



Research Article

Nudging healthcare professionals towards evidence-based medicine: A systematic scoping review

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Abstract: Translating medical evidence into practice is difficult. Key challenges in applying evidence-based medicine are information overload and that evidence needs to be used in context by healthcare professionals. Nudging (i.e. softly steering) healthcare professionals towards utilizing evidence-based medicine may be a feasible possibility. This systematic scoping review is the first overview of nudging healthcare professionals in relation to evidence-based medicine. We have investigated a) the distribution of studies on nudging healthcare professionals, b) the nudges tested and behaviors targeted, c) the methodological quality of studies and d) whether the success of nudges is related to context. In terms of distribution, we found a large but scattered field: 100 articles in over 60 different journals, including various types of nudges targeting different behaviors such as hand hygiene or prescribing drugs. Some nudges – especially reminders to deal with information overload – are often applied, while others – such as providing social reference points – are seldom used. The methodological quality is moderate. Success appears to vary in terms of three contextual characteristics: the task, organizational, and occupational contexts. Based on this review, we propose future research directions, particularly related to methods (preregistered research designs to reduce publication bias), nudges (using less often applied nudges on less studied outcomes), and context (moving beyond one-size-fits-all approaches).

Keywords: Nudging, Healthcare, Professionals, Evidence-based medicine

Supplements: [Open data](#)

Translating knowledge into clinical practice remains notoriously difficult (Grimshaw, Eccles, Lavis, Hill, & Squires, 2012). For example, guidelines take on average more than 17 years to be adopted, and only about half of the guidelines ever achieve widespread clinical use (Bauer, Damschroder, Hagedorn, Smith, & Kilbourne, 2015). Over the past 20 years, increased attention has been given to reducing the gap between evidence-based practice and policy. This has been described using various terms of which evidence-based medicine (EBM) is commonly used (Grimshaw et al., 2012). EBM refers to the conscien-

tious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996).

The limited effect of evidence on behavior might be caused by two challenges in evidence-based medicine. First, the success of evidence-based medicine has led to an overload of evidence being made available (Greenhalgh, Howick, & Maskrey, 2014). Already in 1989, two out of three US physicians stated that the current volume of scientific information was too large (Williamson, German, Weiss, Skinner & Bowes, 1989). This information overload makes it impossible for healthcare professionals to review the best available evidence for each individual case. In particular, the number of clinical guidelines is overwhelming. For example, a 24-hour audit in an acute care hospital identified 3,679 pages of national guidelines that were relevant to the immediate care of 18 patients (Allen & Harkins, 2005).

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Second, general evidence has to be applied to individual cases by healthcare professionals (Greenhalgh, Howick, & Maskrey, 2014; Junghans, 2007). Evidence-based medicine has been criticized for its emphasis on evidence as opposed to professional autonomy (Greenhalgh et al., 2014). A key stance in modern EBM is that knowledge should inform healthcare decision-making, but not necessarily dictate it. This is because, for example, in a very complex medical situation, a general guideline may do more harm than good. One can minimize harm by developing robust evidence-based guidelines that are sensitive to the complexity of patient care, but evidence should be used in combination with expert knowledge and patient needs (Dreyfus & Dreyfus, 2005; Sackett et al., 1996). As such, interventions to promote EBM should not be too restricting and retain the professional's autonomy to deviate.

Nudges might be a possible solution to the two evidence-based medicine challenges described above. A nudge is "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler & Sunstein, 2008, p. 6). Most nudges work through automatic cognitive processes and by changing the choice architecture of a decision. An example of a nudge is changing a default choice, for instance by changing the choice to donate organs from being "opt in" to being "opt out" (Johnson & Goldstein, 2003). Nudging can ease situations of information overload by making information easier to process, for instance by presenting guidelines in 'plain English' (Michie & Lester, 2005). Moreover, nudges have been claimed to leave room for professional autonomy as nudging does not remove freedom of choice (Sunstein & Thaler, 2003).

Accordingly, it is not surprising that the potential of nudging healthcare professionals has been recognized (King, Greaves, Vlaev & Darzi, 2013; Mafi & Parchman, 2018; Vaughn & Linder, 2018). For instance, The Behavioral Insights Health Project at Harvard University was launched to improve medical decisions through tools and research from behavioral economics (Harvard Law School, 2018). Despite this, authors of recent nudge experiments claim to be aware of only a few other experiments nudging healthcare professionals (Bourdeaux, Davies, Thomas, Bewley & Gould, 2014; Kullgren, Krupka, Schachter & Linden, 2018; Meeker et al., 2014a). Therefore, in this article we conduct a systematic scoping review to give an overview of reported nudges that aim to strengthen EBM. Systematic

scoping reviews are used to map what evidence has been produced as opposed to systematic reviews that seek the best available evidence to answer a particular question (The Joanna Briggs Institute, 2015). As such, systematic scoping reviews are especially suitable when researching relatively unexplored fields dealing with broad concepts (Peters et al., 2015). They allow researchers to ask broad questions but adopt a systematic approach in mapping the literature. In our study, we answer the following questions:

1. What is the distribution (journals, countries, year of publication, usage of nudge terminology) of studies on nudges aimed at strengthening use of evidence-based medicine by healthcare professionals?
2. What nudges, aimed at strengthening the use of evidence-based medicine by healthcare professionals, are being applied towards which outcomes?
3. What is the design and methodological quality of experiments testing nudges aimed at strengthening evidence-based medicine by healthcare professionals?
4. To what extent is a nudge's success in strengthening evidence-based medicine by healthcare professionals related to the task, organizational, and occupational contexts?

