T29: UMLS Concept Identification Using the MetaMap System

AMIA Fall Symposium
Tutorial 29, Methods Series
Sunday, November 14, 2010
8:30am – 12:00pm

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François-Michel Lang, James G. Mork

U. S. NATIONAL LIBRARY OF MEDICINE

Tutorial Outline

- Background: why concept identification? (Lan)
- Introduction to MetaMap (Lan)
- The MetaMap algorithm (Lan)
- Input/output formats (François, Jim)
- MetaMap options in depth (Lan)
- MetaMap processing modes (Lan)
- Usage warnings (Lan)
- Access methods (Jim)
- Research projects using MetaMap (Jim, Dina)
- Future directions (Lan)

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Why Concept Identification?

- Structured data vs. text
- Concept identification is useful/essential for many tasks including
  - Information extraction/Data mining
  - Classification/Categorization
  - Text summarization
  - Question answering
  - Literature-based knowledge discovery

Motivation for Creation of MetaMap

- Our original concept identification task, Information Retrieval (IR):
  - retrieval of MEDLINE records based on textual queries by
  - identifying biomedical concepts occurring in both queries and MEDLINE, and
  - leveraging knowledge about concepts contained in UMLS Metathesaurus

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Concept Identification Programs

- Selected programs that map biomedical text to a thesaurus
  - SAPHIRE (*Hersh et al., 1990*)
  - CLARIT (*Evans et al., 1991*)
  - **MetaMap *(Aronson et al., 1994)***
  - Metaphrase (*Tuttle et al., 1998*)
  - **MMTx *(2001)***
  - KnowledgeMap (*Denny et al., 2003*)
  - Mgrep (*Meng, 2009--unpublished*)
- Characteristics of MetaMap
  - Linguistic rigor
  - Flexible partial matching
  - Emphasis on thoroughness rather than speed
  - Restricted to English syntax and vocabulary

Example (best mappings)

- PMID – 9339686
- AB –Cerebral blood flow (CBF) in newborn infants is

Cerebrovascular Circulation

Infant, Newborn

CEREBRAL BLOOD FLOW IMAGING

often below levels necessary to sustain brain viability

Frequent

Levels (qualifier value)

Sustained

Brain

Viable

Entire brain

in adults.

Adult

Example (best mappings ***with WSD***)

- PMID – 9339686
- AB –Cerebral blood flow (CBF) in newborn infants is

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~~CEREBRAL BLOOD FLOW IMAGING~~

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~~Entire brain~~

in adults.

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MetaMap Examples (1/7)

- “*inferior vena caval stent filter*” maps to
  - ‘Inferior Vena Cava Filter’ (‘Vena Cava Filters’) and
  - ‘Stent’
- “*medicine*” with `--allow_overmatches` maps to
  - ‘Alternative Medicine’ or
  - ‘Medical Records’ or
  - ‘Nuclear medicine procedure, NOS’ or ...
- “*pain on the left side of the chest*” with `--quick_composite_phrases` maps to
  - ‘Left sided chest pain’ (under development)

Example: Normal processing (2/7)

```
Phrase: “lung cancer.”

Meta Candidates (8):
  1000 Lung Cancer (Malignant neoplasm of lung) [Neoplastic Process]
  1000 Lung Cancer (Carcinoma of lung) [Neoplastic Process]
   861 Cancer (Malignant Neoplasms) [Neoplastic Process]
   861 Lung [Body Part, Organ, or Organ Component]
   861 Cancer (Cancer Genus) [Invertebrate]
   861 Lung (Entire lung) [Body Part, Organ, or Organ Component]
   861 Cancer (Specialty Type - cancer) [Biomedical Occupation or
   Discipline]
   768 Pneumonia [Disease or Syndrome]

Meta Mapping (1000):
  1000 Lung Cancer (Carcinoma of lung) [Neoplastic Process]
Meta Mapping (1000):
  1000 Lung Cancer (Malignant neoplasm of lung) [Neoplastic Process]
```

Example: Variants (-v) (3/7)

```
Phrase: “lung cancer.”

lung cancer [noun] variants (n=1):
lung cancer{[noun], 0=[]}

lung [noun] variants (n=9):
lung{[noun], 0=[]}  lungs{[noun], 1="i"}  pneumonia{[noun], 5="ds"}
   pneumoniae{[noun], 5="ds"}  pneumonias{[noun], 5="ds"}
   pneumonic{[adj], 2="s"}  pulmonal{[adj], 4="ss"}  pulmonary{[adj],
   2="s"}  pulmonic{[adj], 2="s"}

cancer [noun] variants (n=4):
cancer{[noun], 0=[]}  cancerous{[adj], 3="d"}  cancers{[noun], 1="i"}
   carcinomatous{[adj], 2="s"}
...
```

Example: Compound mappings (4/7)

with
--compute_all_mappings

```
Phrase: “obstructive sleep apnea.”
Meta Candidates (8):

...

Meta Mapping (1000):
  1000 Obstructive sleep apnoea (Sleep Apnea, Obstructive) [Disease or
   Syndrome]
Meta Mapping (901):
   827 Obstructive (Obstructed) [Functional Concept]
   901 Apnea, Sleep (Sleep Apnea Syndromes) [Disease or Syndrome]
Meta Mapping (851):
   827 Obstructive (Obstructed) [Functional Concept]
   827 Sleep [Organism Function]
   827 APNOEA (Apnea) [Pathologic Function]
 …
```

Example: Show sources (-G) (5/7)

```
Phrase: “scorpion sting.“

Meta Candidates (4):
  1000 Scorpion sting {MDR,DXP} [Injury or Poisoning]
   861 Sting (Sting Injury {MTH,MSH,MDR,RCD,SNM,SNOMEDCT,SNMI,WHO})
                 [Injury or Poisoning]
   694 Scorpion (Scorpions {LCH,MSH,MTH,SNM,SNOMEDCT,SNMI,CSP,
                 RCD,NCBI}) [Invertebrate]
   694 SCORPION (Scorpion antigen {MTH,LNC}) [Immunologic Factor]

Meta Mapping (1000):
  1000 Scorpion sting {MDR,DXP} [Injury or Poisoning]
```

Example: Restrict to sources (-GR LCH) (6/7)

```
Phrase: “scorpion sting.”

Meta Candidates (1):
   694 Scorpion (Scorpions {LCH}) [Invertebrate]

Meta Mapping (694):
   694 Scorpion (Scorpions {LCH}) [Invertebrate]
```

Example: Restrict to STs (-J neop) (7/7)

```
Phrase: “lung cancer.”

Meta Candidates (3):
  1000 Lung Cancer (Malignant neoplasm of lung) [Neoplastic Process]
  1000 Lung Cancer (Carcinoma of lung) [Neoplastic Process]
   861 Cancer (Malignant Neoplasms) [Neoplastic Process]

Meta Mapping (1000):
  1000 Lung Cancer (Carcinoma of lung) [Neoplastic Process]
Meta Mapping (1000):
  1000 Lung Cancer (Malignant neoplasm of lung) [Neoplastic Process]
```

MetaMap Demo

http://skr.nlm.nih.gov

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The Algorithm

- Parsing
  - Using SPECIALIST minimal commitment parser, SPECIALIST lexicon, MedPost part of speech tagger
- Variant generation
  - Using SPECIALIST lexicon, Lexical Variant Generation (LVG)
- Candidate retrieval
  - From the Metathesaurus
- Candidate evaluation
- Mapping construction

Parsing

- Text
  - ***Ocular complications of myasthenia gravis.***
- Tagging
  - ***Ocular complications of myasthenia gravis .***

    adj/2 noun prep noun noun/2 pd
- Simplified phrases
  - [mod(***ocular***), head(***complications***)]
  - [prep(***of***), head(***myasthenia gravis***), punc(.)]

Variant Generation

- Variants of adjective ***ocular*** (13, 9 occur in UMLS):
  - ***ocular{[adj], 0=[]}***
    - ***eye{[noun], 2="s"}***
      - ***eyes{[noun], 3="si"}***
      - ***optic{[adj], 4="ss"}***
      - ***ophthalmic{[adj], 4="ss"}***
        - ***ophthalmia{[noun], 7="ssd"}***
          - ***ophthalmias{[noun], 8="ssdi"}***
        - ***ophthalmiac{[noun], 7="ssd"}***
          - ***ophthalmiacs{[noun], 8="ssdi"}***
    - ***oculus{[noun], 3="d"}***
      - ***oculi{[noun], 4="di"}***
    - ***ocularity{[noun], 3="d"}***
      - ***ocularities{[noun], 4="di"}***

Evaluation Function

- Weighted average of
  - centrality (is the head involved?)
  - variation (average of all individual word variations)
  - coverage (how much of the text is matched?)
  - cohesiveness (in how many pieces?)

Evaluation Results

```
Phrase: Ocular complications
 Meta Candidates (8):
    861 Complications (Complication) [patf]
    861 complications (Complication Aspects) [patf]
    777 Complicated [ftcn]
    694 Ocular (Eye) [bpoc]
    638 Eye (Entire Eye) [bpoc]
    611 Optic (Optics) [ocdi]
    611 Ophthalmic [spco]
    588 Ophthalmia (Endophthalmitis) [dsyn]
```

Mapping Construction

```
Phrase: Ocular complications
 Meta Mapping (888):
    Ocular (Eye) [bpoc]
    Complications (Complication) [patf]
 Meta Mapping (888):
    Ocular (Eye) [bpoc]
    complications (Complication Aspects) [patf]
```

Mapping Construction (**with** WSD)

```
Phrase: Ocular complications
 Meta Mapping (888):
     Ocular (Eye) [bpoc]
     Complications (Complication) [patf]
~~ Meta Mapping (888):~~
~~    Ocular (Eye) [bpoc]~~
~~    complications (Complication Aspects) [patf]~~
```

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Input Formats

- ASCII only input
- Unformatted English free text
- MEDLINE Citations
- Input records delimited by blank line
- Single-line delimited input (via job Scheduler)

```
heart attack
lung cancer
```

- Single-line delimited input with ID (Scheduler)

```
000001|heart attack
000002|lung cancer
```

Input Should Have Syntactic Structure

- Lack of structure → long phrases
  → combinatorial explosion in mappings

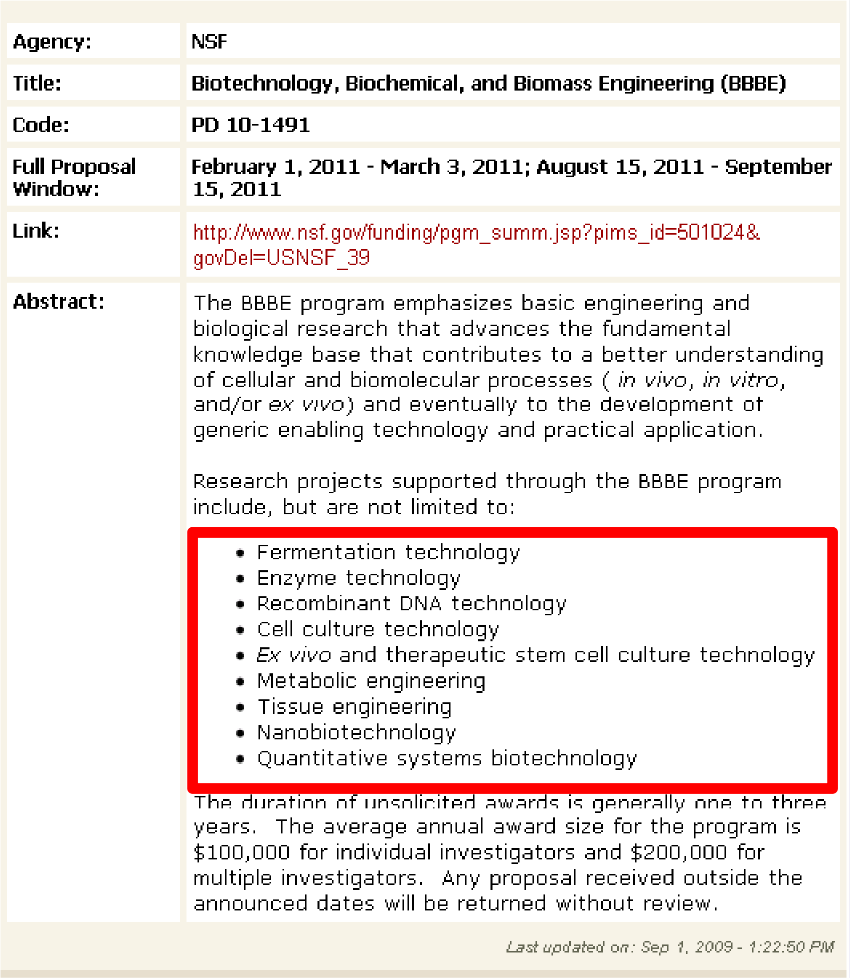
  - protein-4 FN3 fibronectin type III domain GSH lutathione GST glutathione S-transferase hIL-6 human interleukin-6 HSA human serum albumin IC(50) half-maximal inhibitory concentration Ig immunoglobulin IMAC immobilized metal affinity chromatography K(D) equilibrium constant

