JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH

Summer Institute / HIT Series

Health Informatics Standards

(Medical Language and Classification Systems)

Hadi Kharrazi *MHI MD PhD*
kharrazi@jhu.edu

Johns Hopkins University
- *School of Public Health*
- *School of Medicine*

1 hr / ~70 slides

Overview

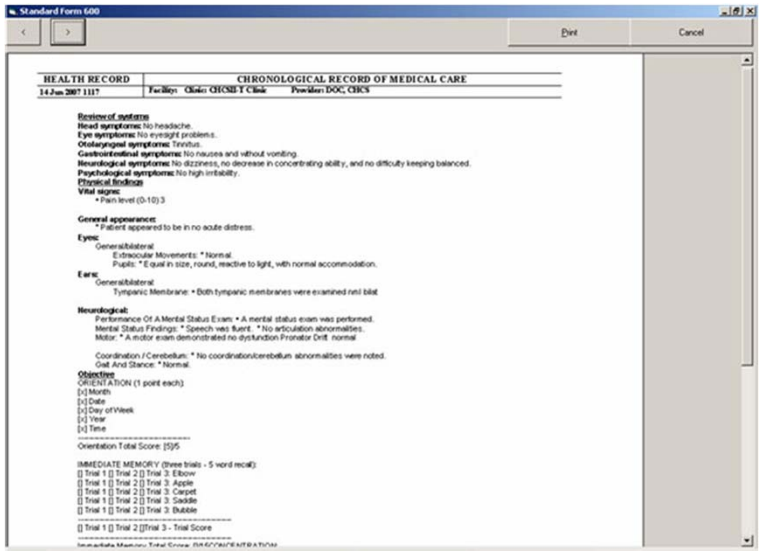
- Introduction
- Classification Methods & Challenges
- Classification Systems
  - Dx: ICD, ICPC, DSM, SNOMED, ICD-O, ICPM, RCC, DRG
  - Procedures: CPT/ICD-CM
  - Lab: LOINC
  - Rx: ATC, RxNorm, NDC
  - Research: MeSH
- Unified Medical Language System
- Resources
  - Books
  - Web

JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH

Introduction

Introduction

- In the traditional patient record, data are available in written format (free text and sometimes numeric)
- Usually many medical terms are ill-defined and are perhaps even ambiguous except for the author of the patient record
- Many patient data are becoming available in computer based patient records (CPRs) and the use of these data for purposes other than traditional archiving is becoming feasible.
- Decision Support Systems may support care such as checking for drug interactions and contraindications → however, many of them will not be feasible unless the free text has a certain structure.

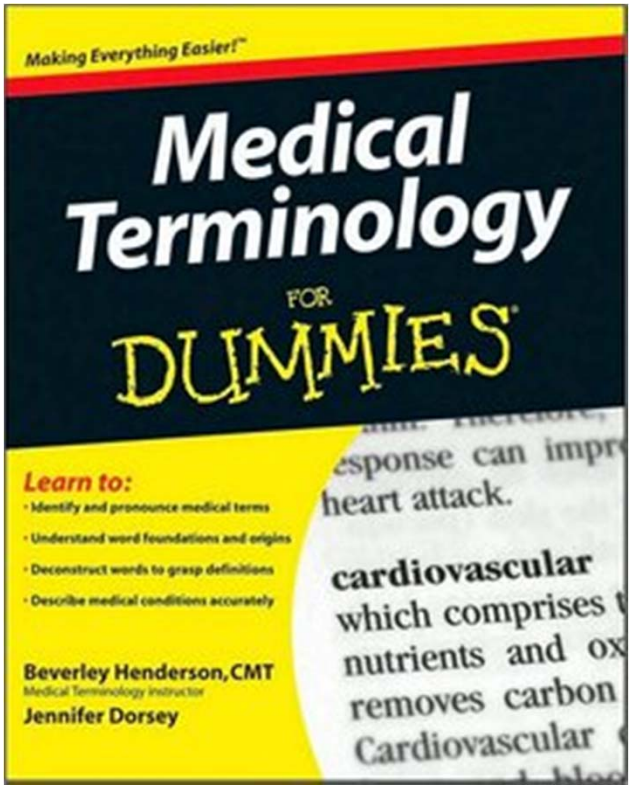


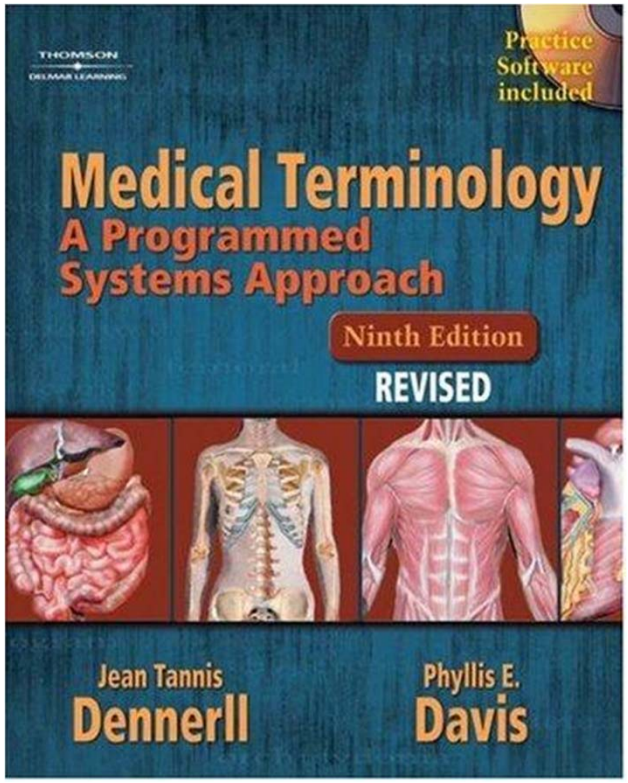
Introduction (cont.)

Application Areas	Advantages of Coding Medical Data
• Patient care	• Data reduction
• Quality control by: o uniform reporting of results o comparing data with those from other units or centers o protocol management o increased insight	• Standardized terminology • Enabling statistical overviews and research • Support of management and planning
• Medical research, including epidemiology	• Coupling with decision-support systems
• Planning and management	

Reasons for Storing Coded Medical Data in a Computer

Introduction (cont.)

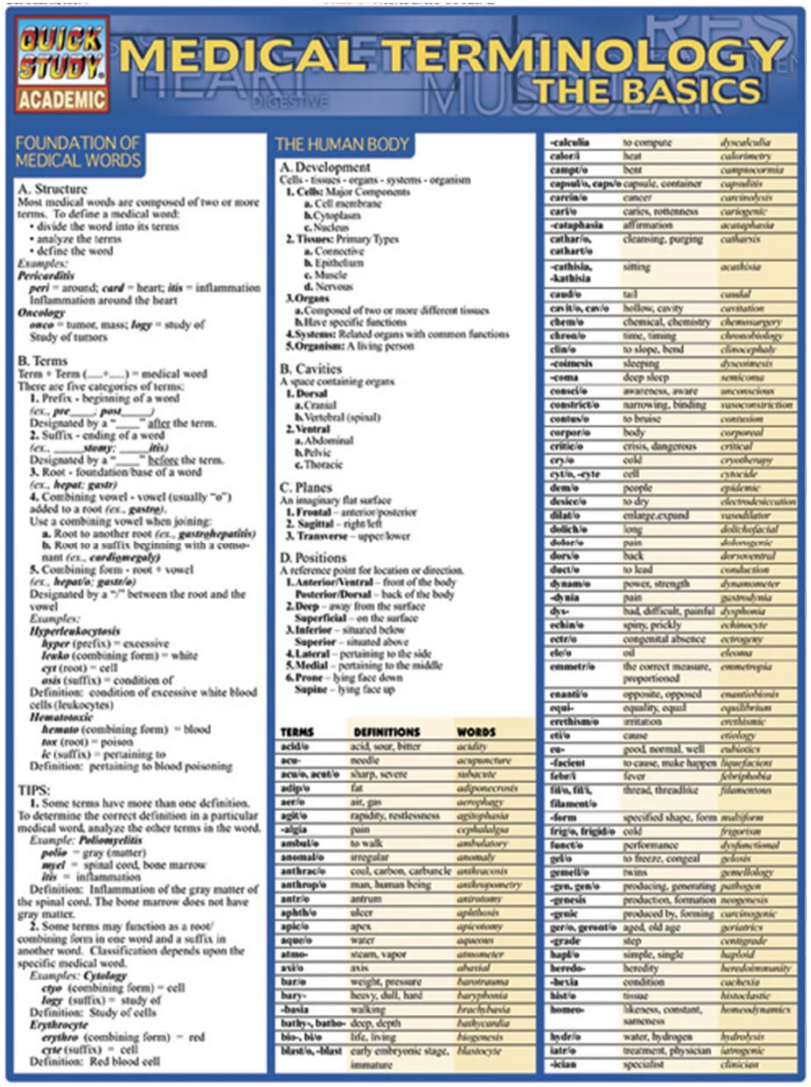




Medical Terminology

Introduction (cont.)

- The free text leads to an infinite list of possible expressions. However statistical overviews and decision support systems can cope with only a finite number of classes.
- The appropriate level of detail and the structure of the classification system depend on the purpose for which the classification system has been designed.
- It must be possible to present all medically relevant expressions in CPRs without any data reduction. Therefore, standardized terminologies are used in these type of applications.



QUICK STUDY ACADEMIC

MEDICAL TERMINOLOGY
THE BASICS

FOUNDATION OF MEDICAL WORDS

A. Structure
Most medical words are composed of two or more terms. To define a medical word:
- divide the word into its terms
- analyze the terms
- define the word

Examples:
Pericarditis
peri = around; ***card*** = heart; ***itis*** = inflammation
Inflammation around the heart
Oncology
onco = tumor, mass; ***logy*** = study of
Study of tumors

B. Terms
Term + Term (.....+.....) = medical word
There are five categories of terms:
1. Prefix - beginning of a word
*(ex., **pre_____**, **post_____**)*
Designated by a "_____" after the term.
2. Suffix - ending of a word
*(ex., _____**stomy**; _____**itis**)*
Designated by a "_____" before the term.
3. Root - foundation/base of a word
*(ex., **hepat**; **gastr**)*
4. Combining vowel - vowel (usually "o") added to a root *(ex., **gastro**)*.
Use a combining vowel when joining:
a. Root to another root *(ex., **gastrohepatitis**)*
b. Root to a suffix beginning with a consonant *(ex., **cardiomegaly**)*
5. Combining form - root + vowel
*(ex., **hepat/o**; **gastr/o**)*
Designated by a "/" between the root and the vowel
Examples:
Hyperleukocytosis
hyper (prefix) = excessive
leuko (combining form) = white
cyt (root) = cell
osis (suffix) = condition of
Definition: condition of excessive white blood cells (leukocytes)
Hematotoxic
hemato (combining form) = blood
tox (root) = poison
ic (suffix) = pertaining to
Definition: pertaining to blood poisoning

TIPS:
1. Some terms have more than one definition. To determine the correct definition in a particular medical word, analyze the other terms in the word.
*Example: **Poliomyelitis***
polio = gray (matter)
myel = spinal cord, bone marrow
itis = inflammation
Definition: Inflammation of the gray matter of the spinal cord. The bone marrow does not have gray matter.
2. Some terms may function as a root/combining form in one word and a suffix in another word. Classification depends upon the specific medical word.
*Examples: **Cytology***
cyto (combining form) = cell
logy (suffix) = study of
Definition: Study of cells
Erythrocyte
erythro (combining form) = red
cyte (suffix) = cell
Definition: Red blood cell

THE HUMAN BODY

A. Development
Cells - tissues - organs - systems - organism
1. **Cells:** Major Components
a. Cell membrane
b. Cytoplasm
c. Nucleus
2. **Tissues:** Primary Types
a. Connective
b. Epithelium
c. Muscle
d. Nervous
3. **Organs**
a. Composed of two or more different tissues
b. Have specific functions
4. **Systems:** Related organs with common functions
5. **Organism:** A living person

B. Cavities
A space containing organs
1. **Dorsal**
a. Cranial
b. Vertebral (spinal)
2. **Ventral**
a. Abdominal
b. Pelvic
c. Thoracic

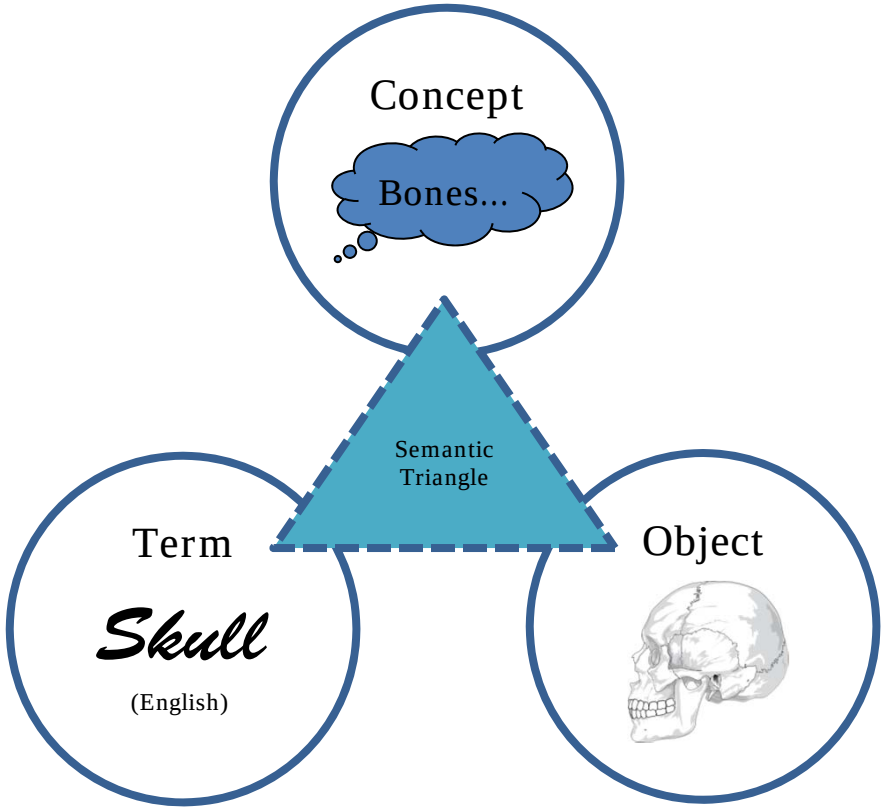
C. Planes
An imaginary flat surface
1. **Frontal** – anterior/posterior
2. **Sagittal** – right/left
3. **Transverse** – upper/lower

D. Positions
A reference point for location or direction.
1. **Anterior/Ventral** – front of the body
Posterior/Dorsal – back of the body
2. **Deep** – away from the surface
Superficial – on the surface
3. **Inferior** – situated below
Superior – situated above
4. **Lateral** – pertaining to the side
5. **Medial** – pertaining to the middle
6. **Prone** – lying face down
Supine – lying face up

