# CLINICAL DECISION SUPPORT SYSTEMS

**Prabhu Murugesan**

**CSC**

pmurugesan7@csc.com

**Senthil Prabhu Natarajan**

**CSC**

snatarajan37@csc.com

**Lakshmi Karthigeyan**

**CSC**

lkarthigeya2@csc.com

CSC Papers 2014

## EXECUTIVE SUMMARY

This white paper describes the ever growing need for a clinical decision support system (CDSS) for healthcare organizations and the options that are available for them to implement it.

CDSS is defined as "*a system that provides clinicians, staff, patients and other individuals with knowledge and person-specific information, intelligently filtered and presented at appropriate times, to enhance health and health care.*"[1]

By the definition, there are three key components that form a CDSS – Knowledge, Intelligent filters and Presentation.

CDSS has been a hot topic over the years; yet, health organizations are finding it difficult to implement a successful CDSS of high quality. There are multi-fold challenges in getting a successful CDSS implemented. These can be broadly classified as clinical and technical challenges, implementation barriers, high maintenance, and evaluation issues.

Though there are challenges and problem areas, the value that CDSS brings to clinicians, patients, medical staffs and health organizations is immense and proven. Hence, health organizations around the globe are under pressure to implement CDSS to improve quality of care and thereby improve patient satisfaction, to adhere to regulatory compliance (i.e., ACO, HIPAA, Meaningful Use, JCAHO), to reduce costs and finally to attract and maintain medical staff.

This white paper explores various aspects of CDSS, discusses the benefits and value, analyzes the challenge areas and discusses some of the possible solutions that CSC could offer to overcome these, thus providing value to the healthcare community.

**Keywords:** business intelligence (BI), clinical decision support, recommendations for care, predictive healthcare, big data in healthcare, evidence based medicine (EBM), meaningful use, natural language processing (NLP), expert interactive system with interface engine, interactive medicine

[1] http://healthit.ahrq.gov/sites/default/files/docs/page/09-0069-EF_1.pdf

# TABLE OF CONTENTS

# INTRODUCTION

CDSS has been the buzz word for years amongst the healthcare IT community and for some of the visionary clinicians and medical community. With almost every hospital now having an Electronic Patient Records (EPR), Clinical Information Systems (CIS) or Hospital Information Systems (HIS), the importance of CDSS has grown tremendously and is growing constantly.

CDSS has more than one definition provided by qualified professionals, institutes and non-profit standards-based organizations. To list a few:

**Wikipedia –** "Clinical decision support system (CDSS) is an interactive decision support system (DSS) Computer Software, which is designed to assist physicians and other health professionals with decision making tasks, such as determining diagnosis of patient data"

**Dr. Robert Hayward, Centre of Health Evidence** – "Clinical Decision Support systems link health observations with health knowledge to influence health choices by clinicians for improved health care"[2]

**HL7 (Health Level Seven International)** – "The act of providing clinicians, patients and other healthcare stakeholders with pertinent knowledge and/or person-specific information intelligently filtered or presented at appropriate times, to enhance health and health care"[3]

**HIMSS (Healthcare Information and Management Systems Society)** – "CDSS is a process for enhancing health-related decisions and actions with pertinent, organized clinical knowledge and patient information to improve health and healthcare delivery".[4]

The core of all these definitions is that a CDSS is meant to provide specific information or knowledge for the users at appropriate times to support or enhance the decision-making process. CDSS doesn't make decisions. It only provides guidance or a reference relating to the appropriate context.

[2] http://en.wikipedia.org/wiki/Clinical_decision_support_system
[3] http://hssp-dss.wikispaces.com
[4] http://www.himss.org/content/files/PatientSafetyandDiabetesFactSheet.pdf

## TYPES OF CDSS

There are different ways by which CDSS can be applied in an EPR application. CDSS can even be applied without an EPR application, to provide stand-alone decision support services. These are as below:[5]

- Decision support feature identified 164,250 alerts, resulting in 82,125 prescription changes
- Problem medication orders dropped 58%, medication discrepancies by 55%

*— HIMSS, 2011*

| CDSS Type | Description |
|---|---|
| Alerts and reminders | • Based on rules, the ability to alert the user when information is received or recorded for the patient.<br>• The alert could be in different forms, including a simple pop-up message, a detailed message with guidelines and an entry into a task list, SMS, email or paging. |
| Clinical guidelines | • Based on rules, the ability to provide a care pathway for a given patient condition. The care pathway includes a simple guideline or reference link when recording information, possible diagnosis, suggested investigations and suggested treatment plan.<br>• Based on rules, the ability to provide a screening alert for a given patient condition. |
| Order sets | • Based on rules, the ability to provide a suggested order set for a given patient condition. |
| Patient data reports / dashboards | • Based on rules, the ability to provide a list or dashboard on the set of patients whose information complies with the rules. |
| Document templates | • Based on rules, the ability to trigger document templates/notes for a given patient condition. |

[5] © 2011 by the Healthcare Information and Management Systems Society (HIMSS)

## WHY CDSS

CDSS is now seen as an integral part of any EPR application. CDSS is also considered as an extension of Business Intelligence (BI), as the very purpose of BI is to enable decision support capability of the user. CDSS, with its sole aim to provide relevant information to the user to make the right decisions, forms a critical part of any BI solution.

