

# Biomedical Information Retrieval

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# Searching – everyone is doing it ...

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*"First, they do an on-line search."*

... everyone knows about it ...



... but new problems have emerged



# Biomedical information retrieval (IR)

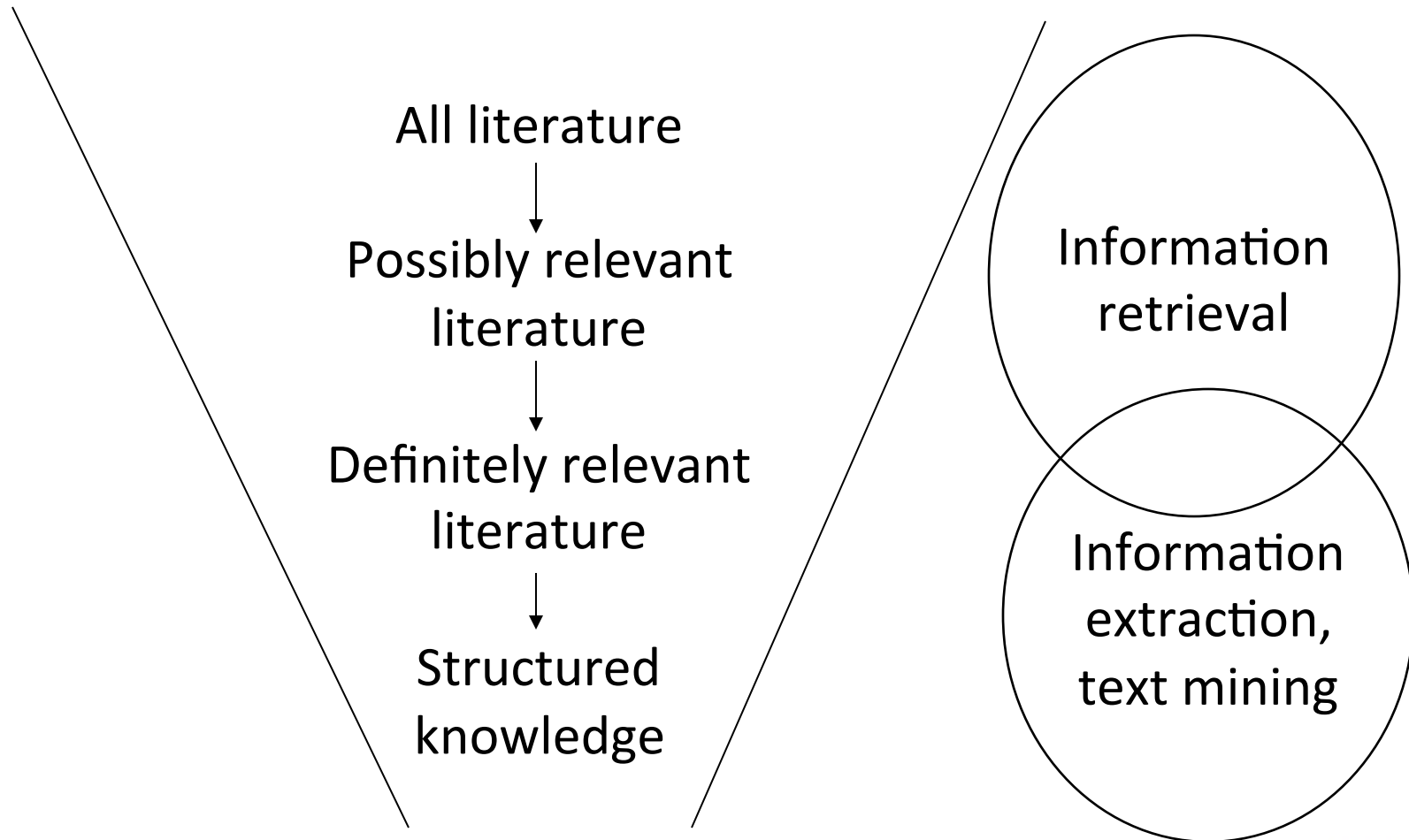
1. IR in Biomedicine
2. Biomedical IR Content
3. Evaluation
4. Research Directions

# IR in biomedicine: major challenges

- We have gone from
  - Information paucity to information overload
  - Paternalistic clinicians to engaged patients
  - Need to reduce waste in healthcare
- Many topics we want to search on have multiple ways to be expressed, e.g., diseases, genes, symptoms, etc.
- The converse is a problem too: Many words and terms used to express topics have multiple meanings
- Balancing open access vs. providing for cost of production and maintenance



# IR is a growing part of “knowledge discovery” (Hersh, 2009)



# Who uses biomedical IR systems?

- Just about all Internet users “search” (if for no other reason than being sent to search pages when URLs fail)
- Most Internet users search for health information
  - Estimates for US adult Internet users who have searched for personal health information is about 80% (Taylor, 2011; Fox, 2011)
  - Virtually all US, Canadian, and UK physicians (and probably those from everywhere else) use electronic sources (Davies, 2010)
  - Large proportion of academic faculty (78-88%) and trainees (88%) own smartphones and use them for information access (Franko, 2011)

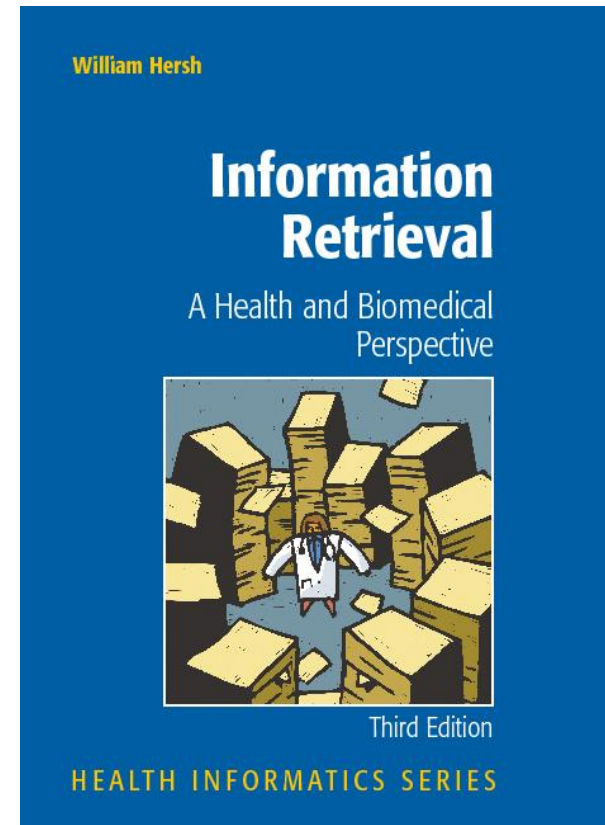


# What kind of health information do people search for? (Fox, 2011)

Health topic	% searching
Specific disease or medical problem	66%
Certain medical treatment or procedure	56%
Doctors or other health professionals	44%
Hospitals or other medical facilities	36%
Health insurance – private or government	33%
Food safety or recalls	29%
Environmental health hazards	22%
Pregnancy and childbirth	19%
Medical test results	16%

# How to find more information about biomedical IR

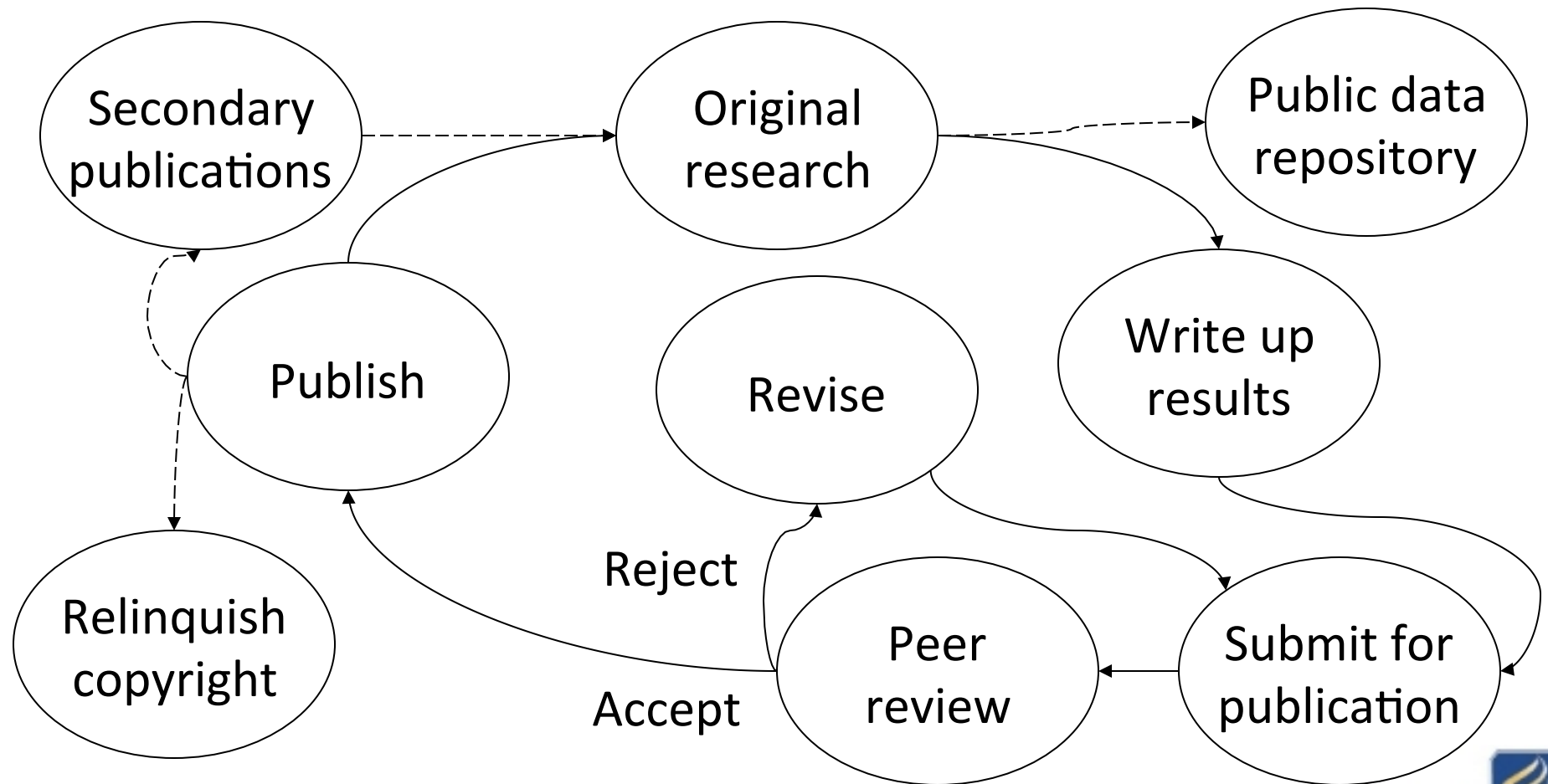
- From me!
- Hersh WR, *Information Retrieval: A Health and Biomedical Perspective*, Third Edition, 2009
  - Web site: [www.irbook.info](http://www.irbook.info)
- OHSU BMI 514/614 – Information Retrieval
- Many other good books, journals, and other sources as well



