

An Evidence-Based Agent for Supporting Emergency Physician Decision Making at the Point of Care

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Changing Healthcare Delivery

- Digitization of Health Information
 - EHR, CPOE, LIS, PACS, CPGs
- Mobile Computers and Applications
 - PDAs, Tablet PCs, Smart Phones
- Point of Care Interactions
 - Mobile Caregivers
- Automatic Clinical Decision Support
 - Leverage disparate clinical information from multiple sources for integrated clinical decision support



Evidence-Based Medicine

- “The conscientious, explicit, and judicious use of current best evidence in making medical decisions”
- Combine clinician expertise with the best available external clinical evidence from systematic research
- In practice there are many barriers that impede evidence-based medicine



Sucessful Provision of Evidence - Checklist

- ❑ Integrate disparate health care information resources
- ❑ Access to and provision of evidence must be seamlessly integrated with existing clinical workflow
- ❑ Evidence must be contextualized for the current patient-physician interaction
- ❑ Evidence should be available where it is most often required - at the point of care



Challenges in Retrieving Evidence

- Natural language processing and semantic understanding are difficult to implement for highly specialized textual corpuses
- As a result low precision is often associated with text or web-based search methodologies
- Ranked presentation style favored by many search engines, make it difficult for users to quickly locate relevant information



Solution

- Must retrieve most relevant documents as well as provide visualization of results that allows fast discrimination of relevant information
- Employ a logical concept-based query mechanism, where concepts relate to specified disease and patient presentation
- Combine concept-based query mechanism for document retrieval with a clustering-based approach for document organization and presentation



The Cochrane Collaboration

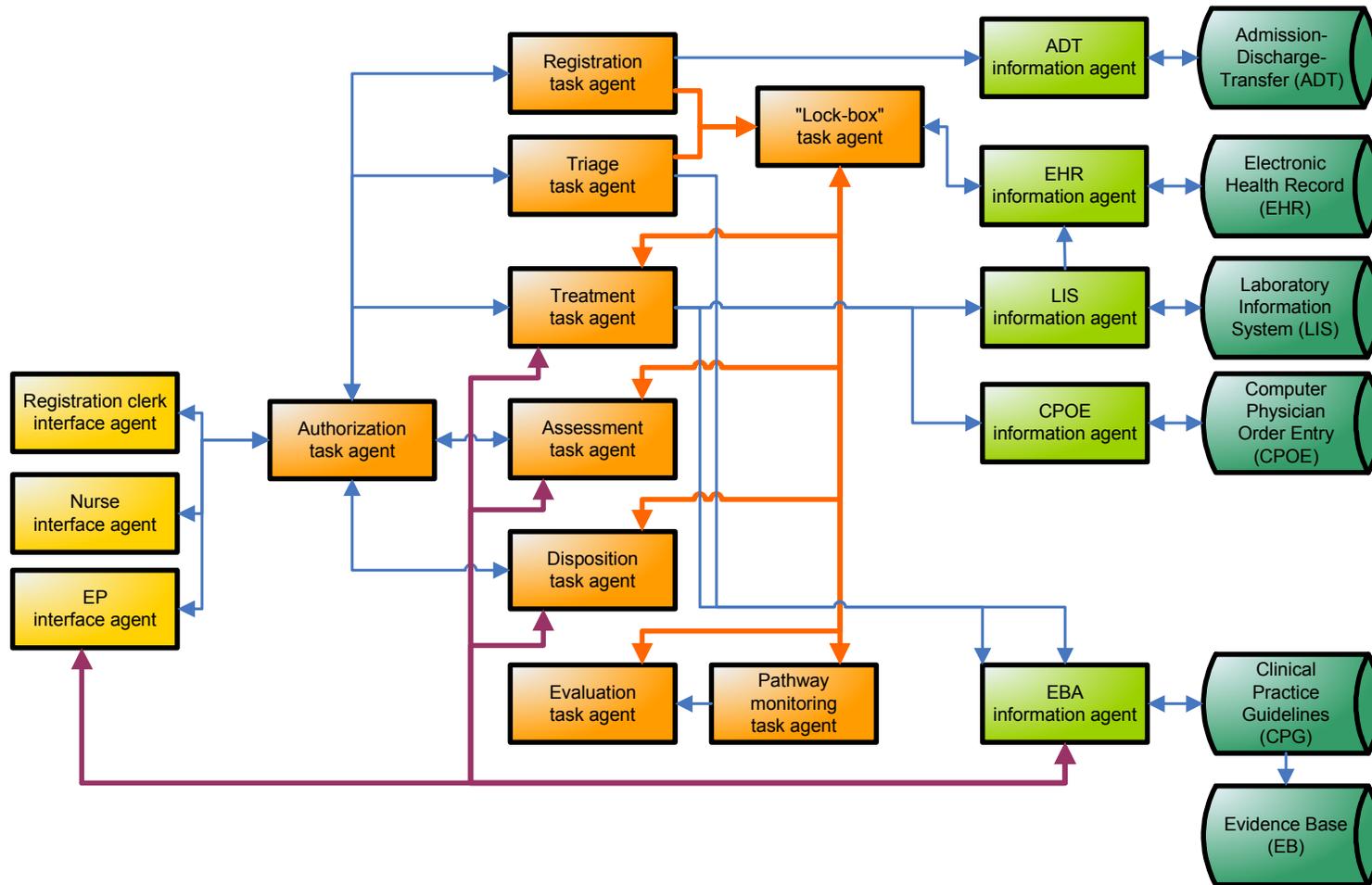
- ❑ Most comprehensive online resource of medical evidence incorporating results of clinical trials and research in a systematized manner
- ❑ Information in Cochrane is indexed using Medical Subject Headings (MeSH)
- ❑ MeSH descriptors applied as part of review process where descriptors represent central concepts as well as other topics discussed to a significant extent