  - from filamentous bacteriophage f1 PCR polymerase-chain reaction PDB Protein Data Bank PSTI human pancreatic secretory trypsin inhibitor RBP retinol-binding protein SPR surface plasmon resonance TrxA

Input Format Syntax Limitation

- Phrase length is negligible constraint in MEDLINE:
  - $\mu = 1.31$
  - $\sigma = 1.18$
- 99.9% of MEDLINE phrases ≤ 8 tokens
- `--phrases_only` MetaMap option

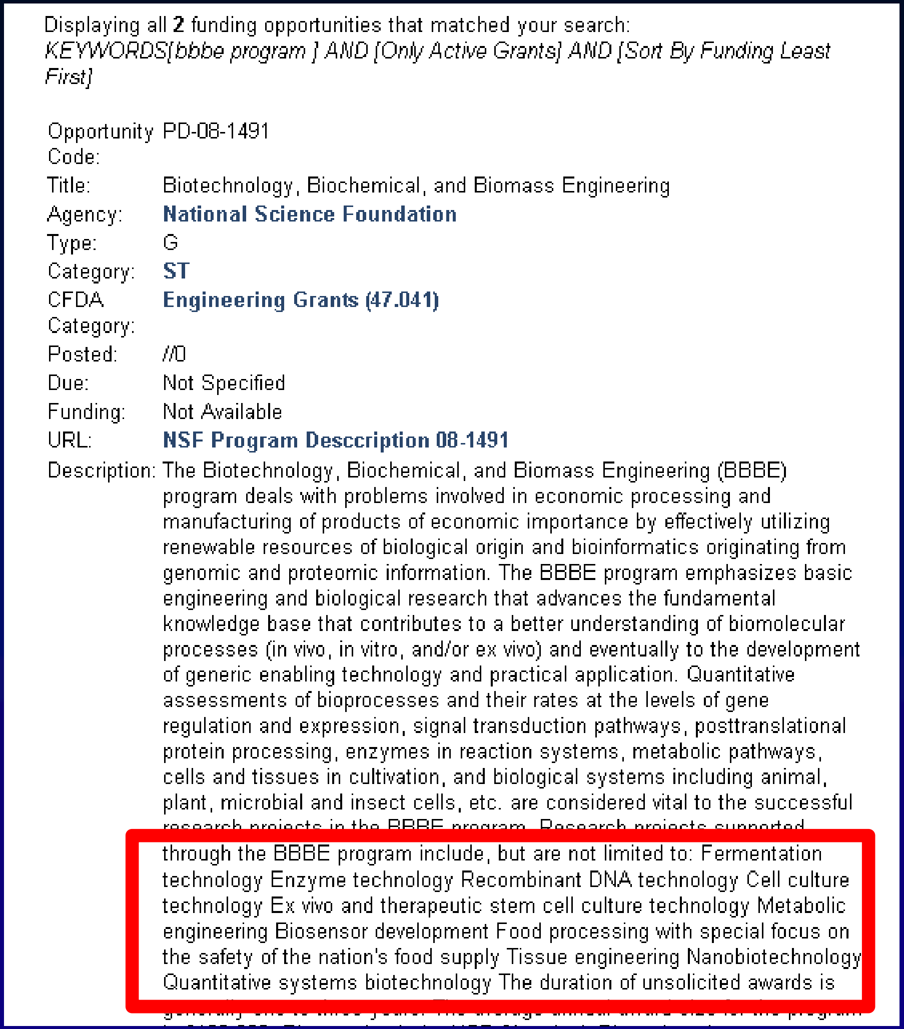
Be careful of bulleted lists!



Agency:	NSF
Title:	Biotechnology, Biochemical, and Biomass Engineering (BBBE)
Code:	PD 10-1491
Full Proposal Window:	February 1, 2011 - March 3, 2011; August 15, 2011 - September 15, 2011
Link:	http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=501024&govDel=USNSF_39
Abstract:	The BBBE program emphasizes basic engineering and biological research that advances the fundamental knowledge base that contributes to a better understanding of cellular and biomolecular processes (*in vivo*, *in vitro*, and/or *ex vivo*) and eventually to the development of generic enabling technology and practical application. Research projects supported through the BBBE program include, but are not limited to: • Fermentation technology • Enzyme technology • Recombinant DNA technology • Cell culture technology • *Ex vivo* and therapeutic stem cell culture technology • Metabolic engineering • Tissue engineering • Nanobiotechnology • Quantitative systems biotechnology The duration of unsolicited awards is generally one to three years. The average annual award size for the program is $100,000 for individual investigators and $200,000 for multiple investigators. Any proposal received outside the announced dates will be returned without review.

Last updated on: Sep 1, 2009 - 1:22:50 PM

Same text…
w/o bullets!



Displaying all **2** funding opportunities that matched your search:
KEYWORDS[bbbe program] AND [Only Active Grants] AND [Sort By Funding Least First]

Opportunity Code:	PD-08-1491
Title:	Biotechnology, Biochemical, and Biomass Engineering
Agency:	**National Science Foundation**
Type:	G
Category:	**ST**
CFDA Category:	**Engineering Grants (47.041)**
Posted:	//0
Due:	Not Specified
Funding:	Not Available
URL:	**NSF Program Desccription 08-1491**
Description:	The Biotechnology, Biochemical, and Biomass Engineering (BBBE) program deals with problems involved in economic processing and manufacturing of products of economic importance by effectively utilizing renewable resources of biological origin and bioinformatics originating from genomic and proteomic information. The BBBE program emphasizes basic engineering and biological research that advances the fundamental knowledge base that contributes to a better understanding of biomolecular processes (in vivo, in vitro, and/or ex vivo) and eventually to the development of generic enabling technology and practical application. Quantitative assessments of bioprocesses and their rates at the levels of gene regulation and expression, signal transduction pathways, posttranslational protein processing, enzymes in reaction systems, metabolic pathways, cells and tissues in cultivation, and biological systems including animal, plant, microbial and insect cells, etc. are considered vital to the successful research projects in the BBBE program. Research projects supported through the BBBE program include, but are not limited to: Fermentation technology Enzyme technology Recombinant DNA technology Cell culture technology Ex vivo and therapeutic stem cell culture technology Metabolic engineering Biosensor development Food processing with special focus on the safety of the nation's food supply Tissue engineering Nanobiotechnology Quantitative systems biotechnology The duration of unsolicited awards is generally one to three years. The average annual award size for the program

Output Formats: Summary

- Human-readable output
- MetaMap Machine Output (MMO)
- XML output
- Colorized MetaMap output (MetaMap 3D)
- Fielded (MMI) Output

Output Formats: Human Readable

```
Phrase: "heart attack"
Meta Candidates (8):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
   861 Heart [Body Part, Organ, or Organ Component]
   861 Attack, NOS (Onset of illness) [Finding]
   861 Attack (Attack device) [Medical Device]
   861 attack (Attack behavior) [Social Behavior]
   861 Heart (Entire heart) [Body Part, Organ, or Organ Component]
   861 Attack (Observation of attack) [Finding]
   827 Attacked (Assault) [Injury or Poisoning]
Meta Mapping (1000):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
```

Human Readable: Metathesaurus String

```
Phrase: "heart attack"
Meta Candidates (8):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
   861 Heart [Body Part, Organ, or Organ Component]
   861 Attack, NOS (Onset of illness) [Finding]
   861 Attack (Attack device) [Medical Device]
   861 attack (Attack behavior) [Social Behavior]
   861 Heart (Entire heart) [Body Part, Organ, or Organ Component]
   861 Attack (Observation of attack) [Finding]
   827 Attacked (Assault) [Injury or Poisoning]
Meta Mapping (1000):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
```

Human Readable: Preferred Name

```
Phrase: "heart attack"
Meta Candidates (8):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
   861 Heart [Body Part, Organ, or Organ Component]
   861 Attack, NOS (Onset of illness) [Finding]
   861 Attack (Attack device) [Medical Device]
   861 attack (Attack behavior) [Social Behavior]
   861 Heart (Entire heart) [Body Part, Organ, or Organ Component]
   861 Attack (Observation of attack) [Finding]
   827 Attacked (Assault) [Injury or Poisoning]
Meta Mapping (1000):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
```

Human Readable: MetaMap Scores

```
Phrase: "heart attack"
Meta Candidates (8):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
   861 Heart [Body Part, Organ, or Organ Component]
   861 Attack, NOS (Onset of illness) [Finding]
   861 Attack (Attack device) [Medical Device]
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Meta Mapping (1000):
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```

Human Readable: Semantic Types

```
Phrase: "heart attack"
Meta Candidates (8):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
   861 Heart [Body Part, Organ, or Organ Component]
   861 Attack, NOS (Onset of illness) [Finding]
   861 Attack (Attack device) [Medical Device]
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   861 Heart (Entire heart) [Body Part, Organ, or Organ Component]
   861 Attack (Observation of attack) [Finding]
   827 Attacked (Assault) [Injury or Poisoning]
Meta Mapping (1000):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
```

Human Readable: w/o SemTypes (-s)

```
Phrase: "heart attack"
Meta Candidates (8):
  1000 Heart attack (Myocardial Infarction)
   861 Heart
   861 Attack, NOS (Onset of illness)
   861 Attack (Attack device)
   861 attack (Attack behavior)
   861 Heart (Entire heart)
   861 Attack (Observation of attack)
   827 Attacked (Assault)
Meta Mapping (1000):
  1000 Heart attack (Myocardial Infarction)
```

Human Readable with CUIs (-I)

```
Meta Candidates (8):
  1000 C0027051:Heart attack (Myocardial Infarction) [Disease or
   Syndrome]
   861 C0018787:Heart [Body Part, Organ, or Organ Component]
   861 C0277793:Attack, NOS (Onset of illness) [Finding]
   861 C0699795:Attack (Attack device) [Medical Device]
   861 C1261512:attack (Attack behavior) [Social Behavior]
   861 C1281570:Heart (Entire heart) [Body Part, Organ, or Organ
   Component]
   861 C1304680:Attack (Observation of attack) [Finding]
   827 C0004063:Attacked (Assault) [Injury or Poisoning]
Meta Mapping (1000):
  1000 C0027051:Heart attack (Myocardial Infarction) [Disease or
   Syndrome]
```

Human Readable with Sources (-G)

```
Meta Candidates (8):
  1000 Heart attack (Myocardial Infarction {MEDLINEPLUS}) [Disease or
   Syndrome]
   861 Heart {AIR, BI, PNDS} [Body Part, Organ, or Organ Component]
   861 Attack, NOS (Onset of illness {MTH, SNOMEDCT, AOD}) [Finding]
   861 Attack (Attack device {MTH, MMSL}) [Medical Device]
   861 attack (Attack behavior {MTH, PSY, AOD}) [Social Behavior]
   861 Heart (Entire heart {MTH, SNOMEDCT}) [Body Part, Organ, or Organ
   Component]
   861 Attack (Observation of attack {MTH, SNOMEDCT}) [Finding]
   827 Attacked (Assault {ICD10AM,ICPC2P}) [Injury or Poisoning]
Meta Mapping (1000):
  1000 Heart attack (Myocardial Infarction {MEDLINEPLUS}) [Disease or
   Syndrome]
```

Output Formats: Human Readable

```
Phrase: "heart attack"
Meta Candidates (8):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
   861 Heart [Body Part, Organ, or Organ Component]
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   861 Attack (Observation of attack) [Finding]
   827 Attacked (Assault) [Injury or Poisoning]
Meta Mapping (1000):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
```

Output Formats: Machine Output

Prolog terms (pretty-printed & condensed!)

