Das Bundesinstitut für Arzneimittel und Medizinprodukte, kurz: BfArM, veröffentlicht jedes Jahr aktualisierte Versionen medizinischer Klassifikationen, wie zum Beispiel der Kodiersysteme ICD-10-GM und OPS. Diese Änderungen in den Kodes erschweren die versionsübergreifende Analyse klinischer Daten, wie sie beispielsweise vom Deutsches Forschungsdatenportal für Gesundheit Medizininformatik-Initiative zur Verfügung gestellt werden. Ein technischer Ansatz dieses Code-Mapping-Problem zu lösen wäre die Verwendung von *ConceptMaps* aus dem FIHR Standards für den Austausch elektronischer Gesundheitsdaten.

1 Grundbegriffe

1.1 Klassifikationen ICD-10-GM und OPS

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1.2 FHIR ConceptMap

«HL7® FHIR® (im Folgenden „FHIR“ genannt) ist der modernste Interoperabilitäts-Standard aus der Produktfamilie von Health Level 7 International (kurz: „HL7“), einer internationalen Standardisierungsorganisation für das Gesundheitswesen, die in der Vergangenheit schon viele erfolgreiche und weit verbreitet genutzte Standards, wie zum Beispiel HL7 Version 2 oder HL7 CDA (Clinical Document Architecture) hervorgebracht hat. [...] HL7 wurde 1987 gegründet, um Standards für klinische Informationssysteme zu erarbeiten. [...] FHIR ist die dritte Generation von Interoperabilitätsstandards aus der Feder von HL7. Die Entwicklung begann im Jahre 2011 als Reaktion auf die Forderungen aus der Industrie nach einer standardisierten Lösung für die Entwicklung webbasierter Applikationen für das Gesundheitswesen.» Heckmann (2022)

„Health Level 7 wurde 1987 gegründet, um Standards für klinische Informationssysteme zu erarbeiten. [...] FHIR ist die dritte Generation von Interoperabilitätsstandards aus der Feder von HLR7. Die Entwicklung begann im Jahre 2011 als Reaktion auf die Forderungen aus der Industrie nach einer standardistieren Lösung für die Entwicklung webbasierter Applikationen für das Gesundheitswesen.“ (Heckmann, 2022, Seite 309)

FHIR Braunstein (2022) HAPI, Ontoserver

- FHIR als Baukasten
- FHIR als Community-Standard

REST

REST Fielding (2000)

ConceptMap

http://hl7.org/fhir/R4/conceptmap.html

ConceptMap
- url
- id
- group
  - source
  - target
  - element
    - code
    - target
      - code
      - equivalence

- ConceptMap: A statement of relationships from one set of concepts to one or more other concepts - either concepts in code systems, or data element/data element concepts, or classes in class models.
  A map from one set of concepts to one or more other concepts
- url: An absolute URI that is used to identify this concept map when it is referenced in a specification, model, design or an instance; also called its canonical identifier. This SHOULD be globally unique and SHOULD be a literal address at which at which an authoritative instance of this concept map is (or will be) published. This URL can be the target of a canonical reference. It SHALL remain the same when the concept map is stored on different servers.
  Canonical identifier for this concept map, represented as a URI (globally unique)
  § wird von HAPI benötigt
- id: The logical id of the resource, as used in the URL for the resource. Once assigned, this value never changes.
  Logical id of this artifact § kann nicht verändert werden
- group: A group of mappings that all have the same source and target system.
  Same source and target systems
- source: An absolute URI that identifies the source system where the concepts to be mapped are defined.
  Source system where concepts to be mapped are defined
- target: An absolute URI that identifies the target system that the concepts will be mapped to.
  Target system that the concepts are to be mapped to
- element: Mappings for an individual concept in the source to one or more concepts in the target.
  Mappings for a concept from the source set
- code: Identity (code or path) or the element/item being mapped.
  Identifies element being mapped
- target: A concept from the target value set that this concept maps to.
  Concept in target system for element
- code: Identity (code or path) or the element/item that the map refers to.
  Code that identifies the target element
- equivalence: The equivalence between the source and target concepts (counting for the dependencies and products). The equivalence is read from target to source (e.g. the target is 'wider' than the source).
  § Auflisten, alle Versionen

- unmapped: What to do when there is no mapping for the source concept. Ünmapped"does not include codes that are unmatched, and the unmapped element is ignored in a code is specified to have equivalence = unmatched.
  What to do when there is no mapping for the source concept
  § provided

2 Verwandte Arbeiten

Mappingqualität

Medicats (ICD-10-GM Versionen)

Beispiele für FHIR-Mappings

UMLS

Oncology -> SNOMED CT

SNOMED als Interlingua

2.1 Normen für Mappings

Health Informatics, Terminology resource map quality measures (MapQual) ISO 21564 (2019)

Health informatics – Principles of mapping between terminological resources ISO 12300 (2014)

