Techniques to improve physicians' use of diagnostic tests: a new conceptual framework
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Authors' objectives
To review the published literature on interventions aimed at improving physicians' use of diagnostic tests and to propose methodological standards for these studies. A further aim was to review selected studies using the PRECEDE framework, a behavioural model that helps categorise interventions based on which behavioural factors are being affected.

Searching
MEDLINE, EMBASE and HEALTHstar were searched for articles published between 1966 and January 1, 1998. The MeSH used for keyword and textword searching included: physician behaviour, physician practice patterns, laboratory use, test ordering, decision making, practice guidelines, appropriateness and education. Researchers in health services, health behaviour, and behaviour modification were contacted for proprietary and other nonpublished references. In addition, references of all articles obtained were scanned to identify others of potential interest. Only studies published in English were included.

Study selection
Study designs of evaluations included in the review
Randomised and non-randomised studies were evaluated (the authors state that both were included because few randomised trials of interventions to modify diagnostic test behaviour exist).

Specific interventions included in the review
Interventions to improve physicians' use of diagnostic tests. Interventions were categorised according to the PRECEDE model of behaviour change. PRECEDE incorporates 3 types of factors that precipitate or inhibit behaviour change - predisposing, enabling, and reinforcing factors. Interventions were categorised according to which behavioural factor(s) were primarily targeted in the intervention. Educational interventions (e.g. lectures on cost-effective testing, and distribution of educational material regarding the clinical utility of prothrombin time testing) were considered to target predisposing factors. Utilisation or change audits primarily act to provide feedback and thus were categorised as reinforcing factors. Changes in the administration structure of test ordering (e.g. order form revisions, a limited number of chemistry and hematology tests allowed each day, elimination of standing laboratory orders) were analysed as enabling interventions.

Participants included in the review
Physicians including: first-year medicine residents, internal medicine residents, attending physicians, family medicine residents, surgical medicine residents, all surgery residents, all physicians, general practitioners, primary care physicians, emergency department physicians, family practice residents, and attending and resident physicians in an adult diabetes clinic.

Outcomes assessed in the review
Resource utilisation e.g. change in test volume or charges.

How were decisions on the relevance of primary studies made?
The authors do not state how the papers were selected for the review, or how many of the reviewers performed the selection.

Assessment of study quality
Five methodological characteristics were examined, giving a maximum total methodological score of 38. They were: patient characteristics (such as demographic and clinical characteristics), methods for allocating physicians to control or intervention groups, the delivery system (e.g. was the insurance status of the patients in the control and intervention...
groups described), the strength of evidence supporting a particular intervention (interventions based on published evidence in peer-reviewed publications were rated as highest and those based on consensus were rated lowest), and outcomes (e.g. whether appropriate end points were measured) and analysis (e.g. was the study adequately powered to detect a significant negative result?). Two investigators, blinded to the authors and institution studied, independently applied the methodological criteria. The readers' agreement was examined by calculating an intraclass correlation.

Data extraction
Two investigators independently reviewed each article in a blinded fashion using a standard data collection form to abstract the key elements of each intervention.

Methods of synthesis
How were the studies combined?
Studies were synthesised narratively. Studies that reported reduced test volume or charges during the intervention period were considered successful. The Student t test was used for the analysis of comparative differences between study types.

How were differences between studies investigated?
Tests for heterogeneity were not performed.

Studies were evaluated according to which behaviour factors were targeted. They were divided into the following groups: predisposing (5 studies), reinforcing (11 studies), enabling (5 studies), predisposing and reinforcing (7 studies), reinforcing and enabling (12 studies), predisposing and enabling (1 study) and predisposing, reinforcing and enabling (8 studies).

Results of the review
Forty-nine studies were included in the review. The total number of participants was not stated.

The maximum methodological quality score was 26 points (of a possible 38) with a mean score of 13 (SD = 4.4).

Seventy-six per cent of the interventions reported reduced volume and/or charges for the test(s) being targeted (not all studies calculated tests of statistical significance). Sixty-two per cent (13/21) of interventions aimed at one behavioural factor were successful in changing behaviour, while 86% (24/28) of interventions targeted at more than one behavioural factor reported success (p=0.12). No statistically significant differences between success rates of interventions targeting predisposing, reinforcing, or enabling factors were evident, but there was inadequate power to find small differences.

Three (60%) of the five interventions involving exclusively physicians' knowledge or attitudes (predisposing factors) were successful. In this category, successful interventions targeted selected tests and the duration of effect was unclear.

Seven studies coupled an educational intervention (predisposing factors) with reinforcements, such as utilisation audits and 6 of these successfully changed behaviour. However, when utilisation audits (reinforcing factors) were used without any accompanying educational material (predisposing factors), rates of behaviour change were lower, with 4 (36%) of 11 interventions producing no change.

Changing the system or environment to enable behaviour change was effective in selected situations. Three (60%) of 5 interventions targeting enabling factors produced change.

Utilisation audits used in conjunction with interventions that remove barriers to behaviour change were successful, with 9 (75%) of 12 reporting positive results. When paired with educational strategies, enabling factor interventions produced change in all 8 studies reviewed.

The success rate for studies published before 1985 (59%) was slightly lower than the studies published since 1985 (81%), however this difference did not reach statistical significance.
Authors' conclusions
The majority of interventions aiming to improve physicians’ testing practices claimed success, with interventions based on multiple behavioural factors trending toward being more successful. Enabling factors that facilitate the preferred diagnostic behaviour through blocking improper test orders or defaulting to the intended practice were the most potent. While methodological flaws hamper drawing strong conclusions from the literature, the application of a behavioural framework appears to be useful in explaining interventions that are successful and can then facilitate interpretation of intervention results.

CRD commentary
The review focuses on a well defined question. The search strategy involved an attempt to identify both published and unpublished literature. Inclusion criteria were appropriate and the validity of the primary studies was adequately assessed. The studies were summarised appropriately.

Sufficient details of the individual studies were given where available, however, the authors note that demographic characteristics of patients were described in only 17 studies (35%) and physicians’ age and sex were outlined explicitly in only one study (2%).

The authors note that a possible explanation for why no significant differences were found between success rates of interventions targeting predisposing, reinforcing, or enabling factors is the lack of sufficient power to find small differences. They also point out that since the primary data were generally of low quality, strong conclusions cannot be drawn.

Implications of the review for practice and research
Practice: The authors state that current laboratory and diagnostic imaging practices need to be improved.

They suggest that when utilisation data are being supplied to physicians as part of an intervention, it should be coupled with educational material and documentation of clinical evidence to predispose physicians to the intended behaviour.

Research: The authors suggest that future research attempting to change physicians’ behaviour should incorporate relevant behaviour change models, such as PRECEDE, and apply rigorous evaluations over longer periods of observation.

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This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.