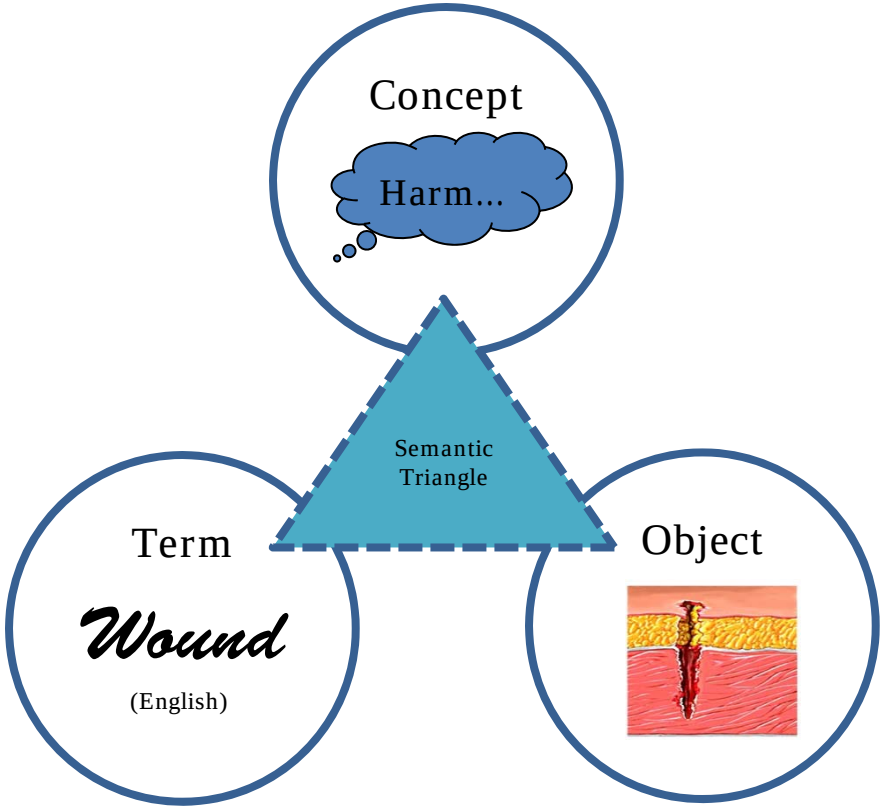
TERMS	DEFINITIONS	WORDS
acid/o	acid, sour, bitter	*acidity*
acu-	needle	*acupuncture*
acut/o, acut/o	sharp, severe	*subacute*
adip/o	fat	*adiponecrosis*
aer/o	air, gas	*aerophagy*
agit/o	rapidity, restlessness	*agitophasia*
-algia	pain	*cephalalgia*
ambul/o	to walk	*ambulatory*
anomal/o	irregular	*anomaly*
anthrac/o	coal, carbon, carbuncle	*anthracosis*
anthrop/o	man, human being	*anthropometry*
antr/o	antrum	*antrotomy*
aphth/o	ulcer	*aphthosis*
apic/o	apex	*apicotomy*
aque/o	water	*aqueous*
atmo-	steam, vapor	*atmometer*
axi/o	axis	*abaxial*
bar/o	weight, pressure	*barotrauma*
bary-	heavy, dull, hard	*baryphonia*
-basia	walking	*brachybasia*
bathy-, batho-	deep, depth	*bathycardia*
bio-, bi/o	life, living	*biogenesis*
blast/o, -blast	early embryonic stage, immature	*blastocyte*
-calculia	to compute	*dyscalculia*
calor/i	heat	*calorimetry*
campt/o	bent	*camptocormia*
capsul/o, caps/o	capsule, container	*capsulitis*
carcin/o	cancer	*carcinolysis*
cari/o	caries, rottenness	*cariogenic*
-catalysis	affirmation	*acatalysia*
cathar/o, cathart/o	cleansing, purging	*cathartic*
-cathisia, -kathisia	sitting	*acathisia*
caud/o	tail	*caudal*
cavit/o, cav/o	hollow, cavity	*cavitation*
chem/o	chemical, chemistry	*chemosurgery*
chron/o	time, timing	*chronobiology*
clin/o	to slope, bend	*clinocephaly*
-coimesis	sleeping	*dyscoimesis*
-coma	deep sleep	*semicoma*
consci/o	awareness, aware	*unconscious*
constrict/o	narrowing, binding	*vasoconstriction*
contus/o	to bruise	*contusion*
corpor/o	body	*corporeal*
critic/o	crisis, dangerous	*critical*
cry/o	cold	*cryotherapy*
cyt/o, -cyte	cell	*cytocide*
dem/o	people	*epidemic*
desicc/o	to dry	*electrodesiccation*
dilat/o	enlarge,expand	*vasodilator*
dolich/o	long	*dolichofacial*
dolor/o	pain	*dolorogenic*
dors/o	back	*dorsoventral*
duct/o	to lead	*conduction*
dynam/o	power, strength	*dynamometer*
-dynia	pain	*gastrodynia*
dys-	bad, difficult, painful	*dysphonia*
echin/o	spiny, prickly	*echinocyte*
ect/o	congenital absence	*ectrogeny*
ele/o	oil	*eleoma*
emmetr/o	the correct measure, proportioned	*emmetropia*
enanti/o	opposite, opposed	*enantiobiosis*
equi-	equality, equal	*equilibrium*
erythrism/o	irritation	*erythrismic*
eti/o	cause	*etiology*
eu-	good, normal, well	*eubiotics*
-facient	to cause, make happen	*liquefacient*
febr/i	fever	*febriphobia*
fil/o, fil/i, filament/o	thread, threadlike	*filamentous*
-form	specified shape, form	*multiform*
frig/o, frigid/o	cold	*frigorism*
funct/o	performance	*dysfunctional*
gel/o	to freeze, congeal	*gelosis*
gemell/o	twins	*gemellology*
-gen, gen/o	producing, generating	*pathogen*
-genesis	production, formation	*neogenesis*
-genic	produced by, forming	*carcinogenic*
ger/o, geront/o	aged, old age	*geriatrics*
-grade	step	*centigrade*
haplo/o	simple, single	*haploid*
heredo-	heredity	*hereditary*
-hexia	condition	*cachexia*
hist/o	tissue	*histolastic*
homeo-	likeness, constant, sameness	*homeodynamics*
hydr/o	water, hydrogen	*hydrolysis*
iatr/o	treatment, physician	*iatrogenic*
-ician	specialist	*clinician*

Introduction (cont.)

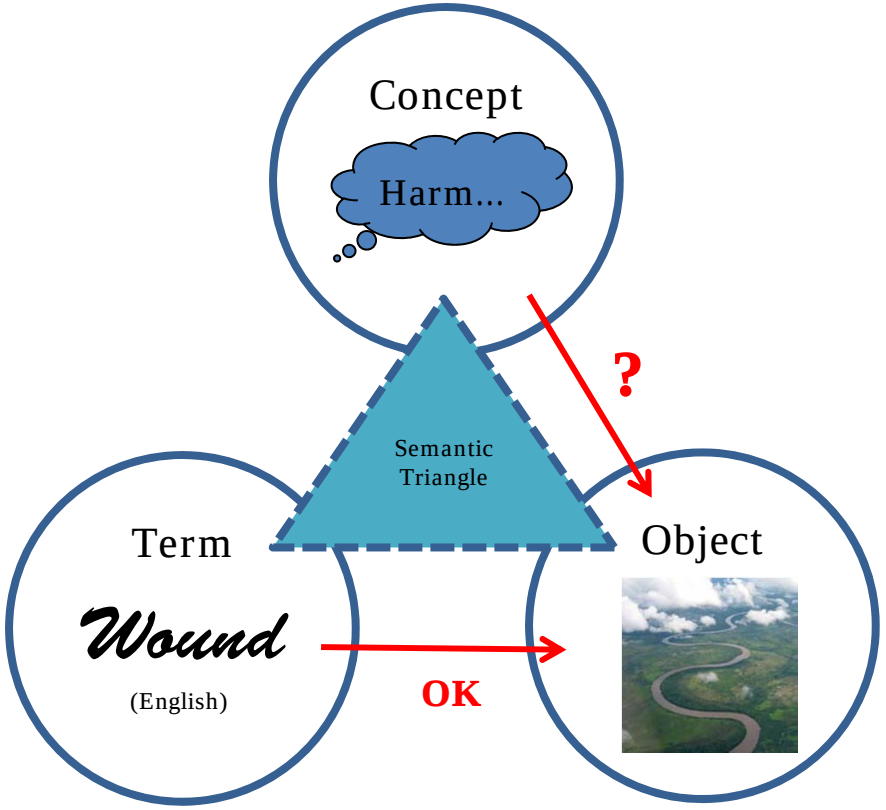
- Three basic elements are used in the so-called semantic triangle: Object, Concept and Term.
- **Object**: also called referents, are particular things in reality, and they are concrete (e.g. the stomach), as well as abstract (e.g. the mind).
- **Concept**: a concept is a unit of thought formed by using the common properties of a set of objects (e.g. an organ)
- **Term**: a term is a designation by a linguistic expression of a concept of an object in a specific language.



Introduction (cont.)

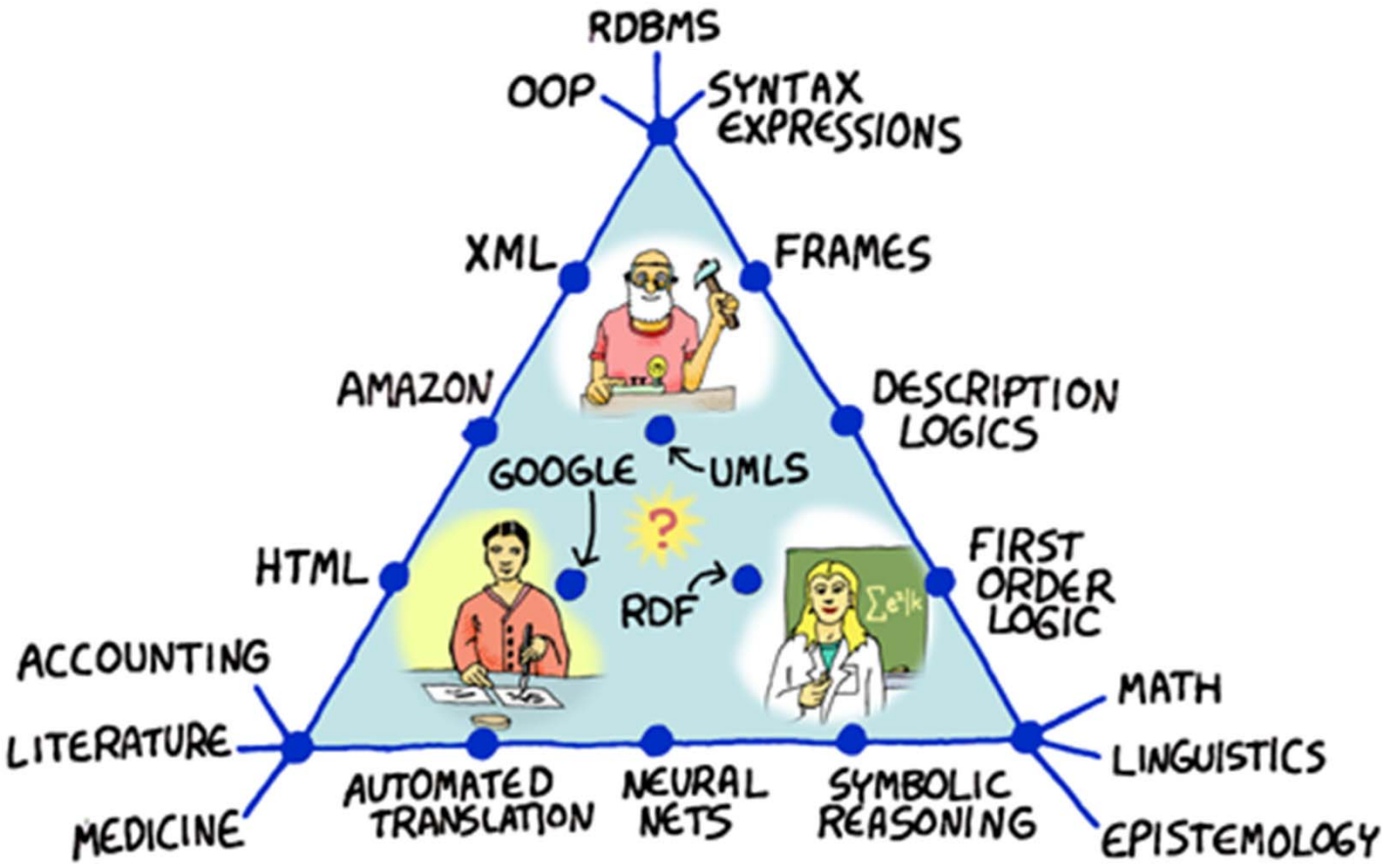


Introduction (cont.)



(past tense of wind)

Introduction (cont.)

