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Can nudge-interventions address health service overuse and underuse? Protocol for a systematic review

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Abstract

Introduction Nudge-interventions aimed at health professionals are proposed to reduce the overuse and underuse of health services. However, little is known about their effectiveness at changing health professionals' behaviours in relation to overuse or underuse of tests or treatments.

Objective To systematically identify and synthesise the studies that have assessed the effect of nudge-interventions aimed at health professionals on the overuse or underuse of health services.

Methods and analysis We will perform a systematic review. All study designs that include a control comparison will be included. Any qualified health professional, across any speciality or setting, will be included. Only nudge-interventions aimed at altering the behaviour of health professionals will be included. We will examine the effect of choice architecture nudges (default options, active choice, framing effects, order effects) and social nudges (accountable justification and pre-commitment or publicly declared pledge/contract). Studies with outcomes relevant to overuse or underuse of health services will be included. Relevant studies will be identified by a computer-aided search of the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library), MEDLINE, CINAHL, Embase, and PsycINFO databases. Two independent reviewers will screen studies for eligibility, extract data, and perform the risk of bias assessment using criteria recommended by the Cochrane Effective Practice and Organisation of Care (EPOC) group. We will report our results in a structured synthesis format, as recommended by the Cochrane EPOC group.

Ethics and dissemination No ethical approval is required for this study. Results will be presented at relevant scientific conferences and in peer-reviewed literature.

Funding No funding is required for this study.

Keywords: nudge, overuse, underuse, health services, health professionals

Strengths and limitations of this study

- This will be the first review to explicitly examine the effect of nudge-interventions aimed at health professionals on the overuse and underuse of health services
- This review has a comprehensive search strategy, will include many study designs, all health disciplines, and outcomes related to overuse or underuse of any test or treatment.
- Nudge-interventions lack definitional and conceptual clarity and make the inclusion and exclusion criteria difficult to define
- Only English language studies will be included
- The results may be able to inform future strategies to address health service overuse and underuse

Introduction

Health professionals' underuse and overuse of health services (e.g., medications, screening tests, diagnostic tests, and treatments) are major problems worldwide.[1 2] The ways in which health professionals make choices influence this overuse and underuse, and ultimately the value and outcomes of patient care.[1 3]

There are many examples of the overuse of inappropriate care.[4 5] This involves health professional provision of medical services that are discouraged by clinical guidelines because they are likely to cause more harm than good, or provide little to no clinical benefit. For example, a study in China found that 57% of patients received antibiotics inappropriately [6]; rates of inappropriate total knee replacement were 26% in Spain and 34% in the USA [7]; the Lancet low back pain (LBP) series[8-10] displayed the worldwide overuse of surgery, opioids, and imaging for LBP; and arthroscopic surgery for degenerative knee disease, a procedure known to be ineffective, is performed more than 2 million times a year across the world.[11 12] A slightly different example is the prescribing of expensive brand-name medications that have existing generic equivalents. For example, a study in US found that in 2009 Medicaid spent an unnecessary $329 million that could have been saved by using generic instead of brand name medications.[13] Overuse of screening tests for cancer has also been documented.[14] Examples include inappropriate screening for cervical cancer,[15] mammography screening for breast cancer,[16 17] and thyroid cancer screening.[18-20]

There are also several examples of the underuse of appropriate care that is known to improve health.[3] For example, the CareTrack study[21] in Australia found that only 57% of patients received appropriate care across 35,573 health care encounters. A 2003 US study[22] found that only 55% of patients in the US received recommended care. High quality studies have displayed the underuse of anticoagulation in patients with atrial fibrillation who are at high risk of stroke,[23-25] and the underuse of beta blockers for patients who have had a myocardial infarction.[26 27] There is also underuse of effective non-pharmacological treatments, including advice for acute LBP[28 29] and exercise prescription for a range of chronic conditions including heart failure, osteoarthritis, and chronic fatigue.[30-33] Both underuse and overuse can drive physical, psychological, and social harms for patients, and the wasteful misallocation of resources.[1 2]

Numerous drivers of overuse and underuse of health services have been documented.[1-4] Thinking strategies at the level of the health professional have been proposed as one driver of these problems.[2] Psychological research has identified strategies of cognition[34 35] that influence health professional judgements in situations of uncertainty, and exert a powerful influence on decision making in health care.[2 36] It is suggested that health professionals exhibit 'predictable' bounded rationality.[37-40] That is, when making decisions, rather than being rational economic optimisers, they follow mind lines (internalised tacit guidelines on how to manage common problems)[41] and heuristics[35 39 42-44] ("common sense", educated guesses, mental rules of thumb, or shortcuts). Because rapid, high-volume clinical decision making is part of the everyday routine of health professionals, and requires combining and synthesising diverse data and performing complex trade-offs between benefits and risks, these mostly unconscious heuristics can be adaptive and accurate.[2 39 45] However, this intuitive decision making can also be dysfunctional and lead to skewed judgment.[37 38] For example, health professionals

underestimate the harms and overestimate the benefits of many tests and treatments.[46] Nineteen different types of heuristics and cognitive biases in clinical decision making have been discussed.[35] Types frequently mentioned in health service improvement conversations[44 47-50] include: default bias or status quo bias (a preference for the current state of affairs), framing effects (influenced by the expression of the same information in different ways), loss aversion (care much more about avoiding losses than care about making gains), order effects (influenced by the different order of the same information), norms (tendency to uphold one's reputations based on peer or social norms), and the salience effect (influenced by the distinctiveness of important material).

Researchers have started to focus on ways of harnessing these cognitive biases and heuristics to influence health professional judgements, choices, and behaviours. This has led to increasing interest in the field of social psychology and behavioural economics. The concept of nudging,[51-53] in particular, has been proposed as one method of promoting 'right healthcare'.[47 54-57] Nudging was popularised in 2008 following the publication of the book Nudge: Improving Decisions about Health, Wealth, and Happiness by Richard H. Thaler and Cass R. Sunstein.[51] They defined a nudge as "any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives". In this way, choice architecture refers to the context in which people choose and make decisions. The definition of nudge has since been updated to provide further clarity for researchers and policy makers.[53] The updated definition is:

"A nudge is a function of any attempt at influencing people's judgement, choice, or behaviour in a predictable way that is
1. Made possible because of cognitive boundaries, biases, routines, and habits in individual and social decision-making posing barriers for people to perform rationally in their own self-declared interests, and
2. Which works by making use of those boundaries, biases, routines, and habits as integral parts of such attempts.
The nudge works independently of
1. Forbidding or adding any rationally relevant choice options,
2. Changing incentives, whether regarding in terms of time, trouble, social sanctions, economic and so forth, or
3. The provision of factual information and rational argumentation."[53]