The first research question concerns the distribution of studies on nudging healthcare professionals towards EBM. We aim to show whether studies are clustered in certain countries or journals, in which years the studies have been published, if studies use nudge-related terminology, as well as the usage of nudge terminology over time.

Answering the second research question will identify which types of nudges are already frequently used and which seem to be overlooked. This provides an overview of currently available studies on nudges aiming to strengthen evidence-based medicine by healthcare professionals by bundling the available evidence. Moreover, we provide an inventory that can be used to design experiments to test nudges aimed at affecting behavior.

It is important to note that our review does not aim to provide an exhaustive overview of nudge studies on health care professionals to date. Instead, our goal is to clarify the current state of nudges related to evidence-based medicine on health care professionals. As such, we focus on studies using nudge related terminology as well as studies referring to

healthcare professionals' behaviors specifically to promote EBM or usage of evidence/guidelines.

Our third research question concerns the quality of, and any indications of, bias in the published studies. To assess this, we use a quality assessment tool for multiple study designs (ICROMS) (Zingg et al., 2016). This assessment of quality can inform future research designs and contribute to the methodological advancement of experiments in public administration (Bouwman & Grimmelikhuijsen, 2016; James, Jilke & Van Ryzin, 2017; Margetts, 2011).

Our fourth research question concerns the relationship between the context and a nudge's success. We use a statistically significant difference in behavior in favor of the nudge intention as a proxy for success. Although nudging has been claimed to be highly effective (Szasz, Palinkas, Palfi, Szollosi & Aczel, 2017), some suggest that success might depend on the context (Gould & Lawes, 2016; Halpern, Ubel & Asch, 2007; Liao et al., 2016; Mafi & Parchman, 2018). This relates to a key challenge of EBM: leaving sufficient professional autonomy to allow deviation depending on the applicability of the evidence in a specific context. We thus focus on "success" related to task, organizational, and occupational contexts in hopes of providing a first step toward informing theoretical models and practical decisions on the role of context in nudging.

The contribution of this study is to provide an overview of the current scope and methodological quality of studies on nudging medical professionals, with the aim of going beyond a one-size-fits-all approach to nudging by directing attention to the interplay between nudges and context (Hallsworth, Egan, Rutter & McCrae, 2018; Jones, 2017). This links to a well-known criticism of the behavioral movement in public administration research and its study of micro-phenomena: that it has moved away from macro-phenomena and big questions (Moynihan, 2018). We follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach (Liberati et al., 2009) and use the PRISMA Extension for Scoping Reviews checklist (see Appendix B) (Tricco et al., 2018).

Theory

Nudging has its origins in behavioral economics. A core foundation of behavioral economics is that humans mainly think through two overarching, but interconnected, processes. This is referred to as dual process theory (Chaiken & Trope, 1999; Evans, 2003;

Evans & Stanovich, 2013). Here we will use the terms system 1 and system 2 as introduced by Stanovich & West (2000) to describe these two processes. Dual process theory has been supported by empirical evidence for separate brain structures (Rangel, Camerer, & Montague, 2008).

System 1 is described as a universal form of cognition present in both humans and animals (Evans, 2003). As such this system is the oldest of the two. Associative learning processes form processes in system 1. System 1 is generally automatic, fast and non-deliberative, allowing one to quickly make sense of a situation and identify how to act (Gawronski & Creighton, 2013; Kahneman, 2011). This system is essential in situations of critical survival. The other cognitive system, system 2, is much younger and is believed to be present only in humans (Evans, 2003). This system is somewhat rational and implies slow, reflective thinking and deliberate decision-making. System 2 permits abstract thinking that cannot be achieved by system 1.

System 1 is characterized by the use of heuristics. Heuristics essentially reduce the complex tasks in assessing probabilities and values to simpler tasks (Lewis, 2008; Tversky & Kahneman, 1974). These heuristics are often very helpful and may help health care professionals to avoid errors, for instance in medical decision making (Marewski & Gigerenzer, 2012). Heuristics, however, sometimes lead to systematic errors which are labelled biases (Benson, 2016; Tversky & Kahneman, 1974). Cognitive biases occur when 'human cognition reliably produces representations that are systematically distorted compared to some aspect of objective reality' (Haselton, Nettle, & Murray, 2015, p. 968). An example is confirmation bias, which represents the seeking or interpreting of information that is in line with existing beliefs (Nickerson, 1998).

Here, we are not considering the cognitive processes, but rather the techniques designed to affect decision-making using processes from system 1. These techniques are often called nudges. For instance, a default might use the status quo bias to nudge people into staying in a savings plan (Thaler & Benartzi, 2004). A key characteristic of nudges is that they do not rule out any option nor change economic incentives, thereby safeguarding professional autonomy. We accompany our description with a nudge taxonomy. Different taxonomies exist which reflect different preferences in thinking about nudges (e.g., Dolan et al., 2012; Johnson et al., 2012; Michie et al., 2011; Sunstein, 2014). Münscher, Vetter, & Scheuerle

(2016) developed a nudge taxonomy, with the goal of creating mutually exhaustive and exclusive sets, on the basis of 127 documented examples of empirically tested interventions. We have adopted this taxonomy because of its systematic approach.

Münscher et al.'s (2016) nudge taxonomy has three main categories: decision information, decision structure and decision assistance. Decision information refers to changing the way information is presented without changing the options themselves. This can, for instance, refer to presenting guidelines in plain English or providing a social reference point (Allcott, 2011; Michie & Lester, 2005). Decision structure is about altering the arrangement of options and the decision-making format. This amounts to changing how alternatives are presented. An example is reducing the number of options that can be easily selected, or changing the effort needed to make a certain decision by changing the default (Johnson & Goldstein, 2003). Decision assistance refers to closing the intention–behavior gap (Sheeran, 2002). Here, people are provided with tools aimed at helping them follow up their intentions. Examples are reminders and asking people to specify when and where they will complete an action (Hagger & Luszczynska, 2014).

