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**An Integrated System for Codes, Classifications and Definitions in Health Care,
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An Integrated System for Codes, Classifications and Definitions in Health Care

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Abstract

This final report of the Dutch Classification and Terminology Committee for Health (WCC) narrates its activity in standardization in the period 1974-1997. The mission of the WCC was the advancement of the one-time recording and exchange of data with regard to health and health care by means of an integrated system for codes, classifications and definitions. Three developmental phases are distinguished with switches of the activity from standards on objects to those on concepts and from standards on concepts to those on terms. For an integrated system increasingly more drastic requirements were considered to be necessary in the consecutive phases:

- *individual objects need a unique identifier,*
- *objects have to be distinguished by sets of intrinsic characteristics,*
- *professional groups determine by consensus on their concepts,*
- *concepts of professional action have to be defined in terminological phrases,*
- *all kinds of diagnostic terms, that physicians may be aware of, should refer to a classification if data collection is the purpose (e.g. ICD-10), and*
- *terms should be analyzed and structured according to their referential meaning.*

Since 1998 a new division of tasks between standardization bodies, terminology and maintenance services replaces the WCC-activity. The Department for Public Health Forecasting of the National Institute of Public Health and the Environment is yet maintaining the ICD-10 in Dutch and conversions of other health-related classifications to the ICD-10, and has been taking over the terms of reference of the WHO Collaborating Centre for the ICIDH.

1. Historical background

WCC, Dutch Classification and Terminology Committee for Health 1974 – 1996

The WCC was installed in 1974 at the request of the then State secretary of the Ministry of Health and Environmental protection in the Netherlands by the Raad voor Gezondheidsresearch (Council for Health Research - RGR/TNO). Its executive activity started in 1978 by appointing a secretary.

The mission of the WCC was the advancement of the one-time recording and exchange of data with regard to health and health care by means of an integrated system for codes, classifications and definitions (= standardization). By 'standardization' was meant: making agreements on these system elements with all interested parties in health care, including the Ministry.

This mission intended to create an iterative process between standardization and integration. It was expected that parties would be more prepared to agree on a proposal for a standard if the one-time recording and exchange of data might advance, i.e. more integration within the system could be realized, and vice versa.

The WCC put an effort in developing a practice of standardization¹ which was keeping with ISO/IEC Guide 2, 1986: General terms and their definitions concerning standardization and related activities. However, existing practices in the use of (international) classifications in health care could not be denied. It prompted the WCC to take the lead in classification development to put it more in line with 'an integrated system'. Such a leadership role is not common in the world of standardization. A standardization body has to restrict itself to the facilitation of a process of standardization, wanted by interested parties. In 1994 the WCC shifted its activity into the direction of more facilitation by issuing a new, more purposeful scenario of standardization which would imply:

- that (inter)national standardization tasks have to be fulfilled for a few classifications and nomenclatures, e.g.
- the International Statistical Classification of Diseases and Related Health Problems, and
- the International Classification of Impairments, Disabilities, and Handicaps;
- that the decentral development of derived products of international classifications, e.g. encoding tools, clinical modifications, has to be stimulated and monitored by means of consultancy by the secretariate²;
- that such derived products, after having been tested with regard to content, can be approved as a standard by the WCC;
- that all codes, classifications, definitions and measurement tools in health care can be made known by recording them in a register, in which case a central clearing house function has to be fulfilled.

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b WCC is the acronym for 'Werkgroep Classificatie en Coderingen', the original for 'Dutch Classification and Terminology Committee for Health'
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A change in governmental politics interfered however with this change in standardization policy. Since 1984 the WCC had been a committee of an advisory body of the ministry, the Nationale Raad voor de Volksgezondheid (the Netherlands council for health care - NRV). Already in 1994, the government decided to discontinue, effective in 1997, all its old advisory bodies. This implied that the new, much smaller, advisory body for the health care sector - the Council for Health and Care (RVZ) - would no longer be able to advise by means of consultations of health care organizations as used to be done by the WCC. The mission of the WCC was transferred to the Center for Standardization of Informatics in Health Care (CSIZ), a new association of health care organizations. The CSIZ intended to be the focal point for standards as well as for classifications and definitions as for exchange protocols (Edifact), chipcards, encryption standards etc. The organization aimed at the authorization of standards, strategic maintenance and information services. The CSIZ would not undertake the development and the updating of standards. The trend in standardization policy, already outlined in the new scenario of the WCC, ended in a new division of tasks between standardization bodies, terminology and maintenance services that replaces the WCC-activity. The Department for Public Health Forecasting of the National Institute of Public Health and the Environment is yet maintaining the ICD-10 in Dutch and conversions of other health-related classifications to the ICD-10, and has been taking over the terms of reference of the WHO Collaborating Centre for the ICIDH. It is obvious at the end of 1998 that a revival of the WCC is not an option. So it is time to launch the final report.