Below are some of the highlights of the benefits that CDSS brings to the healthcare community:

- As per WHO, the chances of receiving appropriate preventive care is only 50%.
- Two million medical facts need to be known to practice medicine.
- Medical literature doubles every 19 years. In specific cases like AIDS care it doubles every 22 months.
- Genomics and personalized medicine will increase this problem exponentially.
- There are 3000+ molecular diagnostic tests in the market. Existing systems do not support this.
- Today drug ordering systems consider only basic facts like age, weight, height, allergies and diagnosis.
- Under meaningful use, providers must implement at least one clinical decision support rule.

**How CDSS can be helpful:**

| Target Area of Care | Examples |
|---|---|
| Preventive care: Alert clinician and other providers who need to know about unusual data (e.g., test results) or communications regarding specific patients | Immunization, screening, disease management guidelines for secondary prevention |
| Diagnosis: Provision of information to the clinician at the point-of-need (e.g., clinical pathway on pneumonia when patient with pneumonia is being admitted to hospital) | Suggestions for possible diagnoses that match a patient's signs and symptoms |
| Planning or implementing treatment: Diagnostic and therapeutic advice using a comprehensive knowledge base and a problem-solving method, such as probabilistic reasoning, neural nets, or heuristic rules | Treatment guidelines for specific diagnoses, drug dosage recommendations, alerts for drug-drug interactions |
| Follow-up management: Automation of routine and repeated tasks for the clinician on a regular time schedule (e.g., provision of all new laboratory values on current patient list every morning) | Corollary orders, reminders for drug adverse event monitoring |
| Hospital, provider efficiency: Organization and presentation of disparate data into logical, intuitive schemas at the point-of-need | Care plans to minimize length of stay, order sets |
| Cost reductions and improved patient convenience: Provide feedback by responding to an action taken by the clinician or to new data entered into the system | Duplicate testing alerts, drug formulary guidelines |

**Examples:**

- A physician orders an X-ray for a patient who has inverted her ankle. When the order is entered into the computer, the physician is reminded of the exact elements of the evidence-based criteria for such an order (Ottawa Ankle Rules). The order is not registered until the physician acknowledges that the patient either does or does not meet the criteria. A decision support system like this has been shown to decrease inappropriate X-ray orders by as much as 47%.
- A booking clerk is trying to block a bed for 8 days for a "Type II Diabetic" patient who is advised to be admitted. The CDSS provides an alert that in the history of the hospital, 90% of the time the length of stay of a "Type II diabetic" patient is 10 days and suggests the clerk book 2 days extra.

- A clinician is trying to prescribe a medication “Ecospirin 75mg” that keeps a check on the blood pressure level for a hypertension patient. The CDSS provides on-demand information that “Ecospirin 75 mg” was previously administered for the patient, but the expected outcome is not met and the CDSS further provides a statistic that “Ecospirin 100 mg” had yielded better results based on the clinical history recorded for various patients.
- A nurse records the vital signs of a child who is admitted to treat rheumatic fever. The CDSS provides an alert that the current vital sign being recorded is quite abnormal compared to the previous readings. The nurse is surprised and repeats the vital signs and finds the value to be same. The nurse uses the CDSS to gather any more information on similar conditions. The CDSS provides statistics of different cases in which the vital signs were abnormal, and the nurse immediately administers a drug that was used in those historical cases to treat the abnormal vital sign.

## COMPONENTS OF CDSS

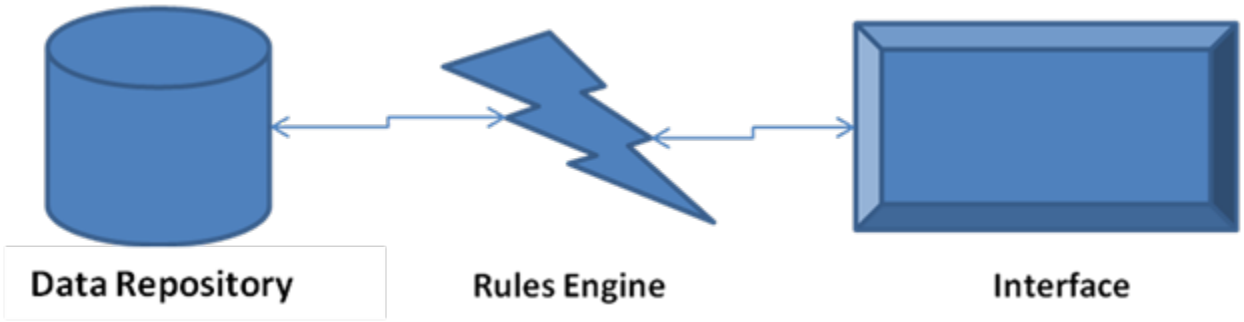
To provide a successful decision support mechanism the CDSS system has to be:

a. Very rich with its contents in terms of knowledge, references and data evidence

b. Very powerful and intelligent to process this huge amount of data with quick response times

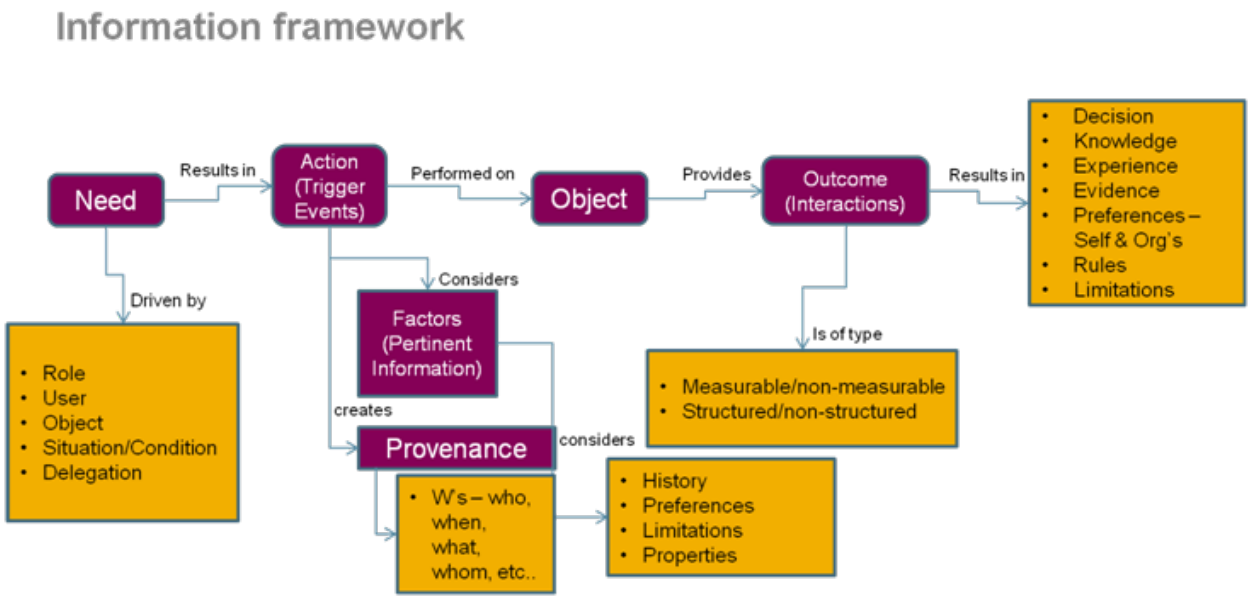
c. Very sophisticated and intuitive to catch the user's attention and not impede the user's action

Thus at a high level, a typical CDSS system comprises three vital components:




**Data Repository –** A data repository for a CDSS is quite complex and huge. The data repository holds all the content that is required by the CDSS to provide meaningful information to the user. The content could be structured knowledge data like the FDBE database that contains drug-related data; or the content could be structured or unstructured text material from renowned medical information institutes like the British Medical Journal (BMJ); or the content could be processed structured data from the EPR applications themselves.

The information model of the data repository is equipped to handle any clinical scenario and able to provide CDSS with relevant associated information for the context. At a high level, the framework of the information model will look like the one below:



| | |
|---|---|
| **Needs** | These are the cases that are to be considered and compared with future cases. |
| **Actions** | These are information/evidences to be considered for future cases. |
| **Factors** | These are parameters considered when an action takes place. These could be patient-based, user-based or organization-based. |
| **Provenance** | These are basic and detailed information about the action – who, when, where. |
| **Outcome** | These are information/evidences to be considered for future cases. |

This framework tries to create a relationship between different data that are associated with an object. Every action or data recorded for a patient is formalized into this framework, so that the action or data is always qualified with rich attributes that provide more meaning to the action/data—for example, the provenance data, factors or pertinent information and outcome associated with the action.