Nudge-interventions are classed as light-touch behaviour change strategies.[58] It is proposed that nudging, through making subtle, but purposeful, changes in how choices and information are presented and framed (the choice architecture)[58 59] in the clinician environment, may tap into clinician automatic cognitive processes (heuristics) in a beneficial way, and push clinicians away from both underuse and overuse of health services.[57 60] Nudges can be designed to remind, guide, or motivate behaviour.[57] Nudges should be inexpensive and easy to implement, not involve a restriction, be implemented in the environment where the target behaviour is performed, and require minimal conscious processing.[51 58 59] Nudging is embedded in libertarian paternalism, a political philosophy in which people's choices are actively guided in their best interests but they remain at liberty to behave differently.[61] It has been suggested that

nudges are often preferred over more assertive methods (e.g. prohibiting the prescription of certain medications) as they do not force people to behave in a specific manner.[62]

Some suggest that using nudges in the health care system may lead to reduced overuse and underuse of health services [54]; and health professionals' immediate environment and choice architecture should be purposefully designed in a way that directs them towards the provision of appropriate care. Other researchers[63] [64] have expressed concern over the potential repercussions of the hastily implementation of nudging interventions. For example, there is a concern that nudging may drive unintended, as well as intended, behaviour changes.[63] [64] We do not know if there is evidence that nudge-interventions are effective at changing health professionals' behaviours in relation to overuse or underuse of tests or treatments, or if results vary depending on the type of nudge, type of health professional, or the target behaviour. Therefore, the objective of this review is systematically identify and synthesise the studies that have assessed the effect of nudge-interventions aimed at health professionals on the overuse or underuse of health services.

METHODS

Search strategy

This review protocol will be registered on the PROSPERO database. All relevant English studies meeting the inclusion criteria will be identified by a computer-aided search of the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library), MEDLINE, CINAHL, Embase, and PsycINFO databases from the period of inception to September 2018. We will use the Polyglot Search Translator (http://crebp-sra.com/#/polyglot) to translate the search strategy across the different databases. The databases will be searched using a variety of subject headings, free text terms, and synonyms relevant to the review in consultation with a librarian with expertise in systematic review searches. Initial terms will be drawn from a small set of key articles. We will use an iterative process to build the search strategy, run the search, scan the relevant retrieved articles for additional terms, and then rebuild the search strategy with the newly identified relevant terms and related subject headings. The search will consist of two rows of terms which will be combined with the word 'AND'. The first row of search terms will be related to nudge-interventions. The second row of search terms will be related to the concepts of overuse and underuse of health services (See supplementary appendix for proposed search strategy). We will conduct citation tracking for included studies in Web of Science and will perform reference checking on all included studies. In addition to database searching, we will examine the reference lists of key articles and relevant reviews (e.g. Cochrane EPOC reviews), and hand search the US National Institutes of Health (NIH) Clinical Trials Registry (http://clinicaltrials.gov/) and The World Health Organization (WHO) International Clinical Trials Registry Platform (ICTRP) (www.who.int/ictrp/). We will contact investigators known to be involved in previous studies that have not yet been published. We will also contact published authors in the field of nudging/behavioural insights/behavioural economics and ask if they are aware of ongoing and unpublished trials. We will also review government department websites that develop and test

behavioural approaches to public policy and service delivery (e.g. UK and Australian 'Behaviour Insights' team websites) for eligible trials.

Inclusion/exclusion criteria

Study design

All study types that include a control comparison will be included. For example, randomised trials, non-randomised trials with concurrent controls, controlled before and after studies, controlled studies with only post-test measures and interrupted time series studies, will all be included.

Population

Any qualified health professional, across any speciality or setting, will be included. Both real clinical and hypothetical/simulated situations (e.g. vignette studies) will be eligible.

Interventions

Only nudges that are aimed at altering the behaviour of health professionals will be included. Nudge-interventions lack definitional and conceptual clarity in the healthcare setting. Based on examination of reviews already completed by Cochrane Effective Practice and Organisation of Care (EPOC) Group, extensive reading of the nudge literature,[52 54 59 65-68] and the Behaviour Change Taxonomy,[69] we will include the following categories of interventions:

1. **Choice architecture nudges (environmental restructuring)**

- Default option nudges (e.g. changing the pre-selected number of medications in the order set menu)
- Active choice nudges
- Framing and salient effect nudges (e.g. require one additional click to order a certain test or treatment, test form redesign, test results report redesign, removal of certain tests from the main order menu, adding certain tests)
- Order effect nudges (e.g. changing the order of items on an existing chart, form, or order entry system)

2. **Social nudges**

- Accountable justification: a requirement to justify a test request or treatment
- Pre-commitment or publicly declared pledge/contract (e.g. a health professional pre-committing to a particular behaviour by publicly signing a letter or poster)

Studies examining the following interventions will be excluded:

- Interventions that restrict the freedom of choice (e.g. elimination or restricting the availability of certain tests or treatments, mandatory use of a request form).
- Regulatory or policy interventions
- Audit and feedback. Audit and feedback has been defined as 'any summary of clinical performance of health care over a specified period of time', or 'clinical performance feedback'.[70] The feedback can include recommendations for clinical action and may be delivered in a written, electronic or verbal format.[70] This means brief feedback letters sent to clinician (peer-comparison or otherwise), will be excluded.
- Clinical decision support systems or new order entry systems that feature substantial changes and require health professional training and competence
- Financial incentives to clinicians
- Mass-media interventions
- Educational interventions or involving an educational or training component
- Opinion leaders
- Charge display or price transparency. While these are minimal interventions, these interventions have been covered extensively in other systematic reviews.[71 72]
- Computerised or paper-based reminders or alerts. Alerts are perceived as intrusive, and are therefore hard to avoid, and are not "light touch" in nature.[73] Reminders have been covered extensively by the Cochrane EPOC group.[74-76]

Comparison

There will be no restriction on the comparator.

Outcomes

Studies with outcomes relevant to overuse or underuse of health services will be included. We define overuse as provision of an *inappropriate* test or treatment. We define underuse as failure to provide an *appropriate* test or treatment. Therefore, to evaluate overuse and underuse, all studies must report some measure of appropriateness. We will consider measures that reference clinical guidelines, best evidence, a recent policy decision, the Choosing Wisely initiative, or expert clinician consensus, to determine whether the test or treatment of interest was appropriate or inappropriate. Measures of appropriateness might include:

- Rate of inappropriate test requests or treatments against national or international guidelines (overuse)
- Rate of not requesting appropriate tests or providing appropriate treatments against national or international guidelines (underuse)
- Rate of author-defined or hospital policy-defined "inappropriate" test requests or treatments (i.e. without specific reference to national or international guidelines) (*possible* or *grey zone* overuse)

- Rate of not providing author-defined or hospital policy-defined "appropriate" tests or treatments (i.e. without specific reference to national or international guidelines) *(possible* or *grey zone* underuse)

Studies will be excluded if they do not include a measure of appropriateness based on clinical guidelines, best evidence, a recent policy decision, the Choosing Wisely initiative, or local clinical consensus.

