

REPOSITORIES WITH MEDICAL RESOURCES, THEIR INDEXING AND RETRIEVAL



Szymon Wilk

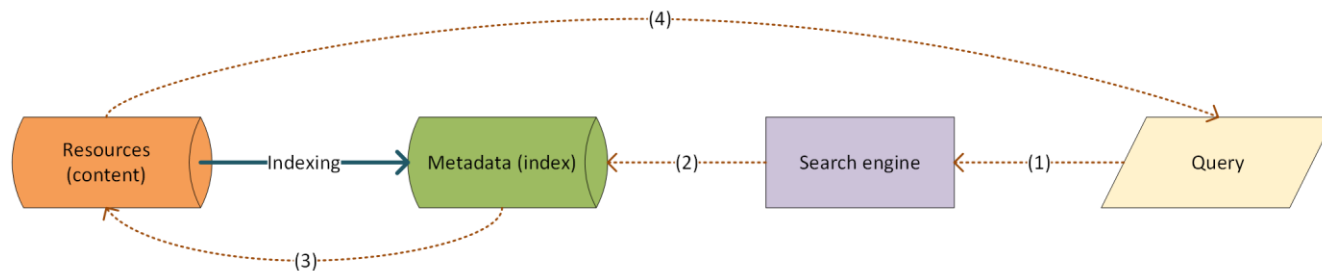
Institute of Computing Science
Poznan University of Technology
Poznan, Poland

INTRODUCTION

Types of information

- **Patient-specific** information – applies to specific patients, associated with healthcare provision and stored in EPR/HIS
- ➔ • **Knowledge-based** information – information (knowledge) derived from research, published in books, journals ...

Information retrieval (IR) is the field concerned with **acquisition, organization** and **searching** of knowledge-based information [Hersh, 2009]



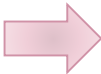
Some history...

- 1878 – Index Medicus
 - Index of medical articles
 - Metadata: title, authors, keywords (*subject headings*)
- 1966 – MEDLARS (Medical Literature Analysis and Retrieval System), NLM
 - Computer-based version of Index Medicus
 - Metadata: similar to paper version (disk space limitations)
 - Medical Subject Headings (MeSH) used as keywords for indexing
 - Running queries sent by regular mail
- 1990s – bibliographic databases managed by NLM made available on the Web (→ MEDLINE/PubMed)

KNOWLEDGE-BASED INFORMATION AND EBM

Information needs

Possible states of information needs in clinical context

1. **Unrecognized** – clinician unaware of information need
-  2. **Recognized** – clinician aware of need but may or may not pursue it
3. **Pursued** – information seeking occurs but may or may not be successful
4. **Satisfied** – „found necessary information“

Unrecognized information needs result in non-adherence to up-to-date clinical practice and sub-optimal quality of care!

Information needs in practice

- On average 3 questions per 4 patients (primary care)
 - What drug to prescribe? What causes observed symptom? ...
- Answer seeking in 12-36% cases
 - No explicit formulation of a question
 - Discarding the search (→ too time-consuming, acceptable searching time = 2 min or less)
- Integration of IR mechanisms with EPR/HIS systems for automatic provision of links to knowledge-based resources

Timpka T, Arborelius E. The GP's dilemmas: a study of knowledge need and use during health care consultations. *Methods Inf Med.* 1990; 29(1):23-9.

Ely JW, Osheroff JA, Ebell MH, et al. Analysis of questions asked by family doctors regarding patient care. *BMJ* 1999;319:358-361.

Hersh WR, Crabtree MK, Hickam DH, et al. Factors associated with success in searching MEDLINE and applying evidence to answer clinical questions. *J Am Med Inform Assoc* 2002;9(3):283-93.

Evidence-based Medicine (EBM)

Integration of **experience** (art) with **best clinical results** (knowledge-based information)
for **informed clinical decision making**

- 3-step process
 1. Phrasing a clinical question that is relevant and answerable
 2. Identifying evidence (studies in articles) that address the question
 3. Critically appraising the evidence – does it apply to the patient?
- Categories of considered questions
 1. Therapy or intervention – benefits?
 2. Diagnosis – diagnosing test?
 3. Harm – detrimental health effect?
 4. Prognosis – outcome of disease course?

Most valuable evidence comes from RCTs, but they are not always possible (e.g., harm and ethical issues)

REPOSITORIES OF KNOWLEDGE- BASED INFORMATION

Types of repositories

1. Bibliographic content

- Citations or pointers to medical literature, no content
- Examples: MEDLINE/PubMed (NLM), EMBASE (“European MEDLINE”), National Guidelines Clearinghouse (NGC) with clinical guidelines

2. Full-text content

- Full publication content, often linked from a bibliographic repository (e.g., PubMed → publisher website)
- Usually maintained by commercial publishers, PubMed Central for publications prepared within NIH grants

Types of repositories

3. Annotated content

- Resources stored in specialized databases depending on the format (image, genomics, citation, EBM...)
- Examples: Visible Human Project, PEIR, The Cochrane Library (Database of Systematic Reviews)

4. Aggregated content

- Aggregation of content from the first three categories (copies or links to original repositories)
- Examples: MedlinePlus, Merck Manual

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New articles from highly accessed journals

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[Cochrane Database Syst Rev \(3\)](#)
[J Biol Chem \(16\)](#)
[J Clin Oncol \(2\)](#)
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[J Clin Oncol. 2018.](#)
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[J Biomed Inform. 2013 Apr;46\(2\):341-53. doi: 10.1016/j.jbi.2013.01.002. Epub 2013 Jan 30.](#)
Mitigation of adverse interactions in pairs of clinical practice guidelines using constraint logic programming.
[Wikik S¹](#), [Michalowski W](#), [Michalowski M](#), [Farion K](#), [Hing MM](#), [Mohapatra S](#).

Author information

Abstract
We propose a new method to mitigate (identify and address) adverse interactions (drug-drug or drug-disease) that occur when a patient with comorbid diseases is managed according to two concurrently applied clinical practice guidelines (CPGs). A lack of methods to facilitate the concurrent application of CPGs severely limits their use in clinical practice and the development of such methods is one of the grand challenges for clinical decision support. The proposed method responds to this challenge. We introduce and formally define logical models of CPGs and other related concepts, and develop the mitigation algorithm that operates on these concepts. In the algorithm we combine domain knowledge encoded as interaction and revision operators using the constraint logic programming (CLP) paradigm. The operators characterize adverse interactions and describe revisions to logical models required to address these interactions, while CLP allows us to efficiently solve the logical models - a solution represents a feasible therapy that may be safely applied to a patient. The mitigation algorithm accepts two CPGs and available (likely incomplete) patient information. It reports whether mitigation has been successful or not, and on success it gives a feasible therapy and points at identified interactions (if any) together with the revisions that address them. Thus, we consider the mitigation algorithm as an alerting tool to support a physician in the concurrent application of CPGs that can be implemented as a component of a clinical decision support system. We illustrate our method in the context of two clinical scenarios involving a patient with duodenal ulcer who experiences an episode of transient ischemic attack.
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PMID: 23376273 DOI: [10.1016/j.jbi.2013.01.002](#)
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Publication Types, MeSH Terms

Publication Types
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PubMed Clinical Queries

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acute abdominal pain in children

Clinical Study Categories

Category:

Scope:

Results: 5 of 796

Two cases of Kawasaki disease presented with acute febrile jaundice.

Kaman A, Aydin-Teke T, Gayretli-Aydin ZG, Öz FN, Metin-Akcan Ö, Eriş D, Tanir G.
Turk J Pediatr. 2017; 59(1):84-86.

Randomized, Double-Blind, Placebo-Controlled Acute Comparator Trials of Lisdexamfetamine and Extended-Release Methylphenidate in Adolescents With Attention-Deficit/Hyperactivity Disorder.

Newcorn JH, Nagy P, Childress AC, Frick G, Yan B, Pliszka S.
CNS Drugs. 2017 Nov; 31(11):999-1014.

