PUBLIC HEALTH FOUNDATION OF INDIA

ASSOCIATION OF HEALTHCARE PROVIDERS INDIA

Indian Institute of Science

Indian Institute of Space Science and Technology

Certificate Course in

Healthcare Technology (CCHT)

Module 2: Technology -led Health Care Part 1

CLINICAL DECISION SUPPORT SYSTEM

Disclaimer

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CLINICAL DECISION SUPPORT SYSTEM

Learning Objectives:

- Definition of CDSS
- Application of CDSS
- Impact of CDSS
- Case Studies (BMJ Series)
- Clinical Examples
- Summary

Overview of Session:

- Evidence Based Medicine
- Decision Support System
- CDSS will be a game changer for better Clinical Outcomes
- Application & Customization
- Patient Safety agenda

Background

Clinical Decision Support Systems (CDSS) have been gaining a lot of recognition in improving patient care. They are computer-based programs that analyze data within Electronic Health Records (EHRs) to provide prompts and reminders to assist health care providers in implementing evidence-based clinical guidelines at the point of care. CDSS aid in improving decision making and computerized physician order entry (CPOE). CDSS helps in reducing medication errors thereby decreasing unnecessary health care expenses.

CDSS often make use of web-applications or integration with electronic health records (EHR) and computerized provider order entry (CPOE) systems wherein the physicians can make entries online.

They can be administered through desktop, tablet, smartphone, but also other devices such as biometric monitoring and wearable health technology. These devices may or may not produce outputs directly on the device or be linked into EHR databases

Rationale for CDSS

For each patient, there are a multitude of parameters considered when taking a decision. When dealing with a large patient load, there is a potential for various errors to happen thereby causing harm to the patient. They have the capacity to manage large amount and rapidly changing quantitative and qualitative patient data. CDSS aid doctors in making decisions quickly and accurately by providing all relevant patient information. CDSS also has the potential to alert the doctors in case of a medication error, drug- drug interaction or adverse events thus preventing these harms from reaching the patient. By doing so, CDSS helps in improving the quality of patient care

Benefits of CDSS

CDSS can improve diagnostic accuracy, patient satisfaction. CDSS has the potency to prevent medication errors and adverse events. It improves efficiency, reduces unnecessary health care related cost and enhances provider and patient satisfaction thereby ensuring increased quality of patient care and enhanced health outcomes.

For example, the below table shows Primary outcome measures identified from systematic review of the literature of CDSS for infection management in primary and secondary car

	PRIMARY OUTCOME MEASURE	Total number	No achieving outcome	Quality of evidence
UNIT LEVEL	Disease specific antimicrobial prescribing rate (e.g. in total ARI visits)	6	3	H
	Rate of antimicrobial prescribing (drug e.g. DDD/1000 patient bed days)	3	3	M
	Economic benefit of CDSS	3	1	M
PATIENT	Mortality (e.g. 30 & 180 days)	1	1	L
	Patient specific complications (SSI's / ADE's / HCAI)	1	1	L
	Diagnostic accuracy e.g. Infection type (e.g. ARI / UTI), Predicting probability of blood stream infection, or predict causative organism	3	3	L
	Individualised dose optimisation	1	1	L
PRESCRIBER	Appropriate emperical prescribing – against subsequent bug sensitivity	3	3	H
	Individual changes in prescribing behaviour (including de-escalation)	4	4	M
	Adherence to local guidelines	9	7	M
	Appropriate prescribing – duration / timing of therapy	2	2	M
	Acceptance of CDSS	2	1	L
	Compliance with dosing guidance	2	0	-

Legend: DDD = Daily defined doses; ARI = Acute respiratory tract infection; HCAI = Healthcare Associated Infection; CDI = *C.difficile* infection; ADE = Adverse drug event

Source: Rawson TM, Moore LSP, Hernandez B, Charani E, Castro-Sanchez E, Herrero P, et al. A systematic review of clinical decision support systems for antimicrobial management: are we failing to investigate these interventions appropriately? Clinical Microbiology and Infection. 2017 Aug;23(8):524–32.

Implementing CDSS

Centre for Disease Control and Prevention suggests that when implementing a CDSS, one needs to consider the setting, policy and Law-Related Considerations, implementation Guidance and resources.

Evidence suggests that incorporating CDSS into an existing EHR has been more successful. It is essential that the hospital ensures that the CDSS is compatible with the existing systems to prevent any undesired failures after implementation. While developing the CDSS, it has to be ensured that it doesn't disrupt the normal workflow and alerts and/or prompts appear while the user is in the decision making process.

If the end users are involved right from the development of CDSS, it will ensure that the CDSS is customized to meet their specific needs ad ensure that unnecessary alerts do not appear. This will ensure acceptance and efficient utilization of CDSS once implemented. The chance of a successful implementation will be high as long as the end users maintain good communication with the designers of the CDSS

Adequate orientation and training needs to be provided to the end users. It is essential that the CDSS produced is user friendly thereby ensuring better compliance from the users. Users must be educated on what is the purpose of CDSS, how it can aid them in decision making, potential benefits etc. The presence of technical experts who can assist users in optimally utilizing the CDSS is also essential.

The alerts should be in simple and easy to understand language. It should also be concise and accurate. The display settings should and be kept simple as possible on a single screen window so that users can get important relevant information quickly and easily.

Constant review of the CDSS performance should be conducted. The frequency of generated alerts should be evaluated and monitored continuously. Regular feedback from users should be obtained and analyzed so that any issues that have the potential to frustrate users can be resolved as soon as possible. Quickly resolving issues may limit users from developing feelings of resistance and negativity toward the CDSS.

If not designed optimally, CDSS can cause more harm than benefit. A user interface that is too busy or difficult to navigate can make the users frustrated. It also has the potential to cause alert fatigue when multiple alerts or pop-ups appear and that can become a nuisance to the user. These issues can significantly slow down the workflow, efficiency, quality, and safety in the delivery of patient care.

Conclusion

It is evident that CDSS has a lot of potential in improving medication management and patient care if implemented in a robust and accurate manner. If possible, it is better to incorporate CDSS into an existing EHR or CPOE to ensure better outcomes. CDSS has to be designed keeping in mind what are specific requirements for the end users. It is also important to have constant validation of CDSS based on user feedback to ensure that there are no barriers to the use.

References:

1. https://www.cdc.gov/dhdsp/pubs/guides/best-practices/clinical-decision-support.htm
2. https://www.healthit.gov/topic/safety/clinical-decision-support
3. Wasylewicz ATM, Scheepers-Hoeks AMJW. Clinical Decision Support Systems. In: Kubben P, Dumontier M, Dekker A, editors. Fundamentals of Clinical Data Science [Internet]. Cham (CH): Springer; 2019 [cited 2020 Sep 22]. Available from http://www.ncbi.nlm.nih.gov/books/NBK543516/
4. https://nursingcenter.com/interiormaster/ce-pages/cearticle/ce_articleprint
5. https://www.researchgate.net/publication/272192610_Clinical_decision_support_systems
6. Rawson TM, Moore LSP, Hernandez B, Charani E, Castro-Sanchez E, Herrero P, et al. A systematic review of clinical decision support systems for antimicrobial management: are we failing to investigate these interventions appropriately? Clinical Microbiology and Infection. 2017 Aug;23(8):524–32.

FOOD FOR THOUGHT

- How BEST we can use CDSS in treating COPD exacerbation

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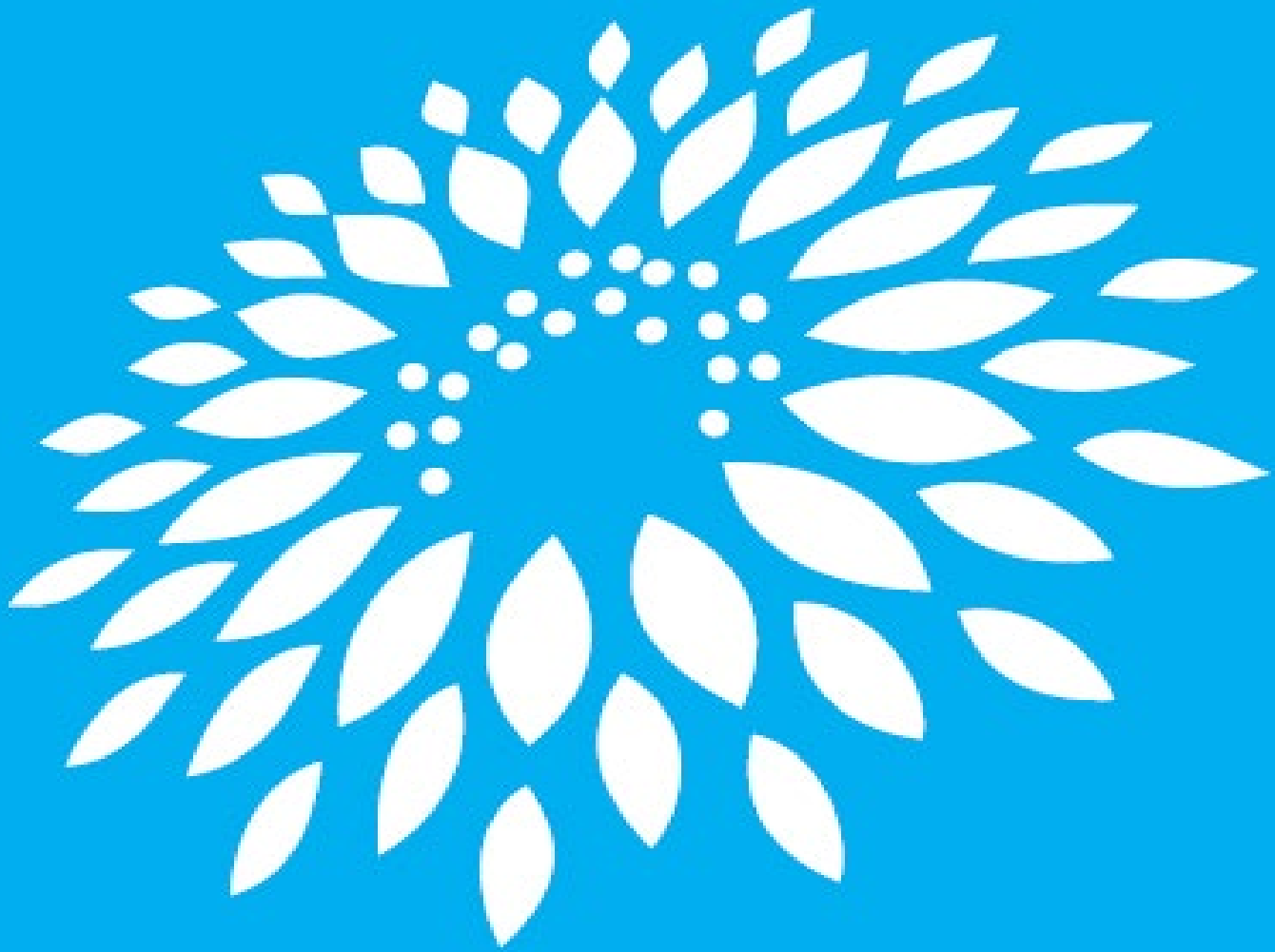
Presentations



CERTIFICATE COURSE IN HEALTHCARE TECHNOLOGY

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Clinical decision support system

CERTIFICATE COURSE IN
HEALTHCARE TECHNOLOGY

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Dr Sanjeev K Singh is a pediatrician by training and did his masters in Hospital Management. He completed his PhD in Infection Control.

He worked as a Regional Coordinator at WHO-India in a disease eradication program for couple of years before joining as Chief Medical Superintendent at a 1350 bed university teaching super specialty hospital - Amrita Institute of Medical Sciences & Research Center at Kochi.

He has done his fellowship in Patient & Healthcare worker Safety from University of Virginia and fellowship on Health Technology Assessment (HTA) from University of Adelaide. He is an Improvement Advisor at Institute of Healthcare Improvement (IHI), US. He is a faculty at Indian Institute of Management (IIM), Kolkata (HEMP) and at IIM Bangalore.

Dr Sanjeev is also an Ambassador from India to Society of Healthcare Epidemiology of America (SHEA) and has been adjudged as “Heros of Infection Control” by Association of Professionals of Infection Control (APIC), US. He is the International surveyor at International Society for Quality (ISQua). He was member of Technical Committee at National Accreditation Board for Hospitals, India (NABH) and was responsible in drafting accreditation standards for 3rd and 4th edition. He is presently the Vice Chairman of Research Committee at NABH. He is Chairman of Technical Committee at AHPI (Association of Healthcare Providers of India) and Health Sector Council of India (Government of India). He is member of Drug Safety Council (GOI) and member of National Advisory Body on Occupational Exposures. He is also member of Healthcare Committee at Federation of Indian Chamber of Commerce of India (FICCI) and Secy of AHPI- Delhi-NCR.

CERTIFICATE COURSE IN
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4. Case Studies (BMJ Series)
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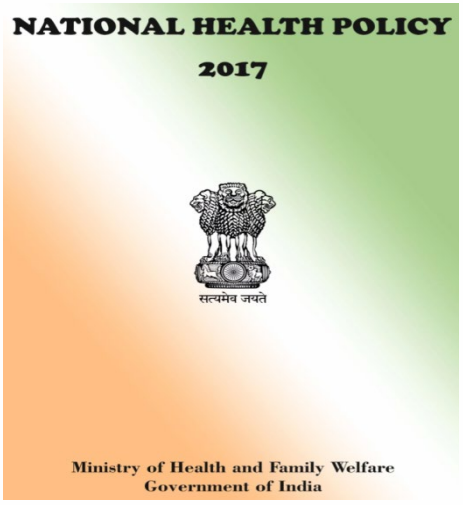
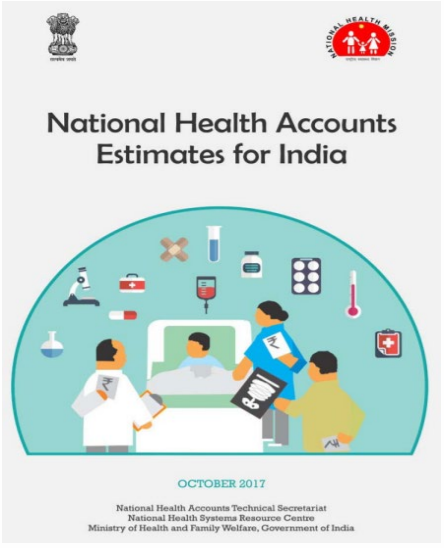
Case Study

- PICU: 8yrs fever 7days with Abd Pain
- Inv: CBC, ESR, Widal, Blood C/S, Urine C/S, USG (whole abd), CT (abd)
- Treatment: Gatiflox + Ceftriaxone
- Blood C/s & Urine C/s: Negative; Hb: 9: K: 3.3
- Treatment: Antibiotics + IV Paracetomol + Tramadol + Emeset + 2 pints N/s + MVI + PRBC

Healthcare expenditure…driver..