All clinical tests and treatment behaviours will be eligible, at all study time points.

Primary outcomes

Health professional overuse or underuse of tests or treatments

Dichotomous outcomes related to health professionals' use of any test (e.g. proportion of patients/requests for imaging, screening, laboratory tests that were appropriate/inappropriate) or treatment (e.g. proportion of patients/ treatments provided [e.g. medications, non-pharmacological therapies] that were appropriate/inappropriate). If possible for dichotomous outcomes, we will report a single effect size for the study's stated primary outcome in each study. Below are examples of measuring our outcomes of interest:

Overuse and underuse expressed as proportion of patients with a specific clinical presentation

$$\%\ \text{underuse} = \frac{\text{Number of people who consulted with Clinical Presentation A and failed to receive an } \textit{appropriate} \text{ test or treatment for Clinical Presentation A}}{\text{Number of people who consulted with Clinical Presentation A}}$$

$$\%\ \text{overuse} = \frac{\text{Number of people who consulted with Clinical Presentation A and received an } \textit{inappropriate} \text{ test or treatment for Clinical Presentation A}}{\text{Number of people who consulted with Clinical Presentation A}}$$

Overuse and underuse expressed as proportion of tests or treatments provided

$$\% \text{ underuse} = \frac{\text{Number of requests for Test A or Treatment A that were appropriate for people who consulted with Clinical Presentation A}}{\text{Number of requests for Test A or Treatment A for people who consulted with Clinical Presentation A in total}}$$

$$\% \text{ overuse} = \frac{\text{Number of requests for Test A or Treatment A that were inappropriate for people who consulted with Clinical Presentation A}}{\text{Number of requests for Test A or Treatment A for people who consulted with Clinical Presentation A in total}}$$

Secondary outcomes

Health professional overuse or underuse of tests or treatments

Continuous outcomes related to health professionals' use of testing and treatment (e.g. duration of intervention, mean number of intervention sessions/provision). For continuous outcomes, we will report the results in natural units, as reported by the study authors, and extract data on the absolute or relative change in testing or treatment practices from baseline, or across groups.

Patient outcomes

1. Dichotomous clinical outcomes: patient-important endpoints (e.g. death, recurrence of illness)
2. Continuous clinical outcomes: various markers of disease (e.g. disability, pain, quality of life, patient satisfaction, length of stay in hospital). Given our broad scope (all health conditions), it is not possible to pre-specify eligible patient outcomes. We will focus on the core patient-relevant outcomes as specified in that disease area. For example, in the

LBP field, physical functioning and health related quality of life are considered core outcomes to measure in clinical trials.

Costs

Any measure of cost of test orders, cost of tests performed, cost per diagnosis, cost of treatment, or overall health care costs.

Adverse effects

Some of the interventions evaluated may have unintended impacts on patient care or health professional workflows. For example, if nudges are intended to reduce the overuse of a certain test, they may lead to the underuse of this test for appropriate populations, or the reductions in use of one test may inadvertently increase the use of another inappropriate test or treatment. We will examine the adverse (undesirable) effects of interventions recommended by the Cochrane EPOC group.[77] These will include adverse effects on

1. Test and treatment delivery or utilisation
2. Health or health behaviours
3. Quality of care
4. Resource use

Where no adverse effects are reported, we will make a distinction between studies where adverse effects were investigated, studies where it is not clear whether adverse effects were investigated, and studies where it is clear that adverse effects were not investigated.

Study selection

One review author (MOK) will download search results to the reference manager software Endnote. De-duplication of results will be completed in the Centre for Research in Evidence Based Practice (CREBP) Systematic Review Accelerator (SRA) deduplication algorithm. This algorithm has greater sensitivity and specificity than Endnote for the deduplication process.[78] Data will be managed in Endnote thereafter. Two review authors (MOK and GF) will independently assess the eligibility of studies by screening titles and abstracts in Endnote for potential inclusion according to the predefined selection criteria. Studies judged to be potentially relevant will be retrieved in full text for further analysis. Any disagreements in judgement will be resolved by discussion to reach a consensus or if this is not possible, with a third review author (AT) until a consensus is reached. If further information about the study is required in order to make a decision about its eligibility, an attempt will be made to contact the study corresponding author(s).

Data Extraction

Two review authors (MOK and AT) will independently extract data for each of the included studies using a modified EPOC data collection checklist. The data extraction spreadsheet will be pilot tested on two included studies to minimize misinterpretation. We will extract information about study design, characteristics of population (country, setting, speciality, number of health professionals, number of patients), details of the interventions using TIDieR items[79]), details of the outcomes (target behaviour, measure of the target behaviour, baseline performance of the health care professional, patient outcome), and study results. If not enough information is provided in the trial report to extract data about intervention effects, we will contact authors to attempt to obtain the required information. We will calculate data from graphs and figures in cases using https://www.digitizeit.de/ where this information is not presented in tables or text. If any information regarding standard deviations is missing, we will calculate them from the extracted confidence intervals (if available) of the same study.

Risk of Bias Assessment

Two authors (MOK and GF) will assess the risk of bias of all eligible studies using the criteria described in the Cochrane EPOC Group Resources for review authors.[80] Nine standard criteria are suggested for all randomised trials, non-randomised trials and controlled before-after studies. Seven standard criteria are used for all interrupted time series studies. Any disagreements in judgement will be resolved by discussion to reach a consensus or if this is not possible, with another reviewer (AT) until a consensus is reached.

Where possible, we will assess the overall certainty of the evidence using the GRADE approach as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions.*[81]

Data Synthesis

We will follow the Cochrane EPOC guidelines for reporting the effects of interventions.[82]
We expect included studies will vary according to study design, health professionals included, setting, types of nudge, and target behaviours. Therefore we expect to report our results in a structured synthesis format, as recommended by the Cochrane EPOC group.

We will separately analyse and report outcome data from different types of study designs. Depending on the studies found, we will also separately analyse and report the outcome data for the difference categories (choice architecture and social nudges) and/or subcategories of nudges (e.g. defaults, pre-commitment). Furthermore, depending on the studies found we will separately analyse and report outcome data on the interventions that target testing or treatment behaviours.

In our structured synthesis, we will try to examine if there are any patterns or variations across different factors and outcomes achieved. Subgroups of interest may include the type of nudge, type of healthcare professional, type of setting, type of target behavior, and whether the study examined a real clinical or hypothetical/simulated situation (e.g. a vignette study).

Dealing with missing data

We will contact authors of included papers if important data are not available.

