

Running Order

All timings approximate

1300 -13:10 Introductions and CWs questions

1310 - 14:10 Origins and progress of evidence-based medicine - Prof Jeremy Wyatt

1410 - 14:20 Break

1420 - 15:00 NCIG - Prof Philip Scott

1500 - 15:30 CDS Refresh - Dr Ed Conley

1530 close



The Digital Professional for Health and Care

BMDS7003 29 Jan 2026

CDS Refresh and Overview of Self-Studies

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Learning Objectives

- 1 – Refresh/reminder/reinforcement of some important of CDS from the last Sync sessions**
- 2 – Step through the topics you will see in self-studies – high level only**
- 3 – Conceptual link of CDS by means of AI**

Some Key Perspectives of CDS

1 – CDS is workflow engineering: the right support, to the right person, at the right time, in the right channel.

CDS intervention succeeds only when it fits naturally into the real sequence of clinical actions, cognitive load, and social interaction.

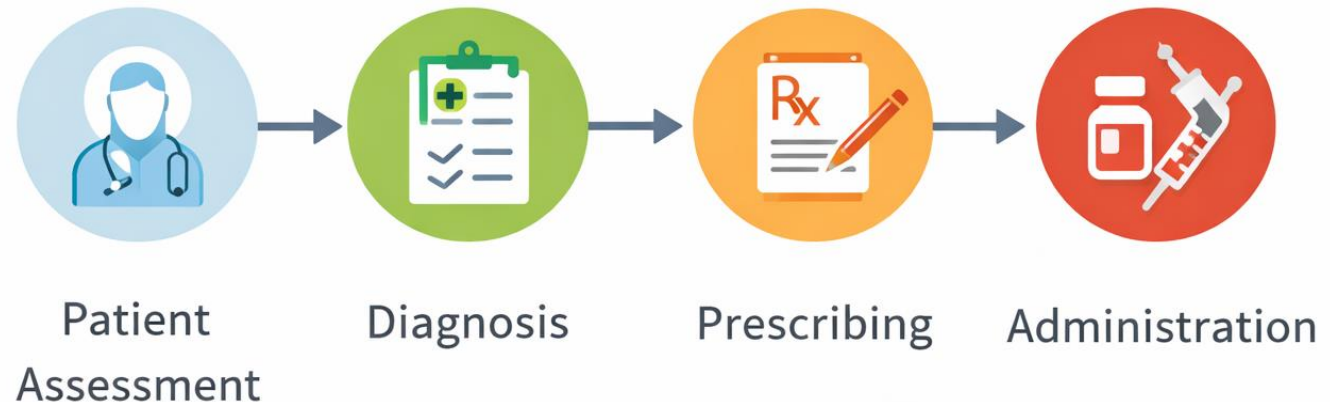
actionable, specific guidance rather than abstract information.

different roles need different views of the same situation

the moment of decision, not five screens later.

a nurse, a GP, and a consultant all experience systems differently.

Most CDS fail not because the evidence is wrong, but because it arrives too late, to the wrong role, in the wrong format, or in a way that interrupts rather than assists. Good CDS feels like part of the work.