Methodology

Scope of review

For a study to be included in the review, it had to deal with nudges that were applied to healthcare professionals on the individual level to promote evidence-based medicine. We focused on encouraging decisions that are seen as appropriate, that is, in accordance with evidence (Proctor et al., 2011). Whether an intervention constituted a nudge was determined using the taxonomy by Münscher, Vetter, & Scheuerle (2016). Studies that focused on adherence to practice guidelines were considered eligible since practice guidelines are “systematically developed statements to assist practitioner and patient decisions about appropriate healthcare for specific clinical circumstances” (Field & Lohr, 1990, p. 8). We chose to include guidelines because they offer instructions on different behaviors related to clinical practice such as which diagnostic or screening test to order, how to provide medical or surgical services and hand hy-

giene (Woolf, Grol, Hutchinson & Eccles, 1999). Although we have not registered this review, all the codes used are provided online in JBPA’s Dataverse¹.

Only reports on experiments were eligible for inclusion. Experiments were seen as comparing the effects of two or more interventions (The Cochrane Collaboration, 2018) and included randomized controlled trials (RCT), before and after studies (BA) and interrupted time series (ITS). Only studies written in English were considered. We did not impose constraints on the year of publication.

Search strategy and study selection

To find eligible studies, we used four methods (Cooper, 2010). First, we searched the Ovid MEDLINE, PubMed, and PsycINFO databases using combinations of the term ‘nudging’ with ‘experiment’, ‘physicians’, ‘guidelines’, or similar terms (producing 65% of the total articles retrieved¹). The specific details of this search strategy are shown in Appendix A. Second, we searched for studies in several top journals that, according to our first search, publish articles concerning nudges on healthcare professionals, namely The Lancet, The British Medical Journal (BMJ), Annals of Internal Medicine, the Journal of the American Medical Association (JAMA), Implementation Science, and BMJ Quality and Safety (producing 25% of the articles retrieved). Third, we scanned relevant overview articles including those identified in the database searches (for example, Szaszi et al., 2017) to find further eligible studies (10% of total articles retrieved). Finally, we consulted experts to check the list of publications and identify any potentially overlooked studies (1% of total articles retrieved). The search process was concluded on May 25th, 2018.

The study selection process is shown in Figure 1. First, we screened 2,322 publications by scanning the abstracts and titles in a blind manner (i.e. concealing authors and journals). We checked if our inclusion criteria (such as topic and language) were met and checked for duplication. Of these 2,322 articles, 377 were deemed potentially eligible and we then read the full texts of these publications. During the full text readings, studies were either excluded or coded in full. The codes used were critically appraised on multiple occasions and refined accordingly. Tabulations and summaries are based on

¹ <https://dataverse.harvard.edu/dataverse/JBPA>

Figure 1
PRISMA Flow Diagram, Based on Workbooks for Systematic Reviews in Excel
(VonVille, 2018)