800 million spend atleast 10% of their household budget on healthcare

Forcing them to survive on 130 Rs per day

All hospitals, including public leads to catastrophic expenditure

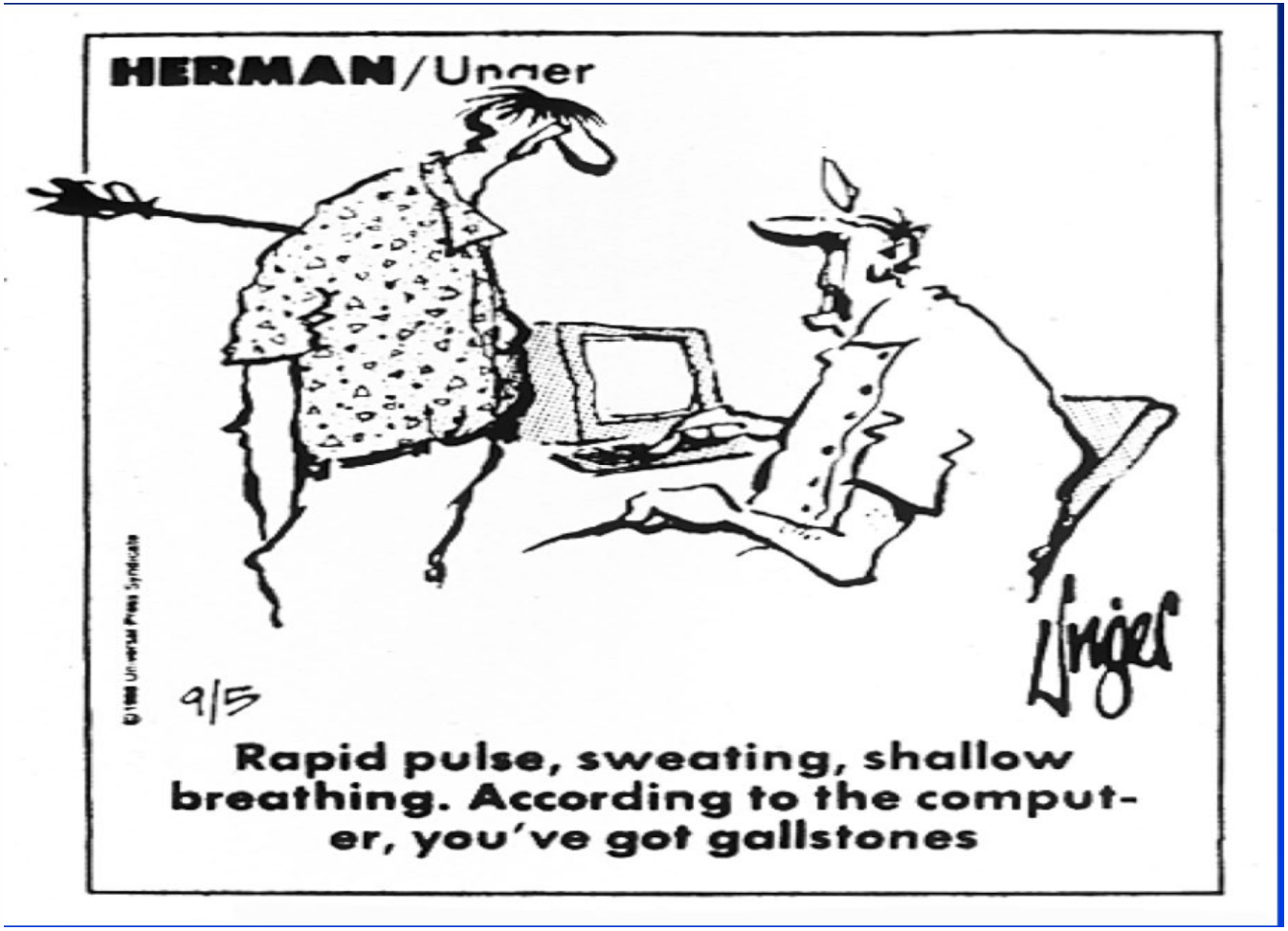
18 % (2014-15) v/s 15 % (2011-12)

Out of pocket expenditure increasing from 10% to 25% of household total income

Evidence Based Medicine Practice

Electronic Database for appropriate decision making

Applying Diagnosis to Public Health Alerts)



One health…Global Health

Macro Picture (IOM 1998)

- **Error rates in the U.S. are high.**
  - 44,000 to 98,000 deaths due to medical error
  - 2.4 million prescription errors in one year in Bosto
  - $17 Billion spent on preventable errors per year.

- **Costs for medical care are increasing rapidly.**

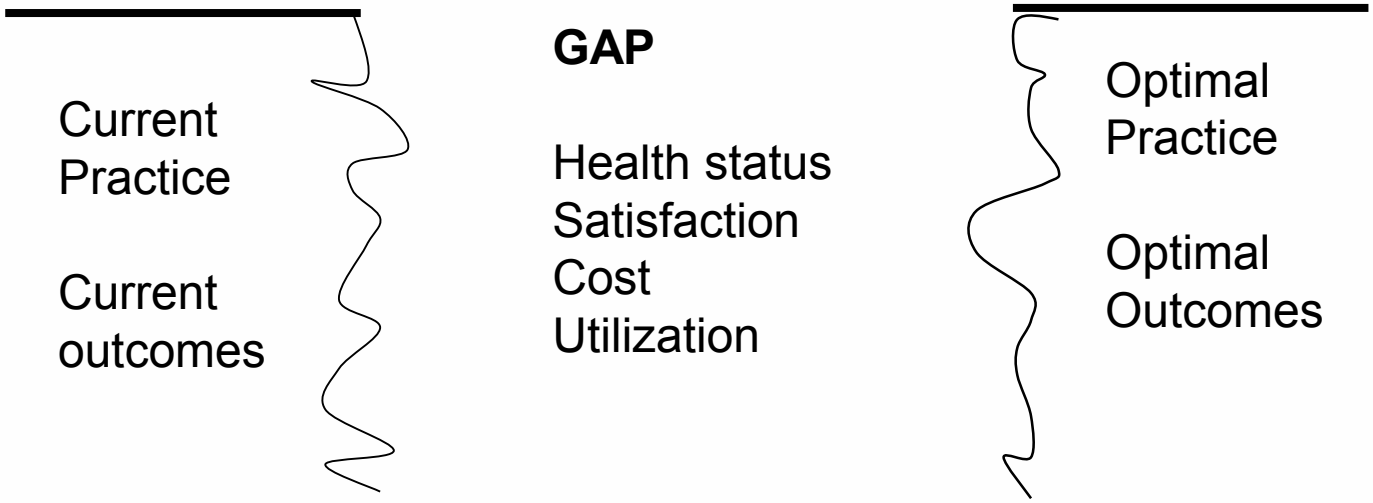
- Can we find ways to improve cost versus care?

Annals of Internal Medicine | IDEAS AND OPINIONS

Appropriate Use of Screening and Diagnostic Tests to Foster High-Value, Cost-Conscious Care

Amir Qaseem, MD, PhD, MHA; Patrick Alguire, MD; Paul Dallas, MD; Lawrence E. Feinberg, MD; Faith T. Fitzgerald, MD; Carrie Horwitch, MD, MPH; Linda Humphrey, MD, MPH; Richard LeBlond, MD; Darilyn Moyer, MD; Jeffrey G. Wiese, MD; and Steven Weinberger, MD

The purpose of clinical practice guidelines



What's the Problem?

Physicians are overwhelmed.

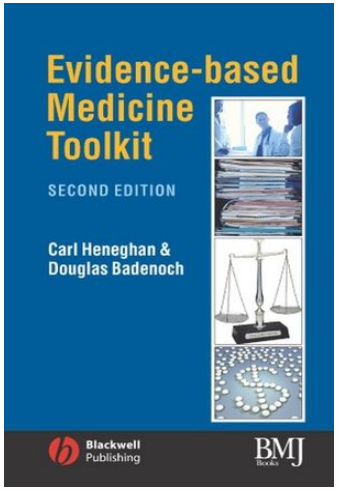
a) Insufficient time available for diagnosis and treatment.
b) Insufficient time available to stay abreast of latest developments.

- Rate of published study results/medical evidence increasing.
- Typically 17 year lag from discovery to improved patient care.
- Inconsistent application of knowledge leads to poor care.

Some in India will never see a physician regardless of their need.

What is evidence-based medicine?

- Evidence-based medicine is the **conscientious, explicit and judicious use** of current best evidence in making decisions about the care of individual patients.

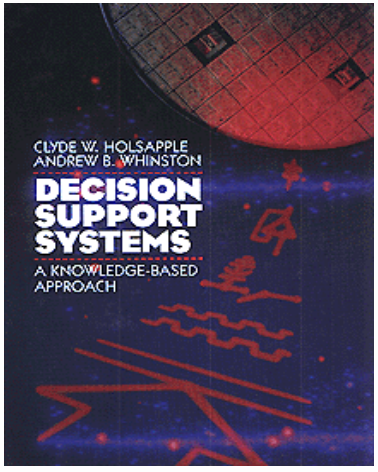


-David Sacket, BMJ 13 Jan 1996

Decision Support

- Embed evidence-based guidelines which describe **stepped-care** into daily clinical practice.
- **Integrate** specialist expertise and primary care.
- Use proven provider **education** methods.
- Share **evidence-based guidelines** and information with patients to encourage their participation.

NCQA

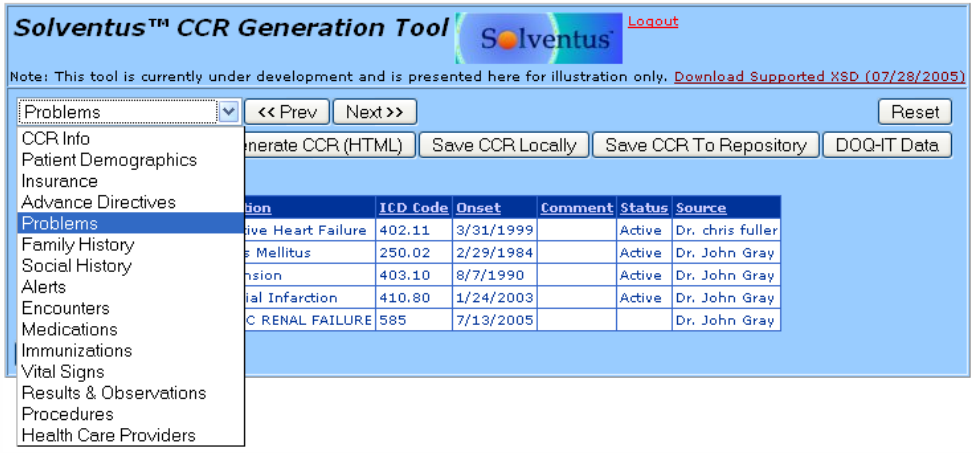


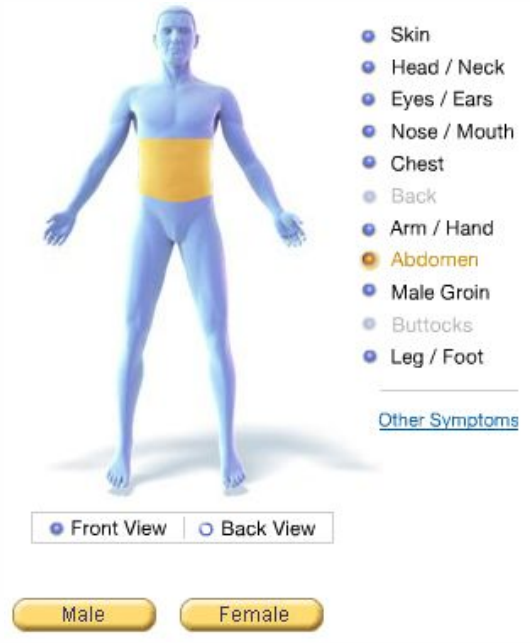
What is a DSS System?

EMR/CIS/HIS (description of patient)

+

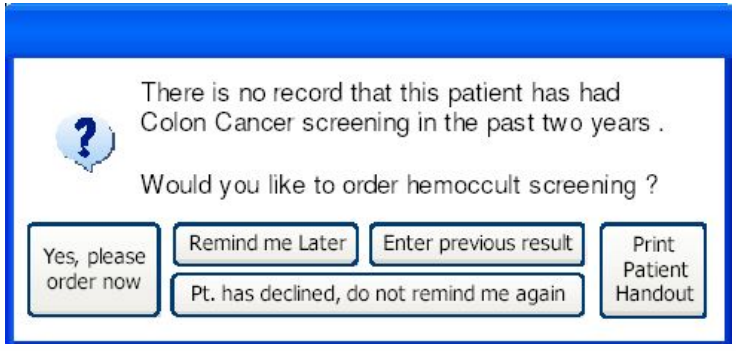
New Symptoms





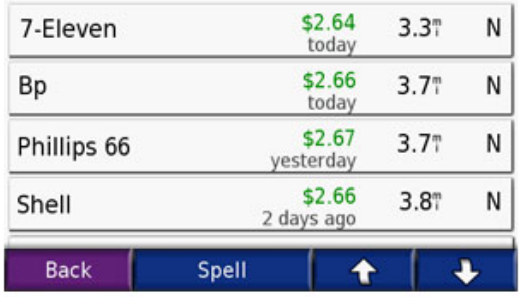
Decision Support

⇒

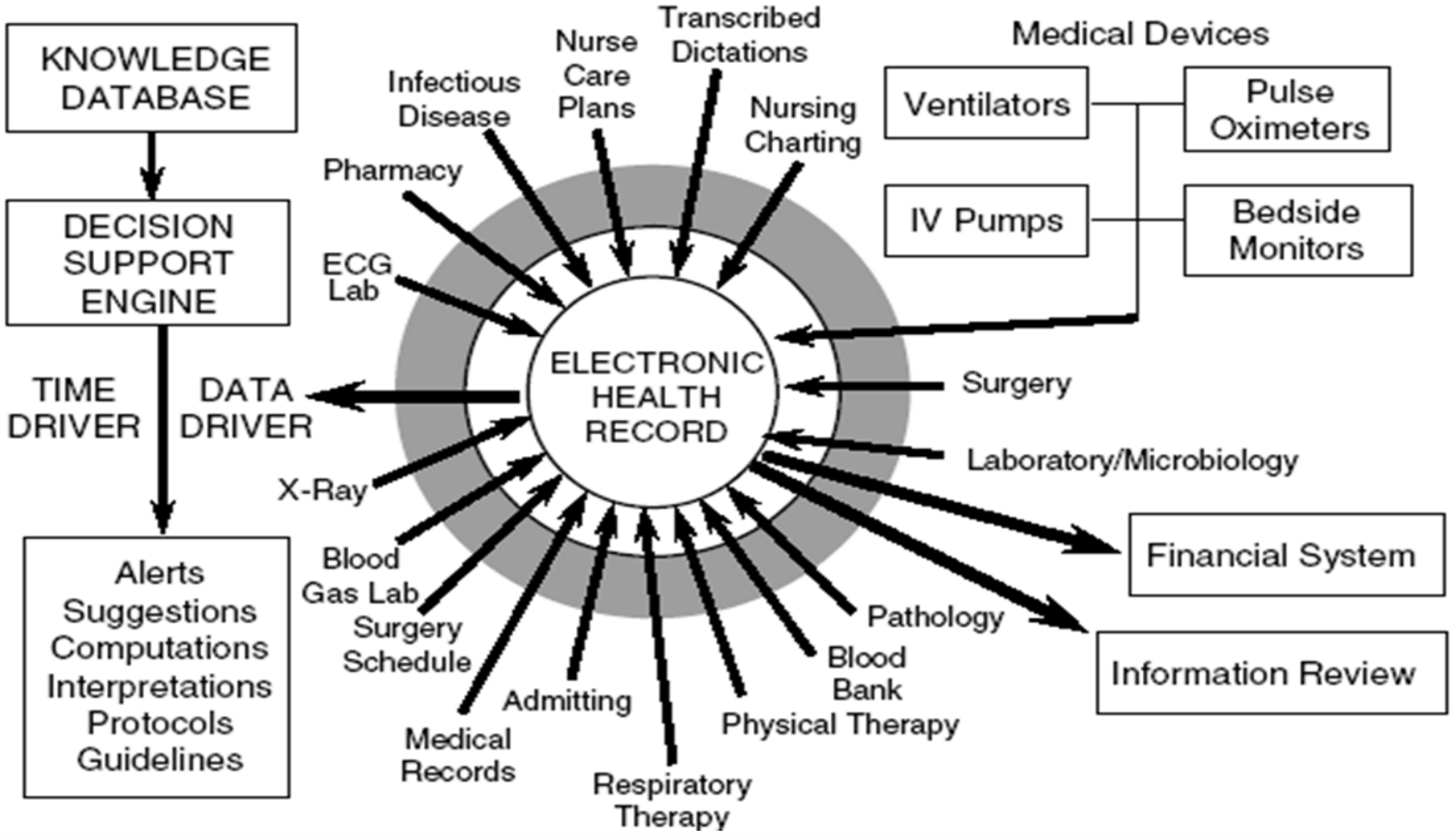


Chronic Care Model

Like a GPS, CDS supplies information tailored to the current situation, and organized for maximum value.



Architecture and key features of HELP System

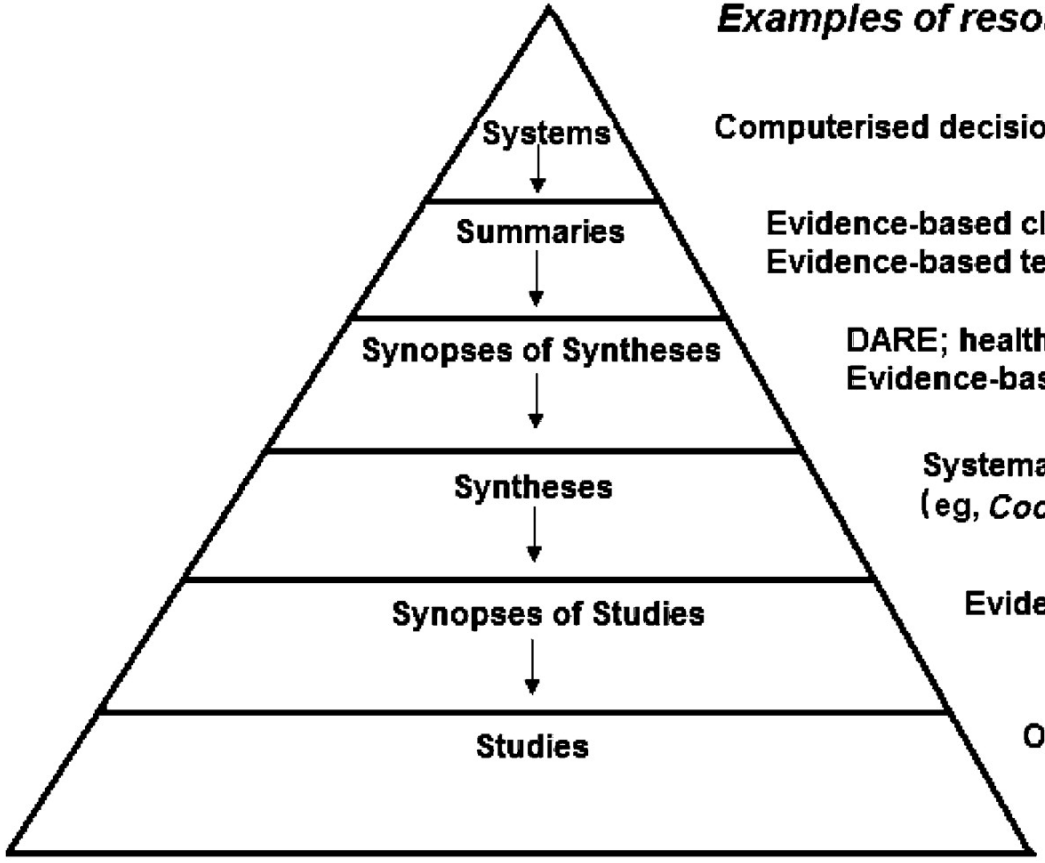


Proposed Solution

Clinical Decision Support System (CDSS)

1. More physician quality time with patients for diagnosis and treatment.
2. Instant recommendations from an “expert”
3. Improved care and accuracy of diagnoses.
    - Reduce liability.
    - Reduce the number of office visits to resolve conditions.
    - Reduce the number of treatments attempted to resolve conditions.
4. Partial solution to healthcare in developing countries that may never see a real physician.