Patient or Public Involvement

Patients and members of the public will not be involved in the design of this study.

Ethics and dissemination

Formal ethical approval is not required for this study. The results will be disseminated through a peer-reviewed publication and conference presentations.

Conclusion

This systematic review will provide evidence in support or against the hypothesis that nudge-interventions aimed at health professionals can address health service overuse and underuse. The results will have important implications for the implementation of health system interventions to improve professional practice and patient outcomes.

Contributors MOK, AT and CGM conceived the idea. All authors planned and designed the study protocol. MOK wrote the first draft; MOK and TH planned the search strategy and data analysis. All authors have approved and contributed to the final written manuscript.

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Supplementary appendix 1

Row 1: Nudge-intervention terms

Decision Making, Computer-Assisted/ or Medical Records Systems, Computerized/ or Medical Order Entry Systems/ OR exp electronic health records/ OR Electronic Prescribing/ OR ((doctor* or GP or GPs or "general practitioner*" or registrar* OR intern* or medical or pharm* or radiolog* or physician* or patholog* or nurs*) adj3 (order* or form* or request* or prescri*)).tw. OR ((Medication* or test* or scan* or imaging or laboratory) adj2 (order* or form* or request*)).tw. OR medication alert system*.tw. OR electronic health record*.tw OR electronic medical record*.tw. OR default*.tw OR “accountable justification”.tw OR “active choice” OR “public commitment” OR pre-commitment.tw OR medication system*.tw OR (computeri?ed provider order entry or CPOE).tw OR electronic request form*.tw. OR nudge*.tw. OR "choice architecture".tw OR (behavi* adj1 economics).tw. OR (behavi* adj1 insight*).tw. OR nudging.tw. OR "Forms and Records Control"/

AND

Row 2: Overuse or underuse of health service terms

Clinical Laboratory Techniques/ OR Diagnostic Imaging/ OR "Quality of Health Care"/ OR deprescriptions/ OR (influence* adj2 decision*).tw. OR Choice Behavior/ OR ((inappropriate* or unnecessary! or misuse OR underuse OR overuse) adj3 (test* or screening OR imaging or prescrib* or prescription* or laboratory)).tw. OR ((clinical or doctor* or physician* or nurs*) adj2 practice pattern*).tw. OR ((medication* or prescribing or prescription*) adj2 error*).tw. OR test ordering pattern*.tw. OR ((over or under or inappropriate) adj2 (prescrib* or order*)).tw. OR Clinical Competence/ OR Unnecessary Procedures/ OR Inappropriate Prescribing/ OR exp Medication Errors/ OR health services misuse/ or medical overuse/ OR practice patterns, nurses'/ or practice patterns, physicians'/ OR Clinical Decision-Making/ OR practice guideline/

Example of Medline strategy:

(Decision Making, Computer-Assisted/ OR Medical Records Systems, Computerized/ OR Medical Order Entry Systems/ OR exp electronic health records/ OR Electronic Prescribing/ OR ((doctor* OR GP OR GPs OR general practitioner* OR registrar* OR intern* OR medical OR pharm* OR radiolog* OR physician* OR patholog* OR nurs*) ADJ3 (order* OR form* OR request* OR prescri*)).ti,ab. OR ((Medication* OR test* OR scan* OR imaging OR laboratory) ADJ2 (order* OR form* OR request*)).ti,ab. OR medication alert system*.ti,ab. OR electronic health record*.ti,ab. OR electronic medical record*.ti,ab. OR default*.ti,ab. OR accountable justification.ti,ab. OR active choice OR public commitment OR pre-commitment.ti,ab. OR medication system*.ti,ab. OR (computeri?ed provider order entry OR CPOE).ti,ab. OR electronic request form*.ti,ab. OR nudge*.ti,ab. OR choice architecture.ti,ab. OR (behavi* ADJ1 economics).ti,ab. OR (behavi* ADJ1 insight*).ti,ab. OR nudging.ti,ab. OR Forms and Records Control/)

AND

(Clinical Laboratory Techniques/ OR Diagnostic Imaging/ OR Quality of Health Care/ OR deprescriptions/ OR (influence* ADJ2 decision*).ti,ab. OR Choice Behavior/ OR ((inappropriate* OR unnecessary! OR misuse OR underuse OR overuse) ADJ3 (test* OR screening OR imaging OR prescrib* OR prescription* OR laboratory)).ti,ab. OR ((clinical OR doctor* OR physician* OR nurs*) ADJ2 practice pattern*).ti,ab. OR ((medication* OR prescribing OR prescription*) ADJ2 error*).ti,ab. OR test ordering pattern*.ti,ab. OR ((over OR under OR inappropriate) ADJ2 (prescrib* OR order*)).ti,ab. OR Clinical Competence/ OR Unnecessary Procedures/ OR Inappropriate Prescribing/ OR exp Medication Errors/ OR health services misuse/ OR medical overuse/ OR practice patterns, nurses'/ OR practice patterns, physicians'/ OR Clinical Decision-Making/ OR practice guideline/)

Reporting checklist for protocol of a systematic review.

Based on the PRISMA-P guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the PRISMA-P reporting guidelines, and cite them as:

Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart LA. Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4(1):1.

		Reporting Item	Page Number
Identification	#1a	Identify the report as a protocol of a systematic review	1
Update	#1b	If the protocol is for an update of a previous systematic review, identify as such	n/a
	#2	If registered, provide the name of the registry (such as PROSPERO) and registration number	n/a
Contact	#3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	1
Contribution	#3b	Describe contributions of protocol authors and identify the guarantor of the review	12
	#4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	n/a
Sources	#5a	Indicate sources of financial or other support for the review	12
Sponsor	#5b	Provide name for the review funder and / or sponsor	12
Role of sponsor or funder	#5c	Describe roles of funder(s), sponsor(s), and / or institution(s), if any, in developing the protocol	12
Rationale	#6	Describe the rationale for the review in the context of what is already known	3-5

Objectives	#7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	5
Eligibility criteria	#8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	6-10
Information sources	#9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	5
Search strategy	#10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	5
Study records - data management	#11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	5
Study records - selection process	#11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	10-11
Study records - data collection process	#11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	10-11
Data items	#12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	10-11
Outcomes and prioritization	#13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	8-11
Risk of bias in individual studies	#14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	11
Data synthesis	#15a	Describe criteria under which study data will be quantitatively synthesised	11
	#15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I2, Kendall's T)	n/a
	#15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	11

	#15d	If quantitative synthesis is not appropriate, describe the type of summary planned	11
Meta-bias(es)	#16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	n/a
Confidence in cumulative evidence	#17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	11

BMJ Open

Can nudge-interventions address health service overuse and underuse? Protocol for a systematic review

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Can nudge-interventions address health service overuse and underuse? Protocol for a systematic review

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Abstract

Introduction Nudge-interventions aimed at health professionals are proposed to reduce the overuse and underuse of health services. However, little is known about their effectiveness at changing health professionals' behaviours in relation to overuse or underuse of tests or treatments.