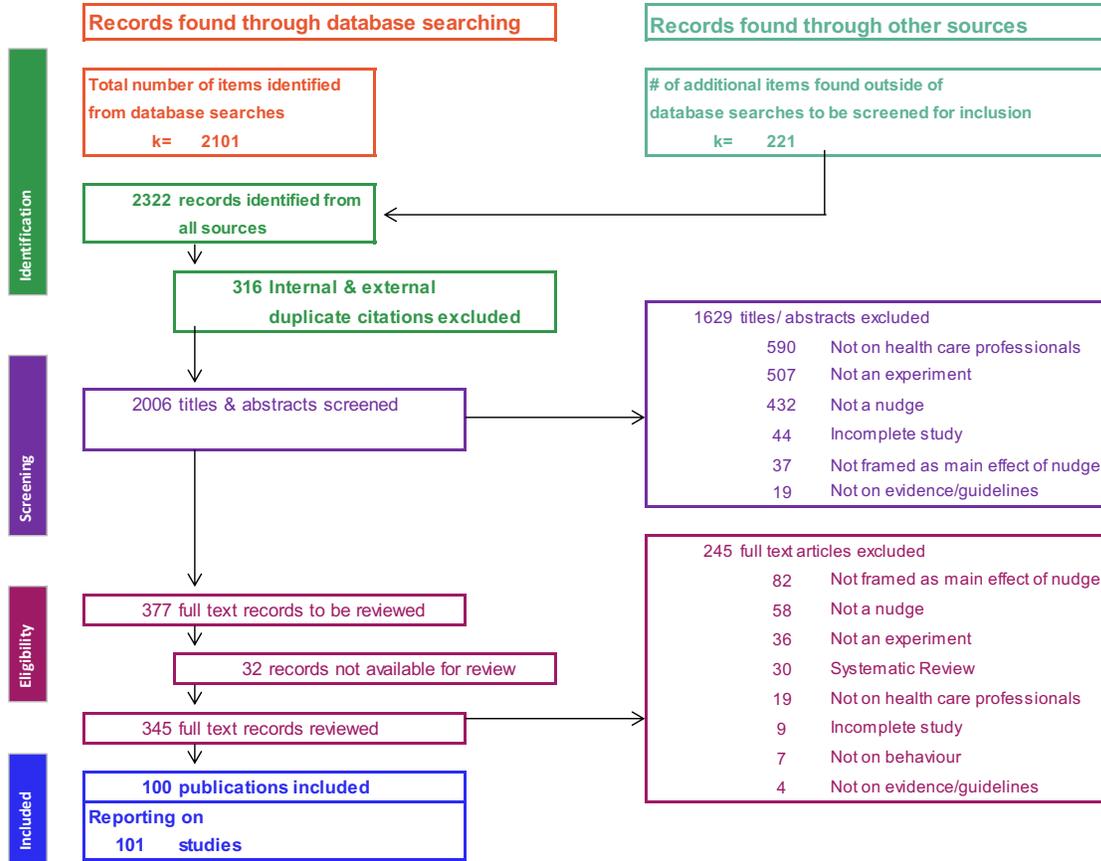
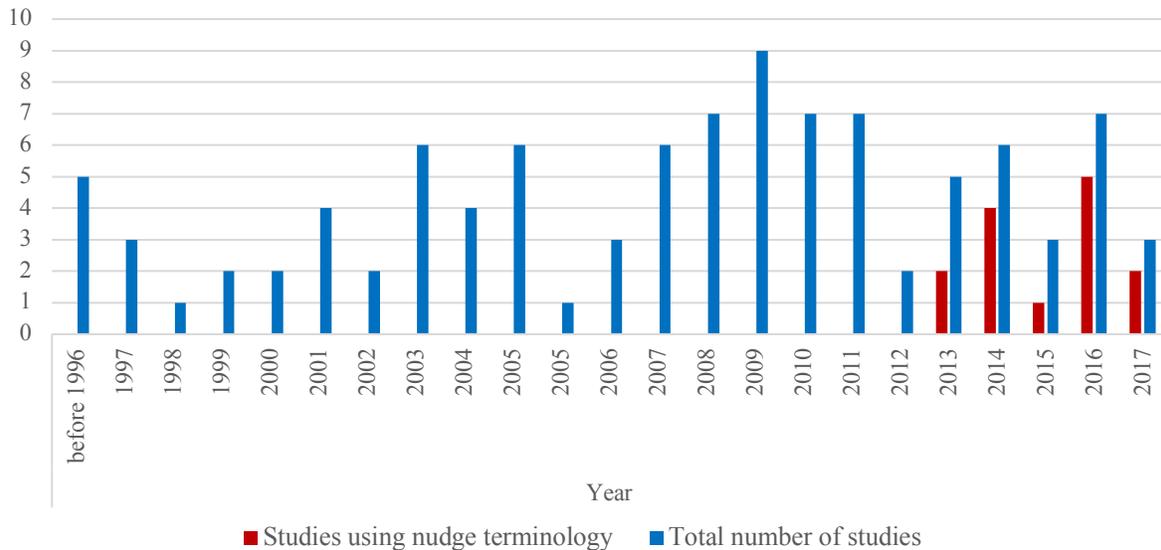


Figure 2
Years of Publication and Usage of Nudge Terminology



these codes. All the included publications are listed in the Supplement. After this final check, we were left with 100 publications, which report on 101 studies and 124 interventions.

Results

Distribution of the studies

We first discuss the distribution of the studies (RQ1). We found that most studies were conducted in Western countries, with a strong dominance of the United States (59% of all studies) (e.g. Flanagan, Doebbeling, Dawson & Beekmann, 1999; Schwann et al., 2011; Tierney et al., 2005) and 10% in the United Kingdom (e.g. Bourdeaux et al., 2014; King et al., 2016; Weir et al., 2013). Only a few studies were from non-Western countries, such as Kenya (Zurovac et al., 2011) and Taiwan (Hung, Lin, Hwang, Tsai, & Li, 2008). This suggests that a Western perspective dominates, which could have important implications as a country bias might be present. This might also influence the external validity of the findings, raising questions as to how applicable they might be in non-Western settings. Further, we found that all the included studies were conducted in a single country, indicating a lack of cross-country comparisons.

The articles included in the systematic scoping review were published in 64 different journals. Most were published in healthcare journals such as the *Journal of the American Medical Informatics Association* (8%) (e.g., Field et al., 2009; Rood, Bosman, Van Der Spoel, Taylor, & Zandstra, 2005; Sequist et al., 2005) and the *Journal of the American Medical Association* (8%) (e.g., Dexter, Perkins, Maharry, & Jones, 2004; Feldstein et al., 2006; Junghans, 2007). Besides these healthcare journals, articles were also found in more general behavioral science or implementation journals, such as in *Implementation Science* (4%) (e.g., Beidas et al., 2017; Kousgaard et al., 2013; Verbiest et al., 2014). In Figure 2, we show the publication years and indicate whether nudge-related terminology was used. We coded a study as containing nudge terminology if we found terms such as “nudge”, “behavioral economics” or “choice architecture”. Figure 2 indicates that there was a peak in publications around 2007 to 2011, but that nudge terminology was not used until 2013.

Nudges and targeted outcomes

The studies included in our review used various nudges as shown in Table 1. Our search highlighted

a diverse field with at least four published interventions in every category. Many studies (42%) concerned reminders and/or making information visible (e.g. Filippi et al., 2003; Förberg et al., 2016; Murtaugh, Pezzin, McDonald, Feldman, & Peng, 2005). Studies in the largest category often used a form of computerized decision support that provides alerts, based on available guidelines, about the appropriateness of a certain decision. As Table 1 shows, the other categories were much less common. For instance, we found only five studies that facilitated commitment (Casper, 2008; Erasmus et al., 2010; Kullgren et al., 2018; Meeker et al., 2014; Verbiest et al., 2014). A detailed description of all the interventions by category can be found in the files for this article uploaded to the JBPA Dataverse.