# Why is IR pertinent to health and biomedicine?

- Growth of knowledge has long surpassed human memory capabilities
- Clinicians have frequent and unmet information needs
- Researchers must frequently update their knowledge in new areas quickly
- Primary literature on a given topic can be scattered and hard to synthesize
- Non-primary literature sources are often neither comprehensive nor systematic
- Web is increasingly used as source of health and biomedical information

# The life-cycle of knowledge-based information (Hersh, 2009)



# Classification of knowledge-based scientific information

- Primary – original research
  - Published mainly in journals but also in conference proceedings, technical reports, books, etc.
  - Can include re-analysis, e.g., meta-analysis and systematic reviews
- Secondary – reviews, condensations, and/or synopses of primary literature
  - Textbooks and handbooks are staples of clinical practitioners, researchers, and others
  - Guidelines are important for normalizing care and measuring quality

# Biomedical IR content: a classification

- Bibliographic
  - By definition rich in metadata
- Full-text
  - Everything on-line
- Annotated
  - Non-text or structured text annotated with text
- Aggregations
  - Bringing together all of the above
- These categories are admittedly fuzzy, and increasing numbers of resources have more than one type



# Bibliographic content

- Bibliographic databases
  - The old (e.g., MEDLINE) have been revitalized with new features
  - New ones (e.g., National Guidelines Clearinghouse) have emerged
- Web catalogs
  - Share many characteristics of traditional bibliographic databases
- Real simple syndication/Rich site summary (RSS)
  - “Feeds” provide information about new content

# Bibliographic databases

- Contain metadata about (mostly) journal articles and other resources typically found in libraries
- Produced by
  - U.S. government
    - e.g., MEDLINE and subsets, genomics information, etc.
  - Commercial publishers
    - e.g., EMBASE – part of larger SciVal, CINAHL

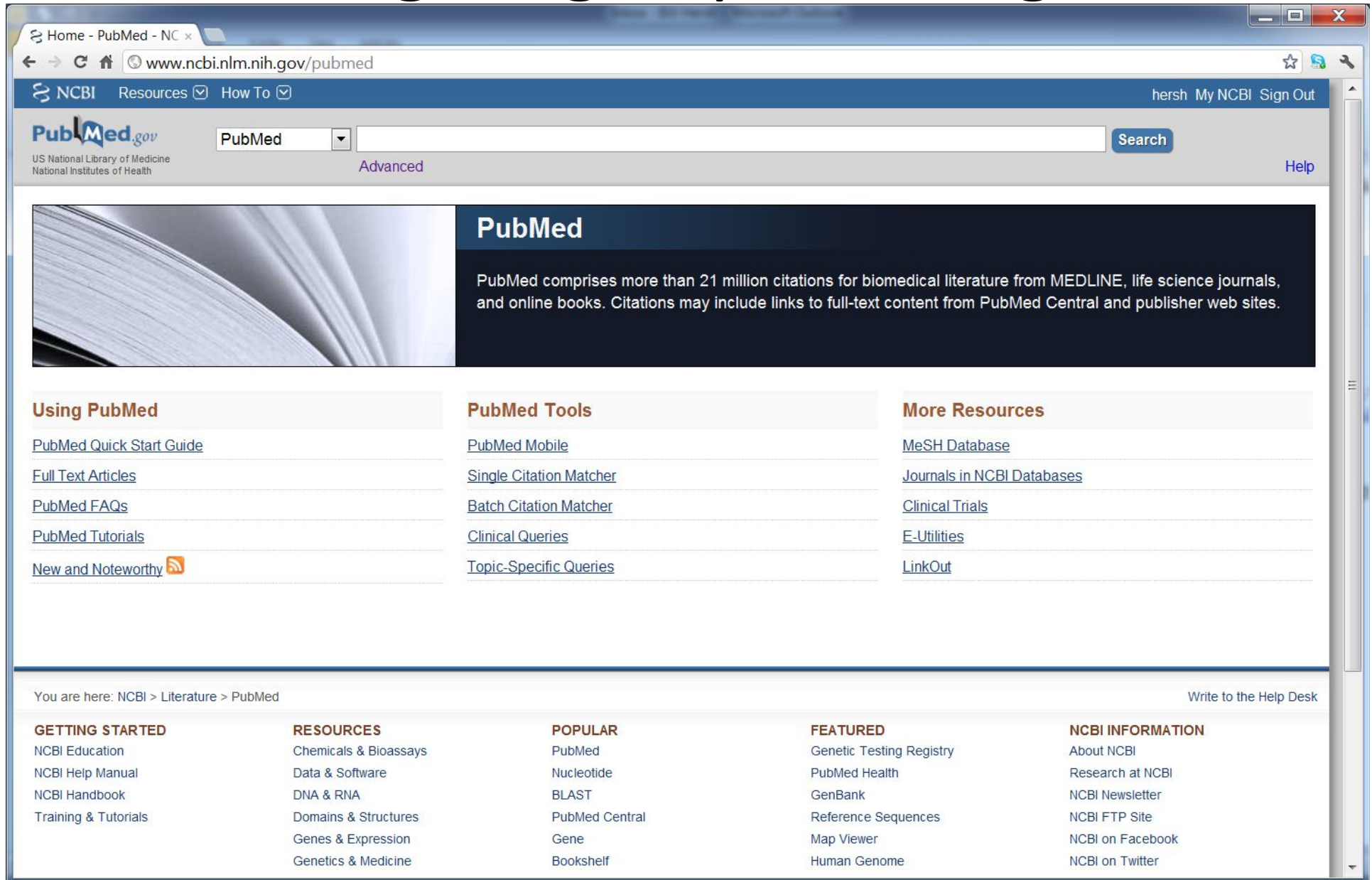
# MEDLINE

- References to biomedical journal literature
  - Original medical IR application – launched in 1966
  - Free to world since 1998 via PubMed – [pubmed.gov](http://pubmed.gov)
- Produced by National Library of Medicine (NLM)
- Statistics ([http://www.nlm.nih.gov/bsd/bsd\\_key.html](http://www.nlm.nih.gov/bsd/bsd_key.html))
  - Over 20 million references to peer-reviewed literature
  - Over 5,000 journals, mostly English language
  - Over 700,000 and growing new references added yearly
- Links to full text of articles and other resources

# Let's take a tour of PubMed

- User wants to know about treatment of congestive heart failure with angiotensin-converting enzyme (ACE) inhibitors
  - PubMed maps query into appropriate Boolean statement
- Simple AND yields way too many results, so want to narrow down, especially to best evidence
  - Done by applying Limits or using Clinical Queries

# Navigating to pubmed.gov



The screenshot shows the PubMed website in a web browser. The address bar displays [www.ncbi.nlm.nih.gov/pubmed](http://www.ncbi.nlm.nih.gov/pubmed). The page header includes the NCBI logo, navigation links for Resources and How To, and user options for heresh, My NCBI, and Sign Out. The main content area features a search bar with a dropdown menu set to 'PubMed', a search button, and a 'Help' link. Below the search bar, a large banner image of a book is shown next to the 'PubMed' title and a description: 'PubMed comprises more than 21 million citations for biomedical literature from MEDLINE, life science journals, and online books. Citations may include links to full-text content from PubMed Central and publisher web sites.'

