Semantic Web: Benefits For Clinical Decision Support At The Bedside

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Clinical Decision Support (CDS)

A system providing "knowledge and person specific or population information intelligently filtered or presented at appropriate times".

--Osheroff et al

- Effective CDS systems manage four dimensions
  - Data structure
  - Semantics
  - Processes
  - Inference
- Semantic Web promises to affect each of these

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“Lost in Translation”

- Subject Matter Experts spend hours/days
  - Describing functional objectives
  - Detailing process orchestration
  - Explaining domain semantics
- Engineers spend hours/days/weeks translating requirements into designs, implementing prototypes, developing pilots, etc
- Endless, costly rework fixing mistakes and functionality “lost in translation”

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Data Structure and Aggregation

- CDS requires information to be:
  - Appropriately comprehensive in detail and scope
  - Structurally consistent
- RDF / Linked Data advantages:
  - Facilitates data aggregation and enrichment across distributed stores ensuring an adequate corpus of detailed clinical information
  - Constructs such as *sameAs*, *equivalentClass*, and *equivalentProperty* help merge data into canonical representations

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Terminology

- CDS requires information to be semantically consistent
- Current terminologies struggle with context, part-whole relations, semantic equivalence, and pre- /post-coordination, concept quantity and complexity
- OWL Advantages:
  - A uniform, rigorous, and understandable schema that includes negation, disjunction and context
  - Clear, logical organization to hierarchies and relationships
  - Improved recognition of semantic equivalence between post-coordinated and pre-coordinated terms

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Domain Knowledge Alignment

- CDS requires information be aligned and consistent with the domain processes they support
  - Care processes cross multiple domains – medical, nursing, quality, fiscal
  - Effective care is coordinated, multi-disciplinary care
- OWL facilitates ontology alignment through:
  - Constructs such as *sameAs*, *equivalentClass*, etc.
  - Rule-based mapping using SWRL
- The Ontology Alignment process encourages different community perspectives/data/vocabularies to dialog/ merge/harmonize – a natural fit for building systems that support multi-disciplinary teams

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World Wide Reasoning

- Reasoning systems should delivery the inference functionality required for a particular problem.
  - Classic “production rules” are not optimal for all clinical decisions
  - CDS is ideally a hybrid system of different tools (fuzzy logic, defeasible logic, etc.)
- Reasoning with a world wide, distributed clinical data
  - Closed World Assumption (CWA) - any statement not known to to be true is false
  - Open World Assumption (OWA) – any statement not known to to be true is considered unknown as opposed to false

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Using The Right Tool For The Job

- Ontology tools such as Protégé or Topbraid:
  - Focus clinical experts on knowledge vs. object modeling
  - Facilitate translation of domain concepts into engineering artifacts
  - Complement model-driven approaches like UML
- By representing domain knowledge explicitly, Semantic Web technologies will have profound functional implications for building affordable, shareable, and clinically effective CDS systems

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But Really…Where Are We?

- Dec 2008 – NwHIN / FHA Connect demonstrations
- Feb 2010 – VLER (VA, DoD, Kaiser) Demonstrations in San Diego
- Dec 2010 - President's Council of Advisors on Science and Technology (PCAST)
- April 2011 - DoD DCMO Mandates BPMN, RDF and OWL Semantic Technologies
- MHS/VHA/IHS -slow to recognize and invest in Semantic Web's potential vs. bio-research or non-medical agencies
- Policy mandates, political climate, and agency ecosystems still drive traditional Relational Database, Service Oriented Architecture and model-driven system development

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Knowledge Management Repository

- Developed a prototypic EMR ontology in OWL
- Assembled an open source tool chain to generate:
  - XSDs for use with SOAP web services
  - Java classes for rule authoring in JBoss Drools and building clinical facts for its Production Rule Engine
- Used a Triple Store, RDF, and mapping triples to transform patient data (AHLTA, VistA and RPMS) into canonical, ontology-defined XML and Java objects
- Shared rules in common repository – executable by all three agencies