Hierarchy of Evidence



Examples of resources:

Computerised decision support systems

Evidence-based clinical practice guidelines
Evidence-based textbooks

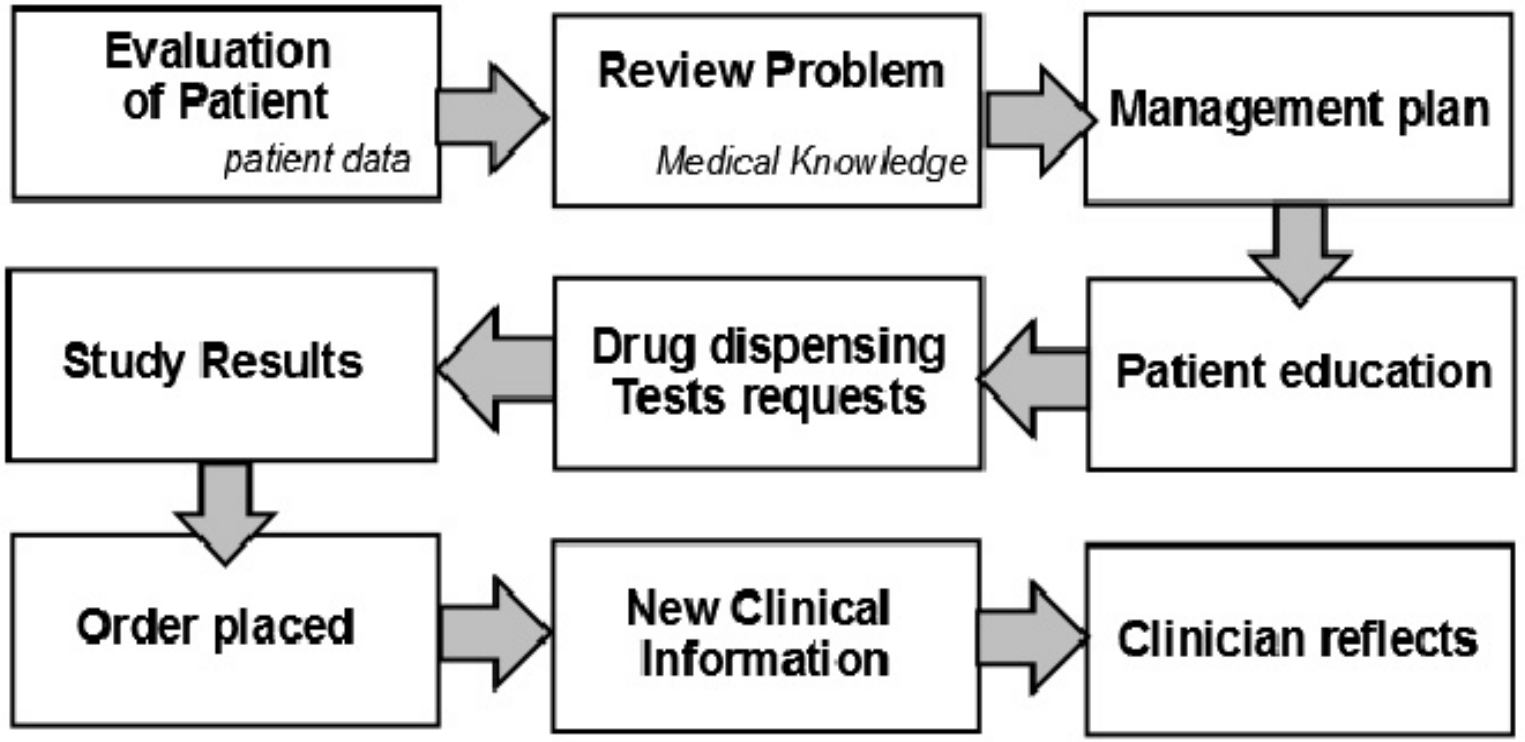
DARE; health-evidence.ca
Evidence-based abstraction journals

Systematic reviews
(eg, *Cochrane Library*)

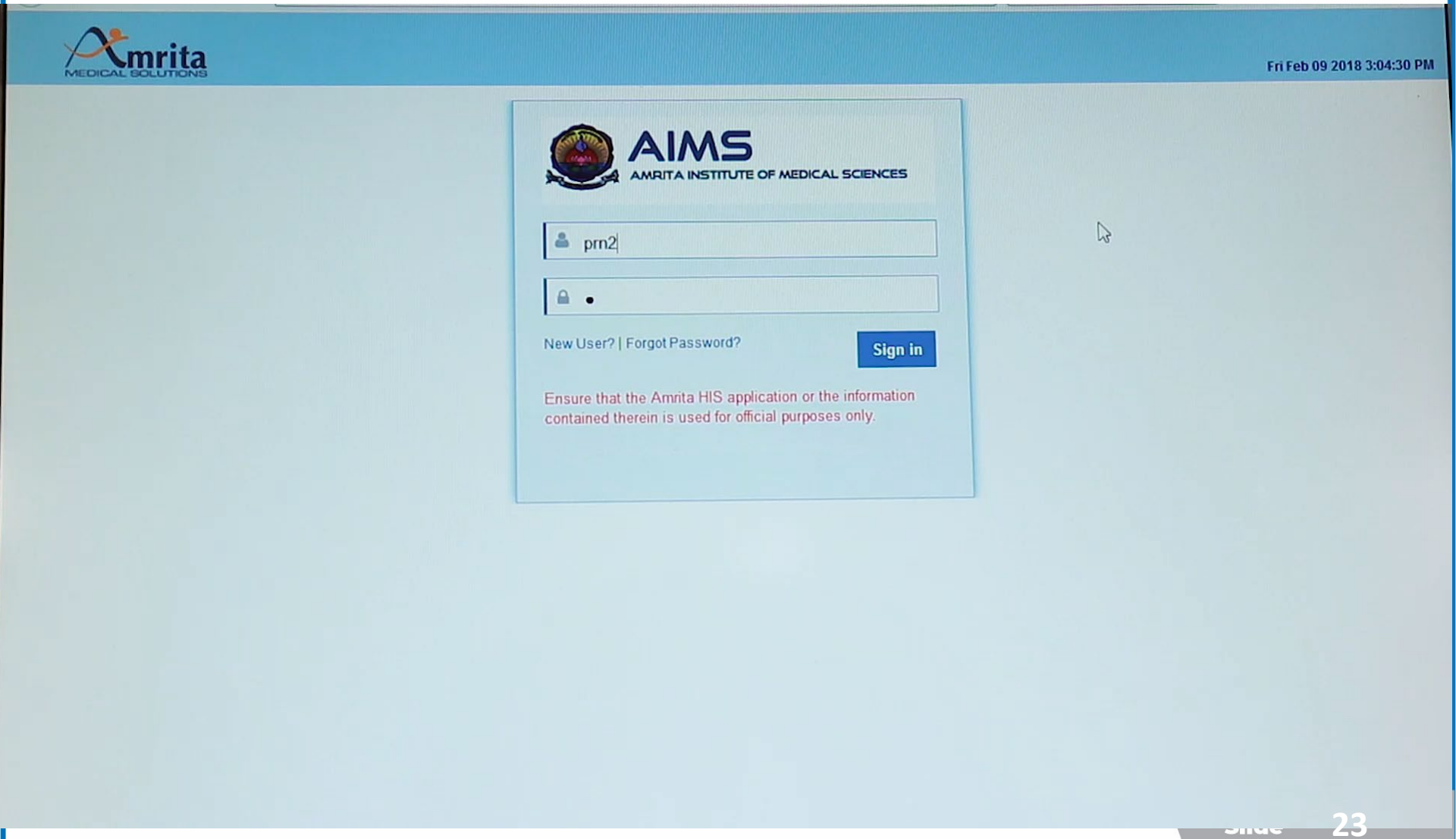
Evidence-based abstraction journals

Original articles published in journals

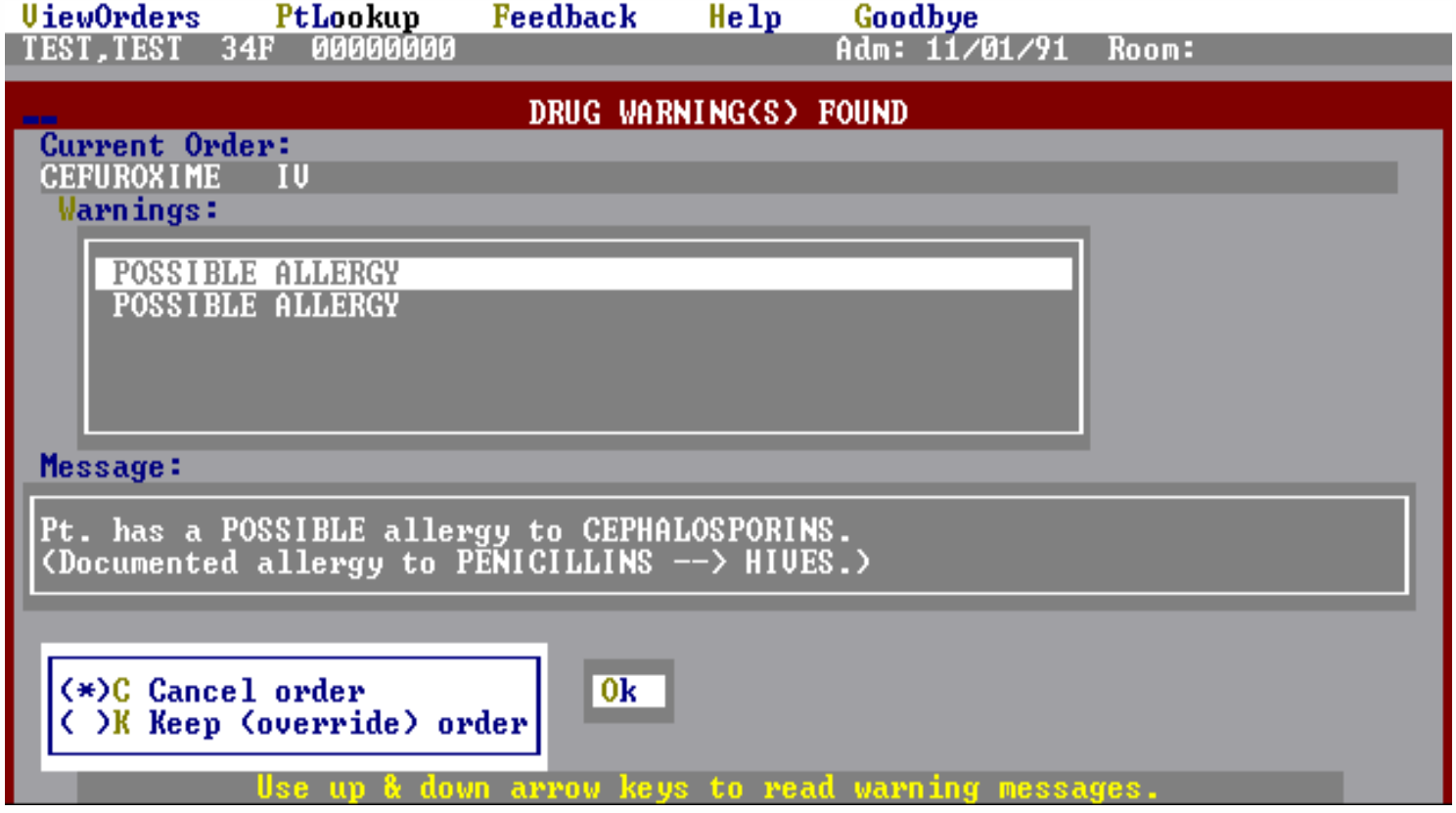
Clinical Workflow: How does CDSS fit ?



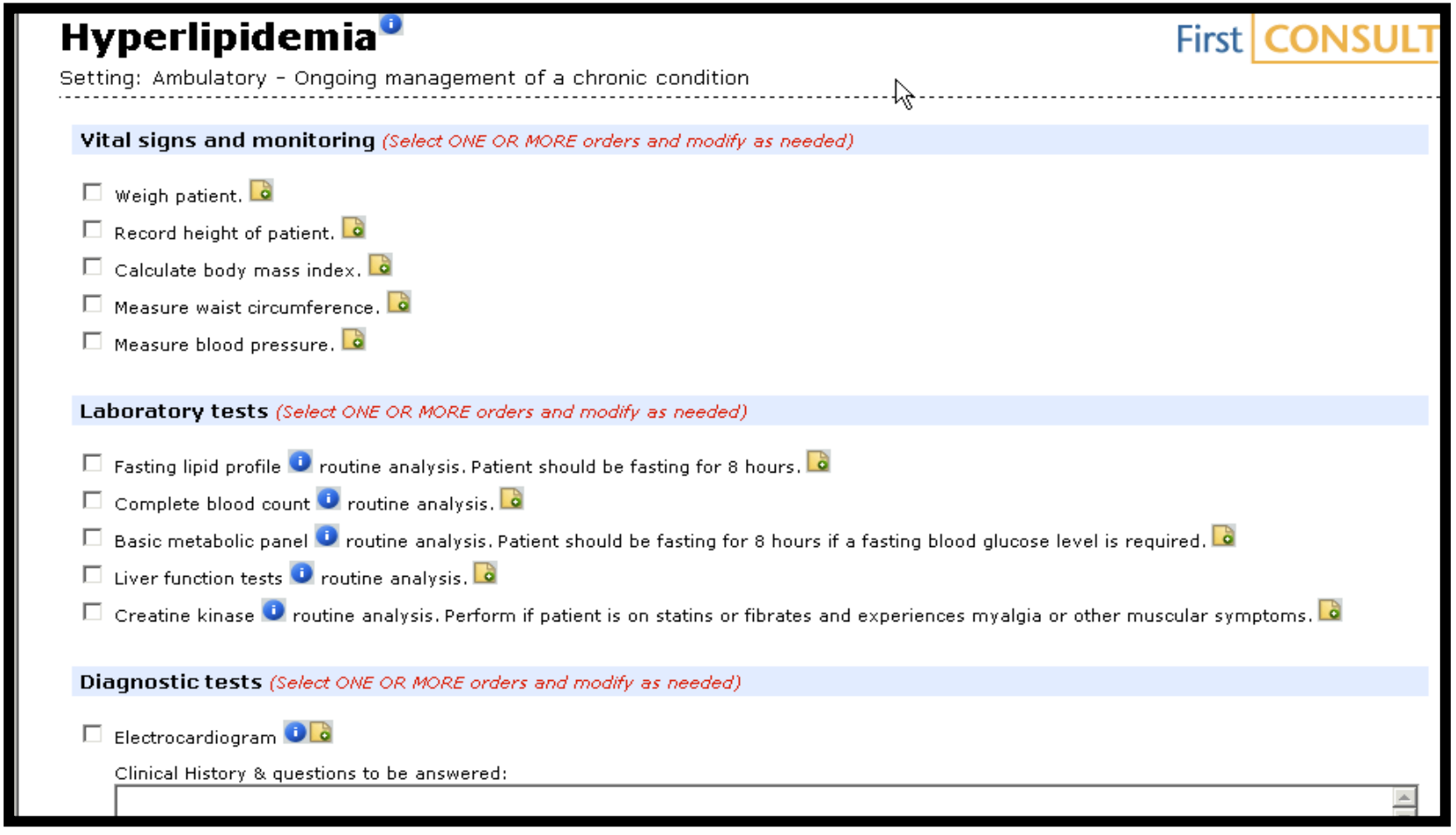
Amrita Experience…



A simple and classic CDS example: Drug warnings



A More Elaborate CDS Example: Order Sets



Hyperlipidemia

First CONSULT

Setting: Ambulatory – Ongoing management of a chronic condition

Vital signs and monitoring *(Select ONE OR MORE orders and modify as needed)*

- ☐ Weigh patient.
- ☐ Record height of patient.
- ☐ Calculate body mass index.
- ☐ Measure waist circumference.
- ☐ Measure blood pressure.