The page is organized into three main columns of links:

- Using PubMed**
  - [PubMed Quick Start Guide](#)
  - [Full Text Articles](#)
  - [PubMed FAQs](#)
  - [PubMed Tutorials](#)
  - [New and Noteworthy](#)
- PubMed Tools**
  - [PubMed Mobile](#)
  - [Single Citation Matcher](#)
  - [Batch Citation Matcher](#)
  - [Clinical Queries](#)
  - [Topic-Specific Queries](#)
- More Resources**
  - [MeSH Database](#)
  - [Journals in NCBI Databases](#)
  - [Clinical Trials](#)
  - [E-Utilities](#)
  - [LinkOut](#)

At the bottom, a breadcrumb trail indicates the current location: 'You are here: NCBI > Literature > PubMed'. To the right of this trail is a link to 'Write to the Help Desk'. The footer is divided into five sections:

- GETTING STARTED**
  - [NCBI Education](#)
  - [NCBI Help Manual](#)
  - [NCBI Handbook](#)
  - [Training & Tutorials](#)
- RESOURCES**
  - [Chemicals & Bioassays](#)
  - [Data & Software](#)
  - [DNA & RNA](#)
  - [Domains & Structures](#)
  - [Genes & Expression](#)
  - [Genetics & Medicine](#)
- POPULAR**
  - [PubMed](#)
  - [Nucleotide](#)
  - [BLAST](#)
  - [PubMed Central](#)
  - [Gene](#)
  - [Bookshelf](#)
- FEATURED**
  - [Genetic Testing Registry](#)
  - [PubMed Health](#)
  - [GenBank](#)
  - [Reference Sequences](#)
  - [Map Viewer](#)
  - [Human Genome](#)
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  - [Research at NCBI](#)
  - [NCBI Newsletter](#)
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# Search on just CHF – note features

congestive heart failure x

www.ncbi.nlm.nih.gov/pubmed?term=congestive%20heart%20failure

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PubMed.gov  
US National Library of Medicine  
National Institutes of Health

PubMed congestive heart failure Search

RSS Save search Advanced Help

Choose additional filters

Text availability  
Abstract available  
Free full text available  
Full text available

Publication dates  
5 years  
10 years  
Custom range...

Species  
Humans  
Other Animals

Article types  
Clinical Trial  
Meta-Analysis  
Practice Guideline  
Randomized Controlled Trial  
Review  
Systematic Reviews  
more ...

Languages  
English  
more ...

Clear all

Display Settings: Summary, 20 per page, Sorted by Recently Added

Send to: Filter your results:

Results: 1 to 20 of 151181

<< First < Prev Page 1 of 7560 Next > Last >>

1. [Atrial fibrillation: its prevalence and risk factor profile in the german general population.](#)  
Schnabel RB, Wilde S, Wild PS, Munzel T, Blankenberg S.  
Dtsch Arztebl Int. 2012 Apr;109(16):293-9. Epub 2012 Apr 20.  
PMID: 22577476 [PubMed - in process]  
[Related citations](#)

2. [Ejection fraction and mortality rate of patients with isolated acute inferior myocardial infarction reperused by streptokinase.](#)  
Beiraghdar M, Pourmoghaddas Z, Reza Torknezhad M, Torkan A.  
ARYA Atheroscler. 2011 Summer;7(2):54-7.  
PMID: 22577446 [PubMed - in process]  
[Related citations](#)

3. [Novel cardiac-specific biomarkers and the cardiovascular continuum.](#)  
Vassiliadis E, Barascuk N, Didangelos A, Karsdal MA.  
Biomark Insights. 2012;7:45-57. Epub 2012 May 2.  
PMID: 22577298 [PubMed - in process]  
[Related citations](#)

4. [Ginseng Reverses Established Cardiomyocyte Hypertrophy and Post Myocardial Infarction-Induced Hypertrophy and Heart Failure.](#)  
Moey M, Gan XT, Xiaoling Huang C, Rajapurohitam V, Martínez-Abundis E, Lui EM, Karmazyn M.  
Circ Heart Fail. 2012 May 10. [Epub ahead of print]  
PMID: 22576957 [PubMed - as supplied by publisher]  
[Related citations](#)

All (151181)  
[Free Full Text \(29674\)](#)  
[Review \(26004\)](#)  
[Manage Filters](#)

Results by year

Related searches

congestive heart failure management  
congestive heart failure readmission  
congestive heart failure review  
congestive heart failure nursing  
congestive heart failure treatment guidelines

Titles with your search terms

Effects of enalapril on mortality in severe congestive heart failure. F [N Engl J Med. 1987]  
Atrial fibrillation and congestive heart failure: risk factors, mechani [Prog Cardiovasc Dis. 2006]  
Effect of metoprolol CR/XL in chronic heart

www.ncbi.nlm.nih.gov/guide/all/



# And more features

The screenshot shows a web browser window with the address bar displaying [www.ncbi.nlm.nih.gov/pubmed?term=congestive%20heart%20failure](http://www.ncbi.nlm.nih.gov/pubmed?term=congestive%20heart%20failure). The page title is "congestive heart failure x". The main content area lists search results, each with a checkbox, a title link, authors, journal information, and PMID. On the right side, there are several panels: "10728 free full-text articles in PubMed Central" with a list of article titles and a "See all (10728)..." link; "Find related data" with a "Database:" dropdown and a "Find items" button; "Search details" showing the search query: "heart failure"[MeSH Terms] OR ("heart"[All Fields] AND "failure"[All Fields]) OR "heart failure"[All Fields] OR ("congestive"[All Fields] AND "heart failure"[All Fields]); and "Recent activity" showing the search term "congestive heart failure (151181)" with a "See more..." link. At the bottom of the browser window, a footer bar contains the text "www.ncbi.nlm.nih.gov/guide/all/" and "cell lung cancer: differences in morbidity and mortality between".

congestive heart failure x

www.ncbi.nlm.nih.gov/pubmed?term=congestive%20heart%20failure

PMID: 22576809 [PubMed - as supplied by publisher]  
[Related citations](#)

☐ [Methicillin-resistant Staphylococcus aureus bacteremia at a university hospital in Japan.](#)

6. Isobe M, Uejima E, Seki M, Yamagishi Y, Miyawaki K, Yabuno K, Masaoka M, Hamaguchi S, Yoshioka N, Tomono K.  
J Infect Chemother. 2012 May 12. [Epub ahead of print]  
PMID: 22576750 [PubMed - as supplied by publisher]  
[Related citations](#)

☐ [\[Congestive heart failure : Reverse cardiac remodeling mediated by left ventricular assist devices\].](#)

7. Wohlschläger J, Milting H, Stypmann J, Hager T, Schmid C, Levkau B, Baba HA.  
Pathologe. 2012 May;33(3):175-82. German.  
PMID: 22576594 [PubMed - in process]  
[Related citations](#)

☐ [Obscured meshwork structure after treatment for heart failure: a case study.](#)

8. Rokutanda T, Misumi I, Hanaoka Y, Akahoshi R, Matsumoto M, Takeda N, Obayashi H, Kaikita K, Yamamuro M, Sugiyama S, Ogawa H.  
Intern Med. 2012;51(9):1049-53. Epub 2012 Apr 29.  
PMID: 22576385 [PubMed - in process]  
[Related citations](#)

☐ [Treatment of left main coronary artery stenosis with drug-eluting stent following heart transplantation.](#)

9. Xue YZ, Liu WT, Wang XH, Gao H, Wang LX.  
Intern Med. 2012;51(9):1037-41. Epub 2012 Apr 29.  
PMID: 22576383 [PubMed - in process]  
[Related citations](#)

☐ [A Pulsatile Control Algorithm of Continuous-Flow Pump for Heart Recovery.](#)

10. Gao B, Chang Y, Gu K, Zeng Y, Liu Y.  
ASAIO J. 2012 May 9. [Epub ahead of print]  
PMID: 22576238 [PubMed - as supplied by publisher]  
[Related citations](#)

**10728 free full-text articles in PubMed Central**

Three-dimensional analysis of right ventricular shape and function in pulmonary [Pulm Circ. 2012]

Comparison of loss of resistance technique between Epidrum® [Korean J Anesthesiol. 2012]

Role of advanced glycation end products in cardiovascular disease. [World J Cardiol. 2012]

[See all \(10728\)...](#)

**Find related data**

Database:

**Search details**

"heart failure"[MeSH Terms] OR ("heart"[All Fields] AND "failure"[All Fields]) OR "heart failure"[All Fields] OR ("congestive"[All Fields] AND "heart failure"[All Fields])

[See more...](#)

**Recent activity**

[Turn Off](#) [Clear](#)

Q congestive heart failure (151181) PubMed

[See more...](#)

www.ncbi.nlm.nih.gov/guide/all/ cell lung cancer: differences in morbidity and mortality between

# Search on just ACE inhibitors

ace inhibitors - PubMed x

www.ncbi.nlm.nih.gov/pubmed?term=ace%20inhibitors

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PubMed.gov  
US National Library of Medicine  
National Institutes of Health

PubMed ace inhibitors

RSS Save search Advanced

Help

Choose additional filters

Text availability  
Abstract available  
Free full text available  
Full text available

Publication dates  
5 years  
10 years  
Custom range...

Species  
Humans  
Other Animals

Article types  
Clinical Trial  
Meta-Analysis  
Practice Guideline  
Randomized Controlled Trial  
Review  
Systematic Reviews  
more ...

Languages  
English  
more ...