Diagnostic Accuracy of MRI Versus CT for the Evaluation of Acute Appendicitis in Children and Young Adults.

Kinner S, Pickhardt PJ, Riedesel EL, Gill KG, Robbins JB, Kitchin DR, Ziemlewicz TJ, Harringa JB, Reeder SB, Repplinger MD.
AJR Am J Roentgenol. 2017 Oct; 209(4):911-919. Epub 2017 Aug 10.

Asparaginase-associated pancreatitis in childhood acute lymphoblastic leukaemia: an observational Ponte di Legno Toxicity Working Group study.

Wolthers BO, Frandsen TL, Baruchel A, Attarbaschi A, Barzilai S, Colombini A, Escherich G, Grell K, Inaba H, Kovacs G, et al.
Lancet Oncol. 2017 Sep; 18(9):1238-1248. Epub 2017 Jul 20.

Observational study on the palatability and tolerability of oral prednisolone and oral dexamethasone in children in Saudi Arabia and the UK.

Aljebab F, Alanazi M, Choonara I, Conroy S.
Arch Dis Child. 2018 Jan; 103(1):83-88. Epub 2017 Jul 22.

[See all \(796\)](#)

This column displays citations filtered to a specific clinical study category and scope. These search filters were developed by [Haynes RB et al.](#) See more [filter information](#).

Systematic Reviews

Results: 5 of 57

Herbal Medicines for Gastrointestinal Disorders in Children and Adolescents: A Systematic Review.

Anheyer D, Frawley J, Koch AK, Lauche R, Langhorst J, Dobos G, Cramer H.
Pediatrics. 2017 Jun; 139(6). Epub 2017 May 4.

Epidemiology of Cryptosporidium in Pediatric Diarrheal Illnesses.

Dabas A, Shah D, Bhatnagar S, Lodha R.
Indian Pediatr. 2017 Apr 15; 54(4):299-309.

Diagnostic Accuracy of History, Physical Examination, Laboratory Tests, and Point-of-care Ultrasound for Pediatric Acute Appendicitis in the Emergency Department: A Systematic Review and Meta-analysis.

Benabbas R, Hanna M, Shah J, Sinert R.
Acad Emerg Med. 2017 May; 24(5):523-551.

Nonpharmacologic Treatment of Pain.

Agoston AM, Sieberg CB.
Semin Pediatr Neurol. 2016 Aug; 23(3):220-223. Epub 2016 Oct 20.

High Variability in the Reported Management of Hepatic Veno-Occlusive Disease in Children after Hematopoietic Stem Cell Transplantation.

Skeens MA, McArthur J, Cheifetz IM, Duncan C, Randolph AG, Stanek J, Lehman L, Bajwa R. HSCT subgroup of the Pediatric Acute Lung Injury & Sepsis Investigators (PALISI).
Biol Blood Marrow Transplant. 2016 Oct; 22(10):1823-1828. Epub 2016 Aug 2.

[See all \(57\)](#)

This column displays citations for systematic reviews, meta-analyses, reviews of clinical trials, evidence-based medicine, consensus development conferences, and guidelines. See [filter information](#) or additional [related sources](#).

Medical Genetics

Results: 5 of 136

Fulminant Type 1 Diabetes in Children: A Multicenter Study in China.

Gu Y, Wang Y, Li P, Wei H, Chen L, Liu Q, Liu Y, Yang Q, Cheng X, He L, et al.
J Diabetes Res. 2017; 2017:6924637. Epub 2017 Sep 26.

Initial Pain Management in Pediatric Acute Pancreatitis: Opioid vs. Non-Opioid.

Grover AS, Mitchell PD, Manzi SF, Fox VL.
J Pediatr Gastroenterol Nutr. 2017 Oct 27; . Epub 2017 Oct 27.

A Rare Cause of Recurrent Acute Pancreatitis in a Child: Isovaleric Acidemia with Novel Mutation.

Sag E, Cebi AH, Kaya G, Karaguzel G, Cakir M.
Pediatr Gastroenterol Hepatol Nutr. 2017 Mar; 20(1):61-64. Epub 2017 Mar 27.

What's unique about acute pancreatitis in children: risk factors, diagnosis and management.

Husain SZ, Srinath AI.
Nat Rev Gastroenterol Hepatol. 2017 Jun; 14(6):366-372. Epub 2017 Mar 15.

Development of a quantitative real-time PCR assay for sapovirus in children under 5-years-old in Regina Margherita Hospital of Turin, Italy.

Bergallo M, Galliano I, Montanari P, Brusin MR, Finotti S, Paderi G, Gablano C.
Can J Microbiol. 2017 Apr; 63(4):296-302. Epub 2016 Dec 2.

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This column displays citations pertaining to topics in medical genetics. See more [filter information](#).

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By Organization

The following concepts classify the clinical specialties that might use the guideline professionally. For more information on each topic, view the [Glossary](#):

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Anesthesiology (56)	Neurology (228)	Preventive Medicine (267)
Cardiology (158)	Nuclear Medicine (93)	Psychiatry (107)
Chiropractic (21)	Nursing (243)	Psychology (111)
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Family Practice (907)	Otolaryngology (48)	Sports Medicine (30)
Gastroenterology (148)	Pathology (89)	Surgery (263)
Geriatrics (191)	Pediatrics (367)	Thoracic Surgery (75)
Hematology (110)	Pharmacology (80)	Urology (95)
Infectious Diseases (150)	Physical Medicine and Rehabilitation (112)	
Internal Medicine (892)		
Medical Genetics (68)		

Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults.

Developer

Source

Status

Classification

National Clinical Guideline Centre. Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults. London (UK): National Institute for Health and Care Excellence (NICE); 2014 Jan. 63 p. (Clinical guideline; no. 176).

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Regulatory Alert

Recommendations

Major Recommendations

Pre-hospital Assessment, Advice and Referral to Hospital

Public health literature and other non-medical sources of advice (for example, St John Ambulance, police officers) should encourage people who have any concerns following a head injury to themselves or to another person, regardless of the injury severity, to seek immediate medical advice. [2003]

Telephone Advice Services

Telephone advice services (for example, National Health Service [NHS] 111, emergency department helplines) should refer patients who have sustained a head injury to the emergency ambulance services (that is, 999) for emergency transport to the emergency department if they have experienced any of the following:

- Unconsciousness or lack of full consciousness (for example, problems keeping eyes open)
- Any focal neurological deficit since the injury
- Any suspicion of a skull fracture or penetrating head injury
- Any seizure ('convulsion' or 'fit') since the injury
- A high-energy head injury
- The injured person or their carer is incapable of transporting the injured person safely to the hospital emergency department without the use of ambulance services (providing any other risk

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INFORMATICS PROFESSIONALS. LEADING THE WAY.

AMIA Annu Symp Proc. 2015; 2015: 895-904.
Published online 2015 Nov 5.

PMCID: PMC4765594

Expanding a First-Order Logic Mitigation Framework to Handle Multimorbid Patient Preferences

[Martin Michalowski](#), Ph.D.,¹ [Szymon Wilk](#), Ph.D.,² [Daniela Rosu](#), Ph.D.,³ [Mounira Kezadri](#), Ph.D.,³ [Wojtek Michalowski](#), Ph.D.,³ and [Marc Carrier](#), MD⁴

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Abstract

Go to: ☺

The increasing prevalence of multimorbidity is a challenge for physicians who have to manage a constantly growing number of patients with simultaneous diseases. Adding to this challenge is the need to incorporate patient preferences as key components of the care process, thanks in part to the emergence of personalized and participatory medicine. In our previous work we proposed a framework employing first order logic to represent clinical practice guidelines (CPGs) and to mitigate possible adverse interactions when concurrently applying multiple CPGs to a multimorbid patient. In this paper, we describe extensions to our methodological framework that (1) broaden our definition of revision operators to support required and desired types of revisions defined in secondary knowledge sources, and (2) expand the mitigation algorithm to apply revisions based on their type. We illustrate the capabilities of the expanded framework using a clinical case study of a multimorbid patient with stable cardiac artery disease who suffers a sudden onset of deep vein thrombosis.

