INFORMATICS PROFESSIONALS. LEADING THE WAY.

1G-2 – Clinical Data Standards

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Clinical Informatics
Board Review Course

Clinical Informatics Subspecialty Delineation of Practice (CIS DoP)

Domain 1: Fundamental Knowledge and Skills (no Tasks are associated with this Domain which is focused on fundamental knowledge and skills)

Clinical Informatics

K001. The discipline of informatics (e.g., definitions, history, careers, professional organizations)
K002. Fundamental informatics concepts, models, and theories
K003. Core clinical informatics literature (e.g., foundational literature, principle journals, critical analysis of literature, use of evidence to inform practice)
K004. Descriptive and inferential statistics
K005. Health Information Technology (HIT) principles and science
K006. Computer programming fundamentals and computational thinking
K007. Basic systems and network architectures
K008. Basic database structure, data retrieval and analytics techniques and tools
K009. Development and use of interoperability/exchange standards (e.g., Fast Health Interoperability Resources [FHIR], Digital Imaging and Communications in Medicine [DICOM])
K010. Development and use of transaction standards (e.g., American National Standards Institute X12)
K011. Development and use of messaging standards (e.g., Health Level Seven [HL7] v2)
K012. Development and use of ancillary data standards (e.g., imaging and Laboratory Information System[LIS])
K013. Development and use of data model standards
K014. Vocabularies, terminologies, and nomenclatures (e.g., Logical Observation Identifiers Names and Codes [LOINC], Systematized Nomenclature of Medicine --Clinical Terms [SNOMED-CT], RxNorm, International Classification Of Diseases[ICD], Current Procedural Terminology [CPT])
K015. Data taxonomies and ontologies
K016. Security, privacy, and confidentiality requirements and practices
K017. Legal and regulatory issues related to clinical data and information sharing
K018. Technical and non-technical approaches and barriers to interoperability
K019. Ethics and professionalism

The Health System

K020. Primary domains of health, organizational structures, cultures, and processes (e.g., health care delivery, public health, personal health, population health, education of health professionals, clinical research)
K021. Determinants of individual and population health
K022. Forces shaping health care delivery and considerations regarding health care access
K023. Health economics and financing
K024. Policy and regulatory frameworks related to the healthcare system
K025. The flow of data, information, and knowledge within the health system

Domain 2: Improving Care Delivery and Outcomes

K026. Decision science (e.g., Bayes theorem, decision analysis, probability theory, utility and preference assessment, test characteristics)
K027. Clinical decision support standards and processes for development, implementation, evaluation, and maintenance
K028. Five Rights of clinical decision support (i.e., information, person, intervention formats, channel, and point/time in workflow)
K029. Legal, regulatory, and ethical issues regarding clinical decision support
K030. Methods of workflow analysis
K031. Principles of workflow re-engineering
K032. Quality improvement principles and practices (e.g., Six Sigma, Lean, Plan-Do-Study-Act [PDSA] cycle, root cause analysis)
K033. User-centered design principles (e.g., iterative design process)
K034. Usability testing
K035. Definitions of measures (e.g., quality performance, regulatory, pay for performance, public health surveillance)
K036. Measure development and evaluation processes and criteria
K037. Key performance indicators (KPIs)
K038. Claims analytics and benchmarks
K039. Predictive analytic techniques, indications, and limitations
K040. Clinical and financial benchmarking sources (e.g., Gartner, Healthcare Information and Management Systems Society [HIMSS] Analytics, Centers for Medicare and Medicaid Services [CMS], Leapfrog)
K041. Quality standards and measures promulgated by quality organizations (e.g., National Quality Forum [NQF], Centers for Medicare and Medicaid Services [CMS], National Committee for Quality Assurance [NCQA])
K042. Facility accreditation quality and safety standards (e.g., The Joint Commission, Clinical Laboratory Improvement Amendments [CLIA])
K043. Clinical quality standards (e.g., Physician Quality Reporting System [PQRS], Agency for Healthcare Research and Quality [AHRQ], National Surgical Quality Improvement Program [NSQIP], Quality Reporting Document Architecture [QRDA], Health Quality Measure Format [HQMF], Council on Quality and Leadership [CQL], Fast Health Interoperability Resources [FHIR] Clinical Reasoning)
K044. Reporting requirements
K045. Methods to measure and report organizational performance
K046. Adoption metrics (e.g., Electronic Medical Records Adoption Model [EMRAM], Adoption Model for Analytics Maturity [AMAM])
K047. Social determinants of health
K048. Use of patient-generated data
K049. Prediction models
K050. Risk stratification and adjustment
K051. Concepts and tools for care coordination
K052. Care delivery and payment models

Domain 3: Enterprise Information Systems

K053. Health information technology landscape (e.g., innovation strategies, emerging technologies)
K054. Institutional governance of clinical information systems
K055. Information system maintenance requirements
K056. Information needs analysis and information system selection
K057. Information system implementation procedures
K058. Information system evaluation techniques and methods
K059. Information system and integration testing techniques and methodologies
K060. Enterprise architecture (databases, storage, application, interface engine)
K061. Methods of communication between various software components
K062. Network communications infrastructure and protocols between information systems (e.g., Transmission Control Protocol/Internet Protocol [TCP/IP], switches, routers)
K063. Types of settings (e.g., labs, ambulatory, radiology, home) where various systems are used
K064. Clinical system functional requirements
K065. Models and theories of human-computer (machine) interaction (HCI)
K066. HCI evaluation, usability engineering and testing, study design and methods
K067. HCI design standards and design principles
K068. Functionalities of clinical information systems (e.g., Electronic Health Records [EHR], Laboratory Information System [LIS], Picture Archiving and Communication System [PACS], Radiology Information System [RIS] vendor-neutral archive, pharmacy, revenue cycle)
K069. Consumer-facing health informatics applications (e.g., patient portals, mobile health apps and devices, disease management, patient education, behavior modification)
K070. User types and roles, institutional policy and access control
K071. Clinical communication channels and best practices for use (e.g., secure messaging, closed loop communication)
K072. Security threat assessment methods and mitigation strategies
K073. Security standards and safeguards
K074. Clinical impact of scheduled and unscheduled system downtimes
K075. Information system failure modes and downtime mitigation strategies (e.g., replicated data centers, log shipping)
K076. Approaches to knowledge repositories and their implementation and maintenance
K077. Data storage options and their implications
K078. Clinical registries
K079. Health information exchanges
K080. Patient matching strategies
K081. Master patient index
K082. Data reconciliation
K083. Regulated medical devices (e.g., pumps, telemetry monitors) that may be integrated into information systems
K084. Non-regulated medical devices (e.g., consumer devices)
K085. Telehealth workflows and resources (e.g., software, hardware, staff)