Clear all

Display Settings: Summary, 20 per page, Sorted by Recently Added

Send to: Filter your results:

Results: 1 to 20 of 46600

<< First < Prev Page 1 of 2330 Next > Last >>

1. [Effective secondary prevention through cardiac rehabilitation after coronary revascularization and predictors of poor adherence to lifestyle modification and medication. Results of the ICAROS Survey.](#)  
Griffo R, Ambrosetti M, Tramarin R, Fattirolli F, Temporelli PL, Vestri AR, De Feo S, Tavazzi L; for the ICAROS investigators.  
Int J Cardiol. 2012 May 8. [Epub ahead of print]  
PMID: 22575623 [PubMed - as supplied by publisher]  
[Related citations](#)

2. [Fragment Screening Using Capillary Electrophoresis \(CEfrag\) for Hit Identification of Heat Shock Protein 90 ATPase Inhibitors.](#)  
Austin C, Pettit SN, Magnolo SK, Sanvoisin J, Chen W, Wood SP, Freeman LD, Pengelly RJ, Hughes DE.  
J Biomol Screen. 2012 May 9. [Epub ahead of print]  
PMID: 22573733 [PubMed - as supplied by publisher]  
[Related citations](#)

3. [Effects of Antihypertensive Drugs on Arterial Stiffness.](#)  
Dudenbostel T, Glasser SP.  
Cardiol Rev. 2012 May 8. [Epub ahead of print]  
PMID: 22573107 [PubMed - as supplied by publisher]  
[Related citations](#)

4. [Randomised trial of ramipril in repaired tetralogy of Fallot and pulmonary regurgitation. The APPROPRIATE study \(ACE inhibitors for potential prevention of the deleterious effects of pulmonary regurgitation in adults with repaired tetralogy of Fallot\).](#)

All (46600)  
[Free Full Text \(8657\)](#)  
[Review \(10270\)](#)  
[Manage Filters](#)

Results by year

Related searches

ace inhibitors renal  
ace inhibitors diabetic  
ace inhibitors arbs  
ace inhibitors kidney  
heart failure ace inhibitors

Titles with your search terms

ACE inhibitors and proteinuria.  
[Pharm World Sci. 1996]  
Diuretics, ACE inhibitors and NSAIDs--the triple whammy.  
[Med J Aust. 2000]  
Pharmacokinetic drug interactions with ACE

www.ncbi.nlm.nih.gov/guide/



# Need to AND these, but still too many

congestive heart failure x

www.ncbi.nlm.nih.gov/pubmed?term=congestive%20heart%20failure%20AND%20ace%20inhibitors

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US National Library of Medicine  
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PubMed congestive heart failure AND ace inhibitors Search

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Abstract available  
Free full text available  
Full text available

Publication dates  
5 years  
10 years  
Custom range...

Species  
Humans  
Other Animals

Article types  
Clinical Trial  
Meta-Analysis  
Practice Guideline  
Randomized Controlled Trial  
Review  
Systematic Reviews  
more ...

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English  
more ...

Clear all

Choose additional filters

Display Settings: Summary, 20 per page, Sorted by Recently Added

Send to: Filter your results:

Results: 1 to 20 of 9468

<< First < Prev Page 1 of 474 Next > Last >>

1. [Capturing the dynamics of systemic Renin-Angiotensin-Aldosterone System \(RAAS\) peptides heightens the understanding of the effect of benazepril in dogs.](#)  
Mochel JP, Peyrou M, Fink M, Strehlau G, Mohamed R, Giraudel JM, Ploeger B, Danhof M.  
J Vet Pharmacol Ther. 2012 May 8. doi: 10.1111/j.1365-2885.2012.01406.x. [Epub ahead of print]  
PMID: 22568394 [PubMed - as supplied by publisher]  
[Related citations](#)

2. [\[Short-term prognosis and treatment of patients hospitalized for acute heart failure in a regional hospital without a cardiocentre\].](#)  
Zeman K, Pohludková L, Spinar J, Jarkovský J, Littnerová S, Dušek L, Miklík R, Felšöci M, Pařenica J.  
Vnitr Lek. 2012 Apr;58(4):273-9. Czech.  
PMID: 22559800 [PubMed - in process]  
[Related citations](#)

3. [\[Peripartum cardiomyopathy: A multiple entity.\]](#)  
Vanzetto G, Martin A, Bouvaist H, Marlière S, Durand M, Chavanon O.  
Presse Med. 2012 May 1. [Epub ahead of print] French.  
PMID: 22554497 [PubMed - as supplied by publisher]  
[Related citations](#)

4. [Warfarin in Heart Failure.](#)  
Eikelboom JW, Connolly SJ.  
N Engl J Med. 2012 May 2. [Epub ahead of print]  
PMID: 22551103 [PubMed - as supplied by publisher] **Free Article**  
[Related citations](#)

5. [Impact of timing in the treatment of angiotensin-converting enzyme inhibitors on outcomes in heart failure patients.](#)

All (9468)  
[Free Full Text \(1677\)](#)  
[Review \(3371\)](#)  
[Manage Filters](#)

Results by year

Titles with your search terms

The effects of **ACE inhibitors** on exercise capacity in the treatment of heart failure [J Cardiovasc Pharmacol. 1990]

Combination neurohormonal blockade with **ACE inhibitors**, angiotensin II and aldosterone antagonists [Can J Cardiol. 1997]

Neurohormonal activation and **congestive heart failure**: today's experience with treatment [Eur Heart J. 1995]

See more...

554 free full-text articles in PubMed Central

Angiotensin receptor blockers and risk of cancer: cohort study among people receiving [BMJ. 2012]

Short term outcomes in **heart failure** patients

# What if I forget the AND?

congestive heart failure x

www.ncbi.nlm.nih.gov/pubmed?term=congestive%20heart%20failure%20ace%20inhibitors

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Article types  
Clinical Trial  
Meta-Analysis  
Practice Guideline  
Randomized Controlled Trial  
Review  
Systematic Reviews  
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Display Settings: Summary, 20 per page, Sorted by Recently Added

Send to: Filter your results:

Results: 1 to 20 of 9468

<< First < Prev Page 1 of 474 Next > Last >>

1. [Capturing the dynamics of systemic Renin-Angiotensin-Aldosterone System \(RAAS\) peptides heightens the understanding of the effect of benazepril in dogs.](#)  
Mochel JP, Peyrou M, Fink M, Strehlau G, Mohamed R, Giraudel JM, Ploeger B, Danhof M.  
J Vet Pharmacol Ther. 2012 May 8. doi: 10.1111/j.1365-2885.2012.01406.x. [Epub ahead of print]  
PMID: 22568394 [PubMed - as supplied by publisher]  
[Related citations](#)

2. [\[Short-term prognosis and treatment of patients hospitalized for acute heart failure in a regional hospital without a cardiocentre\].](#)  
Zeman K, Pohludková L, Spinar J, Jarkovský J, Littnerová S, Dušek L, Miklík R, Felšöci M, Pařenica J.  
Vnitr Lek. 2012 Apr;58(4):273-9. Czech.  
PMID: 22559800 [PubMed - in process]  
[Related citations](#)

3. [\[Peripartum cardiomyopathy: A multiple entity.\]](#)  
Vanzetto G, Martin A, Bouvaist H, Marlière S, Durand M, Chavanon O.  
Presse Med. 2012 May 1. [Epub ahead of print] French.  
PMID: 22554497 [PubMed - as supplied by publisher]  
[Related citations](#)

4. [Warfarin in Heart Failure.](#)  
Eikelboom JW, Connolly SJ.  
N Engl J Med. 2012 May 2. [Epub ahead of print]  
PMID: 22551103 [PubMed - as supplied by publisher] **Free Article**  
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5. [Impact of timing in the treatment of angiotensin-converting enzyme inhibitors on outcomes in heart failure patients.](#)

All (9468)  
[Free Full Text \(1677\)](#)  
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Results by year

Titles with your search terms

The effects of **ACE inhibitors** on exercise capacity in the treatment of heart failure [J Cardiovasc Pharmacol. 1990]

Combination neurohormonal blockade with **ACE inhibitors**, angiotensin II and aldosterone antagonists [Can J Cardiol. 1997]

Neurohormonal activation and **congestive heart failure**: today's experience with treatment [Eur Heart J. 1995]

See more...