Introduction

Go to: ☺

Mitigating clinical practice guidelines (CPGs) for a multimorbid patient is identified as a crucial step in the adoption of CPGs at the point of care^{1,2}. The key problem lies in identifying and mitigating adverse interactions between guidelines given a specific multimorbid patient encounter. In addition to the CPGs, secondary knowledge applicable to both the multimorbidities and the patient state, and patient preferences must be used to propose a consistent therapy for the particular patient encounter. In previous work we proposed a logic-based approach to the mitigation problem that uses first-order logic (FOL) as the formalism for representing CPGs, patient information, and secondary medical knowledge in the form of revision operators^{3,4}. With the emergence of personalized and participatory medicine⁵, patient preferences have become important components of the care process^{6,7}.

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Visible Human Project

Home

The Visible Human Project®

Overview

The Visible Human Project® is an outgrowth of the NLM's 1986 Long-Range Plan. It is the creation of complete, anatomically detailed, three-dimensional representations of the normal male and female human bodies. Acquisition of transverse CT, MR and cryosection images of representative male and female cadavers has been completed. The male was sectioned at one millimeter intervals, the female at one-third of a millimeter intervals.

The long-term goal of the Visible Human Project® is to produce a system of knowledge structures that will transparently link visual knowledge forms to symbolic knowledge formats such as the names of body parts.

The National Library of Medicine thanks the men and the women who will their body to science, thereby enabling medical research and development.

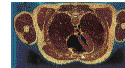
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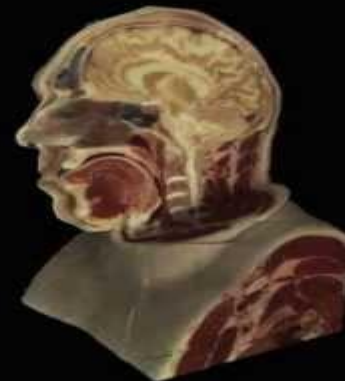
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• NLM Initiatives

- Cryosection, MRI and CT image data of the head of a 72 year old male. Cryosections of the head were photographed at a resolution of 1056 x 1528 pixels. Work done at Brigham and Women's Hospital under contract to NLM. Available only to VHP license holders. These images can be found in the NLM image server.



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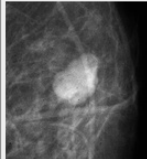

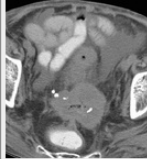
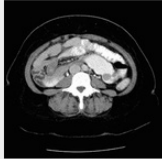
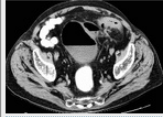
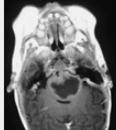
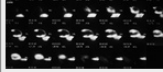
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 <p>Gastrointestinal 821 obrazów</p>	 <p>Genitourinary 334 obrazów</p>
 <p>Head 103 obrazów</p>	 <p>Heart 13 obrazów</p>

<http://peir.path.uab.edu/library/>

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Record Information	Issue: Current All	Restrict to: Reviews Protocols	Sort by: Record Title Match % Date
<input type="checkbox"/> Damage control surgery for abdominal trauma Roberto Cirocchi, Iosief Abraha, Alessandro Montedori, Eriberto Farinella, Isabella Bonacini, Ludovica Tagliabue, Francesco Sciannameo January 2010 Review			
<input type="checkbox"/> Audit filters for improving processes of care and clinical outcomes in trauma systems Christopher Evans, Daniel Howes, William Pickett, Luigi Dagnone October 2009 Review			
<input type="checkbox"/> Spinal immobilisation for trauma patients			

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Systematic review

PLAIN LANGUAGE SUMMARY

Family therapy for asthma in children

Psychological factors may have an effect on asthma in children, or its severity. As some children with families who are having problems have severe asthma, family therapy has been tried. The aim is to resolve any problems there might be in a family, in case they are causing the child stress and then making asthma worse. The review found some evidence from two trials that family therapy (in addition to standard asthma treatments) might help reduce a child's asthma symptoms, but more research is needed to be certain.

BACKGROUND

The incidence of childhood asthma has increased annually at a rapid rate over the last 20 years. A variety of factors have been implicated in the pathogenesis of bronchial asthma including allergies, infections, endocrinological disorders, genetic predisposition and, more recently, psychological elements. Although psychological factors are widely acknowledged to play a part both in precipitating episodes of asthma, and in the control of symptoms, pharmacological treatment alone continues to be the main treatment, and therefore the focus of most research. Recently, however, traditional medical models upholding a split between the "psyche" and the "soma" are being replaced by those which recognise the powerful influences of the mind on the body. Similarly, the need for integrated treatment models which consider behavioural or psychological interventions in addition to pharmacotherapy are well documented (Cluss 1986; Lehrer 1992; Onnis 1984; Molinari 1994; Towns 1994).

Studies which do acknowledge psychosocial aspects to the disease range from cognitive behavioural approaches, to education programmes, relaxation techniques, autogenic therapy, and rational emotive behaviour modification as an adjunct to medication. However, such studies, although recognising that asthma has strong associations with emotional disturbances, have been conducted mainly with adults.

Of the few studies which examine psychological influences in childhood asthma, psychosocial and emotional factors are regarded as important in the most severely ill of asthmatic children (Gustafsson 1986; Lask 1979). A child's chronic illness can place psychological burdens on both child and family (Newacheck 1991; Pless 1991; Steinhauer 1974). In addition, Weil (Weil 1999) concluded that two psychological variables, child and carer mental health, were important predictors of subsequent asthma morbidity. The earliest research conducted in the 1970s indicated the presence of disturbed family relations in the families of children with severe asthma (Liebman 1974; Liebman 1976). This prompted a limited number of trials to be conducted in the area of family therapy.

The theoretical basis which underpins the systemic view of family therapy presupposes that "symptoms" can be the product of a dysfunctional family system. Therapeutic intervention is used to alert

the family system to its dysfunctional behaviours and to empower it to adaptively overcome the difficulties which give rise to the symptoms. The body of research undertaken so far has been based on a structural family therapy perspective which assumes that relationships between family members adhere to certain patterns, which are often maladaptive to the current life situation. Systemic theories regard phenomena in terms of circularity, rather than in the linear terms of cause and effect inherent to the medical model of illness. Therefore asthma is assumed to be both a symptom of the family dysfunction, and a contributor to it (Lask 1979). Family therapy has been used to decrease the symptoms and impact of asthma.

OBJECTIVES

The objective of this review is to test whether family therapy as an adjunct to traditional medication can be shown to have a significant effect in reducing the symptoms and impact of asthma in children.

METHODS

Criteria for considering studies for this review

Types of studies

Clinical trials included were randomised and controlled. Authors have been contacted to ascertain randomisation techniques. Trials included in this review compared family therapy + pharmacological intervention vs pharmacological intervention alone.

Types of participants

Chronically asthmatic children receiving medication who were treated at hospital outpatient departments or clinics, and their families.