Domain 4: Data Governance and Data Analytics

K086. Stewardship of data
K087. Regulations, organizations, and best practice related to data access and sharing agreements, data use, privacy, security, and portability
K088. Metadata and data dictionaries
K089. Data life cycle
K090. Transactional and reporting/research databases
K091. Techniques for the storage of disparate data types
K092. Techniques to extract, transform, and load data
K093. Data associated with workflow processes and clinical context
K094. Data management and validation techniques
K095. Standards related to storage and retrieval from specialized and emerging data sources
K096. Types and uses of specialized and emerging data sources (e.g., imaging, bioinformatics, internet of things (IoT), patient-generated, social determinants)
K097. Issues related to integrating emerging data sources into business and clinical decision making
K098. Information architecture
K099. Query tools and techniques
K100. Flat files, relational and non-relational/NoSQL database structures, distributed file systems
K101. Definitions and appropriate use of descriptive, diagnostic, predictive, and prescriptive analytics
K102. Analytic tools and techniques (e.g., Boolean, Bayesian, statistical/mathematical modeling)
K103. Advanced modeling and algorithms
K104. Artificial intelligence
K105. Machine learning (e.g., neural networks, support vector machines, Bayesian network)
K106. Data visualization (e.g., graphical, geospatial, 3D modeling, dashboards, heat maps)
K107. Natural language processing
K108. Precision medicine (customized treatment plans based on patient-specific data)
K109. Knowledge management and archiving science
K110. Methods for knowledge persistence and sharing
K111. Methods and standards for data sharing across systems (e.g., health information exchanges, public health reporting)

Domain 5: Leadership and Professionalism

K112. Environmental scanning and assessment methods and techniques
K113. Consensus building, collaboration, and conflict management
K114. Business plan development for informatics projects and activities (e.g., return on investment, business case analysis, pro forma projections)
K115. Basic revenue cycle
K116. Basic managerial/cost accounting principles and concepts
K117. Capital and operating budgeting
K118. Strategy formulation and evaluation
K119. Approaches to establishing Health Information Technology (HIT) mission and objectives
K120. Communication strategies, including one-on-one, presentation to groups, and asynchronous communication
K121. Effective communication programs to support and sustain systems implementation
K122. Writing effectively for various audiences and goals
K123. Negotiation strategies, methods, and techniques
K124. Conflict management strategies, methods, and techniques
K125. Change management principles, models, and methods
K126. Assessment of organizational culture and behavior change theories
K127. Theory and methods for promoting the adoption and effective use of clinical information systems
K128. Motivational strategies, methods, and techniques
K129. Basic principles and practices of project management
K130. Project management tools and techniques
K131. Leadership principles, models, and methods
K132. Intergenerational communication techniques
K133. Coaching, mentoring, championing and cheerleading methods
K134. Adult learning theories, methods, and techniques
K135. Teaching modalities for individuals and groups
K136. Methods to assess the effectiveness of training and competency development
K137. Principles, models, and methods for building and managing effective interdisciplinary teams
K138. Team productivity and effectiveness (e.g., articulating team goals, defining rules of operation, clarifying individual roles, team management, identifying and addressing challenges)
K139. Group management processes (e.g., nominal group, consensus mapping, Delphi method)

Knowledge Statements from the DoP

K014. Vocabularies, terminologies, and nomenclatures (e.g., Logical Observation Identifiers Names and Codes [LOINC], Systematized Nomenclature of Medicine --Clinical Terms [SNOMED-CT], RxNorm, International Classification Of Diseases[ICD], Current Procedural Terminology [CPT])

K015. Data taxonomies and ontologies

K018. Technical and non-technical approaches and barriers to interoperability

Terminology standards

Another important area of standards

Benefits of computerization of clinical data depend upon its “normalization”

Clinical language is inherently vague, which is at odds with the precision of computers

The words cancer and carcinoma are no more similar to a computer than apple and zebra

Medicine should have “fewer words, more meaning” like air traffic control and military (Voytovich, 1999)

Overview text (Giannangelo, 2019)

The terminology of terminologies

Terminology – “terms,” but not so simple

Concept – thing or idea, expressed in one or more terms

Synonym – different term for same concept

Polysem – term that means more than one concept

Dictionary – concepts plus meaning

Thesaurus – synonyms grouped by concept

Vocabulary – concepts and terms in a domain

Ontology – structured concepts and relationships between them

Standardized medical vocabularies

Usually have hierarchical structure and some sort of coding scheme

Ultimately want to represent concepts as codes

Cimino (1998) has elucidated “desiderata”

Various approaches to codes include

- Numerical – sequentially or random
- Mnemonic – abbreviation
- Hierarchical – indicate level in hierarchy
- Juxtaposition – composite codes
- Combination – composite using ordering

Should avoid “semantic” codes that put meaning in codes

Terminology standards (Giannangelo, 2019)

Diagnoses
- ICD-9, ICD-10, ICD-11
- Diagnosis-related groups (DRG)

Drugs
- National Drug Code (NDC)
- National Drug File Reference Terminology (NDF-RT)
- RxNorm/RxTerms

Laboratory
- LOINC

Procedures and diagnostic studies
- CPT-4, HCPCS, CDT

Nursing
- NANDA, NIC/NOC, Omaha, etc.