```
candidates([
   ev(-1000, 'C0027051', 'Heart attack', 'Myocardial Infarction', [heart,attack],
       [dsyn], [[[1,2],[1,2],0]], yes, no, ['MEDLINEPLUS], [0/12]),
   ev(-861, 'C0018787', 'Heart', 'Heart', [heart],
       [bpoc], [[[1,1],[1,1],0]], yes, no, ['AIR'],[0/5]),
   ev(-861, 'C0277793', 'Attack,  NOS', 'Onset of illness',  [attack],
       [fndg], [[[2,2],[1,1],0]], yes, no, ['MTH'], [6/6]),
   ev(-861, 'C0699795', 'Attack', 'Attack device', [attack],
       [medd], [[[2,2],[1,1],0]], yes, no, ['MTH','MMSL'], [6/6]),
   ev(-861, 'C1261512', attack, 'Attack behavior', [attack],
       [socb], [[[2,2],[1,1],0]], yes, no, ['MTH','PSY','AOD'], [6/6]),
   ev(-861, 'C1281570', 'Heart', 'Entire heart', [heart],
       [bpoc], [[[1,1],[1,1],0]], yes, no, ['MTH','SNOMEDCT'], [0/5]),
   ev(-861, 'C1304680', 'Attack', 'Observation of attack', [attack],
       [fndg],  [[[2,2],[1,1],0]], yes, no, ['MTH','SNOMEDCT'], [6/6]),
   ev(-827, 'C0004063', 'Attacked', 'Assault', [attacked],
       [inpo], [[[2,2],[1,1],1]], yes, no, ['ICD10AM'], [6/6])]).
```

Output Formats: Machine Output

Prolog terms (pretty-printed & condensed!)

```
candidates([
   ev(-1000, 'C0027051', 'Heart attack', 'Myocardial Infarction', [heart,attack],
       [dsyn], [[[1,2],[1,2],0]], yes, no, ['MEDLINEPLUS], [0/12]),
   ev(-861, 'C0018787', 'Heart', 'Heart', [heart],
       [bpoc], [[[1,1],[1,1],0]], yes, no, ['AIR'],[0/5]),
   ev(-861, 'C0277793', 'Attack,  NOS', 'Onset of illness',  [attack],
       [fndg], [[[2,2],[1,1],0]], yes, no, ['MTH'], [6/6]),
   ev(-861, 'C0699795', 'Attack', 'Attack device', [attack],
       [medd], [[[2,2],[1,1],0]], yes, no, ['MTH','MMSL'], [6/6]),
   ev(-861, 'C1261512', attack, 'Attack behavior', [attack],
       [socb], [[[2,2],[1,1],0]], yes, no, ['MTH','PSY','AOD'], [6/6]),
   ev(-861, 'C1281570', 'Heart', 'Entire heart', [heart],
       [bpoc], [[[1,1],[1,1],0]], yes, no, ['MTH','SNOMEDCT'], [0/5]),
   ev(-861, 'C1304680', 'Attack', 'Observation of attack', [attack],
       [fndg],  [[[2,2],[1,1],0]], yes, no, ['MTH','SNOMEDCT'], [6/6]),
   ev(-827, 'C0004063', 'Attacked', 'Assault', [attacked],
       [inpo], [[[2,2],[1,1],1]], yes, no, ['ICD10AM'], [6/6])]).
```

Output Formats: Unformatted XML

```
<Candidate><CandidateScore>-1000</CandidateScore><CandidateCUI>C0027051</CandidateCUI><CandidateM
atched>Heart attack</CandidateMatched><CandidatePreferred>Myocardial Infarction</CandidatePreferr
ed><MatchedWords Count=2><MatchedWord>heart</MatchedWord><MatchedWord>attack</MatchedWord></Match
edWords><SemTypes Count=1><SemType>dsyn</SemType></SemTypes><MatchMaps Count=1><MatchMap><TextMat
chStart>1</TextMatchStart><TextMatchEnd>2</TextMatchEnd><ConcMatchStart>1</ConcMatchStart><ConcMa
tchEnd>2</ConcMatchEnd><LexVariation>0</LexVariation></MatchMap></MatchMaps><IsHead>yes</IsHead><
IsOverMatch>no</IsOverMatch><Sources Count=24><Source>MEDLINEPLUS</Source></Sources><ConceptPIs C
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```

Output Formats: Formatted XML

```
<Candidate>
 <CandidateScore>-1000</CandidateScore>
 <CandidateCUI>C0027051</CandidateCUI>
 <CandidateMatched>Heart attack</CandidateMatched>
 <CandidatePreferred>Myocardial Infarction</CandidatePreferred>
 <MatchedWords
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 <SemTypes Count=1><SemType>dsyn</SemType></SemTypes>
 <MatchMaps Count=1>
  <MatchMap>
   <TextMatchStart>1</TextMatchStart>
   <TextMatchEnd>2</TextMatchEnd>
   <ConcMatchStart>1</ConcMatchStart>
   <ConcMatchEnd>2</ConcMatchEnd>
   <LexVariation>0</LexVariation>
  </MatchMap>
 </MatchMaps>
 <IsHead>yes</IsHead>
 <IsOverMatch>no</IsOverMatch>
 <Sources Count=24><Source>MEDLINEPLUS</Source></Sources>
 <ConceptPIs Count=1><ConceptPI><StartPos>0</StartPos><Length>12</Length></ConceptPI></ConceptPIs>
</Candidate>
```

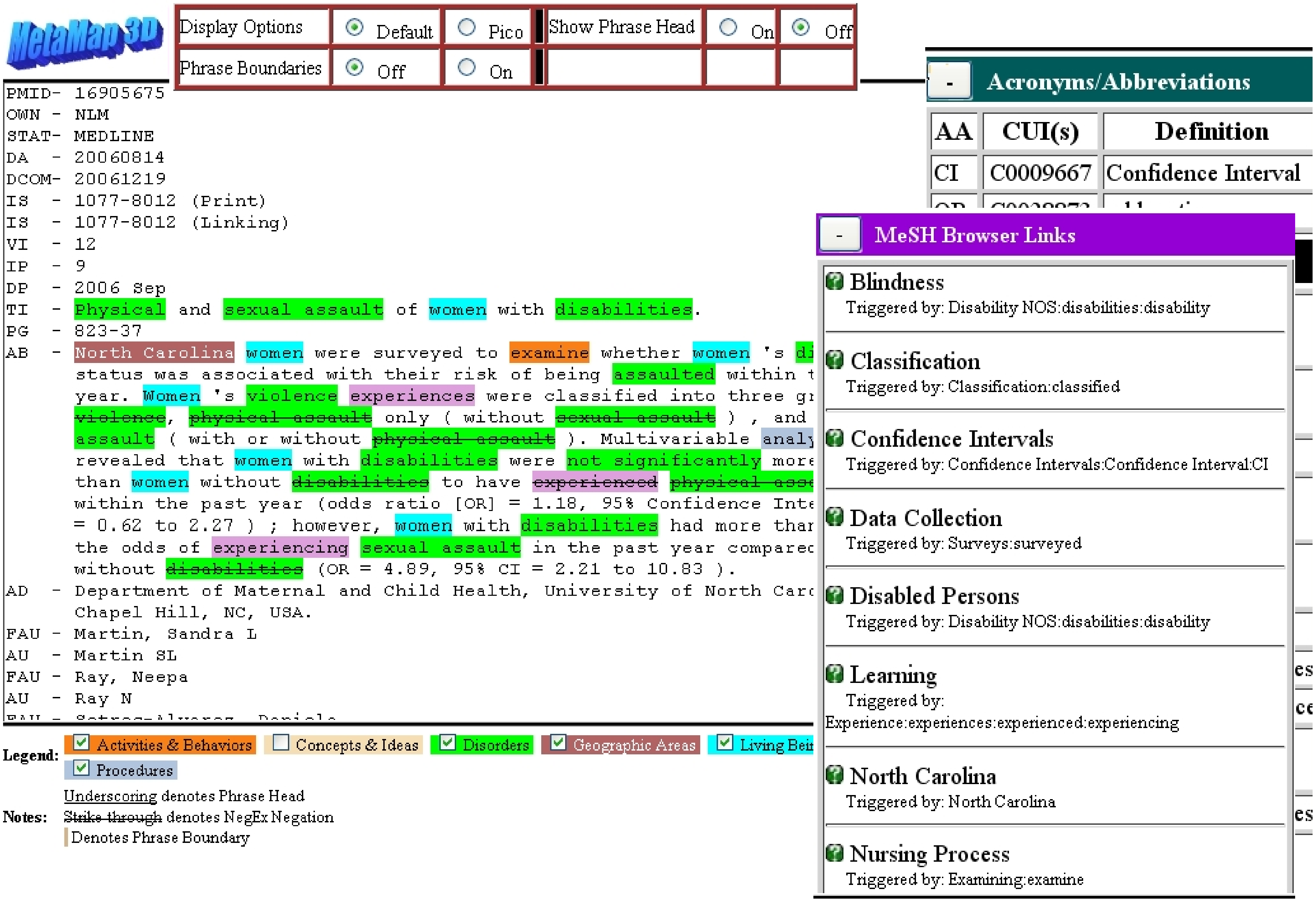

Display Options	● Default	○ Pico	Show Phrase Head	○ On	● Off
Phrase Boundaries	● Off	○ On			

PMID- 16905675
OWN - NLM
STAT- MEDLINE
DA - 20060814
DCOM- 20061219
IS - 1077-8012 (Print)
IS - 1077-8012 (Linking)
VI - 12
IP - 9
DP - 2006 Sep
TI - Physical and sexual assault of women with disabilities.
PG - 823-37
AB - North Carolina women were surveyed to examine whether women 's di
status was associated with their risk of being assaulted within t
year. Women 's violence experiences were classified into three gr
~~violence~~, ~~physical assault~~ only (without ~~sexual assault~~) , and
assault (with or without ~~physical assault~~). Multivariable analy
revealed that women with disabilities were not significantly more
than women without ~~disabilities~~ to have ~~experienced~~ ~~physical asso~~
within the past year (odds ratio [OR] = 1.18, 95% Confidence Inte
= 0.62 to 2.27) ; however, women with disabilities had more than
the odds of experiencing sexual assault in the past year comparec
without ~~disabilities~~ (OR = 4.89, 95% CI = 2.21 to 10.83).
AD - Department of Maternal and Child Health, University of North Caro
Chapel Hill, NC, USA.
FAU - Martin, Sandra L
AU - Martin SL
FAU - Ray, Neepa
AU - Ray N
FAU - Sotres-Alvarez, Daniela

Legend: ☑ Activities & Behaviors ☐ Concepts & Ideas ☑ Disorders ☑ Geographic Areas ☑ Living Bei
☑ Procedures

Notes: Underscoring denotes Phrase Head
~~Strike through~~ denotes NegEx Negation
| Denotes Phrase Boundary

- Acronyms/Abbreviations

AA	CUI(s)	Definition
CI	C0009667	Confidence Interval

- MeSH Browser Links

Blindness
Triggered by: Disability NOS:disabilities:disability

Classification
Triggered by: Classification:classified

Confidence Intervals
Triggered by: Confidence Intervals:Confidence Interval:CI

Data Collection
Triggered by: Surveys:surveyed

Disabled Persons
Triggered by: Disability NOS:disabilities:disability

Learning
Triggered by:
Experience:experiences:experienced:experiencing

North Carolina
Triggered by: North Carolina

Nursing Process
Triggered by: Examining:examine

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- Future directions (Lan)

MetaMap Options

- Word Sense Disambiguation (WSD, -y)
  - Based on Susanne Humphrey's Journal Descriptor Indexing (*Humphrey et al., 1998, 2006*)
  - Provides modest improvement in results
- Negation (--negex)
  - Important for clinical text
  - Based on Wendy Chapman's NegEx algorithm (*Chapman et al., 2001*)
- Behavior options
- Output/Display options

WSD Examples (1/4)

- “Fifteen (6.4%) of 234 colds treated with placebo…”

~~Cold (cold temperature) [npop]~~

Cold (Common Cold) [dsyn]

~~Cold (Cold Sensation) [phsf]~~

WSD Examples (2/4)

- "… the drugs were compared in two four-point, double-blind bioassays."