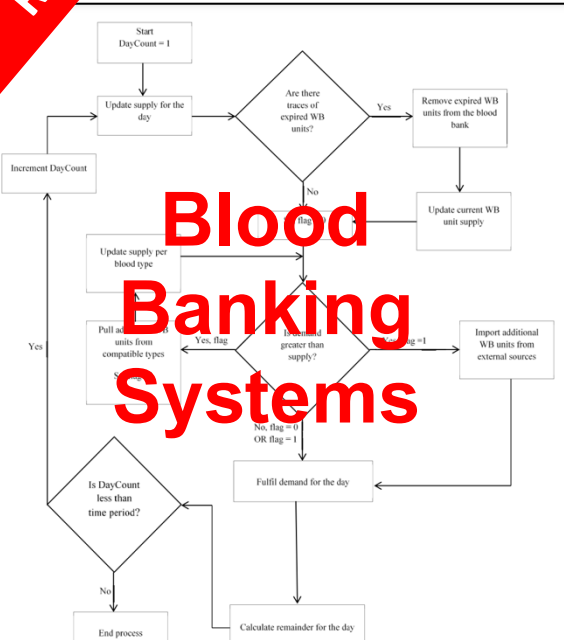


REFRESH

Early standalone applications

Integration with departmental workflows

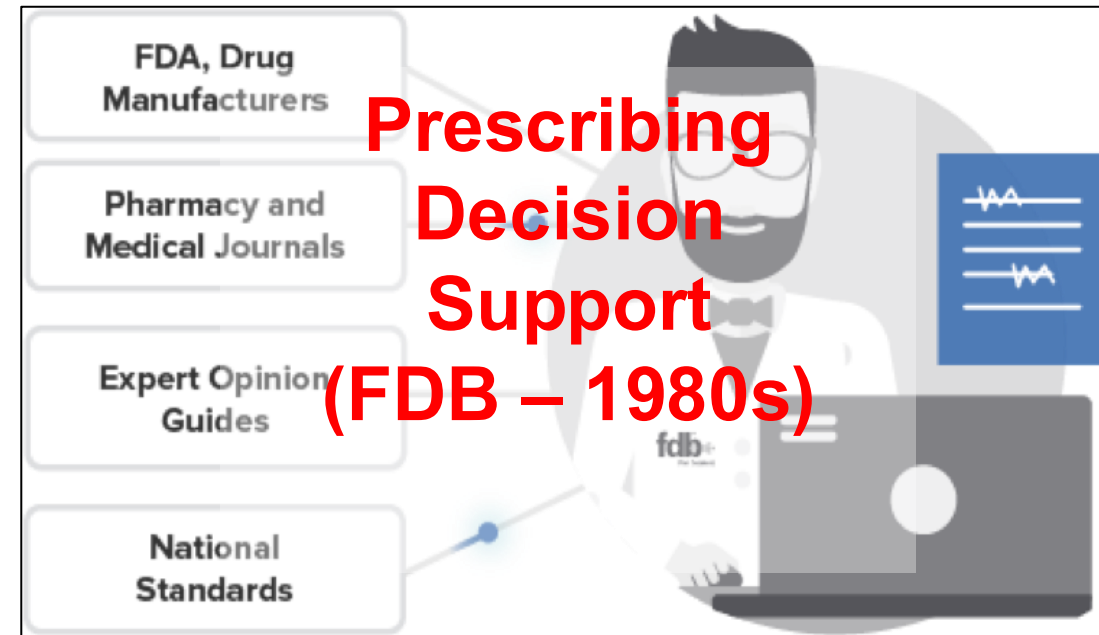
Blood Banking Systems



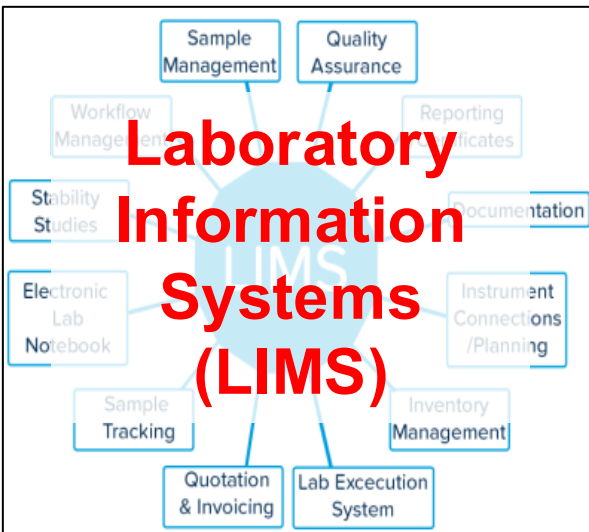
Radiation Therapy Dosimetry Systems



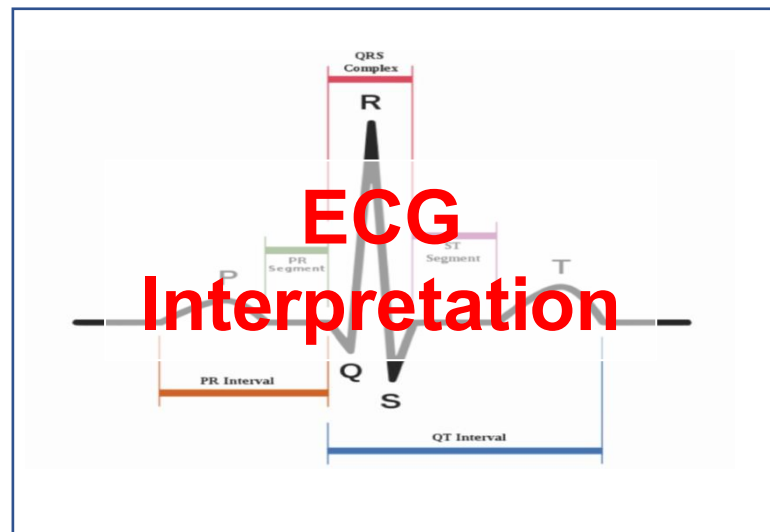
Prescribing Decision Support (FDB – 1980s)