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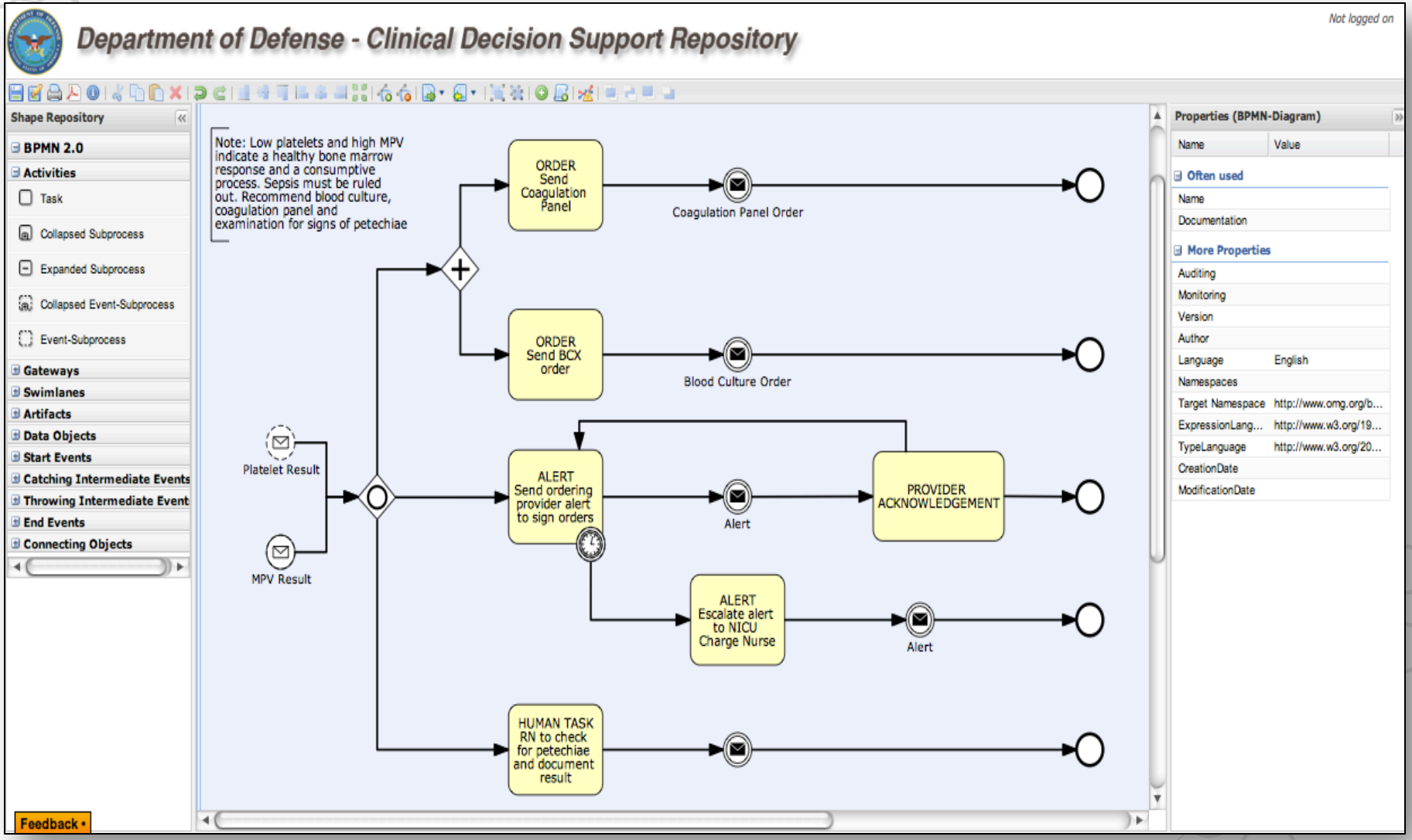
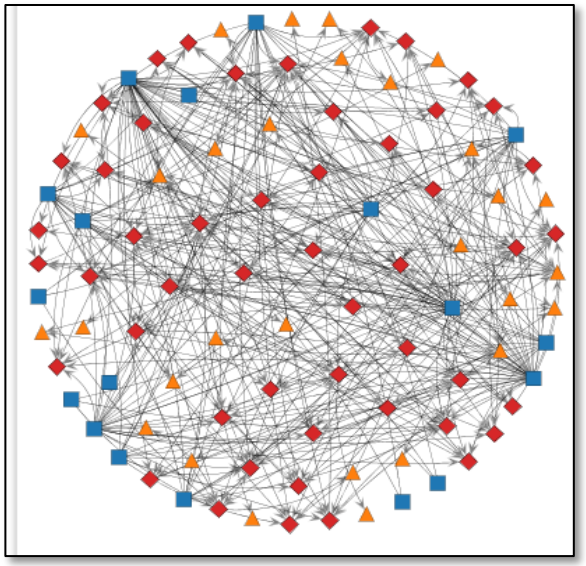
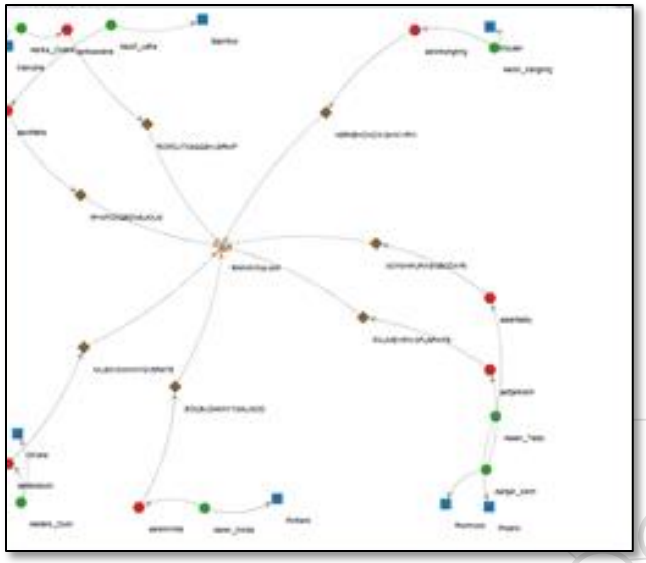
Clinical Decision Support Workbench