Objective To systematically identify and synthesise the studies that have assessed the effect of nudge-interventions aimed at health professionals on the overuse or underuse of health services.

Methods and analysis We will perform a systematic review. All study designs that include a control comparison will be included. Any qualified health professional, across any speciality or setting, will be included. Only nudge-interventions aimed at altering the behaviour of health professionals will be included. We will examine the effect of choice architecture nudges (default options, active choice, framing effects, order effects) and social nudges (accountable justification and pre-commitment or publicly declared pledge/contract). Studies with outcomes relevant to overuse or underuse of health services will be included. Relevant studies will be identified by a computer-aided search of the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library), MEDLINE, CINAHL, Embase, and PsycINFO databases. Two independent reviewers will screen studies for eligibility, extract data, and perform the risk of bias assessment using criteria recommended by the Cochrane Effective Practice and Organisation of Care (EPOC) group. We will report our results in a structured synthesis format, as recommended by the Cochrane EPOC group.

Ethics and dissemination No ethical approval is required for this study. Results will be presented at relevant scientific conferences and in peer-reviewed literature.

Funding No funding is required for this study.

Keywords: nudge, overuse, underuse, health services, health professionals

Strengths and limitations of this study

- This will be the first review to explicitly examine the effect of nudge-interventions aimed at health professionals on the overuse and underuse of health services
- This review has a comprehensive search strategy, will include many study designs, all health disciplines, and outcomes related to overuse or underuse of any test or treatment.
- Nudge-interventions lack definitional and conceptual clarity and make the inclusion and exclusion criteria difficult to define
- Only English language studies will be included
- The results may be able to inform future strategies to address health service overuse and underuse

INTRODUCTION

Health professionals' underuse and overuse of health services (e.g., medications, screening tests, diagnostic tests, and treatments) are major problems worldwide.[1 2] The ways in which health professionals make choices influence this overuse and underuse, and ultimately the value and outcomes of patient care.[1 3]

There are many examples of the overuse of inappropriate care.[4 5] This involves health professional provision of medical services that are discouraged by clinical guidelines because they are likely to cause more harm than good, or provide little to no clinical benefit. For example, a study in China found that 57% of patients received antibiotics inappropriately [6]; rates of inappropriate total knee replacement were 26% in Spain and 34% in the USA [7]; the Lancet low back pain (LBP) series[8-10] displayed the worldwide overuse of surgery, opioids, and imaging for LBP; and arthroscopic surgery for degenerative knee disease, a procedure known to be ineffective, is performed more than 2 million times a year across the world.[11 12] A slightly different example is the prescribing of expensive brand-name medications that have existing generic equivalents. For example, a study in US found that in 2009 Medicaid spent an unnecessary $329 million that could have been saved by using generic instead of brand name medications.[13] Overuse of screening tests for cancer has also been documented.[14] Examples include inappropriate screening for cervical cancer,[15] mammography screening for breast cancer,[16 17] and thyroid cancer screening.[18-20]

There are also several examples of the underuse of appropriate care that is known to improve health.[3] For example, the CareTrack study[21] in Australia found that only 57% of patients received appropriate care across 35,573 health care encounters. A 2003 US study[22] found that only 55% of patients in the US received recommended care. High quality studies have displayed the underuse of anticoagulation in patients with atrial fibrillation who are at high risk of stroke,[23-25] and the underuse of beta blockers for patients who have had a myocardial infarction.[26 27] There is also underuse of effective non-pharmacological treatments, including advice for acute LBP[28 29] and exercise prescription for a range of chronic conditions including heart failure, osteoarthritis, and chronic fatigue.[30-33] Both underuse and overuse can drive physical, psychological, and social harms for patients, and the wasteful misallocation of resources.[1 2]

Numerous drivers of overuse and underuse of health services have been documented.[1-4] Thinking strategies at the level of the health professional have been proposed as one driver of these problems.[2] Psychological research has identified strategies of cognition[34 35] that influence health professional judgements in situations of uncertainty, and exert a powerful influence on decision making in health care.[2 36] It is suggested that health professionals exhibit 'predictable' bounded rationality.[37-40] That is, when making decisions, rather than being rational economic optimisers, they follow mind lines (internalised tacit guidelines on how to manage common problems)[41] and heuristics[35 39 42-44] ("common sense", educated guesses, mental rules of thumb, or shortcuts). Because rapid, high-volume clinical decision making is part of the everyday routine of health professionals, and requires combining and synthesising diverse data and performing complex trade-offs between benefits and risks, these mostly unconscious heuristics can be adaptive and accurate.[2 39 45] However, this intuitive decision making can also be dysfunctional and lead to skewed judgment.[37 38] For example, health professionals underestimate the harms and overestimate the benefits of many tests and treatments.[46] Nineteen different types of heuristics and cognitive biases in clinical decision making have been discussed.[35] Types frequently mentioned in health service improvement conversations[44 47-50]

include: default bias or status quo bias (a preference for the current state of affairs), framing effects (influenced by the expression of the same information in different ways), loss aversion (care much more about avoiding losses than care about making gains), order effects (influenced by the different order of the same information), norms (tendency to uphold one's reputations based on peer or social norms), and the salience effect (influenced by the distinctiveness of important material).

Researchers have started to focus on ways of harnessing these cognitive biases and heuristics to influence health professional judgements, choices, and behaviours. This has led to increasing interest in the field of social psychology and behavioural economics. The concept of nudging,[51-53] in particular, has been proposed as one method of promoting 'right healthcare'.[47 54-57] Nudging was popularised in 2008 following the publication of the book Nudge: Improving Decisions about Health, Wealth, and Happiness by Richard H. Thaler and Cass R. Sunstein.[51] They defined a nudge as "any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives". In this way, choice architecture refers to the context in which people choose and make decisions. The definition of nudge has since been updated to provide further clarity for researchers and policy makers.[53] The updated definition is:

"A nudge is a function of any attempt at influencing people's judgement, choice, or behaviour in a predictable way that is
1. Made possible because of cognitive boundaries, biases, routines, and habits in individual and social decision-making posing barriers for people to perform rationally in their own self-declared interests, and
2. Which works by making use of those boundaries, biases, routines, and habits as integral parts of such attempts.
The nudge works independently of
1. Forbidding or adding any rationally relevant choice options,
2. Changing incentives, whether regarding in terms of time, trouble, social sanctions, economic and so forth, or
3. The provision of factual information and rational argumentation."[53]

