

Computerised decision support systems in order communication for diagnostic, screening or monitoring test ordering: systematic reviews of the effects and cost-effectiveness of systems

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Executive summary

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Executive summary

Background

Order communication systems (OCS) [termed Computerised Physician Order Entry (CPOE) systems in the USA] are computer applications used to enter diagnostic and therapeutic patient care orders, for example laboratory test requests or prescriptions, and to view test results. Many potential benefits of OCS have been identified. These include improvements in clinician ordering patterns, optimisation of clinical time, and aiding communication processes between clinicians and different departments. These systems have the potential to automate the clinical test ordering process and to improve the quality and safety of patient care.

Many OCS now include computerised clinical decision support systems (CDSS), which are information systems designed to improve clinical decision-making. CDSS match individual patient characteristics to a computerised knowledge base, and software algorithms generate patient-specific recommendations. Health-care practitioners or patients can manually enter patient data into the computer system, or alternatively, and increasingly commonly, electronic medical records can be queried for patient data retrieval. Computer-generated recommendations are delivered to the clinician through the electronic medical record, by pager, or through printouts, which may be placed in a patient's paper notes. These systems provide several modes of decision support, including alerts of critical values, reminders of overdue preventative health tasks (including laboratory or radiology imaging tests), advice for drug prescribing, critiques of existing health-care orders, and suggestions around various care issues. The implementation of CDSS is time-consuming, complex and costly.

Objectives

The objectives of this report were to address the following questions:

1. Which CDSS in OCS for diagnostic, screening, or monitoring test ordering are currently in use within the UK, and what are their main

characteristics and their intended/actual scope of use?

2. What is the impact of CDSS in OCS for diagnostic, screening or monitoring test ordering compared to OCS without CDSS on process outcomes, patient outcomes and adverse events/safety?
3. What features of CDSS are associated with clinician or patient acceptance of CDSS in OCS?
4. What is known about the cost-effectiveness of CDSS in diagnostic, screening or monitoring test OCS compared to OCS without CDSS?

Methods

Study question one: CDSS for diagnostic, screening and monitoring test ordering OCS currently in use or being implemented in the UK were identified through contact with the 24 manufacturers/suppliers currently contracted by the National Project for Information Technology [NpFIT (service category 2.20)] to provide either national or specialist decision support. Manufacturers were contacted by e-mail and asked to stipulate whether their specific system was currently in use or being implemented in the UK. They were additionally asked to state the number and at which sites their CDSS were installed. Where they considered this data to be commercial-in-confidence (CIC) they were asked to state this, but at least respond as to whether the CDSS was currently deployed in the UK. Non-responders to the survey were followed-up twice, at two weekly intervals.

Study questions two, three and four: A generic search to identify potentially relevant studies for inclusion in the three systematic reviews was conducted on a range of medical, social science and economic databases between 1974 and 2009; with a total of 22,109 titles and abstracts screened for inclusion. The following study designs were included:

- randomised controlled trials (RCTs)
- cluster randomised controlled trials (CRCTs)
- controlled clinical trials with a contemporaneous control group (CCTs)

- interrupted time series (ITS)
- controlled and uncontrolled pre–post studies (CPP and UPP).

In addition, for the systematic review of economic evaluations and cost–comparison studies, full cost–effectiveness analyses, cost–utility analyses, cost–consequence analyses, and cost–comparison studies were included. The intervention of interest was CDSS, which for the purpose of the reviews was defined as ‘an active knowledge system that uses two or more items of patient data to generate patient-specific assessments or recommendations that are then presented to clinicians for consideration’. For studies to be included in review questions two and four, the CDSS had to be compared to the use of an OCS alone, whereas for review question three, a comparison with OCS alone was not necessarily required for inclusion. To be eligible for inclusion all studies needed to have been conducted either with health-care workers in practice or training, or patients undergoing testing for diagnostic, screening or monitoring purposes. Studies in which the CDSS had not been evaluated in a clinical setting were excluded. Likewise, studies in which the system: (1) only provided summaries of patient information (i.e. no specific test ordering or test interpretative advice was provided); (2) gave aggregate feedback on groups of patients without individual assessment; (3) only provided computer-aided instruction (i.e. provided generic rather than patient-specific advice); or (4) was used in image analysis were excluded.

Outcomes for review question two included objective measures of process of care, for example, test volumes, rates of compliance with CDSS-based guidelines, patient outcomes, and adverse events. Studies which only reported the diagnostic accuracy of the CDSS compared to a gold standard (such as a diagnosis reached by the clinician without use of the CDSS) (i.e. sensitivity and specificity) were excluded. For review question three, the outcome of interest was acceptability of CDSS to clinicians or patients and for review question four the cost-effectiveness of the CDSS plus OCS versus OCS alone.