Literature
- Medical Subject Headings (MeSH)

Devices
- Universal Medical Device (UMD) Nomenclature

Comprehensive
- SNOMED Clinical Terms (CT)
- Unified Medical Language System (UMLS)

Others
- DSM, ICF, ICPC, commercial, etc.

International Classification of Diseases (ICD)

Originated in 1893 as International List of Causes of Death

- Initial primary purpose was to compile mortality statistics
- Eventually taken over by World Health Organization (WHO)

Now called International Classification of Diseases (ICD)

- Has evolved as means to code diseases for more than just cause of death

WHO site for ICD (11 is here!)

- https://www.who.int/classifications/classification-of-diseases

ICD-9 and its variants

ICD-9 approved by WHO in 1975

- Organized hierarchically with one digit for each level of hierarchy
- ICD-9 has four-digit codes

ICD-9-CM (clinical modifications) is U.S. variant with more detail and five-digit codes

Also has additional set of letter codes

- V – for encounters related to prevention and screening
- G – document provision of specific services, such as quality measures

Use in US discontinued with transition to ICD-10-CM in October, 2015, although much data still coded in ICD-9-CM

ICD-10

https://www.cms.gov/Medicare/Coding/ICD10

Adopted by WHO in 1990 – significant changes in structure from ICD-9

Implemented as ICD-10-CM in US after numerous delays in October, 2015 (Outland, 2015)

Also in US, added inpatient procedure codes as ICD-10-PCS

- CPT-4 still used for outpatient procedures

Adaptation of ICD-10 for US included (Barta, 2008)

- ICD-10-CM for diagnosis codes – 3-7 levels
- ICD-10-PCS for procedure codes – 7 levels
- General Equivalence Mappings (GEM) for translation from ICD-9-CM

Differences between ICD-9-CM and ICD-10-CM

ICD-9-CM

13,000+ codes

3-5 characters

First character numeric or V/G/E

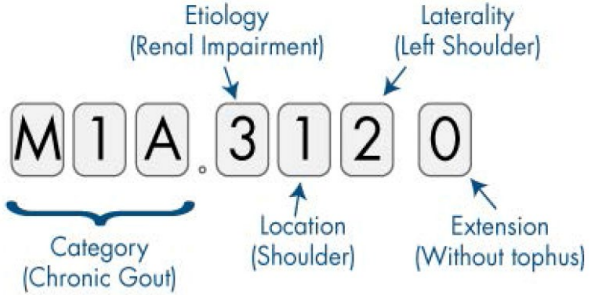
Characters 1-3 – category

Characters 4-5 – etiology, anatomic site, or other clinical detail

ICD-10-CM

69,000+ codes

3-7 characters



First character alpha

Character 2-3 numeric

Character 4-7 alphanumeric

Characters 1-3 – category

Characters 4-6 – etiology, anatomical site, or other clinical detail

Character 7 – extension

Diagnosis-related groups (DRG)

Original intent was to aggregate ICD-9 codes into groups for health services research

Set of several hundred codes that “lump” hospital illnesses

Adopted by HCFA (now CMS) in 1980s for prospective payment for hospitalization in Medicare

DRG categories will stay same initially for ICD-10-CM but may change later (Mills, 2015)

Current Procedural Terminology (CPT-4)

Classification of procedures performed by physicians

Usually required for reimbursement by government and private insurance companies in U.S.

Evaluation/management (E/M) portion documents clinical encounters

Developed, maintained, and copyrighted by American Medical Association (AMA)

Drug terminology

A number of different code sets, mostly led by US government

FedMed is interagency collaboration on agreed set of standard, comprehensive, and freely accessible Federal Medication Terminologies (FMT)

- National Drug Codes (NDC)
- Unique Ingredient Identifier (UNII)
- National Drug File Reference Terminology (NDF-RT)
- NCI Thesaurus (NCIt) Structured Product Labeling (SPL)
- RxNorm, RxTerms

National Drug Codes (NDC)

https://www.fda.gov/drugs/drug-approvals-and-databases/national-drug-code-directory

There is an 11-digit code for each and every pharmaceutical preparation

- First 5 digits for manufacturer, assigned by Food & Drug Administration (FDA), e.g., Merck, Pfizer, etc.
- Next 4 digits for product name, strength, dose form
  - One code for each variant of these
  - Problem: Not unique for same drug from different manufacturer
- Final 2 digits are code for packaging
  - e.g., number of tablets in bottle

Map into other terminology systems in FedMed

Other drug terminology standards

Unique Ingredient Identifier (UNII) specifies ingredients in drugs and other compounds

National Drug File Reference Terminology (NDF-RT, produced by VA) maintains mechanism of action, physiological effect, and structural class

- https://www.pbm.va.gov/nationalformulary.asp

NCIt SPL maintains pharmaceutical dosage form, route of administration, and potency

RxNorm provides semantic structure for formulations and their components

- RxTerms provides interface terminology to RxNorm
- RxNorm/RxTerms emerging as standard into which other drug terminologies must map
- https://www.nlm.nih.gov/research/umls/rxnorm

Logical observations, identifiers, and numerical codes (LOINC; Vreeman, 2017)

https://loinc.org/

For each observation, specify

- Component (analyte) – substance or entity measured or observed
- Property – e.g., mass concentration, numeric fraction
- Time – point in time
- Specimen (system) – e.g., blood, cerebrospinal fluid
- Scale – e.g., qualitative, quantitative, ordinal, nominal
- Method – optional, procedure used to make observation

Being extended beyond original laboratory tests and into other languages beyond English (Vreeman, 2012)

SNOMED Clinical Terms (SNOMED CT)

Systematized Nomenclature of Medicine (SNOMED)

Originally developed by College of American Pathologists (CAP, www.snomed.org)

- Originally a classification for pathologists (SNOP) but extended to all of medicine as SNOMED in 1980s
- Merged with English Clinical Terms Project to form SNOMED CT in 2000 (Spackman, 2000)

In 2007, ownership transferred to International Health Terminology Standards Development Organisation (IHTSDO), which is now called SNOMED International

