



September 2009 – SUPPORT Summary of a systematic review

# Do Computerized Clinical Decision Support Systems have effects on Practitioner Performance and Patient Outcomes?

Computerized clinical decision support systems (CDSSs) are information systems designed to improve clinical decision making. Characteristics of individual patients are matched to a computerized knowledge base, and software algorithms generate patient specific recommendations.

These systems provide several modes of decision support, including alerts of critical values, reminders of overdue preventive health tasks, advice for drug prescribing, critiques of existing health care orders, and suggestions for various active care issues.

## Key messages

- CDSS for diagnosis and reminders for prevention may improve the practitioner performance and may not lead to any difference in the patient outcomes.
- Reminder systems probably improve practitioner performance in ambulatory care.
- CDSS for disease management may improve the practitioner performance.
- CDSS for disease management lead to slightly more improvements in patient outcome compared to conventional disease management.
- CDSS for Drug Dosing and Drug Prescribing may improve the practitioner performance and may not lead to any difference in patient outcomes.
- All studies were done in high-income countries, and to establish and use electronic information systems may present challenges in low-income countries where these systems are lacking.



## Who is this summary for?

People deciding whether to introduce prompts to physicians in different clinician settings.

### ! This summary includes:

- Key findings from research based on a systematic review
- Considerations about the relevance of this research for low- and middle-income countries

### X Not included:

- Recommendations
- Additional evidence not included in the systematic review
- Detailed descriptions of interventions or their implementation

## This summary is based on the following systematic review:

Garg X., Neill A., McDonald H., Rosas-Arellano M.P., Devereaux P.J., Beyene J., Sam J., Haynes R.B. Effects of Computerized Clinical Decision Support Systems on Practitioner Performance and Patient Outcomes: A Systematic Review JAMA. 2005;293:1223-1238.

## What is a systematic review?

A summary of studies addressing a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise the relevant research, and to collect and analyse data from the included studies.

**SUPPORT** – an international collaboration funded by the EU 6th Framework Programme to support the use of policy relevant reviews and trials to inform decisions about maternal and child health in low- and middle-income countries.  
[www.support-collaboration.org](http://www.support-collaboration.org)

**Glossary of terms used in this report:**  
[www.support-collaboration.org/summaries/explanations.htm](http://www.support-collaboration.org/summaries/explanations.htm)

**Background references on this topic:**  
See back page.

# Background

Developers of health care software have attributed improvements in patient care to these applications. Compared with manual clinical decision support systems automatic systems may improve integration into practitioner workflow as well as provide better opportunities to correct inadvertent deficiencies in health care. Many evaluations have shown that many CDSSs improve practitioner performance. However, further research is needed to elucidate the effects of such systems on patient health. As with any health care innovation, CDSSs should be rigorously evaluated before widespread dissemination into clinical practice. This study evaluated the effectiveness of CDSSs on practitioner performance and patient outcomes and updated earlier reviews from the authors.

## How this summary was prepared

After searching widely for systematic reviews that can help inform decisions about health systems, we have selected ones that provide information that is relevant to low- and middle-income countries. The methods used to assess the quality of the review and to make judgements about its relevance are described here: [www.support-collaboration.org/summaries/methods.htm](http://www.support-collaboration.org/summaries/methods.htm)

## Knowing what's not known is important

A good quality review might not find any studies from low- and middle-income countries or might not find any well-designed studies. Although that is disappointing, it is important to know what is not known as well as what is known.

## About the systematic review underlying this summary

**Review objective:** To review controlled trials assessing the effects of computerized clinical decision support systems (CDSSs) and to identify study characteristics predicting benefit patient outcomes.