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Angiotensin receptor blockers and risk of cancer: cohort study among people receiving [BMJ. 2012]

Short term outcomes in **heart failure** patients

# How did it do that?

- PubMed mapping determines terms and appropriate Boolean operators, e.g.,
  - “congestive heart failure ace inhibitors” becomes:
  - ("heart failure"[MeSH Terms] OR ("heart"[All Fields] AND "failure"[All Fields]) OR "heart failure"[All Fields] OR ("congestive"[All Fields] AND "heart"[All Fields] AND "failure"[All Fields]) OR "congestive heart failure"[All Fields]) AND ("angiotensin-converting enzyme inhibitors"[MeSH Terms] OR ("angiotensin-converting"[All Fields] AND "enzyme"[All Fields] AND "inhibitors"[All Fields]) OR "angiotensin-converting enzyme inhibitors"[All Fields] OR ("ace"[All Fields] AND "inhibitors"[All Fields]) OR "ace inhibitors"[All Fields] OR "angiotensin-converting enzyme inhibitors"[Pharmacological Action])



# But 9000+ is still way too much

The screenshot shows the PubMed website interface. The search bar contains the text "congestive heart failure ace inhibitors". The results are displayed as "Results: 1 to 20 of 9468". The sidebar on the left includes filters for Text availability, Publication dates, Species, Article types, and Languages. The main content area shows a list of search results, including a highlighted article titled "Angiotensin-Aldosterone System (RAAS) peptides benazepril in dogs." by Mohamed R, Giraudel JM, Ploeger B, Danhof M. The right sidebar features a "Filter your results:" section with a bar chart showing "Results by year" and a list of "Titles with your search terms".

congestive heart failure x

www.ncbi.nlm.nih.gov/pubmed

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PubMed

congestive heart failure ace inhibitors

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Display Settings: Summary, 20 per page, Sorted by Recently Added

Send to: Filter your results:

Results: 1 to 20 of 9468

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Article types

- ☐ Portraits
- ☐ Practice Guideline
- ☐ Published Erratum
- ☐ Randomized Controlled Trial
- ☐ Research Support, American Recovery and Reinvestment Act
- ☐ Research Support, N.I.H., Extramural
- ☐ Research Support, N.I.H., Intramural
- ☐ Research Support, Non-U.S. Gov't
- ☐ Research Support, U.S. Gov't, Non-P.H.S.
- ☐ Research Support, U.S. Gov't, P.H.S.
- ☐ Research Support, U.S. Government
- ☐ Retracted Publication
- ☐ Retraction of Publication
- ☐ Review
- ☐ Scientific Integrity Review
- ☐ Systematic Reviews
- ☐ Technical Report
- ☐ Twin Study
- ☐ Validation Studies
- ☐ Video-Audio Media
- ☐ Webcasts

Apply

Angiotensin-Aldosterone System (RAAS) peptides benazepril in dogs.

Mohamed R, Giraudel JM, Ploeger B, Danhof M. 2012.01406.x. [Epub ahead of print]

nts hospitalized for acute heart failure in a regional

J, Littnerová S, Dušek L, Miklík R, Felšöci M,

Durand M, Chavanon O.

Free Article

Results by year

Titles with your search terms

The effects of **ACE inhibitors** on exercise capacity in the tr [J Cardiovasc Pharmacol. 1990]

Combination neurohormonal blockade with **ACE inhibitors**, angiotensin II an [Can J Cardiol. 1997]

Neurohormonal activation and **congestive heart failure**: today's experience wit [Eur Heart J. 1995]

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Angiotensin receptor blockers and risk of cancer: cohort study among people receiving [BMJ. 2012]

Short term outcomes in **heart failure** patients



# So can limit by RCT

congestive heart failure x

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PubMed congestive heart failure ace inhibitors Search

RSS Save search Advanced Help

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Abstract available  
Free full text available  
Full text available

Publication dates  
5 years  
10 years  
Custom range...

Species  
Humans  
Other Animals

Article types  
Clinical Trial  
Meta-Analysis  
Randomized Controlled Trial  
Review  
Systematic Reviews  
more ...

Languages  
English  
more ...

Display Settings: Summary, 20 per page, Sorted by Recently Added

Send to: Filter your results:

Results: 1 to 20 of 1195

<< First < Prev Page 1 of 60 Next > Last >>

Filters activated: Randomized Controlled Trial Clear all

1. [Effect of a medication-taking behavior feedback theory-based intervention on outcomes in patients with heart failure.](#)  
Wu JR, Corley DJ, Lennie TA, Moser DK.  
J Card Fail. 2012 Jan;18(1):1-9. Epub 2011 Oct 19.  
PMID: 22196835 [PubMed - indexed for MEDLINE]  
[Related citations](#)

2. [Safety and efficacy of low blood pressures among patients with diabetes: subgroup analyses from the ONTARGET \(ONgoing Telmisartan Alone and in combination with Ramipril Global Endpoint Trial\).](#)  
Redon J, Mancia G, Sleight P, Schumacher H, Gao P, Pogue J, Fagard R, Verdecchia P, Weber M, Böhm M, Williams B, Yusuf K, Teo K, Yusuf S; ONTARGET Investigators.  
J Am Coll Cardiol. 2012 Jan 3;59(1):74-83.  
PMID: 22192672 [PubMed - indexed for MEDLINE]  
[Related citations](#)

3. [Evaluation of multiple biomarkers of cardiovascular stress for risk prediction and guiding medical therapy in patients with stable coronary disease.](#)  
Sabatine MS, Morrow DA, de Lemos JA, Omland T, Sloan S, Jarolim P, Solomon SD, Pfeffer MA, Braunwald E.  
Circulation. 2012 Jan 17;125(2):233-40. Epub 2011 Dec 16.  
PMID: 22179538 [PubMed - indexed for MEDLINE]  
[Related citations](#)

4. [How can optimization of medical treatment avoid unnecessary implantable cardioverter- in patients with idiopathic dilated cardiomyopathy presenting with](#)

Results by year

Titles with your search terms

The effects of ACE inhibitors on exercise capacity in the tr [J Cardiovasc Pharmacol. 1990]

Combination neurohormonal blockade with ACE inhibitors, angiotensin II an [Can J Cardiol. 1997]

Neurohormonal activation and congestive heart failure: today's experience wit [Eur Heart J. 1995]

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Angiotensin receptor blockers and risk of cancer: cohort study among people receiving [BMJ. 2012]

Short term outcomes in heart failure patients

www.ncbi.nlm.nih.gov/pubmed#

# Still too many, so use other limits

The screenshot shows a web browser window with the URL [www.ncbi.nlm.nih.gov/pubmed](http://www.ncbi.nlm.nih.gov/pubmed). The search query is "congestive heart failure ace inhibitors". The results page displays 439 results, with the first four listed. The left sidebar contains filters for Text availability, Publication dates, Species, Article types, Languages, and Systematic Reviews. The right sidebar shows "Titles with your search terms" and "554 free full-text articles in PubMed Central".

**Search Results Summary:**

- Search Query:** congestive heart failure ace inhibitors
- Results:** 1 to 20 of 439
- Display Settings:** Summary, 20 per page, Sorted by Recently Added
- Filters activated:** Systematic Reviews

**Results List:**

- Angiotensin receptor blockers and risk of cancer: cohort study among people receiving antihypertensive drugs in UK General Practice Research Database.**  
Bhaskaran K, Douglas I, Evans S, van Staa T, Smeeth L.  
BMJ. 2012 Apr 24;344:e2697. doi: 10.1136/bmj.e2697.  
PMID: 22531797 [PubMed - in process] **Free PMC Article**  
[Related citations](#)
- Meta-Analysis of Randomized Trials of Angioedema as an Adverse Event of Renin-Angiotensin System Inhibitors.**  
Makani H, Messerli FH, Romero J, Wever-Pinzon O, Korniyenko A, Berrios RS, Bangalore S.  
Am J Cardiol. 2012 Apr 20. [Epub ahead of print]  
PMID: 22521308 [PubMed - as supplied by publisher]  
[Related citations](#)
- Angiotensin receptor blockers for heart failure.**  
Heran BS, Musini VM, Bassett K, Taylor RS, Wright JM.  
Cochrane Database Syst Rev. 2012 Apr 18;4:CD003040.  
PMID: 22513909 [PubMed - in process]  
[Related citations](#)
- Screening for, monitoring, and treatment of chronic kidney disease stages 1 to 3: a systematic review for the u.s. Preventive services task force and for an american college of physicians clinical practice guideline.**  
Fink HA, Ishani A, Taylor BC, Greer NL, Macdonald R, Rossini D, Sadiq S, Lankireddy S, Kane RL, Wilt TJ.  
Ann Intern Med. 2012 Apr 17;156(8):570-81.

**Filter your results:**

- All (439)
- [Free Full Text \(99\)](#)
- [Review \(213\)](#)
- [Manage Filters](#)

**Titles with your search terms**

- The effects of **ACE inhibitors** on exercise capacity in the tr [J Cardiovasc Pharmacol. 1990]
- Combination neurohormonal blockade with **ACE inhibitors**, angiotensin II an [Can J Cardiol. 1997]
- Neurohormonal activation and **congestive heart failure**: today's experience wit [Eur Heart J. 1995]
- [See more...](#)

**554 free full-text articles in PubMed Central**

- Angiotensin receptor blockers and risk of cancer: cohort study among people receiving [BMJ. 2012]
- Short-term outcomes in **heart failure** patients with chronic obstructive pu [World J Cardiol. 2012]
- Peripartum cardiomyopathy: a review. [Tex Heart Inst J. 2012]
- [See all \(554\)...](#)

**Find related data**



# Or further limits

The screenshot shows a web browser window with the address bar displaying [www.ncbi.nlm.nih.gov/pubmed](http://www.ncbi.nlm.nih.gov/pubmed). The page is the PubMed search results for the query "congestive heart failure ace inhibitors".

**Search Bar:** The search bar contains the text "congestive heart failure ace inhibitors". To the right of the search bar are links for "RSS", "Save search", and "Advanced".

**Filters and Settings:** On the left side, there are sections for "Choose additional filters" (with a "Clear all" link), "Text availability" (Abstract available, Free full text available, Full text available), "Publication dates" (5 years, 10 years, Custom range...), "Species" (Humans), "Article types" (Practice Guideline, more ...), and "Languages" (English, more ...). On the right side, there are "Display Settings" (Summary, 20 per page, Sorted by Recently Added), "Send to:" (with a dropdown menu), and "Filter your results:" (All (33), Free Full Text (13), Review (8), Manage Filters).

