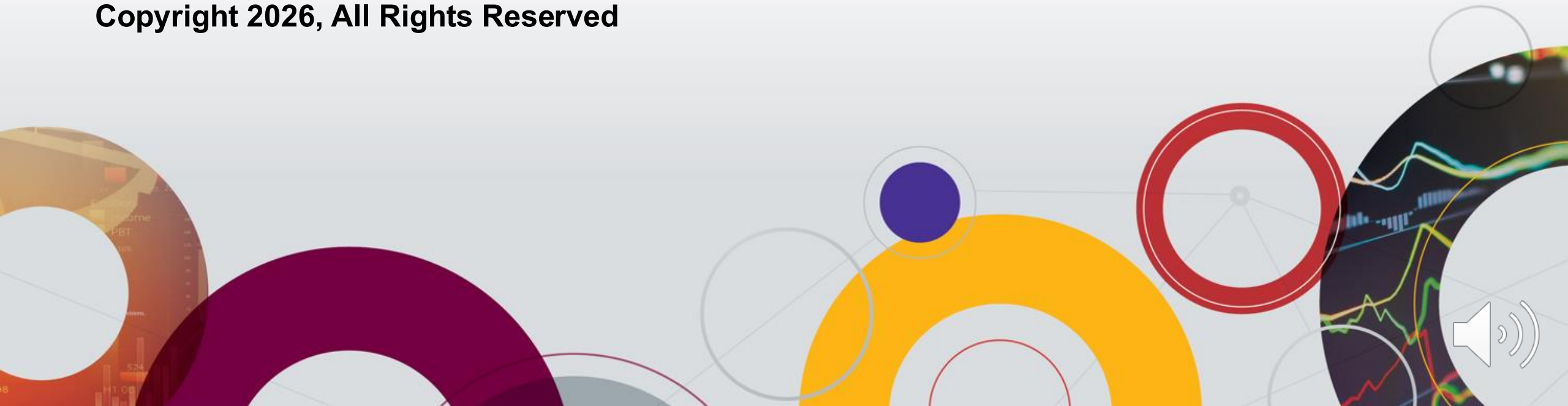


4.4a Terminology Standards

10x10 – Introduction to Biomedical Informatics & Artificial Intelligence
William Hersh, MD, FACMI, FAMIA, FIAHSI
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Terminology standards

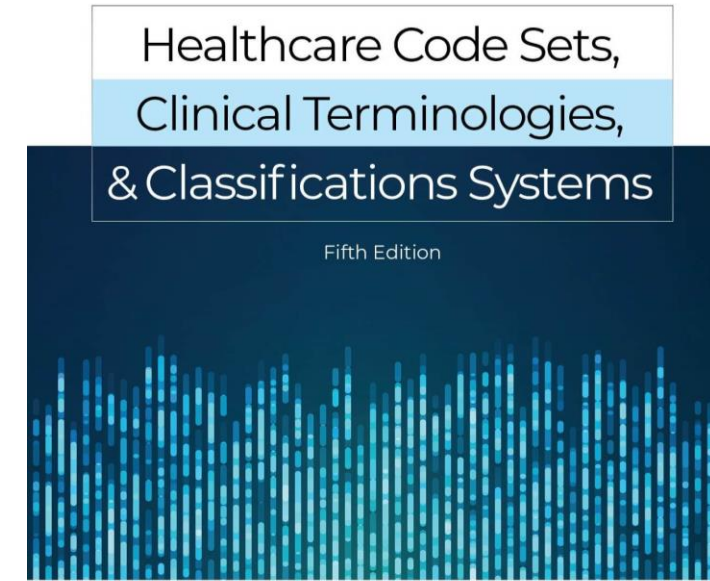
Another important area of standards

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 in a computer than apple and zebra

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



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AHIMA
American Health Information
Management Association®

(Giannangelo, 2025)

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

Coordination – combining of multiple concepts into single code, precoordinated or postcoordinated

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
- ...