Types of interventions

Any family therapy based on systemic theories which focus on the whole family and which aim to arrive at an understanding of

DATA AND ANALYSES

Comparison 1. FAMILY THERAPY & DRUG THERAPY vs DRUG THERAPY ALONE

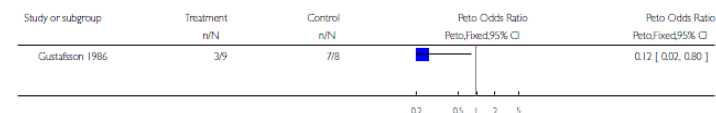
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 General paediatric assessment - no improvement			Peto Odds Ratio (Peto, Fixed, 95% CI)	Totals not selected
2 General paediatric assessment - deterioration			Peto Odds Ratio (Peto, Fixed, 95% CI)	Totals not selected
3 Functionally impaired days - no improvement			Peto Odds Ratio (Peto, Fixed, 95% CI)	Totals not selected
4 Functionally impaired days - deterioration			Peto Odds Ratio (Peto, Fixed, 95% CI)	Totals not selected
5 Nights B2 inhalers used - no improvement			Peto Odds Ratio (Peto, Fixed, 95% CI)	Totals not selected
6 Nights B2 inhalers used - deterioration			Peto Odds Ratio (Peto, Fixed, 95% CI)	Totals not selected
7 Peak expiratory flow rate - no improvement			Peto Odds Ratio (Peto, Fixed, 95% CI)	Totals not selected
8 Peak expiratory flow rate - deterioration			Peto Odds Ratio (Peto, Fixed, 95% CI)	Totals not selected
9 Peak expiratory flow rate - pre-medication, morning			Mean Difference (IV, Fixed, 95% CI)	Totals not selected
10 Peak expiratory flow rate - pre-medication, evening			Mean Difference (IV, Fixed, 95% CI)	Totals not selected
11 Forced expiratory volume - (in 0.75 seconds)			Mean Difference (IV, Fixed, 95% CI)	Totals not selected
12 Thoracic gas volume			Mean Difference (IV, Fixed, 95% CI)	Totals not selected
13 Day wheeze			Mean Difference (IV, Fixed, 95% CI)	Totals not selected
14 Activity			Mean Difference (IV, Fixed, 95% CI)	Totals not selected

Analysis 1.1. Comparison 1 FAMILY THERAPY & DRUG THERAPY vs DRUG THERAPY ALONE, Outcome 1 General paediatric assessment - no improvement.

Review: Family therapy for asthma in children


Comparison: 1 FAMILY THERAPY & DRUG THERAPY vs DRUG THERAPY ALONE

Outcome: 1 General paediatric assessment - no improvement



Family therapy for asthma in children (Review)
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Drugs & Supplements
Learn about prescription drugs, over-the-counter medicines, herbs, and supplements

Videos & Tools
Discover tutorials, health and surgery videos, games, and quizzes

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Medical Encyclopedia
Articles and images for diseases, symptoms, tests, treatments

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ClinicalTrials.gov
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EHR/PHR → **Problem, medication, or lab code-based request** → **MedlinePlus Connect**
MedlinePlus Connect → **Consumer health information targeted response** → **EHR/PHR**

Patient portal **Clinical system**

1. A patient portal, patient health record (PHR) system, or electronic health record (EHR) system sends a problem, medication, or lab code-based request to MedlinePlus Connect.
2. MedlinePlus Connect responds with targeted information.

Accepted codes:

- diagnoses – ICD-9/10-CM, SNOMED-CT
- drugs – RxNorm
- examinations – LOINC

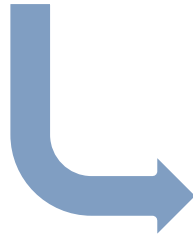
Also plain text queries (in English)
Results returned in JSON

<https://medlineplus.gov/>

MedLinePlus

ICD-9-CM code = 250.33

https://apps2.nlm.nih.gov/medlineplus/services/mpconnect_service.cfm?mainSearchCriteria.v.cs=2.16.840.1.113883.6.103&mainSearchCriteria.v.c=250.33&knowledge



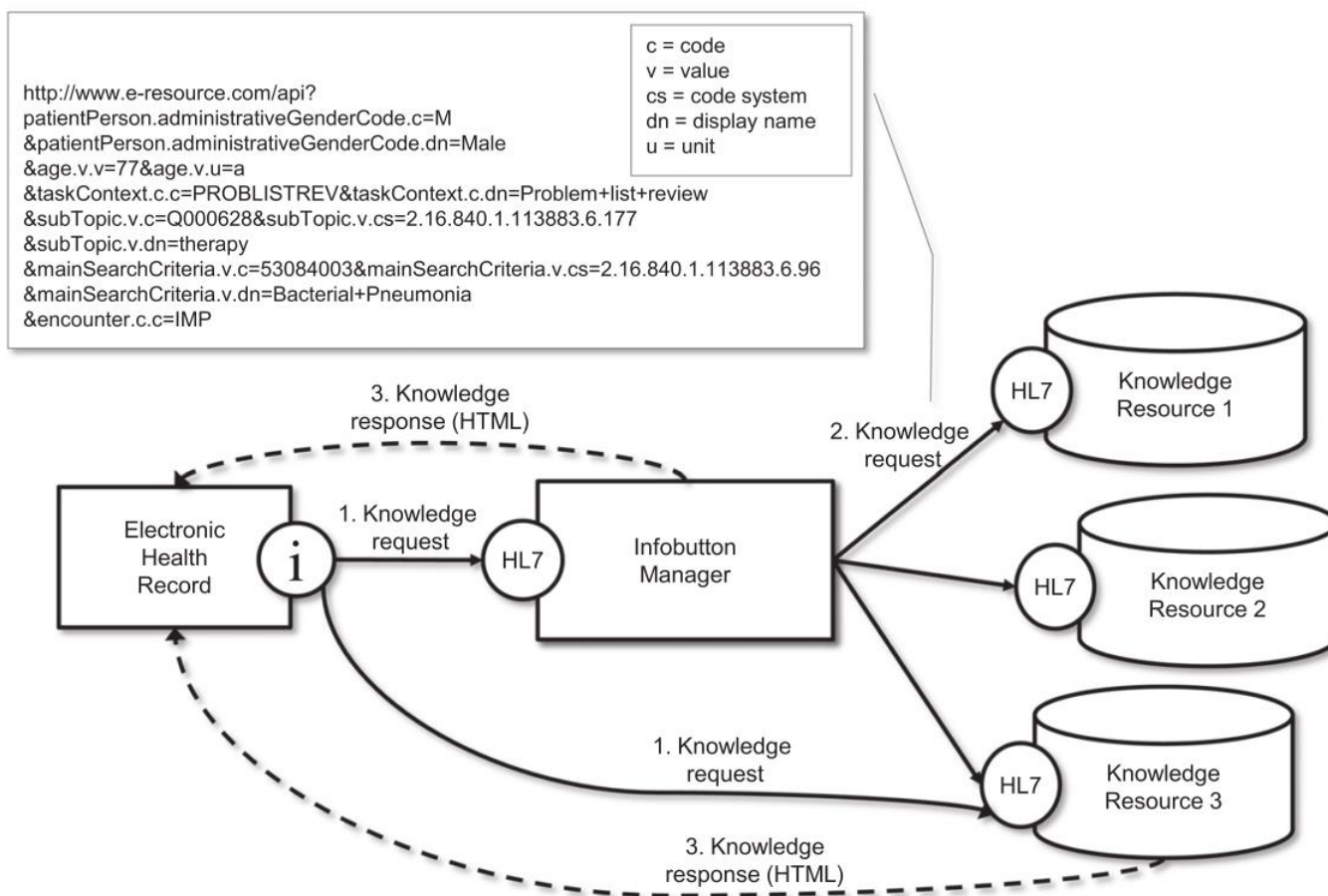
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      "title": {
        "_value": "Coma",
        "type": "text"
      },
      "link": [
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          "rel": "alternate",
          "type": "html",
          "href": "https://medlineplus.gov/coma.html?utm_source=mpplusconnect&utm_medium=service"
        }
      ],
      "id": {
        "_value": "tag: https:, 2018-12-01:https://medlineplus.gov/coma.html?utm_source=mpplusconnect&utm_medium=service"
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        "_value": "2018-01-12T00:01:27Z"
      },
      "summary": {
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        "type": "html"
      }
    }
  ],
}
```


INFOBUTTONS


Infobuttons

- Links from EPR/HIS to (potentially) relevant resources in external repositories with knowledge-based information
- **Infobutton Manager** – selection of a specific information source depending on the context (e.g., patient data, query topic, “consumer” of a response)
- Detailed specification in the HL7 standard (*context-aware information retrieval*)
 - Based on HL7 V3 RIM
 - Query and its content defined as RMIM
 - Invocation via URL, SOAP or RESTful
- Open-source implementation of the infrastructure

Infobutton Manager – schemat działania



Infobutton - context

Open  nbutton

OpenInfobutton

*Server:

*Execution mode:

*Requesting Organization:

*Task context:

*Main search criteria: Code: Display name: Code system:

Age: Value: Unit:

Age group:

Gender:

Care setting:


Performer: language: discipline:

Information recipient: language: discipline:


Output (XML and JSON available only in the production server):