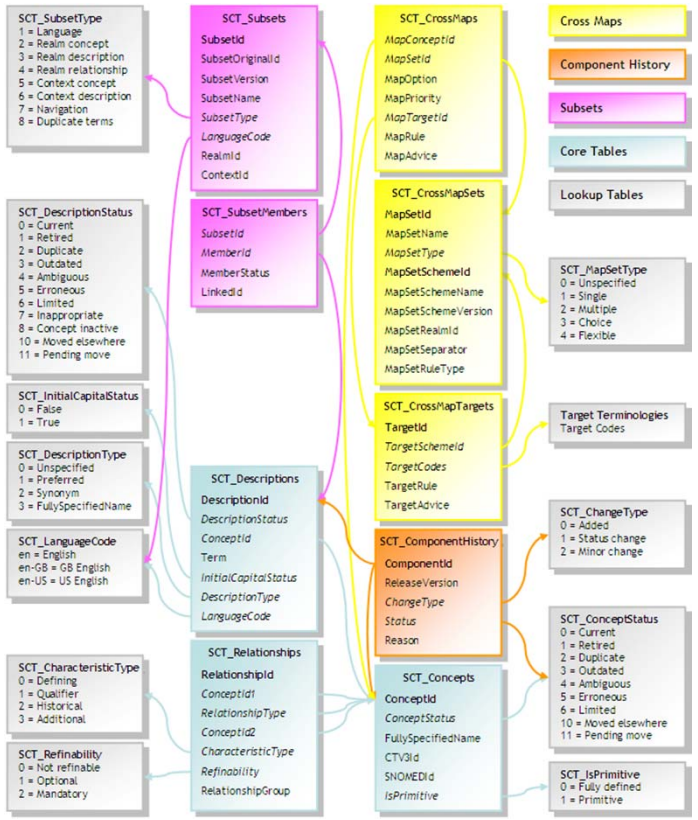


JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH

Classification Methods and Challenges

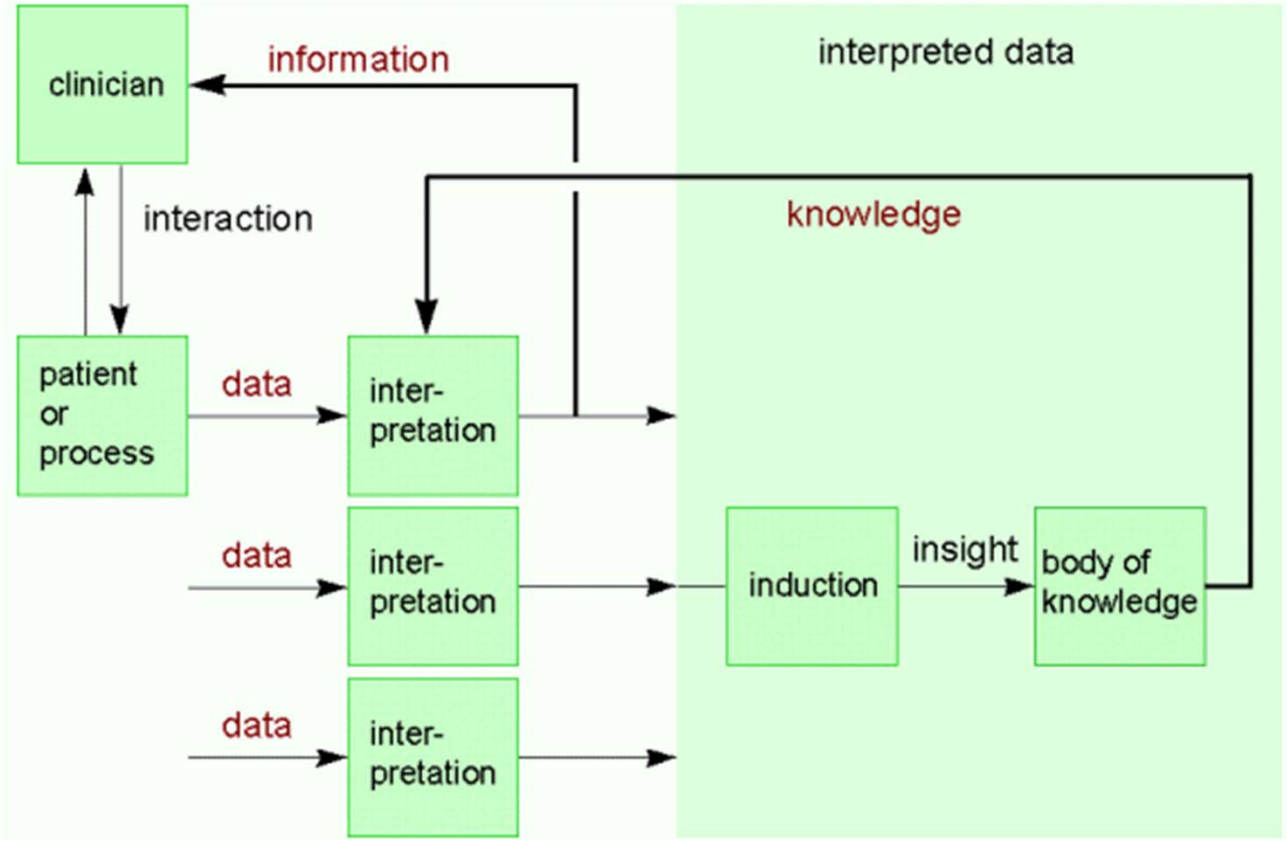
Classification Methods and Challenges

- A classification is an ordered system of concepts within a domain, with implicit or explicit ordering principles → depends on their intended use.
- A classification is based on prior knowledge and forms a key to the extension of knowledge.
- The purpose of classification is to support the generation of health case statistics or to facilitate research such as classifying diagnosis of the patients into disease classes.
- In a classification, concepts are ordered according to generic relations. Generic relations are relations of the type 'A is a kind of B'. For example, pneumonia is a kind of lung disease, where pneumonia represents the narrower concept and lung disease represents the broader concept.



SNOMED-CT Schema

Classification Methods and Challenges (cont.)



A patient or a biological process generates data that are observed by the clinician. Information is derived from the data by interpretation, which is fed back to the clinician. By inductive reasoning with the interpreted data, collected from many similar patients or processes, new knowledge is obtained, which is added to the body of knowledge in medicine. This knowledge is used for the interpretation of other data.

Classification Methods and Challenges (cont.)

- Classifications contain concepts within a certain domain. Example of domains are reason for encounter, diagnosis, and medical procedure. ICD9 is a classification of diagnosis.
- A classification allows one to compare findings collected in different environments. For instance if we want to compute the number of beds required per age category in a hospital we could use the following age classes:

Babies	age	0 - 3
Children	age	4 -12
Teenagers	age	13 -18
Adults	age	19 - 64
Elderly	age	65+

- In this simple example, classifying is done according to a single criterion: age (differentiating criterion)

Classification Methods and Challenges (cont.)

Requirements for a classification	Additional requirements for computer-assisted coding systems
1. Domain completeness 2. Non-overlapping classes (mutual exclusiveness) 3. Suitable for its purpose 4. Homogeneous ordering (one principle per level) 5. Clear criteria for class boundaries 6. Unambiguous and complete guidelines for application 7. Appropriate level of detail	1. Allow for the use of synonyms 2. Allow for the use of lexical variations 3. Insensitive to spelling errors 4. Reliability • Consistent operation (insensitive to ordering of terms) • Correct

Requirements for a classification and additional requirements for computer-assisted coding systems

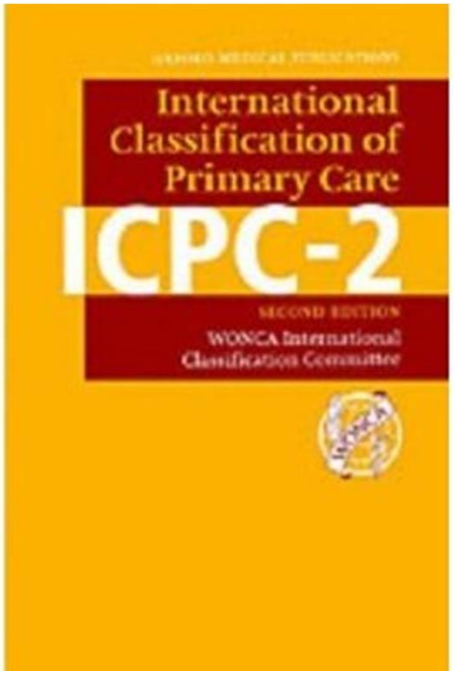
Classification Methods and Challenges (cont.)

- **Ordering System**

- In classifications that use more than one ordering principle the situation is more complicated. In classifying diseases we deal with the following aspects among others: anatomic location, etiology, morphology and dysfunction.

- Such an ordering throughout a classification is called an axis. Multiaxial classifications use several ordering simultaneously. In the International Classification of Primary Care (ICPC) the diagnoses are classified along two axes, one for the organ systems (an alphabetic characters) and one for the component (a number).

- In ICPC the classes are chosen in such a way that for health care studies in primary care, each class will contain a sufficient number of cases. For the same reason for example all tropical diseases are grouped together which is not appropriate for tropical countries.



Classification Methods and Challenges (cont.)

First axis: organ systems

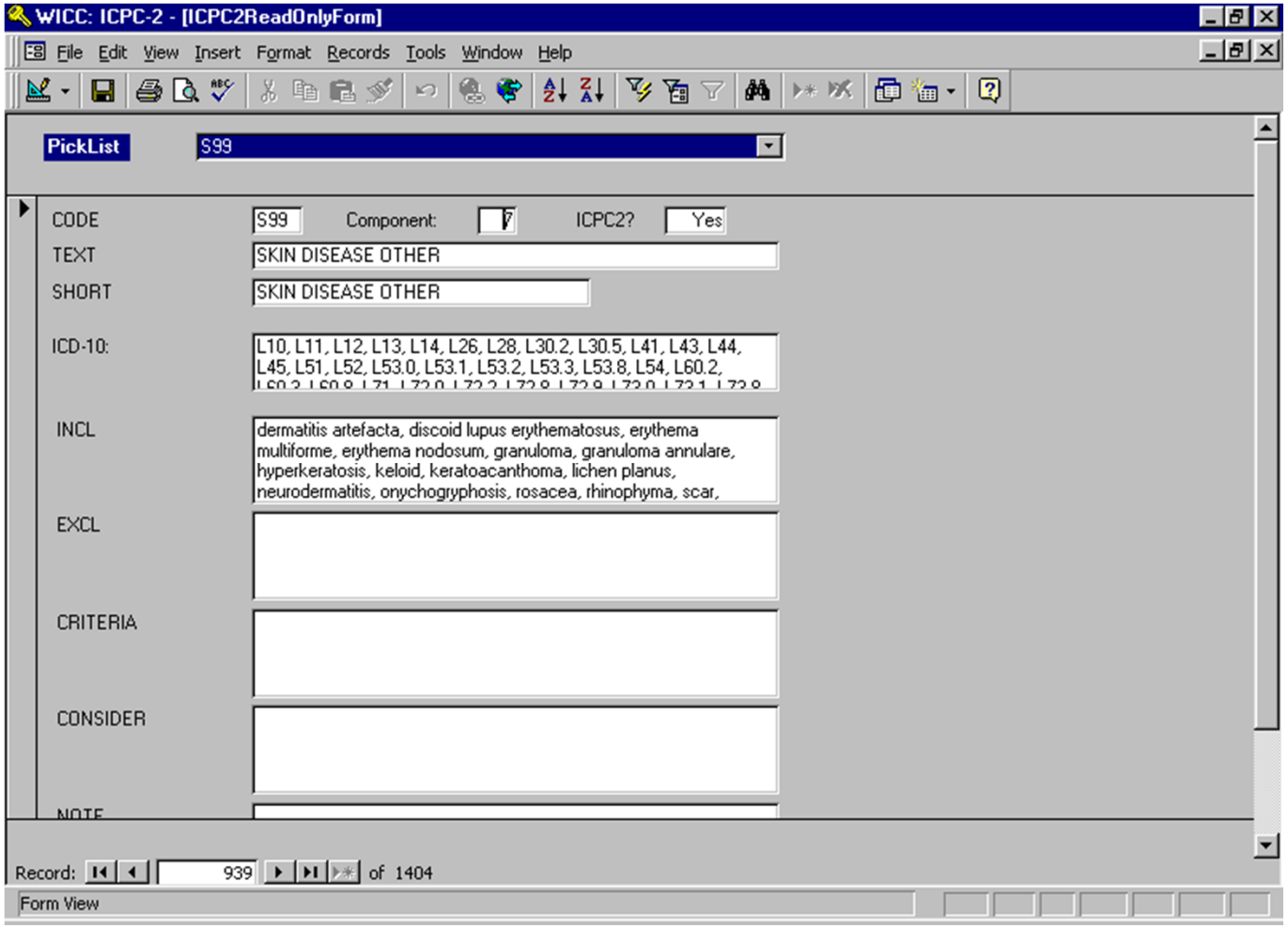
Code	Organ System
A	General and unspecified
B	Blood
D	Digestive
F	Eye
H	Ear
K	Circulatory
L	Musculoskeletal
N	Neurological
P	Psychological
R	Respiratory
S	Skin
T	Endocrine and metabolic
U	Urology
W	Pregnancy and family planning
X	Female genital system
Y	Male genital system
Z	Social problems

Second axis: components

Code	Component
1 - 29	Symptoms and complaints
30 - 49	Diagnostic screening and prevention
50 - 59	Treatment and medication
61 - 61	Test results
62	Administrative
63 - 69	Other
70 - 99	Diagnoses

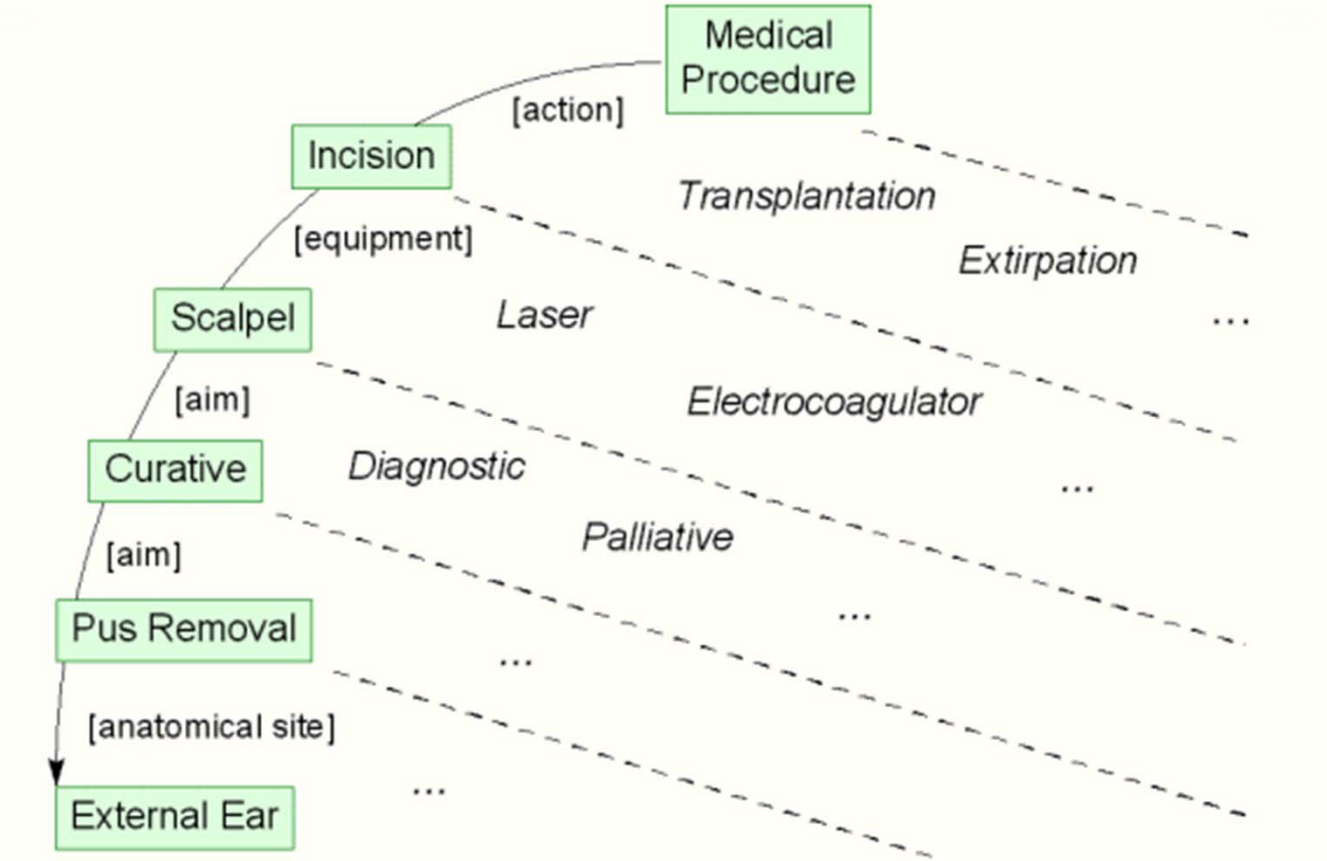
The Two-Axial ICPC

Classification Methods and Challenges (cont.)



The ICPC MS Access database

Classification Methods and Challenges (cont.)



Example of a multilevel classification of medical procedures.
The differentiating criteria are indicated between rectangles.
The criteria for membership in each subclass are not adopted here.