Laboratory tests *(Select ONE OR MORE orders and modify as needed)*

- ☐ Fasting lipid profile routine analysis. Patient should be fasting for 8 hours.
- ☐ Complete blood count routine analysis.
- ☐ Basic metabolic panel routine analysis. Patient should be fasting for 8 hours if a fasting blood glucose level is required.
- ☐ Liver function tests routine analysis.
- ☐ Creatine kinase routine analysis. Perform if patient is on statins or fibrates and experiences myalgia or other muscular symptoms.

Diagnostic tests *(Select ONE OR MORE orders and modify as needed)*

- ☐ Electrocardiogram

Clinical History & questions to be answered:

CDSS Components

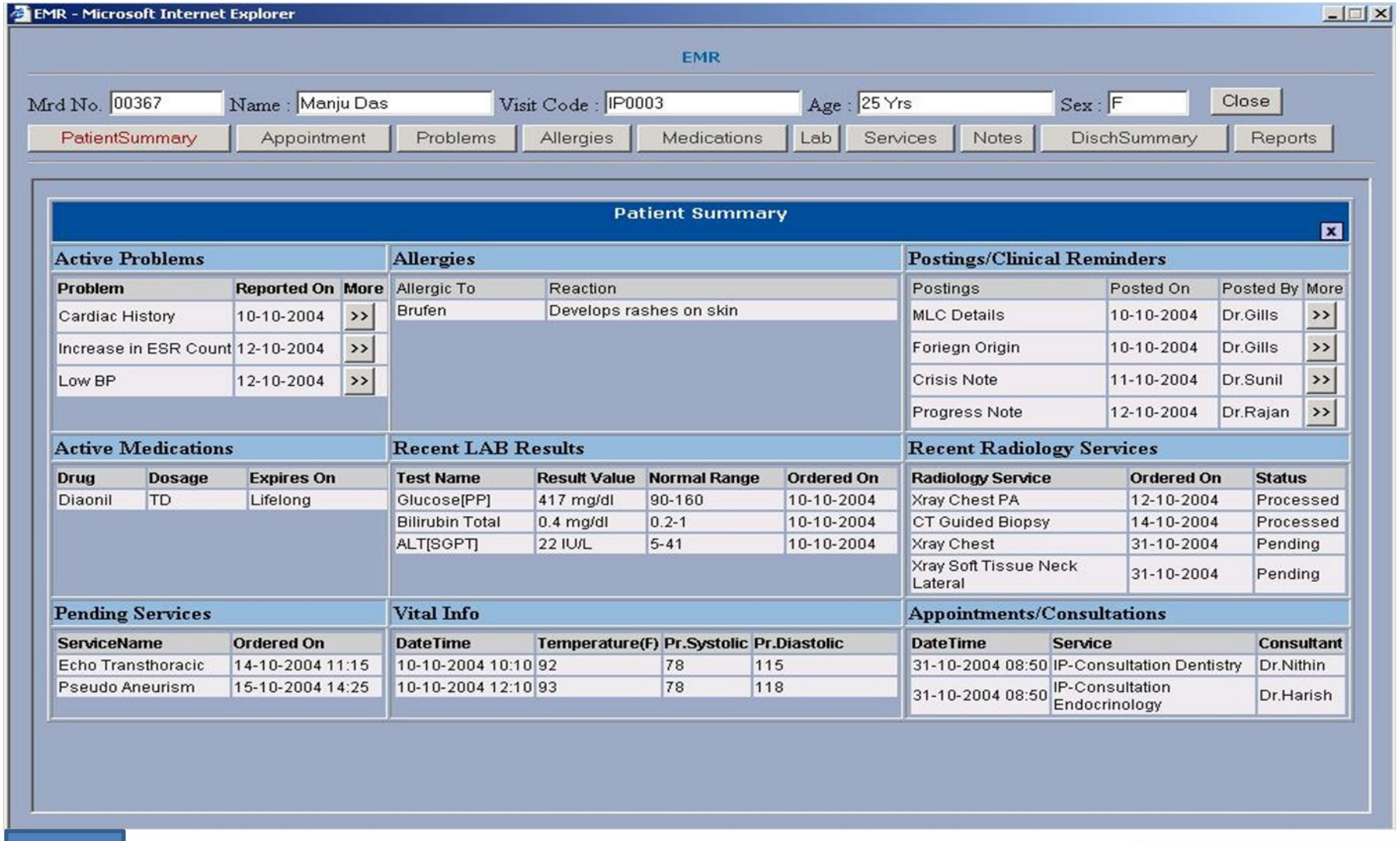
Encompassing a variety of tools to enhance decision-making in the clinical workflow.

- computerized alerts and reminders to care providers and patients
- clinical guidelines
- condition-specific order sets
- focused patient data reports and summaries
- documentation templates
- diagnostic support
- contextually relevant reference information among other tools.

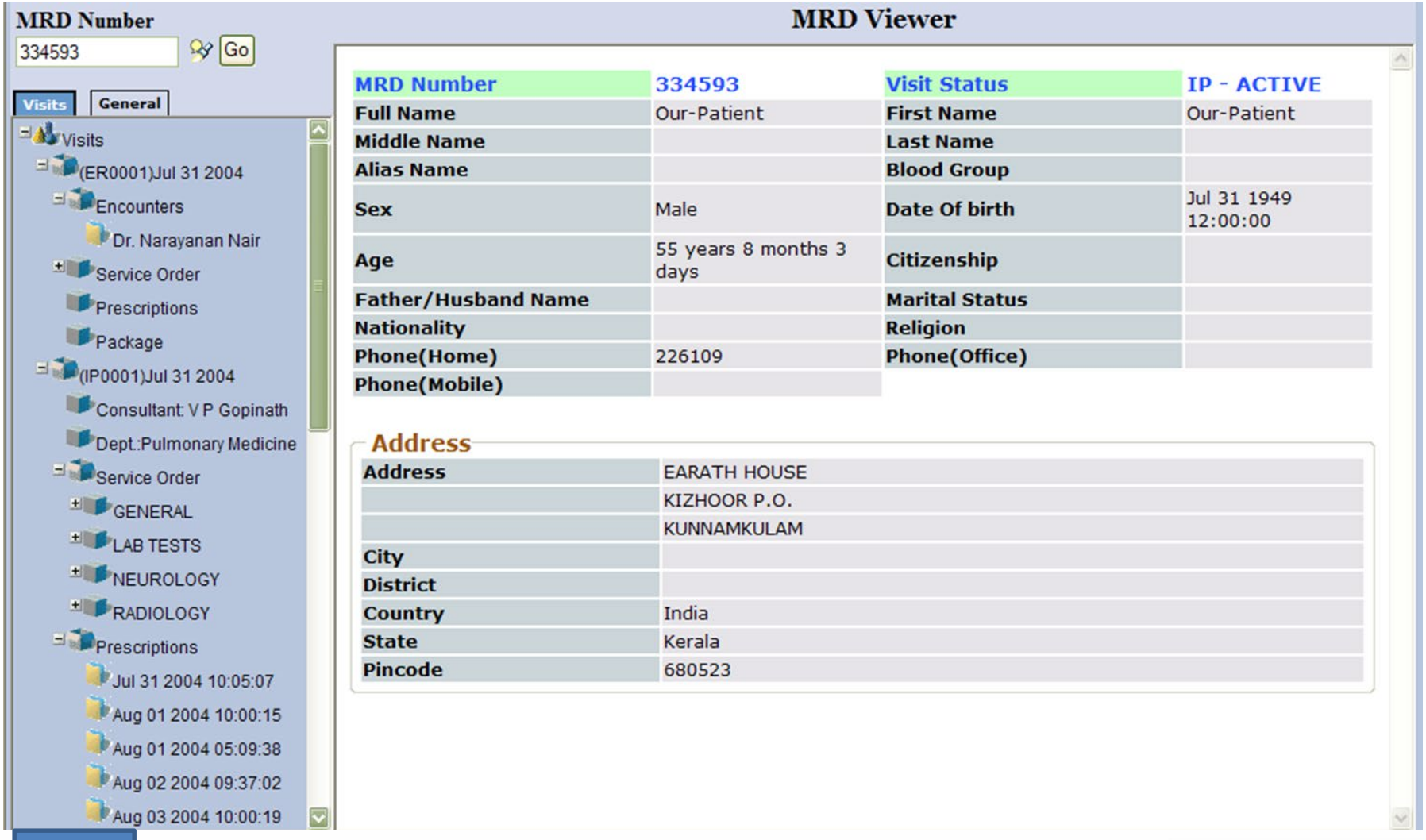
Types of CDSS

- Drug-Drug Interactions
- Drug-Allergy interactions
- Dose Range Checking
- Pick lists
- Standardized evidence based order sets
- Links to knowledge references
- Links to local policies
- Alerts
- Rules to meet strategic objectives (core measures, antibiotic usage, blood management)
- Documentation templates
- Relevant data displays
- Point of care reference information (i.e. InfoButtons)
- Web based reference information
- Diagnostic decision support tools

Electronic Medical Record



EMR Viewer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Encounters
Dr. Narayanan Nair
Service Order
Prescriptions
Package
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Consultant: V P Gopinath
Dept.:Pulmonary Medicine
Service Order
GENERAL
LAB TESTS
NEUROLOGY
RADIOLOGY
Prescriptions
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Aug 01 2004 10:00:15
Aug 01 2004 05:09:38
Aug 02 2004 09:37:02
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Age 55 years 8 months 3 days
Citizenship
Father/Husband Name
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Nationality
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Phone(Home) 226109
Phone(Office)
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KIZHOOR P.O.
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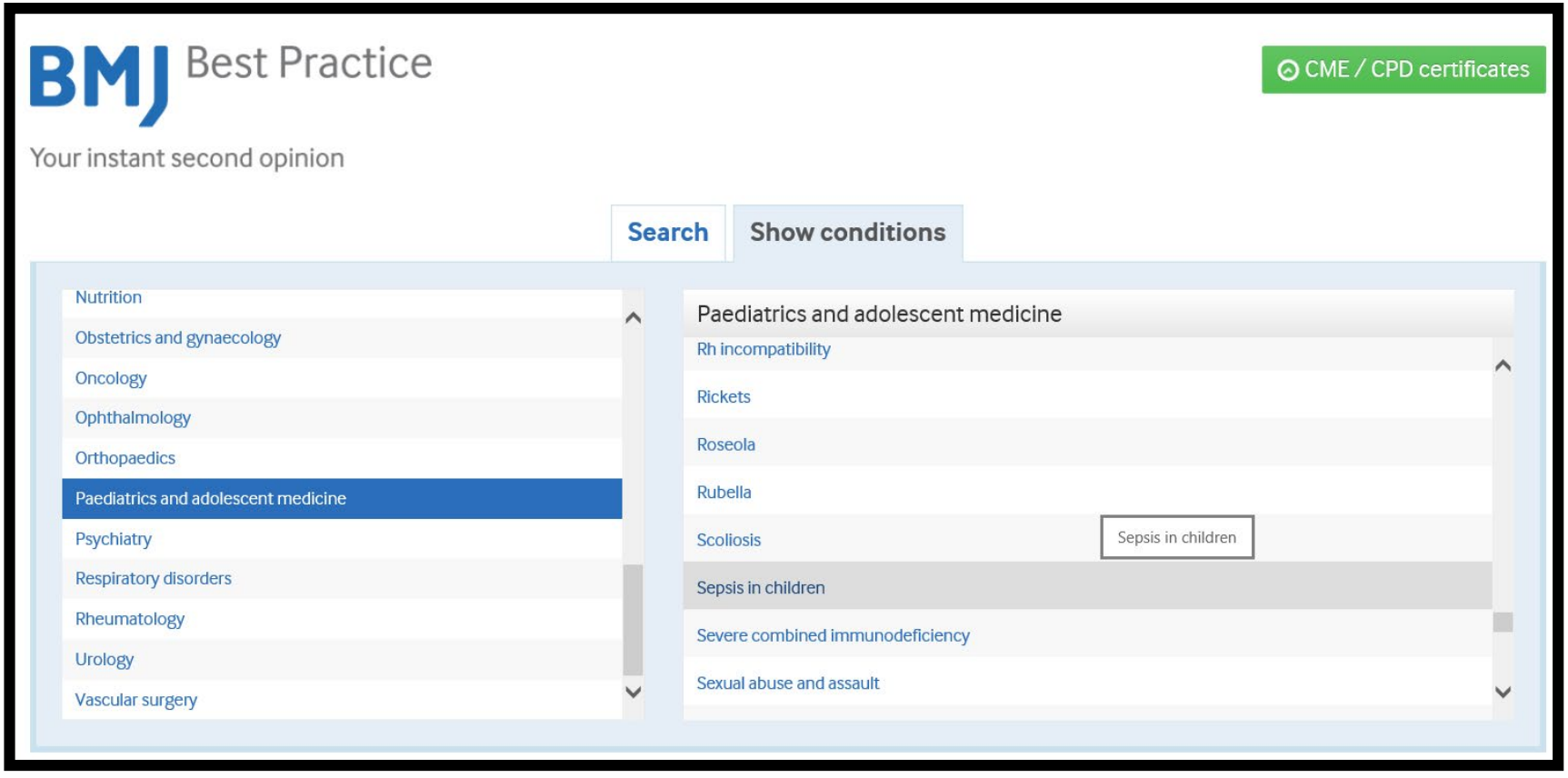
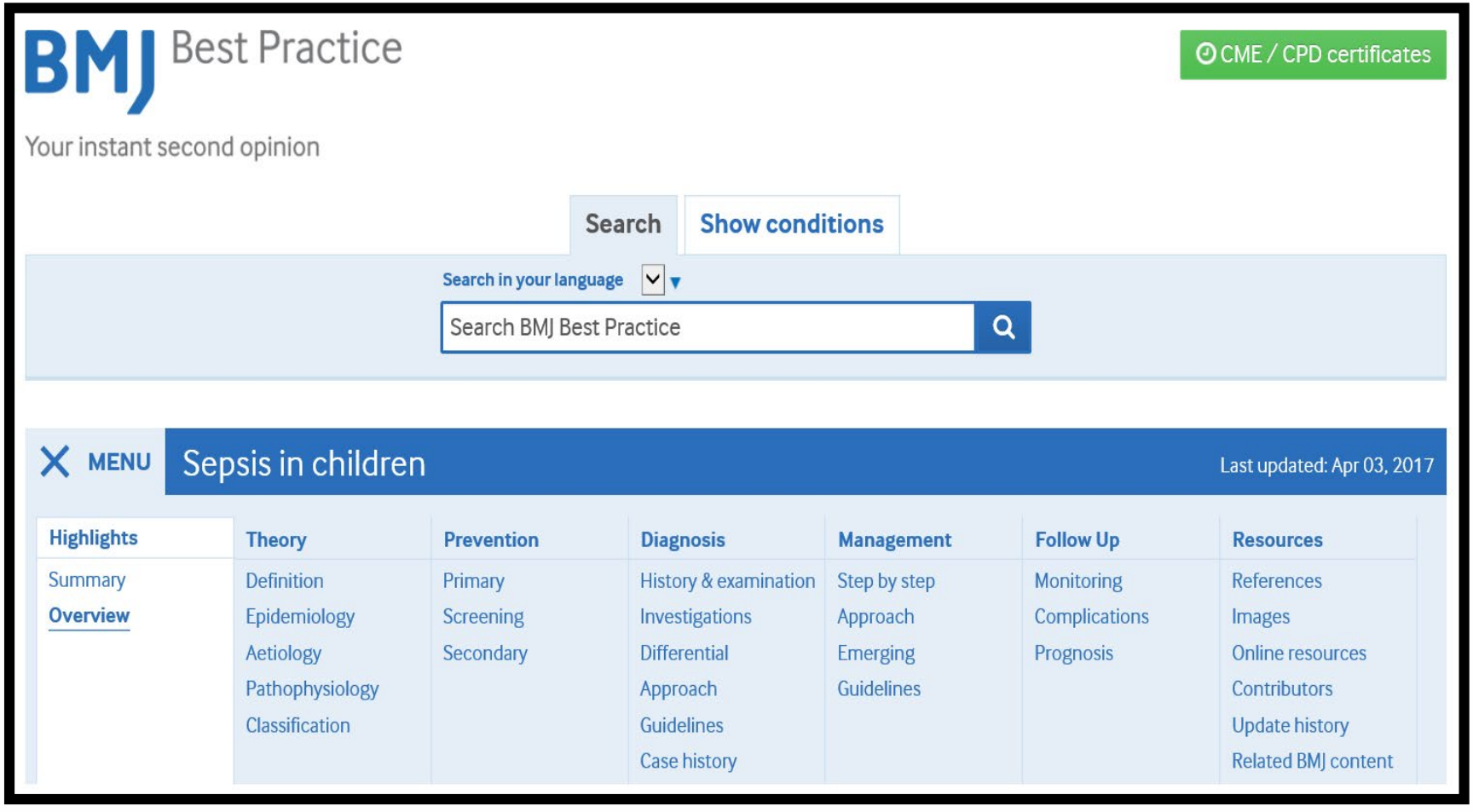
District
Country India
State Kerala
Pincode 680523

Best Practices (http://bestpractice.bmj.com)



Best Practices (Pediatrics/ Sepsis)



Classification of Sepsis

MENU Sepsis in children Last updated: Apr 03, 2017

Classification

International Consensus Conference on Pediatric Sepsis definitions [3]

The following standardised definitions were initially developed by the International Consensus Conference on Pediatric Sepsis to standardise entry criteria for large multi-centre clinical trials. It should be noted that clinical diagnosis of sepsis must occur earlier in the care pathway than classification allows.