In the course of its more than 20 years of existence the WCC had built up an international reputation. Its secretariate participated in WHO activities (ICD and ICIDH³) and European activities^{4,5,6}, see also paragraphs 2.3, 3.1, 3.2 and 4.1. In view of these activities a final report in English might sufficiently be justified. Nevertheless the international activities are not the main reason. For this, reference has to be made to the mission of the WCC, in short: standardization by integrating codes, classifications and definitions for the one-time recording and exchangeability of data in health care. To achieve this mission three consecutive phases have been passed through, described in the chapters 2, 3 and 4:

- phase 1 (1974-85): the naming of objects;
- phase 2 (1986-95): the description of professional action;
- phase 3 (1996 +): the naming and description of health and disease phenomena.

In each phase a growing number of terminological requirements was developed, assessing the kind of integration the system had to attain.

- phase 1: a set of intrinsic characteristics would be sufficient for the identification and classification of objects;
- phase 2: a language-independent conceptual framework would be needed, structuring characteristics in a terminological phrase, for the classification and definition of professional action;
- phase 3: a tool is needed for the knowledge analysis of all kinds of terms that professionals are using for the naming, and for the classification and definition of health and disease phenomena.

Phase 2 and 3 enlarged the scope of activities to the multilingual and international level. That is why this report is written in English.

2. The naming of objects

Domains, identification and classification of objects

The first report of the WCC⁷, written in 1975 by a few leading executives in health information in the Netherlands, guided the activities in phase 1. These executives distinguished the following domains: health and disease phenomena, surgical procedures, medicaments, and organizational units in health care (hospitals and practices). Obviously they wished to distinguish these domains of objects for reasons of data collection, statistics, epidemiology etc. They wanted also a unique identifier for hospitals and practices, and standard classifications and codes for medical data.

2.1. Domains of objects in an integrated system

The choice of domains of objects is less self-evident than it looks like. In the next section (2.2.) a slightly different choice in the mid 80s is mentioned as a hindrance for the integration of the system. The existing identification of physicians interfered with the unique identification of their practices as organizational units for health care. A more recent example shows how terminological principles can evolve to a well-considered choice of domains. In 1994 a Dutch committee recommended a product typing in hospital care corresponding to AP-DRG's (All Patient Diagnosis Related Groups), i.e. a statistical clustering of diagnoses, complications, procedures, and age and sex of patients, mixing objects from different domains. In a recent report⁸ on the developmental principles for the arrangement of the hospital information supply it was argued that in this way the effectiveness and efficiency of hospital care can not be examined. A different clustering, Disease Staging, was recommended in which disease phenomena are distinguished from procedures or characteristics of patients. This choice was suggested by the terminological distinction between the intrinsic and extrinsic characteristics of objects.

A characteristic is defined as a mental representation of a property of an object or of a set of objects⁹. An *intrinsic characteristic* represents an inherent property of an object (e.g. a surgical procedure is at least characterized by a *direct* object of a surgical *deed*), an *extrinsic characteristic* reflects an object's relation to another object (e.g. a *disease* as a reason for a *surgical procedure*, *age* as a criterion for *length of stay in the hospital* after a surgical procedure).

In principle one does not need the extrinsic characteristics of an object to perceive it in reality and to distinguish it

from other objects. *A set of intrinsic characteristics will be sufficient for the identification and classification of objects. The requirement for an integrated system in phase 1 was the standardization of types of intrinsic characteristics which could classify the objects of health care in their different domains.*

One intrinsic characteristic, a unique identifier (e.g. proper names, consecutive code numbers) was an extra requirement for the distinguishment of an individual object from another one with the same set of other intrinsic characteristics.^c By identification is meant a unique coding of every individual object coming up to the same set of characteristics as other objects (= a set of objects).

In section 2.2. the identification of objects in an integrated system is described, and likewise in 2.3. the classification of objects.

2.2. Identification of organizational units

Around 1980 an organizational unit in the Dutch health care was given official recognition if located at a specific place and if it intended to deliver a specific set of health services in the period for which the recognition was given. In principle a recognition was supplied neither to an institution located at different places, nor to a functional unit within one location, e.g. a ward in a hospital building. Although there were exceptions to the rule, for most institutions it was clear which individual objects had to be distinguished. The Ministry authorized the WCC standard¹⁰ which proposed to give a unique identification (a consecutive code number) to each object, the so-called WCC code which is still in use for settlements of hospitals, nursing homes, psychiatric hostels, etc.

In the mid 80s the WCC proposed to give a unique code also to each general and clinical practice in health care, integrating this interim standard¹¹ with the former one. A practice had to be distinguished from an individual professional because in many situations there is not a one-to-one relation. Different physicians can participate in one (group) practice, a physician can appoint an assistant in times of vacation or illness, etc. The location criterion remained possible but not for all kinds of practices. However, the proposed standard was not authorized because the main Dutch information systems identified individual professionals; practices could be detected only indirectly. No new activities with regard to the identification of organizational units in health care could be developed since. The domains were already fixed: unique identifiers in health care regards individual professionals and organizational units, excluding practices which could be characteristics of both.