As in any knowledge management systems, in CDSS, the data repository should be capable of handling terabytes of data that come from different sources, and should be agile to grow periodically but very frequently. The challenges around data repositories and a potential solution can be summarized as below:

| Challenges | Solution |
|---|---|
| • Growth rate of the data repositories that is created from various sources is too high and it is ever-challenging for any system to keep pace with it | **Big data,** with its capability to handle 4 Vs (Volume, Velocity, Variety and Value), is the solution to keep pace with the growth of the data repository and provide high-performing response times. Big data also handles a variety of data types in an integrated framework to provide a single view of information that can be used by the CDSS to provide decision support. |
| • Maintaining such huge data to provide zero down time and zero data loss with high performance response times is always a challenge from the infrastructure perspective | |
| • Data repositories don't always come in a standard format – this varies from structured tables to highly unstructured text material to charts and diagrams. It is quite challenging to handle all such different data types in a single framework. | |

**Rules Engine** – The Rules engine is the central component of any CDSS and plays a vital role in analyzing and interpreting the knowledge data.

The rules engine understands the context; for example, a clinician tries to order a "Pregnancy test" for a "male" patient and starts analyzing the data repository for:

a. Any previous evidence of "Pregnancy test" done on "male" patients

b. Any reference materials on "Pregnancy test"

c. Any published knowledge on "Pregnancy test" for "male" patients

d. Any alternative test that could be done instead of "pregnancy test" and provides a wealth of information back to the user on all these aspects

This rich information interpreted by the rules engine will form the basis of decision support that the CDSS offers to the user. The user is thus well equipped to make an informed decision on whether it is relevant to proceed with the "pregnancy test" or chose an alternate test as suggested by the CDSS. (It is worth noting that in any case, CDSS is just a support system and the decision is always made by the user.)

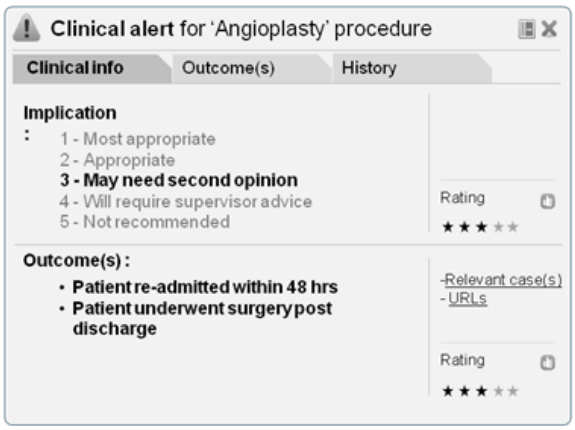
The challenges around a rules engine and a potential solution can be summarized as below:

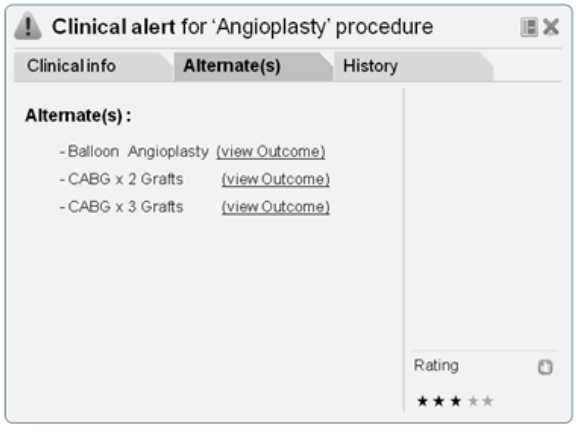
| Challenges | Solution |
|---|---|
| • The creation and maintenance of rules is a complex process requiring both clinical and IT expertise | Go for **open source** like Open CDSS from HL7, where the quality and dependency of the rules engine evolve continuously with contributions and validations from the world's leading standards-related organizations and healthcare IT competency groups. |
| • The performance of the rules engine is always in question given the range of complex rules that the CDSS has to process against such a voluminous knowledge data | |
| • The quality, relevancy and dependency of the rules engine is not proven yet, as there are no healthcare domain certifications available for rules engines | |

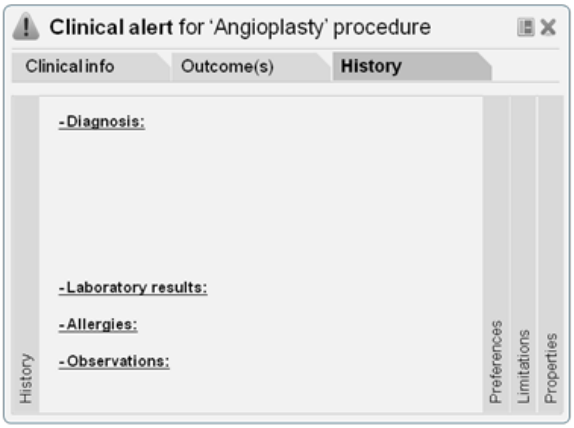
**Interface** – Interfaces are the sophisticated part of any CDSS and play the vital role of establishing the communication between the EPR applications and the CDSS. The interface could be UI-based or service-based.

