PPEs) are to be worn:**



The social norm sticker was put above the aprons in all non-isolation rooms in units C & D. Moreover, the sticker was projected on a screen in the shared canteen:

**81% van de IC-medewerkers in een vergelijkbaar ziekenhuis (UMC) geeft de duurzame optie de voorkeur: enkel een schort dragen bij de handelingen waar dat vereist is. Sluit je bij hen aan en beperk je schortgebruik.**



Translation: 81% of intensive care staff in a similar hospital (Utrecht Medical Centre (UMC)) prefer the sustainable option: only wearing an apron when required. Join them and limit your apron use.

**Placement of the sticker in an ICU room. The aprons, in white packaging, are encircled in red:**



### **Debriefing statement**

Dear IC staff,

You may have noticed that we (Tamarah Verhoog and Theo Post) spent a few weeks in your department in July, as announced in the newsletter. We would like to explain why.

We are two economics students who are participating in a project organised by the Green Team as part of our theses. The goal of that project is a fully circular IC by 2030. Within this project, space is given to students, including non-medical students, to conduct research.

In spring, it was announced that the hygiene and infection prevention board wanted to introduce a more flexible policy, where aprons were no longer required for all contact moments with patients but only for contacts with excreta. We took this opportunity to first count the number of aprons being used, for one week and a half. Then, in units A&B, we placed a reminder sticker above the aprons. In C&D, we placed information, based on a pilot in the UMC Utrecht, above the aprons. The purpose of both stickers was to emphasise the new policy and therewith reduce apron use.

The results of the experiment were not very exciting: on average 5 to 6 aprons are used per room during the day shift and this number has not changed during the sticker period. The reason that we could not give very concrete answers during the experiment is the validity of the results: if a participant is not aware that he/she is part of an experiment, there is a greater probability that the participant will behave normally, which is exactly what an experiment is supposed to recreate.

If you have any questions, please do not hesitate to contact us. We also plan to present our theses at the EMC in the near future, where you are of course also invited. We can be reached at [tamarahverhoog@gmail.com](mailto:tamarahverhoog@gmail.com) & [theo1357@hotmail.com](mailto:theo1357@hotmail.com).

We would like to thank you all kindly for our nice time at the EMC: compared to Woudestein it was a completely different world, which was not only interesting for the experiment but also very cool to see in real life.

Kind regards, and thanks again for your (unconscious) participation! ~ Tamarah & Theo



## A3 Ethical approval

Date: 15th June 2022

Subject: Approval ethics review application ETH2122-0751

Our reference: ETH2122-0751

Dear Sophie van der Zee,

On the 10th of June 2022 the Erasmus School of Economics IRB-E received your request for approval of your research project Promoting sustainable behavior amongst ICU personnel. Thank you for submitting your research proposal.

Hereby, I am pleased to let you know that the Board has decided to advise positively on your application. Based on the information you have provided, we conclude that your research proposal sufficiently respects the safety and rights of participants and recognises the responsibilities of the researcher(s) involved and of their host and sponsoring organisations. The approval decision is valid for three years.

Once you start your research, please be aware that you are responsible for adhering to the Netherlands Code of Conduct for Research Integrity whether working individually or in a team. Please note that you are required to submit an amendment in case any significant changes occur.

Yours sincerely,

On behalf of the Erasmus School of Economics IRB-E

Ethics ETH2122-0751: Sophie van der Zee

## A4 Life cycle assessment of the aprons studied

### **Environmental savings of less apron usage**

In the Netherlands, a normative institution (the NEN) sets requirements for hospital consumables. Regulation NEN-EN-13795-1 controls surgical clothing. Regulation NEN-EN-14126 focuses on protective clothing in labs. For ICUs, no official nationwide norms have been issued. Consequently, local HIPBs decide on the appropriateness of PPEs, granting the freedom to choose pro-environmental options.

To distinguish between countless kinds of aprons, environmental savings need to be quantified by conducting a specified life cycle assessment (LCA). LCAs are systematic analyses of a product's environmental impact over its lifetime. Simply using less plastic is not necessarily better, it depends on numerous factors like materials used, lifetime, transportation, etc.

The aprons that are used at EMC ICU are delivered in boxes that contain three packages of fifty aprons. The boxes and packaging including the aprons weigh 9.6 kilos, the aprons 8.6 kilos, leading to a weight of approximately 57.33 grams per apron. In LCA studies, comparable apron weights of 63 and 65 grams were found (Griffing et al., 2018 & Bhutta et al., 2021). Nevertheless, these studies were

performed on aprons made of polypropylene. The aprons EMC ICU uses are made of nonwoven tissue (28 g/m<sup>2</sup>) and a coating of polyethene film (25 µm). The aprons dimensions of the apron are 145 cm \* 75 cm. The ratio of nonwoven tissue to polyethene film could, however, not be obtained, which renders a full LCA impossible.

A LCA study that considered several types of aprons resulted in an average CO<sub>2</sub> equivalent of 65 g per apron (Bhutta et al., 2021). In another study that considered aprons, a CO<sub>2</sub> equivalent of 310 g per apron was found (Griffing et al., 2018). CO<sub>2</sub> equivalents are measurement units that are used to standardise measurements of environmental impacts. As both were based on polypropylene, and polyethene tends to have a lower environmental impact due to being a bioplastic, these results cannot be directly copied (Dennis et al., 2007). Moreover, CO<sub>2</sub> is only one of many factors that help to explain the environmental impact of a product. Nevertheless, the studies provide an impression of the impact that reducing apron usage, especially when the considerable number of aprons used per year in a hospital department is considered, can have.

#### A5 Stata commands

\*Obtain an overview of descriptive statistics (mean, median) for the variables\*

*Tabstat apronusage, statistics (mean median) by(treatment)*

\*Perform a Mann-Whitney U test with Apronusage as dependent variable and Treatment as independent variable\*

*ranksum apronusage, by(treatment)*