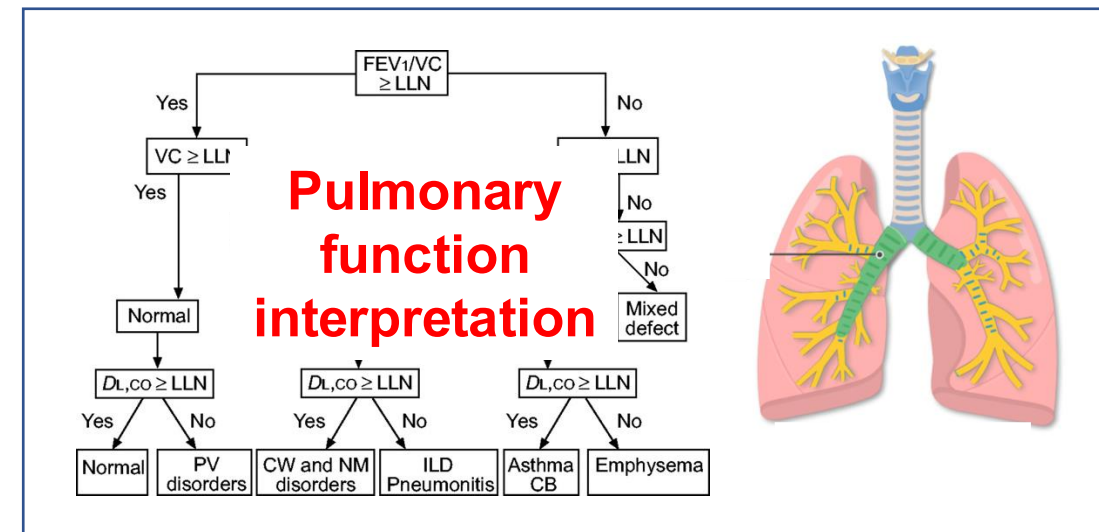
Laboratory Information Systems (LIMS)



ECG Interpretation



Pulmonary function interpretation



Some Key Perspectives of CDS

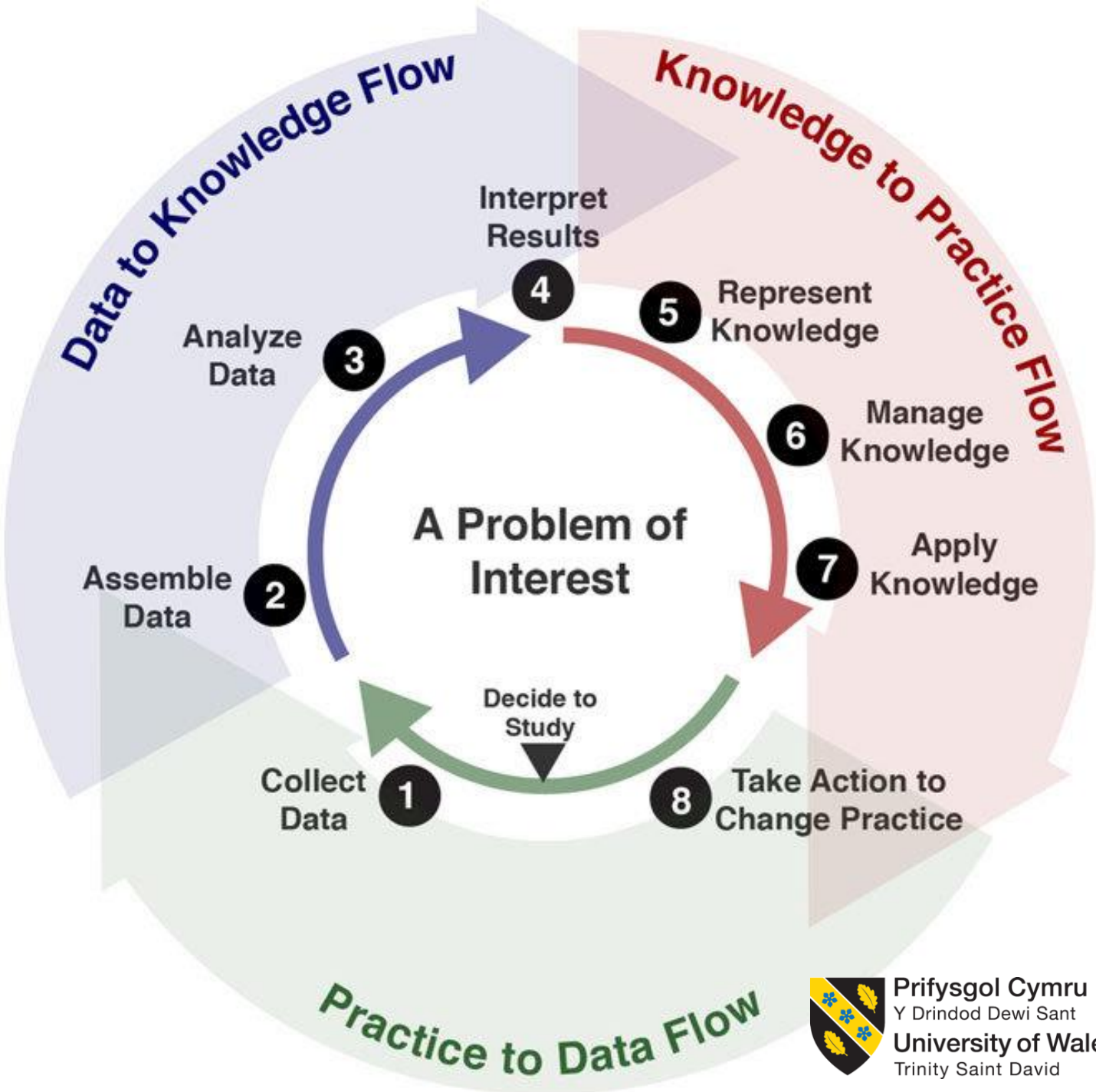
2 – CDS fails more from implementation & context than evidence of weak algorithms or knowledge