```
http://dev-service.oib.utah.edu:8080/infobutton-service/infoRequest?
representedOrganization.id.root=1.3.6.1.4.1.3768&xsItTransform=Infobutton_UI_VA&taskContext.c.c=MLREV&mainSearchCriteria.v.cs=2.16.840.1.113883.6.103&main
SearchCriteria.v.dn=warfarin&patientPerson.administrativeGenderCode.c=M&age.v.v=44&age.v.u=a&encounter.c.c=IMP&informationRecipient=PROV
```


Infobuttons – demo







Open  nbutton

Electronic Health Record University of Utah **Information audience** Patient






Age 

Gender







Problem list

- Heart Failure 
- Post traumatic stress disorder 
- Gastroesophageal reflux 
- Diabetes mellitus type 2 
- Migraine 
- Add problem 

Medications

- Rosuvastatin (Crestor), 20 Mg, Tablet, Oral 
- Linagliptin (Tradjenta), 5 Mg, Tablet, Oral 
- Warfarin (Coumadin) 7.5Mg, Tablet, Oral 
- Clopidogrel 300 MG Oral Tablet 
- Amoxicillin 500 MG Oral Tablet 

Lab results

- Serum digoxin 1.5 mg/dl **N** 
- Total cholesterol 300 mg/dl **H** 
- K 2.8 mEq/l **L** 
- Na 127 mEq/l **L** 
- C Reactive Protein 555 ug/dl **H** 
- HbA1c 8.2% **H** 

INDEXING AND SEARCHING

Indexing of resources

- **Manual indexing**
 - Conducted by human experts
 - Using some controlled terminology and an approved protocol (e.g., for solving disagreement between experts)
 - Applied (usually) to bibliographic and annotated resources
- **Automatic indexing**
 - Using terms appearing in indexed resources and/or some controlled terminology
 - Applied typically to full text resources
- **Hybrid indexing** → automatic indexes “cleaned” later by human experts (e.g., MEDLINE)

Controlled terminologies

Controlled terminology is a **set of concepts** (a canonical term and alternatives) and **relations between them** (hierarchy, synonym, related) used for indexing and for encoding resources.

- MeSH (Medical Subject Heading)
 - Terminology developed by NLM (MEDLINE), 1st edition in 1960
 - Annual updates and extensions: 5,700 concepts in 1st edition and 26k+ in the most recent (170k+ terms)
 - Types of entries
 - *Descriptor* (main heading) → a biomedical concept
 - *Qualifier* (subheading) → additional characteristic of a descriptor
 - *Supplementary concept record* → drug or other chemical substance
- EMTREE (for EMBASE)

MeSH descriptors and qualifiers

Liver MeSH Descriptor Data 2017

Details	Qualifiers	MeSH Tree Structures	Concepts
MeSH Heading	Liver		
Tree Number(s)	A03.620		
Unique ID	D008099		
Annotation	/ blood supply: consider also LIVER CIRCULATION ; / cytol: consider also HEPATOCYTES & KUPFFER CELLS ; / surg: consider also HEPATECTOMY & LIVER TRANSPLANTATION ; inflammation = HEPATITIS & its specifics; specialty is HEPATOLOGY see GASTROENTEROLOGY ; do not confuse "hepatic" with "intrahepatic"; "intrahepatic" may refer to BILE DUCTS , INTRAHEPATIC & its diseases		
Scope Note	A large lobed glandular organ in the abdomen of vertebrates that is responsible for detoxification, metabolism, synthesis and storage of various substances.		
Entry Term(s)	Livers		
See Also	Hepatectomy		
Consider Also	consider also terms at HEPAT-		
Public MeSH Note	/cytology was LIVER CYTOLOGY 1964-65; /enzymology was LIVER ENZYMOLOGY 1964-65; /physiology was LIVER FUNCTION 1964-65		
History Note	/cytology was LIVER CYTOLOGY 1964-65; /enzymology was LIVER ENZYMOLOGY 1964-65; /physiology was LIVER FUNCTION 1964-65		
Entry Combination	transplantation:Liver Transplantation		
Date of Entry	1999/01/01		
Revision Date	2015/06/16		

Liver MeSH Descriptor Data 2017

Details	Qualifiers	MeSH Tree Structures	Concepts
Allowable Qualifiers	abnormalities (AB) anatomy & histology (AH) blood supply (BS) chemistry (CH) cytology (CY) diagnostic imaging (DG) drug effects (DE) embryology (EM) enzymology (EN) growth & development (GD) immunology (IM) injuries (IN) innervation (IR) metabolism (ME) microbiology (MI) parasitology (PS) pathology (PA) physiology (PH) physiopathology (PP) radiation effects (RE) secretion (SE) surgery (SU) ultrastructure (UL) virology (VI)		

surgery MeSH Qualifier Data 2017

Details	Concepts
MeSH Qualifier	surgery
Unique ID	Q000601
Annotation	subhead only; includes "operation", "surgical therapy"; for tissue section or coagulation by laser; not for transplantation (= /transplantation); indexing policy: Manual 19.8.70; DF: /surg or /SU
Scope Note	Used for operative procedures on organs, regions, or tissues in the treatment of diseases, including tissue section by lasers. It excludes transplantation, for which "transplantation" is used.
Entry Version	SURG
Abbreviation	SU
Entry Term(s)	intraoperative procedures invasive procedures operations operative procedures operative therapy perioperative procedures peroperative procedures preoperative procedures
Online Note	search policy: Online Manual; use: main heading/SU or SU (SH) or SUBS APPLY SU
History Note	66; used with Category A, C & F 1966-74; A, C & F 1975; A, B2, C & F 1976-89; A1-10, A13-14, A16, B2, C & F 1990 forward
Date of Entry	1973/12/27
Revision Date	2003/07/24

Organization of descriptors

- Descriptors are divided into 16 categories
- Categories are represented as multi-level trees
 - From the most general to specific descriptors
 - Up to 13 levels of hierarchy
- A descriptor may appear in several categories (trees)

1. – Anatomy [A]

- [Body Regions \[A01\]](#) +
- [Musculoskeletal System \[A02\]](#) +
- [Digestive System \[A03\]](#) +
- [Respiratory System \[A04\]](#) +
- [Urogenital System \[A05\]](#) +
- [Endocrine System \[A06\]](#) +
- [Cardiovascular System \[A07\]](#) +
- [Nervous System \[A08\]](#) +
- [Sense Organs \[A09\]](#) +
- [Tissues \[A10\]](#) +
- [Cells \[A11\]](#) +
- [Fluids and Secretions \[A12\]](#) +
- [Animal Structures \[A13\]](#) +
- [Stomatognathic System \[A14\]](#) +
- [Hemic and Immune Systems \[A15\]](#) +
- [Embryonic Structures \[A16\]](#) +
- [Integumentary System \[A17\]](#) +

2. – Organisms [B]

- [Animals \[B01\]](#) +
- [Algae \[B02\]](#) +
- [Bacteria \[B03\]](#) +
- [Viruses \[B04\]](#) +
- [Fungi \[B05\]](#) +
- [Plants \[B06\]](#) +
- [Archaea \[B07\]](#) +
- [Mesomycetozoea \[B08\]](#) +

- 3. + [Diseases \[C\]](#)
- 4. + [Chemicals and Drugs \[D\]](#)
- 5. + [Analytical, Diagnostic and Therapeutic](#)
- 6. + [Psychiatry and Psychology \[F\]](#)
- 7. + [Phenomena and Processes \[G\]](#)
- 8. + [Disciplines and Occupations \[H\]](#)
- 9. + [Anthropology, Education, Sociology](#)
- 10. + [Technology, Industry, Agriculture \[J\]](#)
- 11. + [Humanities \[K\]](#)

[Virus Diseases \[C02\]](#)

[RNA Virus Infections \[C02.782\]](#)

[Orthomyxoviridae Infections \[C02.782.620\]](#)

► [Influenza, Human \[C02.782.620.365\]](#)

[Influenza in Birds \[C02.782.620.375\]](#)

[Respiratory Tract Diseases \[C08\]](#)

[Respiratory Tract Infections \[C08.730\]](#)

[Bovine Respiratory Disease Complex \[C08.730.085\]](#) +

[Bronchitis \[C08.730.099\]](#) +

[Common Cold \[C08.730.162\]](#)

[Empyema, Pleural \[C08.730.265\]](#) +

► [Influenza, Human \[C08.730.310\]](#)

[Laryngitis \[C08.730.368\]](#) +

[Legionellosis \[C08.730.382\]](#) +

[Lung Abscess \[C08.730.407\]](#)

[Lung Diseases, Fungal \[C08.730.435\]](#) +

Unified Medical Language System (UMLS)

- A set of tools and resources to support automatic processing of biomedical texts developed by NLM
- Metathesaurus
 - Combines multiple existing dictionaries and terminologies
 - Hierarchy and relations between concepts coming from different sources and specified in different languages
- Semantic Network
 - Hierarchy and relations between semantic types associated with specific concepts defined in Metathesaurus
- API for invoking UMLS functions from external applications

Metathesaurus