2.3. Classification of medicaments

Any part of the perceivable or conceivable world is an (individual) object⁹, e.g. one enteric coated tablet of ibuprofen 200 mg. The question whether two or more of those tablets from the same or different badges are alike, is a matter of pharmaceutical production, i.e. standardization of objects. Identification of medicaments is not intended in an integrated system. In the case of a patient taking one ibuprofen tablet, it is a tablet out of many identical tablets. The naming of medicaments for the one-time recording and interchange of data is a matter of classification. In such a classification of medicaments without identification one may say that one deals with concepts of medicaments instead of a set of medicaments as objects. In this context a classification is a system of concepts structured by generic relations.^d

Which set of characteristics of medicaments will be sufficient for their classification?

The classification of medicaments was originally set up departing from existing classifications and definitions (a Dutch pharmacotherapeutic classification, European Pharmacopoeia). In a WCC inquiry¹² in 1985 it was concluded that a medicament - defined in the Supply of Medicaments Act of 1963 - can be described in terms of 8 main characteristics (see *table 1* below):

Table 1

Type of characteristic	Level
1. substance(s) ¹³	= qualitative composition I
2. strength ¹⁴	= quantitative composition II
3. pharmaceutical dosage form ¹⁵ +	
4. route of administration ¹⁶	= generic level III
5. trade name	= wholesale trade IV
6. information regarding origin and legal registration	= wholesale product V
7. packaging ¹⁷	= article VI
8. batch number	= batch VII

This classification by types of characteristics on consecutive generic levels marked the end of phase 1: the classification of perceivable objects. During the further development of the different levels (= generic relations) a few types of extrinsic characteristics were removed. Originally a classification of active substances was developed according to pharmacotherapeutic groups and locus of action (= extrinsic characteristics of substances), and a classification of pharmaceutical dosage forms according to route of administration (= extrinsic characteristic of form). After 1991 the WCC reduced the classification of substances into an alphabetical list. The CPMP (Committee on Proprietary

^c Because of the fact that almost everything can be given a code (a domain, an object, a characteristic) the term coding system is a homonym which should be avoided.

^d Classification is a homonym, like a coding system, classification can relate to domains (classification of fields of knowledge), objects (books, articles, papers), characteristics (substances, routes of administration). Classification is also a name in use for existing products (classification of diseases). For this reason the phrase 'in this context' is used.

Medicinal Products) reduced the list of dosage forms. Furthermore, the levels wholesale trade (IV) and product (V) were united in an interim standard¹⁸ proposing a set of complementary lists. At last, the classification of medicaments consisted of five generic relations between six levels and one relation within level III. The seven types of characteristics are composed of a number of complementary lists of intrinsic characteristics. These characteristics of different types are used in sets describing a medicament on a specific level, e.g. an article: ibuprofen, 200 mg, enteric coated tablet, oral, Advil - Whitehall Laboratories, Madison - U.S. Patent No. 5, 087, 454, bottle for 125 tablets.

3. The description of professional action

Classification and definition of concepts

Although the classification of medicaments deals with concepts, these concepts obviously refer to perceivable objects. With professional activities a different situation occurs. If any part of the conceivable world is an individual object⁹ and every human is free in concept formation, every conceivable professional action can be called an object. A procedure can already be a blood pressure measurement and a procedure can encompass an open heart surgery by a team of medical specialists. A lot of new questions arise. Is a professional activity one or several procedures if it is done in more sessions? Are procedures only done by surgeons, or by all kinds of physicians, or also by nurses and allied health professionals? Are procedures directed to individuals, cohorts, populations? A pragmatic way out of this kind of problems is to determine the scope of the domain by the procedure concepts professionals wish to use. *In that case the universe of conceivable objects is based on the consensus within a professional group, possibly reached in consultation with medical record officers, informaticians and others. This requirement was envisioned at the start of phase 2 (1986) of the development of an integrated system: the description of professional action by classification and definition.*

3.1. Classification of procedures in medicine

Which classifications comprise the procedures in health care that should be recorded once and that should be exchanged? In 1986, after a five year long period of discussion with the interested parties in the Dutch health care, the WCC could decide to translate and to extend four chapters (1, 5, 8 and 9) of the International Classification of Procedures in Medicine¹⁹ as the standard for medical specialist procedures.

International agreement on the scope and form of the ICPM was reached as long ago as 1971 at a meeting of the American Hospital Association, when it was decided that the classification:

- 'should be susceptible to expansion for those who need greater detail, but it should also offer the possibility of use in a condensed form;
- should be applicable to inpatients and outpatients;
- should include all types of procedures to be recorded for statistical, administrative, clinical or research purposes, encompassing exploratory, radiological, surgical and other procedures of diagnostic, prophylactic or therapeutic nature'¹⁹ (Vol. 1, p. vi).