  ~~double (Diplopia) [dsyn]~~ vs. Double (Duplicate) [ftcn]

  ~~Blind (Blind Vision) [dsyn]~~ vs. BLIND (Blinded) [resa] vs. ~~Blind (Visually Impaired Persons) [podg]~~

  Bioassays (Biological Assay) [lbpr]

WSD Examples (3/4)

- “More neuroactive substances were prescribed for patients with superior mentation and minimal physical disability; the difference between low and high groups was 1.7 (mentation) and 2.8 (physical status).”

```
High (Euphoric mood) [menp] vs. ~~High [qlco]~~WRONG
Groups [inpr]
```

WSD Examples (4/4)

- "The authors conclude that these cases of progressive hepatic disease with histologic changes simulating those found in livers of alcoholic patients offer evidence that heavy alcohol consumption may affect the liver in an indirect fashion."

~~Liver (Entire liver) [bpoc]~~ vs. ~~Liver [bpoc]~~
vs. LIVER (Liver Extract) [orch,phsu] WRONG

Negation Example

- "There is no focal infiltrate or pleural effusion."
- `--negex` output (in addition to normal output):

```
NEGATIONS:
Negation Type:     nega
Negation Trigger:  no
Negation PosInfo:  9/2
Negated  Concept:  C0332448:Infiltrate
Concept  PosInfo:  18/10

Negation Type:     nega
Negation Trigger:  no
Negation PosInfo:  9/2
Negated  Concept:  C2073625:pleural effusion, C0032227:Pleural Effusion
Concept  PosInfo:  32/16
```

Behavior Options (1/4)

- Data model options

`-A --strict_model` (the default; focused on concepts likely to be found in text)

`-C --relaxed_model` (includes most Metathesaurus content)

- Major options highlighted earlier

```
-y --word_sense_disambiguation
   --negex
```

- Other major options

`-Q --quick_composite_phrases` (experimental, for well-behaved larger phrases: *pain on the left side of the chest*)

`-i --ignore_word_order`

Example: Default (with word order)

```
Phrase: “Jurkat T cells”

Meta Candidates (8):
913 Jurkat Cells [Cell]
901 T-Cells (T-Lymphocyte) [Cell]
827 Cells [Cell]
793 Cell (Entire cell) [Cell]
793 Cell (Cell Device Component) [Medical Device]
793 Cell (Cell (compartment)) [Spatial Concept]
743 Cellular [Functional Concept]
721 Cellularity [Qualitative Concept]

Meta Mapping (913):
913 Jurkat Cells [Cell]
```

Example: Ignore Word Order (-i)

```
Phrase: “Jurkat T cells”

Meta Candidates (8):
882 T-Cells (T-Lymphocyte) [Cell]
858 Jurkat Cells [Cell]
790 Cells [Cell]
756 Cell (Entire cell) [Cell]
756 Cell (Cell Device Component) [Medical Device]
756 Cell (Cell (compartment)) [Spatial Concept]
706 Cellular [Functional Concept]
684 Cellularity [Qualitative Concept]

Meta Mapping (882):
882 T-Cells (T-Lymphocyte) [Cell]
```

Behavior Options (2/4)

- Browse mode options (example below)

```
-z --term_processing
-o --allow_overmatches
-g --allow_concept_gaps
-m --hide_mappings
```

- Inference mode optio

```
-Y --prefer_multiple_conc
```

With `--term_processing`,

With `--allow_overmatches`

With `--allow_concept_gaps`, ıant

“*mouse protein*” →

‘Ly6d protein, mouse’

among over 8,000 results

Behavior Options (3/4)

- Parsing/lexical options (not often used)

```
-t --no_tagging
-d --no_derivational_variants
-D --all_derivational_variants
-a --all_acros_abbrs
-u --unique_acros_abbrs_only
```

- List truncation options (reduces tenuous matches and saves processing time)

```
-r --threshold <integer>
```

Behavior Options (4/4)

- Source/ST limitation options

```
-R --restrict_to_sources <list>
-e --exclude_sources <list>
-J --restrict_to_sts <list>
-k --exclude_sts <list>
```

Output/Display Options (1/2)

- Human-readable output/display options

```
-p --hide_plain_syntax
-x --syntax
-T --tagger output
-v --variants
-c --hide_candidates
-m --hide_mappings
-I --show_cuis
-s --hide_semantic_types
-G --sources
```

Useful for explaining MetaMap's behavior

Output/Display Options (2/2)

- Other output/display options (override human-readable options)

`-q --machine_output`

`-N --fielded_mmi_output` (mmi = MetaMap Indexing)

`-% --XML <none> (format` or `noformat)`

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MetaMap Processing Modes

- Semantic mode (the *normal*, *default* mode)
  - Seeks *correct*, or *best*, answer
  - Uses MetaMap's strict data model
- Inference mode (`-Y, --prefer_multiple_concepts`)
  - Similar to semantic mode except
  - Prefers multiple concepts to facilitate inferencing
- Browse mode (`-zogm, --term_processing --allow_overmatches --allow_concept_gaps --hide_mappings`)
  - Seeks all answers, even tenuous ones
  - Often uses MetaMap's relaxed data model (`-C`)
  - Often includes `–i, --ignore_word_order`

Example: Semantic Mode (with WSD)

```
-y, --word_sense_disambiguation
```

```
> metamap –y
…
Phrase: "bladder cancer"
Meta Candidates (10):
  1000 bladder cancer (Malignant neoplasm of urinary bladder) [Neoplastic Process]
  1000 Bladder Cancer (Carcinoma of bladder) [Neoplastic Process]
   861 Bladder (Urinary Bladder) [Body Part, Organ, or Organ Component]
   861 Cancer (Malignant Neoplasms) [Neoplastic Process]
   861 Cancer (Neoplasm) [Neoplastic Process]
   861 Cancer (Cancer Genus) [Eukaryote]
   861 Bladder (Entire bladder) [Body Part, Organ, or Organ Component]
   861 Cancer (Primary malignant neoplasm) [Neoplastic Process]
   861 Cancer (Cancer:-:Point in time:^Patient:-) [Clinical Attribute]
   805 Vesical (Vesico-) [Spatial Concept]
Meta Mapping (1000):
  1000 Bladder Cancer (Carcinoma of bladder) [Neoplastic Process]
```

Example: Inference Mode (with WSD)

```
metamap –yY                 -y, --word_sense_disambiguation
…                            -Y, --prefer_multiple_concepts
Phrase: "bladder cancer"
Meta Candidates (10):
   694 Bladder (Urinary Bladder) [Body Part, Organ, or Organ Component]
   694 Cancer (Malignant Neoplasms) [Neoplastic Process]
   694 Cancer (Neoplasm) [Neoplastic Process]
   694 Cancer (Cancer Genus) [Eukaryote]
   694 Bladder (Entire bladder) [Body Part, Organ, or Organ Component]
   694 Cancer (Primary malignant neoplasm) [Neoplastic Process]
   694 Cancer (Cancer:-:Point in time:^Patient:-) [Clinical Attribute]
   666 bladder cancer (Malignant neoplasm of urinary bladder) [Neoplastic Process]
   666 Bladder Cancer (Carcinoma of bladder) [Neoplastic Process]
   638 Vesical (Vesico-) [Spatial Concept]
Meta Mapping (777):
   694 Bladder (Entire bladder) [Body Part, Organ, or Organ Component]
   694 Cancer (Malignant Neoplasms) [Neoplastic Process]
```

Example 1/2: Browse Mode

```
-z, --term_processing
-o, allow_overmatches
-g, allow_concept_gaps
-m, --hide_mappings
```

```
> metamap –zogm
…
Phrase: "bladder cancer"
Meta Candidates (5597):
  1000 bladder cancer (Malignant neoplasm of urinary bladder) [Neoplastic Process]
          Cancer of Bladder
          Malignant Bladder Neoplasm
  1000 Bladder Cancer (Carcinoma of bladder) [Neoplastic Process]
          BLADDER CARCINOMA
          Cancer of Bladder
   861 Bladder (Urinary Bladder) [Body Part, Organ, or Organ Component]
   861 Cancer (Malignant Neoplasms) [Neoplastic Process]
…
   583 gall bladder (Gallbladder) [Body Part, Organ, or Organ Component]
   583 Cancer Hospital (Hospitals, Cancer) [Health Care Related
         Organization,Manufactured Object]
…
```

Example 2/2: Browse Mode

```
-z, --term_processing
-o, allow_overmatches
-g, allow_concept_gaps
-m, --hide_mappings
```

```
> metamap –zogm
…
Phrase: “achilles reflex"
Meta Candidates (815):
   861 Achilles (Structure of achilles tendon) [Body Part, Organ, or Organ Component]
   861 Reflex (Reflex action) [Organ or Tissue Function]
   861 reflex (Reflex motion descriptor) [Organ or Tissue Function]
   861 Reflex (Observation of reflex) [Finding]
   827 Achilles tendon reflex (Ankle reflex) [Clinical Attribute]
          Ankle reflex
   827 reflexes (Examination of reflexes) [Diagnostic Procedure]
   722 examination of Achilles reflex [Diagnostic Procedure]
          ankle reflex exam
   679 intensity of left Achilles tendon reflex [Finding]
          left ankle jerk reflex
   679 intensity of right Achilles tendon reflex [Finding]
          right ankle jerk reflex
   583 Gag reflex (Gagging) [Finding]
…
```

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Candidates vs. Mappings

- The mappings are MetaMap's *final answer* to text input
- The candidate list is an *intermediate result*
  - Often contains many bad matches among the good ones (similar to Browse mode results vs. Semantic mode results)
  - Should be used judiciously/selectively and only when mappings are found to be inadequate

Candidates vs. Mappings Example

```
Phrase: "heart attack"
Meta Candidates (8):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
   861 Heart [Body Part, Organ, or Organ Component]
   861 Attack, NOS (Onset of illness) [Finding]
   861 Attack (Attack device) [Medical Device]
   861 attack (Attack behavior) [Social Behavior]
   861 Heart (Entire heart) [Body Part, Organ, or Organ Component]
   861 Attack (Observation of attack) [Finding]
   827 Attacked (Assault) [Injury or Poisoning]
Meta Mapping (1000):
  1000 Heart attack (Myocardial Infarction) [Disease or Syndrome]
```