Infection:

- Suspected or proven infection with any pathogen.

Systemic inflammatory response syndrome (SIRS):

- Generalised inflammatory response defined by the presence of 2 or more of the following criteria (abnormal temperature or white cell count must be one of the criteria):
  - Abnormal core temperature (<36°C or >38.5°C [<97°F or >101°F])
  - Abnormal heart rate (>2 standard deviations above normal for age, or <10th percentile for age if child is <1 year of age)
  - Raised respiratory rate (>2 standard deviations above normal for age, or mechanical ventilation for acute lung disease)
  - Abnormal white cell count in circulating blood (above or below normal range for age, or >10% immature white cells).

Sepsis:

- SIRS in the presence of infection.

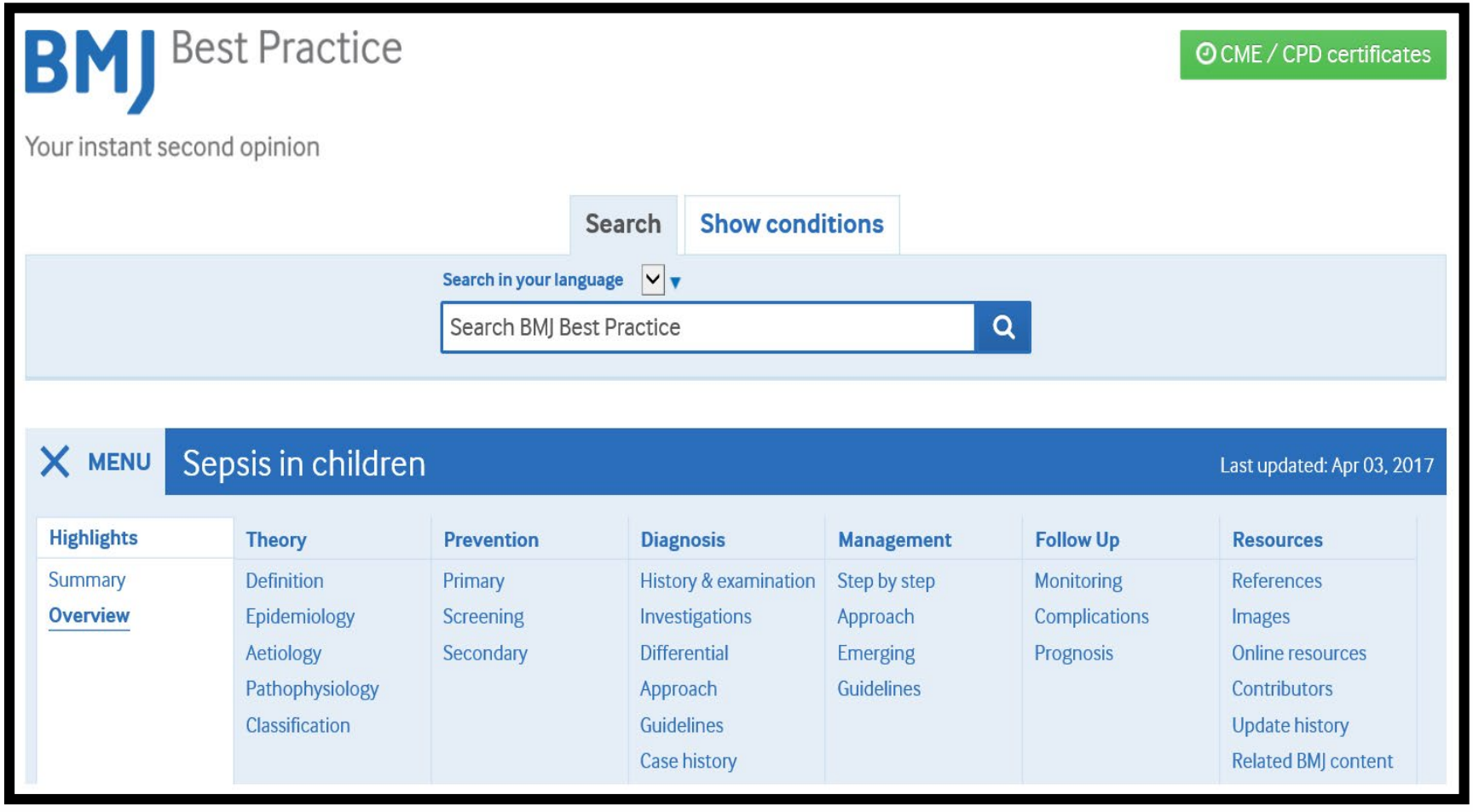
Severe sepsis:

- Sepsis in the presence of cardiovascular dysfunction, acute respiratory distress syndrome, or dysfunction of 2 or more organ systems.

Classification: Sepsis

- Sepsis:
  - SIRS in the presence of infection.
- Severe sepsis:
  - Sepsis in the presence of cardiovascular dysfunction, acute respiratory distress syndrome, or dysfunction of 2 or more organ systems.
- Septic shock:
  - Sepsis with cardiovascular dysfunction persisting after at least 40 mL/kg fluid resuscitation in 1 hour.
- Refractory septic shock:
  - Fluid-refractory septic shock: shock persisting after ≥60 mL/kg of fluid resuscitation
  - Catecholamine-resistant septic shock: shock persists despite therapy with catecholamines (i.e., dopamine and/or adrenaline [epinephrine], or noradrenaline [norepinephrine] infusion).

Best Practices (Pediatrics/ Sepsis)



Sepsis: Management Guidelines (NICE)

NICE National Institute for Health and Care Excellence

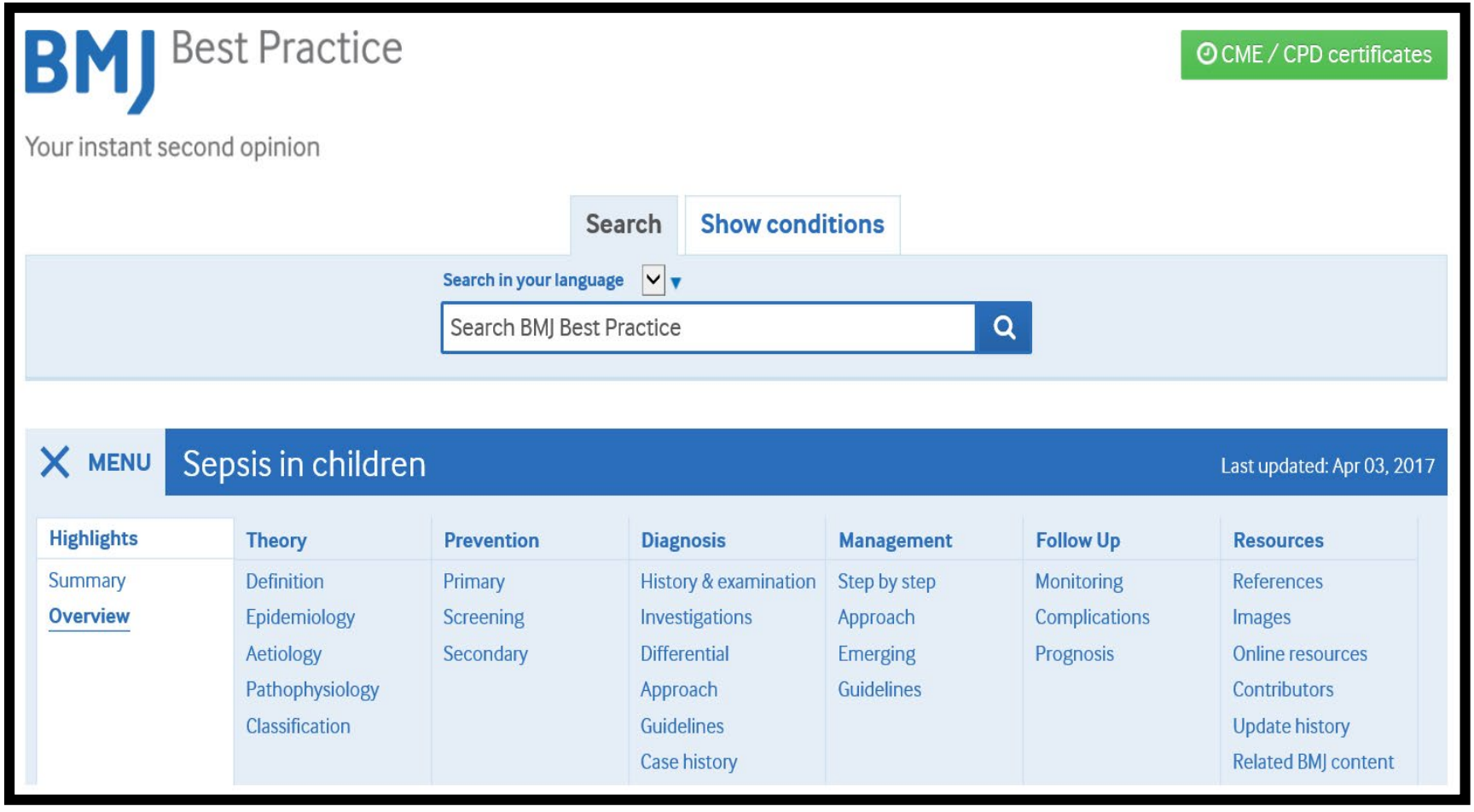
NICE guideline

Fever in under 5s: assessment and initial management

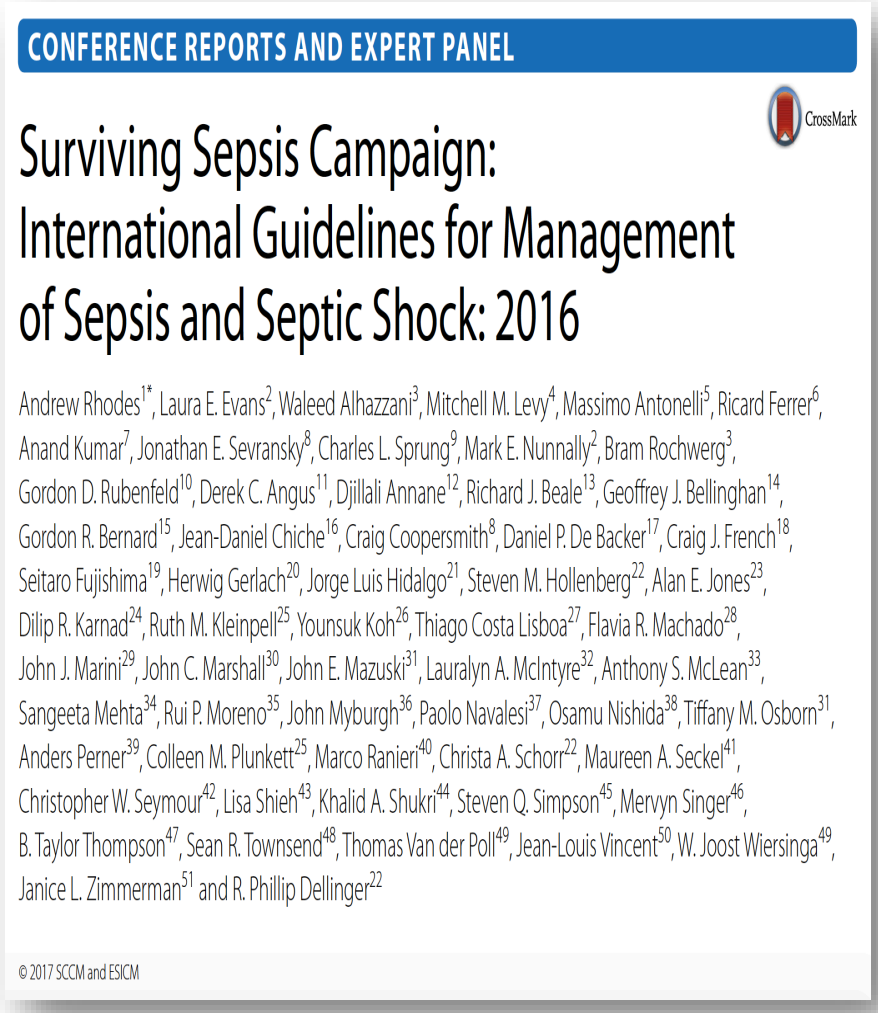
Clinical guideline
Published: 22 May 2013
nice.org.uk/guidance/cg160

Contents

Best Practices (Pediatrics/ Sepsis)