MET (Mobile Emergency Triage)

- Research domain is pediatric asthma (most common chronic disease in children -10% of the Canadian population)
- Asthma Care Pathway is Complex:
 - Diverse users complete many different tasks from the management workflow using various information systems
- Model MET Clinical Decision Support System using a Multi-Agent Architecture

MET MAS





Agent Interactions for Retrieval of Evidence

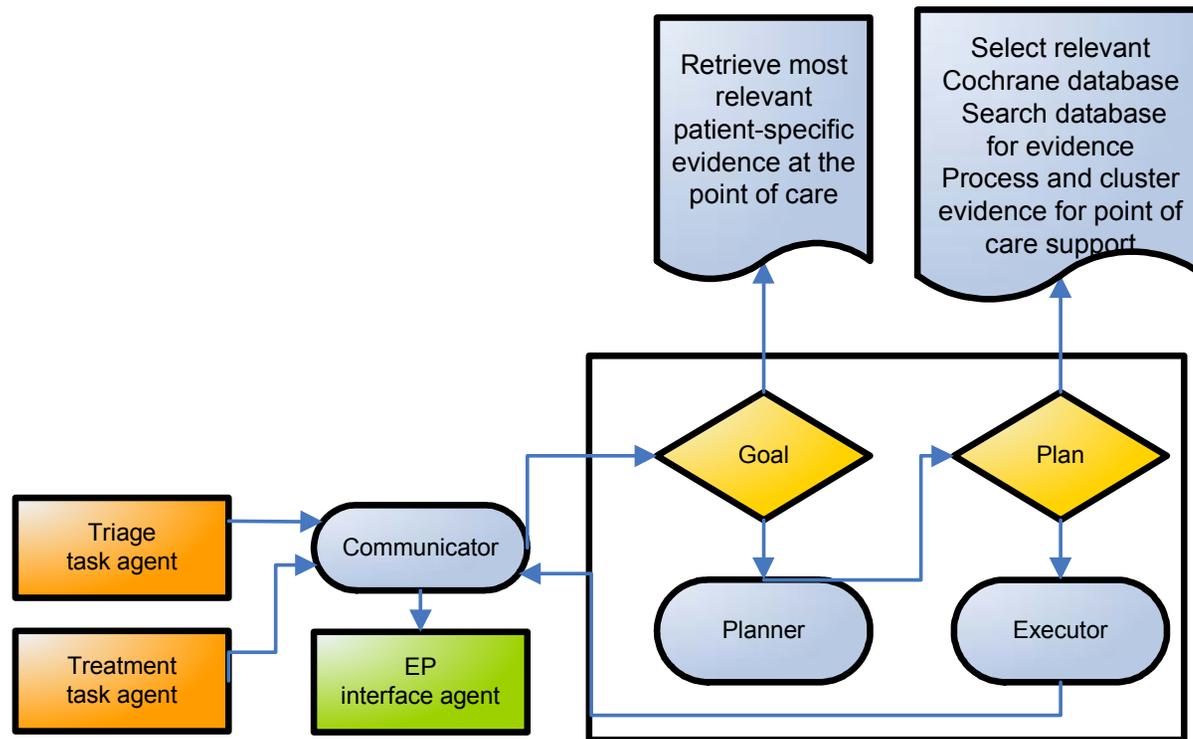
- Triage Agent:
 - Uses fragments of patient information (symptoms, diagnosis) to predict the severity of the asthma attack and associated length of stay for the patient in the ED