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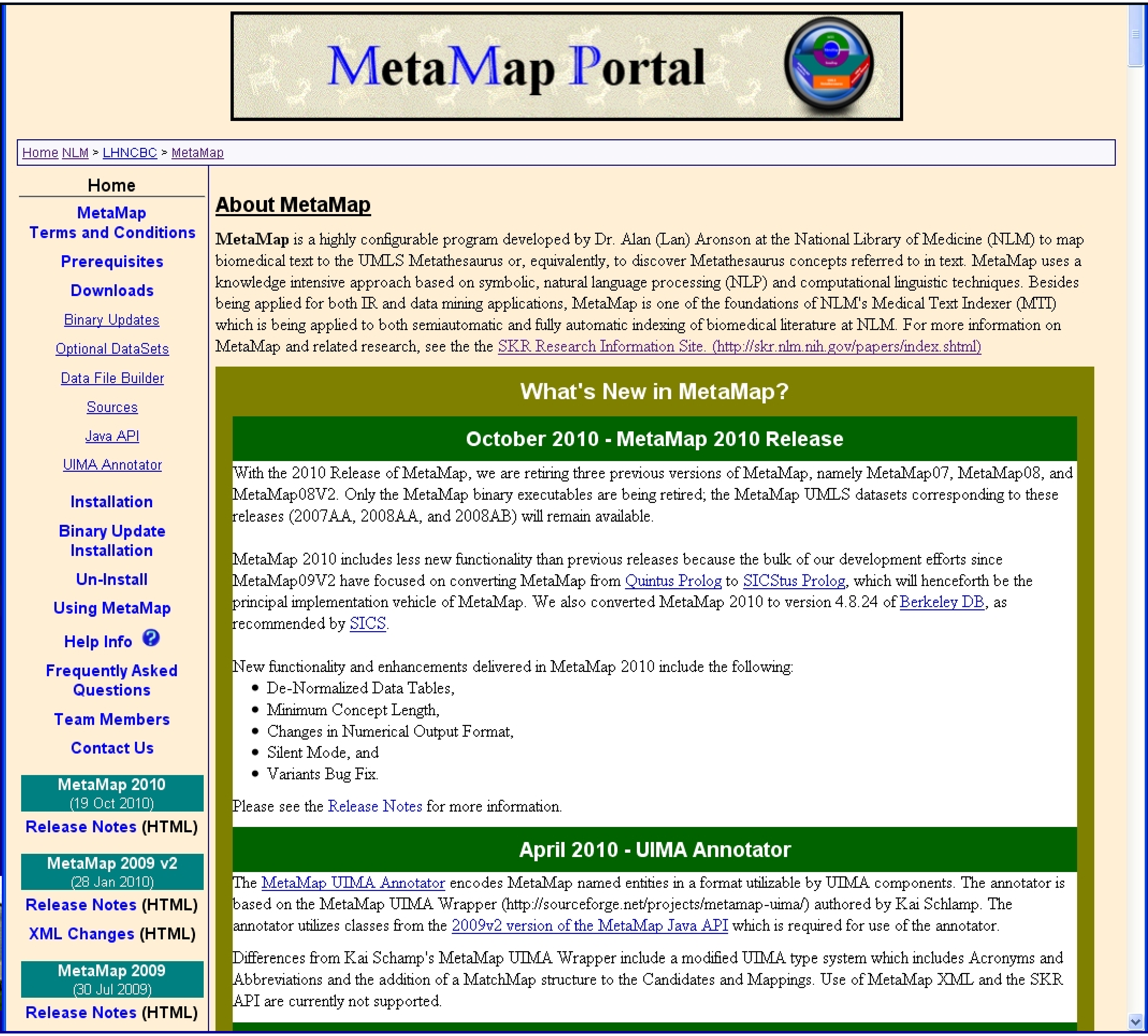
MetaMap Availability

- Web access (start here)
  - Interactive and batch (file) processing via Scheduler
  - `http://skr.nlm.nih.gov/`
- MMTx (MetaMap Transfer) (becoming obsolete)
  - Java-based implementation of MetaMap
  - `http://mmtx.nlm.nih.gov/`
  - MetaMap vs. MMTx
- MetaMap itself
  - Initial release (for Linux): September, 2008
  - `http://metamap.nlm.nih.gov/`

All usage requires UMLS license agreement

MetaMap APIs

- Java MetaMap API
  - http://metamap.nlm.nih.gov/#MetaMapJavaApi
- Java API to SKR Scheduler
  - http://skr.nlm.nih.gov/SKR_API
- MetaMap UIMA Annotator
  - http://metamap.nlm.nih.gov/#MetaMapUIMA



Home NLM > LHNCBC > MetaMap

Home

MetaMap
Terms and Conditions

Prerequisites

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Data File Builder

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Java API

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Binary Update Installation

Un-Install

Using MetaMap

Help Info

Frequently Asked Questions

Team Members

Contact Us

MetaMap 2010
(19 Oct 2010)

Release Notes (HTML)

MetaMap 2009 v2
(28 Jan 2010)

Release Notes (HTML)

XML Changes (HTML)

MetaMap 2009
(30 Jul 2009)

Release Notes (HTML)

About MetaMap

MetaMap is a highly configurable program developed by Dr. Alan (Lan) Aronson at the National Library of Medicine (NLM) to map biomedical text to the UMLS Metathesaurus or, equivalently, to discover Metathesaurus concepts referred to in text. MetaMap uses a knowledge intensive approach based on symbolic, natural language processing (NLP) and computational linguistic techniques. Besides being applied for both IR and data mining applications, MetaMap is one of the foundations of NLM's Medical Text Indexer (MTI) which is being applied to both semiautomatic and fully automatic indexing of biomedical literature at NLM. For more information on MetaMap and related research, see the the SKR Research Information Site. (http://skr.nlm.nih.gov/papers/index.shtml)

What's New in MetaMap?

October 2010 - MetaMap 2010 Release

With the 2010 Release of MetaMap, we are retiring three previous versions of MetaMap, namely MetaMap07, MetaMap08, and MetaMap08V2. Only the MetaMap binary executables are being retired; the MetaMap UMLS datasets corresponding to these releases (2007AA, 2008AA, and 2008AB) will remain available.

MetaMap 2010 includes less new functionality than previous releases because the bulk of our development efforts since MetaMap09V2 have focused on converting MetaMap from Quintus Prolog to SICStus Prolog, which will henceforth be the principal implementation vehicle of MetaMap. We also converted MetaMap 2010 to version 4.8.24 of Berkeley DB, as recommended by SICS.

New functionality and enhancements delivered in MetaMap 2010 include the following:

- De-Normalized Data Tables,
- Minimum Concept Length,
- Changes in Numerical Output Format,
- Silent Mode, and
- Variants Bug Fix.

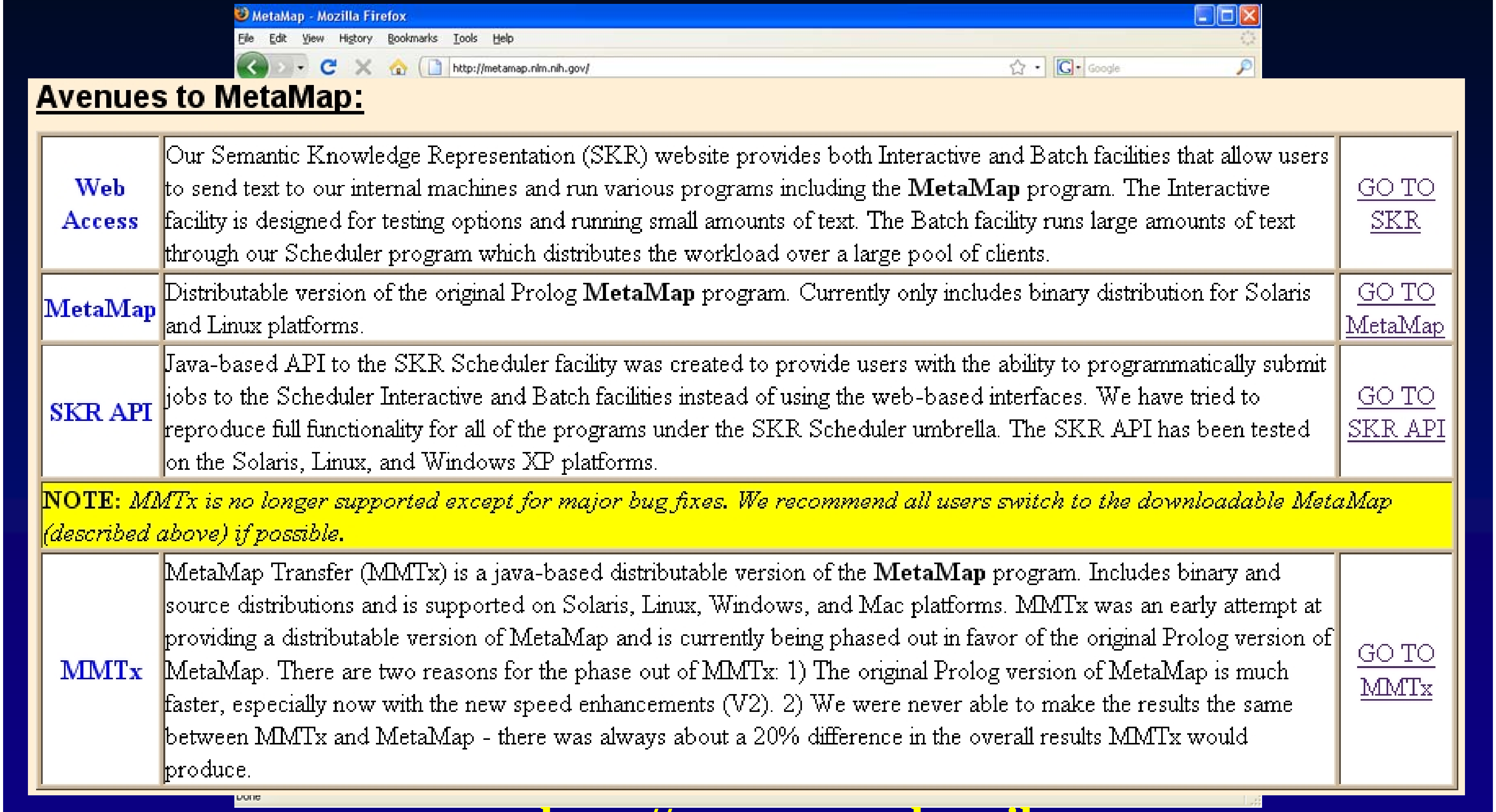
Please see the Release Notes for more information.

April 2010 - UIMA Annotator

The MetaMap UIMA Annotator encodes MetaMap named entities in a format utilizable by UIMA components. The annotator is based on the MetaMap UIMA Wrapper (http://sourceforge.net/projects/metamap-uima/) authored by Kai Schlamp. The annotator utilizes classes from the 2009v2 version of the MetaMap Java API which is required for use of the annotator.

Differences from Kai Schamp's MetaMap UIMA Wrapper include a modified UIMA type system which includes Acronyms and Abbreviations and the addition of a MatchMap structure to the Candidates and Mappings. Use of MetaMap XML and the SKR API are currently not supported.