Multilingual – currently available in US English, UK English, Spanish, Danish and Swedish; being translated to others

SNOMED CT

Starter Guide and other documentation

- https://confluence.ihtsdotools.org/display/DOCSTART/SNOMED+CT+Starter+Guide

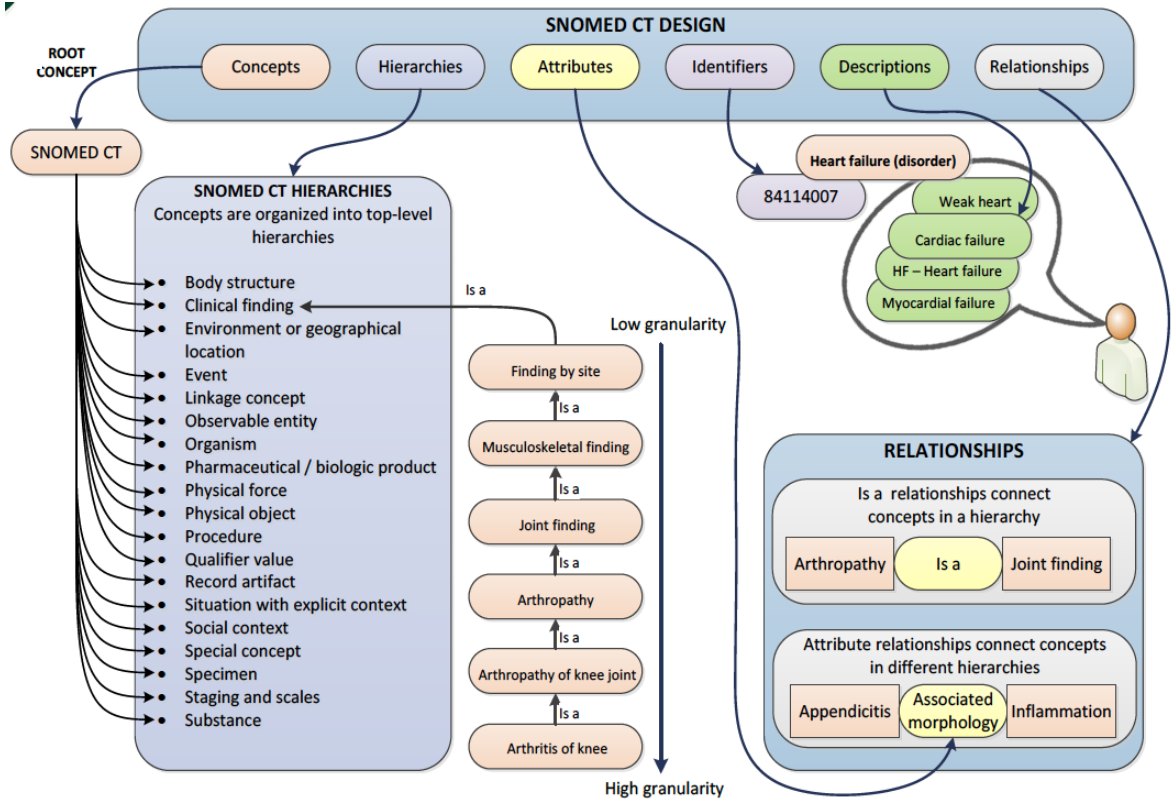
Richest vocabulary for describing clinical observations and findings

- Coverage is extensive
- Key feature is “multi-axial” or compositional approach
  - Allows terms to be combined, e.g., lung + inflammation
  - Allows modifiers to be added, e.g., severe, worsening

Contains

- > 300,000 concepts
- > 1M “descriptions” (terms) expressing concepts
- > 1M relationships between concepts

SNOMED CT design



Efforts at reconciliation of vocabularies

The Unified Medical Language System (UMLS) Project of the NLM is an attempt at reconciliation (Humphreys, 1998)

https://www.nlm.nih.gov/research/umls/

Consists of three components

- Metathesaurus
- Semantic network – generic relationships between semantic types of concepts, e.g., diseases and treatment
- Specialist lexicon – based on Metathesaurus words and terms, designed to assist in natural language processing applications

UMLS Metathesaurus

From documentation

- Metathesaurus is “a database of information on concepts that appear in one or more of a number of different controlled vocabularies and classifications used in biomedicine”

Is a “meta”-thesaurus among terms across the major vocabularies

- Synonymous terms from different vocabularies are given same concept identifier
- Each distinct term can have different lexical variants, aka strings

Structure of UMLS Metathesaurus

All terms from all vocabularies representing same notion are grouped as a concept

- Linked by Concept Unique Identifier (CUI)

All source terms of similar form (i.e., differing only in lexical variation) are grouped as terms

- Linked by Term Unique Identifier (LUI)