The image displays two screenshots of the Metathesaurus web application, showing search results for two different terms.

Top Screenshot: Search for 'clinical decision support system'

- Search Panel:** The search term is 'clinical decision support system'. The release is set to '2016AB'. The search type is 'Word'. The source is set to 'All Sources'. The search results list shows two results: [C0526070](#) Decision Support Systems, Clinical and [C4035904](#) Clinical decision support (CDS) system.
- Basic View Panel:** The concept is [C0526070](#) Decision Support Systems, Clinical. The semantic type is [Intellectual Product](#) [T170]. The definition is: 'MSH/null - Computer-based information systems used to integrate clinical and patient information and provide support for decision-making in patient care. MSHNOR/null - Datamaskinbaserte informasjonssystemer anvendt for å integrere klinisk informasjon med pasientinformasjon og gi støtte til avgjørelser innen pasientbehandlingen.' The synonyms (38) include: [Beslissingsondersteunend systeem, klinisch](#), [Beslissingsondersteunende systemen, klinische](#), [Beslutsstøtssystem, kliniska](#), MSHSWE, CLIN DECISION SUPPORT SYSTEMS, Clinical Decision Support Systems, DECISION SUPPORT SYSTEMS CLIN, MSH, Decision Support Systems, Clinical, Entscheidungsunterstützende Systeme, klinische, KLINICHESKIE RESHENIIA, KOMP'UTERNYE SISTEMY PODDERZHKI PRINIATIIA, KLINICHESKIKH RESHENII SISTEMY PODDERZHKI, and MSHRUS.

Bottom Screenshot: Search for 'aspirin'

- Search Panel:** The search term is 'aspirin'. The release is set to '2016AB'. The search type is 'Word'. The source is set to 'All Sources'. The search results list shows 1172 results, including: [C0004057](#) Aspirin, [C1454756](#) N-acetyl-S-(alpha-methyl-4-(2-methylpropyl)-5-oxo-1H-imidazol-2-yl)benzoic acid, [C3843719](#) Aspirin or aspirin-containing product, [C0002370](#) Aluminum aspirin, [C0004058](#) Aspirin allergy, [C0004059](#) aspirin intolerance, [C0004060](#) Poisoning by aspirin, [C0005035](#) acetylsalicylic acid hydrolase, and [C0067608](#) N-3'-a-propylphenazonyl-2-acetoxybenzoate.
- Basic View Panel:** The concept is [C0004057](#) Aspirin. The semantic type is [Organic Chemical](#) [T109] and [Pharmacologic Substance](#) [T121]. The definition is: 'MSH - 2-(Acetyloxy)benzoic acid. DRUGBANK - 2-(Acetyloxy)benzoic Acid. MSH - 2-Acetoxybenzenecarboxylic acid. NCI - 2-Acetoxybenzoic acid. NDFRT - PDQ. ASA - ASPIRIN.' The synonyms (92) include: 2-(ACETYLOXY)benzoic acid, DRUGBANK, 2-(Acetyloxy)benzoic Acid, MSH, NCI, NDFRT, PDQ, 2-Acetoxybenzenecarboxylic acid, 2-Acetoxybenzoic acid, AAS, ASA, and ASPIRIN.

Semantic Network

The image displays a web-based Semantic Network interface with three main panels. The left panel, titled 'Search', contains a search bar with 'abdominal pain', a 'Go' button, and filters for 'Release' (2016AB) and 'Search Type' (Word). Below these are 'All Sources' and a list of search results (194 total). The middle panel, titled 'Basic View', shows the details for the concept 'Abdominal Pain' (C0000737). It includes a 'Semantic Type' (Sign or Symptom [T184]) and a 'Definition'. The right panel, titled 'Report', shows a 'Report' view of the concept, including 'Sign or Symptom', 'Definition', 'Properties', 'Parents', 'Relations', 'Inverse Relations', 'Inherited Relations', and 'Inverse Inherited Relations'. An orange arrow points from the 'Sign or Symptom' section in the 'Basic View' panel to the 'Sign or Symptom' section in the 'Report' panel.

Search **Tree** **Recent Searches**

Term CUI Code

abdominal pain Go

Release: 2016AB

Search Type: Word

Source: All Sources AIR ALT AOD AOT

Search Results (194)

[1 - 25]

- C0000737 Abdominal Pain
- C0423651 No abdominal pain
- C1394864 severe; abdominal pain, abdominal rigidity
- C0000727 Abdomen, Acute
- C0000729 Abdominal Cramps
- C0151263 nausea or abdominal pain
- C0232488 Abdominal colic
- C0232491 Chronic abdominal pain
- C0232492 Upper abdominal pain
- C0232493 Epigastric pain
- C0232495 Lower abdominal pain
- C0234246 Rebound tenderness
- C0235299 Right upper quadrant pain
- C0238548 abdominal pain radiating to back
- C0238551 Left lower quadrant pain
- C0238552 Left upper quadrant pain

Basic View **Report View** **Raw View**

Concept: C0000737 Abdominal Pain

Semantic Type

Sign or Symptom [T184]

Definition

Abdominal - An unpleasant sensation characterized by physical discomfort (such as pricking, throbbing, or aching) and perceived to originate in the abdomen. [HPO:probinsom]

MEDLINEPLUS/null -

Your abdomen extends from below your chest to your groin. Some people call it the stomach, but your abdomen contains many other important organs. Pain in the abdomen can come from any one of them. The pain may start somewhere else, such as your chest. Severe pain doesn't always mean a serious problem. Nor does mild pain mean a problem is not serious.

Call your healthcare provider if your pain lasts a week or more or if you have pain with other symptoms. Get medical help immediately if

- You have abdominal pain that is sudden and sharp
- You also have pain in your chest, neck or shoulder
- You're vomiting blood or have blood in your stool
- Your abdomen is stiff, hard and tender to touch
- You can't move your bowels, especially if you're also vomiting

MSH/null - Sensation of discomfort, distress, or agony in the abdominal region.

MSHCZE/null - Pocit nevolnosti, obtíže nebo bolesti v břišní oblasti; obvykle při funkčních poruchách, tkáňových poraněních nebo nemocích.

NCI/null - Painful sensation in the abdominal region.

NCI_CTCAE/null - A disorder characterized by a sensation of marked discomfort in the abdominal region.

NCI_NICHD/null - Discomfort in the central region of the body located between the chest and the groin.

Synonyms (123)

Relations **List** **Tree**

2016AB

Select a Semantic Type.

- Quantitative Concept
- Receptor
- Regulation or Law
- Reptile
- Research Activity
- Research Device
- Self-help or Relief Organization
- Sign or Symptom

-or-

Select a Relation Label.

- adjacent_to
- affects
- analyzes
- assesses_effect_of
- associated_with
- branch_of
- brings_about
- carries_out

Report **Raw Report**

Sign or Symptom

Definition

An observable manifestation of a disease or condition based on clinical judgment, or a manifestation of a disease or condition which is experienced by the patient and reported as a subjective observation.

Properties

Unique Identifier: T184

Tree Number: A2.2.2

Parents

Finding

Relations

- Sign or Symptom [degree_of Sign or Symptom](#) (D)
- Sign or Symptom [isa Finding](#) (D)
- Sign or Symptom [diagnoses Pathologic Function](#) (D)
- Sign or Symptom [diagnoses Anatomical Abnormality](#) (D)
- Sign or Symptom [diagnoses Injury or Poisoning](#) (D)

Inverse Relations

Inherited Relations

Inverse Inherited Relations

MetaMap

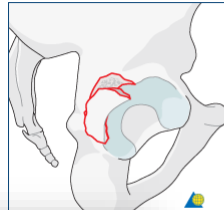
- System for analyzing biomedical texts (in English) and recognizing concepts from Metathesaurus
- Core element of Medical Text Indexer (MTI) used by NLM for automatic indexing of medical publications
- Available for free (open source), can be used to build custom solutions; also available online

MetaMap

MeSH only



1. Introduction and epidemiology



Posterior wall fractures are the most common acetabular fractures and account for approximately 24% of acetabular fractures.

They typically involve the rim of the acetabulum, a portion of the retroacetabular surface, and a variable segment of the articular cartilage.

The fracture line leaves undisturbed the major portion of the posterior column. A posterior dislocation is usually associated.

Posterior wall column.

All available terminologies