REFRESH

CDS needs a complete Learning Health cycle

- 1 from data generation...
- 2 to aggregation...
- 3 through analysis...
- 4, 5 knowledge creation...
- 6, 7 knowledge dissemination and use...
- 8 **implementation** - ongoing measurement, continuous feedback and refinement



Some Key Perspectives of CDS

- 3 - **Data quality and representation** determine CDS safety; poor coding, missingness, and bias propagate into decisions.
- 4 - **Knowledge management** is the hidden bottleneck: content ownership, versioning, governance, and rapid updating matter most.
- 5 - **Clinical reasoning** and human judgement remain central; CDS should scaffold decisions, not replace accountability.

Clinical Decision Support: a 25 Year Retrospective and a 25 Year Vision

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Summary

Objective: The objective of this review is to summarize the state of the art of clinical decision support (CDS) circa 1990, review progress in the 25 year interval from that time, and provide a vision of what CDS might look like 25 years hence, or circa 2016.

Method: Internal review of the medical literature with iterative review and discussion among the authors to arrive at six axes (data, knowledge, inference, architecture and technology, implementation and integration, and users) to frame the review and discussion of selected barriers and facilitators to the effective use of CDS.

Results: In each of the six axes, significant progress has been made. Key obstacles to achieving and realizing potential include: data with an increased availability of data, development of knowledge bases for CDS, and improvement of capabilities to share knowledge artifacts, explosion of methods involving and relying upon clinical data, evolution of information technologies and architectures to facilitate the broad application of CDS, improvement of methods to implement CDS and integrate CDS into the clinical workflow, and increasing sophistication of the end user. All have played a role in improving the effective use of CDS in healthcare delivery.

Conclusion: CDS has evolved dramatically over the past 25 years and will likely evolve just as dramatically or more so over the next 25 years. Increasingly, the clinical encounter between a clinician and a patient will be supported by a wide variety of cognitive aides to support diagnosis, treatment, care coordination, surveillance and prevention, and health maintenance or wellness.

Keywords: Clinical decision support, electronic health record, health information technology, expert systems, artificial intelligence

Health Aff (Millwood) 2016;35(1):158-16
http://dx.doi.org/10.1353/hlth.2016.0044
Published online August 2, 2016

Introduction

In this review of the evolution of Clinical Decision Support (CDS) from 1990 to 2015 we first describe the “state-of-the-art” for CDS circa 1990, and provide an overview of the key issues of the day. We next describe the evolution that occurred according to six dimensions of technology and implementation practice relevant to CDS: data, knowledge, inference, architecture and technology, implementation and integration, and the evolving end-user. We highlight the barriers and enablers of technology development and effective use of CDS in practice over the past 25 years. Next, we ambitiously describe a potential vision for CDS 25 years hence, and suggest critical issues to monitor the quality of CDS and clinical analytics in the IT-enabled healthcare delivery system.

This paper frames the discussion around CDS defined as follows:

Clinical decision support is a process for enhancing health-related decisions and actions with pertinent, organized, clinical knowledge, and patient information to improve health and healthcare delivery. Information recipients can include patients, clinicians, and others involved in patient care delivery; information delivered can include general clinical knowledge and guidance, intelligently processed patient data, or a mixture of both; and information delivery formats can be drawn from a rich palette of options that includes data and order entry facilitators, filtered data displays, reference information, alerts, and others [1].

Further, CDS has been considered as one component of an over-arching strategy toward

widespread and effective use of knowledge in practice, including three essential pillars: 1) best knowledge available when needed, high adoption, and effective use; 2) continuous improvement of knowledge; and 3) CDS methods [2]. This would assure that:

Clinical decision support (CDS) provides clinicians, staff, patients, or other individuals with knowledge and person-specific information, intelligently filtered or presented at appropriate times, to enhance health and health care [3].