Nudge-interventions are classed as light-touch behaviour change strategies.[58] It is proposed that nudging, through making subtle, but purposeful, changes in how choices and information are presented and framed (the choice architecture)[58 59] in the clinician environment, may tap into clinician automatic cognitive processes (heuristics) in a beneficial way, and push clinicians away from both underuse and overuse of health services.[57 60] Nudges can be designed to remind, guide, or motivate behaviour.[57] Nudges should be inexpensive and easy to implement, not involve a restriction, be implemented in the environment where the target behaviour is performed, and require minimal conscious processing.[51 58 59] Nudging is embedded in libertarian paternalism, a political philosophy in which people's choices are actively guided in their best interests but they remain at liberty to behave differently.[61] It has been suggested that nudges are often preferred over more assertive methods (e.g. prohibiting the prescription of certain medications) as they do not force people to behave in a specific manner.[62]

Some suggest that using nudges in the health care system may lead to reduced overuse and underuse of health services [54]; and health professionals' immediate environment and choice architecture should be purposefully designed in a way that directs them towards the provision of appropriate care. Other researchers[63 64] have expressed concern over the potential repercussions of the hastily implementation of nudging interventions. For example, there is a concern that nudging may drive unintended, as well as intended, behaviour changes.[63 64] We do not know if there is evidence that nudge-interventions are effective at changing health

professionals' behaviours in relation to overuse or underuse of tests or treatments, or if results vary depending on the type of nudge, type of health professional, or the target behaviour. Therefore, the objective of this review is systematically identify and synthesise the studies that have assessed the effect of nudge-interventions aimed at health professionals on the overuse or underuse of health services.

METHODS

Search strategy

This review protocol has been registered on the PROSPERO database (CRD42019123261). All relevant English studies meeting the inclusion criteria will be identified by a computer-aided search of the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library), MEDLINE, CINAHL, Embase, and PsycINFO databases from the period of inception to May 2019. We will use the Polyglot Search Translator (http://crebp-sra.com/#/polyglot) to translate the search strategy across the different databases. The databases will be searched using a variety of subject headings, free text terms, and synonyms relevant to the review in consultation with a librarian with expertise in systematic review searches. Initial terms will be drawn from a small set of key articles. We will use an iterative process to build the search strategy, run the search, scan the relevant retrieved articles for additional terms, and then rebuild the search strategy with the newly identified relevant terms and related subject headings. The search will consist of two rows of terms which will be combined with the word 'AND'. The first row of search terms will be related to nudge-interventions. The second row of search terms will be related to the concepts of overuse and underuse of health services (See supplementary appendix for proposed search strategy). We will conduct citation tracking for included studies in Web of Science and will perform reference checking on all included studies. In addition to database searching, we will examine the reference lists of key articles and relevant reviews (e.g. Cochrane EPOC reviews), and hand search the US National Institutes of Health (NIH) Clinical Trials Registry (http://clinicaltrials.gov/) and The World Health Organization (WHO) International Clinical Trials Registry Platform (ICTRP) (www.who.int/ictrp/). We will contact investigators known to be involved in previous studies that have not yet been published. We will also contact published authors in the field of nudging/behavioural insights/behavioural economics and ask if they are aware of ongoing and unpublished trials. We will also review government department websites that develop and test behavioural approaches to public policy and service delivery (e.g. UK and Australian 'Behaviour Insights' team websites) for eligible trials.

Inclusion/exclusion criteria

Study design

All study types that include a control comparison will be included. For example, randomised trials, non-randomised trials with concurrent controls, controlled before and after studies, controlled studies with only post-test measures and interrupted time series studies, will all be included.

Population

Any qualified health professional, across any speciality or setting, will be included. Both real clinical and hypothetical/simulated situations (e.g. vignette studies) will be eligible.

Interventions

Only nudges that are aimed at altering the behaviour of health professionals will be included. Nudge-interventions lack definitional and conceptual clarity in the healthcare setting. Based on examination of reviews already completed by Cochrane Effective Practice and Organisation of Care (EPOC) Group, extensive reading of the nudge literature,[52 54 59 65-68] and the Behaviour Change Taxonomy,[69] we will include the following categories of interventions:

1. **Choice architecture nudges (environmental restructuring)**

- Default option nudges (e.g. changing the pre-selected number of medications in the order set menu)
- Active choice nudges
- Framing and salient effect nudges (e.g. require one additional click to order a certain test or treatment, test form redesign, test results report redesign, removal of certain tests from the main order menu, adding certain tests)
- Order effect nudges (e.g. changing the order of items on an existing chart, form, or order entry system)

2. **Social nudges**

- Accountable justification: a requirement to justify a test request or treatment
- Pre-commitment or publicly declared pledge/contract (e.g. a health professional pre-committing to a particular behaviour by publicly signing a letter or poster)

Studies examining the following interventions will be excluded:

- Interventions that restrict the freedom of choice (e.g. elimination or restricting the availability of certain tests or treatments, mandatory use of a request form).
- Regulatory or policy interventions
- Audit and feedback. Audit and feedback has been defined as 'any summary of clinical performance of health care over a specified period of time', or 'clinical performance feedback'.[70] The feedback can include recommendations for clinical action and may be delivered in a written, electronic or verbal format.[70] This means brief feedback letters sent to clinician (peer-comparison or otherwise), will be excluded.
- Clinical decision support systems or new order entry systems that feature substantial changes and require health professional training and competence
- Financial incentives to clinicians
- Mass-media interventions
- Educational interventions or involving an educational or training component
- Opinion leaders
- Charge display or price transparency. While these are minimal interventions, these interventions have been covered extensively in other systematic reviews.[71 72]
- Computerised or paper-based reminders or alerts. Alerts are perceived as intrusive, and are therefore hard to avoid, and are not “light touch” in nature.[73] Reminders have been covered extensively by the Cochrane EPOC group.[74-76]

Comparison

There will be no restriction on the comparator.

Outcomes

Studies with outcomes relevant to overuse or underuse of health services will be included. We define overuse as provision of an *inappropriate* test or treatment. We define underuse as failure to provide an *appropriate* test or treatment. Therefore, to evaluate overuse and underuse, all studies must report some measure of appropriateness. We will consider measures that reference clinical guidelines, best evidence, a recent policy decision, the Choosing Wisely initiative, or expert clinician consensus, to determine whether the test or treatment of interest was appropriate or inappropriate. Measures of appropriateness might include:

- Rate of inappropriate test requests or treatments against national or international guidelines (overuse)
- Rate of not requesting appropriate tests or providing appropriate treatments against national or international guidelines (underuse)
- Rate of author-defined or hospital policy-defined "inappropriate" test requests or treatments (i.e. without specific reference to national or international guidelines) (*possible* or *grey zone* overuse)
- Rate of not providing author-defined or hospital policy-defined "appropriate" tests or treatments (i.e. without specific reference to national or international guidelines) *(possible* or *grey zone* underuse)

Studies will be excluded if they do not include a measure of appropriateness based on clinical guidelines, best evidence, a recent policy decision, the Choosing Wisely initiative, or local clinical consensus.