2.2 Medicats

Medical Classification and Terminology Systems in a Secondary Use Context: Challenges and Perils Hund et al. (2016)

Medicats Hund

2.3 ConceptMap für UMLS

Building Interoperable FHIR-based Vocabulary Mapping Services: A Case Study of OHDSI Vocabularies and Mappings

using multiple groups Saripalle (2019)

instead? – An Interoperable UMLS Terminology Service Using FHIR

2.4 Interlingua SNOMED CT

SNOMED Philipp et al. (2022)

Probleme:

- Uneindeutig, med. Fachpersonal benötigt

- Deutsche Version SNOMED CT

- OPS

- Wenn Mapping von ICD-10-GM auf SNOMED CT existiert, kann versionsübergreifendens Mapping für ICD-10-GM immer noch hilfreich sein.

Kode	Titel
203533003	Peroneal spastic flat foot
90374001	Acquired spastic flat foot
53226007	Talipes planus
44480001	Acquired flexible flat foot
203531001	Hypermobile flat foot
203534009	Acquired pes planus
203532008	Rigid flat foot

3 Aufbau & Beiträge dieser Arbeit

4 Quali

WHO-FIC Classifications and Terminology Mapping

Principles

1. Establish use case(s) before developing the map
2. Clearly define the purpose, scope, and directionality of the map.
3. Maps should be unidirectional and single purposed. Separate maps should be maintained for bidirectional maps (to support both a forward and a backward map table). Such unidirectional maps can be handy to support data continuity for epidemiological and longitudinal studies. Maps should not be reversed.
4. Develop clear and transparent documentation that is freely available to all and describes the purpose, scope, limitations, and methodology of the map.
5. Ideally, the producers of both terminologies in any map participate in the mapping effort to ensure that the result accurately reflects their terminologies' meaning and usage. At a minimum, both terminology producers should define the primary purpose and parameters of the mapping task, review and verify the map, develop the plan for testing and validation, and devise a cost-effective strategy for building, maintaining, and enhancing the map over time.
6. Map developers should agree on team members' competencies, knowledge, and skills at the project's onset. Ideally, users of the map also participate in its design and testing to ensure that it fits its intended purpose.
7. Quality Assurance (QA) and Usage Validation: QA and usage validation is ensuring the reproducibility, traceability, usability and comparability of the maps. Establish the QA and usage validation protocols at the beginning of the project and apply them throughout the mapping process. Factors that may be involved in quality assurance include quality-assurance rules, testing (test protocols, pilot testing), and quality metrics (such as computational metrics or precisely defined cardinality, equivalence, and conditionality). Usage validation of maps is an independent process involving users of the maps (not developer of the maps) in order to determine whether the maps are fit for purpose (e.g. do the end users reach to the correct code in the target terminology when using manual and automated maps etc.). Usage validation is essential to ensure the integrity of the information from source data to the final coding. Key principles for usage validation of maps include:
   (a) use of the ground truth of the original source data1 (e.g. diagnosis as written in the medical record) as the reference point;

(b) compare the original source data with the end results of the following two processes
   i. Coding of original source data with a source terminology – map code(s) of source terminology to code(s) of target terminology
   ii. Coding of original source data with target terminology

(c) statistically significant sample size that is representative of the target terminology and its prototypical use case settings.

(d) Usage validation of automated maps should always include human (i.e. manual) validation

Clear documentation of the QA process and validation procedures is essential in this step in the mapping process. If conducting a pilot test is feasible, it will improve the QA/validation process. Mapping is an iterative process that will improve overtime as it is used in real settings.

8. Dissemination: Upon publication and release, include information about release mechanisms, release cycle, versioning, source/target information, licence agreement requirements, and a feedback mechanism for users. Dissemination of maps should also include documentation, as stated above, describing the purpose, scope, limitations, and methodology used to create the maps.

9. Maintenance: establish an ongoing maintenance mechanism, release cycle, types and drivers of changes, and versioning of maps. The maintenance phase should include an outline of the overall lifecycle plan for the map, open transparent resolution mechanism for mapping problems, continuous improvement process, and decision process around when an update is required. Whenever maps are updated, the cycle of QA and validation must be repeated.

10. When conducting mapping manually, it is recommended to provide map specialists with the necessary tools and documentation to drive consistency when building the map. These include such items as the tooling environment (workflow details and resources related to both source and target schemes); source and target browsers, if available; technical specifications (use case, scope, definitions); editorial mapping principles or rules to ensure consistency of the maps, particularly where human judgement is required; and implementation guidance. Additionally, it is best practice to provide an environment that supports dual independent authoring of maps as this is thought to reduce bias between human map specialists. Developing a consensus management process to aid in resolving discrepancies and complex issues is also beneficial.