```
Phrase: "Posterior wall fractures"
>>>> Phrase
posterior wall fractures
<<<< Phrase
>>>> Mappings
Meta Mapping (827):
  827 Fractures (Fractures, Bone) [Injury or Poisoning]
<<<< Mappings

Phrase: "are"
>>>> Phrase
<<<< Phrase

Phrase: "the most common acetabular fractures"
>>>> Phrase
most common acetabular fractures
<<<< Phrase
>>>> Mappings
Meta Mapping (704):
  574 Acetabulum [Body Part, Organ, or Organ Component]
  812 Fractures (Fractures, Bone) [Injury or Poisoning]
<<<< Mappings

Phrase: "and"
>>>> Phrase
<<<< Phrase

Phrase: "account"
>>>> Phrase
account
<<<< Phrase
>>>> Mappings
Meta Mapping (900):
  900 Accountability [Idea or Concept]
<<<< Mappings
```

```
Phrase: "Posterior wall fractures"
>>>> Phrase
posterior wall fractures
<<<< Phrase
>>>> Mappings
Meta Mapping (981):
  981 Posterior wall fracture [Intellectual Product]
<<<< Mappings

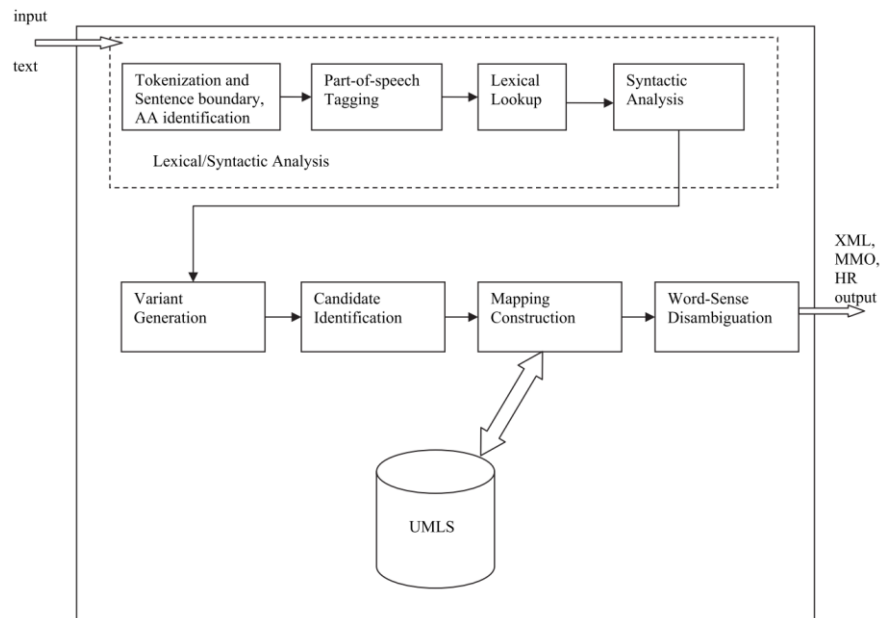
Phrase: "are"
>>>> Phrase
<<<< Phrase

Phrase: "the most common acetabular fractures"
>>>> Phrase
most common acetabular fractures
<<<< Phrase
>>>> Mappings
Meta Mapping (815):
  645 Common (Common (qualifier value)) [Quantitative Concept]
  842 Acetabular Fracture [Injury or Poisoning]
Meta Mapping (815):
  645 Common (shared attribute) [Functional Concept]
  842 Acetabular Fracture [Injury or Poisoning]
<<<< Mappings

