Ethical Challenges in Modeling and Simulation of Nudging in Care

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Abstract. Due to the demographic change, there is a disproportionately increasing demand for professional care services in contrast to available caregivers. Consequently, innovative technologies, e.g., Internet-of-Things devices or robotics enabling a change of behavior, must be developed to strengthen patients' independency for improving patients' quality of life and for exonerating the caregivers. Therefore, nudging can be used to initiate beneficial behavior change. To evaluate the effectiveness of different nudging methods, modeling and simulation can be used. In this paper, we discuss ethical implications of such simulations with respect to the conflict of interest between the individuals' autonomy, self-determined life, and duty of care. Thereby, challenges that developers have to face are identified and discussed.

Keywords: Methods of Behavior Change, Nudging, Agent-based Simulation, Ethical Implications, Health Care

1 Introduction

As a result of the demographic change, the population is ageing and the number of people in need of care increases. Experts predict no reversal of this trend [1, 2, 3]. This results in an ascending demand of professional care services, whereas this demand cannot be met by the number of available caregivers [4]. Hence, the independence of people in need of care must be preserved for as long as possible. Thereby, a longer care at home can be enabled because care-dependents are able to execute simple tasks, which otherwise would afford professional assistance. One approach to achieve a higher degree of independence is to encourage beneficial behavior, e.g., through using innovative technologies like Internet-of-Things devices. The concept of *nudging* summarizes methods, that are meant to influence behavior without forcing it by taking away options or setting high financial incentives [5]. Before using a method, its effectiveness in encouraging the intended behavior should be ensured to prevent negative consequences. To evaluate the effectiveness of different nudging methods, modeling and simulation can be used [6, 7]. This paper discusses ethical implications that infer from such a simulation approach with respect to the conflicts of interest between the individuals' autonomy, self-determinism, and duty of care.

This work is structured as follows: Section 2 gives an introduction in the concept of nudging, as well as modeling of nudging in care. In Section 3, a discussion on the ethical implications of nudging in care and of a respective simulation model is presented. Finally, in Section 4 we conclude and discuss potential future work.

2 Modeling and Simulation of Nudging

The concept of nudging, as defined by Thaler and Sunstein, describes methods of manipulating human behaviors without decreasing the choice set or making use of prohibitions [5]. Nudging covers methods that change a given decision architecture to generate behavior that is beneficial for the decision-maker or general public. Methods of nudging include, e.g., provision of defaults and feedback, or structuring complex decisions. The approach stems from behavioral economics and is mainly used as political instrument, e.g., to increase sustainability and energy efficiency [8, 9], to increase work efficiency of employees [10, 11] or as a political instrument in healthcare [12, 13, 14]. Furthermore, nudging is already used in nursing and assisted living to improve the patients' independence, e.g., to increase urine consistency [15, 16, 17].

Modeling and simulation have established for analyzing and evaluating behaviors [18, 19]. To measure the effect of nudging methods on care-dependents' behavior via simulation, nudges have to be formalized, which means altering the patients' environmental conditions. Furthermore, the cognitive decision-making of the care-dependents has to be modeled to represent the processes that cause acceptance and rejection of nudging methods, and the respective behavior of the care-dependents. To model care-dependents, Agent-based Modeling (ABM) seems to be well-suited, as it has established in modeling of cognitive decision-making and behaviors of human beings [20, 21, 22, 23, 24]. For generating model behavior, empirical studies must be

carried out which collect both general data on the patients (e.g. degree of independence) and on the behavior investigated before and after the addition of specific nudging methods. An example that can lead to an improvement in independence is to encourage care-dependents to drink enough. Dehydration can lead to health issues and states of confusion that decrease the self-sufficiency capacity especially of the elderly [25]. Drinking could be nudged, e.g., by providing feedback on the patients' behavior or by reminding them to drink by using IoT devices [26, 27] or motion detectors that are placed near water sources and provide visual stimuli (light). This scenario serves as an application example for modeling and simulation.

In the following, we discuss ethical implications that must be addressed while modeling and simulation in order to contribute to improving the quality of the care-dependents' lives.