	What the review authors searched for	What the review authors found
<b>Interventions</b>	Randomized and nonrandomized controlled trials that evaluated the effect of a CDSS compared with care provided without a CDSS on practitioner performance or patient outcomes.	100 trials met the defined criteria. 88% were randomized. Of the randomized trials, 49% were cluster randomized and 40% used a cluster as the unit of analysis or adjusted for clustering in the analysis. Ninety seven trials described the effect of CDSS on at least 1 measure of health care practitioner performance. Fifty-two trials assessed at least 1 patient outcome.
<b>Participants</b>	The population of interest was composed of Physicians and Practitioners in practice or training.	92% of trials enrolled physicians as primary users, 48% enrolled training health care practitioners (interns and residents) as users, 34% described pilot testing with users prior to implementation and 42% described user instructional training at the time of implementation
<b>Settings</b>	Any clinical setting.	76% of trials took place in academic centers, and 33% were inpatient-based. Most of them were conducted in the United States (69%), followed by the United Kingdom (14%), Canada (5%), Australia (4%), Italy(2%), and Austria, France, Germany, Israel, Norway, and Switzerland (1% each).
<b>Outcomes</b>	The outcomes assessed were the effect of CDSSs on clinician performance, a measure of the process of care, or patient outcomes.	A myriad of outcomes were measured using CDSS for diagnosis, reminder system for prevention, disease management and Drug Dosing and Drug Prescribing

**Date of most recent search:** September 2004.

**Limitations:** : This is a well conducted systematic review. However it is limited by restriction of the searches to English-language studies and the methods used for data analysis.

Garg X., Neill A., McDonald H., Rosas-Arellano M.P., Devereaux P.J., Beyene J., Sam J., Haynes RB. Effects of Computerized Clinical Decision Support Systems on Practitioner Performance and Patient Outcomes: A Systematic Review JAMA. 2005;293:1223-1238.

# Summary of findings

The review included 100 studies. All the studies were Randomized and non Randomized Controlled Trials and were done in high-income settings (mostly in the USA).

## 1) Computerized systems for diagnosis compared to conventional diagnosis

There were 10 trials evaluating diagnostic system in mental health, for acute cardiac ischemia and for a few other conditions. All the studies measured practitioner performance and 5 studies assessed patient outcomes

→ **Computerized systems for diagnosis may improve the practitioner performance and may not lead to any difference in the patient outcomes.**

### About the quality of evidence (GRADE)



**High:** Further research is very unlikely to change our confidence in the estimate of effect.



**Moderate:** Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.



**Low:** Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.



**Very low:** We are very uncertain about the estimate.

For more information, see last page

Computerized systems for diagnosis compared to conventional diagnosis				
<p><b>Patients or population:</b> Physicians and Practitioners in practice or training  <b>Settings:</b> Ambulatory care, emergency rooms and paediatric and surgical hospital services  <b>Intervention:</b> Computerized systems for diagnosis  <b>Comparison:</b> Conventional diagnosis</p>				
Outcomes	Impact* (VC)	Number of participants (studies)	Quality of the evidence (GRADE)	Comments
<b>Practitioner performance</b>	4 out of 10 studies demonstrated the CDSSs was beneficial	10 studies	⊕⊕○○ Low	2 successful studies decreased the rate of unnecessary hospital or coronary admission by 15% The third increased mood disorder screening in a posttraumatic stress disorder clinic by 25% The fourth improved the time to diagnosis of acute bowel obstruction by 94%
<b>Patient outcomes</b>	No improvement reported (0%)	5 studies	⊕⊕○○ Low	

p: p-value    GRADE: GRADE Working Group grades of evidence (see above and last page)

## 2) Computerized reminder systems for prevention compared to conventional prevention

There were 21 trials evaluating reminder systems in cancer screening, vaccination and preventive care. Performance outcomes were usually rates of screening, counselling, vaccination, testing, medication use or the identification of risk behaviors. All trials measured performance and only one study evaluated patient outcomes

- Computerized reminder systems for prevention may improve practitioners' performance
- Reminder systems probably improve practitioners' performance in ambulatory care
- Computerized reminder systems may not lead to any difference in patient outcomes

Computerized reminder system for prevention compared to conventional prevention				
<p><b>Patients or population:</b> Physicians and Practitioners in practice or training  <b>Settings:</b> Ambulatory care and hospital services  <b>Intervention:</b> Computerized reminder system for prevention  <b>Comparison:</b> Conventional prevention</p>				
Outcomes	Impact* (VC)	Number of participants (studies)	Quality of the evidence (GRADE)	Comments
Practitioner performance	16 out of 21 studies demonstrated CDSS was beneficial	21 studies	⊕⊕○○ Low	Post hoc subgroup analyses demonstrated a significant reduction in winter hospitalization and emergency department visits in patients eligible for pneumococcal or influenza vaccination.
Patient outcomes	No improvement reported (0%)	1 study	⊕⊕○○ Low	
p: p-value    GRADE: GRADE Working Group grades of evidence (see above and last page)				

### 3) Computerized system for disease management compared to conventional disease management

There were 40 studies of CDSSs for active health conditions including diabetes, cardiovascular prevention and a myriad of different non-classified conditions.