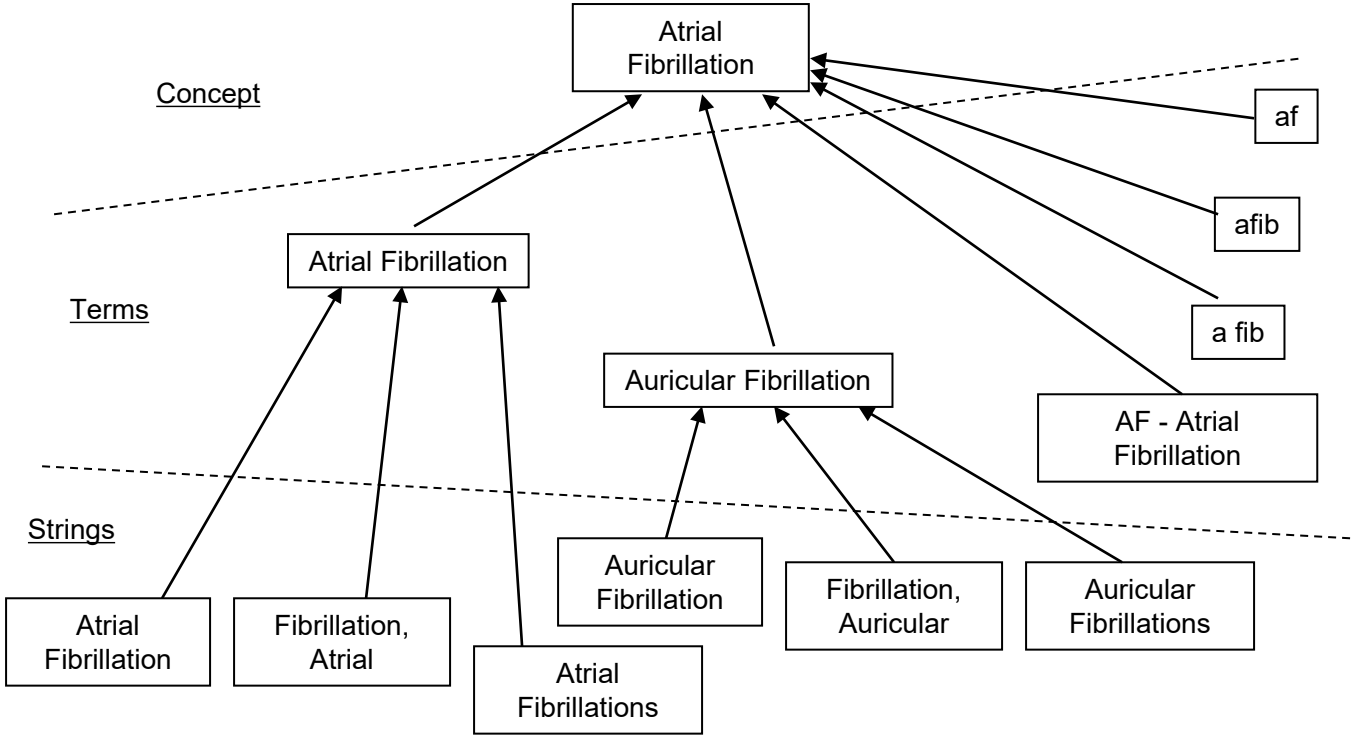
Within each term, lexical variants are strings

- Linked by String Unique Identifier (SUI)

Each string is an atom from its source

- Linked by Atomic Unique Identifier (AUI)

Example Metathesaurus concept: Atrial Fibrillation



Limitations and use of UMLS Metathesaurus

Limitations

- Only one-to-one relationships are mapped
- Only terms from source vocabularies present; no new terms added
- No unifying hierarchy is present, only those that exist in source vocabularies
- Not extensible (i.e., in the SNOMED sense)

Use

- Modest at this point
- More of a “repository” for vocabularies

Some other healthcare vocabularies

Common Dental Terminology (CDT)

Medical Subject Headings (MeSH) (used in information retrieval)

Universal Medical Device Nomenclature (UMD)

Diagnostic and Statistical Manual of Mental Disorders (DSM) – has its controversies (Kupfer, 2013)

International Classification of Functioning, Disability, and Health (ICF)

International Classification of Primary Care (ICPC)

Some commercial terminology efforts

Intelligent Medical Objects (IMO, https://www.imohealth.com/) – provides mapping, updates, and access to terminologies

Medcin (Medicomp, https://medicomp.com/medcin/) – focused on documentation at point of care in EHR

HDD Access (https://www.hddaccess.com/) – terminology system developed by 3M, moved to open-source model

Bringing it all together

Toward semantic interoperability – “computer utterance” in one system has same effect in any other (Dolin, 2011)

Likely direction? From ONC Interoperability Roadmap, 21st Century Cures Act, etc.

- FHIR-based API
- OAuth2/OpenID security and authentication
- Types of data
  - Documents – IHE specifications, CCDA
  - Discrete – US Core Data for Interoperability, SNOMED CT and other terminologies

Key Readings

Giannangelo, K., 2019. *Healthcare Code Sets, Clinical Terminologies, and Classification Systems, 4th edition*. ed. AHIMA

Appendix

Examples and other information

Use cases for standardized terminology (Chute, 2005)

Information capture – documenting findings, conditions, and outcomes

Communication – transferring information

Knowledge organization – classification of diseases, treatments, etc.

Information retrieval – accessing knowledge-based information

Decision support – implementing decision support rules

Harder for computers than humans: synonymy and polysemy

How many different ways can you say *common cold*?

Synonyms include

- Cold
- Upper respiratory infection
- URI
- Pharyngitis, bronchitis, rhinitis, etc.
- Viral syndrome
- …

How many different ways is *lead* used in medicine?

Polysems include

- Hypertension leads to heart disease
- An EKG lead
- Lead poisoning
- …

A few issues about terminologies and coding

Rosenbloom (2006) distinguishes categories and uses of terminology

- Interface – support data entry (Rosenbloom, 2008)
- Processing – optimize natural language processing
- Reference – enable storage, analysis, retrieval

Coding is a major activity of health information management (HIM) profession (Scott, 2008)

- With growth of uses and technology, field is changing (Calhoun, 2012)
- Computer-assisted coding is use of computer programs to assist human coders (Tully, 2012)

Example of ICD-9-CM

481 Pneumococcal pneumonia
482 Other bacterial pneumonia
- 482.0 Pneumonia due to *Klebsiella pneumoniae*
- 482.1 Pneumonia due to Pseudomonas
- 482.2 Pneumonia due to *Hemophilus influenzae*
- 482.3 Pneumonia due to Streptococcus
  - 482.30 Pneumonia due to Streptococcus, unspecified *
  - 482.31 Pneumonia due to Group A Streptococcus *
  - 482.32 Pneumonia due to Group B Streptococcus *
  - 482.39 Other streptococcal pneumonia *
- 482.4 Pneumonia due to Staphylococcus
  - 482.40 Pneumonia due to Staphylococcus, unspecified *
  - 482.41 Pneumonia due to *Staphylococcus aureus* *
  - 482.49 Other Staphylococcus pneumonia *
- 482.8 Pneumonia due to other specified bacteria
  - 482.81 Pneumonia due to anaerobes *
  - 482.82 Pneumonia due to *Escherichia coli* *
  - 482.83 Pneumonia due to other Gram-negative bacteria *
  - 482.84 Legionnaires' disease *
  - 482.89 Pneumonia due to other specified bacteria *
- 482.9 Bacterial pneumonia, unspecified

483 Pneumonia due to other specified organism
- 483.0 *Mycoplasma pneumoniae* *

484 Pneumonia in infectious diseases classified elsewhere *
- 484.3 Pneumonia in whooping cough *
- 484.5 Pneumonia in anthrax *

Some limitations of ICD-9 (Chute, 1998)

"Not otherwise specified" (NOS) codes indicate "other" category that may be ambiguous, e.g.,

- 482.30 Pneumonia due to Streptococcus, unspecified
- Changes with new diseases, such as from Non-A, Non-B Hepatitis to C, D, etc.