Management Guidelines



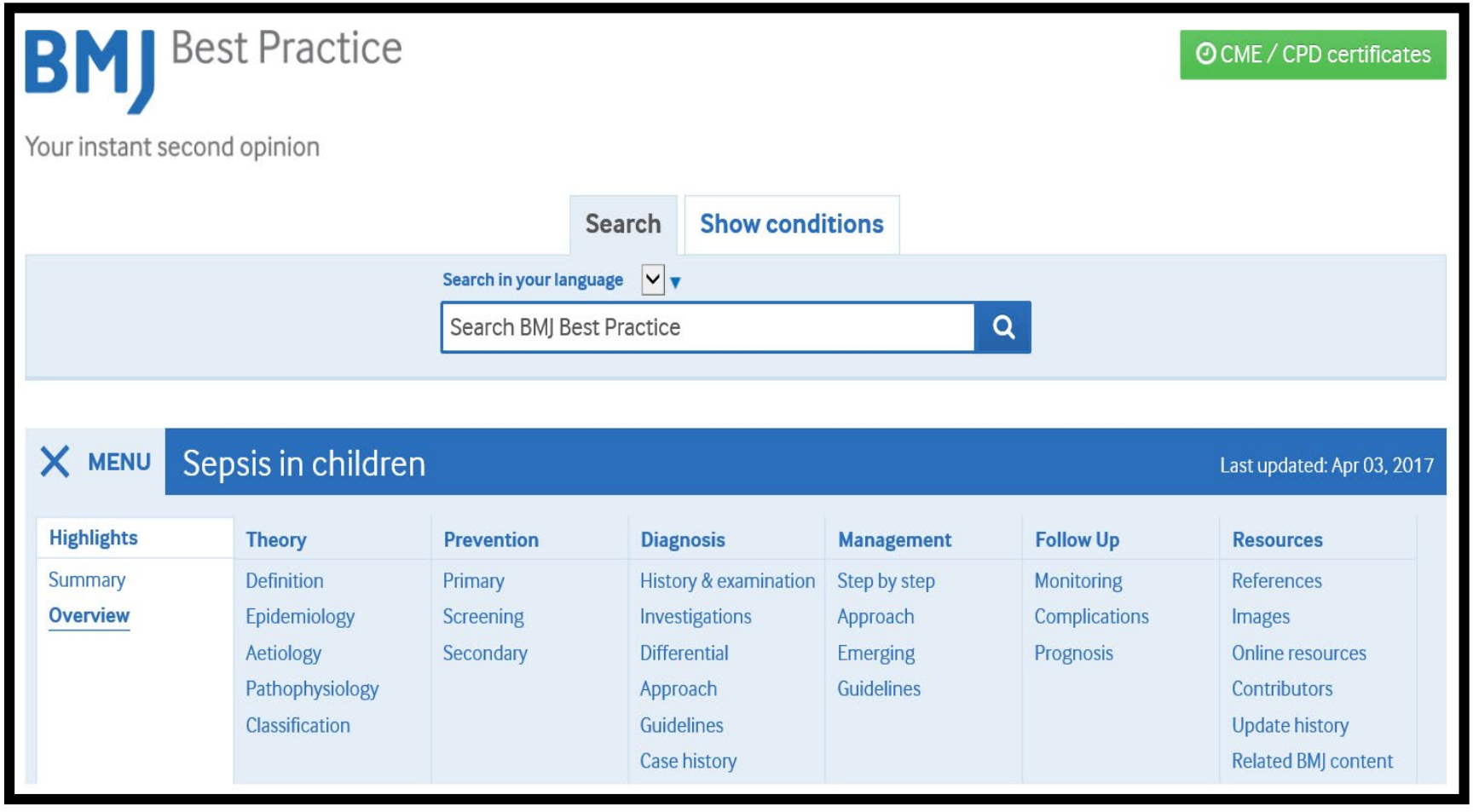
CONFERENCE REPORTS AND EXPERT PANEL

Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016

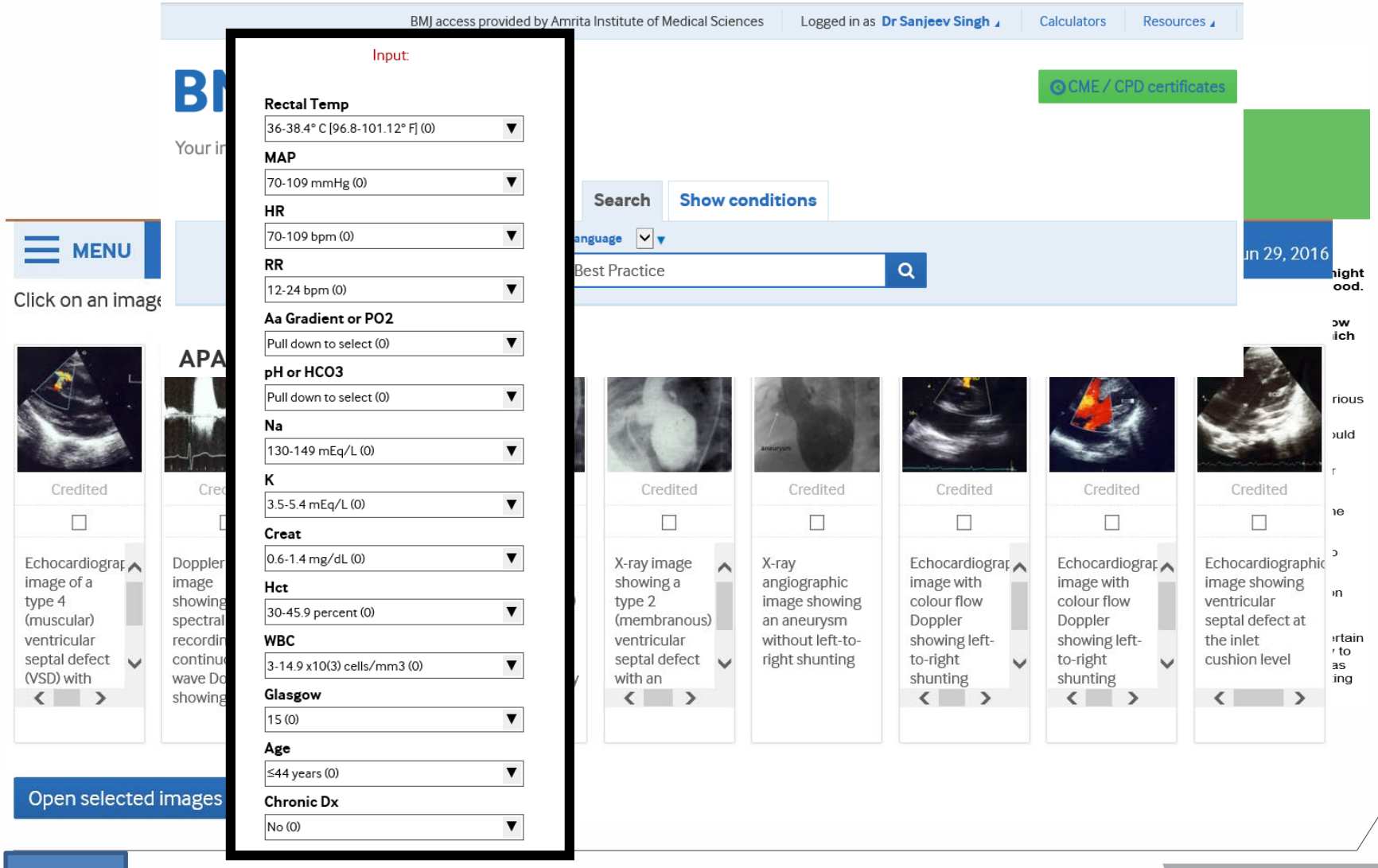
Andrew Rhodes[1*], Laura E. Evans[2], Waleed Alhazzani[3], Mitchell M. Levy[4], Massimo Antonelli[5], Ricard Ferrer[6], Anand Kumar[7], Jonathan E. Sevransky[8], Charles L. Sprung[9], Mark E. Nunnally[2], Bram Rochwerg[3], Gordon D. Rubenfeld[10], Derek C. Angus[11], Djillali Annane[12], Richard J. Beale[13], Geoffrey J. Bellinghan[14], Gordon R. Bernard[15], Jean-Daniel Chiche[16], Craig Coopersmith[8], Daniel P. De Backer[17], Craig J. French[18], Seitaro Fujishima[19], Herwig Gerlach[20], Jorge Luis Hidalgo[21], Steven M. Hollenberg[22], Alan E. Jones[23], Dilip R. Karnad[24], Ruth M. Kleinpell[25], Younsuk Koh[26], Thiago Costa Lisboa[27], Flavia R. Machado[28], John J. Marini[29], John C. Marshall[30], John E. Mazuski[31], Lauralyn A. McIntyre[32], Anthony S. McLean[33], Sangeeta Mehta[34], Rui P. Moreno[35], John Myburgh[36], Paolo Navalesi[37], Osamu Nishida[38], Tiffany M. Osborn[31], Anders Perner[39], Colleen M. Plunkett[25], Marco Ranieri[40], Christa A. Schorr[22], Maureen A. Seckel[41], Christopher W. Seymour[42], Lisa Shieh[43], Khalid A. Shukri[44], Steven Q. Simpson[45], Mervyn Singer[46], B. Taylor Thompson[47], Sean R. Townsend[48], Thomas Van der Poll[49], Jean-Louis Vincent[50], W. Joost Wiersinga[49], Janice L. Zimmerman[51] and R. Phillip Dellinger[22]

- Fluid Therapy
- Glucose monitoring
- Source Control
- Antimicrobials
- Corticosteroids
- Vasopressors
- Mechanical Ventilation
- Blood Products
- Sedation & Analgesia
- Nutrition
- VTE Prophylaxis
- SUD Prophylaxis
- Goals of Care

Best Practices



Additional Clinical Resources



Process Improvement

A Clinical Decision Support System for Prevention of Venous Thromboembolism

Effect on Physician Behavior

Pierre Durieux, MD, MPH
Rémy Nizard, MD
Philippe Ravaud, MD, PhD
Nicolas Mounier, MD
Eric Lepage, MD, PhD

COMPUTER-BASED CLINICAL DECISION support systems (CDSSs) are defined as "any software designed to directly aid in clinical decision making in which characteristics of individual patients are matched to a computerized knowledge base for the purpose of generating patient-specific assessments or recommendations that are then presented to clinicians for consideration."[1] Clinical decision support systems have been promoted for their potential to improve the quality of health care by supporting clinical decision making. In particular, it has been suggested that physicians have difficulties processing complex information[2] and will improve their prescription practices in response to electronically delivered recommendations.[3] However, given their rapid rate

Context Computer-based clinical decision support systems (CDSSs) have been promoted for their potential to improve quality of health care. However, given the limited range of clinical settings in which they have been tested, such systems must be evaluated rigorously before widespread introduction into clinical practice.

Objective To determine whether presentation of venous thromboembolism prophylaxis guidelines using a CDSS increases the proportion of appropriate clinical practice decisions made.

Design Time-series study conducted between December 1997 and July 1999.

Setting Orthopedic surgery department of a teaching hospital in Paris, France.

Participants A total of 1971 patients who underwent orthopedic surgery.

Intervention A CDSS designed to provide immediate information pertaining to venous thromboembolism prevention among surgical patients was integrated into daily medical practice during three 10-week intervention periods, alternated with four 10-week control periods, with a 4-week washout between each period.

Main Outcome Measure Proportion of appropriate prescriptions ordered for anticoagulation, according to preestablished clinical guidelines, during intervention vs control periods.

Results Physicians complied with guidelines in 82.8% (95% confidence interval [CI], 77.6%-87.1%) of cases during control periods and in 94.9% (95% CI, 92.5%-96.6%) of cases during intervention periods. During each intervention period, the appropriateness of prescription increased significantly ($P<.001$). Each time the CDSS was removed, physician practice reverted to that observed before initiation of the intervention. The relative risk of inappropriate practice decisions during control periods vs intervention periods was 3.8 (95% CI, 2.7-5.4).

Conclusions In our study, implementation of clinical guidelines for venous thromboembolism prophylaxis through a CDSS used routinely in an orthopedic surgery department and integrated into the hospital information system changed physician behavior and improved compliance with guidelines.

JAMA. 2000;283:2816-2821 www.jama.com

What is the evidence

EDITOR'S CHOICE

Effects of clinical decision-support systems on practitioner performance and patient outcomes: a synthesis of high-quality systematic review findings

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ABSTRACT

Objective To synthesize the literature on clinical decision-support systems' (CDSS) impact on healthcare practitioner performance and patient outcomes.

Design Literature search on Medline, Embase, Inspec, Cinahl, Cochrane/Dare and analysis of high-quality systematic reviews (SRs) on CDSS in hospital settings. Two-stage inclusion procedure: (1) selection of publications on predefined inclusion criteria; (2) independent methodological assessment of preincluded SRs by the 11-item measurement tool, AMSTAR. Inclusion of SRs with AMSTAR score 9 or above. SRs were thereafter rated on level of evidence. Each stage was performed by two independent reviewers.

Results 17 out of 35 preincluded SRs were of high methodological quality and further analyzed. Evidence that CDSS significantly impacted practitioner performance was found in 52 out of 91 unique studies of the 16 SRs examining this effect (57%). Only 25 out of 82 unique studies of the 16 SRs reported evidence that CDSS positively impacted patient outcomes (30%).

Conclusions Few studies have found any benefits on patient outcomes, though many of these have been too small in sample size or too short in time to reveal clinically important effects. There is significant evidence that CDSS can positively impact healthcare providers' performance with drug ordering and preventive care reminder systems as most clear examples. These outcomes may be explained by the fact that these types of CDSS require a minimum of patient data that are largely available before the advice is (to be) generated: at the time clinicians make the decisions.

provides a brief overview of strategies for the effective implementation of change in patient care.[3] One of the interventions discussed is the use of reminders and computers for the implementation of evidence in daily practice. It is concluded that, among other interventions on the organizational and team level, professional development needs to be built into daily patient care as much as possible. This preferably should take place at the point of care with clinical decision-support tools and real-time patient-specific reminders to help doctors make the best decisions. Clinical decision support is defined as: 'providing clinicians or patients with computer-generated clinical knowledge and patient-related information, intelligently filtered or presented at appropriate times, to enhance patient care.'[4] Clinical knowledge incorporated in clinical decision-support systems (CDSS), for instance, can be based on available best evidence which is represented in guideline recommendations.

There are many different types of clinical tasks that can be supported by CDSS. A well-known and frequently applied CDSS is the patient-monitoring device (eg, an ECG or pulse oximeter) that warns of changes in a patient's condition. CDSS integrated in Electronic Medical Record systems (EMRs) and computerized physician order entry systems (CPOEs) can send reminders or warnings for deviating laboratory test results, check for drug—drug interactions, dosage errors, and other prescribing contraindications such as a patient's allergies, and generate lists of patients eligible for a particular intervention (eg, immunizations or follow-up

CDSS & Medical Informatics

Sambasivan *et al. BMC Medical Informatics and Decision Making* 2012, **12**:142
http://www.biomedcentral.com/1472-6947/12/142

BMC Medical Informatics & Decision Making

RESEARCH ARTICLE Open Access

Intention to adopt clinical decision support systems in a developing country: effect of Physician's perceived professional autonomy, involvement and belief: a cross-sectional study

Murali Sambasivan[1*], Pouyan Esmaeilzadeh[2], Naresh Kumar[3] and Hossein Nezakati[4]

Hypothesis tested were: Physician perceived threats to professional autonomy; Physician involvement in planning, design & implementation; Physicians beliefs on performance improvement…

Abstract

in the planning, design and implementation increases their intention to use CDSS ($p < 0.01$); (3) Physicians belief that the new CDSS will improve his/her job performance increases their intention to use CDSS ($p < 0.01$).

Conclusion: The proposed model with the three main constructs (physician's professional characteristic, involvement and belief) explains 47% of the variance in the intention to use CDSS. This is significantly higher than the models addressed so far. The results will have a major impact in implementing CDSS in developing countries.

Keywords: Clinical decision support system, Professional autonomy, Performance expectancy, Effort expectancy, Participation in decision making, Intention to use, Physicians, Malaysia

Systematic Review & Meta-analysis

Published in final edited form as:
Mayo Clin Proc. 2015 April ; 90(4): 469–480. doi:10.1016/j.mayocp.2014.12.026.

Digital Health Interventions for the Prevention of Cardiovascular Disease: A Systematic Review and Meta-Analysis

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Abstract

Objective—To assess the potential benefit of digital health interventions (DHI) on cardiovascular disease outcomes (CVD events, all-cause mortality, hospitalizations) and risk factors compared to non-DHI interventions.

Patients and Methods—We conducted a systematic search of PubMed, MEDLINE, EMBASE, Web of Science, OVID, CINHAL, ERIC, PsychInfo, Cochrane, and CENTRAL from January 1, 1990 and January 21, 2014. Included studies examined any element of DHI (telemedicine, web-based strategies, email, mobile phones, mobile applications, text messaging, and monitoring sensors) and CVD outcomes or risk factors. Two reviewers independently evaluated study quality utilizing a modified version of the Cochrane Collaboration risk assessment tool. Authors extracted CVD outcomes and risk factors for CVD such as weight, BMI, blood pressure, and lipids from 51 full-text articles that met validity and inclusion criteria.

Results—DHI significantly reduced CVD outcomes (RR=0.61, (95% CI, 0.45–0.83), P=.002; I^2=22%). Concomitant reductions in weight (−3.35 lbs, (95% CI, −6.08 lbs, −1.01 lbs); P=.006; I^2=96%) and BMI (−0.59 kg/m^2, (95% CI, −1.15 kg/m^2, −0.03 kg/m^2); P=.04; I^2=94%) but not blood pressure (+4.95 mmHg, (95% CI, −4.5 mmHg, 14.4 mmHg); P=.30; I^2=100%) were found in these DHI trials compared to usual care. Framingham 10 year risk percentages were also significantly improved (−1.24%; 95% CI −1.73%, −0.76%; n=6; P<0.001; I^2=94%). Results were

PLOS | ONE

RESEARCH ARTICLE

The Effects of Clinical Decision Support Systems on Medication Safety: An Overview

Pengli Jia[1], Longhao Zhang[1], Jingjing Chen[2], Pujing Zhao[1], Mingming Zhang[1]*

1 Chinese Evidence-based Medicine Centre, West China Hospital, Sichuan University, Chengdu, PR, China, 2 Department of Otolaryngology-Head and Neck Surgery, The First Affiliated Hospital of Zhejiang Chinese Medical University, Hangzhou, PR, China

Results

Twenty systematic reviews, consisting of 237 unique randomized controlled trials(RCTs) and 176 non-RCTs were included. Evidence that CDSS significantly impacted process of care was found in 108 out of 143 unique studies of the 16 SRs examining this effect (75%). Only 18 out of 90 unique studies of the 13 SRs reported significantly evidence that CDSS positively impacted patient outcomes (20%). Ratings for the overall scores of AMSTAR resulted in a mean score of 8.3 with a range of scores from 7.5 to 10.5. The reporting quality was varied. Some contents were particularly strong. However, some contents were poor.

Conclusions

CDSS reduces medication error by obviously improving process of care and inconsistently improving patient outcomes. Larger samples and longer-term studies are required to ensure

OPEN ACCESS Freely available online

PLOS ONE

A Clinical Decision Support System for Integrating Tuberculosis and HIV Care in Kenya: A Human-Centered Design Approach

Caricia Catalani[1,2*], Eric Green[3,4], Philip Owiti[5], Aggrey Keny[4], Lameck Diero[5], Ada Yeung[6], Dennis Israelski[1,7], Paul Biondich[5,6]

1 Innovative Support to Emergency, Disease, & Disaster (InSTEDD), Sunnyvale, California, United States of America, **2** School of Public Health, University of California, Berkeley, California, United States of America, **3** Kijani Consulting, Chapel Hill, North Carolina, United States of America, **4** Duke University, Chapel Hill, North Carolina, United States of America, **5** Academic Model for the Prevention and Treatment of HIV (AMPATH), Eldoret, Kenya, **6** Regenstrief Institute, Indiana University, Indianapolis, Indiana, United States of America, **7** School of Medicine, Stanford University, Palo Alto, California, United States of America

Table 4. Tailored, educational, & promotional message content.