SEMOSS

- RDF framework to explore and uncover connections between clinical data sources, interfaces





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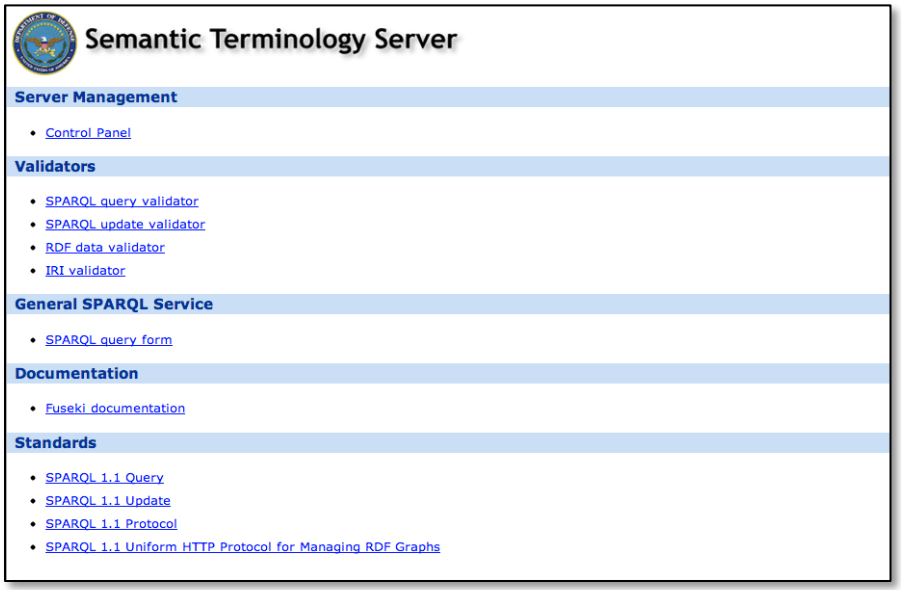
SKOS Terminology Service

- SKOS ontologies for RXNORM, SNOMED, LOINC, and NDFRT; stored in Jena triple store searchable using SPARQL; exposed using HL7 CTS2 SOA Service; deployed on iEHR ESB



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Special Product Label Graphs

- VA NLP project that processed SPLs to extract drug "facts" including indications, side-effects, box warnings, etc.
- Triples validated by clinical SMEs within IHTSDO Workbench
- Exported as RDF for "mash-up" with other RDF graphs (SNOMED, NDFRT, RXNORM) and VA VistA data
- Presented in CCOW portal that obtains patient context directly from EMR thick client.