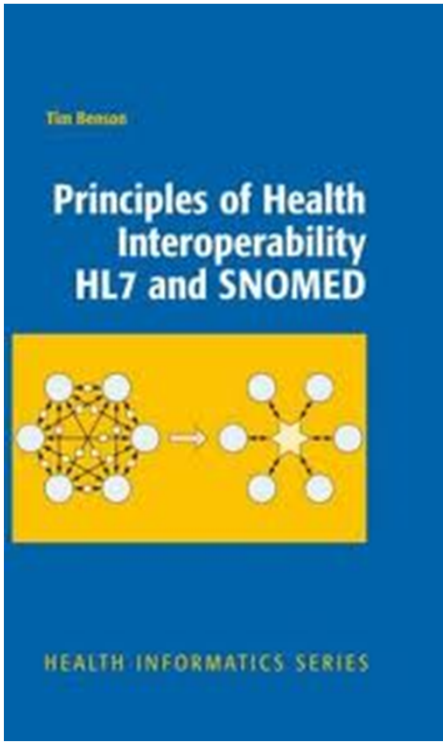
Classification Methods and Challenges (cont.)

- **Nomenclatures and Thesauri**

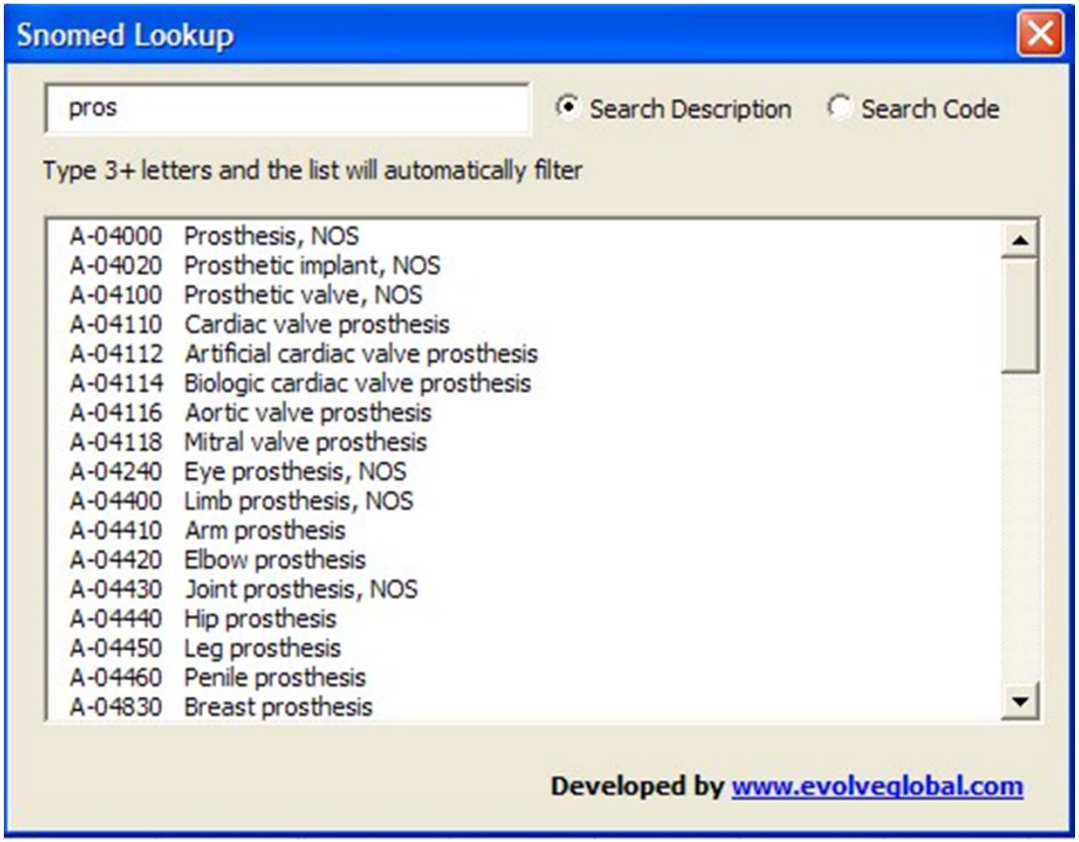
- One of the problems of uniform registration in health care is the lack of a common terminology.

- A **thesaurus** is a list of terms used for a certain application area or domain. Examples are a list of diagnostic terms. A thesaurus is always intended to be complete for its domain. Sometimes it contains a list of synonyms for each preferred term which simulates the usage of standardized terminology.

- In a **nomenclature** codes are assigned to medical concepts and medical concepts can be combined according to specific rules to form more complex concepts. This leads to a large number of possible code combinations. A nomenclature is useful in producing standardized reports such as discharge letters. SNOMED is a popular nomenclature.



Classification Methods and Challenges (cont.)



The SNOMED lookup database

Classification Methods and Challenges (cont.)

The SNOMED mobile lookup database

Classification Methods and Challenges (cont.)

- **Codes**

- Coding is the process of assigning an individual object or case to a class or to a set of classes in the case of a multiaxial classification. In most classifications classes are designated by codes. Codes may be formed by numbers, alphabets or both.

- **Number codes**: Sequential (each new class will be given the next unused number – adding new classes is easy), Random (hiding patient information), Reserved Series (for sets of classes when no expansion of the set of classes is expected)

- **Mnemonic codes**: formed from one or more characters of its related class rubric which helps memorizing them. This coding is good for limited lists of classes. (ENT, ...)

- **Hierarchical codes**: are formed by extending an existing code with one or more additional characters for each additional level of detail. ICD9 uses hierarchical coding system.

Classification Methods and Challenges (cont.)

- **Juxtaposition codes**: are composite codes consisting of segments. Each segment provides a characteristic of the associated class. ICPC uses juxtaposition coding system.
- **Combination codes**: is based on ordering principles (20 actions, 10 equipments, 5 aims and 100 anatomical site = almost 100,000 classes). By using a six-digit combination code (four segments) for each principle a coding clerk has to distinguish only a limited number (135) codes.
- **Value addition codes**: only powers of 2 are used as a representation of a data item or class. Example:

  2^0 = 1 for smoker/ 0 nonsmoker
  2^1 = 2 for overweight / 0 for no overweight
  2^2 = 4 for high blood pressure / 0 for no blood pressure

  number 7 represents 1+2+4 → smoker/overweight/high blood pressure and number 5 represents 1+0+4 → smoker/no overweight/high blood pressure

Classification Methods and Challenges (cont.)

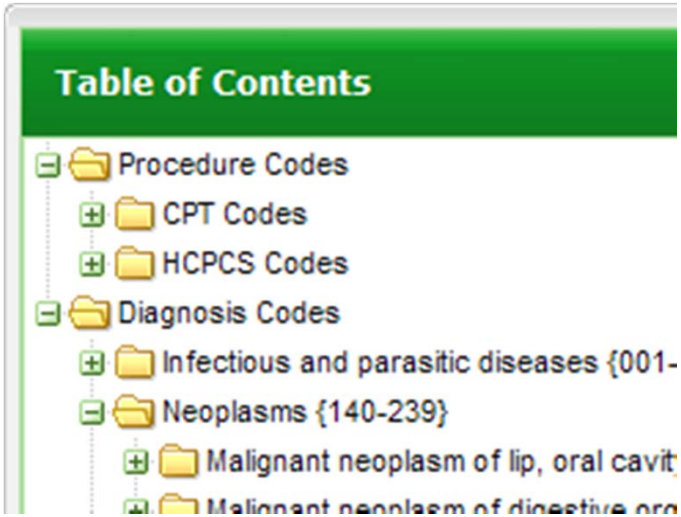
- **Taxonomy**

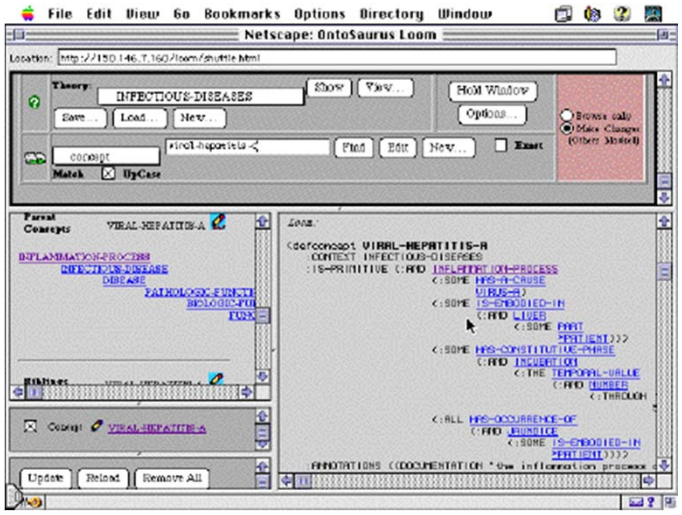
- Taxonomy is the theoretical study of classification including its basic principles, procedures and rules (science of classification).

- All objects in a group have some features in common that is they fall within the boundaries of a group. A group maybe further subdivided on the basis of another feature or character.

- In ICD9, the classification and subdivision are preformed by the grouping of diseases in organ systems or by etiology.

- The different chapters (main disease categories or etiological categories) of ICD-9 are subdivided into groups, the groups are divided into three-digit classes and so on.

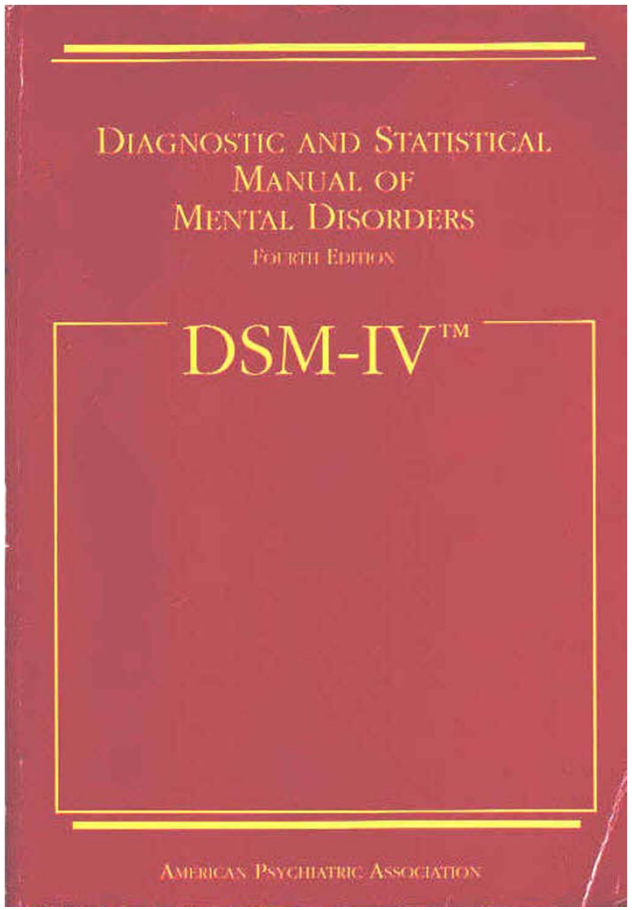




Classification Methods and Challenges (cont.)

- **Nosology**

- Nosology is usually defined as the science of the classification of diseases. It usually involves syndromes, disorders, injuries and diseases (taxonomy of diagnostic terms).
- Nosology explains the definition of the diseases (only essential characteristics of the diseases) but nosography explains the description of the diseases (includes accidental characteristics that are correlated with the essence of the disease).
- There is a growing feeling that classifications such as ICD, SNOMED and DSM-IV (Diagnostic and Statistical Manual for Mental Disorders) do not justice to the way in which diagnostic terms are actually used in heath care and that a new paradigm is needed.



Classification Methods and Challenges (cont.)

ARA Criteria for the Classification of Rheumatoid Arthritis

1.	Morning stiffness
2.	Arthritis of three or more joint areas
3.	Arthritis of hand joints
4.	Symmetric arthritis
5.	Rheumatoid nodules
6.	Serum rheumatoid factor
7.	Typical radiographic changes

At least four of the seven criteria must be fulfilled

Classification Challenges (cont.)

- Classification problems concern the ordering of concepts in a way that is logically sound, elegant and user friendly. Coding problems concern the technical support to enable coding clerks to assign an individual case to the right class.
- **Classification Problems**

  Not all combinations that can generated are sensible. For example a "transplantation to remove an abscess" is not sensible. Sometimes they are ambiguous.

  We cannot always apply each ordering principle to all diseases. For example using etiology as the ordering principle, we can classify "viral pneumonia" as a viral disease, but we cannot classify "pneumonia" with the same degree of certainty to any etiological class. Therefore pneumonia will be classified using an anatomical ordering principle such as pulmonary disease.

  The dynamic nature of classification explains the continuous need for maintenance of classifications such as ICD and SNOMED. For example AIDS was first only classified as immune disease but then after they found out it has a viral cause, they also classified it as a viral disease.

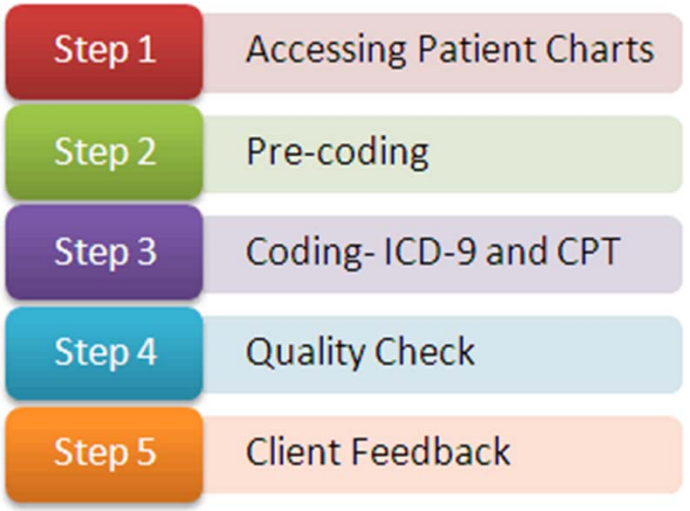
Classification Challenges (cont.)

- **Coding Problems**

  The basic problem is that the language used in the classification is rather different from the clinical language found in the patient record.