MetaMap/MMTx Distribution Modes


MetaMap - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://metamap.nlm.nih.gov/
Google
Done

Avenues to MetaMap:

Web Access	Our Semantic Knowledge Representation (SKR) website provides both Interactive and Batch facilities that allow users to send text to our internal machines and run various programs including the **MetaMap** program. The Interactive facility is designed for testing options and running small amounts of text. The Batch facility runs large amounts of text through our Scheduler program which distributes the workload over a large pool of clients.	GO TO SKR
MetaMap	Distributable version of the original Prolog **MetaMap** program. Currently only includes binary distribution for Solaris and Linux platforms.	GO TO MetaMap
SKR API	Java-based API to the SKR Scheduler facility was created to provide users with the ability to programmatically submit jobs to the Scheduler Interactive and Batch facilities instead of using the web-based interfaces. We have tried to reproduce full functionality for all of the programs under the SKR Scheduler umbrella. The SKR API has been tested on the Solaris, Linux, and Windows XP platforms.	GO TO SKR API
NOTE: *MMTx is no longer supported except for major bug fixes. We recommend all users switch to the downloadable MetaMap (described above) if possible.*		
MMTx	MetaMap Transfer (MMTx) is a java-based distributable version of the **MetaMap** program. Includes binary and source distributions and is supported on Solaris, Linux, Windows, and Mac platforms. MMTx was an early attempt at providing a distributable version of MetaMap and is currently being phased out in favor of the original Prolog version of MetaMap. There are two reasons for the phase out of MMTx: 1) The original Prolog version of MetaMap is much faster, especially now with the new speed enhancements (V2). 2) We were never able to make the results the same between MMTx and MetaMap - there was always about a 20% difference in the overall results MMTx would produce.	GO TO MMTx

http://metamap.nlm.nih.gov

U. S. NATIONAL LIBRARY OF MEDICINE

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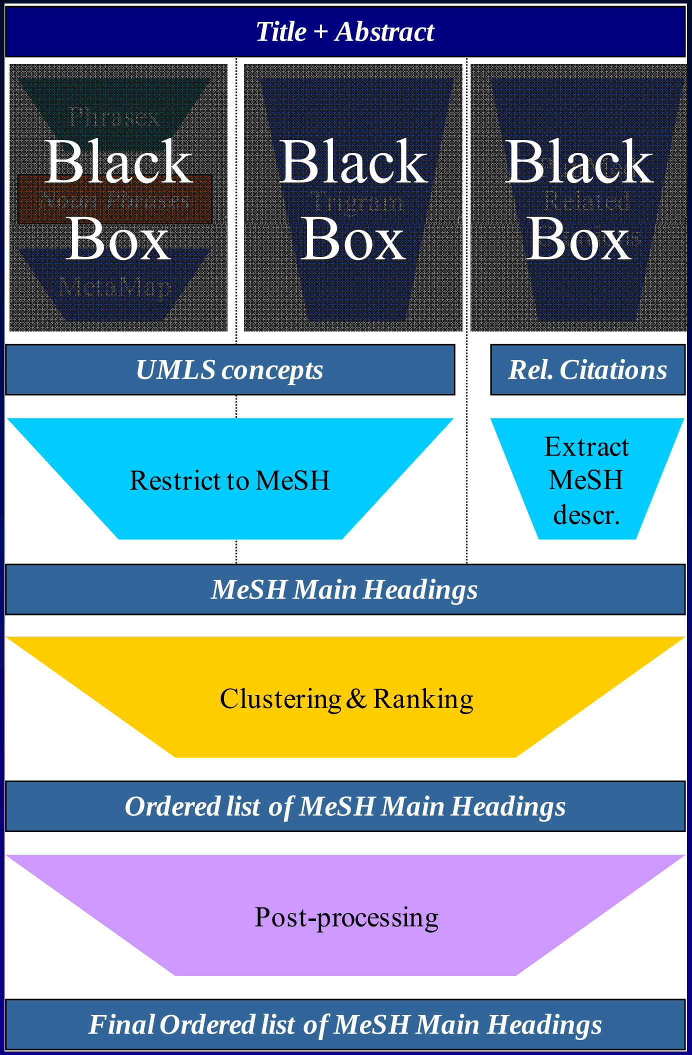
- Future directions (Lan)

NLM Applications using MetaMap: MTI (Medical Text Indexer)

- Product of Indexing Initiative
- Assists NLM Indexers
- Production since mid-2000
- Uses article Title and Abstract
- Semi-Automatic MeSH Indexing Recommendations
- Automatic Keyword Indexing



Title + Abstract

Phrasex

Black Box

Noun Phrases

MetaMap

Black Box

Trigram

Black Box

Related

UMLS concepts

Rel. Citations

Restrict to MeSH

Extract MeSH descr.

MeSH Main Headings

Clustering & Ranking

Ordered list of MeSH Main Headings

Post-processing

Final Ordered list of MeSH Main Headings

MTI Uses

- Assisted indexing of MEDLINE/PubMed articles (DCMS)
  - Citations processed nightly
- Assisted indexing of Cataloging (TSD) and History of Medicine Division (HMD) records
  - Production mid-2007
  - Easy modification to MTI to accommodate differences
  - Tightly integrated into their workflow
- Automatic indexing of NLM Gateway meeting abstracts

How MTI Uses MetaMap

- Dominate input pathway (weighted 7 – 2 over PRC)
- Calls MetaMap twice
- Pass I – cast a wide net to identify as many UMLS concepts as possible, while balancing time constraints
  - metamap –iDN
  - Ignore Word Order (-i)
  - All Derivational Variants (-D)
  - Fielded MMI Output (-N)

How MTI Uses MetaMap (contd.)

- Pass II – more focused review for actual MeSH Headings in the text, reinforces Pass I items
  - metamap –dN –R ‘MSH’
  - No Derivational Variants (-d)
  - Fielded MMI Output (-N)
  - Restrict to Sources (-R) restricted to MeSH

MetaMap Fielded MMI Output (-N)

```
17285228|MM|430.78|Homocystine|C0019879|[aapp,bacs]|["Homocystine"-ab-3-
"Homocysteine","Homocystine"-ab-2-"homocysteine","Homocystine"-ab-1-
"Homocysteine","Homocystine"-ti-1-"homocysteine"]|TI;AB|406:12|227:12|74:12|35:12
```

`17285228` (PMID)

`MM` (Path Name)

`430.78` (Score)

`Homocystine` (UMLS Concept P

`C0019879` (UMLS Concept Uniq

`[aapp,bacs]` (List of Semantic

`["Homocystine"-ab-3-"Homocysteine","Homocystine"-ab-2-"homocysteine","Homocystine"-ab-1-"Homocysteine","Homocystine"-ti-1-"homocysteine"]` (List of Entry Term Quartets)

`TI;AB` (Location(s), boost scores for TI)

`406:12|227:12|74:12|35:12` (List of Positional Information Groups [start:length])

Entry Term Quartet

`"Homocystine"-ab-2-"homocysteine"`

`"Homocystine"` – UMLS Concept Preferred Name

`ab` – Found in Abstract

`2` – Found in section's second utterance

`"homocysteine"` – Actual text used for mapping

Filtering Using Entry Term Information

- Homocystine vs Homocysteine

```
0000000|MM|424.55|Homocystine|C0019879|[aapp,bacs]
        |["Homocystine"-ti-1-"Homocystine"]|TI|20:11
0000000|MM|424.55|homocysteine|C0019878|[aapp,bacs]
        |["homocysteine"-ti-1-"Homocystine"]|TI|20:11
```

- Borne → Bear

```
0000000|MM|734.96|Ursidae Family|C0004897|[mamm]
       |["Bear"-ti-1-"borne"]|TI|32:5
0000000|MM|112.74|Bearing Device Component|C1704689|[medd]
       |["Bearing"-ti-1-"borne"]|TI|32:5
0000000|MM|112.74|Caliber|C1301886|[qnco]
       |["Bore"-ti-1-"borne"]|TI|32:5
```

Example

Text: preventing hemorrhage pre-operatively

- No Derivational Variants (-d)

```
812 HAEMORRHAGE NOS (Hemorrhage) [Finding]
```

Needs both to find

- All Derivational Variants + Ignore Word Order (-iD)

```
783 Operative haemorrhage (Blood Loss, Surgical)
   [Pathologic Function]
```

Examples from metamap10 with 2010AA UMLS

Ambiguity Example

Text: respirable particulate matter

- No Derivational Variants (-d)

Nothing for “respirable”

Only needs -D to find

- All Derivational Variants + Ignore Word Order (-iD)

~~523 respiration (Cell Respiration) [Cell Function]~~

523 Respirator (Mechanical Ventilator) [Medical Device]

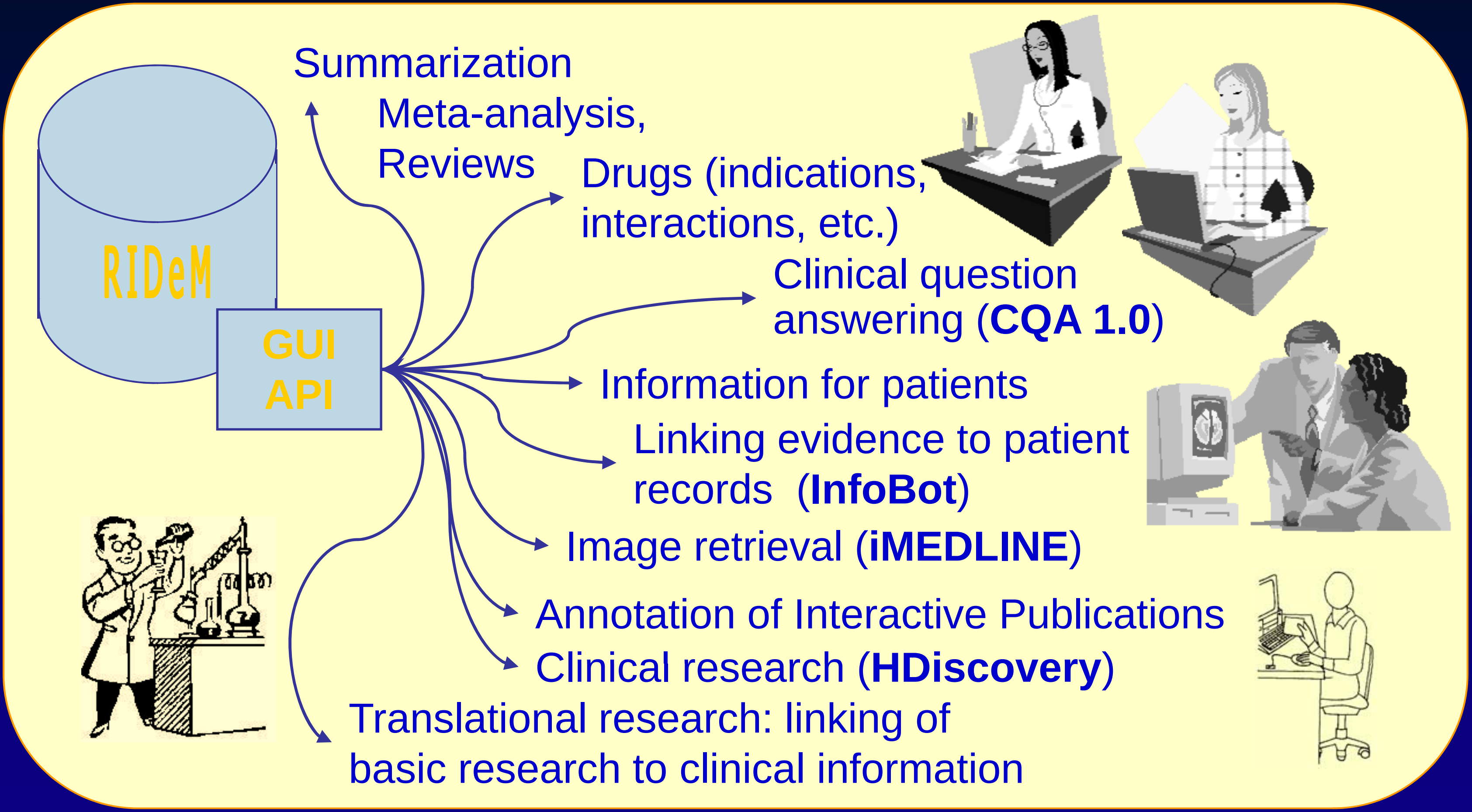
~~523 Respiration [Physiologic Function]~~

~~523 respirator (Treatment with respirator) [Therapeutic or Preventive Procedure]~~

~~523 respiration (respiratory gaseous exchange in organisms) [Biologic Function]~~

Examples from metamap10 with 2010AA UMLS

NLM Applications using MetaMap: RIDeM (Repository for Informed Decision Making)



Summarization

Meta-analysis, Reviews

Drugs (indications, interactions, etc.)