**Results:** The results section shows "Results: 1 to 20 of 33". The first four results are listed:

- 1. Seedat YK, Rayner BL; Southern African Hypertension Society.**  
S Afr Med J. 2011 Dec 14;102(1 Pt 2):57-83. Erratum in: S Afr Med J. 2012 Feb;102(2):94.  
PMID: 22273141 [PubMed - indexed for MEDLINE]  
[Related citations](#)
- 2. Management of chronic heart failure in adults: synopsis of the National Institute For Health and clinical excellence guideline.**  
Mant J, Al-Mohammad A, Swain S, Laramée P; Guideline Development Group.  
Ann Intern Med. 2011 Aug 16;155(4):252-9.  
PMID: 21844551 [PubMed - indexed for MEDLINE]  
[Related citations](#)
- 3. [Multidisciplinary guideline 'Heart failure 2010'].**  
Voors AA, Walma EP, Twickler TB, Rutten FH, Hoes AW; multidisciplinaire werkgroep 'Hartfalen 2010'.  
Ned Tijdschr Geneeskd. 2011;155:A2957. Dutch.  
PMID: 21447221 [PubMed - indexed for MEDLINE]  
[Related citations](#)
- 4. 2010 guidelines of the Taiwan Society of Cardiology for the management of hypertension.**  
Chiang CE, Wang TD, Li YH, Lin TH, Chien KL, Yeh HI, Shyu KG, Tsai WC, Chao TH, Hwang JJ, Chiang FT, Chen JH; Hypertension Committee of the Taiwan Society of Cardiology.  
J Formos Med Assoc. 2010 Oct;109(10):740-73.  
PMID: 20970072 [PubMed - indexed for MEDLINE]  
[Related citations](#)

**Titles with your search terms:** The effects of **ACE inhibitors** on exercise capacity in the tr [J Cardiovasc Pharmacol. 1990]  
Combination neurohormonal blockade with **ACE inhibitors**, angiotensin II an [Can J Cardiol. 1997]  
Neurohormonal activation and **congestive heart failure**: today's experience wit [Eur Heart J. 1995]  
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**554 free full-text articles in PubMed Central:** Angiotensin receptor blockers and risk of cancer: cohort study among people receiving [BMJ. 2012]  
Short-term outcomes in **heart failure** patients with chronic obstructive p [World J Cardiol. 2012]  
Peripartum cardiomyopathy: a review. [Tex Heart Inst J. 2012]  
[See all \(554\)...](#)

**Find related data**

# Another option is Clinical Queries

The screenshot displays the PubMed Clinical Queries website. The browser address bar shows the URL: [www.ncbi.nlm.nih.gov/pubmed/clinical?term=congestive%20heart%20failure%20ace%20inhibitors](http://www.ncbi.nlm.nih.gov/pubmed/clinical?term=congestive%20heart%20failure%20ace%20inhibitors). The page header includes the NCBI logo, navigation links for Resources and How To, and user information for 'hersh' with options for My NCBI and Sign Out.

## PubMed Clinical Queries

Results of searches on this page are limited to specific clinical research areas. For comprehensive searches, use [PubMed](#) directly.

Search input: congestive heart failure ace inhibitors [X] **Search**

### Clinical Study Categories

Category:  Scope:

### Systematic Reviews

**Results: 5 of 8016**

[Peripartum cardiomyopathy: A multiple entity.]  
Vanzetto G, Martin A, Bouvaist H, Marlière S, Durand M, Chavanon O. *Presse Med.* 2012 May 1; . Epub 2012 May 1.

Do angiotensin receptor blockers prevent myocardial infarctions as well as other initial therapies?  
Singh A, Bangalore S. *Curr Opin Cardiol.* 2012 Apr 21; . Epub 2012 Apr 21.

Meta-Analysis of Randomized Trials of Angioedema as an Adverse Event of Renin-Angiotensin System Inhibitors.  
Makani H, Messerli FH, Romero J, Wever-Pinzon O, Korniyenko A, Berrios RS, Bangalore S. *Am J Cardiol.* 2012 Apr 20; . Epub 2012 Apr 20.

Angiotensin receptor blockers for heart failure.  
Heran BS, Musini VM, Bassett K, Taylor RS, Wright JM. *Cochrane Database Syst Rev.* 2012 Apr 18; 4:CD003040. Epub 2012 Apr 18.

Screening for, monitoring, and treatment of chronic kidney disease stages 1 to 3: a systematic review for the u.s. Preventive services task force and for an american college of physicians clinical practice guideline.  
Fink HA, Ishani A, Taylor BC, Greer NL, Macdonald R, Rossini D.

### Medical Genetics

Topic:

**Results: 5 of 439**

Angiotensin receptor blockers and risk of cancer: cohort study among people receiving antihypertensive drugs in UK General Practice Research Database.  
Bhaskaran K, Douglas I, Evans S, van Staa T, Smeeth L. *BMJ.* 2012 Apr 24; 344:e2697. Epub 2012 Apr 24.

Meta-Analysis of Randomized Trials of Angioedema as an Adverse Event of Renin-Angiotensin System Inhibitors.  
Makani H, Messerli FH, Romero J, Wever-Pinzon O, Korniyenko A, Berrios RS, Bangalore S. *Am J Cardiol.* 2012 Apr 20; . Epub 2012 Apr 20.

Angiotensin receptor blockers for heart failure.  
Heran BS, Musini VM, Bassett K, Taylor RS, Wright JM. *Cochrane Database Syst Rev.* 2012 Apr 18; 4:CD003040. Epub 2012 Apr 18.

Screening for, monitoring, and treatment of chronic kidney disease stages 1 to 3: a systematic review for the u.s. Preventive services task force and for an american college of physicians clinical practice guideline.  
Fink HA, Ishani A, Taylor BC, Greer NL, Macdonald R, Rossini D.

### Medical Genetics

**Results: 5 of 258**

Endogenous aldosterone is involved in vascular calcification in rat.  
Wu SY, Yu YR, Cai Y, Jia LX, Wang X, Xiao CS, Tang CS, Qi YF. *Exp Biol Med (Maywood).* 2012 Jan 1; 237(1):31-7. Epub 2011 Dec 20.

Transforming growth factor  $\beta_1$  oppositely regulates the hypertrophic and contractile response to  $\beta$ -adrenergic stimulation in the heart.  
Huntgeburth M, Tiemann K, Shahverdyan R, Schlüter KD, Schreckenberger R, Gross ML, Mödersheim S, Caglayan E, Müller-Ehmsen J, Ghanem A, et al. *PLoS One.* 2011; 6(11):e26628. Epub 2011 Nov 17.

Regulation of angiotensin-(1-7) and angiotensin II type 1 receptor by telmisartan and losartan in adriamycin-induced rat heart failure.  
Zong WN, Yang XH, Chen XM, Huang HJ, Zheng HJ, Qin XY, Yong YH, Cao K, Huang J, Lu XZ. *Acta Pharmacol Sin.* 2011 Nov; 32(11):1345-50. Epub 2011 Oct 3.

Angiotensin-converting enzyme 2 overexpression improves central nitric oxide-mediated sympathetic outflow in chronic heart failure.  
Zhang H, Li Y, Patel MR.



# Clinical Queries also allows other question types

The screenshot shows the PubMed Clinical Queries web interface. The browser tab is 'PubMed Clinical Quer...' and the address bar shows the URL 'www.ncbi.nlm.nih.gov/pubmed/clinical?term=congestive%20heart%20failure%20ac...'. The NCBI logo and navigation links 'Resources' and 'How To' are visible. The main heading is 'PubMed Clinical Queries'. Below it, a note states: 'Results of searches on this page are limited to specific clinical research areas. For comprehensive'. A search bar contains the text 'congestive heart failure ace inhibitors'. Under the heading 'Clinical Study Categories', there is a 'Category:' dropdown menu set to 'Therapy' and a 'Scope:' dropdown menu with options: 'Etiology', 'Diagnosis', 'Therapy' (highlighted), 'Prognosis', and 'Clinical prediction guides'. The 'Results: 5' are shown. To the right, under the heading 'Systematic Reviews', the 'Results: 5 of 439' are shown.

PubMed Clinical Quer x

← → ↺ 🏠 [www.ncbi.nlm.nih.gov/pubmed/clinical?term=congestive%20heart%20failure%20ac...](http://www.ncbi.nlm.nih.gov/pubmed/clinical?term=congestive%20heart%20failure%20ac...)