We found that the largest category contained interventions aimed at changing prescribing habits (30%) (e.g. Flanagan et al., 1999; Larsen et al., 1989; Strom et al., 2010). Other studies were on laboratory tests or diagnostic image ordering (26%) (e.g. Gill, Chen, Glutting, Diamond & Lieberman, 2009; Kahan, Waitman, & Vardy, 2009; Kucher et al., 2005) or on hand hygiene (18%) (e.g. King et al., 2016; Kwok, Juergens, & McLaws, 2016; Nevo et al., 2010). A few studies addressed other behaviors such as medical handovers (e.g. Messing, 2015) and providing cognitive behavioral therapy (e.g. Beidas et al., 2017b).

The type of nudge being used seems to be related to the desired outcomes. Nudges on hand hygiene mostly involved changing option-related efforts (36%) (e.g. Chan, Homa & Kirkland, 2013; Nevo et al., 2010), such as by changing the location of hand hygiene dispensers. We did not find any studies on hand hygiene that involved nudges in the form of making information visible, providing reminders, or changing defaults. Studies on prescribing mostly involved making information visible or providing reminders (54%) (e.g. Buising et al., 2008; Hicks et al., 2008; Martens et al., 2007). Changing prescribing habits was also nudged by providing social reference points (10%) (e.g. Denton, Smith, Faust, & Holmboe, 2001; Hallsworth et al., 2016; Kiefe et al., 2001). Studies related to ordering habits mostly nudged by making information visible or providing reminders (51%) (e.g. Bindels et al., 2003; Lo et al., 2009; Roukema, Steyerberg, van der Lei & Moll, 2008) but also by changing the range or composition of options (18%) (e.g. Kahan et al., 2009; Poley et al., 2007). No studies on changing option-related efforts were found related to prescribing or ordering.

Table 1
Applied nudge categories and techniques (based on Münscher et al., 2016)

Nudge category	Number	Example
<u>A. Decision information</u>		
A1 Translate information	9 (7%)	Emphasizing consequences for patients of proper hand hygiene (Grant & Hofmann, 2011)
A2 Make information visible	23 (19%)	Suggesting alternatives when clinicians propose antibiotics (Meeker et al., 2016)
A3 Provide social reference point	7 (6%)	Showing general practitioners that they prescribe more antibiotics than their peers (Hallsworth et al., 2016)
<u>B. Decision structure</u>		
B1 Change choice defaults	9 (7%)	Changing the default for tests from optional to pre-selected (Olson et al., 2015)
B2 Change option-related efforts	8(6%)	Putting medical tools in line of sight (hand hygiene dispensers) (Nevo et al., 2010)
B3 Change range or composition of options	10 (8%)	Grouping tests on order forms or displaying them individually (Kahan et al., 2009)
B4 Change option consequences	4 (3%)	Asking for accountable justifications (Meeker et al., 2016)
<u>C. Decision assistance</u>		
C1 Provide reminders	28 (23%)	Putting reminders on operating room schedules (Patterson, 1998)
C2 Facilitate commitment	5 (4%)	Hanging poster-sized commitment letters including photographs and signatures (Meeker et al., 2014)
<i>Other (Multifaceted)</i>	21 (17%)	Providing cues through posters and stickers in a schematic breast shape with space for recording three mammography referrals on charts (Grady, Lemkau, Lee & Caddell, 1997)
Total (n)	124	(This is higher than the number of studies as some studies addressed multiple nudges.)

Nudges were administered in different types of environments. Most were applied in digital environments (66%), followed by nudges on paper (15%). Some nudges altered the position or presentation of objects in the physical environment (6%). The remaining nudges involved changing the environment, for instance by adding a clean smell (e.g. Bimbach, King, Vlaev, Rosen, & Harvey, 2013), were delivered by people, or were delivered in multiple or unspecified ways. Most nudges (70%) that were applied in digital environments aimed at changing ordering or prescribing behaviors (e.g. Melnick et al., 2010).

Quality of studies

To answer the second research question, we assessed the methodological quality of the studies using ICROMS (Zingg et al., 2016): a single-step approach for assessing the quality of studies with multiple

study designs. ICROMS provides criteria for assessing the quality of different study designs while allowing scores to be compared. Below, we show the scores for the different categories in Table 2. ICROMS scores for all the included studies are in the JBPA Dataverse files for this article.

For those studies with randomized controlled trials (RCT), controlled before and after studies (CBA) and controlled interrupted time series (CITS) designs, the average score met the minimum required level. The mean scores in the non-controlled before and after studies (NCBA) and non-controlled interrupted time series (NCITS) categories were below the minimum required score, with none of the NCBA studies meeting the minimum threshold. This gives an indication of the lower quality of such non-controlled before and after studies (NCBAs). However, these numbers only tell part of the story about

Table 2
ICROMS Scores Per Category

Design category	Number of studies	Mean score (range); max possible score	Minimum required score
Randomized controlled trial (RCT)	70 (68%)	22 (5 – 27); 32	22
Non-controlled before and after study (NCBA)	17 (17%)	16 (11 – 21); 30	22
Non-controlled interrupted time series (NCITS)	5 (5%)	19 (10 – 23); 30	22
Controlled before and after (CBA)	6 (6 %)	18 (10 – 24); 30	18
Controlled interrupted time series (CITS)	3 (3%)	19 (18 – 19); 30	18
Total	101 (100%)	N/A	N/A

study quality. For instance, in many studies key information was often not given, making it hard to evaluate the risk of bias.