Clinical question answering (**CQA 1.0**)

Information for patients

Linking evidence to patient records (**InfoBot**)

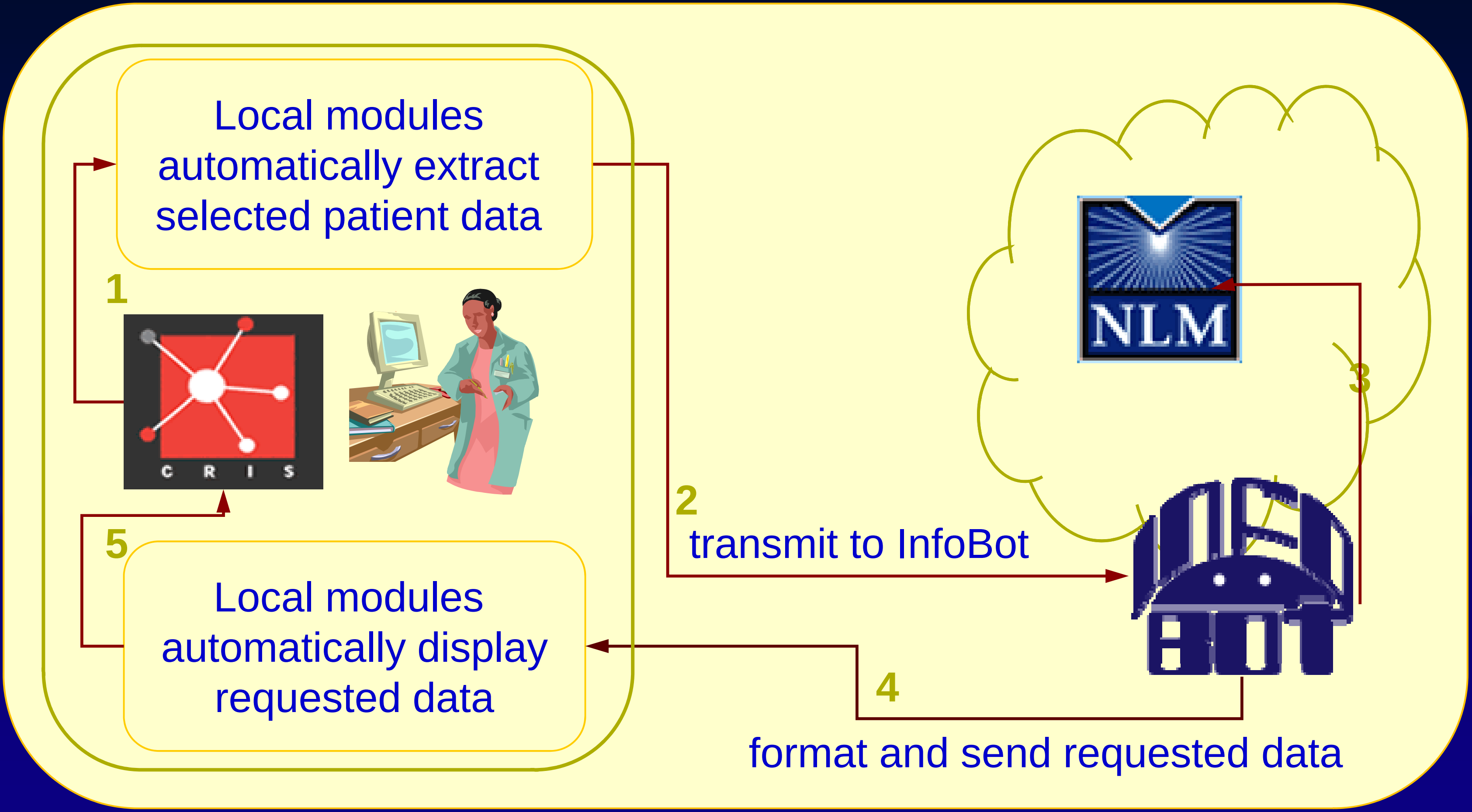
Image retrieval (**iMEDLINE**)

Annotation of Interactive Publications

Clinical research (**HDiscovery**)

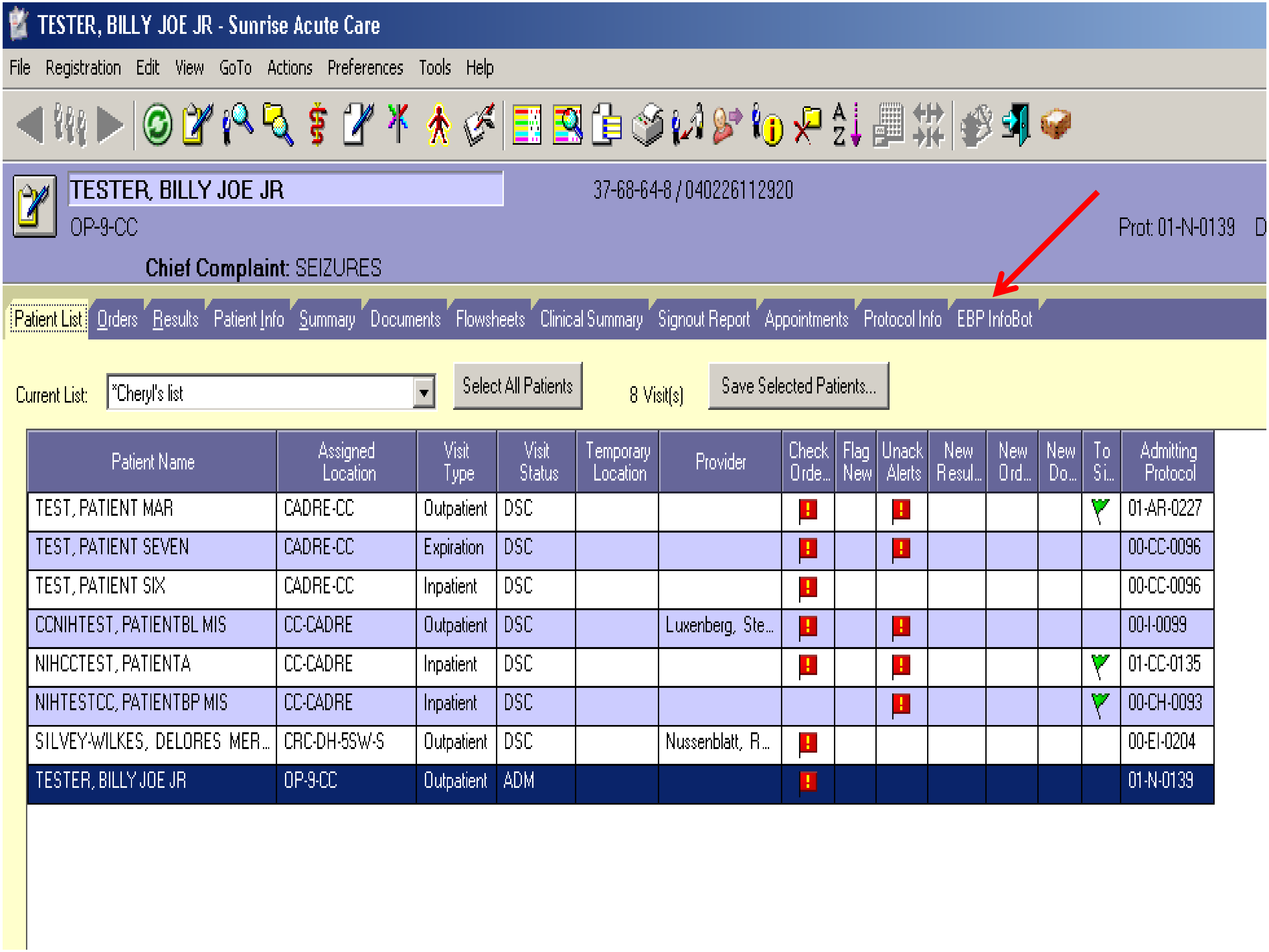
Translational research: linking of basic research to clinical information

Example data flow: InfoBot



Local modules automatically extract selected patient data

Local modules automatically display requested data



TESTER, BILLY JOE JR

37-68-64-8 / 040226112920

OP-9-CC

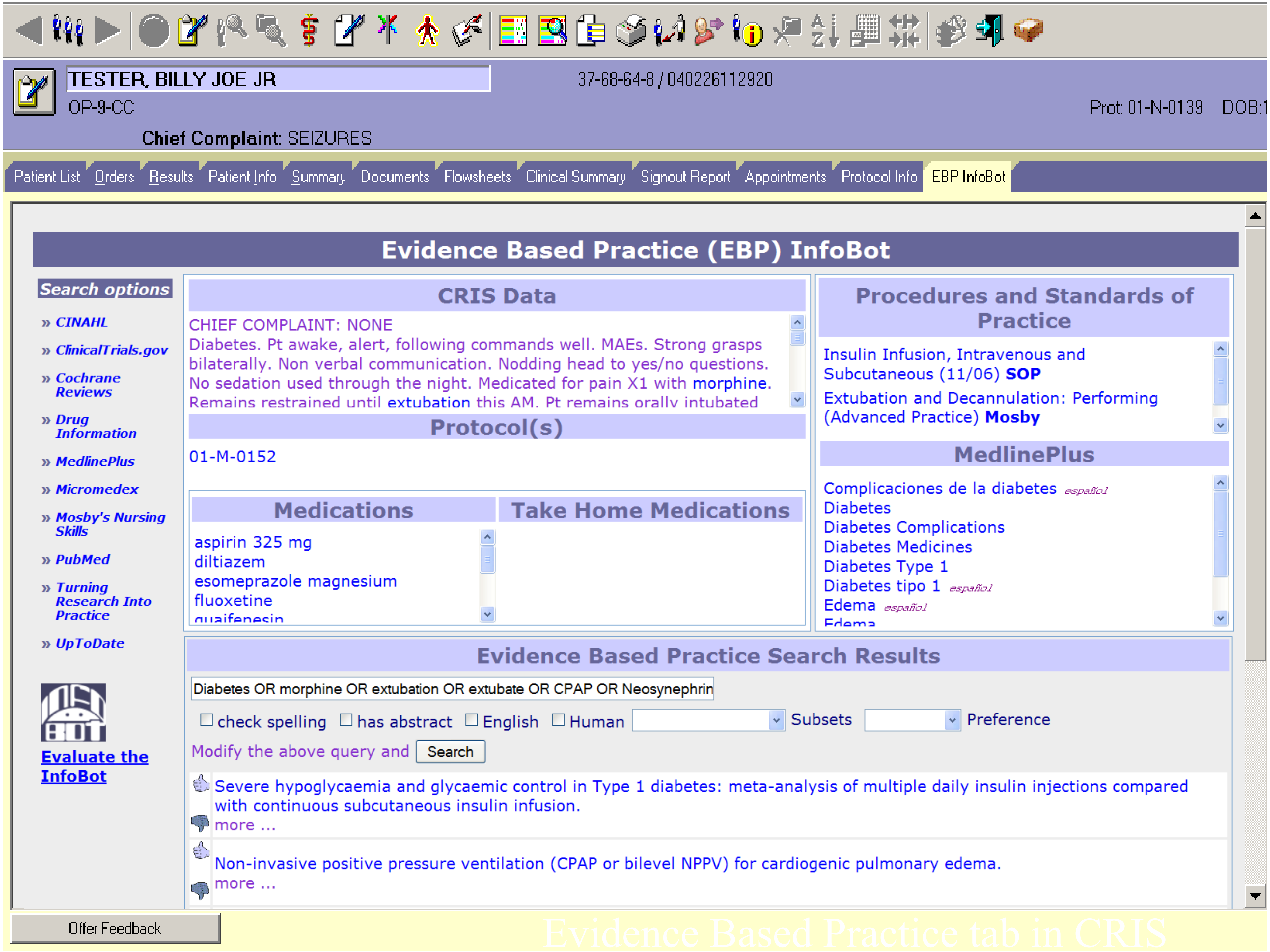
Prot: 01-N-0139 D

Chief Complaint: SEIZURES

Current List: *Cheryl's list

8 Visit(s)

Patient Name	Assigned Location	Visit Type	Visit Status	Temporary Location	Provider	Check Orde...	Flag New	Unack Alerts	New Resul...	New Ord...	New Do...	To Si...	Admitting Protocol
TEST, PATIENT MAR	CADRE-CC	Outpatient	DSC			❗		❗				⚑	01-AR-0227
TEST, PATIENT SEVEN	CADRE-CC	Expiration	DSC			❗		❗					00-CC-0096
TEST, PATIENT SIX	CADRE-CC	Inpatient	DSC			❗							00-CC-0096
CCNIHTEST, PATIENTBL MIS	CC-CADRE	Outpatient	DSC		Luxenberg, Ste...	❗		❗					00-I-0099
NIHCCTEST, PATIENTA	CC-CADRE	Inpatient	DSC			❗		❗				⚑	01-CC-0135
NIHTESTCC, PATIENTBP MIS	CC-CADRE	Inpatient	DSC					❗				⚑	00-CH-0093
SILVEY-WILKES, DELORES MER...	CRC-DH-5SW-S	Outpatient	DSC		Nussenblatt, R...	❗							00-EI-0204
TESTER, BILLY JOE JR	OP-9-CC	Outpatient	ADM			❗							01-N-0139