Standardized medical vocabularies

Cimino (1998) has elucidated “desiderata”

Most have hierarchical structure and some sort of coding scheme

Ultimately want to represent terms as codes

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, 2025)

Diagnoses

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

Drugs

- National Drug Code (NDC)
- Medication Reference Terminology (MED-RT)
- RxNorm/RxTerms

Vaccines

- Vaccines Administered (CVX)

Laboratory

- Logical Observation Identifiers Names and Codes (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, UCUM, 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
- Major use has been in diagnosis assigned for health care insurance claims, often called “claims data”

Most countries currently use ICD-10, although much data encoded in ICD-9 does not always directly translate to ICD-10 (Khera, 2018)

[ICD-11](#) released in 2018 and adds

- Post-coordination of terms and modifiers
- Interoperability with other terminology systems, especially SNOMED

ICD, NEC, and NOS

Feature	NEC	NOS
Full Form	Not Elsewhere Classified	Not Otherwise Specified
Used When	Diagnosis is known, but no specific ICD code exists	Diagnosis is vague or insufficiently described
Reflects	Limitation of classification system	Limitation of documentation
Indicates	Specific but uncoded condition	Unspecified or general condition
Common Phrases in ICD	"Other specified..." or "...NEC"	"Unspecified" or "...NOS"

ICD-9 and 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

ICD-9-CM also has additional set of

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

Look-up at [Find-A-Code](#) or [ICD9Data.com](#)

Example of ICD-9-CM

Diseases of the circulatory system (390-459)

Ischemic heart disease (410-414)

(410) Acute myocardial infarction

(410.0) MI, acute, anterolateral

(410.1) MI, acute, anterior, NOS

(410.2) MI, acute, inferolateral

(410.3) MI, acute, inferoposterior

(410.4) MI, acute, other inferior wall, NOS

(410.5) MI, acute, other lateral wall

(410.6) MI, acute, true posterior

(410.7) MI, acute, subendocardial

(410.9) MI, acute, unspecified

...

(414) Other forms of chronic ischemic heart disease

...

+ (414.01) Coronary atherosclerosis, native coronary artery

+ (414.02) Coronary atherosclerosis, autologous vein bypass graft

+ (414.04) Coronary atherosclerosis, artery bypass graft



Some limitations of ICD-9 (Chute, 1998)

NOS codes indicate “other” category that may be ambiguous, e.g.,

- 410.9 “unspecified” acute MI
- Changes with new diseases such as from [Non-A, Non-B Hepatitis to C, D, etc.](#)

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

Changing codes can lead to “semantic drift” (Cimino, 2011), e.g.,

- Prior to 2003, non-traumatic cardiovascular collapse (shock) was coded by 785.59 – Other Shock without Mention of Trauma
- In 2003, 785.52 – Septic Shock introduced, changing meaning of 785.59 (and potentially showing increase in rate of septic shock)

ICD-10

Released 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
- ICD-10-PCS for procedure codes
- General Equivalence Mappings (GEM) for translation from ICD-9-CM

Look-up at [Find-A-Code](#) or [ICD10Data.com](#)

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

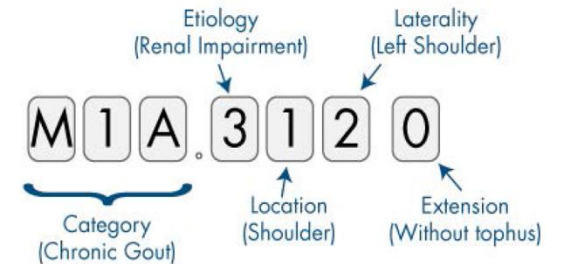
Character 2 numeric

Character 3-7 alphanumeric

Characters 1-3 – category

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

Character 7 – extension, e.g., initial, subsequent, sequelae



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 penicillins, 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 increased procedure codes from 4000 to >87,000 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

ICD-9

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

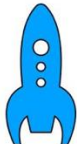
Excess granularity of ICD-10-CM?

Reaching absurdity? (Mathews, 2011), e.g..

- 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

Top 20 Strange ICD-10 Codes

The International Classification of Diseases (ICD) is a system used for coding diagnoses & reasons for visit in healthcare & medical records

	Animal-Related Injuries Bitten by cow - W55.21 Struck by orca - W56.22 Pecked by chicken - W61.33 Struck by turtle - W59.21	
	Hobbies & Outdoor Activities Injured at opera house - Y92.253 Injured while knitting & crocheting - Y93.D1 Burn due to water skis on fire - V91.07 Balloon accident injuring occupant - V96.0 Explosion of bicycle tire - W37.0	
	Space Adventures Prolonged stay in weightless environment - X52 Spacecraft collision injuring occupant - V95.43	
	In the Wrong Place at the Wrong Time Shock due to being struck by lightning - T75.01 Injured at library - Y92.241 Injured while sleeping - Y93.84	
	Events Probably Not So Rare Problems in relationship with in-laws - Z63.1 Dependence on enabling machines & devices - Z99.89 Walked into wall - W22.01	
	Events That Should Never Happen Bubonic plague - A20.0 Sucked into jet engine - V97.33 Asphyxiation due to being trapped in a discarded refrigerator - T71.23	
		