Fundamentally, CDS is viewed as an essential component of a Learning Health System where a virtuous cycle is created from data generation, to aggregation, analysis, knowledge creation, knowledge dissemination and use, and ongoing measurement for continuous feedback and refinement [3-5]. We subscribe to this belief and suggest that over the next 25 years the use of clinical decision support and a wide variety of cognitive aides will become routine in clinical practice [6].

Evolution of CDS over the Past 25 Years

State of the Art in CDS in 1990

In the early 1990's, hospital environments typically had some form of a hospital information system, a variety of departmental information systems [7], and potentially in more advanced settings, applications to support scanned documents, quality reporting, and research applications (often used and maintained outside the traditional “IT” (information technology) department)

WMA Yearbook of Medical Informatics 2016

Middleton’s review arrived at “six axes of CDS” to discuss the barriers and facilitators to effective use in the real world:

1. Data
 2. Knowledge
 3. Inference
 4. Architecture and technology
 5. Implementation and integration
 6. Users
- ...where

 - cognitive load
 - time pressure
 - professional responsibility converge.

Failures are experienced subjectively...

- irritation
- distraction
- obstruction

REFRESH

Summary of potential pitfalls with CDS

CDS can disrupt clinician workflow

CDS can increase time required to complete tasks

GDPR personal data transportability can be difficult from CDS

CDS can create dependency

CDS needs expensive specialist maintenance

CDS can give alert fatigue

Many CDS systems have interoperability issues

Unstandardised data - corrupt data = incorrect CDS inferences

CDS can increase cognitive effort

CDS can create face-to-face "disconnect" with patients

CDS can de-skill (compare pocket calculators with manual calculation)

Substantial upfront CDS costs

Up to 95% of CDS alerts are inconsequential



Brief Review of BMDS-7003 Self-Study Papers

Review of work so far

Date Y-M-D Title, Subject and PDFs supplied

2025-11-27 Self-directed learning activity BMDS7003-01 **CDS BENEFITS AND RISKS** with PDF Sutton et al

2025-12-11 POSTPONED Self-directed learning activity BMDS7003-02 - postpone - **GUIDES CHECKLIST** with PDF Van de Velde

2026-01-08 Self-directed learning activity BMDS7003-03 mod **TWO STREAM CDS** with PDF Medlock et al

2026-01-22 Self-directed learning activity BMDS7003-04 **MAP OF MEDICINE** with PDF Brennan et al

2026-02-05 Self-directed learning activity BMDS7003-05 **MINDLINES** with PDFs Gabay and LeMay + Wieringa + Greenhalgh

2026-02-12 Final Sync session (will issue here the **postponed** BMDS7003-02)

Note there is a long gap between these self studies and the presentation of them, a list will be issued with assigned topics closer to the day:

2026-04-23 Presentations on BMDS7003 topics

Only final reminder is limit for formative feedback on the assignment is 6th Feb. Just send directly by email don't use Moodle for formative.

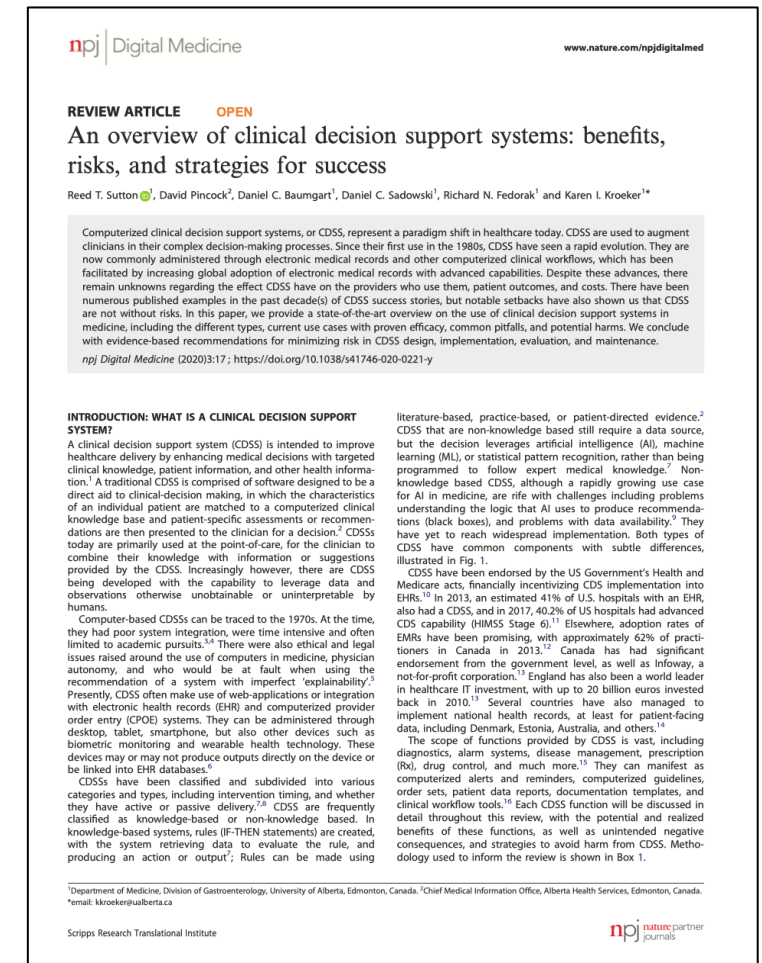
BMDS-01 Paper (supplied 28 Nov)