"Not elsewhere classified" (NEC) codes indicate no separate specific code available to represent condition documented

- 311 Depressive disorder, not elsewhere classified
- Used for "non-major" depression

Limitations of ICD-9 (cont.)

Use of digits in codes can be problematic

- When there are more than 10 items at a level

Granularity often inadequate

- Only one code for most cancers in a given location
- e.g., 162.4 Malignant neoplasm of middle lobe, bronchus or lung

Not extensible

- Cannot add modifiers for location, severity
- Cannot indicate causal relationships

Major difference is increased granularity … on a massive scale

995.29 Unspecified adverse effect of other drug, medicinal and biological substance

T360X5A Adverse effect of penicillin's, initial encounter

T361X5A Adverse effect of cephalosporins and other beta-lactam antibiotics, initial encounter

T362X5A Adverse effect of chloramphenicol group, initial encounter

T363X5A Adverse effect of macrolides, initial encounter

T364X5A Adverse effect of tetracyclines, initial encounter

T365X5A Adverse effect of aminoglycosides, initial encounter

T366X5A Adverse effect of rifampicins, initial encounter

T367X5A Adverse effect of antifungal antibiotics, systemically used, initial encounter

T368X5A Adverse effect of other systemic antibiotics, initial encounter

Plus 170 additional codes

ICD-10-PCS increases from 3,838 to 71,957 codes

1	2	3	4	5	6	7
Specialty	Body System	Root Operation	Body Part	Approach	Device	Qualifier

Example: **0SRD0JZ**
Right knee joint replacement:

0	Medical and Surgical Section
S	Lower Joints
R	Replacement
D	Knee
0	Open
J	Synthetic Substitute
Z	No Qualifier

Granularity also an issue for ICD-10-PCS

37.31 Pericardiectomy	025N0ZZ Destruction of Pericardium, Open Approach 025N3ZZ Destruction of Pericardium, Percutaneous Approach 025N4ZZ Destruction of Pericardium, Percutaneous Endoscopic Approach 02BN0ZZ Excision of Pericardium, Open Approach 02BN3ZZ Excision of Pericardium, Percutaneous Approach 02BN4ZZ Excision of Pericardium, Percutaneous Endoscopic Approach 02TN0ZZ Resection of Pericardium, Open Approach 02TN3ZZ Resection of Pericardium, Percutaneous Approach 02TN4ZZ Resection of Pericardium, Percutaneous Endoscopic Approach

Some excess granularity reaching absurdity (Mathews, 2011)?

Struck by falling object on board a watercraft

- V93.40 – Merchant ship
- V93.41 – Passenger ship
- V93.42 – Fishing boat
- V93.43 – Powered watercraft
- V93.44 – Sailboat
- V93.48 – Unpowered watercraft
- V93.49 – Unspecified

Detailed codes invite artistry (icd10illustrated.com)

V97.33xD
Sucked into jet engine, subsequent encounter

V32.1xxS
Passenger in three-wheeled motor vehicle injured in collision with two- or three-wheeled motor vehicle in nontraffic accident, sequela

More about ICD-10

50% of all codes are related to musculoskeletal system, primarily injuries

25% of all codes are related to fractures

36% of all codes distinguish laterality, i.e., left vs. right

Most impacted are Orthopedics, Obstetrics/Gynecology, and Behavioral Health

Primary care has medium level of impact

Medical specialties have low level of impact

Informatics concerns over excess granularity of ICD-10 and whether transition to a more extensible terminology system, such as SNOMED or even ICD-11, might be a better approach (Chute, 2012)

Informatics concerns about ICD-10-CM

Excess granularity of ICD-10-CM

- Would transition to a more compositional terminology system, such as SNOMED or even ICD-11 (to be derived from SNOMED), have been a better approach (Chute, 2012)?
- Although ICD-11 just completed but not ready for US rollout for at least several more years

36% of all mappings between ICD-9-CM and ICD-10-CM are convoluted, ranging by specialty from 5% (hematology) to 60% (obstetrics and injuries) (Boyd, 2013)

DRG examples for respiratory diseases

Respiratory disease w/ major chest operating room procedure, no major complication or comorbidity 75

Respiratory disease w/ major chest operating room procedure, minor complication or comorbidity 76

Respiratory disease w/ other respiratory system operating procedure, no complication or comorbidity 77

Respiratory infection w/ minor complication, age greater than 17 79

Respiratory infection w/ no minor complication, age greater than 17 80

Simple Pneumonia w/ minor complication, age greater than 17 89

Simple Pneumonia w/ no minor complication, age greater than 17 90

Respiratory disease w/ ventilator support 475

Respiratory disease w/ major chest operating room procedure and major complication or comorbidity 538

Respiratory disease, other respiratory system operating procedure and major complication 539