In conformity with this the ICPM consisted of nine chapters and four levels of subdivision:

1. Procedures for medical diagnosis, based on the Physicians' Current Procedural Terminology²⁰
2. Laboratory procedures
3. Radiology and certain other applications of physics in medicine
4. Preventive procedures
5. Surgical procedures, based on the forerunner of Volume 3 of the ICD-9 Clinical Modification²¹
6. Drugs, medicaments and biological agents and
7. ditto
8. Other therapeutic procedures
9. Ancillary procedures

The ICPM was the basis for the development of the WCC standard, the ICPM-DE (Dutch Extension)²², which consists of six levels of subdivision. The ICPM, however, had been published for 'trial purposes'. In 1989 the participants of the revision conference (ICD-10) recommended to WHO to refrain itself from an international classification of procedures, primarily because the rapid and extensive changes in this field were difficult to cope by the elaborate system of consultation in use with WHO.

By applying the consensus requirement consistently, any conceivable activity is a procedure if a professional group agreed that this activity should and could be a class in - for example - the ICPM-DE. This requirement overruled the former one (cf. chapter 2) whether or not there are sufficient intrinsic characteristics for the classification of a concept, e.g. classifying a medicament at a specific level of classification. The very starting point, that is the acceptance of the conceptualized structure of the ICPM, presented as a monohierarchical classification, entailed a subordinate role for other requirements. In the ICPM-DE the requirement of a sufficient number of characteristics^e almost diluted to intentions, like the following:

- *Ideally*, a classification will have a structure in which the classes are defined intensionally by characteristics;
- A classification *should* have 'homogeneity': This is the degree to which, in the intensional definition of two or more classes which belong to the same wider concept, the same types of characteristics are used.

^e Characteristic is a homonym, like coding system or classification; domains, objects and concepts can be classified and defined by characteristics.

Furthermore, the experience was that the consensus requirement itself diluted in the long run. The WCC standard for procedures was translated into German and German physicians were consulted about it. After a few years it was clear that the compatibility between the ICPM-Dutch and -German Extensions²³ had been reduced.

After 1985 different professional groups in the Netherlands rejected the ICPM structure. They preferred to describe procedures intensionally by intrinsic characteristics, like the classification of medicaments (see *table 2* on the next page).

Although there is a code system in the Netherlands encompassing the ICPM-DE and several standards from *table 2*, it can not be claimed that these standards refer to an integrated system of *classifications* of procedures:

- almost every professional group has its own subdivision of anatomy^{24 25};
- some professional groups still want to use a language in which an extrinsic characteristic (e.g. the diagnosis) is crucial for their classification of procedures (e.g. neurosurgery);
- in other languages and countries different classifications and types of characteristics are in use which are as right or wrong as the ones incorporated in the Dutch standards;
- the application of characteristics describing a concept varies (see 3.2.).

Table 2

Standards	Type of characteristics
Diagnostic procedures of radiology and nuclear medicine ²⁶	Technique anatomical localisation
Therapeutic procedures of radiotherapy and nuclear medicine ²⁷	technique combined radiation and assisting procedure target area (types of anatomical characteristics)
Laboratory procedures ²⁸	Subject Specimen determination method result
Medical microbiology and medical immunology ²⁹	component of host or micro organism antibodies functional properties specimen determination method
Procedures of allied health professions ³⁰	Subject Technique starting posture client activity client place of client activity

In view of the existing diversity within medicine and other disciplines in health care the consensus requirement can never be fulfilled. But do we really need consensus on classifications in order to attain an integrated system for codes, classifications and definitions? Can different classifications within the same domain be members of one system? The answer might be in the affirmative. The standards in *table 2* consist of sets of characteristics of procedures instead of classifications of procedures. Not every possible set of characteristics exists in reality and the sets in use may change over the years, due to scientific discoveries and technological innovations in medicine. Furthermore, different classifications can be developed from procedures described by the same sets of characteristics. An ENT specialist can choose the anatomical site as the primary principle of subdivision in his classification³¹, a vascular surgeon can choose the surgical deed to start with in his classification. Therefore, the presentation of procedure concepts in a classification depends at least on the preferred sequence in types of characteristics. In this way different classifications are imaginable in one domain and do exist in reality, e.g. for surgical procedures in different countries.

For an integrated system it could be sufficient to have agreement on the types of characteristics. *The consensus requirement might be restricted to classifications of professional groups guided by their specific scientific knowledge and protocols for procedures, leaving it to the informaticians to fulfil the former requirement (see chapter 2): to have available a sufficient set of characteristics for every possible concept in their classifications.* In this way the one-time recording and the interchangeability of data might be reached for concepts.

3.2. Definition of procedures in medicine

Can a set of characteristics really be sufficient? Half-way through phase 2 it became clear that there is another important difference between the description of perceivable objects and conceivable objects (concepts) by

characteristics. A sufficient number of intrinsic characteristics can class and identify a perceivable object. That will not necessarily hold for the concept of a procedure. An artery can be a characteristic of a procedure concept in different ways. It might be a characteristic either as a target organ, or as a way along which a target organ can be approached, or as a transplant. For the one-time recording and interchangeability of procedure data a set of characteristics has to be supplemented by the modes in which these characteristics are mutually related. In other words, in an integrated system the concepts have to be described by definitions rather than by strings of intrinsic characteristics. A definition is a statement that describes a concept in order to permit its differentiation from related concepts^{9 32}.