Message Objective	Patient-Specific, Educational & Promotional Message Content
Remind to screen to determine active TB status	TB symptoms include chronic cough, fever, & weight loss. Please ask [patient name] about all symptoms and order/interpret a CXR. AMPATH is committed to offering anti-TB meds or IPT to all eligible patients.
Remind to conduct symptomatic screening when CXR normal	TB symptoms not recorded for [patient name] in last encounter. Patient has NORMAL CXR. If no symptoms, consider initiating IPT. IPT saves lives.
Remind to conduct symptomatic screening when CXR abnormal	TB symptoms not recorded for [patient name] in last encounter. Patient has ABNORMAL CXR. If patient has symptoms, consider initiating TB treatment. TB treatment saves lives.
Remind to conduct ongoing symptomatic screening for patients on IPT	TB symptoms not recorded for [patient name] in last encounter. AMPATH requires continued screening of patients while on IPT. Symptoms may mean that [she/he] has active TB and needs to stop IPT.
Remind to obtain CXR to determine active TB status when symptoms suggestive of TB (possible TB treatment initiation)	[Patient name] reported TB symptoms during the last encounter. Please order CXR to determine if [she/he] has active TB and needs to begin lifesaving treatment.
Remind to order further investigations when CXR is normal and symptoms present	[Patient name] reported TB symptoms during the last encounter. [Her/His] CXR results were normal. Please order further tests such as sputum microscopy to rule out TB. TB treatment is free and available.
Remind to initiate anti-TB meds	[Patient name] may have TB. [Her/His] reported TB symptoms during the last visit and had an abnormal CXR. Order sputum test to determine if [she/he depending on gender] should start lifesaving TB treatment today.
Remind to consider stopping IPT	[Patient name] reported symptoms suggestive of TB at last encounter. Symptoms could mean that [he/she] has active TB and needs to stop IPT.
Remind to obtain CXR to determine active TB status when symptoms NOT suggestive of TB (possible IPT initiation)	If patient still does NOT report TB symptoms today, a normal CXR means that [he/she] is eligible for IPT. IPT could save [his/her] life. Order CXR to determine IPT eligibility or record existing results to end this reminder.
Remind to initiate IPT	[Patient name]'s test results do NOT suggest active TB. If patient still does not report TB symptoms today, consider initiating IPT now. IPT is effective and could save [his/her] life.
Remind to order further investigations when CXR is Abnormal and symptoms absent	[Patient name] reported no TB symptoms during the last encounter, however CXR results were abnormal. Please order further tests such as sputum microscopy to rule out TB. At AMPATH, we are committed to stopping TB.
Remind to monitor adherence to IPT regimen	[Patient name]'s adherence to IPT was not reported at the last encounter. Please monitor adherence until the patient completes a 9-month course or stops for other reasons. IPT only saves lives when adherence is high.
Remind to encourage patient to complete IPT if not adherent	[Patient name] reported low IPT adherence at the last encounter. Please encourage [her/him] to complete the full 9-month course by discussing barriers to adherence. IPT only saves lives when adherence is high.

CDSS: Antibiotic Stewardship

Holstiege J, et al. J Am Med Inform Assoc 2015;22:236–242. doi:10.1136/amiajnl-2014-002886, Review

Effects of computer-aided clinical decision support systems in improving antibiotic prescribing by primary care providers: a systematic review

RECEIVED 17 April 2014
REVISED 11 July 2014
ACCEPTED 23 July 2014
PUBLISHED ONLINE FIRST 14 August 2014

Jakob Holstiege[1], Tim Mathes[2], Dawid Pieper[2]

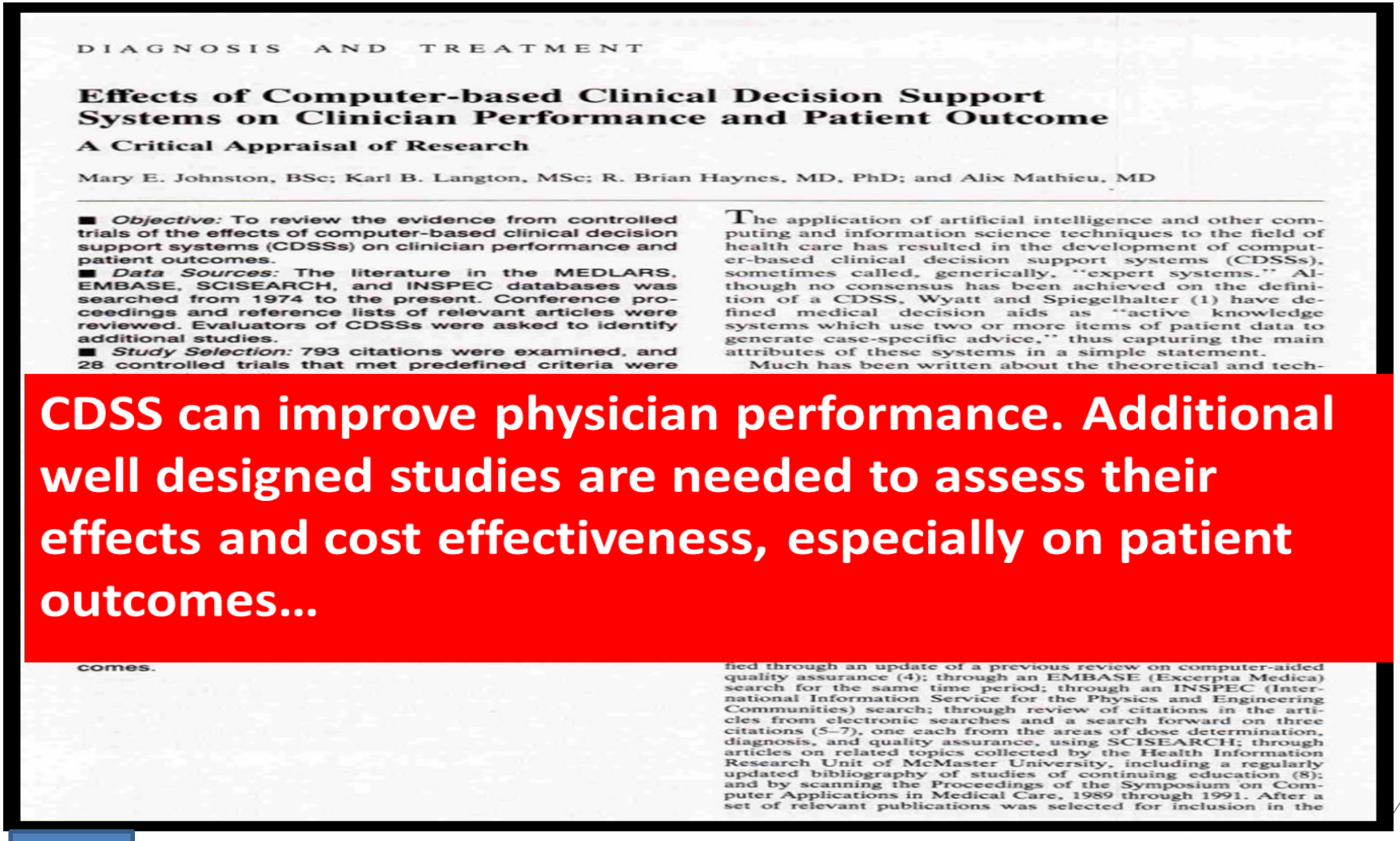
ABSTRACT

Objective To assess the effectiveness of computer-aided clinical decision support systems (CDSS) in improving antibiotic prescribing in primary care.

CD promising effectiveness in improving antibiotic prescribing behavior in primary care. Magnitude of effects compared to no intervention, appeared to be similar to other moderately effective single interventions directed at primary care providers.

triggering high adoption by providers as a perquisite of clinically relevant improvement of antibiotic prescribing.

CDSS: Clinical Outcomes…



DIAGNOSIS AND TREATMENT

Effects of Computer-based Clinical Decision Support Systems on Clinician Performance and Patient Outcome

A Critical Appraisal of Research

Mary E. Johnston, BSc; Karl B. Langton, MSc; R. Brian Haynes, MD, PhD; and Alix Mathieu, MD

■ *Objective:* To review the evidence from controlled trials of the effects of computer-based clinical decision support systems (CDSSs) on clinician performance and patient outcomes.

■ *Data Sources:* The literature in the MEDLARS, EMBASE, SCISEARCH, and INSPEC databases was searched from 1974 to the present. Conference proceedings and reference lists of relevant articles were reviewed. Evaluators of CDSSs were asked to identify additional studies.

■ *Study Selection:* 793 citations were examined, and 28 controlled trials that met predefined criteria were

comes.

The application of artificial intelligence and other computing and information science techniques to the field of health care has resulted in the development of computer-based clinical decision support systems (CDSSs), sometimes called, generically, "expert systems." Although no consensus has been achieved on the definition of a CDSS, Wyatt and Spiegelhalter (1) have defined medical decision aids as "active knowledge systems which use two or more items of patient data to generate case-specific advice," thus capturing the main attributes of these systems in a simple statement.

Much has been written about the theoretical and tech-

fied through an update of a previous review on computer-aided quality assurance (4); through an EMBASE (Excerpta Medica) search for the same time period; through an INSPEC (International Information Service for the Physics and Engineering Communities) search; through review of citations in the articles from electronic searches and a search forward on three citations (5–7), one each from the areas of dose determination, diagnosis, and quality assurance, using SCISEARCH; through articles on related topics collected by the Health Information Research Unit of McMaster University, including a regularly updated bibliography of studies of continuing education (8); and by scanning the Proceedings of the Symposium on Computer Applications in Medical Care, 1989 through 1991. After a set of relevant publications was selected for inclusion in the

CDSS can improve physician performance. Additional well designed studies are needed to assess their effects and cost effectiveness, especially on patient outcomes…

CDSS: UTI, Diagnosis

Diagnostic decision support for UTI based on symptoms and signs

Choose if appropriate	Symptom description	ICPC2 code	ICD10 code
(•) yes ( ) no	Dysuria	U01	R30
(•) yes ( ) no	Urinary frequency	U02	R35
( ) yes (•) no	Haematuria	U06	N02, R31
( ) yes (•) no	Vaginal discharge	X14	N89.8
( ) yes (•) no	Vaginal irritation		
( ) yes (•) no	Costovertebral angle tenderness		

Next

CDSS: UTI, Risk stratification

From the information we gathered so far, the probability of UTI diagnosis is: **92.43%**, we need a bit more information to give you full decision support.

1. Back pain? ○ Yes ◉ No

2. Fever? ○ Yes ◉ No

3. Risk factors for complicated UTI? ○ Yes ◉ No

Risk factors for complicated UTI

- Severe illness, including hypotension, tachycardia, reduced levels of consciousness, or dehydration.
- People older than 65 years of age.
- Abnormalities of renal tract anatomy and function (such as vesico-ureteric reflux, polycystic kidney disease).
- Foreign body within the renal tract, including renal stones and urinary, ureteric, or nephrostomy catheters.
- Immunocompromised patients, due to immunosuppressant drug use, cancer, cancer therapies, or AIDS.
- Diabetes.
- Pregnancy.
- Persistent infection despite treatment.
- Renal impairment.

Next

CDSS: UTI, Management

From all the information we gathered, the final probability of UTI diagnosis is: 89.78%.

High probability of UTI (>80%): Consider empirical treatment without urine dipstick or urine culture.

Further Advice: Diagnose lower UTI

- No need for urine dipstick
- No need for urine C+S
- Consider empirical treatment

Patient information leaflet for lower UTI

Accept this diagnosis and continue to prescribe for lower UTI

CDSS: UTI, Prescribing

You are prescribing on Cystitis/urinary infection, other for **Dunleavy, Mary**, who is allergic to penicillin

Clinical guidelines for this clinical scenario (**Lower UTI**) are available, view them here and come back or prescribe directly

1. Accept one of the recommended prescription by clicking the button beside the chosen medicine

Recommended	Choose	ATC code	Drug	Strength	Cost *(incremental)*	Category	Link for drug information	Recommendation	Accept recommendation
Yes	◉	J01EA01	trimethoprim	200mg	5	Infections and infestations (J, P, QI)	drug details	200mg twice daily (400mg in total per day) for 3 days	Confirm and save to consultation
Yes	○	J01XE01	nitrofurantoin	50mg	20	Infections and infestations (J, P, QI)	drug details	50mg four times daily (200mg in total per day) for 3 days	Confirm and save to consultation

OR

2. a) Choose an alternative medicine:

Enter a single keyword or part of its name [ ] Search medicines by generic names

CDSS for antibiotic prescription in primary care in France (Antibioclic)

- developed and released in October 2011
- Since 2017 a smartphone application has been available.
- access and use is free of charge, does not require registration and is granted to any healthcare professional or service user 24 h/day, 7 days/week
- successfully implemented and adopted by French GPs, with data indicating sustained use and a continuous increase in users
- may have a positive impact on users' prescriptions, antibiotic consumption, AMR and patient care

ANTIBIOCLIC

Antibiothérapie rationnelle en soins primaires

Dernière MàJ : 12/01/2015

NOUVELLE RECHERCHE SOURCES ACTUALITÉ À PROPOS CONTACT

+ Bienvenue sur la nouvelle version du site ANTIBIOCLIC +

RECHERCHE ANTIBIOTIQUE

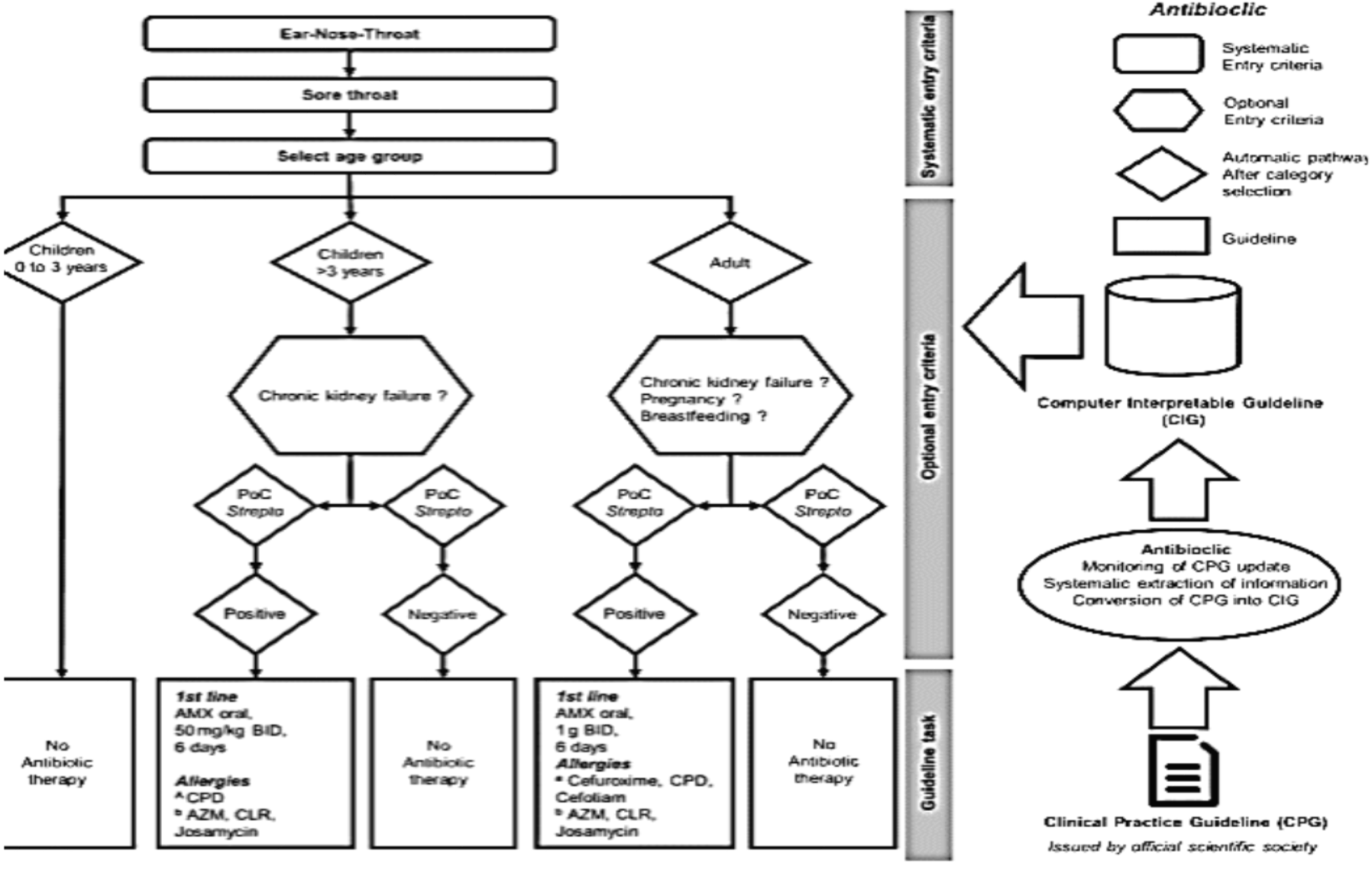
Domaine anatomique

Choisissez ...

Pathologie

Choisissez ...