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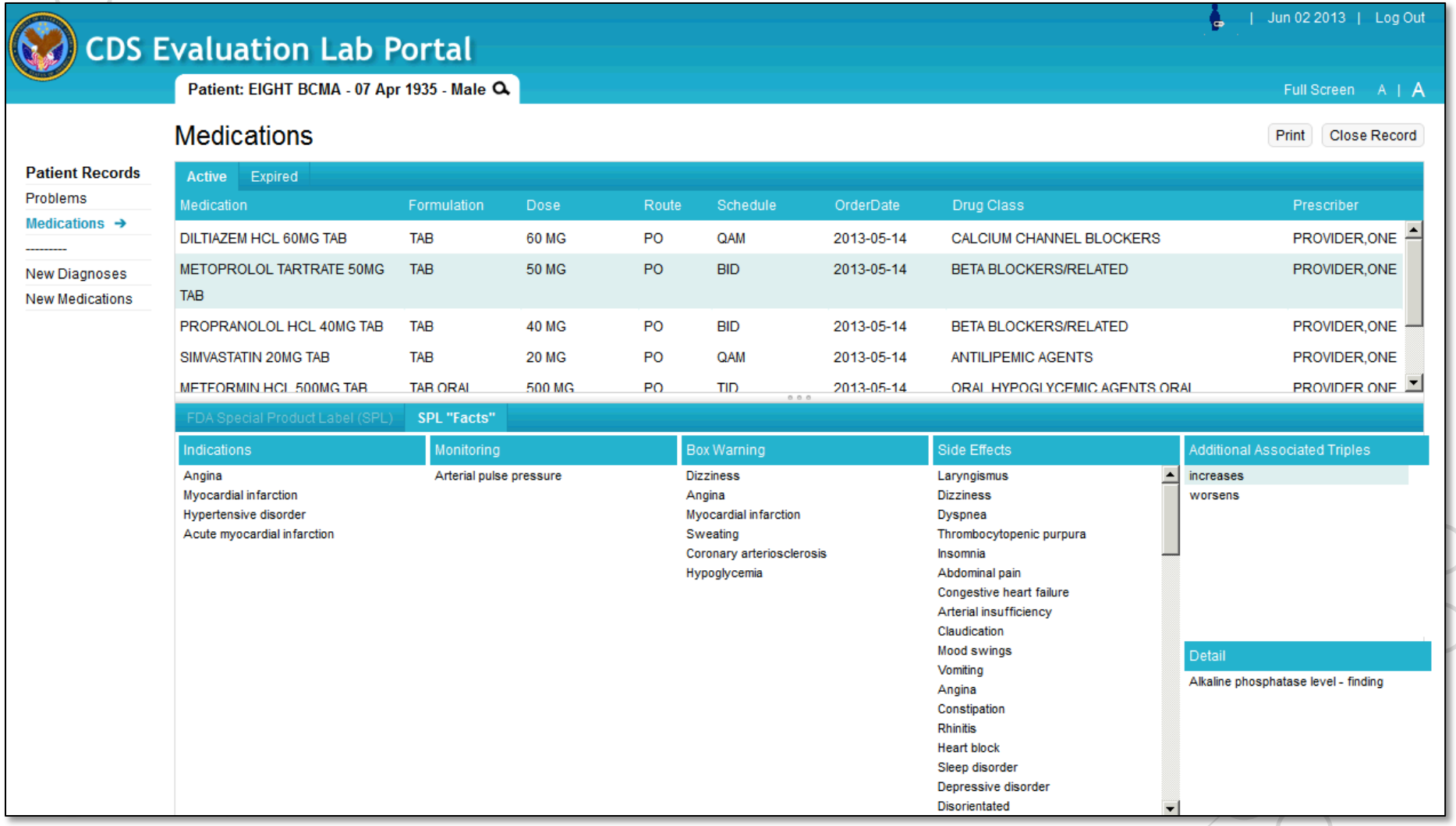
SPL “Triples” At The Bedside



FEB 2013 iEHR Announcement

"Rather than building a single integrated system from scratch, we will focus our immediate efforts on integrating VA and DoD health data as quickly as possible, by focusing on interoperability and using existing solutions."

--Defense Secretary Leon Panetta

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Future Prospects?

- Renewed agency interest in Semantic Web
- Significant opportunity for:
  - Infrastructure products and services (plumbing)
  - Vocabulary and ontology modeling (knowledge)
  - Privacy and data segmentation solutions for federated data (security)
- Continued need for product/studies/ demonstrations of how Semantic Web improves outcomes – sustains health

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