3 Ethics of Simulating Nudging in Care

First, we consider the ethical implications of nudging in care and then discuss moral challenges of simulation in this domain.

3.1 Ethics of Nudging in Care

The ethics of nudging offer a broad area for discussion, where the concept is mainly criticized. The major points of criticism focus on endangering the decision-makers' autonomy and their growing habituation to manipulation. Furthermore, the consequences of manipulation are not necessarily suitable for each individual, dependent on the given context, as well as determined by the intention of the decision architect [28, 29]. *Assistive Technologies (AT)* also target maintaining the independence of those in need of care. Ultimately, the ethical considerations here focus on four well-established principles formulated by Beauchamp and Childress [30]. These principles (*autonomy, beneficence, non-maleficence, justice*) derive and are underpinned from multiple sources as common morality, health ethics, the Declaration of Helsinki as well as basic laws (e.g., need for consent before medical procedure execution or Art. 1 of the Charter of fundamental rights of the European Union) [30, 21, 32, 33].

3.2 Moral Challenges in Modeling and Simulation of Nudging in Care

A simulation model is needed to formalize different nudges and their impacts on care-dependents' behaviors. As mentioned earlier, simulation models of nudging and behavior change already exist [6, 7]. Nevertheless, transferring this to the care domain confronts us as developers with new challenges. Since empirical studies are required for model creation, and the results of a simulation are meant to be transferred to reality where care-dependents are affected, ethical challenges of modeling and simulation in this context have to be discussed.

Several codes and guidelines have built that shall "inspire and guide the ethical conduct of all computing professionals" [34]. These guidelines and principles address

ethical questions that developers have to face and demand the developer to supply a positive contribution for society and its environment [34, 35, 36]. Therefore, the benefits for the patients (increase of independency and quality of life) must be carefully weighed against the costs (loss of autonomy through manipulation of decision) throughout the whole process of model creation and application.

We start our ethical considerations at the collection and analysis of patient data by means of an empirical study. Ethical codes, e.g., the *ACM Code of Ethics* or the *ethical guidelines of the GI*, point out that the right for autonomy and privacy as well as the protection of the human dignity has to be respected [34, 35, 36]. This includes the sensibility of collected personal data. Therefore, a re-identification of anonymized patient data has to be ruled out. As a possible technique, we suggest the introduction of control groups for which no data is collected during the study. Additionally, the collected data should be abstracted, e.g., by using probability distributions [37]. Nevertheless, patients may experience unpleasant consequences, such as realizing their own weaknesses or exposing them to relatives during the experiment. Therefore, the developer has to thoroughly weigh which data and causal relationships of variables are really necessary for model generation and validation and can be published, with respect to possible consequences for the individual care-dependent.

Second, the principles declare that the developer is responsible for negative consequences resulting from using the model. This also includes injury of patients and misuse of personal data. For example, the model could be used to test nudging methods that advantage an interest group but disadvantage patients with negative consequences. Thus, a careful consideration of possible effects for all concerned and the use of approved scientific methods for model creation are recommended [34, 35]. Because those nudging methods that prove to have the most influence on care-dependents' behavior are meant to be applied to reality, the outcomes of the simulation have to be reliable. Therefore, the evaluation of nudging methods should be based on defined indicators that allow for evaluation as well as comparison of methods. In order to ensure that care-dependents' interests are followed the indicators should be defined objectively. Additionally, an inadvertent misuse of the model can be prevented by a detailed documentation of the model's purpose, application or possible consequences.

4   Conclusion

In this paper, we discussed ethical implications, that might be faced during modeling and simulation of nudging in care. A lot of attempts aim at phrasing rules in the field of ATs as well as robotics and members of the EU Parliament made a corresponding demand to the EU Commission in 2017 [38]. Although guidelines exist in the area of modeling and simulation, there are only few limitations that developers have to face. Additionally, ethical challenges that arise in modeling and simulation depend strongly on the respective application area. Therefore, it is up to the developers to assume social responsibility for their models and to respect formulated ethical principles. Nevertheless, further discussion has to be started, to guarantee a thorough assessment and to reinforce awareness of this issue.

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