For diabetes care, practitioner performance was usually judged by rates of retinal, foot, urine protein, blood pressure, and cholesterol examinations. In studies of cardiovascular prevention, performance was judged by blood pressure and cholesterol assessment, identification of smoking, and use of cardio protective medications.

- Computerized systems for disease management may improve practitioners' performance
- For diabetes management and cardiovascular prevention more precise data findings are provided
- Computerized systems for disease management lead to slightly more improvements in patient outcomes

System for disease management compared to conventional disease management				
<b>Patients or population:</b> Physicians and Practitioners in practice or training <b>Settings:</b> Ambulatory care, emergency rooms, hospital services and nursing homes <b>Intervention:</b> System for disease management <b>Comparison:</b> Conventional disease management				
Outcomes	Impact* (VC)	Number of participants (studies)	Quality of the evidence (GRADE)	Comments
<b>Practitioner performance</b>	23 out of 37 studies measuring this outcome improved some measure of practitioner performance	37 studies	⊕⊕○○ Low	For diabetes care 71% of trials reported improvements In studies of cardiovascular prevention 38% of 13 trials reporting improvements
<b>Patient outcomes</b>	Of the 27 trials measuring patient outcomes, 5 (18%) demonstrated improvements.	27 studies	⊕⊕○○ Low	One CDSS improved blood pressure control. A second CDSS reduced urinary incontinence in nursing home residents over a10-week period. A third CDSS improved scores of barotraumas and organ dysfunction in mechanically ventilated patients with acute respiratory distress syndrome. A fourth CDSS reduced patient-reported asthma exacerbations, emergency nebulizer use, and the need for additional consultations for asthma management. A fifth CDSS reduced hospital length of stay patients with a variety of general medical diagnoses.
p: p-value GRADE: GRADE Working Group grades of evidence (see above and last page)				

## 4) Computerized system for Drug Dosing and Drug Prescribing compared to conventional Drug dosing and prescribing

There were 29 trials of drug dosing and prescribing. 24 of them assessed single-drug dosing and 5 multiple drug prescribing

→ **Computerized systems for Drug Dosing and Drug Prescribing may improve practitioners' performance, but may not lead to any difference in patient outcomes**

System for Drug Dosing and Drug Prescribing				
<p><b>Patients or population:</b> Physicians and Practitioners in practice or training  <b>Settings:</b> Ambulatory care, emergency rooms and hospital services  <b>Intervention:</b> System for Drug Dosing and Drug Prescribing  <b>Comparison:</b> Conventional Drug dosing and prescribing</p>				
Outcomes	Impact* (VC)	Number of participants (studies)	Quality of the evidence (GRADE)	Comments
<b>Practitioner performance</b>	15 out of 24 single drug dosing and 4 out of 5 multiple drug prescribing studies improved some measure of practitioner performance	29 studies	⊕⊕○○ Low	The 24 single-drug dosing systems ranged from a simple calculator for parenteral nutrition to more complex algorithms that considered the pharmacokinetics of warfarin, aminoglycosides, or theophylline.
<b>Patient outcomes</b>	2 out of 18 single drug dosing studies improve some measure of patient outcomes.	18 studies	⊕⊕○○ Low	The majority of patient outcomes measured were not improved in these trials.
p: p-value    GRADE: GRADE Working Group grades of evidence (see above and last page)				

# Relevance of the review for low- and middle-income countries

## → Findings

## ▷ Interpretation\*

### APPLICABILITY

- All studies were conducted in high-income countries
- All the interventions were very different, as were the populations and settings.
- 76% of the studies took place in academic Centers.
- Better performance was identified in studies in which the trial authors also developed the CDSS software.
- Review included only English-language studies

- ▷ *Important issues in adopting CDSS include user acceptance, workflow integration, compatibility with legacy applications, system maturity and upgrade availability. Availability of computers or electricity and back up generators in resource poor settings that are not on the power grid should be considered.*
- ▷ *Patient reminders or some mechanism to involve patients, might be used to achieve better preventive care performance.*
- ▷ *The strict definitions for inclusion and improvement of a CDSS may have underestimated the influence of some system and study methodological factors on CDSS success*

### EQUITY

- The included studies provide no data about differential effects of the intervention in disadvantaged populations.