  Two solutions are available:

  - Morpho-Semantic → grouping the stem words into similar categories
  - Synonym Thesaurus → pointing the unknown term to an existing entry in the classification by its synonyms



Classification History

- (1629) First Attempt at registration was the London Bills of Mortality.
- (1893) International List of Causes of Death (ILCD) by Jacques Bertillon
- (1933) Standard Classified Nomenclature of Disease (SNOD)
- (1938) Fifth edition of the ILCD was published by ISI (International Statistical Institute)
- (1946) WHO officially becomes responsible to undertake ILCD and create a similar one for morbidity.
- (1948) 6th revision of ILCD
- (1955) 7th revision of ILCD
- (1961) 5th and the last edition of SNOD
- (1965) Systematic Nomenclature of Pathology (SNOP) with 4 axes
- (1965) 8th revision of ILCD
- (1975) 9th which is renamed to ICD-9 – later ICD-9CM (clinical modifications)
- (1976) International Classification of Procedures in Medicine (ICPM)
- (1979) Systematized Nomenclature of Human and Veterinary Med (SNOMED) 7-11 axes
- (1989) 10th releasing ICD-10 (classification by etiology rather than manifestation of the diseases)

JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH

Classification Systems

Classification Systems

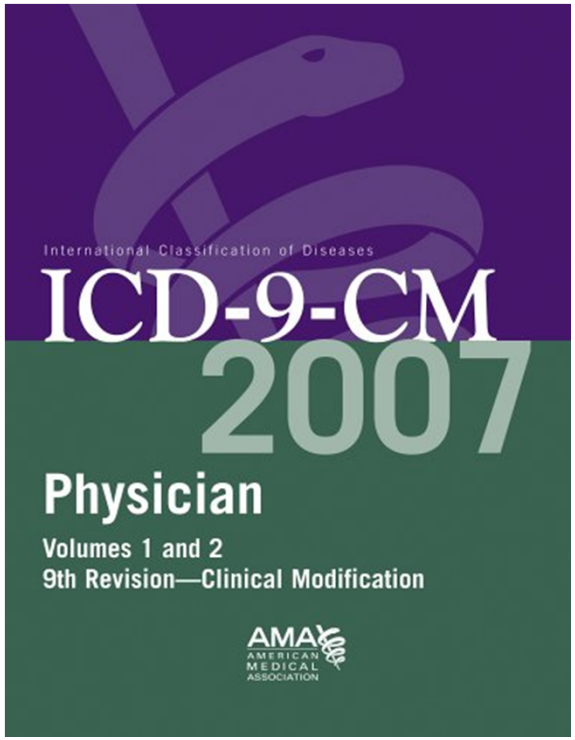
- **ICD (International Classification of Diseases)**

  ICD the standard coding system for patient record abstraction. The first edition was published in 1900 and almost every 10 year is being revised.

  WHO is responsible for its maintenance. The latest version is ICD-10 (at the time of the creation of this slide) which is released in 1992.

  ICD consists of a core classification of three-digit codes, which are the minimum requirement for reporting mortality statistics to WHO. An optional fourth digit provides an additional level of detail.

  At all levels, the numbers 0 to 7 are used for further detail, whereas the number 8 is reserved for all other cases and the number 9 is reserved for unspecified coding.



Classification Systems (cont.)

The basic ICD is meant to be used for coding diagnostic item terms but ICD-9 (and 10) also contain a set of expansions for other medical terms. For instance, ICD-9 also contains a list of codes starting with the letter "V" for reasons of encounter, or the letter "E" for external causes of death.

The U.S. National Center for Health Statistics has published ICD-9-CM which is fully compatible with ICD-9 but it contains an extra level of detail where needed such as medical procedures.

A00-B99	Infectious and parasitic diseases
C00-D48	Neoplasms
D50-D89	Disorders of the blood … involving the immune mechanism
E00-E90	Endocrine, nutritional and metabolic diseases
F00-F99	Mental and behavioural disorders
G00-G99	Diseases of the nervous system
H00-H59	Disease of Ear and Mastoid Process
…	…

A00	**Intestinal infectious diseases**
A00.0	Cholera due to Vibrio cholerae 01, biovar cholerae, **Classical cholera**
A00.1	Cholera due to Vibrio cholerae 01, biovar eltor, **Cholera eltor**
A00.9	Cholera, unspecified
A01	**Typhoid and paratyphoid fevers**

http://www.who.int/classifications/icd/en/

Classification Systems (cont.)

Chapter	Blocks	Title
I	A00-B99	Certain infectious and parasitic diseases
II	C00-D48	Neoplasms
III	D50-D89	Diseases of the blood and blood-forming organs and certain disorders involving
IV	E00-E90	Endocrine, nutritional and metabolic diseases
V	F00-F99	Mental and behavioural disorders
VI	G00-G99	Diseases of the nervous system
VII	H00-H59	Diseases of the eye and adnexa
VIII	H60-H95	Diseases of the ear and mastoid process
IX	I00-I99	Diseases of the circulatory system
X	J00-J99	Diseases of the respiratory system
XI	K00-K93	Diseases of the digestive system
XII	L00-L99	Diseases of the skin and subcutaneous tissue
XIII	M00-M99	Diseases of the musculoskeletal system and connective tissue
XIV	N00-N99	Diseases of the genitourinary system
XV	O00-O99	Pregnancy, childbirth and the puerperium
XVI	P00-P96	Certain conditions originating in the perinatal period
XVII	Q00-Q99	Congenital malformations, deformations and chromosomal abnormalities
XVIII	R00-R99	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere
XIX	S00-T98	Injury, poisoning and certain other consequences of external causes
XX	V01-Y98	External causes of morbidity and mortality
XXI	Z00-Z99	Factors influencing health status and contact with health services
XXII	U00-U99	Codes for special purposes

The ICD-10 chapter headings

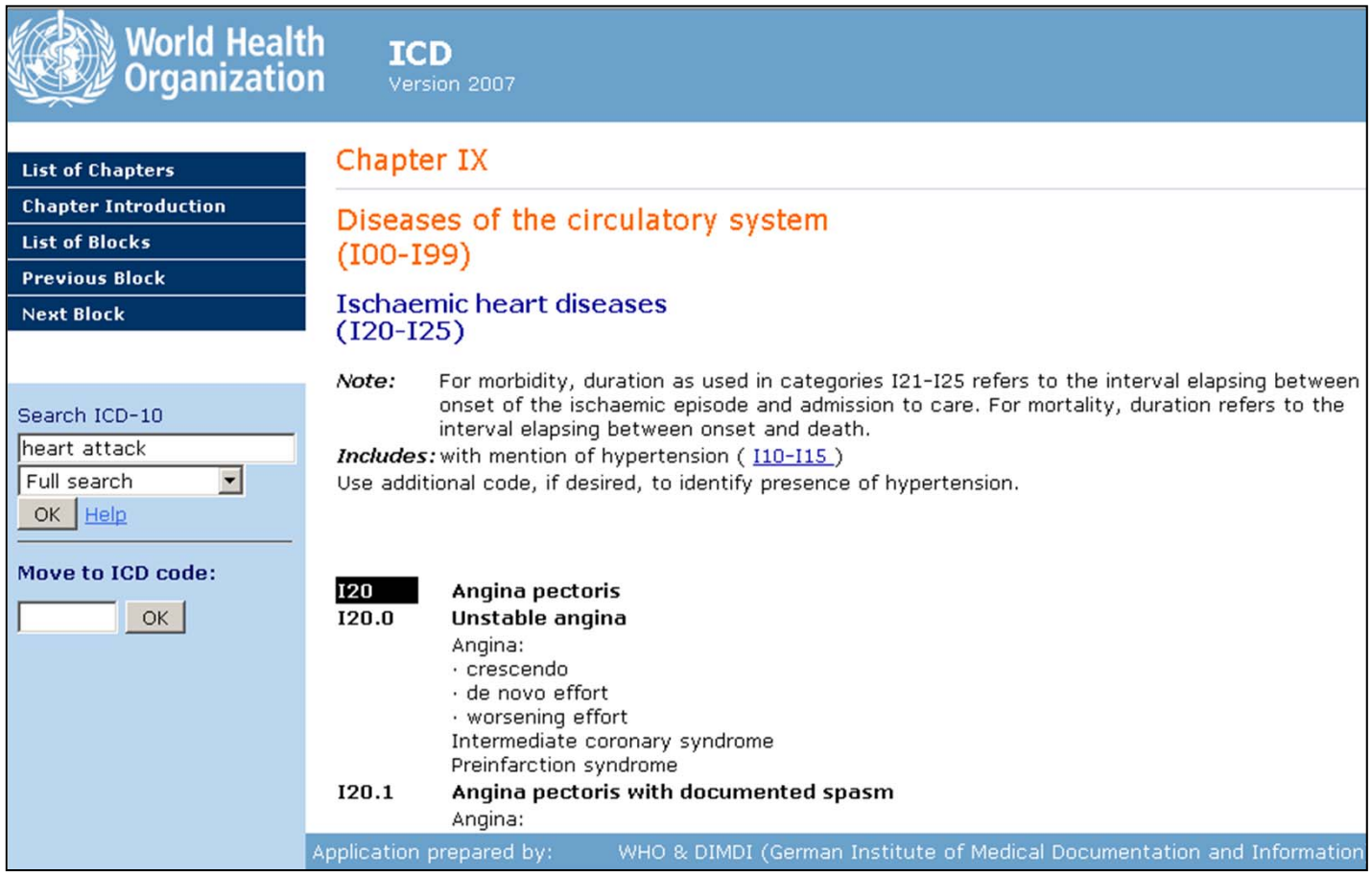
http://www.who.int/classifications/apps/icd/icd10online/

Classification Systems (cont.)

Code				Disease
001	-	139		Infectious and parasitic diseases
001	-	009		Infectious diseases of the digestive tract
003				Other Salmonella Infections
	-		003.0	Salmonella gastroenteritis
	-		003.1	Salmonella Septicemia
	-		003.2	Localized Salmonella Infections
	-		003.20	Localized Salmonella Infection, Unspecified
	-		003.21	Salmonella Meningitis
	-		003.22	Salmonella Pneumonia
	-		003.23	Salmonella Arthritis
	-		003.24	Salmonella Osteomyelitis
	-		003.29	Other Localized Salmonella Infections
	-		003.8	Other Specified Salmonella Infections
	-		003.9	Salmonella Infections, Unspecified

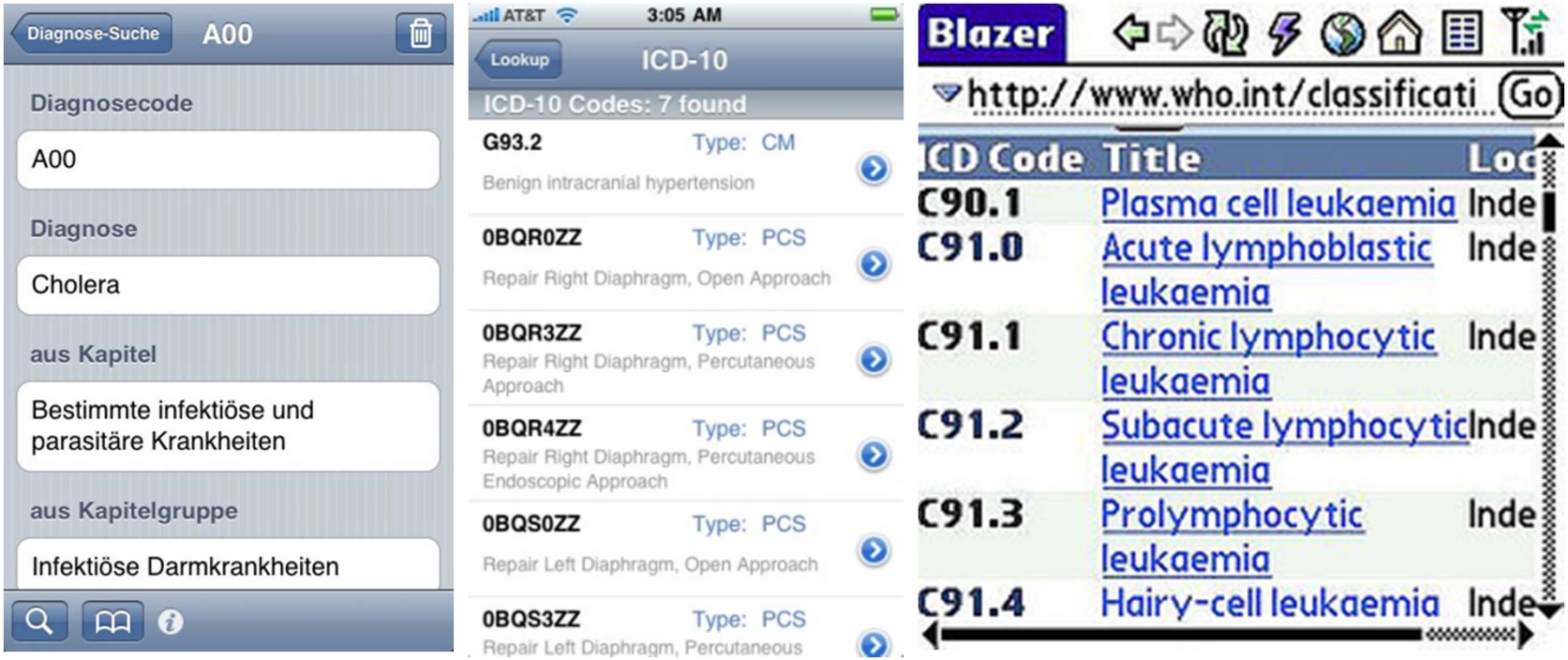
Example of a Four-Digit Code Level in ICD-9 and the Five-Digit Code Level as Extended by the ICD-9-CM.

Classification Systems (cont.)



ICD10 on WHO's website

Classification Systems (cont.)



ICD9 and ICD10 on various mobile platforms

Classification Systems (cont.)

- **ICPC (International Classification of Primary Care)**

  The World Organization of National Colleges, Academies and Academic Associations of General Practitioners (WONCA) did not accept ICD-9 and came up with ICPC.

  ICPC is less granular than ICD. ICPC contains not only diagnostic codes, but also codes for reasons for encounter (RfE), therapies and lab tests.

  ICPC is a two-axis system: first one is oriented toward the body system (coded by letters) and the second one is the component (coded by two digit numbers). For example the diagnosis of pneumonia is coded as R81 (R for respiratory tract and 81 for the diagnostic component).

  ICPC is used to encode encounters structured according to the SOAP (Subjective, Objective, Assessment and Plan) which helps it to organize patient-oriented information by disease episodes.

Classification Systems (cont.)

First axis: organ systems

Code	Organ System
A	General and unspecified
B	Blood
D	Digestive
F	Eye
H	Ear
K	Circulatory
L	Musculoskeletal
N	Neurological
P	Psychological
R	Respiratory
S	Skin
T	Endocrine and metabolic
U	Urology
W	Pregnancy and family planning
X	Female genital system
Y	Male genital system
Z	Social problems

Second axis: components

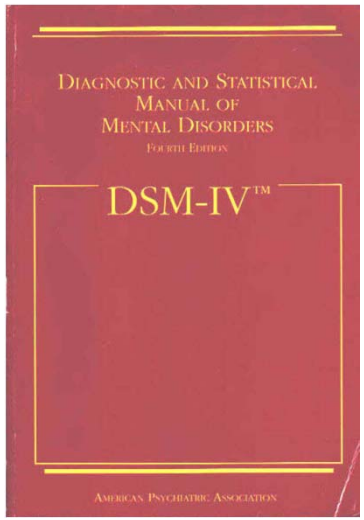
Code	Component
1 - 29	Symptoms and complaints
30 - 49	Diagnostic screening and prevention
50 - 59	Treatment and medication
61 - 61	Test results
62	Administrative
63 - 69	Other
70 - 99	Diagnoses

The Two-Axial ICPC

Classification Systems (cont.)

- **DSM (Diagnostic and Statistical Manual for Mental Disorder)**

  DSM was published by American Psychiatric Association (APA) in 1952. The latest version (at the time of the slide creation) **DSM-V** has been coordinated with the development of ICD-10. The classification is intended to be used by psychiatrists.