3.2.1. A conceptual framework

The CEN/ENV1828, Structure for classification and coding of surgical procedures⁵, requires for the standard definition of a procedure a terminological phrase, consisting of concept fields, with or without modifiers, connected by semantic links and governed by a list of combinatorial rules (see *table 3*).

Table 3

Elements of surgical procedure terminological phrases	lexical items	Examples/rules
concept fields	surgical deed human anatomy pathology medical device	to open, to close, to pass through, to install, to remove circulatory tract, digestive tract, muscles, skeleton, skin fracture, neoplasm, adhesion, thrombus, stoma, lesion pacemaker, needle, pin, catheter, clip, endoscope, laser
types of modifier	Extent Side Number	Partially, totally, radically Left, right, both, lateral, medial Two (lobes of right lung) etc.
semantic links	direct object ^f indirect object means	Colon in the phrase: colon removed Polyp in the phrase: polyp removed from colon Colon in the phrase: polyp removed from colon Endoscope in the phrase: polyp removed from colon by means of endoscope
combinatorial rules	1 2 3	Each phrase shall, as a minimum, consist of a direct object and a surgical deed Each phrase shall contain human anatomy either as a direct object or as an indirect object Each phrase shall not include pathology unless the procedure cannot be described adequately without it

A conceptual framework as outlined in *tabel 3* is language-independent. Using this framework, every description of a surgical procedure, either as a definition or - less explicit - as a class in a classification, can be compared with related concepts. Annex E in the CEN/ENV 1828 reported that the conceptual framework can be applied throughout all kinds of surgical procedures as can be seen from 1000 analysed surgical statements (classes) from English, French, German and Dutch procedure classifications.

In 1995 it was a challenge³³ to create the organization to complete, authorize and maintain the conceptual framework for surgical procedures. In 1996 the project Galen-In-Use (GIU) got the financial support of the European Union to start such an organization.

3.2.2. A description logic

The finding mentioned at the end of subsection 3.2.1. will be reinforced by the Galen Common Reference Model (CORE model) of GIU. The CORE model for procedures³⁴ will be formulated in the Galen Representation and Integration Language (GRAIL). GRAIL is a description logic separating concepts into their components, classifying the components separately, and then recombining them into composite entities and classifying them on the basis of their definitions and descriptions. So: GRAIL restructures procedure descriptions as far as its concepts and components can be analysed, composed and classified into 'analytical' statements. There are however statements in a description which can not or only partly be analysed and restructured. In order to cope with these 'non-analytical' statements, GRAIL has developed some specific features:

- to capture the 'terminological part' of clinical knowledge (see point 1).
 - to handle part-whole relations and other transitive relations (see point 2),
1. "The goal of the CORE model is to capture the 'terminological' part of clinical knowledge. The distinction is not easy to define. Technically, the boundaries are drawn along the limits of what can be represented within a set of constructs. Organisationally they are set by consensus. Pragmatically, there is often a rough correspondence. For example the classification of 'rheumatoid arthritis' as an inflammatory arthritis^g is

^f Object is a homonym too, because in the real world an object can be perceived or conceived (ISO 704) and in CEN/ENV 1828 an object is a term, a lexical item.

^g This statement is part of a quotation and can not be changed, although it might be clear that an arthritis is inflammatory like snow is white.

uncontroversial. However, various clinical groups have established different diagnostic criteria based on scoring systems — five out of seven criteria for one, six out of ten for another, etc. To require consensus on the diagnostic criteria before we can agree a terminology is fruitless. Coincidentally, though the individual criteria can be represented in GRAIL, notions such as ‘five out of seven’ cannot be shown. Hence we take ‘inflammatory arthritis’ as terminological and the diagnostic criteria as ‘extrinsic’, requiring a separate, possibly application-specific reasoner.”³⁴ (subsection 13.4.4.3., p. 106)

2. “Many medical concepts are the combination of an anatomy (topography) and a lesion or process — e.g. ‘ulcer of the stomach’, ‘fracture of the femur’ — or a process and a cause — e.g. ‘viral hepatitis’, ‘diabetic retinopathy’. The organisation of anatomy is strongly dependent on part-whole relations and the organisation of causal structures on causal relations, both of which are transitive in many situations. Since all reasoning in GRAIL is by means of classification in the subsumption hierarchy (y is a kind of x), these other transitive relations must be coordinated with the primary subsumption hierarchy. The relationship is not straightforward: the ‘shaft of the femur’ is a part of the femur rather than a kind of the femur, but a ‘fracture of the shaft of the femur’ is a kind of a ‘fracture of the femur’ and a ‘femur with a fractured shaft’ is a kind of a ‘fractured femur’...”³⁴ (subsection 13.3.3., p. 97)

These features show that GRAIL handles diagnostic criteria, part-whole relations and causal relations by excluding more specific clinical knowledge from its description logic (see point 1) or by reduction of transitive knowledge to analytical combinations (see point 2).