All clinical tests and treatment behaviours will be eligible, at all study time points.

Primary outcomes

Health professional overuse or underuse of tests or treatments

Dichotomous outcomes related to health professionals' use of any test (e.g. proportion of patients/requests for imaging, screening, laboratory tests that were appropriate/inappropriate) or treatment (e.g. proportion of patients/ treatments provided [e.g. medications, non-pharmacological therapies] that were appropriate/inappropriate). If possible for dichotomous outcomes, we will report a single effect size for the study's stated primary outcome in each study. Below are examples of measuring our outcomes of interest:

Overuse and underuse expressed as proportion of patients with a specific clinical presentation

$$\% \text{ underuse} = \frac{\text{Number of people who consulted with Clinical Presentation A and failed to receive an } \textit{appropriate} \text{ test or treatment for Clinical Presentation A}}{\text{}}$$

$$\% \text{ overuse} = \frac{\text{Number of people who consulted with Clinical Presentation A and received an } \textit{inappropriate} \text{ test or treatment for Clinical Presentation A}}{\text{Number of people who consulted with Clinical Presentation A}}$$

Overuse and underuse expressed as proportion of tests or treatments provided

$$\% \text{ underuse} = \frac{\text{Number of requests for Test A or Treatment A that were appropriate for people who consulted with Clinical Presentation A}}{\text{Number of requests for Test A or Treatment A for people who consulted with Clinical Presentation A in total}}$$

$$\% \text{ overuse} = \frac{\text{Number of requests for Test A or Treatment A that were inappropriate for people who consulted with Clinical Presentation A}}{\text{Number of requests for Test A or Treatment A for people who consulted with Clinical Presentation A in total}}$$

Secondary outcomes

Health professional overuse or underuse of tests or treatments

Continuous outcomes related to health professionals' use of testing and treatment (e.g. duration of intervention, mean number of intervention sessions/provision). For continuous outcomes, we will report the results in natural units, as reported by the study authors, and extract data on the absolute or relative change in testing or treatment practices from baseline, or across groups.

Patient outcomes

1. Dichotomous clinical outcomes: patient-important endpoints (e.g. death, recurrence of illness)
2. Continuous clinical outcomes: various markers of disease (e.g. disability, pain, quality of life, patient satisfaction, length of stay in hospital). Given our broad scope (all health conditions), it is not possible to pre-specify eligible patient outcomes. We will focus on the core patient-relevant outcomes as specified in that disease area. For example, in the LBP field, physical functioning and health related quality of life are considered core outcomes to measure in clinical trials.

Costs

Any measure of cost of test orders, cost of tests performed, cost per diagnosis, cost of treatment, or overall health care costs.

Adverse effects

Some of the interventions evaluated may have unintended impacts on patient care or health professional workflows. For example, if nudges are intended to reduce the overuse of a certain test, they may lead to the underuse of this test for appropriate populations, or the reductions in use of one test may inadvertently increase the use of another inappropriate test or treatment. We will examine the adverse (undesirable) effects of interventions recommended by the Cochrane EPOC group.[77] These will include adverse effects on

1. Test and treatment delivery or utilisation
2. Health or health behaviours
3. Quality of care
4. Resource use

Where no adverse effects are reported, we will make a distinction between studies where adverse effects were investigated, studies where it is not clear whether adverse effects were investigated, and studies where it is clear that adverse effects were not investigated.

Study selection

One review author (MOK) will download search results to the reference manager software Endnote. De-duplication of results will be completed in the Centre for Research in Evidence Based Practice (CREBP) Systematic Review Accelerator (SRA) deduplication algorithm. This algorithm has greater sensitivity and specificity than Endnote for the deduplication process.[78] Data will be managed in Endnote thereafter. Two review authors (MOK and GF) will independently assess the eligibility of studies by screening titles and abstracts in Endnote for potential inclusion according to the predefined selection criteria. Studies judged to be potentially relevant will be retrieved in full text for further analysis. Any disagreements in judgement will be resolved by discussion to reach a consensus or if this is not possible, with a third review author (AT) until a consensus is reached. If further information about the study is required in order to make a decision about its eligibility, an attempt will be made to contact the study corresponding author(s).

Data Extraction

Two review authors (MOK and AT) will independently extract data for each of the included studies using a modified EPOC data collection checklist. The data extraction spreadsheet will be pilot tested on two included studies to minimize misinterpretation. We will extract information about study design, characteristics of population (country, setting, speciality, number of health professionals, number of patients), details of the interventions using TIDieR items[79]), details of the outcomes (target behaviour, measure of the target behaviour, baseline performance of the health care professional, patient outcome), and study results. If not enough information is provided in the trial report to extract data about intervention effects, we will

contact authors to attempt to obtain the required information. We will calculate data from graphs and figures in cases using https://www.digitizeit.de/ where this information is not presented in tables or text. If any information regarding standard deviations is missing, we will calculate them from the extracted confidence intervals (if available) of the same study.

Risk of Bias Assessment

Two authors (MOK and GF) will assess the risk of bias of all eligible studies using the criteria described in the Cochrane EPOC Group Resources for review authors.[80] Nine standard criteria are suggested for all randomised trials, non-randomised trials and controlled before-after studies. Seven standard criteria are used for all interrupted time series studies. Any disagreements in judgement will be resolved by discussion to reach a consensus or if this is not possible, with another reviewer (AT) until a consensus is reached.

Where possible, we will assess the overall certainty of the evidence using the GRADE approach as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions*.[81]

Data Synthesis

We will follow the Cochrane EPOC guidelines for reporting the effects of interventions.[82] We expect included studies will vary according to study design, health professionals included, setting, types of nudge, and target behaviours. Therefore we expect to report our results in a structured synthesis format, as recommended by the Cochrane EPOC group.

We will separately analyse and report outcome data from different types of study designs. Depending on the studies found, we will also separately analyse and report the outcome data for the difference categories (choice architecture and social nudges) and/or subcategories of nudges (e.g. defaults, pre-commitment). Furthermore, depending on the studies found we will separately analyse and report outcome data on the interventions that target testing or treatment behaviours.

In our structured synthesis, we will try to examine if there are any patterns or variations across different factors and outcomes achieved. Subgroups of interest may include the type of nudge, type of healthcare professional, type of setting, type of target behavior, and whether the study examined a real clinical or hypothetical/simulated situation (e.g. a vignette study).

Dealing with missing data

We will contact authors of included papers if important data are not available.

Patient or Public Involvement

Patients and members of the public will not be involved in the design of this study.

