

Analysis of Physician Questions in an Ambulatory Care Setting

by Christopher Cimino, M.D. and G. Octo Barnett, M.D.

Laboratory of Computer Science - Massachusetts General Hospital
50 Staniford Street - Fifth Floor
Boston, MA 02114
ccimino@hstbme.mit.edu

Abstract

We collected 38 questions generated by physicians based on their active patient medical records. Each question was associated with a single term in a specific record (Key Term). These questions were analyzed with respect to word content and concept content. Concepts were matched to the National Library of Medicine's Metathesaurus (Meta-1). Thirty-seven Key Terms matched completely to Meta-1 terms. Each question matched to an average of 4.1 Meta-1 terms for a total of 156 concepts. Based on word count, these 156 concepts accounted for 40 percent, stop words accounted for 39 percent, and numbers and drug trade names accounted for less than 1 percent of the words. The remaining 20 percent of the words could be matched to 69 concepts not in Meta-1. Review of all concepts showed that they could be divided into medical terms (Noun Concepts), modifiers (Modifier Concepts), and concepts that provided context for the questions (Relation Concepts). The majority of Relation Concepts did not match to Meta-1. A vocabulary of Relation Concepts would provide a useful starting point for a computer system designed to aid physicians in answering clinical questions.

Introduction

It has been demonstrated that the information needs of clinical physicians are not being met [1-6]. The specific obstacles to meeting these information needs in an ambulatory setting included the unavailability of the proper resource, lack of knowledge about what the proper resource might be, and lack of time [1,2,7,8].

We have been working on an Interactive Query Workstation (IQW); a computer system to aide medical professionals in accessing computer-based information [9]. The IQW must have the proper resources available, provide guidance in choosing the proper resource, and help the user answer their question in an timely manner. An important design consideration is deciding which resources should be incorporated into the IQW. In order to identify these resources, it is necessary to know what types of

clinical questions physicians ask, how these questions are typically stated, and what information resources might provide answers to these queries.

Several methods have been employed for assessing physician needs. Woolf et. al. made use of standard questionnaires [3]. They found that many of the perceived needs were related to treatment or differential diagnosis. Covell et. al. performed interviews and observations of practicing physicians [1]. Their comparison between reported and observed needs showed that physicians do not accurately assess their needs. Osheroff et. al. relied solely on observation [10]. They used a broad definition of information needs and found that the most common needs were for patient specific data of the type usually found in a medical record. All of these studies showed that the information needs were often generated by specific patient situations.

These studies give a general description of the nature of physician information seeking behaviour, but do not provide precise enough information to allow the proper resources to be choosen for inclusion in the IQW. The studies are also not detailed enough to suggest how a typical query can be processed automatically. Test set of physician questions exist which provide more information about how questions might be transformed into information retrieval strategies [11], but these are usually collected for bibliographic databases and the questions are more likely to be research oriented. We felt it was necessary to gather more specific data about physician's information seeking strategies in clinical practice.

Previous studies suggested that we would need to collect our data through direct interaction with the physician in the normal working environment. In addition, it seemed desirable to collect actual examples of physician needs rather than reports of their needs. Finally, we felt the experimental collection would have more validity if the physicians generated clinical quereis were based on specific patient data.

Methods and Procedures

Three physicians were enrolled in this study. Each physician was presented with the medical records for ten of his patients. The records were clinical summaries

generated from the computer-based record and identical to the summaries used in actual encounters. The patients were selected from those with at least five active problems and who had been seen at least twice a year for the previous two years. For each record, the physicians were asked to write down questions concerning these patients. They were asked to note the item in the record most related to each question (Key Term).

All Key Terms associated with questions were analyzed based on categories predefined by the COSTAR medical record system. These categories are physical exam, problems*, medication, non-medication therapy, laboratory results, procedures, and administrative. Each question was classified according to an internal medicine sub-specialty. Each question was classified according to whether it required an answer that was specific or broad in scope. For example, a general question might be "What is the treatment for psoriasis?" while a specific question would be "Is methotrexate appropriate treatment for psoriasis?" Word frequency analysis was performed on all the questions. The selected Key Terms were matched against the Unified Medical Language Metathesaurus (Meta-1) terms [12]. Phrases in the questions were also matched to Meta-1 terms. Matches were evaluated by examining the definitions given in Meta-1. Where no definitions were available, the matches were evaluated by examining other Meta-1 terms which were lexical variants, synonyms, related terms, ancestors, or children to the candidate Meta-1 term.

Results

A total of 38 questions were collected. The Key Terms that generated questions all came from three categories out of the possible seven. These were the medication category (n=7), laboratory results category (n=5), and problem category (n=26).

The questions concerned topics in all internal medicine sub-specialties (Table I) in a distribution that is similar to previous studies [1]. There was no significant difference between the topics asked by individual physicians.