Phrase: "and"
>>>> Phrase
<<<< Phrase

Phrase: "account"
>>>> Phrase
account
<<<< Phrase
>>>> Mappings
Meta Mapping (1000):
  1000 Account # (Account number:Identifier:Point in time:~Patient:Nominal) [Clinical Attribute]
Meta Mapping (1000):
  1000 account (account - ActClass) [Idea or Concept]
<<<< Mappings
```


Text processing in MetaMap



1. Tokenization, sentence boundary determination and acronym/abbreviation identification
2. Part-of-speech tagging
3. Lexical lookup of input words in the SPECIALIST lexicon (UMLS)
4. Syntactic analysis – identification of phrases
5. Variant generation (with variants of all phrase words)
6. Candidate identification and evaluation
7. Mapping construction by combining best candidates
8. Word sense disambiguation by checking semantic consistency of mappings and surrounding text

Automatic indexing

- Preprocessing of indexed documents
 - Splitting the text into words/tokens (*tokenization*)
 - Removal of “insignificant” words (stopwords)
 - Normalization of the format (e.g., all lowercase)
 - Transformation of words into their canonical form (*terms*) through *stemming* (a common part) lub *lemmatization* (base form)

Stemming: am, are, is → am, ar, is

Lemmatization: am, are, is → be

- **Bag of words** representation – a collection of all terms that appear in the text
 - Direct construction of the index
 - Computation of additional metrics (TF-IDF)

TD-IDF representation

TF = *term frequency*
IDF = *inverse document frequency*

- Each document represented as a vector in m -dimensional space (m = number of terms, also called *vector-space model*)
- Specific vector elements defined as

$$TFIDF(t, d) = TF(t, d) \times IDF(t)$$

$TF(t, d)$ = number of occurrences of term t in document d

$$IDF(t) = \log \left(\frac{\text{number of all documents}}{\text{number of documents containing term } t} \right)$$

- Combination of local (TF) and global (IDF) perspectives when evaluating specific terms and documents

Problems with automatic indexing

- **Synonymy** – different words, same meaning
- **Polysemy** – the same word, different meanings
- **Content** – words in a document may not reflect its major focus (digressions, references to other concepts)
- **Context** – words take on meaning based on their surrounding (e.g., high blood pressure)
- **Granularity** – queries and documents describe concepts at different levels (e.g., classes of drugs and specific drugs)

Possible solution (to some of the problems): index or query expansion, using n-grams or word embedding...

Searching and retrieval

- Two approaches for matching documents and queries
 - **Exact match** – queries given as logical expressions (AND, OR , NOT) → full match of a document an query is required
 - **Partial match** – application of various matching measures, selection of best matching documents → *relevance ranking*
- Exact match traditionally aimed for bibliographic and annotated repositories, while partial match at full-text ones

Exact match is preferred by more advanced users (perception of better control), however, no significant differences in obtained results

Computing partial matching

- **Jaccard** similarity – for the *bag of words* representation

$$\text{sim}(d_i, d_j) = \frac{|d_i \cap d_j|}{|d_i \cup d_j|}$$

- **Cosine** similarity – dla the TFIDF (vector) representation

$$\text{sim}(d_i, d_j) = \frac{d_i \cdot d_j}{\|d_i\| \times \|d_j\|} = \frac{\sum_t \text{TFIDF}(t, d_i) \times \text{TFIDF}(t, d_j)}{\|d_i\| \times \|d_j\|}$$

When computing similarity between a document and a query, then TF is established from the query, and IDF from the set of documents.

Evaluation measures for IR systems

Direct or system-oriented evaluation

- *Precision and recall*

$$precision(q) = \frac{|retrieved_q \cap relevant_q|}{|retrieved_q|}$$

$$recall(q) = \frac{|retrieved_q \cap relevant_q|}{|relevant_q|}$$

- *Precision@k* – established for the first k retrieved documents
- *Average precision* (taking into account the order of returned documents) and *mean average precision* (for a set of queries)

$$average_precision(q) = \frac{\sum_{k=1}^n precision@k_q}{|retrieved_q \cap relevant_q|}$$

Problem with direct evaluation

- Relies on the “ground truth” established by experts
- For each query there should be a (separate) set of relevant documents (→ significant workload imposed on experts)
- Significant differences between experts in evaluations of documents for a given query (κ – Cohen’s kappa)
 - OHSUMED collection $\kappa = 0.41$
 - Our experiment $\kappa = 0.30$



Poor agreement
between observers!

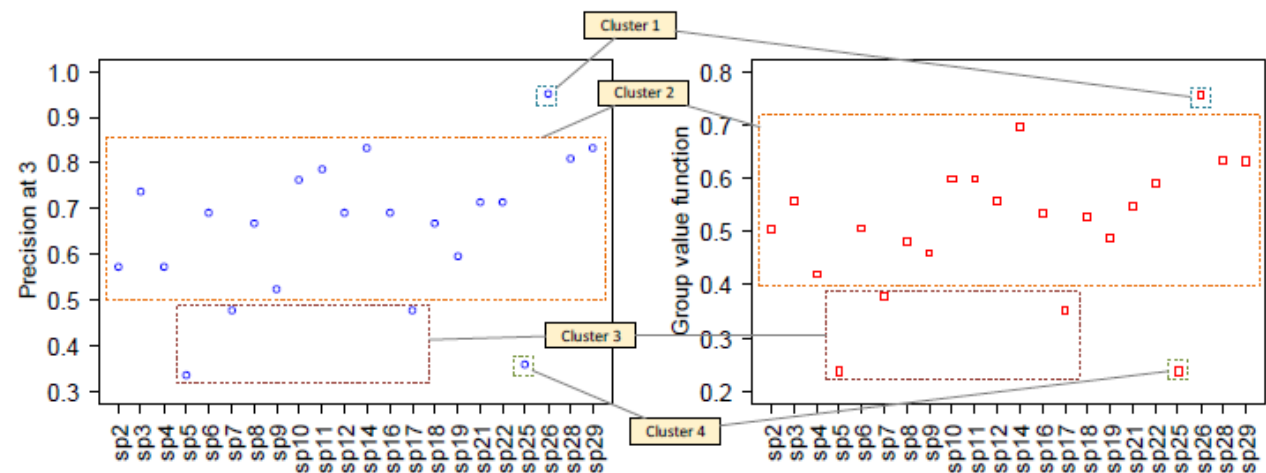
Our experiment...

Appendix 3. Coded triples representing relevance evaluations by physicians

Participant	Vignette		
	1	2	3
sp2	XXX	XXX	YX
sp3	XNN	XXX	XN
sp4	NNY	XXX	NX
sp5	XXX	XXX	XX
sp6	XNX	YXN	XX
sp7	XXN	XXX	XX
sp8	XXX	NXN	XY
sp9	NNY	YXX	XX
sp10	NNY	YXN	NX
sp11	NNY	YXN	NX
sp12	NNN	XXX	NX
sp14	NYN	YXX	NN
sp16	NNN	YXX	XX
sp17	XXN	NXX	XX
sp18	NYN	XXX	NN
sp19	XYN	XXX	YX
sp21	NXN	YXX	XX
sp22	NNN	XNN	NN
sp25	NNX	XXX	NX
sp26	YYY	YNN	NN
sp28	YNN	YNN	NN
sp29	NNY	NXN	NX

There are major differences between evaluations across vignettes. For example, physician sp5 (considered all of them to be relevant) and sp25 (considered all of them not relevant).

Appendix 6. Selected clustering of physicians in the context of precision at 3 and group value function



Physician sp5 from cluster 3 and sp25 from cluster 4 are very similar in terms of these two measures. However, a closer look at their coded triples (Appendix 3) reveals differences in evaluations across vignettes. For example, reviews retrieved for vignette 1 were evaluated as *XXX* by sp5 and as *NNX* by sp25, while for vignette 10 the evaluations were *NNX* for sp5 and *XXX* for sp25. While these differences were compensated after averaging values of both measures over all vignettes, they were captured by the kappa coefficient (that indicated the lack of agreement between sp5 and sp25) and resulted in placing these two physicians in two different clusters.

Other approaches to evaluation

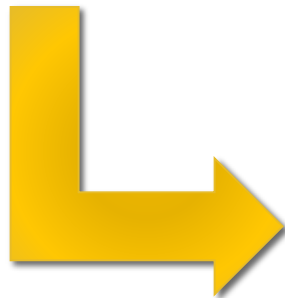
- **Indirect** or **user-oriented** evaluation – impact of using the IR system on the outcome of tasks conducted by its users
- Typical scenario – answering questions before and after using an IR system to search for information
 - No differences between exact and partial query matching techniques
 - Diversified increase in accuracy depending on the class of users (larger for nurses, smaller for physicians), however, comparable final results

Impact on EBM and IR systems on decisions

Table 3 Nine observational studies reporting cognitive impact of clinical information-retrieval technology on physicians (sorted by frequency of searches for information with positive impact)

Reference number	Searches with positive impact (%)	Number of searches	Number of participants	Recall	Design	Platform
Hayward et al. [28]	20	20	9	Up to 1 month	Cross-sectional	Multiple databases on CD-ROM
Jousimaa et al. [21]	36	2036	102	None	Cohort	Finnish guidelines on CD-ROM
Lindberg et al. [29]	36	1158	552	CIT ^a : Up to 12 months	Cross-sectional	Bibliographic database on CD-ROM
Swinglehurst et al. [30]	39	60	22	Up to 1 month	Case series	Multiple databases (device not reported)
Haynes et al. [20]	41	280	158	Up to 8 months	Cohort	Bibliographic database on the internet
Gorman et al. [14]	51	60	48	Up to 14 months	Cross-sectional	Bibliographic database on the internet
Veenstra [31]	59	261	30	Up to 12 months	Cross-sectional	Bibliographic database on the internet
Schwartz et al. [17]	70	92	3	Not specified	Cohort	Multiple databases on the internet
Crowley et al. [27]	82	625	82	None	Cohort	Multiple databases on the internet

^a CIT: critical incident technique. This technique is known to be reliable and valid, and may reduce recall bias.



- Changed patient management
- Information influenced decision
- An impact on clinical problem solving
- Increased understanding/knowledge or provided reassurance
- Would have had an impact on doctors or their practice
- Had an impact
- Would affect the treatment of future patients
- Confirmed patient care decisions or changed patient management