Ethics and dissemination

Formal ethical approval is not required for this study. The results will be disseminated through a peer-reviewed publication and conference presentations.

CONCLUSION

This systematic review will provide evidence in support or against the hypothesis that nudge-interventions aimed at health professionals can address health service overuse and underuse.

The results will have important implications for the implementation of health system interventions to improve professional practice and patient outcomes.

Contributors MOK is the guarantor. All authors contributed to the conception and design of the study. MOK drafted the manuscript and CM provided overall guidance. MOK, JS, and AT developed the nudge-intervention categories. MOK and GF designed the search strategy and picked the risk of bias assessment tool. TH gave specific feedback on data extraction and the analysis plan. All authors commented on drafts of the protocol and added subject-specific expertise where necessary. All authors read the final draft of the manuscript and provided feedback. All authors read and approved the final manuscript.

Competing interests None declared

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Supplementary appendix 1

Row 1: Nudge-intervention terms

Decision Making, Computer-Assisted/ or Medical Records Systems, Computerized/ or Medical Order Entry Systems/ OR exp electronic health records/ OR Electronic Prescribing/ OR ((doctor* or GP or GPs or "general practitioner*" or registrar* OR intern* or medical or pharm* or radiolog* or physician* or patholog* or nurs*) adj3 (order* or form* or request* or prescri*)).tw. OR ((Medication* or test* or scan* or imaging or laboratory) adj2 (order* or form* or request*)).tw. OR medication alert system*.tw. OR electronic health record*.tw OR electronic medical record*.tw. OR default*.tw OR “accountable justification”.tw OR “active choice” OR “public commitment” OR pre-commitment.tw OR medication system*.tw OR (computeri?ed provider order entry or CPOE).tw OR electronic request form*.tw. OR nudge*.tw. OR "choice architecture".tw OR (behavi* adj1 economics).tw. OR (behavi* adj1 insight*).tw. OR nudging.tw. OR "Forms and Records Control"/

AND

Row 2: Overuse or underuse of health service terms

Clinical Laboratory Techniques/ OR Diagnostic Imaging/ OR "Quality of Health Care"/ OR deprescriptions/ OR (influence* adj2 decision*).tw. OR Choice Behavior/ OR ((inappropriate* or unnecessary! or misuse OR underuse OR overuse) adj3 (test* or screening OR imaging or prescrib* or prescription* or laboratory)).tw. OR ((clinical or doctor* or physician* or nurs*) adj2 practice pattern*).tw. OR ((medication* or prescribing or prescription*) adj2 error*).tw. OR test ordering pattern*.tw. OR ((over or under or inappropriate) adj2 (prescrib* or order*)).tw. OR Clinical Competence/ OR Unnecessary Procedures/ OR Inappropriate Prescribing/ OR exp Medication Errors/ OR health services misuse/ or medical overuse/ OR practice patterns, nurses'/ or practice patterns, physicians'/ OR Clinical Decision-Making/ OR practice guideline/

Example of Medline strategy:

(Decision Making, Computer-Assisted/ OR Medical Records Systems, Computerized/ OR Medical Order Entry Systems/ OR exp electronic health records/ OR Electronic Prescribing/ OR ((doctor* OR GP OR GPs OR general practitioner* OR registrar* OR intern* OR medical OR pharm* OR radiolog* OR physician* OR patholog* OR nurs*) ADJ3 (order* OR form* OR request* OR prescri*)).ti,ab. OR ((Medication* OR test* OR scan* OR imaging OR laboratory) ADJ2 (order* OR form* OR request*)).ti,ab. OR medication alert system*.ti,ab. OR electronic health record*.ti,ab. OR electronic medical record*.ti,ab. OR default*.ti,ab. OR accountable justification.ti,ab. OR active choice OR public commitment OR pre-commitment.ti,ab. OR medication system*.ti,ab. OR (computeri?ed provider order entry OR CPOE).ti,ab. OR electronic request form*.ti,ab. OR nudge*.ti,ab. OR choice architecture.ti,ab. OR (behavi* ADJ1 economics).ti,ab. OR (behavi* ADJ1 insight*).ti,ab. OR nudging.ti,ab. OR Forms and Records Control/)

AND

(Clinical Laboratory Techniques/ OR Diagnostic Imaging/ OR Quality of Health Care/ OR deprescriptions/ OR (influence* ADJ2 decision*).ti,ab. OR Choice Behavior/ OR ((inappropriate* OR unnecessary! OR misuse OR underuse OR overuse) ADJ3 (test* OR screening OR imaging OR

prescrib* OR prescription* OR laboratory)).ti,ab. OR ((clinical OR doctor* OR physician* OR nurs*) ADJ2 practice pattern*).ti,ab. OR ((medication* OR prescribing OR prescription*) ADJ2 error*).ti,ab. OR test ordering pattern*.ti,ab. OR ((over OR under OR inappropriate) ADJ2 (prescrib* OR order*)).ti,ab. OR Clinical Competence/ OR Unnecessary Procedures/ OR Inappropriate Prescribing/ OR exp Medication Errors/ OR health services misuse/ OR medical overuse/ OR practice patterns, nurses'/ OR practice patterns, physicians'/ OR Clinical Decision-Making/ OR practice guideline/)

Reporting checklist for protocol of a systematic review.

Based on the PRISMA-P guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the PRISMA-P reporting guidelines, and cite them as:

Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart LA. Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4(1):1.

		Reporting Item	Page Number
Identification	#1a	Identify the report as a protocol of a systematic review	1
Update	#1b	If the protocol is for an update of a previous systematic review, identify as such	n/a
	#2	If registered, provide the name of the registry (such as PROSPERO) and registration number	n/a
Contact	#3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	1
Contribution	#3b	Describe contributions of protocol authors and identify the guarantor of the review	12
	#4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	n/a
Sources	#5a	Indicate sources of financial or other support for the review	12
Sponsor	#5b	Provide name for the review funder and / or sponsor	12
Role of sponsor or funder	#5c	Describe roles of funder(s), sponsor(s), and / or institution(s), if any, in developing the protocol	12
Rationale	#6	Describe the rationale for the review in the context of what is already known	3-5

Objectives	#7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	5
Eligibility criteria	#8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	6-10
Information sources	#9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	5
Search strategy	#10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	5
Study records - data management	#11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	5
Study records - selection process	#11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	10-11
Study records - data collection process	#11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	10-11
Data items	#12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	10-11
Outcomes and prioritization	#13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	8-11
Risk of bias in individual studies	#14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	11
Data synthesis	#15a	Describe criteria under which study data will be quantitatively synthesised	11
	#15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I2, Kendall's T)	n/a
	#15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	11

	#15d	If quantitative synthesis is not appropriate, describe the type of summary planned	11
Meta-bias(es)	#16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	n/a
Confidence in cumulative evidence	#17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	11