CDS BENEFITS AND RISKS

Sutton et al is an overview of clinical decision support systems (CDSS) - what types are there, use cases, benefits and common pitfalls, minimizing risks...

Describes how CDSS is either "knowledge-based" or "non-knowledge-based" the former uses programmed rules, and the latter leverages artificial intelligence and machine learning algorithms.

Covers CDSS potential risks - disrupted workflows, alert fatigue, impact on user skills, computer literacy challenges, and issues with system/content maintenance and data quality.



BMDS-01 Worked Example

Example Reflection and Tasks in BMDS7003-01

Distinguishing “Knowledge-Based” and “Non-Knowledge-Based” CDS

Knowledge-Based CDS: Relies on established medical knowledge, rules, and guidelines. For example, it uses “if-then” logic and **pre-programmed rules**. Clinicians interact with these systems to receive recommendations based on clinical protocols.

Non-Knowledge-Based CDS: Leverages machine learning and artificial intelligence to analyse data patterns without relying on explicit medical knowledge. These systems can make predictions and provide recommendations based on historical data and learned algorithms, **but they often lack transparency** (black-box nature).

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Encountering “Non-Knowledge-Based” CDS

Examples encountered or feasible applications:

- *Predictive analytics for sepsis detection using patient data trends.*
- *AI-powered radiology tools that identify anomalies in medical imaging.*
- *Genetic risk prediction tools that analyse genomic data for disease risk.*

BMDS-01 Worked Example

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Insights from Table 1 Sutton et al., 2020:

Potential harms of CDSS experienced or observed:

Alert Fatigue: Frequent irrelevant alerts causing clinicians to overlook important ones.

Fragmented Workflow: Systems that interrupt clinical routines or require separate platforms for data input/output.

Typical functions and advantages experienced or observed:

Improved Patient Safety: Alerts for drug interactions and reminders for critical interventions.

Enhanced Workflow Efficiency: Automated documentation and streamlined clinical workflows.

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BMDS-01 Worked Example

Task: List of 10 Types of CDS

1. Alert and reminder systems (e.g., medication dosing).
2. Diagnostic support systems (e.g., differential diagnosis suggestions).
3. Guideline and protocol adherence systems.
4. Order sets (e.g., for lab tests or treatments).
5. Medication interaction checkers.
6. Imaging decision support tools (e.g., radiology).
7. Patient monitoring systems using wearable devices.
8. Predictive analytics tools (e.g., risk of disease progression).
9. Patient-facing decision support systems (e.g., Personal Health Records).
10. Workflow automation tools (e.g., auto-fill for clinical notes).

Task:

BMDS-01 Worked Example



CDSS Example	Expected Benefits	Potential Pitfalls	Mitigation Strategies
Existing: AI for Imaging Analysis	Faster detection of anomalies; reduced workload.	User distrust due to “ <u>black-box</u> ” nature.	Incorporate explainable AI (XAI); validate using clinical trials.
Future: Genomic Risk Prediction	Personalized medicine; early disease intervention.	Data privacy concerns.	Secure data encryption; compliance with GDPR/healthcare privacy standards

Task: AI in Clinical Decision Support

Recent Literature Examples:

AI-based triage tools for emergency rooms (e.g., Babylon Health).

Machine learning for identifying diabetic retinopathy (Google AI).

Predictive models for hospital readmission rates.

Self-study BMDS-02

GUIDES CHECKLIST

(postponed, will issue 12 Feb)

Van de Velde et al

Development and testing of the **GUIDES checklist**, a tool designed to improve the successful implementation of CDS systems based on clinical guidelines.

The checklist is structured around four domains (**context, content, system, and implementation**), was created through a systematic review of existing literature, expert panel feedback, patient consultations, and pilot testing.

Can be applied to assessing and addressing factors influencing the success or failure of CDS implementations - **technological, clinical, organizational, and human elements**.