We now zoom in on specific criteria where there is clearly room for improvement in the two categories with the most studies: RCT and NCBA studies. In RCTs, allocation concealment was generally rated poorly (57% of the maximum possible score on average). A solution for this would be to have the allocation carried out centrally by an independent third party (as in Van Wyk et al., 2008). Moreover, many studies could suffer from selective outcome reporting since, in many instances, no study protocol was provided and it was not explicitly stated whether studies were selectively reporting or not (on average, these studies scored 58% of the maximum possible score). The situation could be improved by authors opting to preregister experiments which would also address publication bias problems (Stern & Simes, 1997).

The NCBA studies scored particularly poorly with only one study (Creedon, 2005) justifying the sample chosen or carrying out a baseline measurement to prevent selection bias. Here, researchers could pay more attention to how their sample might create a bias in the results, for instance by comparing sample demographics to the demographics of the population being studied. Furthermore, very few studies attempted to justify the lack of a control group (score of 15% of the maximum possible) and only one (O'Connor, Adhikari, DeCaire, & Friedrich, 2009) attempted to mitigate the effects of not having a control group. This indicates that there is a risk of bias in most studies that use such a design.

Success of nudges by context

Our third research question focused on the contextual conditions under which nudges are successful.

The studies included in our review are highly heterogeneous. We, therefore, conducted a narrative synthesis. We used significant changes in behavior in the preferred direction as a proxy for success (Szasz et al., 2017). In addition to the type of nudges that are successful, we wanted to explore to what extent the context matters in the success of nudging. Nudges are potentially dependent on three types of context: the task, organizational and occupational contexts.

Most studies (65%) reported positive results. The categories with the highest percentages of positive outcomes were changing option-related efforts (88% of studies reported success, for instance Chan et al., 2013), providing social reference points (71%, for instance Hong, Ching, Fung & Seto, 1990), and using a combination of nudges (76%, for instance Hulgán et al., 2004). The categories with the highest percentages of mixed outcomes were facilitating commitment (40%, for instance Kullgren, Krupka, Schachter & Linden, 2018) and changing choice defaults (22%, for instance Ansher et al., 2014). Change option consequences had the highest percentage of null outcomes (50%, for instance Beidas et al., 2017), followed by translating information (44%, for instance Jousimaa et al., 2002). Very few negative effects were reported (a notable exception being Dexter et al., 2004), which could be due to publication bias. Further details on the interventions are provided JBPA Dataverse files for this article.

In terms of context, the task at hand clearly matters. In the reviewed studies, nudging to promote hand hygiene was most successful (77%). A reason for this could be that the need for hand hygiene is widely accepted (Luangasanatip et al., 2015) and nudging might be less successful for other outcomes whose desirability is questioned. For instance, the effect of action planning on care to encourage smoking cessation was particularly apparent among GPs who

had already intended to implement this activity but had not yet done so routinely (Verbiest et al., 2014). Mixed results were more commonly found for nudges related to ordering tests and diagnostic imaging (24% of studies reported mixed results). Sequist et al. (2005) provide an example of mixed findings in noting that the success of the intervention they studied depended on the service being recommended and the particular disease. This indicates that professionals will deviate from the nudging intention if they find the promoted action inappropriate.

Sometimes nudges are designed so that they adapt to reflect individual cases. These nudges are based on algorithms. For instance, in one study IF-THEN rules were created based on guidelines (Martens et al., 2007). These rules generate specific reminders for relevant cases, but not for others. This contextualization of the nudge can be beneficial in reducing problems created by applying general guidelines to individual cases. However, such applications are limited. Martens et al. (2007) further indicated that they were not certain whether complex recommendations always translated into meaningful reminders. Moreover, some physicians rebelled at the notion of a computer telling them how to manage their patients (Tierney et al., 2003).

Nudges may well work differently in different organizational contexts. Our review showed that the most successful nudges were reported in hospitals (74% of studies in hospitals report positive results). A study by Kiefe et al. (2001) noted that physicians in rural settings were less likely to improve treatment by responding to feedback. This could be because rural physicians are more autonomous. Helder et al. (2012) indicated that not only the organization, but even the type of unit or shift can influence the results. They reported an overall positive effect for a screen-saver intervention, but no effect when calculated for the night shift alone. They suggest that nudges might work better in highly visible situations and not so well when people operate individually.

The effectiveness of nudges depends on the occupational context, meaning that success depends on the professional that is working with the nudge. For instance, academic physicians might be more aware of guidelines, influencing their reaction to nudges (Martens et al., 2007; Tannenbaum et al., 2015) and newly qualified residents might be more susceptible to nudges than more experienced physicians (Cumings, Frisof, Long, & Hrynkiwich, 1982; Fogarty, Sturrock, Premji, & Prinsloo, 2013). This is an indication that public professionals, depending on their

level of professionalization, react differently to nudges.

Discussion

As far as we are aware, this is the first systematic scoping review to map studies on nudging healthcare professionals towards applying evidence-based medicine. In this review, we have studied the distribution, the nudges and the targeted outcomes, the methodological quality, and the influence of context on the nudges' success. Based on our results, we draw four conclusions. We relate these conclusions to EBM challenges in dealing with information overload and applying professional autonomy when applying general guidelines to individual cases.

Distribution of studies

Our first research question was about the distribution (journals, countries, year of publication and nudge terminology) of studies. We have three main conclusions. First, most studies are conducted in Western settings, and all of them in a single country. This raises questions about the external validity of the findings. Future studies could be conducted in other country settings. Second, we found studies in 64 different journals. This emphasizes the need for scoping reviews such as this one to bundle available evidence. Third, healthcare professionals 'have been nudged' since 1974. However, nudge-related terms were not used until 2013, indicating that interventions have only recently been recognized as nudges.