3.2.3. Differences between the framework of CEN/ENV 1828 and the CORE model

The differences between the framework of CEN/ENV 1828 and the CORE model - the Galen representation of surgical procedures - arise because the CEN framework was never designed to be implemented as a formal system, whereas the CORE model has a formal implementation which it must follow.

An example: In the CEN standard, a surgical deed is a part of a surgical procedure, and all surgical procedures must have one or more surgical deeds. Within the CORE model the ability to nest or embed surgical procedures recursively is required, so that a complex surgical procedure might be defined as being the combined enactment of a number of (less) complex surgical procedures (deeds). For this reason, the CORE model “chooses at the present time to represent ‘surgical procedure’ as a specialisation of a surgical deed, rather than as a discrete concept”³⁴ (section 4.3., p. 39). Therefore, the use of semantic links is different. In the CEN/ENV 1828 direct objects are connected with the surgical procedure. In the CORE model the direct object has to be connected with the surgical deed.

Another example: In order to prevent nonsense compositions, the Galen anatomical model requires that the indirect object is connected with the direct object. Galen attempts to develop a coherent, detailed, scalable and extensive model of anatomy as a key component of its CORE model. This anatomical model is not a new consensus on ‘nomina anatomica’ but a way of avoiding impossible compositions of anatomical terms. All possible compositions are sanctioned, hence excluding illogical ones, e.g. a surgical removing (deed) of a kidney cyst (direct object) in a thyroid (indirect object). This way of sanctioning still will result in an enormous number of possible concepts, as the views on human anatomy differ considerably between pathology, surgery, radiology, orthopaedics, physical therapy, etc. These specialisations generate too many (slightly) different concepts. If consensus between those disciplines could be reached they would not be specialisms. The diversity of concepts within medicine and allied disciplines prohibits by definition consensus. Given this diversity GRAIL may lead to too many - possible - concepts to incorporate within an integrated system for codes, classifications and definitions. Perhaps there is a way out for GRAIL, by calling clinical diversity also ‘extrinsic’ (cf. point 1 in subsection 3.2.2.).

The CORE model of Galen-In-Use has added to the framework of the CEN standard some extra features for the definition of surgical procedures, described in different classifications. At the end of phase 2 (1995) it was obvious that the requirement of a sufficient number of intrinsic characteristics (section 3.1.) could be replaced by *the requirement that a language-independent conceptual framework has to structure preferably intrinsic characteristics in a terminological phrase, for the description of professional actions in such a way that the one-time recording and interchangeability of procedure data is possible.*

It should be noticed that this requirement can be fulfilled irrespective of languages and classifications in use. It should also be noticed that this result can be attained with statements which can be analysed and restructured, keeping clinical and transitive knowledge representation out by the specific features of the CORE model.

3.2.4. Analytical and non-analytical statements

The CORE model might be sufficient for those classifications whose requisites for differentiation can be attained with ‘analytical’ statements, i.e. for procedure classifications. In 1996/97 in the Galen-In-Use project thousands of classes of the ICPM-DE were prepared for GRAIL, confirming that the new requirement for an integrated system of surgical procedures can be met with the CORE model. There were less than thirty statements which could not be analysed sufficiently. This preparation was done in the SPET, Surgical Procedure Editing Tool, originally developed by P. Zanstra and E. van der Haring of the University of Nijmegen, where also a few members of the former WCC secretariate participate in the GIU project. In our view the shortcomings of GRAIL to incorporate non-analytical statements were an extra motivation for the development of SPET. The main reason for its development was that SPET protects the users of Galen for some of the more complex features of GRAIL.

In Galen-in-use SPET is a tool for the intermediate representation of medical concepts. SPET can support the

dissection methodology of (sub)categories in many kinds of classification. At present, its dissection work is the pre-processing part of the GIU modelling process. The objective of this work within the Classification Management Suite is to have on the one side the CORE model and on the other side a structured representation of one or more classifications with mappings between each of the classifications and the model. Though separating analytical from non-analytical information is hardly needed for procedure classifications, this feature might be important for classifications of phenomena which can not be restricted to analytical statements without a serious loss of information.

Two examples of *dissections* may illustrate the problem of information reduction which announces a third phase in the development of an integrated system:

Rubric “valgising osteotomy of femur”

main cutting (deed)
to achieve valgising
acts on pathological posture (non-analytical)
acts on femur

Comment: The knowledge that a posture is pathological, is not analytical but clinical.

Rubric “open reduction of fracture of thoracal vertebra without internal fixation, but with application of skull traction”

main reduction (deed)
has approach open
acts on fracture
has location vertebra
has location thorax
without internal fixation
deed putting into traction
acts on skull and spine (non-analytical)

Comment: The knowledge that skull traction results in spinal traction, is not analytical but empirical. The rubric itself does not mention traction of the spine.

In this way, procedure descriptions may contain more information than analytical statements can cover. For the differentiation of procedures in an integrated system (this time the CORE model) this loss of information does not matter. From this section 3.2. it must also be concluded that some statements are used for the differentiation of causal relations, diagnostic criteria, syndromes consisting of associated conditions, and other concepts of empirical or theoretical nature. These kinds of statements characterize health and disease phenomena, objects which are essentially varying and changing mixtures of perception and concept formation.