RESEARCH

Open Access



The GUIDES checklist: development of a tool to improve the successful use of guideline-based computerised clinical decision support

Stijn Van de Velde^{1*}, Ilkka Kunnamo², Pavel Roshanov³, Tiina Kortteisto⁴, Bert Aertgeerts⁵, Per Olav Vandvik^{6,7}, Signe Flottorp^{1,7}, GUIDES expert panel

Abstract

Background: Computerised decision support (CDS) based on trustworthy clinical guidelines is a key component of a learning healthcare system. Research shows that the effectiveness of CDS is mixed. Multifaceted context, system, recommendation and implementation factors may potentially affect the success of CDS interventions. This paper describes the development of a checklist that is intended to support professionals to implement CDS successfully.

Methods: We developed the checklist through an iterative process that involved a systematic review of evidence and frameworks, a synthesis of the success factors identified in the review, feedback from an international expert panel that evaluated the checklist in relation to a list of desirable framework attributes, consultations with patients and healthcare consumers and pilot testing of the checklist.

Results: We screened 5347 papers and selected 71 papers with relevant information on success factors for guideline-based CDS. From the selected papers, we developed a 16-factor checklist that is divided in four domains, i.e. the CDS context, content, system and implementation domains. The panel of experts evaluated the checklist positively as an instrument that could support people implementing guideline-based CDS across a wide range of settings globally. Patients and healthcare consumers identified guideline-based CDS as an important quality improvement intervention and perceived the GUIDES checklist as a suitable and useful strategy.

Conclusions: The GUIDES checklist can support professionals in considering the factors that affect the success of CDS interventions. It may facilitate a deeper and more accurate understanding of the factors shaping CDS effectiveness. Relying on a structured approach may prevent that important factors are missed.

Keywords: Clinical computerised decision support systems, Practice Guidelines, Guideline adherence, Evidence-based medicine, Implementation

Self-study BMDS-03

TWO STREAM CDS

issued 8 JAN 2026

Medlock et al

A "**Two-Stream Model**" model differentiates between a **clinical stream** (reasoning about the patient) and a **cognitive-behavioural stream** (reasoning about the user).

"CDSS **effectiveness** should be evaluated not only by its impact on clinical care but also by its usability" - its influence on workflows, and its facilitation of appropriate decisions.

Emphasis on a **holistic evaluation** of CDSS, outcomes **PLUS** user experience, workflow integration, and the cognitive processes involved in decision making.



Self-study BMDS-04

MAP OF MEDICINE

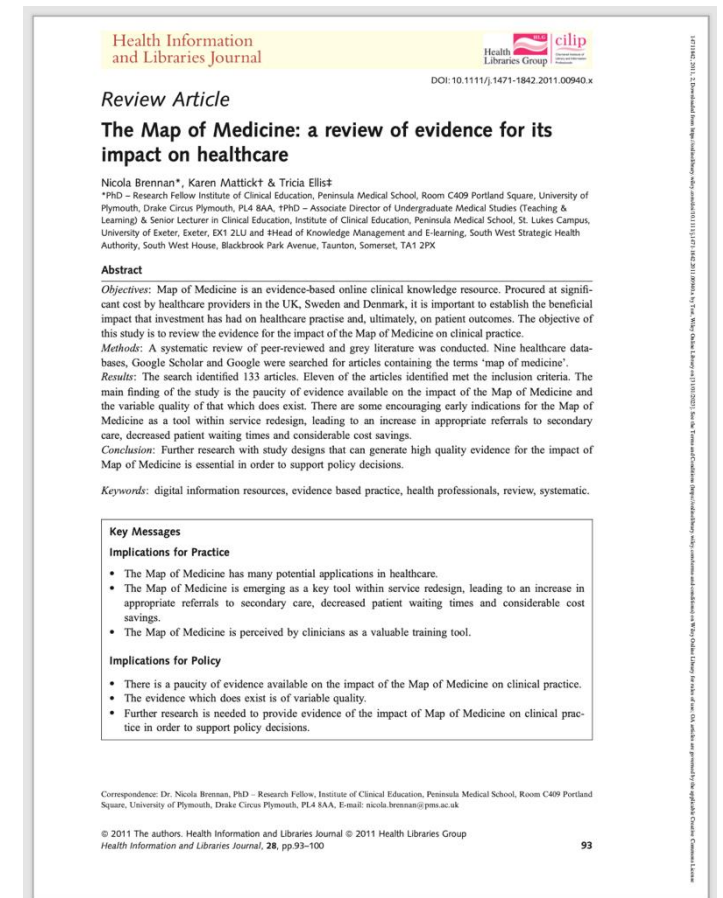
Failed CDS case study - issued 22 Jan 2026

Brennan et al

Systematic review of impact of **Map of Medicine**, an evidence-based online clinical knowledge resource, on healthcare practice.