Types of nudges and targeted outcomes studied

Our second research question was about what types of nudges have been applied and towards which outcomes. We found that studies testing nudging are more widespread than often claimed (Bourdeaux et al., 2014). Some nudges, such as reminders in computerized decision-support systems, are studied more often than many others, such as using defaults. The focus on reminders makes sense as reminders address the EBM challenge of coping with information overload: reminders make relevant information easily available to healthcare professionals at point-of-care. Nevertheless, other nudging forms can also mitigate information overload. Nudges could for instance make existing guidelines easier to use by simplifying their format (John & Blume, 2018; Michie & Lester, 2005).

Apart from information overload, nudges target 'irrational' behavior by healthcare professionals and

use cognitive biases to change behavior. For instance, nudges can facilitate commitment to close the intention–behavior gap or change defaults in ordering systems (Ansher et al., 2014; Kullgren et al., 2018). These nudges might be especially useful when barriers other than information overload have been identified. For instance, for fairly general guidelines about hand hygiene, the location of hand hygiene dispensers has been described as a main barrier to compliance by nurses (Sadule-Rios & Aguilera, 2017). There are, however, only a few related studies and further research is needed.

Furthermore, the nudges studied mainly focus on outcomes related to ordering, prescribing, and hand hygiene. Future research could test existing EBM nudges in less researched areas, such as administration and medical handover. In designing new studies, one should be aware that some nudges are more applicable to certain behaviors than others. For instance, it is not surprising that we did not find any studies using a default-type nudge to encourage hand hygiene since having clean hands by default is unachievable. In comparison, we also found few studies reminding healthcare professionals to wash their hands – a nudge that seems highly feasible. Further, even without actively nudging, the design of current systems might have an influence on performative behaviors. Choice architecture is always present and, if options are not displayed, this will influence the choices people make (Tannenbaum et al., 2015). Therefore, we would encourage critical reviews of existing choice architectures (Vaughn & Linder, 2018).

Methodological quality of studies

Our third research question focusses on assessing methodological quality. The methodological analysis indicated that many studies were only of moderate study quality. Researchers could improve methodological quality to reduce the risk of bias and simultaneously increase the validity of the study outcomes. We would urge quality improvements by making small changes, such as ensuring allocation concealment is carried out by a third party, and also by making larger changes, such as by preregistering experiments. In terms of non-controlled before and after studies, more attention should be paid to the potential bias introduced by sample selection, and the omission of a control group should always be justified. Moreover, we often found studies were unclear as to what choices had been made, and why. Collec-

tively, we should therefore strive to increase our reporting standards. We suggest using reporting guidelines and checklists, such as the Consolidated Standards of Reporting Trials (CONSORT) statement (Moher et al., 2010).

Nudges in different task, organizational and occupational contexts

In our fourth research question, we highlight the role of three contextual conditions for success: task, organization and occupation. We first note that 65% of published studies report success (i.e. statistically significant improvements). This could be due to publication bias, which is characterized by an aversion to publishing studies with null results (Ferguson & Heene, 2012). Here, we suggest preregistering experiments as a partial solution (Nosek & Lakens, 2014). Nevertheless, the 65% of ‘successful’ studies in this paper is considerably below the 83% successful intervention rate reported in a more general systematic scoping review of nudges (Szasz et al., 2017). We can offer two reasons for this. First, publication bias could be less widespread in studies dealing with evidence-based medicine than studies about nudges in general. Second, it could be that nudges are less successful in EBM due to other factors such as study design or contextual factors. We summarize the influence of task, organizational, and occupational contexts below.

First, we see that the targeted task is important in determining the success of a nudge. This could be because tasks that are widely accepted, such as hand hygiene, are more suitable to nudging. Related to this, some outcomes would seem less appropriate to nudging. In a clinical context, appropriateness depends to a large extent on outcomes. For example, Patel, Volpp, & Asch (2018) state that reducing the default duration of opioid prescriptions may make sense in acute conditions, as often seen in an emergency department, but may be inappropriate for clinicians caring for patients with chronic pain. This example further stresses the importance of carefully considering the behaviors being nudged.

Some nudges present contextualized information based on algorithms. This diminishes the problem of using general guidelines in individual cases, as nudges become customized to specific clinical scenarios. The question is, to what extent should nudges be contextualized for specific tasks? Evidence-based medicine has been criticized for overly focusing on algorithmic rules that oversimplify clinical realities (Greenhalgh et al., 2014). In line with this,

complex clinical realities might not always be suitable for nudges, as nudges always involve some form of simplification, either through IF-THEN rules or by targeting a quite general outcome such as reduced antibiotic prescribing (“Thou should not prescribe antibiotics for cases of flu”). Here, we see that EBM nudging suffers from a similar problem to that of applying heuristics: simplifying complex realities can be beneficial, but not all situations can be easily simplified. We would therefore advise practitioners and authors to consider nudge–task fit and assess impressions of the complexity and appropriateness of the targeted behaviors with specialized healthcare professionals.

Second, the organizational context seems to have an influence. Physicians in a large city hospital have been found to react differently than a rural physician (Kiefe et al., 2001). Nurses during the night shift might not be influenced by nudges that are effective during the day shift (Helder et al., 2012). More research is needed on how working autonomously, in teams, and/or under various levels of visibility can make nudges more or less effective.

Third, the occupational context is important. Less experienced doctors are, for instance, more inclined to accept a default than experts (Fogarty et al., 2013; Martens et al., 2007). More information on the interplay between professionalism and nudges would be useful. In terms of algorithms, it has been shown that if people are experts, or believe they are experts, they tend to follow decision rules less often and as a result perform worse (Arkes, Dawes, & Christensen, 1986). Does the same occur if ‘experts’ override nudges such as default options, or are these experts a necessary counterforce to the nudge? Overall, we see a need for future research to focus on the implications of task, organizational, and occupational contexts for nudges and thus to move away from a one-size-fits-all view of nudging. Instead, the focus should be on how the context of public professionals matters in nudging (Jones, 2017).

