Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review
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CRD summary
This review assessed the effects of computerised-clinical decision support systems (CDSSs) on practitioner performance and patient outcomes. The authors concluded that many CDSSs improve practitioner performance, whereas the effects on patient outcomes were understudied and inconsistent when examined. This was a well-conducted review and the conclusions are likely to be reliable.

Authors' objectives
To assess the effects of computerised-clinical decision support systems (CDSSs) on practitioner performance and patient outcomes and to identify features of successful systems.

Searching
MEDLINE, EMBASE, the Cochrane Database of Systematic Reviews, DARE, the Cochrane CENTRAL Register and Inspec were searched from 1998 to September 2004 for studies published in English; the search terms were reported. The authors identified studies published before 1998 in an earlier review (see Other Publications of Related Interest). Additional studies were sought from reference lists, articles citing included studies as listed in the Science Citation Index, PubMed related feature, informatics conference proceedings, contact with authors of primary studies, and other recent reviews.

Study selection
Study designs of evaluations included in the review
Randomised controlled trials (RCT) and non-randomised controlled trials with a concurrent control group were eligible for inclusion.

Specific interventions included in the review
Studies that compared CDSSs with routine care without CDSS were eligible for inclusion. The studies had to use CDSSs providing patient-specific advice that was reviewed by a health practitioner before any clinical action was taken. Studies of systems that reported only summaries of patient information, provided feedback of groups rather than individuals, only provided computer-aided instruction, or were used for the analysis of images were excluded. Studies assessing the performance of diagnostic CDSS against a defined ‘gold’ standard were excluded unless the study compared care using a diagnostic CDSS with care without CDSS. The review categorised systems by clinical application: diagnosis; reminder systems for prevention; disease management; and drug dosing and drug prescribing. The included studies were mainly conducted in the USA.

Participants included in the review
Studies of systems used solely by medical students were excluded. Users of systems in the included studies were predominantly physicians (92% of studies); other users included health practitioners in training (interns and residents).

Outcomes assessed in the review
Studies that assessed practitioner performance and patient outcomes were eligible for inclusion. The included studies differed considerably in the type and number of outcomes measured. The review assessed success of the CDSS, defined as an improvement of 50% or more in the outcomes measured.

How were decisions on the relevance of primary studies made?
Pairs of reviewers selected the studies and resolved any disagreements through consensus or with the help of a third reviewer. Inter-rater agreement was good (kappa 0.81).
Assessment of study quality
All of the studies were scored on a 10-point scale that assessed the method of treatment allocation, unit of allocation, baseline differences between the treatment groups, objectivity of outcome measures and completeness of follow-up. Further details of the scoring system were reported.

Studies were also assessed for adjustment for clustering in cluster RCTs and the use of a power calculation.

The authors did not state who performed the validity assessment.

Data extraction
Pairs of reviewers extracted the data and resolved any disagreements through consensus or with the help of a third reviewer. The original authors were contacted for missing data and to verify extracted data. The data extracted included all reported practitioner and patient health outcomes. Descriptive measures, including proportions for categorical measures and means and standard deviations for continuous measures, were also extracted.

Methods of synthesis
How were the studies combined?
The studies were grouped according to clinical application and combined in a narrative.

How were differences between studies investigated?
In addition to grouping according to clinical application, the association between outcomes and characteristics of studies was examined using univariate and multivariate logistic regression. The study characteristics examined were defined a priori and included: automatic prompting of users, or users required to activate the system; system part of medical record or computer order entry system, or not; the provision of reminders or information; study quality; study authors were also developers of the system, or not; pilot testing described; and user training described.

Results of the review
One hundred studies were included (3,826 practitioners or practices, caring for more than 92,895 patients). Of these, 88 were RCTs.

The mean quality score was 7 (range: 2 to 10). Fifty-two per cent of the RCTs described an appropriate method of treatment allocation and 28% reported allocation concealment.

Overall, the CDSS improved outcomes in 62 (64%) of the 97 studies assessing practitioner performance and 7 (13%) of the 52 studies assessing patient outcomes.

Systems for diagnosis (10 studies): 4 of the 10 studies assessing practitioner performance found benefit from the CDSS. Successful systems were diagnostic systems for cardiac ischaemia in emergency department (2 studies), mood disorder screening in a post-traumatic stress clinic (1 study), and the diagnosis of acute bowel obstruction (1 study). None of the 5 studies assessing patient outcomes found success.

Reminder systems for prevention (21 studies): 16 of the 21 studies assessing practitioner performance found benefit from the CDSS. The outcomes included rates of screening, counselling, vaccination, testing use of medication, or identifying at-risk behaviours. Successful systems were reported mainly for ambulatory care. The single study assessing patient outcomes found no improvement in the primary analysis.

Systems for disease management (40 studies): 23 of the 37 studies assessing practitioner performance found benefit from the CDSS. Success with CDSS was found for: 5 of the 7 studies of diabetes care; 5 of the 13 studies of cardiovascular prevention; 6 of the 9 studies of urinary incontinence, human immunodeficiency virus management, functional assessment and acute respiratory distress syndrome; all 4 studies monitoring the effects of prescribed treatment; and 3 of the 4 studies aimed at reducing unnecessary health care utilisation. Five of the 27 studies assessing patient outcomes found benefit from the CDSS. Improvements were found for blood-pressure control (1 study), urinary incontinence (1 study), barotrauma and organ dysfunction in ventilated patients (1 study), patient-reported
exacerbations of asthma (1 study), and length of hospital stay (1 study).

Systems for drug dosing and drug prescribing (29 studies): 15 of the 24 single-drug dosing studies assessing practitioner performance found benefit from the CDSS; 2 of the 18 single-drug studies assessing patient outcomes also found benefit from the CDSS. Four of the 5 multi-drug prescribing studies assessing practitioner performance found benefit from the CDSS, but none improved patient outcomes. Factors associated with CDSS success in improving practitioner performance were automatic prompting to use the system compared with user activated (odds ratio adjusted for study quality 3.0, 95% confidence interval: 1.2, 7.1) and studies where the study authors developed the system compared with those where the authors were not developers (odds ratio 6.6, 95% confidence interval: 1.7, 26.7).

Authors’ conclusions
Many CDSSs improved practitioner performance, but the effects on patient outcomes were understudied and inconsistent when examined.

CRD commentary
The review question was clear in terms of the study design, intervention and outcomes. Several relevant sources were searched, the search terms were stated and attempts were made to locate unpublished data, thus minimising the potential for publication bias. However, by limiting the included studies to those in English, the authors might have missed some relevant studies. Two reviewers independently selected the studies and extracted the data, thus reducing the potential for bias and errors. Validity was assessed using specified established criteria.

Adequate details of each included study were given. Defining a primary outcome of success would seem to be a reasonable method of summarising such diverse and numerous studies. The narrative synthesis using descriptive summary measures was appropriate, although it might have been useful to have examined the results from RCTs separately. However, the authors assessed the influence of five predetermined study characteristics on the results, including study quality. The authors’ conclusions are likely to be reliable.

Implications of the review for practice and research
Practice: The authors did not state any implications for practice.

Research: The authors stated that further research is required to assess the effects of CDSSs on the patients’ health.

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Record Status
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.