A **UI-based interface** of a typical CDSS will provide screen real estate that gives the view of the knowledge/data from the data repository, filtered by the rules engine, to the user. This includes, but is not limited to: (a) implications of the user action in context, (b) the suggested action or alternative action, (c) possible outcomes of the user action, (d) historical view or evidence of user action in the past and (e) reference information on the user action.

A sample CDSS UI, when the user tries to record that the procedure “Angioplasty” is planned for the patient, is shown below:




In the “clinical info” tab, the UI presents the implication of the action along with possible outcome(s). In the “Alternate” tab, the UI presents various possible alternate procedures for “angioplasty” along with their outcomes. In the “History” tab, the UI presents the clinical data that was considered by the CDSS to provide the decision support.

A **service-based interface** of a typical CDSS will provide a set of data ideally formatted as XML back to the subscribed EPR application for it to process the output on its own. The global standards for the data format are either available or still being evolved. HL7 provides one such standard.

## GLOBAL STANDARDS

The Data Security Standard (DSS) specifies a standard interface for providing clinical decision support as a software service, and is a part of a larger effort to standardize software service interfaces for healthcare known as the HL7-OMG Healthcare Services Specification Project (Ref: Kawamoto *et al., JAMIA*, 2009).

There are 3 major interfaces for the HL7/OMG DSS standard. These interfaces are:

- **Evaluation**: used to evaluate patient data using "knowledge modules" to generate patient-specific conclusions
- **Metadata Discovery:** used to identify metadata regarding the service and its knowledge modules
- **Query:** used to query for knowledge modules of interest.

***Need to communicate with other systems about relevant healthcare concepts***

| Type | Standards | Reference |
|---|---|---|
| Standard terminologies | • Unified Medical Language System and component terminologies (e.g., SNOMED, LOINC, RxNorm) | http://searchhealthit.techtarget.com/definition/Unified-Medical-Language-System |
| Standard information models | • HL7 version 2 and version 3 information models<br>• Open EHR archetypes<br>• ASTM International Continuity of Care Record<br>• HL7-ASTM International Continuity of Care Document<br>• HL7 virtual medical record (vMR) standard | http://www.opencds.org/<br><br>http://www.igi-global.com/article/archetype-based-semantic-interoperability-web/2812 |
| Standards for patient data expected to be available for CDSS | • HL7 virtual medical record (vMR) standard | http://wiki.hl7.org/index.php?title=Virtual_Medical_Record_(vMR) |
| Standard approaches forterminology and ontology inference | • HL7 Common Terminology Services standard | http://informatics.mayo.edu/LexGrid/downloads/CTS/specification/ctsspec/cts.htm |

***Need to create and represent clinical knowledge that can be used for CDSS***

| Type | Standards | Reference |
|---|---|---|
| Standardized representation of clinical knowledge in non-executable format suitable for translation into executable format | • ASTM International Guideline Elements Model (GEM) standard | http://www.openclinical.org/gmmgem.html |
| Standardized representation of clinical knowledge in an executable format | • Standards for representing clinical rules (HL7 Arden Syntax standard, HL7 GELLO standard)<br>• Standards for representing knowledge documents (HL7 Structured Product Label standard, HL7 Order Set draft standard, HL7 Health Quality Measures Format draft standard) | http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1480304/<br><br>http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3097480/ |

***Standards to utilize clinical knowledge to deliver CDSS interventions within health information systems***

| Type | Standards | Reference |
|---|---|---|
| Standardized approaches to utilizing machine-executable clinical knowledge to generate CDSS | • Standards for accessing CDSS capabilities through a service call (HL7 Decision Support Service draft standard , OMG Decision Support Service standard, HL7 Context-Aware Knowledge Retrieval (“Info button”) standard) | http://www.opencds.org/<br><br>http://www.omg.org/spec/CDSS/1.0/ |
| Standardized approaches to interacting with health information systems to deliver CDSS | • Standards for retrieving patient data from health information systems (HL7 Retrieve, Locate, and Update Service draft standard; various information model and terminology standards)<br>• Standards for EHR functionality (HL7 EHR Functional Model, Certification Commission for Health Information Technology certification criteria ) | http://library.ahima.org/xpedio/groups/public/documents/ahima/bok1_025731.hcsp?dDocName=bok1_025731<br>(registration required) |