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Detailed codes invite artistry – ICD-10 Illustrated



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



Other benefits and challenges for ICD-10

Benefits

- ICD-10-CM adds Z codes that allow for circumstances beyond clinical encounters for diseases, e.g., social determinants of health, genetic susceptibility to disease, other health services provided, etc.

Challenges

- Would transition to a more compositional terminology system, such as SNOMED or even ICD-11 (to be aligned with SNOMED), be a better approach (Chute, 2012; Rodrigues, 2015)?
- Proliferation of many country-specific versions, e.g., ICD-10-AM (Australia), ICD-10-CA (Canada), ICD-10-TM (Thailand), etc. that compromise international health comparisons (Jette, 2010)

ICD-11

New features include (Chute, 2022)

- [Foundation](#) of network of terms that can be “linearized” for specific uses, such as morbidity and mortality classification
- [Postcoordination](#) of terms, e.g., cancer and location, infection and microorganism

Transition from ICD-10-CM

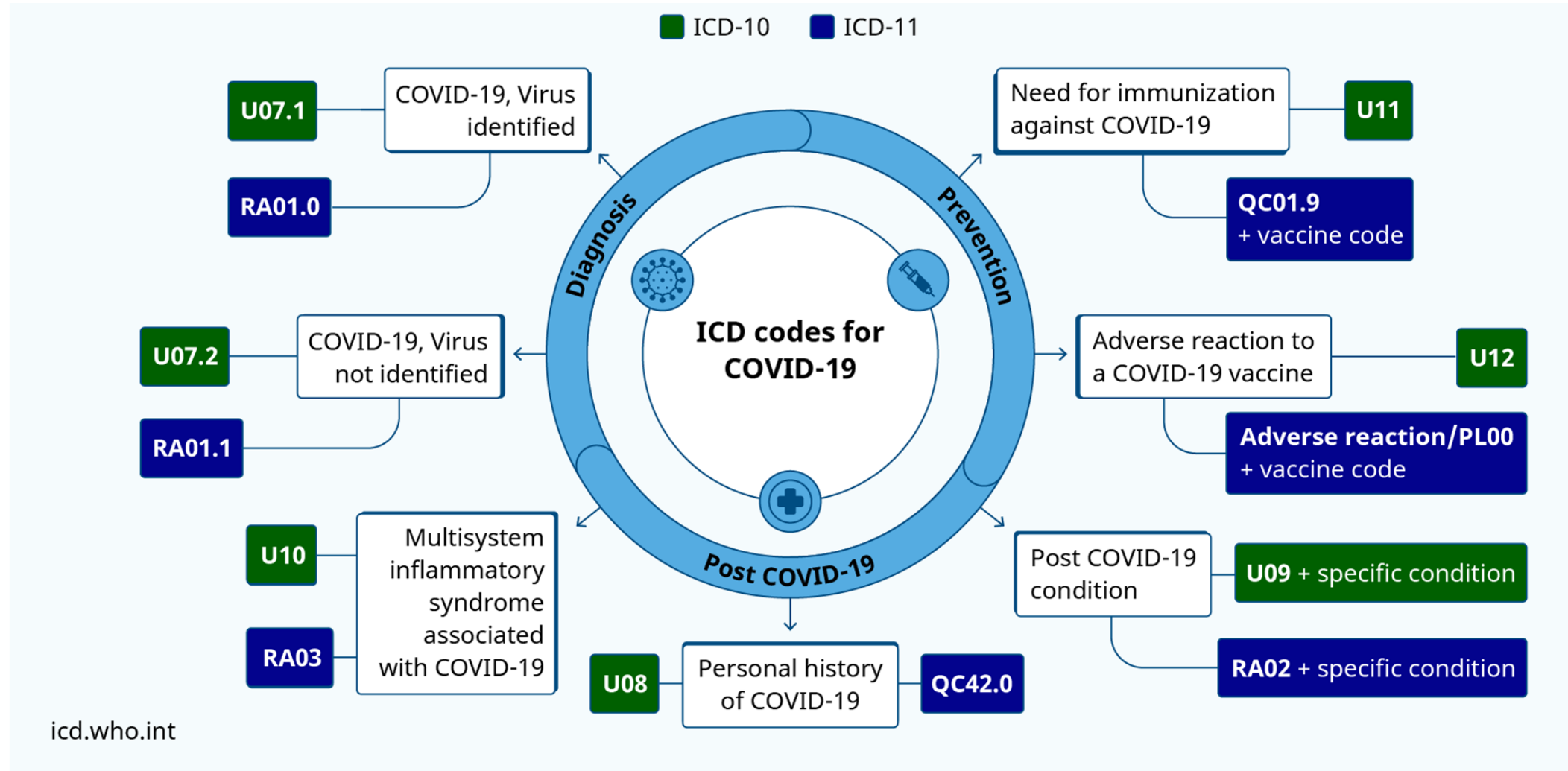
- For 388 codes for common diseases, 60% coverage with postcoordination (Fung, 2020)
- For 943 most commonly used codes in US, increased to 90% with use of coding guidelines and hierarchical structure – can need to develop US CM version be unnecessary? (Fung, 2023)