  The etiology or the pathophysiological processes are only known for some mental disorders. Therefore DSM-V is non-theoretical with regard to etiology or the pathophysiological process except for disorders with an established etiology.

  DSM is designed to describe the clinical manifestation of the disease along several axes. Therefore DSM is a multiaxial classification system based on the following axes:

  (1) clinical syndromes, (2) personality disorders and special developmental disorders, (3) relevant physical conditions, (4) severity of psychological stressors and (5) overall psychological functioning.

Classification Systems (cont.)

A. Either 1 or 2

(1) six (or more) of the following symptoms of inattention have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Inattention:

a) often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities

b) often has difficulty sustaining attention in tasks or play activities

c) often does not seem to listen when spoken to directly

d) often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions)

e) often has difficulty organizing tasks and activities

f) often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)

g) often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, or tools)

h) is often easily distracted by extraneous stimuli i) is often forgetful in daily activities (2) six (or more) of the following symptoms of hyperactivity-impulsivity have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Hyperactivity:

a) often fidgets with hands or feet or squirms in seat

b) often leaves seat in classroom or in other situations in which remaining seated is expected

c) often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness)

d) often has difficulty playing or engaging in leisure activities quietly

e) is often "on the go" or often acts as if "driven by a motor"

f) often talks excessively

Impulsivity:

g) often blurts out answers before questions have been completed

h) often has difficulty awaiting turn

i) often interrupts or intrudes on others (e.g., butts into conversations or games)

B. Some hyperactive-impulsive or inattentive symptoms that caused impairment were present before 7 years of age.

C. Some impairment from the symptoms is present in 2 or more settings (e.g., at school [or work] or at home).

D. There must be clear evidence of clinically significant impairment in social, academic, or occupational functioning.

E. The symptoms do not occur exclusively during the course of a pervasive developmental disorder, schizophrenia, or other psychotic disorder and are not better accounted for by another mental disorder (e.g., mood disorder, anxiety disorder, dissociative disorder, or personality disorder).

DSM IV diagnostic criteria for ADHD

Classification Systems (cont.)

- **SNOMED (Systematized Nomenclature of Human and Veterinary Medicine)**

  SNOMED allows for the coding of several aspects of a disease and therefore it is a multiaxial system.

  SNOMED II had 7 axes but SNOMED international has 11 axes. Each of these axes forms a complete hierarchical classification systems.

  A diagnosis in SNOMED may consist of four codes. For example the disease code D-13510 (Pneumococcal pneumonia) is equivalent to the combination of: T-28000 (topology code for Lung), M-40000 (morphology code for inflammation) and L-25116 (Living organism axis for Streptococcus pneumonia).

  In SNOMED international almost all diagnostic terms of ICD-9-CM are incorporated in the disease module (D-codes).

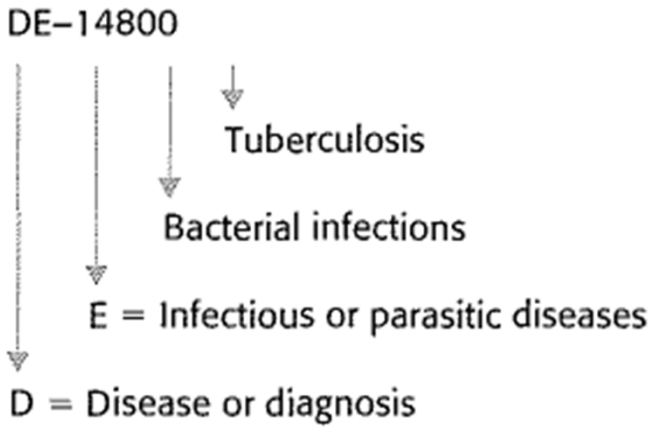
  SNOMED can be combined however the results are not always meaningful.

Classification Systems (cont.)

Axis	Definition	Description
T	Topography	Anatomic terms
M	Morphology	Changes found in cells, tissues and organs
L	Living organisms	Bacteria and viruses
C	Chemical	Drugs
F	Function	Signs and symptoms
J	Occupation	Terms that describe the occupation
D	Diagnosis	Diagnostic terms
P	Procedure	Administrative, diagnostic and therapeutic procedures
A	Physical agents and forces	Devices and activities associated with the disease
S	Social context	Social conditions and important relationships in medicine
G	General	Syntactic linkages and qualifiers

The 11 Axes of SNOMED International.

Classification Systems (cont.)



SNOMED codes are hierarchically structured. Implicit in the code, tuberculosis is an infectious bacterial disease.

Module designator

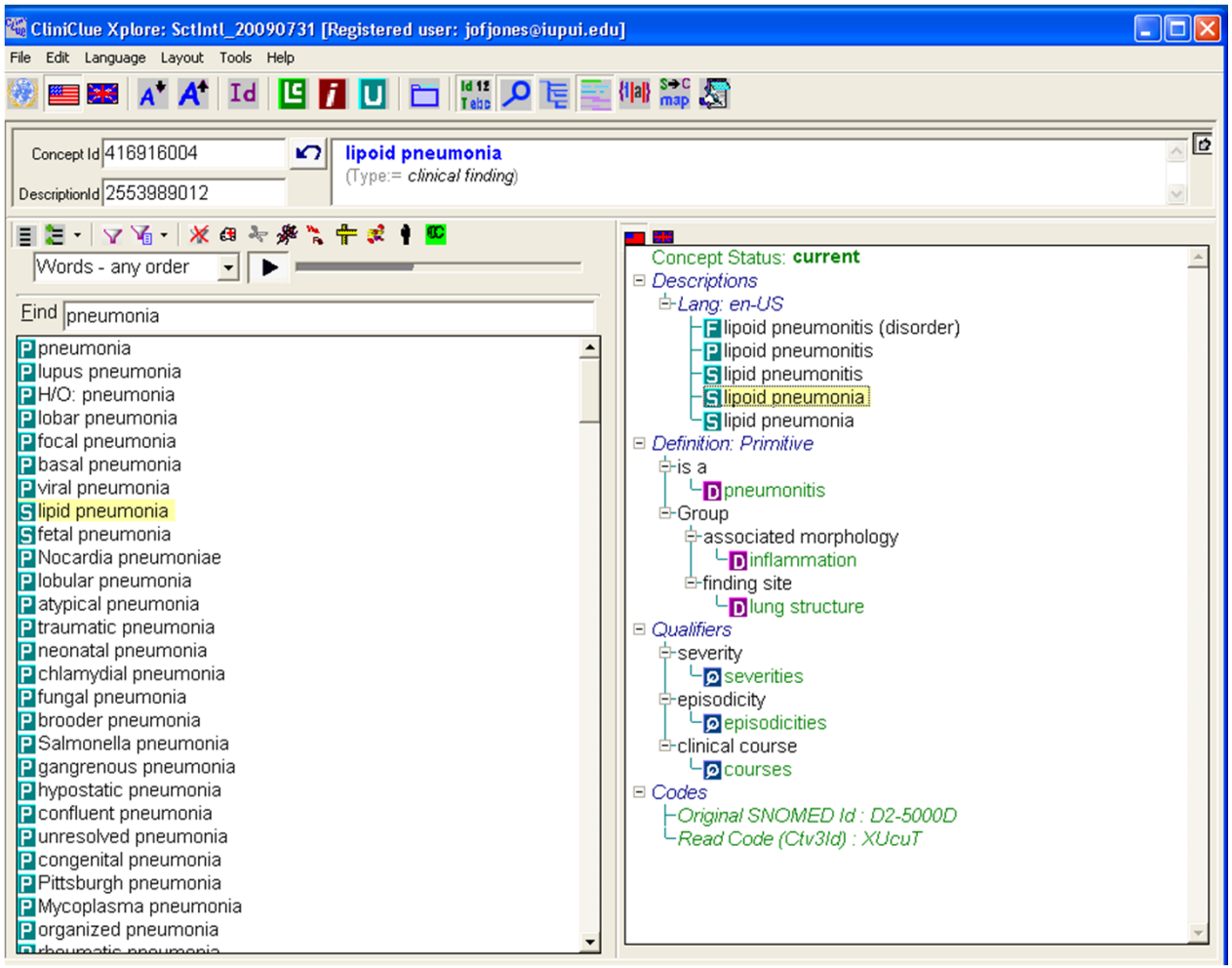
Topography (T)
Morphology (M)
Function (F)
Diseases/diagnoses (D)
Procedures (P)
Occupations (J)
Living organisms (L)
Chemicals, drugs and biological products (C)
Physical agents, forces and activities (A)
Social context (S)
General linkage-modifiers (G)

The SNOMED International modules (or axes).

	Nomenclature				**Classification**
Axis	T	+ M	+ L	+ F	= D
Term	Lung	+ Granuloma	+ *M. tuberculosis*	+ Fever	= Tuberculosis
Code	T-28000	+ M-44000	+ L-21801	+ F-03003	= DE-14800

An example of SNOMED's nomenclature and classification. Some terms (e.g. tuberculosis) can be cross-referenced to others, to give the term a richer clinical context.

Classification Systems (cont.)



SNOMED browser

Classification Systems (cont.)

- **ICD-O (ICD for Oncology)**

  The second edition published in 1990 is an extension of the draft neoplasm chapter of ICD-10.

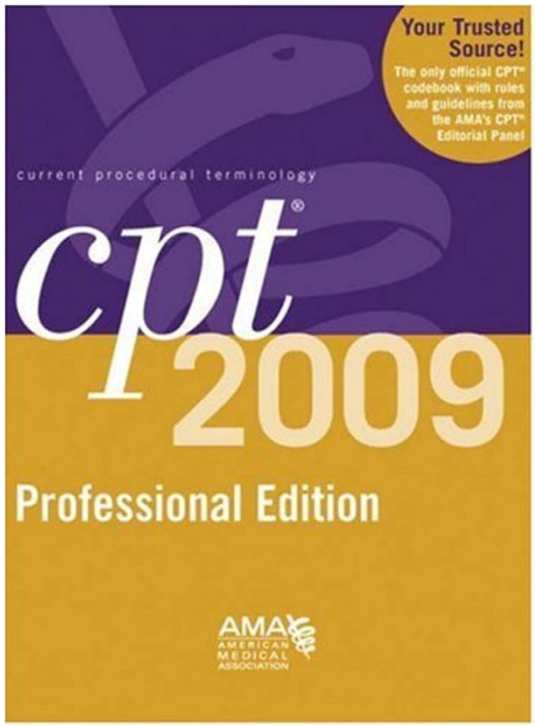
  ICD-O combines a four-digit topography code based on ICD with a morphological code that includes a neoplasm behavior code and a code for histological grading and differentiation.

  ICD-O codes have been adopted in the morphology axes of SNOMED. ICD-O is widely used for cancer registration.

- **CPT (Current Procedural Terminology)**

  CPT is mainly in U.S. for billing and reimbursement.

  It provides a coding scheme for diagnostic and therapeutic procedures that define procedures with codes based on the cost.



Classification Systems (cont.)

- **ICPM (International Classification of Procedures in Medicine)**

  ICPM was published in 1976 by WHO for trial purposes. It contained chapters on diagnostic, laboratory, preventive, surgical and other procedures.

  Unfortunately it was not continued. The procedural part of ICD-9-CM is based on ICPM. ICPM is mandatory in Germany and Netherlands for reimbursement and administration purposes.

- **RCC (Read Clinical Classifications)**

  RCC or Read Code was developed privately by a British GP (James Read) in the early 1980s.

  The British National Health Service (NHS) adopted it in 1990.

  RCC is specially designed to include all of the possible terms used in a CPR (Computerized Patient Record). Synonym, acronym and eponym equivalents are also available.

  RCC has a hierarchical structure with a five digit alphanumeric code. RCC is also cross referenced with ICD-9 and ICD-9-CM.

Classification Systems (cont.)

Diseases
Occupations
History/symptoms
Examinations/signs
Diagnostic procedures
Radiology/diagnostic imaging
Preventive procedures
Operative procedures
Other therapeutic procedures
Administration
Drugs/appliances
Health status measurements
Diagnosis Related Groups (DRGs)

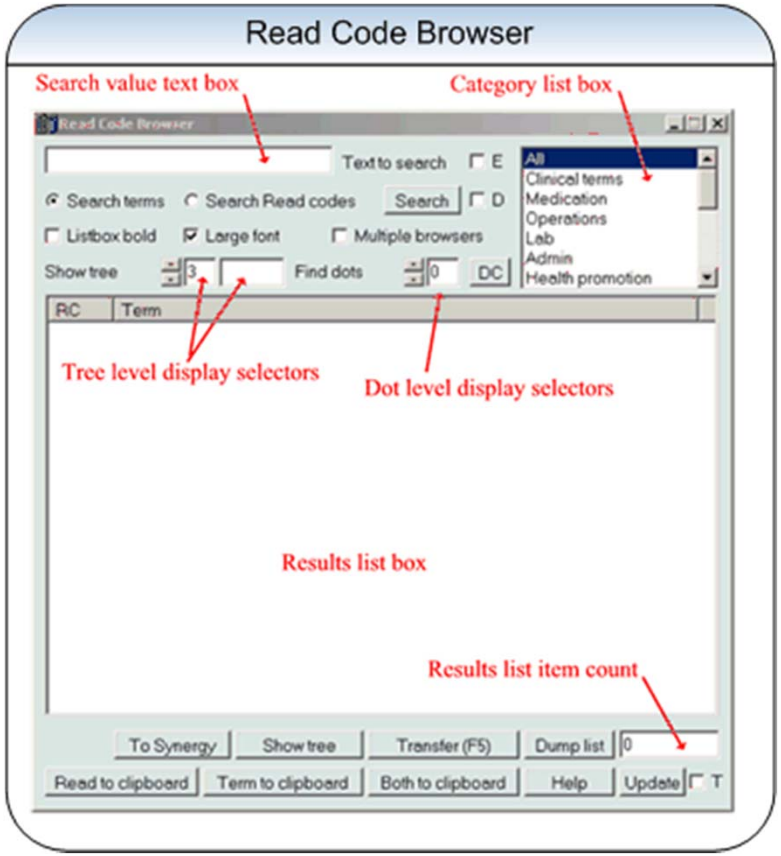
Domains Covered by the British RCC

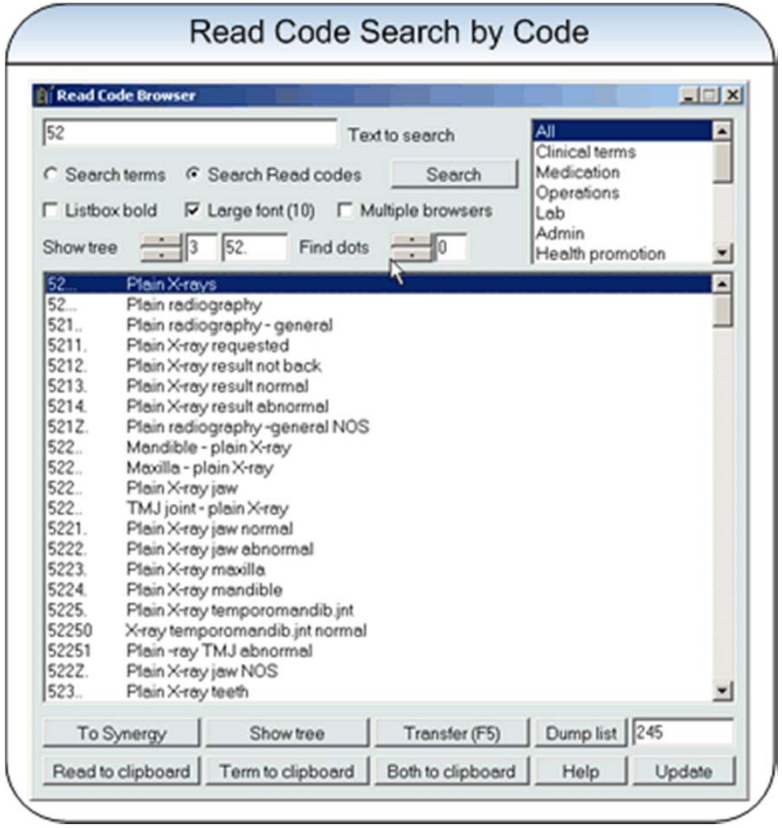
Classification Systems (cont.)