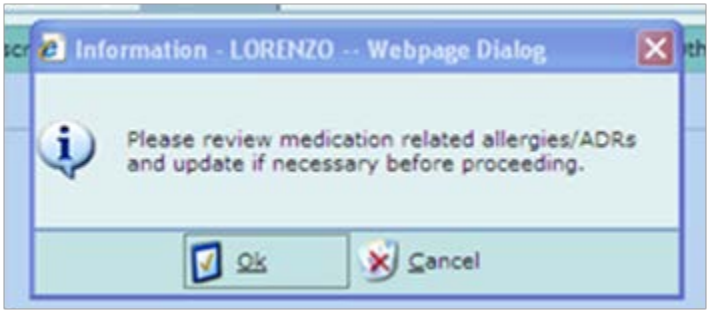
## CSC IN CDSS

CSC, with its rich experience and expertise in the healthcare domain, has been working on providing solutions and services in the CDSS area for some time. Though there is no single discrete CDSS product available, each EPR/HIS product from CSC has elements of CDSS and has been providing decision support to users.

> Certification of CareVeillance marks an important milestone because it validates the solution's capability in giving our clients the confidence they need when making the crucial decisions about their organizations' EHR investments.
>
> *— News release, CSC, 2011*

For example, iCM (Clinical Manager) is delivered with decision support capability through MLMs (Medical Logic Modules), where the rules are created and executed through MLM at different instances of the iCM application.

Similarly, Lorenzo offers decision support for prescriptions by integrating with FDBE (drug database) and also has its own rules engine in the form of constraints.