HCFA Common Procedure Coding System (HCPCS)

https://www.cms.gov/Medicare/Coding/MedHCPCSGenInfo/

HCPCS Level One is CPT-4

HCPCS Level Two adds items and supplies and non-physician services

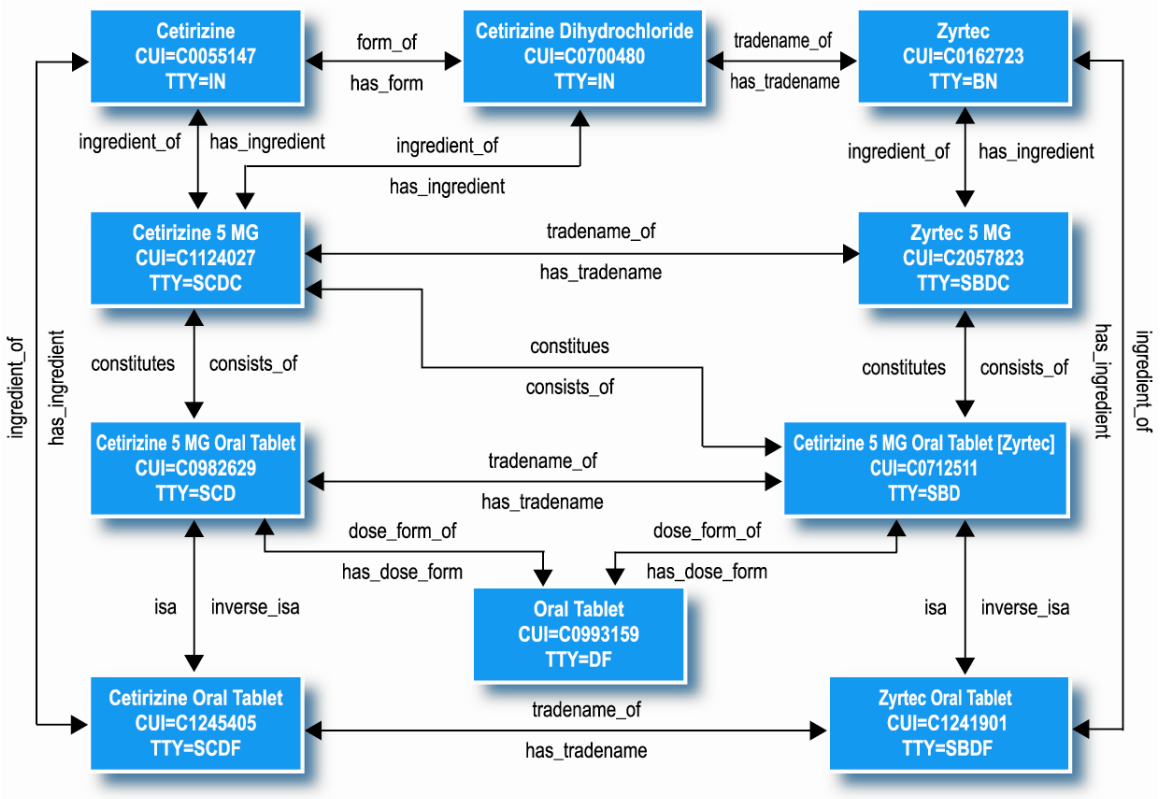
HCPCS Level Three added local codes

- Abolished in 2003 under HIPAA rules

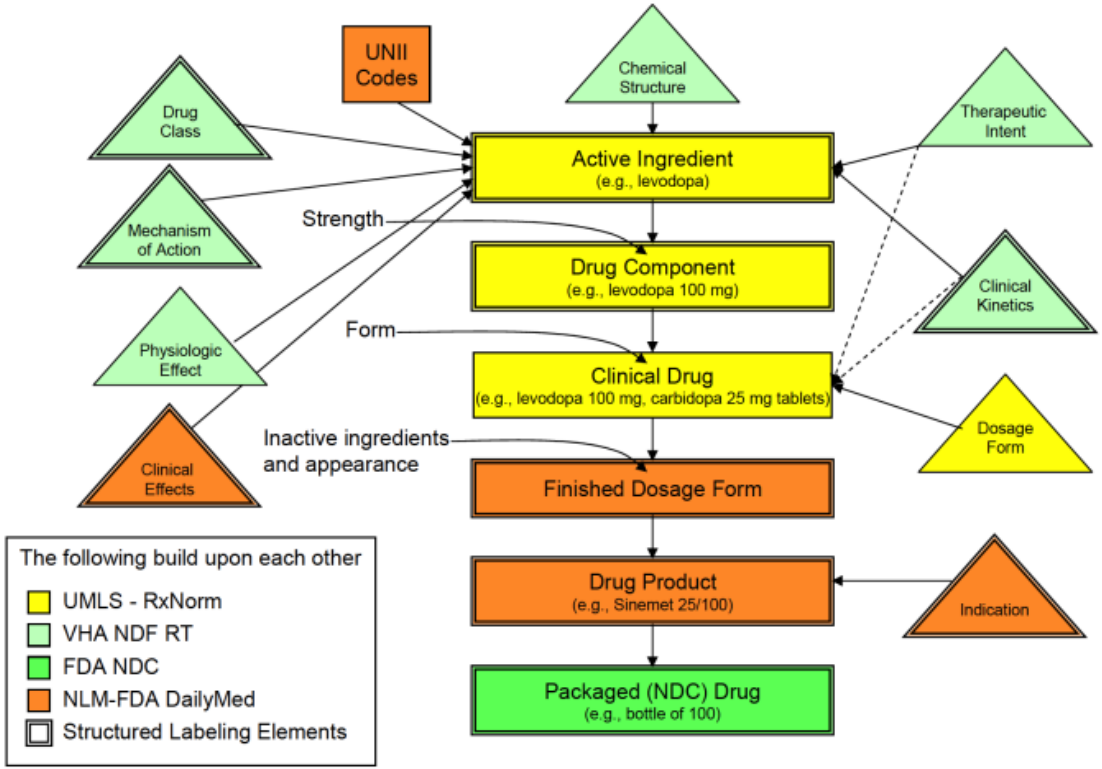
With adoption of ICD-10, professional fees and outpatient procedures will be billed using CPT-4/HCPCS and inpatient procedures will be billed using ICD-10-PCS

- ICD-10-CM diagnosis codes will be required for all

Relationships in RxNorm (Bodenreider, 2004)