Level	Term	RCC	ICD-9-CM
1	Infectious/parasitic diseases	A	001-139
2	Viral disease with exanthem	A5	050-057
3	Rubella	A56	056
4	Rubella + neurological complications	A560	0560
5	Rubella + encephalomyelitis	A5601	056.01

Example of RCC mapping to ICD-9-CM

Classification Systems (cont.)





RCC browser

Classification Systems (cont.)

- **Current Procedural Terminology (CPT)**
- The American Medical Association developed the Current Procedural Terminology (CPT) in 1966 to provide a precoordinated coding scheme for diagnostic and therapeutic procedures that has since been adopted in the United States for billing and reimbursement.

CPT	CPT Description	Place of Service	POS Code
90801	Initial Diagnostic Interview	All	All
90804, 90806, 90808	Individual Psychotherapy	11 13	Office Assisted Living Facility
90816, 90818, 90822	Individual Psychotherapy	21 31 51 52	Inpatient hospital Skilled Nursing Facility Inpatient psychiatric facility Partial psychiatric facility
96101 96118	Psychological Testing Neuorpsychological Testing	All	All

Sample CPT codes used for physician procedure reporting

Classification Systems (cont.)

- **LOINC**
- Originally called Laboratory Observations, Identifiers, Names and Codes (LOINC), the system has been extended to include non-laboratory observations (vital signs, electrocardiograms), so Logical has replaced Laboratory to reflect the change.

Blood glucose	GLUCOSE:MCNC:PT:BLD:QN:
Plasma glucose	GLUCOSE:MCNC:PT:PLAS:QN:
Serum glucose	GLUCOSE:MCNC:PT:SER:QN:
Urine glucose concentration	GLUCOSE:MCNC:PT:UR:QN:
Urine glucose by dip stick	GLUCOSE:MCNC:PT:UR:SQ:TEST STRIP
Glucose tolerance test at 2 hours	GLUCOSE^2H POST 100 G GLUCOSE PO: MCNC:PT:PLAS:QN:
Ionized whole blood calcium	CALCIUM.FREE:SCNC:PT:BLD:QN:
Serum or plasma ionized calcium	CALCIUM.FREE:SCNC:PT:SER/PLAS:QN:
24-hour calcium excretion	CALCIUM.TOTAL:MRAT:24H:UR:QN:
Whole blood total calcium	CALCIUM.TOTAL:SCNC:PT:BLD:QN:
Serum or plasma total calcium	CALCIUM.TOTAL:SCNC:PT:SER/PLAS:QN:
Automated hematocrit	HEMATOCRIT:NFR:PT:BLD:QN: AUTOMATED COUNT
Manual spun hematocrit	HEMATOCRIT:NFR:PT:BLD:QN:SPUN
Urine erythrocyte casts	ERYTHROCYTE CASTS:ACNC:PT:URNS:SQ: MICROSCOPY.LIGHT
Erythrocyte MCHC	ERYTHROCYTE MEAN CORPUSCULAR HEMOGLOBIN CONCENTRATION:MCNC:PT:RBC:QN:AUTOMATED COUNT
Erythrocyte MCH	ERYTHROCYTE MEAN CORPUSCULAR HEMOGLOBIN:MCNC:PT:RBC:QN: AUTOMATED COUNT

LOINC Code examples

Classification Systems (cont.)

- **RxNorm & NDC**
- The WHO Drug Dictionary is an international classification of drugs that provides proprietary drug names used in different countries.
- Drugs are classified according to the Anatomical-Therapeutic-Chemical (ATC) classification, with cross-references to manufacturers and reference sources.
- The National Drug Codes (NDC), produced by the FDA, is applied to all drug packages.
- RxNorm is the results of a collaboration between the FDA, the NLM, the VA, and the pharmacy knowledge base vendors.

Category	Property	Value
NAMES	RxNorm Name	venlafaxine 100 MG Oral Tablet [Effexor]
	RxNorm Synonym	Effexor 100 MG Oral Tablet
	RxNorm Synonym	Effexor 100 MG (as venlafaxine hydrochloride) Oral Tablet
CODES	RxCUI	208848
	UMLSCUI	C0710468
	NDA	NDA020151
	SPL SET ID	cf2d9bee-f8e3-477a-e4b4-f0e82657b7d2
ATTRIBUTES	TTY	SBD
	HUMAN_DRUG	US
	PRESCRIBABLE	Y
	AVAILABLE_STRENGTH	100 MG
SOURCES	Source	Gold Standard Alchemy
	Source	Multum MediSource Lexicon
	Source	Micromedex RED BOOK
	Source	Metathesaurus FDA National Drug Code Directory
	Source	Metathesaurus FDA Structured Product Labels

Classification Systems (cont.)

- **ATC (Anatomic Therapeutic Chemical Code)**

  ATC has been developed for the systematic and hierarchical classification of drugs.

  ATC is the result of the addition of the Chemical codes in 1970s by the Norwegian Medical Depot to the European Pharmaceutical Market codes.

  Advantages of ATC:

  - It identifies a drug product, including the active substances, the route of administration, and the dose.
  - It is both therapeutically and chemically oriented.
  - It is accepted by WHO

  Disadvantage of ATC: it does not cover combination products, dermatological preparations, and locally compounded preparations.

Classification Systems (cont.)

Five Levels of the ATC Code Illustrated by the Code for Furosemide

ge	Description
C	Cardiovascular system *(1st level, anatomical main group)*
C03	Diuretics *(2nd level, therapeutic main group)*
C03C	High-level diuretics *(3rd level, therapeutic subgroup)*
C03CA	Sulfanomides *(4th level, chemical/therapeutic subgroup)*
C03CA01	Furosemide *(5th level, subgroup for chemical substance)*

At the lowest (5th) level the code also contains information on the defined daily dosage (DDD), the unit of measurement, and the route of administration

Classification Systems (cont.)

Unit	Unit Abbreviation	Route of Administration	Abbreviation for Route of Administration
gram	g	Inhalation	Inhal
milligram	mg	Nasal	N
microgram	mcg	Oral	O
unit	E	Parenteral	P
thousand units	TE	Rectal	R
million units	ME	Sublingual/ buccal	SL
millimole	mmol	Transdermal	Td
milliliter	ml	Vaginal	V

Units and Administration Routes Defined in the ATC code

Classification Systems (cont.)

- **DRG (Diagnosis Related Group)**

  DRG codes are based on ICD-9-CM and other factors not included in ICD-9.

  The grouping of the codes are based on factors that affect the cost of treatment and the length of stay in the hospital, such as severity, complications, and type of treatment.

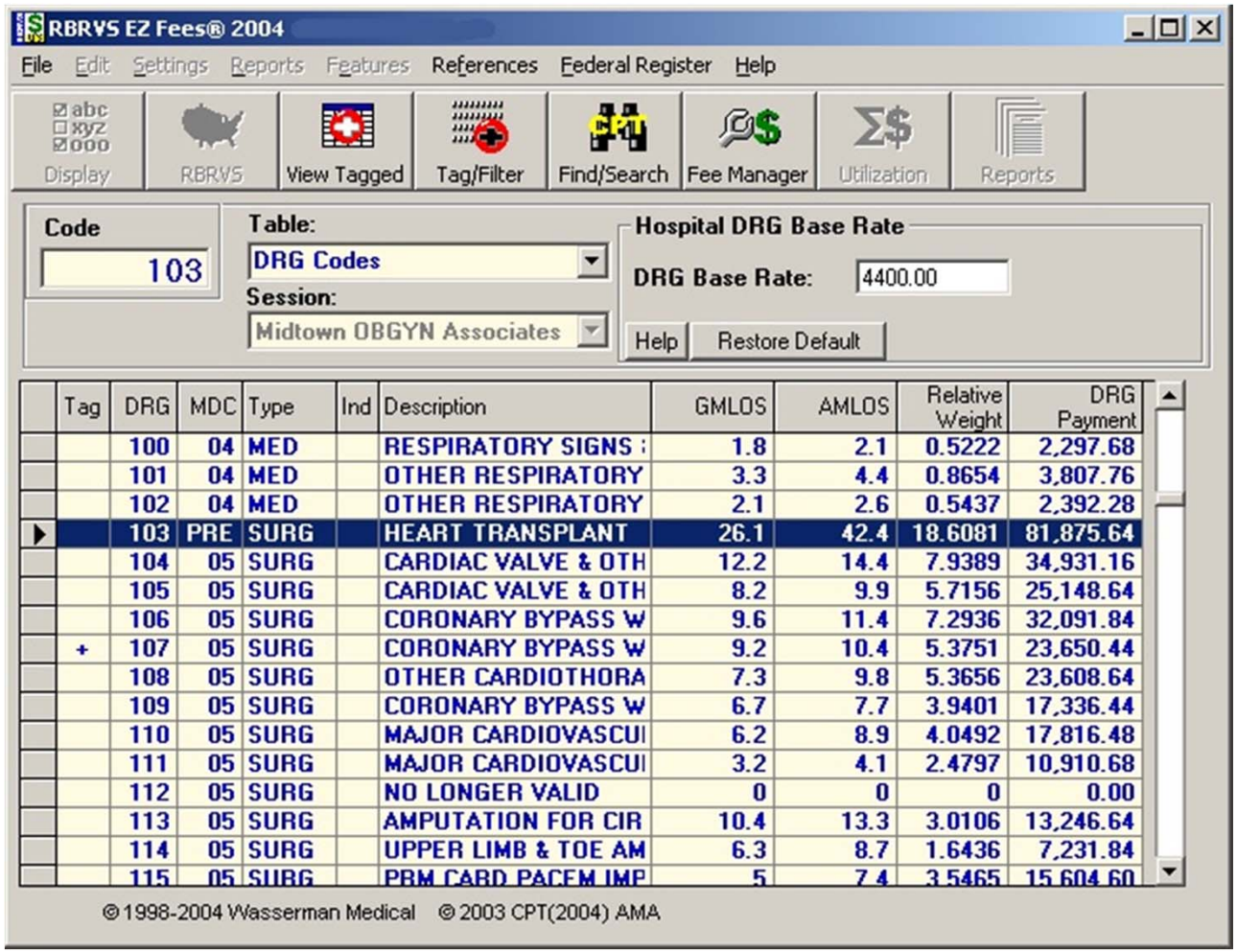
  DRG may be used for budgeting. Because factors related to the delivery of care are included, their usefulness for budgeting is disputable.

  Some disease groups are clustered which is called case mix.

		2001	
Code	Description	No. of Admissions	LOS (days)
373	Vaginal delivery without complication	1175	2.4
391	Normal newborn	878	2.0
1	Craniotomy except for trauma	932	6.9
410	Chemotherapy without leukemia	489	4.8
209	Lower extremity joint replacement	391	5.8
14	Cerebrovascular disorder	278	5.2
389	Full-term neonate with major problems	442	5.6
390	Neonate with other problems	386	3.0
127	Heart failure and shock	297	4.2
143	Chest pain	372	1.2
467	Other factors influencing health	325	2.2
89	Simple pneumonia and pleurisy	284	4.1
371	Cesarean section without complication	296	5.8
144	Other circulatory diagnosis	224	6.3
302	Kidney transplant	280	7.6
372	Vaginal delivery with complication	244	3.2
108	Other cardiovascular procedures	306	11.4
305	Urologic without complication	193	3.3
50	Sialoadenectomy	14	2.3
75	Major chest procedures	193	7.6
182	Gastrointestinal with complication	214	4.1
205	Liver disorders with complication	172	7.3
110	Cardiovascular with complication	213	11.8
25	Seizure and headache	169	4.0
296	Nutritional or metabolic disorder	160	3.9

LOS = length of stay.

Classification Systems (cont.)



DRG Browser

Classification Systems (cont.)

- **MeSH (Medical Subject Headings)**

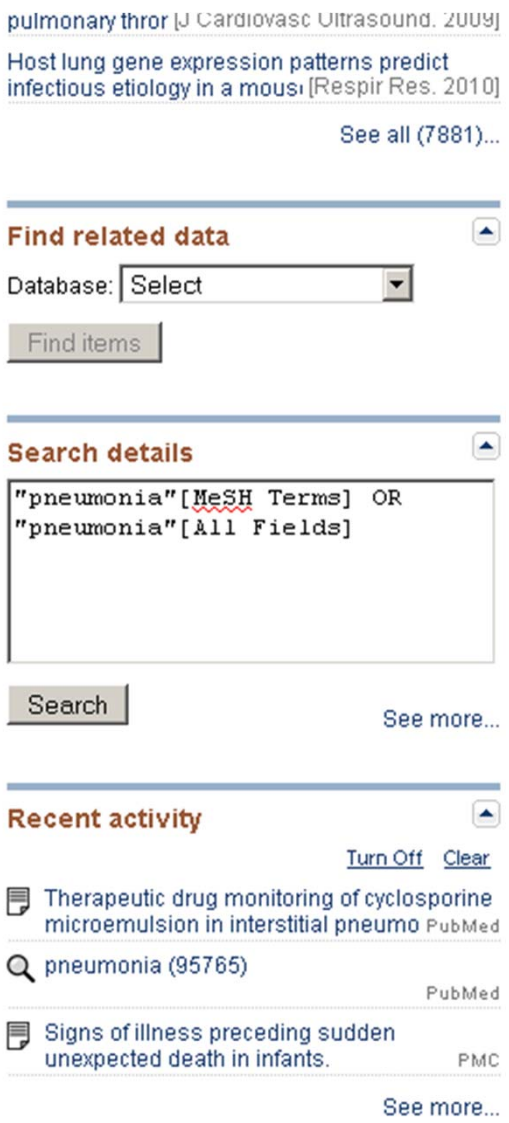
  MeSH is developed and maintained by the National Library of Medicine (NLM) in U.S.

  MeSH is used to index the world medical literature.

  Within MeSH a concept may appear as a narrower concept (hierarchical format).

  MeSH forms the basis for the Unified Medical Language System (UMLS) also developed by NLM.

  UMLS is not a classification system, rather is a project to enhance retrieving information from biomedical sources.



Classification Systems (cont.)