**An Alert to check for allergies**

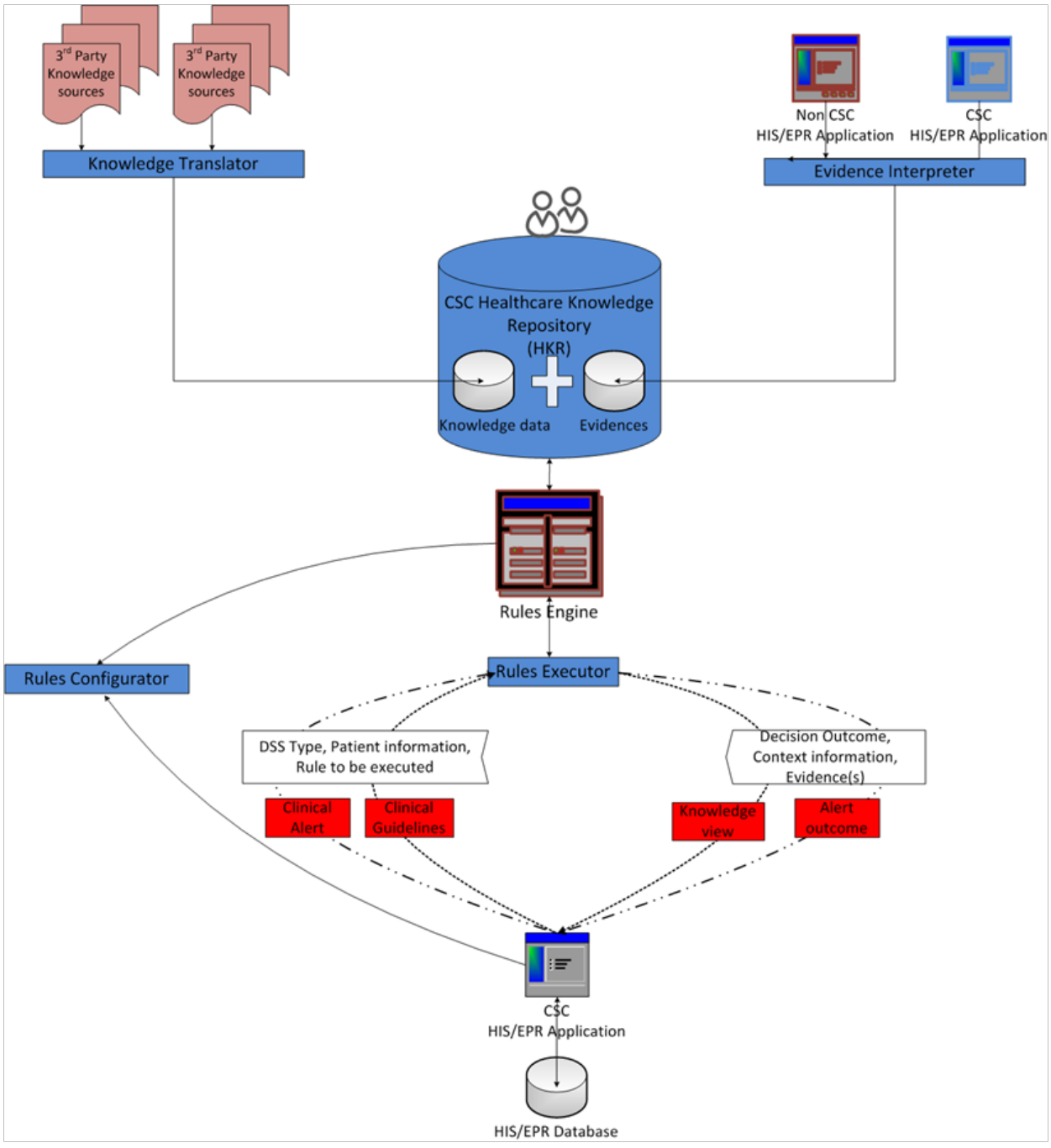

**Duplicate check when requesting a lab investigation**

**CareVeillance** – In the context of CDSS, CSC has made a huge difference with the product CareVeillance, which acts as a surveillance system that monitors patients' clinical data and triggers alerts when there are any risks observed. Like any typical CDSS solution, CareVeillance uses its own data repository, Corticon; a third-party component as rules engine; and its own customized UI for displaying and managing risk alerts.

## CSC'S VISION FOR CDSS

Having discussed the importance of CDSS and its potential to make a difference for customers and thereby generate huge potential for growth in the healthcare domain, CSC is investing in initiatives towards CDSS. CDSS is one of the key initiatives within the Business Intelligence portfolio published by CSC Healthcare India.

CSC has a vision for CDSS, and all efforts are being made to realize this vision and bring value to customers. A high-level framework for the CDSS and its components is shown below:



At a high level there are three parts to the solution:

a. One part aims to **collate knowledge** from different sources – 3rd party knowledge sources and the EPR application data itself. There would be specialized processes and tools that handle these sources and form the knowledge that is stored in the CSC healthcare knowledge repository.

b. The second part deals with the **inference and intelligent filtering** of the knowledge based on the context. This will be supported by a rules engine.

c. The third part is the **interface** that deals with the communication between the core CDSS and the EPR/HIS applications that uses CDSS.

Below are snapshots of the individual components that form part of this solution:

- **Third-party knowledge sources:** Refers to publications from global standard institutes and global healthcare organizations
- **Knowledge translator:** Refers to a system application like Natural Language Processors (NLP) or a highly systemized manual process that converts the publications and other materials from third-party sources into structured data
- **CSC Healthcare Knowledge Repository:** Refers to the data repository that holds the volumes and volumes of knowledge/data that are required to provide decision support
- **Evidence interpreter:** Refers to a manual process similar to medical codification, where the clinical history is interpreted as evidences to fit into the information model discussed earlier
- **Rules configurator:** Refers to the application which will allow users to configure the rules or set of rules that are associated with an action or event within the EPR/HIS application
- **Rules executor:** Refers to the applicaiton that triggers the rules execution within the EPR/HIS application and also communicates the output from the rules engine

## CONCLUSION

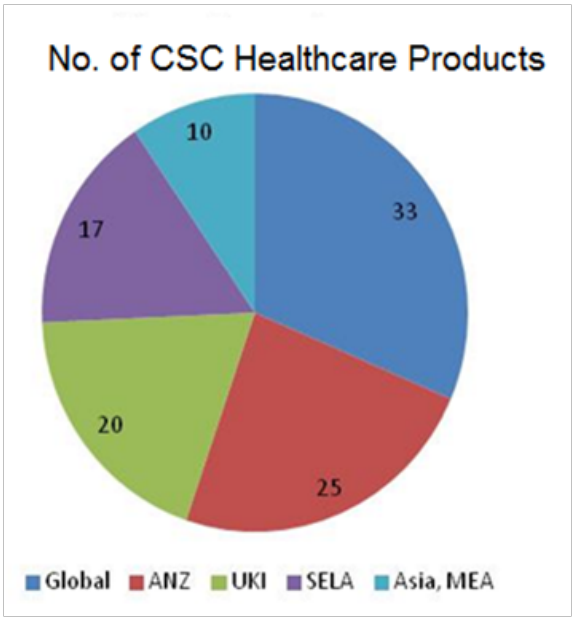
With the ever-growing recognition and need for CDSS, it is evident that EPR applications without CDSS will not stand in the future and will not add value for clients.

Aligning with CSC's vision statement "FORWARD TOGETHER," it is imperative that CDSS plays a vital role in the healthcare portfolio and helps the organization to GROW by offering a best-in-class industry solution.

With the acquisition of iSoft, CSC leads the market share of EPR applications in multiple geographies. This provides a great opportunity for CSC to deliver a high-quality and reliable CDSS solution to the market, given no other vendor has such a reach in this area. At right is a snapshot of CSC's healthcare product portfolio across different geographies, where CSC can extend the CDSS solution to bring greater value to existing customers.