The reviews were undertaken using standard systematic review methods, with studies being screened for inclusion, data extracted and quality assessed by two reviewers. Results were broadly grouped for each question according to the type of CDSS intervention and study design where possible. These were then combined using a narrative synthesis with relevant quantitative results tabulated.

Results

Study question 1: Which CDSS in OCS for test ordering are currently in use within the UK, and what are their main characteristics and their intended/actual scope of use?

The response rate from the survey of manufacturers and suppliers under the additional Supply and Capacity contract (ASCC) was extremely low at only 17%, with only four manufacturers providing any type of feedback. All of this was classified as being CIC, and therefore did little to provide any information on the current deployment of CDSS within the NHS.

Study question 2: What is the impact of CDSS in OCS for diagnostic, screening or monitoring test ordering compared to OCS without CDSS on process outcomes, patient outcomes and adverse events/safety?

Twenty-four studies reported in 23 publications met the inclusion criteria for the review. These consisted of seven CRCTs (29%), four RCTs (17%), two non-randomised controlled trials (8%), one randomised crossover trial (4%), two ITS studies (8%), one controlled pre–post study (CPP, 4%), and seven uncontrolled pre–post studies (UPP). Duration of follow-up varied widely with a median of 7 months (range: 2–72).

In terms of the study settings, 17 (71%) of the studies were conducted in the USA, followed by two (8%) each conducted in the UK and Spain, with the remaining three studies conducted in France, the Netherlands and Belgium (4% each) respectively. Of the 17 studies conducted in the USA, 12 had been undertaken at three large academic centres that are well renowned for being ‘leaders’ at the forefront of CDSS and OCS development and implementation: the Wishard Memorial Hospital, Indianapolis, IN; Brigham and Women’s Hospital, Boston, MA; and the Vanderbilt University Medical Centre. The systems used within these centres are all home-grown, and sharply focused on specific wards or units, and/or display a technical novelty side to their investigation. Only two studies were conducted within the UK. Both of these were focused on specific patient groups, namely screening patients for hyperlipidemia, and those being assessed for or undergoing liver transplantation. Both of these studies and therefore the systems assessed were relatively old with the studies published in 1994 and 1996 respectively.

There was considerable heterogeneity between the identified studies in terms of the type of CDSS assessed, the settings in which the studies were conducted, the patient populations, whether the studies focused on the impact of the CDSS on a single type of laboratory or imaging test order or on multiple tests and the study designs. All the studies focused upon the decision to order a test, its appropriateness and timing. No studies were identified that addressed the results reporting process within CDSS, with the provision of context specific interpretative comments to help interpretation of test results by clinicians.

However, the studies could broadly be grouped into those assessing: (1) the impact of presenting test charges ($n = 3$); (2) previous test results ($n = 2$); (3) reminders to undertake preventative care measures or laboratory test medication monitoring ($n = 10$); (4) studies that displayed restricted lists of test orders ($n = 2$); and (5) those in which the CDSS provided a recommendation ($n = 7$).

The results of the studies were generally highly mixed and equivocal, often both within and between studies, but broadly showed a beneficial impact of the use of CDSS in conjunction with OCS over and above OCS alone. Overall, if the findings of both primary and secondary outcomes are taken into account, then CDSS significantly improved practitioner performance in 15 out of 24 studies (62.5%), including:

- one of three studies (33.33%) assessing the impact of the display of costs
- one of the two studies (50%) assessing the impact of the display of previous test results
- six of the 10 studies (60%) examining the use of reminders
- one of the two studies (50%) that used the display of previous test results
- and two of the seven studies (28.6%) that assessed the impact of the display of recommendations.

Four studies also assessed the impact of test cancellation or delay on potential adverse events. There were no significant differences between treatment groups in any of these four trials in terms of extra health-care utilisation by patients or adverse events. Therefore the impact of cancelling either costly or redundant tests on adverse outcomes currently appears to be negligible.

Study question 3: What features of CDSS are associated with clinician or patient acceptance of CDSS in order communication systems?

A total of 31 papers were screened for relevance for this question. However, none met the inclusion criteria. It was therefore not possible to address this question in this assessment.

Study question 4: What is known about the cost-effectiveness of CDSS in diagnostic, screening or monitoring test order communication systems compared to order communication systems without CDSS?