TESTER, BILLY JOE JR 37-68-64-8 / 040226112920

OP-9-CC Prot: 01-N-0139 DOB:1

Chief Complaint: SEIZURES

Evidence Based Practice (EBP) InfoBot

Search options

- » CINAHL
- » ClinicalTrials.gov
- » Cochrane Reviews
- » Drug Information
- » MedlinePlus
- » Micromedex
- » Mosby's Nursing Skills
- » PubMed
- » Turning Research Into Practice
- » UpToDate

Evaluate the InfoBot

CRIS Data

CHIEF COMPLAINT: NONE
Diabetes. Pt awake, alert, following commands well. MAEs. Strong grasps bilaterally. Non verbal communication. Nodding head to yes/no questions. No sedation used through the night. Medicated for pain X1 with morphine. Remains restrained until extubation this AM. Pt remains orally intubated

Protocol(s)

01-M-0152

Medications

aspirin 325 mg
diltiazem
esomeprazole magnesium
fluoxetine
guaifenesin

Take Home Medications

Procedures and Standards of Practice

Insulin Infusion, Intravenous and Subcutaneous (11/06) **SOP**

Extubation and Decannulation: Performing (Advanced Practice) **Mosby**

MedlinePlus

Complicaciones de la diabetes *español*
Diabetes
Diabetes Complications
Diabetes Medicines
Diabetes Type 1
Diabetes tipo 1 *español*
Edema *español*
Edema

Evidence Based Practice Search Results

Diabetes OR morphine OR extubation OR extubate OR CPAP OR Neosynephrin

☐ check spelling ☐ has abstract ☐ English ☐ Human Subsets Preference

Modify the above query and Search

Severe hypoglycaemia and glycaemic control in Type 1 diabetes: meta-analysis of multiple daily insulin injections compared with continuous subcutaneous insulin infusion.
more ...

Non-invasive positive pressure ventilation (CPAP or bilevel NPPV) for cardiogenic pulmonary edema.
more ...

Evidence Based Practice tab in CRIS

Text types processed for RIDeM

	Format	Encoding	Length	idiosyncrasies
MEDLINE abstracts	XML	UTF-8	~300 words	structured /not , well-formed
Clinical questions	unknown	unknown	~10	Structured /not
Clinical notes	"ASCII art"	unknown	20--600	ungrammatical
Case descriptions	unknown	unknown	~700	well-formed/not
Full-text journal articles Interactive Publications	HTML, PDF, XML…	UTF-8	~3,000	structured/not, well-formed
DailyMed drug package inserts	XML+SPL	UTF-8	~800	structured, well-formed

Text pre-processing

- Required (batch file submission and API)
  - ASCII encoding
  - Size under 2,000 - 3,000 characters
  - Format (MEDLINE, free text, single line, etc.)
- Sensible
  - Isolate sections/passages for entity extraction
    - Indication section of a drug label, image description in the article
  - Remove mark-up tags
  - Expand colloquial abbreviations
    - In the NIH CC notes MAN=Multiple Endocrine Neoplasia
- Optional
  - Split HTML lists into items
  - Use a third party parser to extract phrases

MetaMap settings

- Access mode
  - Batch file submission
    - DailyMed package inserts processing
    - Full-text processing for image text indexing
  - API
    - Note and question processing (back-off to local table look-up)
- Options
  - Default for experiments
  - Subset semantic types to disorders, interventions, anatomy
- Output format
  - Machine (trade-off between ease of processing and volume)

MetaMap output processing

- Extract into RIDeM concept container:
  - Lexical match
  - Concept unique identifier
  - Concept preferred name
  - Semantic types list
  - Negation status
  - Phrase type
  - POS list
  - First character offset
  - Length

Target entity extraction: InfoBot clinical notes

- UMLS-based recognition of the elements of a well-formed clinical question (Patient/Problem-Intervention)
- Example text

1st Research Participatio Problem: Hodgkin's Disease Lymphoma, Post MRD HSCT; t will verbalize understanding of role in research ion/protocol and about the disease process.

Interventions: Obtain/Monitor Labs per protocol. Review results of tests such as CT scan/PET/DEXA scans. Have LIP or MD discuss protocol with pt and keep patient up-to-date on progress. Pt to keep appointments with follow-up clinics and tests. Provide with reference materials, internet access, information about medications and education materials. Pt to follow plan of ca LIP and ask questions to address concerns.

HLA-matched related donor

Allogeneic Hematopoietic Stem Cell Transplantation

Dual Energy X-ray Absorptiometry

Licensed independent practitioner

Default MetaMap output analysis

1st Research Participation Problem: Hodgkin's Disease; Lymphoma, Post MRD HSCT;

Goal/s: Pt will verbalize understanding of role in research participation/protocol and about the disease process.

Planned Interventions: Obtain/Monitor Labs per protocol. Review results of tests such as CT scan/PET/DEXA scans. Have LIP or MD discuss protocol with pt and keep patient up-to-date on progress. Pt to keep appointments with follow-up clinics and tests. Provide pt with reference materials, internet access, information about medications and education materials. Pt to follow plan of care by LIP and ask questions to address concerns.

correct sense; correct sense, but high level; wrong sense (FP and FN); ignored

Entity extraction

- Discard lexical matches under four characters (unless MetaMap identified an author-defined abbreviation – scientific publications, or the abbreviation is on the clinical institution local list)
- Mark high-level terms (using a local look-up list)
- Discard stop-words (using a local look-up list)
- Apply document-specific extraction methods
  - MEDLINE abstracts – position in the document, frequency, co-occurrence, classifiers

Entity extraction: Case description

72 yo male admitted from *Location* Hosp s-p seizure activity. Pt has pmh of hodgkins dx, s-p chemo, and HTN. Pt had gone to hospital on *Date* for confusion and unsteady gait, head CT was negative and pt sent home on ASA. Returned on *Date* with focal seizure and then grand mal and was admitted to *Location* Hospital ICU. Started on Ativan gtt. MRI done showing diffuse lesions consistent with encephalitis. Head CT with ? of embolic stroke. Pt continued with seizures and transferred to *Location* for further workup.

✓ correct

? nothing extracted

✗ wrong

Problem		
✓	?	✗
93%	0%	7%

Population		
✓	?	✗
97%	0%	3%

Intervention		
✓	?	✗
84%	0%	16%

Entity extraction: MEDLINE abstracts

Allogeneic hematopoietic stem-cell transplantation in patients with hematologic malignancies after dose-escalated treosulfan/fludarabine conditioning.

PURPOSE: Treosulfan was introduced recently as a conditioning agent for allogeneic blood stem-cell transplantation. The favorable nonhematologic toxicity profile at 3 x 10 g/m(2) was the basis for dose escalation in this prospective, multicenter trial.

PATIENTS AND METHODS: **Fifty-six patients with various** **hematologic malignancies** who were not eligible for standard conditioning were treated with one of three doses: 10 g/m(2), 12 g/m(2), or 14 g/m(2) of intravenous **treosulfan**, which was administered on days -6 to -4 combined with **fludarabine** 30 mg/m(2) on days -6 to -2. Patients in complete remission (CR; 42%) or non-CR (58%) received grafts from matched related (47%) or matched unrelated (51%) donors; one patient had a mismatched related donor (2%).

RESULTS: No engraftment failure occurred. **Overall, extramedullary toxicity and the nonrelapse mortality rate at 2 years (20%) were low and did not increase with dose.** Cumulative incidence of relapse/progression reached 31%. The overall survival and progression-free survival rates were 64% and 49%, respectively, in the total study population. An inverse dose dependency of relapse incidence was indicated in the subgroup receiving transplantations from matched related donors (P = .0568).

CONCLUSION: **Treosulfan-based conditioning was feasible at all three doses. The 3 x 14 g/m(2) dose was selected for additional studies, because it combines desired characteristics of low toxicity and a low relapse rate**.

✓ correct

? nothing extracted

✗ wrong

Problem			Population			Intervention			Outcome		
✓	?	✗	✓	?	✗	✓	?	✗	✓	?	✗
90%	5%	5%	**80%**	13%	7%	**80%**	0%	20%	**95%**	0%	5%

MetaMap UMLS clinical content views

- Experiments
  - 2008 Extract PICO frames from MEDLINE abstracts
  - 2009 Extract PICO elements from clinical notes
- Data
  - 2008 LNCV document collection
  - 2009 LNCV clinical text collection
- Conclusions
  - Different tasks need different MetaMap views
    - Filters
    - Semantic type subsets

Tutorial Outline

- Background: why concept identification? (Lan)
- Introduction to MetaMap (Lan)
- The MetaMap algorithm (Lan)
- Input/output formats (François, Jim)
- MetaMap options in depth (Lan)
- MetaMap processing modes (Lan)
- Usage warnings (Lan)
- Access methods (Jim)
- Research projects using MetaMap (Jim, Dina)

➢ **Future directions (Lan)**

Ongoing MetaMap Development (1/2)

- Technical algorithm enhancements resulting in at least 3x speedup in MetaMap execution
  - MetaMap is now up to 10 times faster than MMTx
- Environment development
  - Migration from Sun/Solaris to Linux environment
  - Update to current Berkeley DB to coordinate with migration from Quintus to SICStus Prolog
  - Release of MetaMap for OS X and soon for Windows
- MetaMap 3D (colorized MetaMap output)
- Detection of user-defined acronyms

Ongoing MetaMap Development (2/2)

- Higher-order tokenization
  - Detection of author-defined acronyms/abbreviations
  - To be augmented with recognition of chemical names, bibliographic references, numeric quantities, etc.
- Negation detection (--negex)
- Word sense disambiguation (WSD, -y)
  - Currently based on Journal Descriptor Indexing (JDI)
  - To be augmented and combined with other, Machine Learning approaches (Antonio Jimeno-Yepes)

Future MetaMap Development (1/2)

- Release MetaMap for Windows
- Further develop API services
- Enhance MetaMap’s accuracy with additional WSD algorithms
- Augment tokenization with recognition of chemical names, bibliographic references, numeric quantities, etc.
- Complete composite phrase processing (e.g., *pain on the left side of the chest*)

Future MetaMap Development (2/2)

- Enhance of processing short words, including acronyms/abbreviations
- Handle space/hyphen/null alternation (e.g., *breast feed/breast-feed/breastfeed*)
- Tune MetaMap's evaluation metric to improve accuracy
- Technical enhancements in graceful back-off for long phrases
- Incorporate user-suggested improvements

Web Pointers*

- 2010 AMIA MetaMap Tutorial (T29: UMLS Concept Identification using the MetaMap System) slides available at: http://skr.nlm.nih.gov/papers/
- Semantic Knowledge Representation Project: http://skr.nlm.nih.gov/ (interactive/batch MetaMap, MTI, SemRep, …)

Start here

- MetaMap Portal: http://metamap.nlm.nih.gov/ (downloadable binary version of Prolog/C implementation, API, …)
- NLM Indexing Initiative: http://ii.nlm.nih.gov/ (general II or MTI information)

* All MetaMap access requires a UMLS license:

http://www.nlm.nih.gov/research/umls/license.html

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Comments or Questions?