11. In computational mapping, it is advisable to include resources to ensure consistency when building a map using a computational approach, including a description of the tooling environment, when human intervention would occur, documentation (e.g. the rules used in computerized algorithms), and implementation guidance. It is also advisable to always compute the accuracy and error rate of the maps. It is also essential to manually verify and validate the computer-generated mapping lists. Such manual checking is necessary for the quality assurance process, as maps generated automatically will almost always contain errors. Such manually verified maps can also help train the machine- learning model when maps for different sections of terminologies are being generated sequentially.

12. Cardinality is a metric in mapping that must be clearly defined regarding what is being linked between source and target and how the cardinalities are counted. For example, SNOMED CT codes for functional impairments are semantically different from ICF codes. A 1:1 map between the two does not mean semantic equivalence. In terms of counting, what SNOMED International considers to be a 1:1 map includes what others may consider being a 1:many map.

13. Level of equivalence, such as broader, narrower, or overlap, should be specified.

14. Maps must be machine-readable to optimize their utility2.

15. ICD-11: When creating maps using ICD-11 and other WHO systems, mapping into the Foundation Component comes first, then maps to MMS could created through linearization aggregation2

ISO/TR 12300

Prinzipien:

1. Each map should have a (preferably single) declared purpose
2. Scenarios are developed and articulated to define the requirements for the map table
3. The map table should be in a machine processable format
4. Identify each version of each terminological resource as a version of the Map Table
5. Members of the project team should have knowledge of both of the terminological resource and experience in their practical application
6. Establish the extent to which the conventions and rules of each terminological resource will be followed
7. Custodians of terminological resources should be involved in mapping projects
8. The automated and manual methods applied should be transparent and documented
9. Every map should describe the direction of the map
10. Cardinality of each individual map should be clearly specified
11. Any loss or gain of meaning should be made explicit and risk assessed
    All maps should demonstrate the degree of equivalence
12. All mapping projects should make explicit the guidelines and heuristics applied in developing and interpreting the maps when implemented
13. Documentation supporting the map should describe the map data structures, distribution format and licensing arrangements
14. Every mapping project should have a quality assurance plan which includes testing and validation
15. Every mapping project should have a consensus management process
16. Maps should be maintained and routinely updated during their lifespan
17. Every map should have a maintenance and evaluation plan, which includes the mechanisms for version control
18. Maps should have continuing improvement processes
19. Every map should have supporting documentation to assist implementation and use
20. Map development and maintenance is best managed through a team

ISO 21564

Determinants of map quality

1. Common categorical structure (ja)
2. Shared semantic domain (ja)
3. Language and Translation (keine Übersetzung)

4. Equivalence Identification / Publication (ja)
5. Equivalence Assessment (abweichungen zw. source und target)
6. Map Set Outliers
7. Clear documentation of the purpose of the map
8. Currency of the map (zeitliche Nähe)
9. Business Arrangements
10. Methodology Documentation
11. Percentage of map validated
12. Method of validation
13. Decision making (klare Prozesse)
14. Tools used to develop or maintain the map (ja)
15. Workforce
16. Governance (Entscheidungen)
17. Map Maintenance

Literatur

M. Braunstein, *Health Informatics on FHIR: How HL7's API is Transforming Healthcare*, ser. Health Informatics. Springer International Publishing, 2022.

R. T. Fielding, "Architectural styles and the design of network-based software architectures," Doctoral Dissertation, University of California, Irvine, 2000. [Online]. Available: https://ics.uci.edu/~fielding/pubs/dissertation/top.htm

S. Heckmann, *Digitalstrategie im Krankenhaus: Einführung und Umsetzung von Datenkompetenz und Compliance*. Springer Fachmedien Wiesbaden, 2022, ch. HL7® FHIR® als Grundlage für moderne Digitalstrategien, pp. 307–331.

H. Hund, *medicats*. [Online]. Available: https://github.com/hhund/medicats

H. Hund, S. Gerth, H. Katus, and C. Fegeler, "Medical classification and terminology systems in a secondary use context: Challenges and perils," *Studies in health technology and informatics*, vol. 228, pp. 394–398, 2016.

ISO 12300, *Health Informatics – Principles of Mapping between Terminological Systems*, International Organization for Standardization, 2014. [Online]. Available: https://www.iso.org/standard/51344.html

ISO 21564, *Health Informatics – Terminology Resource Map Quality Measures (MapQual)*, International Organization for Standardization, 2019. [Online]. Available: https://www.iso.org/standard/71088.html

Medizininformatik-Initiative, *Forschungsdatenportal für Gesundheit*. [Online]. Available: https://forschen-fuer-gesundheit.de

P. Philipp, J. Veloso de Oliveira, A. Appenzeller, T. Hartz, and J. Beyerer, "Evaluation of an automated mapping from icd-10 to snomed ct," in *2022 International Conference on Computational Science and Computational Intelligence*, 12 2022, pp. 1604–1609.

R. Saripalle, "Representing umls knowledge using fhir terminological resources," in *2019 IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*. IEEE, 2019, pp. 1109–1112.