CHERCHER


Ear-Nose-Throat
Sore throat
Select age group
Children 0 to 3 years
Children >3 years
Adult
Chronic kidney failure ?
Chronic kidney failure ?
Pregnancy ?
Breastfeeding ?
PoC Strepto
PoC Strepto
PoC Strepto
PoC Strepto
Positive
Negative
Positive
Negative
No Antibiotic therapy
1st line
AMX oral,
50 mg/kg BID,
6 days
Allergies
[a] CPD
[b] AZM, CLR, Josamycin
No Antibiotic therapy
1st line
AMX oral,
1 g BID,
6 days
Allergies
* Cefuroxime, CPD, Cefotiam
[b] AZM, CLR, Josamycin
No Antibiotic therapy
Systematic entry criteria
Optional entry criteria
Guideline task
Antibioclic
Systematic Entry criteria
Optional Entry criteria
Automatic pathway After category selection
Guideline
Computer Interpretable Guideline (CIG)
Antibioclic
Monitoring of CPG update
Systematic extraction of information
Conversion of CPG into CIG
Clinical Practice Guideline (CPG)
Issued by official scientific society

Outcome of Antibioclic

- The number of queries increased from a median of 796/day [IQR, 578–989] in 2012 to 11 125/day [5592–12 505] in 2018.
- Unique users increased from 414/day [245–494] in 2012 to 5365/day [2891–5769] in 2018.
- Time taken to make a query was 2 min [1.9–2.1].
- Most users (81%) were GPs, with median age of 38 years [31–52] and 58% were female.
- Among the 4016 GPs who responded to the surveys, the vast majority (96%) reported using the CDSS during the consultation, with 24% systematically using Antibioclic to initiate an antibiotic course and 93% having followed the CDSS recommendation for the latest prescription.
- Most GPs were comfortable using the CDSS in front of a patient.

Standards (Operability)

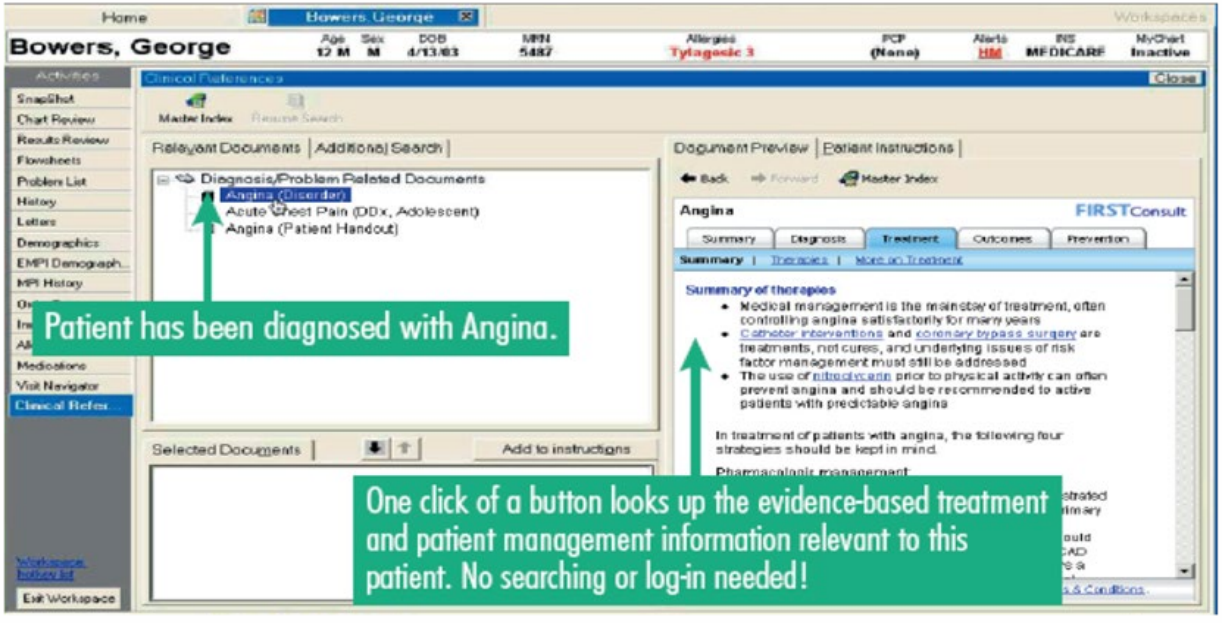
- HIPAA (Health Insurance Portability and Accountability Act)
- HL 7 (Health level 7)- LIS, RIS, PACS
- DICOM (Digital Imaging and Communication in Medicine)
- PACS (Picture archiving and Comm System)
- ICD – 10 (International Code of Diseases)
- FIHR – Fast HC Intra-operability Resources
- SNOWMED CT – Systematised Nomenclature for Medicine Clinical Terms
- IEEE – Institute of Electrical & Electronics Engineers (SDO)

Regulatory Compliance

- Health Information & Technology for Economics & Clinical Health Act (HITECH) 2009
- Food & Drug Administration, Safety & Innovation Act (FDASIA) 2012
- HIPAA
- Affordable Care Act
- IT 2000 (India)

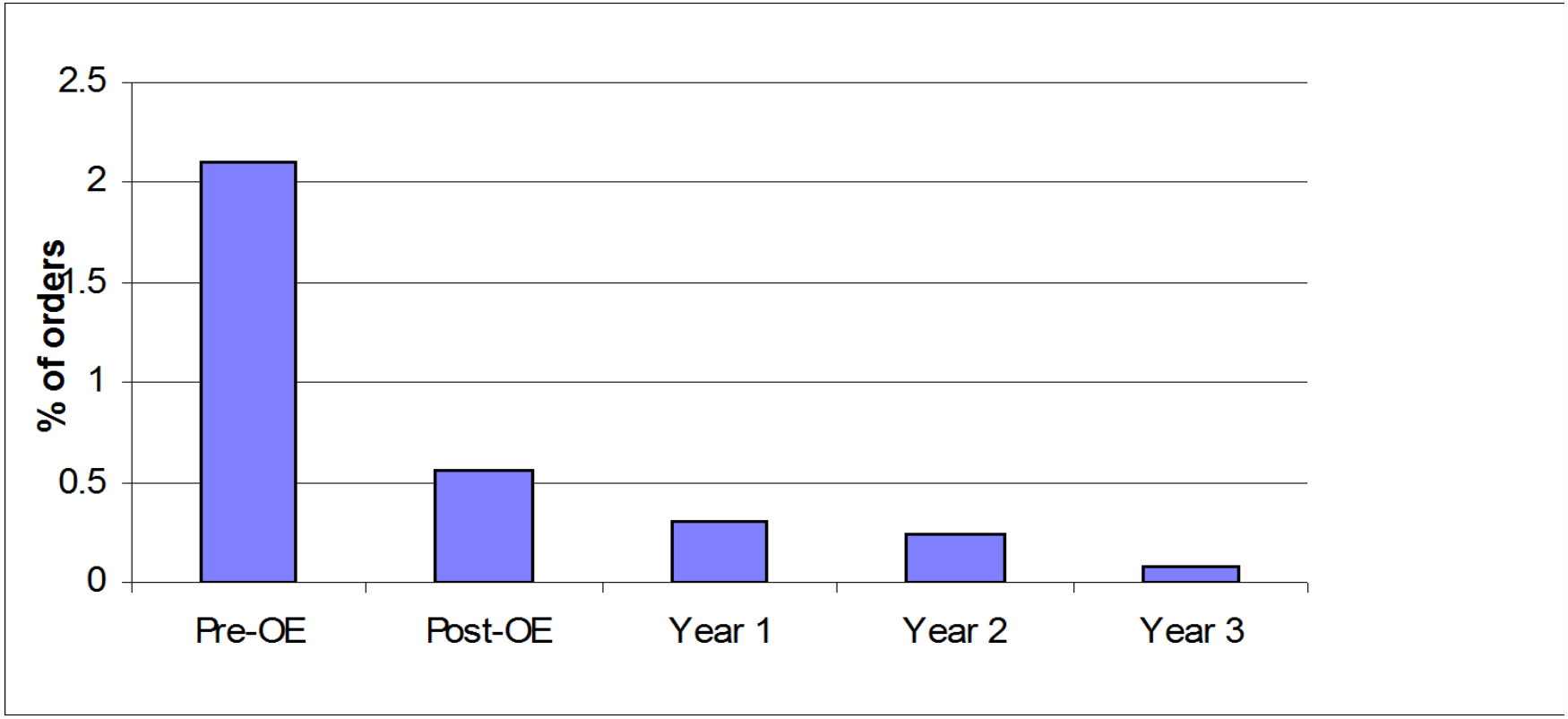
Benefits of CDSS

- CDSS has a number of important benefits, including:
  - Increased quality of care and enhanced health outcomes
  - Avoidance of errors and adverse events
  - Improved efficiency, cost-benefit, and provider and patient satisfaction

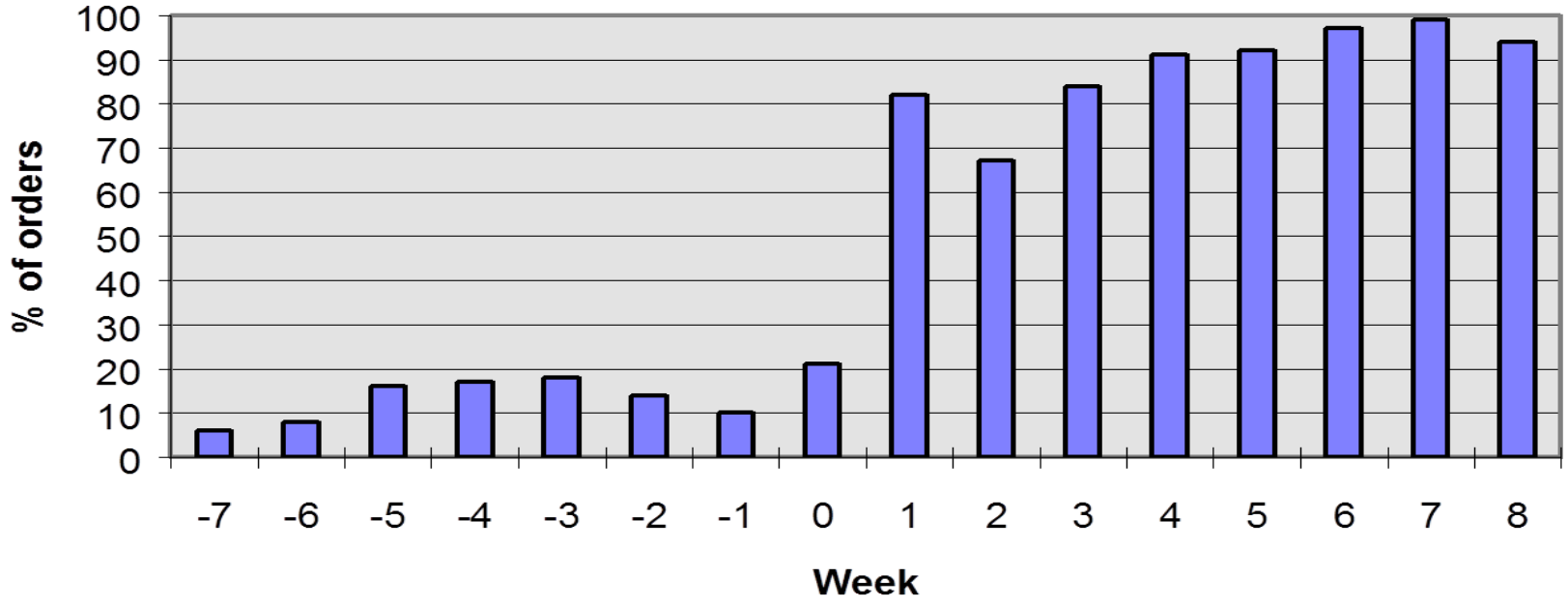


CDS can reduce errors

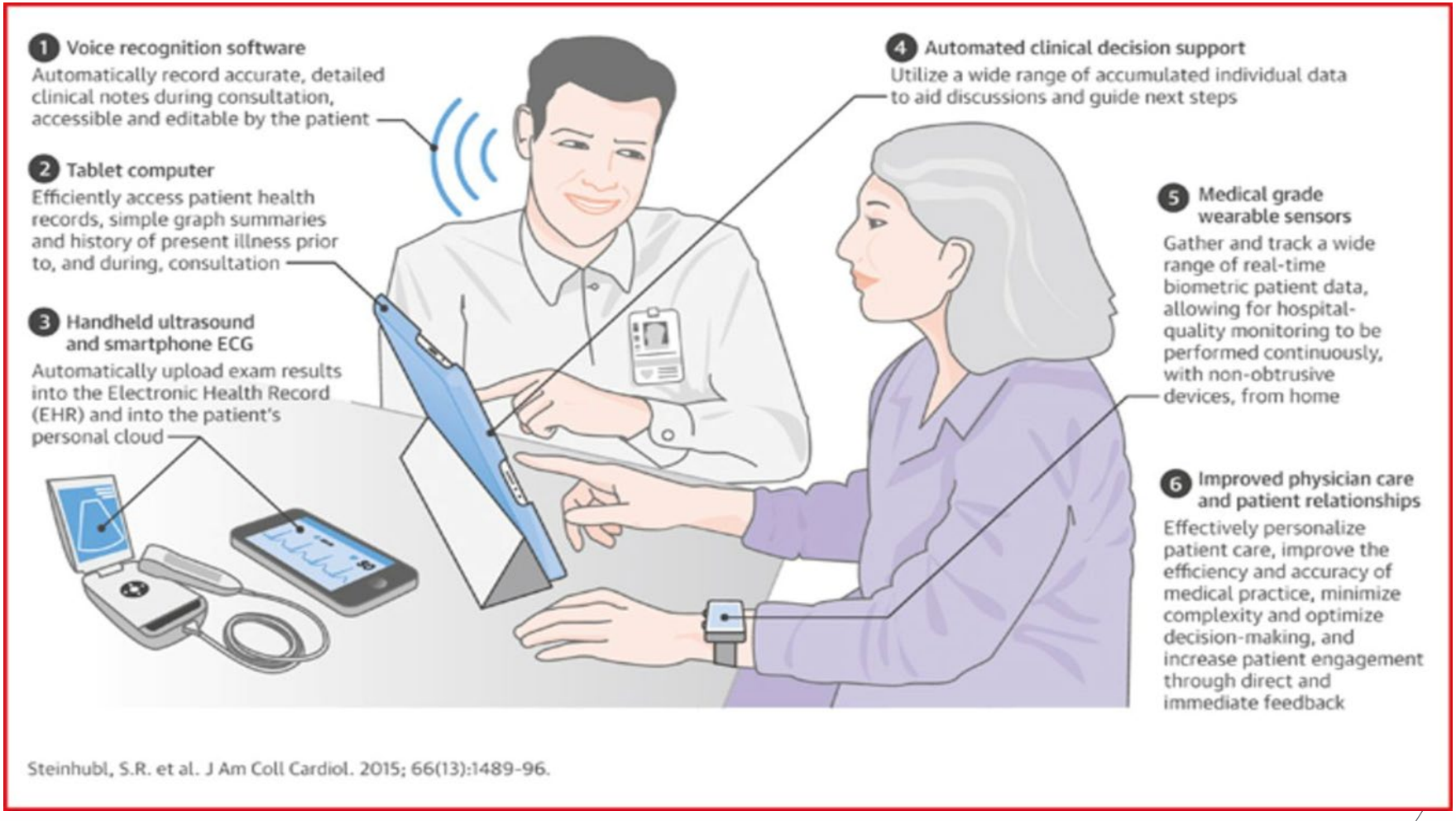
Reduced dosing errors after implementing CDS with CPOE



CDS can improve adoption of best practices Use of recommended H2 blocker before and after CPOE



Gadgets: Applications



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Recap: Where do we go from here?

- Promote Computer Interpretable Clinical Guideline (CIG) knowledge base development at the federal level with continuing maintenance from AHRQ.
  - AHRQ already maintains written clinical guidelines
  - MoHFW (CEA) / BMJ Evidence Based Practice represents national vetting of clinical guidelines.
  - Digitalization to be explored

- Form Internal Working study group on clinical interfaces and systems.
  - Review past analyses of clinical interfaces.
  - Work with doctors, nurses, hospitals, HMO's, etc. to obtain input and feedback.

Take Home Messages
– Multiple Efforts on Multiple Fronts needed

- Guidelines
  - Development of guidelines for each Disease group
- Rules
  - Development of rule sets to support clinical decision making
  - Common modeling as per Expert Group
- Alerts
  - Standardization of EHR formats for alerts for drugs, diagnostics, medication management
  - Goals of care

Assignment- COPD exacerbation

- ***Purpose:*** To improve the care of patients presenting with an acute exacerbation of COPD.
- ***Objectives:***
  - To ensure that patients with acute exacerbation of COPD are investigated appropriately.
  - To ensure that patients with acute exacerbation of COPD are treated appropriately.

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