Table I Questions Categorized By Subspecialty Topic

Subspecialty	Number
Endocrinology	6
Gastroenterology	6
Rheumatology	6
Cardiology	5
Hematology/oncology	5
Neurology/psychiatry	4
Pulmonary disease	2
Nephrology	1
Non-internal medicine	3

The questions were almost evenly split between those requesting specific information (n=21) and those requesting general information (n=18). One question contained both general and specific requests ("What is the natural history of mitral valve prolapse and what is the optimal timing of valve replacement?"). Questions generated from laboratory Key Terms tended to be specific (Table II). Questions from other category Key Terms were evenly divided between specific and general.

Table II Questions Categorized by Medical Record Category and Breadth

Breadth	Specific	Broad
Category		
Problem	14*	13*
Medication	3	4
Laboratory	4	1

* One question from a problem category Key Term was classified as containing both a specific and a broad component.

Many of the most frequently used words were articles, prepositions, or conjunctions. The most frequently used word was WHAT. Table III shows the most frequently used words after deleting words that are found in the National Library of Medicine's stop word list [13] (e.g., AND, OR, IF, and TO). Some words (e.g., PATIENTS and NEGATIVE) were used by only one physician. Sometimes these words had closely related words or phrases that were used by the other physicians. For example, two of the physicians both used the word PROGNOSIS very frequently but the third physician did not. The third physician frequently used the related concept NATURAL HISTORY. Table III also shows the most frequently used concepts.

The Key Terms were matched against the National Library of Medicine's Medical Subject Headings (MeSH). Thirty-one Key Terms matched directly to MeSH terms. Another four concepts matched to a combination of MeSH terms or subheadings (e.g., BLOOD LEAD matched to "Lead / BL" and KNEE X-RAY matched to "Knee" and "X-Ray, Diagnostic"). Thirty-three concepts matched to Meta-1. These included all thirty-one MeSH terms and two additional terms: NOCTURNAL LEG CRAMPS and PALPITATIONS. The source vocabularies for these two terms in Meta-1 were COSTAR and SNOMED, respectively. A total of thirty-seven terms matched to MeSH terms, Meta-1, or to combinations of MeSH terms or subheadings. The one term that did not match completely to MeSH or Meta-1, TOXIC GOITER, matched partially to the MeSH term, GOITER.

Table III Most Frequently Used Non-Stop Words and Concepts

Word	Occurrence	Related Terms	Concept Occurrence	Number of Physicians
Prognosis	9	"Natural History"	14	3
Patient	10	Patients	11	3
Treatment	5	Therapy, Therapies	9	3
Carcinoma	7	Malignancy	8	2
Efficacy	7		7	3
History	6		6	2
Natural	5	(see Prognosis above)		
Surgical	2	Surgery, Surgically	5	3
Arthritis	4		4	2
Following	4		4	2
Negative	4		4	1
Recurrence	2	Recurring, Recurrent	4	3
Drug	3		3	3
Recommendations	1	Recommended, Recommendation	3	3

Each question was reviewed for concepts matching to Meta-1. Each question matched to an average of 4.1 unique Meta-1 terms. This gave a total of 156 matched topics which covered 251 words or 40 percent of the 633 words in the 38 questions.

A total of 382 words were not covered by these matches. Of the unmatched words, 243 were stop words (39% of all words), 9 were numbers (from laboratory results or dosage information) (<1%), and 3 were drug trade names (<1%). Review of the remaining 127 unmatched words generated a list of 69 unmatched concepts (Table IV). These concepts were further subdivided. Six unmatched Noun Concepts were found which related to specific medical entities. Forty-two Modifier Concepts acted to alter the meaning of other concepts. Twenty-one Relation Concepts were found which related one or more medical entities (Noun Concepts) in the question and implied information about the expected answer. Relation Concepts are closely related to the context of the question. For example, the terms KNEE, DEGENERATIVE CHANGES and KNEE REPLACEMENT can be used in several different questions. Possible questions include whether KNEE REPLACEMENT can cause DEGENERATIVE CHANGES of the KNEE, whether KNEE REPLACEMENT can treat DEGENERATIVE CHANGES of the KNEE, or whether it is contraindicated in patients with DEGENERATIVE CHANGES. With the addition of the term TIMING it becomes clear that the question concerns treatment. The Relation Concept TIMING relates the three Noun Concepts and implies that the answer will provide criteria for deciding when knee replacement should be performed. The questions were reviewed for additional Relation Concepts and a total of 14 unique Relation Concepts were found (Table V).

Discussion

The motive for this study was to collect information that would describe physician information needs and guide the design of the IQW. The identification of Key Terms by itself was not sufficient to describe the information needs. The analysis of Meta-1 terms provided a better description of the information needs. The analysis of unmatched Meta-1 terms suggested an approach to automated processing of physician queries.