Or should US transition to SNOMED CT instead (Millar, 2016)?

- Mapping between found challenges with nonsynonymous synonyms, mismatch in granularity, composite conditions, and residual categories (Fung, 2024)

Can access at WHO via [browsing](#), [searching](#), and [API](#) and at [Find-A-Code](#)

Challenge for all coding systems is evolving diseases, e.g., COVID-19



Diagnosis-related groups (DRG)

Original intent was to aggregate ICD-9-CM 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

- For some DRGs, modifiers allow increased reimbursement
 - Major Complication or Comorbidity (MCC)
 - Complications or Comorbidities (CC)

Have migrated to ICD-10-CM groupings (Pollard, 2020)

- Can be searched at [ICD10Data.com](https://www.icd10data.com)

DRG examples for respiratory diseases

- [177](#) Respiratory infections and inflammations with mcc
- [178](#) Respiratory infections and inflammations with cc
- [179](#) Respiratory infections and inflammations without cc/mcc
- [180](#) Respiratory neoplasms with mcc
- [181](#) Respiratory neoplasms with cc
- [182](#) Respiratory neoplasms without cc/mcc
- [183](#) Major chest trauma with mcc
- [184](#) Major chest trauma with cc
- [185](#) Major chest trauma without cc/mcc
- [186](#) Pleural effusion with mcc
- [187](#) Pleural effusion with cc
- [188](#) Pleural effusion without cc/mcc
- [189](#) Pulmonary edema and respiratory failure
- [190](#) Chronic obstructive pulmonary disease with mcc
- [191](#) Chronic obstructive pulmonary disease with cc
- [192](#) Chronic obstructive pulmonary disease without cc/mcc
- [193](#) Simple pneumonia and pleurisy with mcc
- [194](#) Simple pneumonia and pleurisy with cc
- [195](#) Simple pneumonia and pleurisy without cc/mcc
- [J10.00](#)  Influenza due to other identified influenza virus with unspecified type of pneumonia
- [J10.01](#)  Influenza due to other identified influenza virus with the same other identified influenza virus pneumonia
- [J10.08](#)  Influenza due to other identified influenza virus with other specified pneumonia
- [J11.00](#)  Influenza due to unidentified influenza virus with unspecified type of pneumonia
- [J11.08](#)  Influenza due to unidentified influenza virus with specified pneumonia
- [J15.0](#)  Pneumonia due to Klebsiella pneumoniae
- [J15.1](#)  Pneumonia due to Pseudomonas
- [J15.20](#)  Pneumonia due to staphylococcus, unspecified
- [J15.211](#)  Pneumonia due to Methicillin susceptible Staphylococcus aureus
- [J15.212](#)  Pneumonia due to Methicillin resistant Staphylococcus aureus
- [J15.29](#)  Pneumonia due to other staphylococcus
- [J15.5](#)  Pneumonia due to Escherichia coli
- [J15.61](#)  Pneumonia due to Acinetobacter baumannii
- [J15.69](#)  Pneumonia due to other Gram-negative bacteria
- [J15.8](#)  Pneumonia due to other specified bacteria
- [J17](#)  Pneumonia in diseases classified elsewhere