NCBI Resources [v] How To [v]

## PubMed Clinical Queries

Results of searches on this page are limited to specific clinical research areas. For comprehensive

congestive heart failure ace inhibitors

### Clinical Study Categories

Category: Therapy ▼

Scope: Etiology  
Diagnosis  
Therapy  
Prognosis  
Clinical prediction guides

Results: 5

### Systematic Reviews

Results: 5 of 439

# National Guidelines Clearinghouse

- Produced by Agency for Healthcare Research and Quality (AHRQ)
  - [www.guideline.gov](http://www.guideline.gov)
- Contains detailed information about guidelines
  - Including degree they are evidence-based
  - Interface allows comparison of elements in database for multiple guidelines
- Has links to those that are free on Web and links to producers when proprietary



# Web catalogs

- Generally aim to provide quality-filtered Web sites aimed at specific audiences
  - Distinction between catalogs and sites blurry
- Some are aimed towards clinicians
  - HON Select – <http://www.hon.ch/HONselect/>
  - Translating Research into Practice – [www.tripdatabase.com](http://www.tripdatabase.com)
- Others are aimed towards patients/consumers
  - Healthfinder – [www.healthfinder.gov](http://www.healthfinder.gov)

# RSS

- RSS “feeds” provide short summaries, typically of news, journal articles, or other recent postings on Web sites
- Users receive RSS feeds by an RSS aggregator that can typically be configured for the site(s) desired and to filter based on content
  - Work as standalone, in Web browsers, in email clients, etc.
- Two versions (1.0, 2.0) but basically provide
  - Title – name of item
  - Link – URL of full page
  - Description – brief description of page

# Full-text content

- Contains complete text as well as tables, figures, images, etc.
- If there is corresponding print version, both are usually identical
- Includes
  - Periodicals
  - Books
  - Web sites – may include either of above

# Full-text primary literature

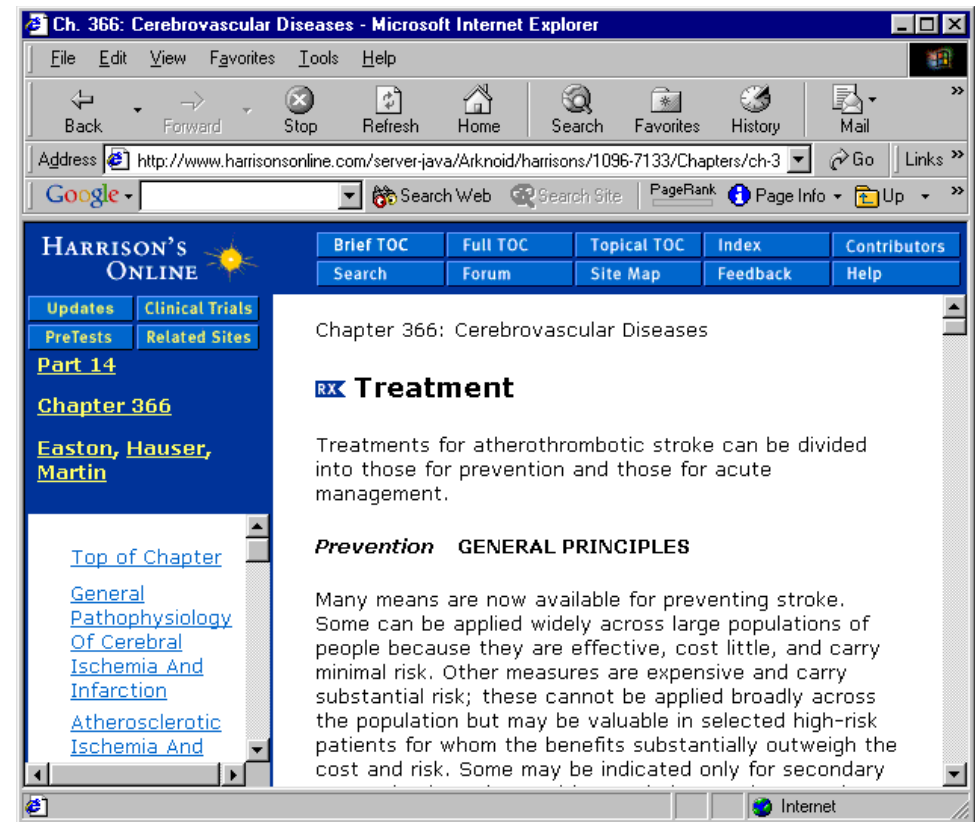
- Almost all biomedical journals available electronically
  - Many published by Highwire Press ([www.highwire.org](http://www.highwire.org)), which adds value to content of original publisher, including *British Medical Journal*, *Journal of the American Medical Association*, *New England Journal of Medicine*, etc.
  - Growing number available via open-access model, e.g., *Biomed Central* (BMC), *Public Library of Science* (PLOS)
- Other publishers license and provide to vendors – e.g., from Ovid, MDConsult, etc.
- Impediments to wider dissemination are economic and not technical (Hersh 2000; McGuigan, 2007)

# Books

- Textbooks
  - Most well-known clinical textbooks are now available electronically
    - e.g., *Harrison's Principles of Internal Medicine*
  - Most are bundled into large collections by publishers
    - e.g., Access Medicine, Elsevier, Kluwer (Lippincott Williams & Wilkins)
  - NLM has developed books site as part of PubMed
    - <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=Books>
- Compendia of drugs, diseases, evidence, etc.
- Handbooks – very popular with clinicians

# Value added for electronic books

- Multimedia, e.g., skin lesions, shuffling gait of Parkinson's Disease, etc.
- Bundling of multiple books
- Can be updated in between "editions"
- Linkage to other information, e.g., to references, self-assessments, updates, other resources, etc.



# Web sites

- Plenty of good content can be retrieval by Google, Bing, and other general search engines
  - *Caveat lector et viewer* - let the reader and the viewer beware (Silberg, 1997)
- There are also more narrow coherent collections of information on Web
  - Usually take advantage of Web features, such as linking, multimedia
  - Increasingly integrated with other resources and available on different platforms (e.g., integrated into electronic health records [EHRs], on smartphones, etc.)

# Some notable full-text content on Web sites

- Government agencies
  - National Cancer Institute
    - [www.cancer.gov](http://www.cancer.gov)
  - Centers for Disease Control – travel and infection information
    - [www.cdc.gov](http://www.cdc.gov)
    - <http://www.cdc.gov/travel/>
  - Other NIH institutes, e.g., National Heart, Lung, and Blood Institute (NHLBI)
    - [www.nhlbi.nih.gov](http://www.nhlbi.nih.gov)



# Full-text Web sites (cont.)

- Physician-oriented medical news and overviews, e.g.,
  - Medscape – [www.medscape.com](http://www.medscape.com)
  - PEPID – [www.pepid.com](http://www.pepid.com)
  - Many professional societies provide to members, e.g.,  
[http://www.acponline.org/clinical\\_information/](http://www.acponline.org/clinical_information/)
- Patient/consumer-oriented, e.g.,
  - Intellihealth – [www.intelihealth.com](http://www.intelihealth.com)
  - NetWellness – [www.netwellness.com](http://www.netwellness.com)
  - WebMD – [www.webmd.com](http://www.webmd.com)
- Many mobile apps provide health information, e.g.,
  - iTriage – [www.itriagehealth.com](http://www.itriagehealth.com)

# Annotated

- Non-text or structured text annotated with text
- Includes
  - Image collections
  - Citation databases
  - Evidence-based medicine databases
  - Clinical decision support
  - Genomics databases
  - Other databases

# Image collections

- Most prominent in the “visual” medical specialties, such as radiology, pathology, and dermatology
- Well-known collections include
  - Visible Human – [http://www.nlm.nih.gov/research/visible/visible\\_human.html](http://www.nlm.nih.gov/research/visible/visible_human.html)
  - BrighamRad – <http://brighamrad.harvard.edu/>
  - WebPath – <http://library.med.utah.edu/WebPath/webpath.html>
  - More pathology – PEIR, [www.peir.net](http://www.peir.net)
  - DermIS – [www.dermis.net](http://www.dermis.net)
  - More dermatology – [www.visualdx.com](http://www.visualdx.com)
- Many have associated text, which assists with indexing and retrieval

# Citation databases

- *Science Citation Index and Social Science Citation Index*
  - Database of journal articles that have been cited by other journal articles
  - Now part of a package called *Web of Science*, which itself is part of a larger product, *Web of Knowledge* (Thomson-Reuters)
    - [isiwebofknowledge.com](http://isiwebofknowledge.com), [wokinfo.com](http://wokinfo.com)
- SCOPUS – <http://www.info.sciverse.com/scopus>
- Google Scholar – [scholar.google.com](http://scholar.google.com)

# Evidence-based medicine databases

- Cochrane Database of Systematic Reviews
  - Collection of systematic reviews, kept updated
- Evidence “formularies”
  - Clinical Evidence – BMJ
  - JAMAevidence
  - PIER (Physician’s Information and Education Resource, American College of Physicians) – disease-oriented overviews, tagged for evidence
- Up to Date
  - Clinically oriented overviews of medicine
- InfoPOEMS
  - “Patient-oriented evidence that matters”



# Clinical decision support (CDS)

- Content used in CDS systems, usually part of EHRs
  - Order sets (usually “evidence-based”)
  - CDS rules
  - Health/disease management templates
- Growing and evolving commercial market for such tools, especially as EHR adoption increases; leaders include
  - Zynx – [www.zynxhealth.com](http://www.zynxhealth.com)
  - Thomson Reuters – [thomsonreuters.com](http://thomsonreuters.com)
  - EHR vendors themselves and partners

# Genomics databases

- National Center for Biotechnology Information (NCBI, [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov); Sayers, 2012)  
collection links
  - Literature references – MEDLINE
  - Textbook of genetic diseases – On-Line Mendelian Inheritance in Man
  - Sequence databases – Genbank
  - Structure databases – Molecular Modeling Database
  - Genomes – Catalog of genes
  - Maps – Locations of genes on chromosomes

# Other databases

- ClinicalTrials.gov
  - Originally database of clinical trials funded by NIH
  - Now used as register for clinical trials, with results reporting for some (DeAngelis, 2005; Laine, 2007; Zarin, 2011)
- NIH RePORTER
  - <http://projectreporter.nih.gov/reporter.cfm>
  - Database of all research grants funded by NIH
  - Replaced the CRISP database