In many cases, the category of the Key Term was unrelated to the topic of the question. Many questions contained explicit references to other Key Terms but these were not identified by the physicians as being the item that generated the question. For example, one question identified a laboratory result as the Key Term and asked whether the side effects of the patient's beta blockers could cause this result. The physician could have associated his question with either Key Term in the record so the identified Key Term was an incomplete indication of his information need.

Other questions contained references to potential Key Terms that were not in a specific patient's record. This was usually because the physician was speculating about their applicability to the patient ("What is the efficacy of methotrexate in psoriasis?", "What is the optimal timing of total knee replacement?"). These questions could not be generated from a patient's record without additional input from the physician. The analysis of the full text of the physician questions provides information about this additional input.

The Meta-1 terms that were matched provided more information about what each question was related to but usually did not provide an unambiguous interpretation. For example, one question contained the concepts METHOTREXATE and PSORIASIS. The combination of these concepts could represent several questions

including "Does methotrexate cause psoriasis?", "Does methotrexate treat psoriasis?", or "Is the use of methotrexate contraindicated in someone with psoriasis?" This suggests that Meta-1 could be used to narrow down the meaning of a question to a small subset of possibilities but not to a single possibility.

Table IV Unmatched Concepts

Relation Concepts	
efficacy	indications
timing	yearly
how long to continue	optimal timing
versus	options
test interpretation	differentiate
prevent	meaning
predictors of good outcome	relation between
evaluation	rule out
prognostic importance	recommendation
recommended therapy	alternative
prescribed	
Noun Concepts	
surgical repair	euthyroid
RAI treatment	WAP rhythm
aortic gradient	sinus bradycardia
Modifier Concepts	
depression of levels	to look out for
previous	last
occasional	episode of frequently
occur	recent
multiple	current (medication)
drug-related	severe
right	latest information
value increased	migratory
best	newer information
disease-related	burned-out
numerous manifestations	demonstrated
symptomatic	term
asymptomatic	major problem
common	long suspected
better	moderate
history	greater than
induced	bursts of
narrow	since
starting	developed
latest data	negative (test)
no evidence of	positive (test)

Analysis of the unmatched terms provided a set of Relation Concepts which played an important role in defining the questions. Meta-1 is associated with a semantic network which has relationship terms defined [14,15] and these relationship terms were compared to the unmatched terms. Some of the relationship terms were closely related in meaning to Relation Concepts in a particular question. For example, the Meta-1 relationship "use in" could be substituted for the EFFICACY to produce the essentially equivalent phrases "EFFICACY OF METHOTREXATE IN PSORIASIS" and "METHOTREXATE use in PSORIASIS". The phrases "DIFFERENTIAL DIAGNOSIS OF APHTHOUS STOMATITIS" and "cause OF APHTHOUS STOMATITIS" are also equivalent. These substitutions were only partially useful because the Relation Concepts often matched only one form of the more broadly defined relationship terms. Sometimes complex phrases were being related instead of simple noun phrases ("H-2 blocker EFFICACY in PREVENTION of RECURRENCE of duodenal ulcer"). Sometimes these complex phrases were implicit in the question. For example, Meta-1 provides three temporal relationships (precede, follow, co-occur), but "What is the optimal timing?" is not asking whether one event should "follow" another but the "degree" to which is should "follow". The most frequently occurring Relation Concept, PROGNOSIS, could not be satisfactorily described by any combination of Meta-1 relationship terms. There are plans to expand the number relationship terms in Meta-1 [14]. The will probably be very useful for the IQW since Relation Concepts represent a significant component of the questions to be processed.

Table V All Relation Concepts Found in 38 Questions

Concept	Related Phrases	Occurrence
prognosis	natural history	14
efficacy	indications	8
timing	yearly, optimal timing	4
	how long to continue	
differentiate	versus, relation between	3
drug interactions		3
options	alternative	3
prescribed	recommendation, recommended therapy	3
complications		2
prevent		2
meaning,	test interpretation	2
	prognostic importance	
cause	differential diagnosis	1
evaluation		1
predictors of good outcome		1
rule out		1

Conclusion

While many words in the questions could be matched to existing Meta-1 terms, these were not usually sufficient to capture the context of the questions. The Meta-1 terms provides specifics about the question but other phrases provided information about what question was being asked. The creation of a vocabulary of Relation Concepts appears to be a useful next step in our design of an Interactive Query Workstation. A larger sample of questions will be needed to build this vocabulary. Many of the questions were related to prognosis or therapy Relation Concepts. Providing information on therapy and prognosis will be important needs to be served by the system we create.

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* The COSTAR name for this category is diagnosis division. Many of the COSTAR codes contained in this category are more logically referred to as problems, e.g., WEIGHT LOSS and PALPITATIONS. COSTAR is a trademark of the Massachusetts General Hospital.

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