- Treatment Task Agent:
 - Records the treatment recommended by the patient

- Evidence Based Agent (EBA):
 - Uses triage assessment from triage agent and treatment from treatment task agent to mine Cochrane Library for best evidence in applying recommended treatment to current patient

- Interface Agent:
 - Displays results to EP on mobile device at point of care

Evidence-Based Agent





Algorithm

Identify correct Cochrane database to initiate search for relevant evidence

Instantiate disease (M) and patient concepts (P) with relevant instances from MeSH ontology and underlying patient ontology respectively

Mi == disease concepts, Pi == patient concepts

Formulate concept-based query (Con_Q) by combining Mi and Pi into text-based search by logically combining the instances with an “AND” operator and specifying the Cochrane index to be searched by each component of the query

Con_Q = Mi [MeSH] AND Pi [Full Text]

Retrieve ranked list of evidence from the Cochrane Library and export to local database for indexing

Formulate clusters (C) with cluster labels (L) where evidence from the Cochrane library will be stored by automatically extracting instances of P as cluster labels

For all Pi: “Pi” == Ci with label Li

Formulate multiple word text-based queries (Clus_Q) as comma delimited strings with which to cluster the retrieved evidence by extracting attribute names and attribute values for each P

For all Pi: Clus_Qi == “Pi.AttributeName, Pi.ValueName”

Pass query strings to textual search engine and assign retrieved evidence-based documents (E) to relevant clusters based on the discovery of the query strings within the documents

For all Clus_Qi: Ei == Ci with descriptor Li



Sample Scenario

- 10 year old boy experiencing an asthma exacerbation presents to the ED
- EP records patient details and values of clinical attributes and triage agent calculates patient is experiencing moderate exacerbation
- In response to triage assessment EP recommends patient is treated with β -agonists



Sample Scenario

- Triage and treatment communicated to EBA
- Formulate concept-based query:
 - Disease and patient concepts where disease concepts represented using MeSH terms and patient concepts derived from underlying patient ontology
 - Specify Cochrane index to be search by each component
- “asthma [MeSH] ” AND “child [MeSH]” AND “moderate [full text search]” AND “β-agonists [full text search] ”



Sample Scenario

- Ranked list of evidence retrieved from Cochrane
- Create clusters for visualization:
 - Cluster labels automatically extracted from constituent elements of patient-specific concept
- Every possible combination of constituent elements used in creating clusters
 - “diagnosis”, “treatment” “diagnosis and treatment”



Sample Scenario

- Formulate queries to identify instances of patient-specific concepts in retrieved articles
- Queries automatically extracted from patient-specific concept-based search component
 - “diagnosis, moderate”, “treatment, β -agonists”, “diagnosis, moderate, treatment, β -agonists”
- Assign articles retrieved from Cochrane to the relevant clusters for presentation



Conclusions and Future Work

- Introduced a concept-based framework for retrieving patient-specific evidence to provide decision-support at the point of care
- Provides enhanced precision for information retrieved by busy professionals
- Clustering provides better visualization of retrieved information at the point of care
- Development of prototype agent continuing
- Integration of EBA with MET framework