Limitations

The present review has several limitations. First, we cannot be certain that this review covers all nudges related to evidence-based medicine by healthcare professionals. In systematic scoping reviews, the trade-off between breadth and comprehensiveness is often reported as a challenge (Pham et al., 2014). Our search strategy focused on behavioral aspects in healthcare, seeking studies referring to nudge-related

terms and studies referring to healthcare professionals’ behaviors to promote EBM. In this sense, our study encompasses an already broad spectrum of studies that goes beyond those using nudge terminology but might nevertheless have overlooked studies using other terms (Szasz et al., 2017). Especially for reminders, there is already a large body of literature (for an overview see Cheung et al., 2012). Our findings could also be skewed due to publication bias. We attempted to address this by explicitly asking experts to add unpublished studies, but it is possible that some relevant studies have been overlooked.

Second, the heterogeneity of the studies meant that we could not conduct a meta-analysis. Instead, we have provided a systematic scoping review (Szasz et al., 2017). We recognize that even though heterogeneity is a strong argument against conducting meta-analyses, our systematic scoping review is limited because it does not consider effect size, sample and other relevant measures (Ioannidis, Patsopoulos, & Rothstein, 2008). Moreover, in this study we use a statistically significant difference in behavior in the direction of the nudge intervention as a proxy for success. Future research could also carry out meta-analyses of specific categories in those areas where there is sufficient homogeneity in the published studies. For some nudging categories, such as reminders, meta-analyses of their effects on healthcare professionals already exist and provide more detailed information on their effectiveness (Cheung et al., 2012). Other nudging categories, such as using defaults, need additional studies with similar designs in order to assess their effectiveness with healthcare professionals.

Third, ‘success’ can also be evaluated in terms of other outcomes. O’Connor et al. (2009) for instance stated that while most changes in order sets were beneficial, order set changes were also associated with an unintended overall increase in ordering night-time sedation. Tierney et al. (2003) noted that physicians and pharmacists found the nudge intrusive and time consuming. Although such issues are beyond the scope of this review, these reports highlight the importance of not only studying significant differences, but also evaluating the impact on professionals’ attitudes and unintended negative consequences.

Fourth, we categorized interventions in the choice architecture category we found most fitting. However, we found the choice architecture categories by Münscher, Vetter, & Scheuerle (2016) to be not entirely exclusive of each other. Therefore, we

advise scholars looking for interventions in a particular category to review the related categories in the JBPA Dataverse files for this article as well. Despite these limitations, we do believe that we have shed new light on the scope of the nudging field and identified possible avenues for future research.

Conclusions

The aim of this research was to expose the current state of research on nudge interventions designed to promote evidence-based medicine by healthcare professionals. We found more than a hundred studies in over sixty journals and identified ten distinct nudging categories associated with outcomes ranging from hand hygiene to prescribing. Moreover, we found that nudges have been used since the 1970s, despite nudge terminology not appearing until 2013. Reminders that deal with information overload are used the most often. However, further studies on less reported nudge categories that could also mitigate information overload, such as the effect of simplifying existing guidelines, are required. We also need more studies that explore outcomes beyond hand hygiene, image ordering and prescribing, as well as assessments of current choice architectures. Our methodological assessment identified considerable room for improvement in the identification of success, through better study design and more detailed reporting, with suggestions made related to allocation concealment and preregistration. Future research

should also consider the roles of task, organizational, and occupational contexts in theoretical models regarding the design of nudges, thereby moving beyond one-size-fits-all approaches.

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Notes

1. Percentages are rounded.
2. References included in the systematic review and cited in this article. Note that not all publications included in our review have been cited. For a full list of all included articles, see the files for this article uploaded to the JBPA Dataverse.

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Appendix

Appendix A – Search strategy

Specific search

((nudge or nudging “choice architecture” or “behavioural economics” or “behavioural economics”) and (health care or healthcare or medical) and (practitioners or doctors or nurses or clinicians or surgeons) and (guidelines or “evidence based medicine”)).af. and (experiment* or trial or intervention).ab. – Ovid Medline, PsychINFO

Broad search

(“choice architect*” OR nudg* OR behavior*) AND (health care OR healthcare OR medic*) AND (experiment* OR trial OR intervention) AND (practitioners OR doctors OR nurses OR clinicians OR surgeons) AND (guidelines OR “evidence based medicine”)[all] – PubMed

Appendix B – PRISMA statement for scoping reviews

Preferred Reporting Items for Systematic reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results and conclusions that relate to the review questions and objectives.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review’s questions/objectives lend themselves to a scoping review approach.	2
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	2
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address) and, if available, provide registration information, including the registration number.	4

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language and publication status) and provide a rationale.	4
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	4
Search	8	Present the full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix A
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	4
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	4
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Supplement
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	3, 7-8
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	4
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	5
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Supplement
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Supplement
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Supplement

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	5-9
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	9-11
Limitations	20	Discuss the limitations of the scoping review process.	11-12
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	12
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	12

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where sources of evidence (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion and policy documents) that may be eligible in a scoping review as opposed to studies. This is not to be confused with information sources (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac et al. (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results and relevance before using it to inform a decision. This term is used for items 12 and 19, instead of "risk of bias" (which is more applicable to systematic reviews of interventions), to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion and policy documents).

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