National Library of Medicine - Medical Subject Headings

2010 MeSH

MeSH Descriptor Data

Return to Entry Page

Standard View. Go to Concept View; Go to Expanded Concept View

MeSH Heading	Pneumonia
Tree Number	C08.381.677
Tree Number	C08.730.610
Annotation	general or unspecified; prefer specifics; PNEUMONIA, INTERSTITIAL see LUNG DISEASES, INTERSTITIAL and IDIOPATHIC INTERSTITIAL PNEUMONIAS and its specifics are also available
Scope Note	Inflammation of any part, segment or lobe, of the lung parenchyma.
Entry Term	Experimental Lung Inflammation
Entry Term	Lobar Pneumonia
Entry Term	Lung Inflammation
Entry Term	Pneumonia, Lobar
Entry Term	Pneumonitis
Entry Term	Pulmonary Inflammation

Mesh for Pneumonia

Classification Systems (cont.)

MeSH Tree Structures

Respiratory Tract Diseases [C08]
- Lung Diseases [C08.381]
  - Acute Chest Syndrome [C08.381.074]
  - Cystic Adenomatoid Malformation of Lung, Congenital [C08.381.150]
  - Cystic Fibrosis [C08.381.187]
  - Plasma Cell Granuloma, Pulmonary [C08.381.331]
  - Hemoptysis [C08.381.348]
  - Hepatopulmonary Syndrome [C08.381.385]
  - Hypertension, Pulmonary [C08.381.423] +
  - Lung Abscess [C08.381.450]
  - Lung Diseases, Fungal [C08.381.472] +
  - Lung Diseases, Interstitial [C08.381.483] +
  - Lung Diseases, Obstructive [C08.381.495] +
  - Lung Diseases, Parasitic [C08.381.517] +
  - Lung Injury [C08.381.520] +
  - Lung Neoplasms [C08.381.540] +
  - Pneumonia [C08.381.677]
    - Bronchopneumonia [C08.381.677.127]
    - Pleuropneumonia [C08.381.677.473]
    - Pneumonia, Aspiration [C08.381.677.529] +

Mesh for Pneumonia

JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH

Unified Medical Language System *(UMLS)*

Unified Medical Language System (UMLS)

- The UMLS project is a long-term research and development project at the U.S. National Library of Medicine (NLM) whose goal is to develop resources that will support intelligent information retrieval from a wide range of disparate biomedical information sources.
- The project is directed by a multidisciplinary team, including physicians, computer and information scientists, and linguists, and involves collaboration with many medical informatics research groups.
- The project work has resulted in a set of knowledge sources and accompanying programs that are updated regularly.
- Online access to the UMLS knowledge sources is provided through the Internet-based UMLS Knowledge Source Server, which includes an application programming interface (API) and a World Wide Web interface.
- The Web site requires an access code and may be found at http://umlsks.nlm.nih.gov/

Unified Medical Language System (cont.)

- **UMLS Metathesaurus**

  The Metathesaurus contains information about biomedical concepts and terms from a large number of controlled terminologies and thesauri. The Metathesaurus adds information to the concepts, including semantic types, definitions, and inter-concept relationships.

  The following terminologies are used:

  - the Systematized Nomenclature of Medicine (SNOMED International),
  - the Read Thesaurus,
  - the International Classification of Diseases - Clinical Modification (ICD9-CM),
  - the Universal Medical Device Nomenclature System,
  - the WHO Adverse Drug Reaction Terminology,
  - the Classification of Nursing Diagnoses (NANDA),
  - the Home Health Care Classification of Nursing Diagnoses and Interventions,
  - the Physicians' Current Procedural Terminology (CPT),
  - the Medical Subject Headings (MeSH),
  - the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), and
  - the Thesaurus of Psychological Index Terms

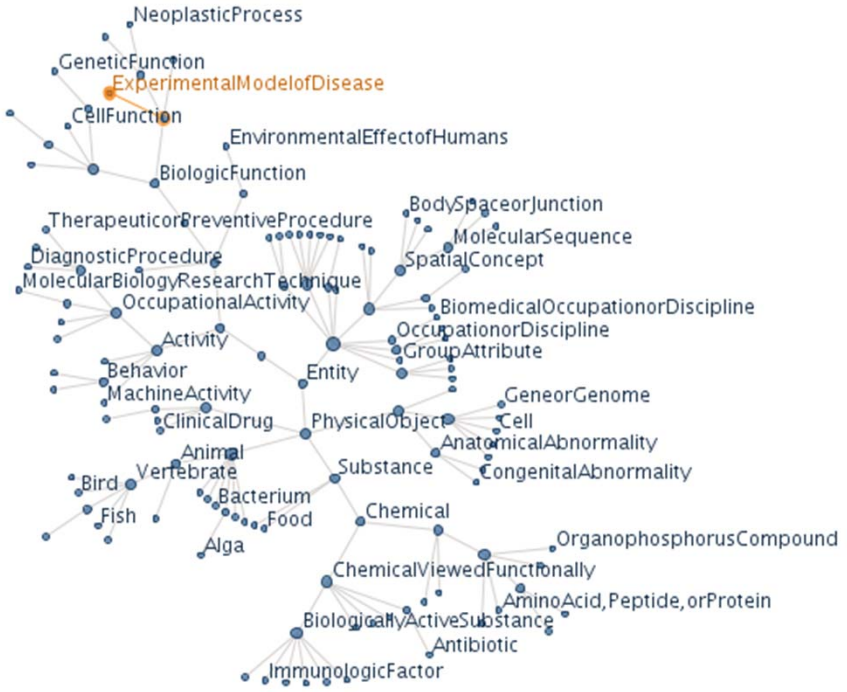
- In addition, translations of some of the terminologies into languages other than English are included.

Unified Medical Language System (cont.)

- **UMLS Semantic Network**

  The Semantic Network, through its high-level semantic types, or categories, provides a consistent categorization of all concepts represented in the Metathesaurus. The links between the semantic types provide the structure for the Network and represent important relationships in the biomedical domain.

  There are semantic types for organisms, anatomical structures, biologic function, chemicals, events, physical objects, and concepts or ideas. The primary relationship is the "is_a" link, and there are five major categories of additional relationships: physical, spatial, temporal, functional, and conceptual relationships.



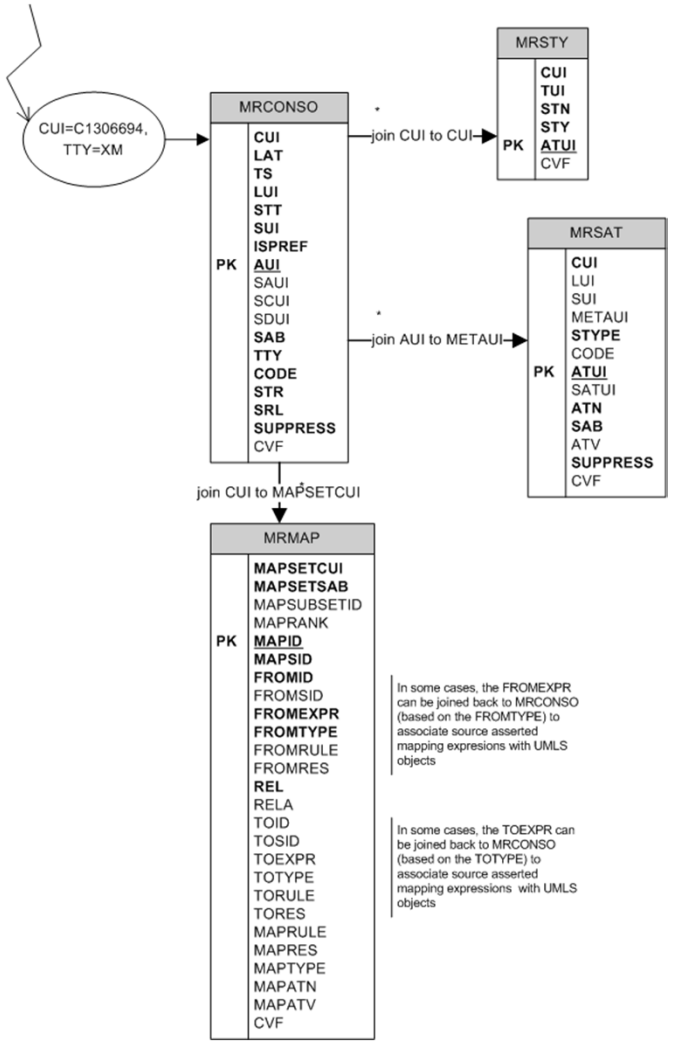
Unified Medical Language System (cont.)

- **SPECIALIST Lexicon**

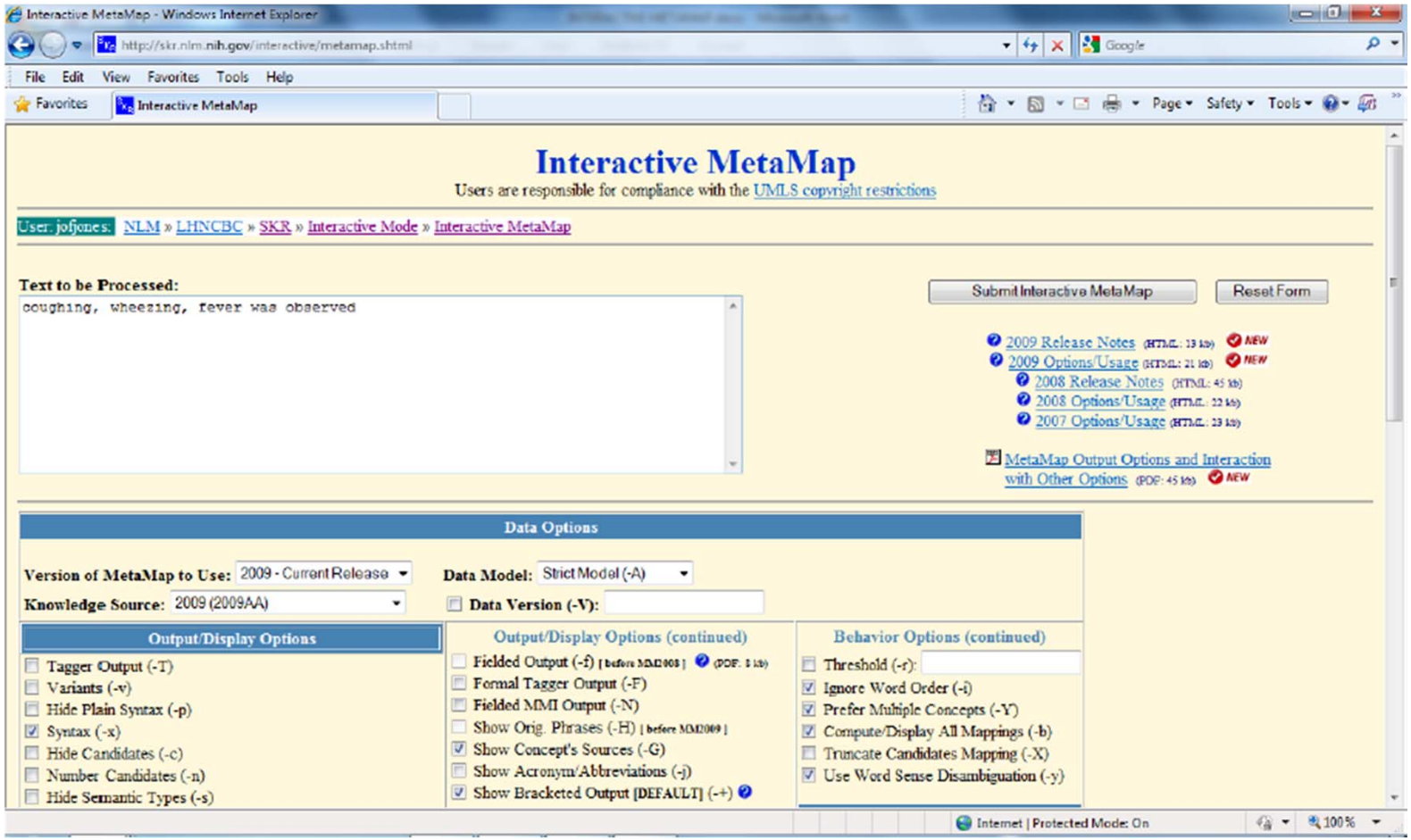
  The SPECIALIST lexicon is an English language lexicon with many biomedical terms. It has been developed in the context of the SPECIALIST natural language processing project at NLM. The lexicon entry for each word or term records syntactic, morphological, and orthographic information. Lexical entries may be single or multi-word terms and are selected for coding from a variety of sources, including lexical items from MEDLINE citation records.

- **UMLS Information Sources Map**

  The Information Sources Map contains information about the scope, location, vocabulary, syntax rules, and access conditions of biomedical databases of all kinds.



Unified Medical Language System (cont.)

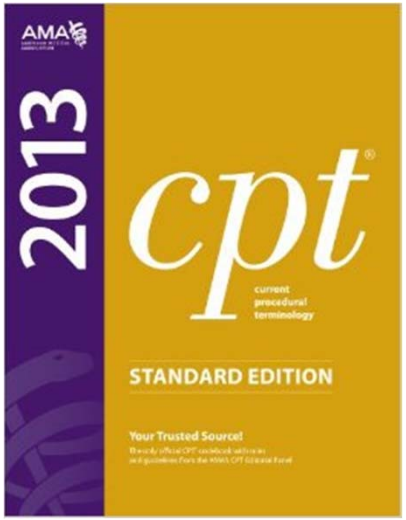


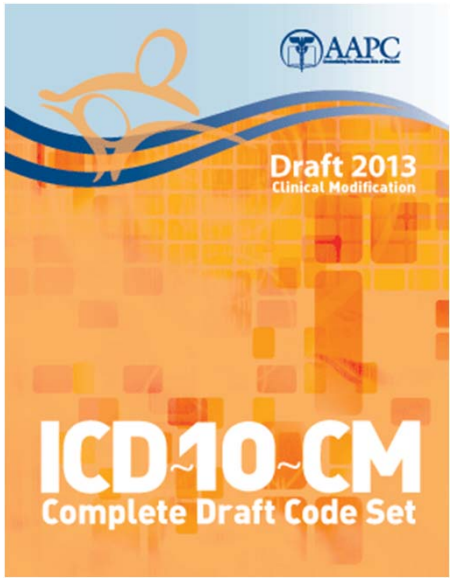
Interactive MetaMap

JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

Additional Resources

Resources – Books





Resources – Web

- **Standardized Coding Organizations**:
  - ICD: www.who.int/classifications/icd/en/
  - SNOMED: www.nlm.nih.gov/research/umls/Snomed/snomed_main.html
  - CPT: www.ama-assn.org/ama/pub/physician-resources/solutions-managing-your-practice/coding-billing-insurance/cpt.page
  - LOINC: loinc.org
  - RxNorm: www.nlm.nih.gov/research/umls/rxnorm/

Summary

- Introduction
- Classification Methods & Challenges
- Classification Systems
  - Dx: ICD, ICPC, DSM, SNOMED, ICD-O, ICPM, RCC, DRG
  - Procedures: CPT/ICD-CM
  - Lab: LOINC
  - Rx: ATC, RxNorm, NDC
  - Research: MeSH
- Unified Medical Language System
- Resources
  - Books
  - Web