# Aggregations – integrating many resources

- Clinical: Merck Medicus – [www.merckmedicus.com](http://www.merckmedicus.com)
  - Collection of many resources available to any licensed US physician
- Biomedical research: Model organism databases, e.g., Mouse Genome Informatics
  - [www.informatics.jax.org](http://www.informatics.jax.org)
- Consumer: MEDLINEplus – [medlineplus.gov](http://medlineplus.gov)
  - Integrates a variety of licensed resources and public Web sites



# Evaluation

- Questions often asked
  - Is system used?
  - Are users satisfied?
  - Do they find relevant information?
  - Do they complete their desired task?
- Most studied group is physicians, with systematic reviews of results (Hersh, 1998, Pluye, 2005)
- Most IR evaluation research has focused on retrieval of relevant documents, which may not capture full spectrum of usage
  - Often consists of challenge evaluations that develop “test collections” – best known is (non-medical) Text Retrieval Conference (TREC, [trec.nist.gov](http://trec.nist.gov)) (Voorhees, 2005)

# Is system used?

- Most studies done prior to ubiquitous Internet, electronic health records, mobile devices, etc.
- Studies in various clinical settings (Hersh, 2009; Magrabi, 2005) showed average use varied from 0.3 to 8.7 accesses per person-month
- Whatever the actual number, this paled in comparison to known physician information needs (Gorman, 1995) of two questions per every three patients

# Are users satisfied?

- Most studies report good user satisfaction, but some interesting studies to note
  - Nielsen (1994) meta-analysis found association (though imperfect) between user satisfaction and ability to use computer systems
  - Most Internet users believe they mostly find information they are seeking (Taylor, 2010; Fox, 2011)

# Do they find relevant information?

- Most common approach to evaluation
- Usually measured by relevance-based measures of recall and precision
- With ranked output, can combine recall and precision into aggregate measures
  - Mean average precision (MAP)
  - Binary preference (bpref)
  - Normalized discounted cumulative gain (NCDG)



# How well do clinicians search? Early results from Haynes (1990)

Searcher Type	Recall	Precision
Novice clinicians	27%	38%
Expert clinicians	48%	48%
Librarians	49%	57%

## Other findings

- Little overlap among retrieval sets
  - Searchers tended to find similar quantities of disparate relevant documents
- Novice searchers satisfied with results
  - Adequate information or ignorant bliss?

# Extending evaluation beyond physicians and documents

- Other clinicians
  - Nurses – Rolye, 1995
  - Pharmacists – Wanke, 1988
  - Nurse practitioners – Hersh, 2000; Hersh, 2002
- Biomedical researchers
  - Very little study of their use of IR systems
  - Investigated by TREC Genomics Track (Hersh, 2006; Hersch, 2009) – <http://ir.ohsu.edu/genomics/>
- Image retrieval – ImageCLEFmed (Hersh, 2006; Hersch, 2009)
  - Retrieval performance related to query type, measure selection
  - <http://ir.ohsu.edu/image/>

# Recall and precision studies yield useful results, but

- Are searchers able to solve their information problems by using system?
  - Some results research have used “task-oriented approach” to measure question-answering
  - Hersh (2002) – use of MEDLINE to answer clinical questions
    - Medical students answered 34% of questions before system, 51% afterwards
    - Nurse practitioner students answered 34% of questions before system but did not change with system
    - Time to answer a question was ~30 minutes
    - No association of recall or precision with correct answering

# Another task-oriented study

- Westbrook (2005) – use of online evidence system
  - Physicians answered 37% of questions before system, 50% afterwards
  - Nurse specialists answered 18% of questions before system, 50% afterwards
  - Those who had correct answers had higher confidence in their answers, but those not knowing answer initially had no difference in confidence whether answer right or wrong

# How do IR systems impact physician practice? (Pluye, 2004)

- Qualitative study found four themes mentioned by physicians
  - Recall – of forgotten knowledge
  - Learning – new knowledge
  - Confirmation – of existing knowledge
  - Frustration – that system use not successful
- Researchers also noted two additional themes
  - Reassurance – that system is available
  - Practice improvement – of patient-physician relationship

# Challenges for IR evaluation moving forward

- Must understand tasks of user and focus evaluation accordingly
- Ultimate measure, like any other informatics application, might be health outcome
  - This may be difficult with IR systems since usage may not directly impact outcomes of patient care or research activity



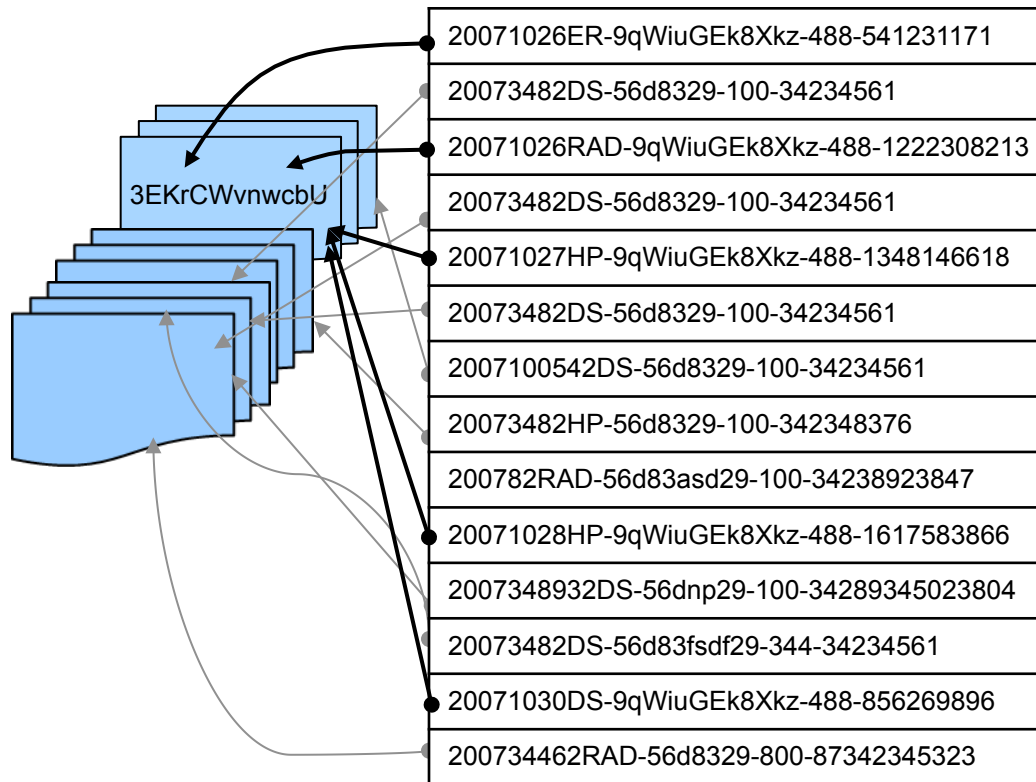
# Research directions – applying IR to medical records

- Most medical records still in narrative documents, where natural language processing (NLP) techniques are improving but still imperfect (Stanfill, 2010)
- For some tasks, can we take an IR approach?
  - TREC Medical Records Track uses de-identified corpus of medical records in initial task of identifying patients as candidates for clinical research studies (Voorhees, 2011)

# TREC Medical Records Track test collection

VISIT LIST

RECORD-VISIT MAP



DISCHARGE SUMMARY

...

PRINCIPAL DIAGNOSES:

1. Urinary tract infection.
2. Gastroenteritis.
3. Dehydration.
4. Hyperglycemia.
5. Diabetes mellitus.
6. Osteoarthritis.
7. History of anemia.
8. History of tobacco use.

HOSPITAL COURSE: The patient is a \*\*AGE[in 40s]-year-old insulin-dependent diabetic who presented with nausea,...

Report Extract

17,198 visits

101,712 reports (93,552 mapped to visits)

# Topics of TREC Medical Records Track – easy and hard

- Easiest – consistently best results
  - 105: Patients with dementia
  - 132: Patients admitted for surgery of the cervical spine for fusion or discectomy
- Hardest – consistently worst results
  - 108: Patients treated for vascular claudication surgically
  - 124: Patients who present to the hospital with episodes of acute loss of vision secondary to glaucoma
- Large differences between best and worst results
  - 125: Patients co-infected with Hepatitis C and HIV
  - 103: Hospitalized patients treated for methicillin-resistant *Staphylococcus aureus* (MRSA) endocarditis
  - 111: Patients with chronic back pain who receive an intraspinal pain-medicine pump

# Another research direction: question-answering

- Users may retrieve documents, but usually want answers to questions
- Subarea of IR research has focused on question-answering systems (Strzalkowski, 2006)
- Most recent “hype” of question-answering is the IBM Watson system
  - Developed out of TREC Question-Answering Track (Voorhees, 2005; Ferrucci, 2010)
  - Beat humans at Jeopardy (Markoff, 2011)
  - Now being applied to healthcare (Ferrucci, 2012)

# Conclusions

- Mine
  - IR, including in biomedicine, has become widespread and mainstream
  - Challenges still exist, especially in specific domains and/or for specific tasks
  - Plenty of room left for research but building on top of existing systems and not de novo
- Yours?