Only two studies met the inclusion criteria, both of which were cost-comparison analyses. These were contained within studies of the impact of CDSS plus OCS versus OCS alone which had been included in the review for question 2. One of the studies, conducted in the Netherlands, focused on a cost-comparison between the use of CDSS that showed an optimal but restricted list of blood tests versus OCS alone (unrestricted lists), while the other, conducted in Spain, focused on the cost impact of using CDSS guideline recommendations in the management of patients with hyperlipidemia. Both of the studies found the use of CDSS plus OCS versus OCS alone had no significant impact on test costs.

The Dutch study reported a mean cost decrease of 3% for blood tests orders (€639) in each of the intervention clinics compared with a 2% (€208) increase in control clinics in test costs. However, this difference failed to reach conventional levels of statistical significance. The Spanish study reported a significant increase in the cost of laboratory tests from €41.8 per patient per annum to €47.2 after implementation of the system.

Conclusions

Review question 1: Although a survey of manufacturers and suppliers under the ASCC was undertaken to establish the present deployment or implementation of CDSS within the NHS, the survey response rate was extremely low at only 17%. Most of the very limited data provided by contractors was designated as being CIC and therefore it was not possible to address the question of which CDSS are currently being used within the NHS in this assessment by this method.

Review question 2: The findings from the review on the impact of CDSS plus OCS versus OCS alone are mixed and equivocal. Overall, if the findings of both primary and secondary outcomes are taken into account then CDSS showed a statistically significant benefit on either process or practitioner performance outcomes in nearly two-thirds of the studies. Furthermore, in four studies that assessed adverse effects of either test cancellation or delay, no significant detrimental effects in terms of additional utilisation of health-care resources or adverse events were observed. However, none of the studies assessed patient outcomes such as complications, disease progression or quality of life, and therefore it is unclear whether the use of CDSS either for curtailing unnecessary or redundant tests, or increasing the appropriateness of tests and their timing has any potential impact on health-care outcomes that are relevant to patients. Also, although CDSS appears to have a potentially small positive impact on diagnostic, screening or monitoring test ordering, the majority of the studies come from a limited number of institutions in the USA with 'home-grown' systems, and it is unclear how well these results would extrapolate to the current NHS situation in which 'off the shelf' systems are being installed. Furthermore, it should be noted that the studies included in this review ranged in year of publication from 1980 to 2009; with 10 of the studies published within the last 4 years. Therefore, potentially the older systems evaluated in this review will now be obsolete, and many of the systems will have been changed and upgraded in light of the constant changes in the demand for different technologies.

Review question 3: No studies were identified which assessed the features of CDSS that are associated with clinician or patient acceptance of CDSS in OCS in the test ordering process. This question therefore could not be addressed in this review.

Review question 4: Given the very limited data available on the cost-effectiveness of CDSS plus OCS compared with OCS alone, and the highly specific indications in which both of the identified studies were undertaken, it is not possible to extrapolate findings to the wider context in which diagnostic, screening or monitoring test ordering occurs within the NHS. It is therefore not possible to comment on the likely cost-effectiveness of CDSS within OCS as they would be implemented and used within a wider NHS clinical setting at this time.

Suggested research priorities

There is a need to establish which CDSS in OCS are currently being piloted, implemented or already deployed within the NHS and the type of systems (e.g. hospital or laboratory information systems) with which they interface. A comprehensive survey of individual Strategic Health Authorities, user sites, primary care trusts, Connecting for Health via their IT investment survey, pathology services, the Royal Colleges of Pathologists, and Radiologists is therefore warranted to establish which systems are in place or likely to be implemented within the context of the NpFIT. The results of such a survey would hopefully inform system commissioners as to the best manner in which to conduct a rigorous evaluation of the CDSS within OCS that are already being implemented or currently 'rolled out'.

Currently there is very little evidence from the UK on the impact of CDSS in OCS compared to OCS alone, and no evidence on the impact of 'off the shelf' CDSS which are of relevance to the NpFIT and the NHS. There is therefore a need to establish whether there is any 'grey' literature available from NHS Trusts that have already implemented OCS as this would be potentially of use in informing how to design and implement evaluation studies of CDSS within OCS within the NHS.

We believe the key current need is for a well designed and comprehensive survey, and on the basis of the results of this potentially for evaluation studies in the form of CRCTs or RCTs which incorporate process, and patient outcomes, as well as full economic evaluations alongside the trials to assess the impact of CDSS in conjunction with OCS versus OCS alone for diagnostic, screening or monitoring test ordering in the NHS. The economic evaluation should incorporate the full costs of potentially developing, testing, and installing the system, including staff training costs.

Study registration

This study is registered as 61.

Publication

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NIHR Health Technology Assessment programme

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