Apart from catering to existing customers, the CDSS solution (as discussed above) can be given as a stand-alone or plug-in application for new customers as well. With its global deployment services and expertise, CSC is also well placed to mitigate any risks in taking CDSS to the user community group. With its expertise, CSC is uniquely positioned to conceptualize, design, create and deliver a CDSS system that will change the face of healthcare IT for clinicians and the healthcare community.

> At this point in time, the appropriate decision is not whether to design and implement CDSS, but how to design and implement it.
>
> *— www.ahrq.gov, 2009*
>
> Clinicians and other stakeholders should implement clinical decision support systems that incorporate these features whenever feasible and appropriate.
>
> *— BMJ 2005; 330:765*



# GLOSSARY

| Abbreviation | Description |
|---|---|
| ACO | Accountable care organization |
| AIDS | acquired immune deficiency syndrome |
| ASTM | American Society for Testing and Materials |
| Big Data | Big data analytics is the process of examining large amounts of data of a variety of types to uncover hidden patterns, unknown correlations and other useful information |
| BMJ | British Medical Journal |
| CDSS | Clinical decision system |
| CIS | Clinical Information Systems |
| DSS | decision support system |
| EHR | electronic health record |
| EPR | Electronic Patient Records |
| FDBE | First Databank Europe (Drug database) |
| GELLO | Expression Language |
| GEM | Guideline Elements Model |
| HIMSS | Healthcare Information and Management Systems Society |
| HIPAA | Health Insurance Portability and Accountability Act |
| HIS | Hospital Information Systems |
| HL7 | Health Level Seven International |
| iCM | Clinical manager application |
| JCAHO | Joint commission on accreditation of healthcare organizations |
| LOINC | Logical Observation Identifiers Names and Codes |
| Meaningful Use | Meaningful use is the set of standards defined by the Centers for Medicare and Medicaid Services (CMS) Incentive Programs that governs the use of electronic health records |
| MLMs | Medical Logic Modules |
| NLP | Natural Language Processors |
| OMG | Object Management Group |
| Order sets | Is a predefined template that has been utilized in the standard care of hospitals for many years |
| RxNorm | standardized drug nomenclature |
| SNOMED | Systematized Nomenclature of Medicine |
| vMR | virtual medical record |
| WHO | World Health Organization |
| XML | Extensible Markup Language |

## ABOUT THE AUTHORS

**Prabhu Murugesan** focuses on business analysis and solution configuration for CSC's Lorenzo electronic patient records system, the flagship product for the healthcare industry. He explores new technologies and ideas to enhance the product. This paper is the result of one such research initiative on business intelligence, meaningful use and decision support systems. He and his team are working to turn the paper's ideas into a prototype. pmurugesan7@csc.com

**Senthil Prabhu Natarajan** designs, develops and implements healthcare applications and is an integral part of the Lorenzo team at CSC. With 13 years of experience in the IT industry, the majority of his career has been spent designing products for the healthcare industry that are now being used in various hospitals in the US and UK. snatarajan37@csc.com

**Lakshmi Karthigeyan** is a business analyst working on CSC's NHS–Lorenzo Delivery Organization. She has 12 years of experience as a trainer, designer and business analyst in the mobile and healthcare industries. Her areas of interest include designing emergency department solutions and mobile healthcare applications. lkarthigeya2@csc.com

**Worldwide CSC Headquarters**

**The Americas**
3170 Fairview Park Drive
Falls Church, Virginia 22042
United States
+1.703.876.1000

**Asia, Middle East, Africa**
Level 9, UE Biz Hub East
6 Changi Business Park Avenue 1
Singapore 468017
Republic of Singapore
+65.68099.000

**Australia**
26 Talavera Road
Macquarie Park
NSW 2113
Australia
+61(2)9034.3000

**Central and Eastern Europe**
Abraham-Lincoln-Park 1
65189 Wiesbaden
Germany
+49.611.1420

**Nordic and Baltic Region**
Retortvej 8
DK-2500 Valby
Denmark
+45.36.14.4000

**South and West Europe**
Immeuble Balzac
10 place des Vosges
92072 Paris la Défense Cedex
France
+33.1.55.707070

**UK and Ireland Region**
Royal Pavilion
Wellesley Road
Aldershot, Hampshire
GU11 1PZ
United Kingdom
+44(0)1252.534000

**About CSC**
*The mission of CSC is to be a global leader in providing technology-enabled business solutions and services.*

*With the broadest range of capabilities, CSC offers clients the solutions they need to manage complexity, focus on core businesses, collaborate with partners and clients and improve operations.*

*CSC makes a special point of understanding its clients and provides experts with real-world experience to work with them. CSC leads with an informed point of view while still offering client choice.*

*For more than 50 years, clients in industries and governments worldwide have trusted CSC with their business process and information systems outsourcing, systems integration and consulting needs.*

*The company trades on the New York Stock Exchange under the symbol "CSC."*