- ▷ *Strategies and resources explicitly pointed to disadvantaged populations might reduce health inequity in preventive care. However the challenges of establishing CDSS, eg lack of computers especially in LIC that do not routinely use electric records, will limit their use in these settings and may therefore limit access to disadvantaged populations.*

### ECONOMIC CONSIDERATIONS

- The included studies provide no data about cost of the interventions.
- Most CDSSs used research funding to facilitate implementation. Up to 21% of trials used staff paid by research funds for data entry or CDSS recommendation delivery

- ▷ *Although some studies have assessed the costs when outcomes were improved, the cost effectiveness of these systems remains unknown*
- ▷ *The cost of CDSS could be higher for a practice without computers or a database, which could be the situation in LMICs.*
- ▷ *Resources available for implementing CDSS need to be considered when assessing whether the intervention effects are likely to be transferable to settings in low- and middle-income countries.*
- ▷ *Funding for support personnel and health personnel training is an additional cost to be considered.*

### MONITORING & EVALUATION

- In this study, effects of CDSS over performance and patient outcomes were assessed.

- ▷ *CDSS with improved technical performance and usability are proliferating in some high- and middle-income countries. Further rigorous evaluations particularly in relation to their effect on patient health and in LMIC are needed. .*
- ▷ *Economic evaluations should be included in future primary studies about CDSS.*

\*Judgements made by the authors of this summary, not necessarily those of the review authors, based on the findings of the review and consultation with researchers and policymakers in low- and middle-income countries. For additional details about how these judgements were made see:

<http://www.support-collaboration.org/summaries/methods.htm>

# Additional information

## Related literature

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## This summary was prepared by

Gabriel Bastías and Cristian Herrera, Pontificia Universidad Católica de Chile, Chile

## Conflict of interest

None declared. For details, see: [www.support-collaboration.org/summaries/coi.htm](http://www.support-collaboration.org/summaries/coi.htm)

## Acknowledgements

This summary has been peer reviewed by: Fernando Althabe, Argentina, Mike English, Kenya, Tracey Perez Koehlmoos, Bangladesh

## This summary should be cited as

Gabriel Bastías and Cristian Herrera. Do the Computerized Clinical Decision Support Systems have effects on Practitioner Performance and Patient Outcomes? A SUPPORT Summary of a systematic review. March 2009. [www.support-collaboration.org/summaries.htm](http://www.support-collaboration.org/summaries.htm)

## Keywords

*All Summaries:* evidence-informed health policy, evidence-based, systematic review, health systems research, health care, low- and middle-income countries, developing countries, primary health care.

## About quality of evidence (GRADE)

The quality of the evidence is a judgement about the extent to which we can be confident that the estimates of effect are correct. These judgements are made using the GRADE system, and are provided for each outcome. The judgements are based on the type of study design (randomised trials versus observational studies), the risk of bias, the consistency of the results across studies, and the precision of the overall estimate across studies. For each outcome, the quality of the evidence is rated as high, moderate, low or very low using the definitions on page 3.

### For more information about GRADE:

[www.support-collaboration.org/summaries/grade.htm](http://www.support-collaboration.org/summaries/grade.htm)

## SUPPORT collaborators:

**The Alliance for Health Policy and Systems Research (HPSR)** is an international collaboration aiming to promote the generation and use of health policy and systems research as a means to improve the health systems of developing countries. [www.who.int/alliance-hpsr](http://www.who.int/alliance-hpsr)

**The Cochrane Effective Practice and Organisation of Care Group (EPOC)** is a Collaborative Review Group of the Cochrane Collaboration: an international organisation that aims to help people make well informed decisions about health care by preparing, maintaining and ensuring the accessibility of systematic reviews of the effects of health care interventions.

[www.epocoslo.cochrane.org](http://www.epocoslo.cochrane.org)

**The Evidence-Informed Policy Network (EVIPNet)** is an initiative to promote the use of health research in policymaking. Focusing on low- and middle-income countries, EVIPNet promotes partnerships at the country level between policy-makers, researchers and civil society in order to facilitate both policy development and policy implementation through the use of the best scientific evidence available. [www.evipnet.org](http://www.evipnet.org)

### For more information:

[www.support-collaboration.org](http://www.support-collaboration.org)

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