4. The naming and description of health and disease phenomena Terms in an integrated system

Gradually a person sees, comprehends and describes an object of the physical or imaginable world. In doing so he uses two parallel approaches. He distinguishes the object as a unique whole and as a unique set of characteristics. The object is the starting point for both a holistic and reductionistic concept formation^{35 36}. In phase 2 this dualism induced the bipartition into non-analytical and analytical statements.

Statements are written in terminological phrases, i.e. in words and sentences. Phase 3 in the development of an integrated system for codes, classifications and definitions started with another academic study of a member of the WCC secretariate³⁷. It deals with the lexical analysis of statements referring to perceivable and conceivable objects, rather than their conceptual analysis.

Professionals in health care need all kinds of terms for the naming, classification and definition of health and disease phenomena. A phenomenon like disease has often a course, which may change its characteristics and the terms referring to these characteristics. By a varying and changing perception and concept formation the terms may change too. If little is known of a disease, terms may refer to it with a unique name, a general term, a vague word, an unspecified rubric, a collective expression like ‘other’. As more facts become known, terms can refer to a disease with elementary, operational, quantitative, and theoretically based indications. In the next section 4.1. the existing use of terms in the international classification of diseases and related health problems³⁸, the ICD-10, is exemplified. Section 4.2. deals with the knowledge analysis of diagnostic terms, i.e. statements.

4.1. Classifications for health and disease phenomena

The Dutch translation of the ICD-10³⁹ will count more than 50,000 alphabetical entries, referring to diagnostic terms in the tabular list. Why has the ICD so many diagnostic terms? The answer is that the ICD has to provide the various kinds of diagnostic terms that physicians may be aware of^h. The ICD has a lexicographic function for physicians and medical record officers. Only in this way it can be an instrument for data collection serving various statistical and other purposes, e.g.:

^h If the ICD could be reduced to a logical coherent representation of medical knowledge the principle of parsimony or ‘razor of Ockham’ would have cut off all those terms which can be considered as synonymous or co-extensive terms of the obviously less numerous terms representing this knowledge.

- mortality and morbidity, i.e. the underlying cause of death, the main condition for an episode of care, additional diagnoses,
- (electronic) patient records, i.e. injuries, indications for the referral to a hospital, differential diagnoses, complications, etc.

A few examples of coding rules may illustrate what from the ICD is required for data collection. Although little or no data on the cause or condition may be available, every dead person has to be counted for mortality statistics. If little is known of the disease of a deceased person, this little bit is coded as the underlying cause. According to the coding rules for mortality, only symptoms and ways of dying (heart failure, respiratory failure) are excluded as causes. In cases of unknown causes there is a general code R99, other ill-defined and unspecified causes of death, which has to be used. This situation of trying to make the best out of the available data holds for mortality and morbidity statistics as well as, for example, for general and clinical practices. Coding departments may assist this work. Furthermore, a lot of coding rules may serve the data recording to become even more accurate than will be possible or necessary in clinical practice. The quality of the coding, however, depends primarily on the perception and concept formation of the physician, who may have less or more clinical experience and who may have been educated in medicine recently or decades ago. The ICD, including its alphabetical index, is therefore a collection of all kinds of terms that physicians may be aware of. The selection of terms they will use, however, will depend on the task they want to fulfil. The reason why, for example, a bacterium name will be used by a specialist for internal diseases⁴⁰ to characterize the disease of a patient, may depend on

- his/her knowledge on the question whether or not that bacterium characterizes this disease (e.g. is this disease by definition, often or occasionally due to that bacterium?),
- the question whether or not it is the cause this time,
- how much it matters to know the bacterium for the drug therapy to be prescribed.

For his/her clinical practice the location and general cause of a disease may be sufficient, e.g. pericarditis in elsewhere classified bacterial diseases (I32.0). According to the morbidity coding rules, a bacterial causation is an essential characteristic for the coding of the main condition (Volume 2³⁸, p. 100), and therefore the coding department will demand of the specialist for internal diseases or the laboratory for medical microbiology to mention the responsible bacterium, in order to code the cause more specifically, e.g. meningococcal heart disease (A39.5). *In phase 3 the development of an integrated system requires the handling of all kinds of diagnostic terms referring to classes in, for example, the ICD-10.* The examples may demonstrate that the coding of these terms, in use in health services, is currently the main reason for the complexity of ICD-10.

The ICD has started already fourteen decades ago with a complex collection of domains, proposed by William Farr: five mutually non-exclusive categories of causes of death:

- epidemic diseases
- constitutional or general diseases
- local diseases arranged by site
- developmental diseases
- injuries

The consecutive revisions of ICD have followed this approach. They can be characterised by an ever increasing complexity without adequate tools to handle this. This trend makes the currently pending implementation of ICD-10 comprehensible, following a revision period being longer than ever. Having supervised five revisions WHO provided the opportunity for the ICD to become the most quoted scientific reference. However it may also be the most criticised classification in health care. Therefore everything should be done to develop better health information tools.