Scarcity of high-quality evidence to definitively establish its impact; *case studies* suggested potential benefits such as reduced inappropriate referrals to secondary care, cost savings, and decreased patient waiting times and a valuable training tool.

Lesson - evaluate the real-world impact using **robust research methodologies** to assess the effectiveness of such technologies (not anecdotal evidence or case studies alone).



Self-study BMDS-05

MINDLINES

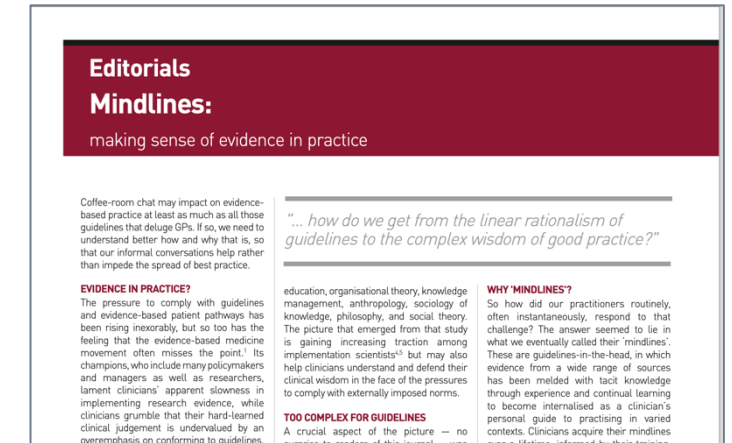
to be issued 5 Feb

Systematic review of the literature on "mindlines"—
internalised, collectively reinforced tacit guidelines

It critiques traditional evidence-based medicine's
rationalist assumptions and its exploration of tacit
knowledge and collective knowledge creation.

Understanding mindlines provides a more nuanced
perspective on **how knowledge is actually shared and
enacted in healthcare**, challenging simplistic models of
knowledge translation – highlights the complexities of
integrating research evidence into clinical practice via
digital technologies.

Gabbay and le May



Wieringa and Greenhalgh

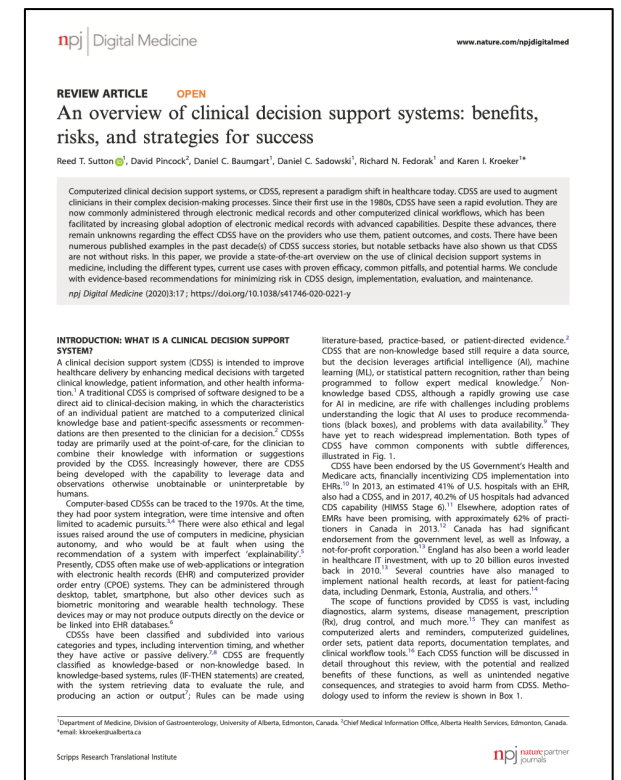


Perspective on the many types of CDSS

A wide scope of tools.

- Alerting systems (e.g., medication interaction warnings)
- Order sets and protocols
- Diagnosis support (e.g., symptom checkers)
- Treatment recommendations
- Patient-specific risk assessment tools
- Image analysis and interpretation aids
- Outcome prediction models
- Decision aids for patients
- Guidelines and protocols
- Data visualisation dashboards

Sutton et al



Perspective on AI in CDSS

will revisit in BMDS-7010

Artificial intelligence is rapidly transforming CDS

History and Search Details						Download	Delete
Search	Actions	Details	Query	Results	Time		
#2	...	!	Search: Artificial intelligence in clinical decision support Filters: in the last 1 year, Review	922	10:32:05		

General Pubmed
Search [here](#)

Applications include natural language processing for clinical documentation

Machine learning for risk prediction

Computer vision for image analysis.

Careful consideration is needed to address ethical concerns and potential biases and “black box” effects associated with these technologies.

Compare knowledge-based versus non-knowledge-based systems,