Relationship of federal drug terminologies



LOINC Examples

Blood glucose GLUCOSE:MCNC:PT:BLD: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

Ionized whole blood calcium CALCIUM.FREE:SCNC:PT:BLD:QN:

24 hour calcium excretion CALCIUM.TOTAL:MRAT:24H:UR:QN:

Automated hematocrit HEMATOCRIT:NFR:PT:BLD:QN:AUTOMATED COUNT

Manual spun hematocrit HEMATOCRIT:NFR:PT:BLD:QN:SPUN

Erythrocyte MCV ERYTHROCYTE MEAN CORPUSCULAR VOLUME:ENTVOL:PT:RBC:QN:AUTOMATED COUNT

ESR by Westergren method ERYTHROCYTE SEDIMENTATION RATE:VEL:PT:BLD:QN:WESTERGREN

SNOMED CT license

In 2003, CAP and NLM negotiated five-year license for all of US

- Continued with transfer to IHTSDO

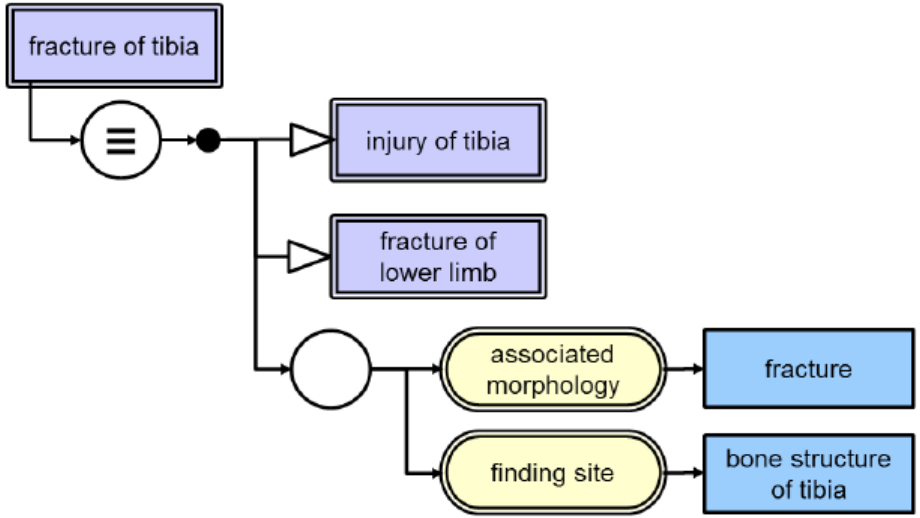
Can be freely used by all public and private entities within US (or other countries that license) for any healthcare, public health, research, educational, or statistical use

Can encode patient level data sets and redistribute them as long as users do not extract significant portions

SNOMED CT expressions – some are pre-coordinated

Precoordinated expression representing fracture of tibia	Identifier only	31978002
	With display term	31978002 |fracture of tibia |

Graphic view of the defining relationships of the concept |fracture of tibia|



Nursing vocabularies

Critical for capturing and assessing diagnosis, interventions, and outcomes of nursing care (Welton, 2016)

Many vocabularies over years, with

- Interface terminologies with irreconcilable information models
- Terms not always the way clinicians express themselves
- Tedious to use in patient documentation
- Varying licensing models
- Lack of mapping to reference terminologies, such as LOINC and SNOMED CT

Recent efforts in nursing informatics community to reconcile and map to major other terminologies (Westra, 2015; Matney, 2016)

Nursing terminologies landscape (ONC, 2017)

Interface Terminologies	Minimum Data Sets
1. Clinical Care Classification (CCC) System 2. International Classification for Nursing Practice (ICNP) 3. North American Nursing Diagnosis Association International (NANDA-I) 4. Nursing Interventions Classification System (NIC) 5. Nursing Outcomes Classification (NOC) 6. Omaha System 7. Perioperative Nursing Data Set (PNDS) 8. ABC Codes	1. Nursing Minimum Data Set (NMDS) 2. Nursing Management Minimum Data Set (NMMDS)
	Reference Terminologies
	1. Logical Observation Identifiers Names and Codes (LOINC) 2. SNOMED Clinical Terms (SNOMED CT)

All approved by ANA and included in UMLS Metathesaurus

Other terminology activities

Development by NIH of common data elements (CDEs) for research studies – https://www.nlm.nih.gov/cde/index.html, e.g.,

- Patient Reported Outcome Measurement System (PROMIS, https://www.healthmeasures.net/explore-measurement-systems/promis)
- National Institute of Neurological Disorders and Stroke Common Data Elements Project (https://www.commondataelements.ninds.nih.gov/)
- Rare Diseases Registry Program (RaDaR, https://ncats.nih.gov/radar)
- Consensus Measures for Phenotypes and Exposures (PhenX, www.phenx.org)

Clinical element model (CEM)

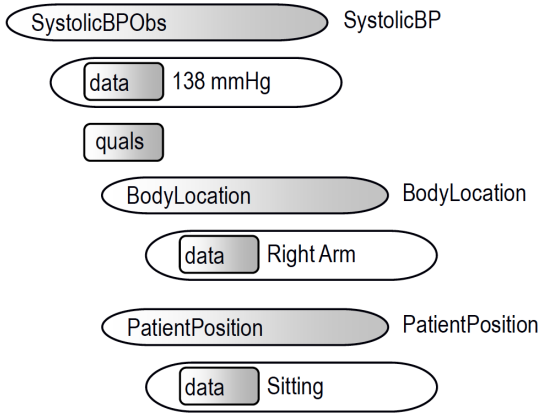
"Stack of coded items" can be ambiguous, need model for clinical elements (Coyle, 2008)

Clinical Information Modeling Initiative (CIMI) aims to create CEMs for clinical data

- http://informatics.mayo.edu/CIMI/index.php/Main_Page

Used in ONC SHARPn Project for secondary uses of clinical data (Tao, 2013)

Most experience at Intermountain Healthcare (Oniki, 2014)



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