Already at the Revision Conference for the ICD-10 in 1989 the WCC “regretted that little was done to remedy inherent weaknesses in the structure of the ICD itself and in the ‘family’ of health related classifications We advocate strongly an active role of WHO to work together with member states and interested groups towards improvements of the system. In the Netherlands work is done in this respect and willingness to contribute exists.” (cf. the letter of the WCC to WHO on 20 September 1989)

At last, in 1997, the WHO asked for ideas on the content and scope of a long term strategy for its classification-related activities. A plan of action for activities through the year 2010 is in preparation. It may encompass:

- the family of classifications (parameters for inclusion into the family);
- the formalization of the updating mechanism;
- the evaluation of the updating process and future revisions;
- the review and evaluation of tools which support and enhance the quality and utility of ICD data:
 - conversion tables;
 - bridge coding and comparability ratios;
 - training (e.g. TENDON⁴¹);
 - automated encoding and coding-assisting software (e.g. MICAR⁴², LUCID⁴³);
 - data presentation (e.g. tabulation lists);
 - analytical methods (e.g. multiple cause of death analysis);
- the enhancement of classification-related networksⁱ:

i With reference to for example Galen-In-Use and ‘linguistic tools’, like GRAIL and SPET, strengthening (relations between) classifications.

- GRAIL (see subsection 3.2.2./3.)
- SPET (see subsection 3.2.4.)

The plan is still (October 1998) a draft, susceptible to editorial and policy changes. The reason to mention it here is to demonstrate the willingness of WHO and the Collaborating Centers for the Classification of Diseases to handle the complexity more extensively than before. The basic idea is not to start again a time-consuming and costly revision process, leading to a new compromise, an ICD-11. The basic idea may become the re-analysis of diagnostic terms by a linguistic tool (see next section) to support and enhance ICD updates, the family of classifications, and the quality and utility of ICD data.

4.2. Knowledge analysis of diagnostic statements

The ICD is not a systematic representation of the analytical, empirical and theoretical knowledge of the medical sciences. The lexicographic function of the ICD is fulfilled by its Alphabetical list as well as its Tabulation list. Its 4-character rubrics are supplemented by many inclusion terms, exclusions, definitions, diagnostic criteria and notes for coding. For data collection this lexicographic function is considered to be essential. An individual case has to be labeled with - preferably - the most appropriate term(s). The question which term(s) that will be, however, does not have to be restricted to the subjective perception and concept formation of the physician and the coding experience with the ICD.

Each diagnostic term has also a value (or appropriateness) of its own. It is a statement with an empirical or theoretical value. According to section 3.2. the value of an analytical statement can be derived from the characteristics of a terminological phrase, e.g. 'hepatitis' is 'inflammation of the liver'. This is an analytic truth (true by definition). Its negation results in a contradiction. If one does not understand what is meant by inflammation of the liver, one has a linguistic problem. Diagnostic statements can also express an accepted theory, an empirical generalisation, a hypothesis (tentative theory) or a rare connection. Its negations result in a controversial theory, another empirical generalisation, hypothesis or rare connection. If one does not understand what is meant by these kinds of statements, one has a knowledge problem.

F.J. Flier (1996) illustrated these four kinds of non-analytical statements (truths) with the following examples:

- AIDS is a viral disease
This is neither analytic, nor normative, nor contingent. It is a so-called 'synthetic necessity'. It is necessarily true if the theory is correct.
- the thyroid is a hormone producing organ
We know all too well that not all thyroids produce hormones. What we mean here is that normal thyroids produce a hormone, or that the desired situation is that thyroids produce a hormone. Many statements in the domain of anatomy and physiology are contingent or normative.
- the spiral fracture is a fracture of a long bone
This is not an analytic truth, although it may in fact be true that all spiral fractures are fractures of long bones. 'Spiral fracture' and 'spiral fracture of a long bone' are not synonymous, but they may have the same extension, i.e. they may be co-extensive. 'Spiral fracture of a short bone' is not a contradiction, although it has probably never been reported yet. This kind of statement may be called contingent co-extensive.
- fractures are caused by traffic accidents
This is only true for some fractures. It is not analytic. It is not normative. It is a contingent statement which is in fact only true in some cases.

Diagnostic statements can be modeled according to their value, or appropriateness to name or describe a phenomenon, in a descending sequence: analytical statements, statements of an accepted theory, usually true (contingent) statements, tentative statements and statements which are sometimes true. For this modeling a new linguistic tool^j is required to construct an integrated system for codes, classifications and definitions in which health and disease phenomena are covered.

The idea of Galen-In-Use is that the GRAIL model needs a universal model of medical concepts (knowledge). This is impossible, regarding the existing diversity of terms in use in medicine. This report suggests that the linguistic and conceptual analysis of diagnostic terms in classifications can be united by a tool which can handle also all kinds of statements in a systematic way without pretending to have an all encompassing model of medicine. Such a tool will support the knowledge analysis of classifications of diagnostic and procedural terms. The new ICIDH will also benefit by this tool. A new long term strategy may be able to use this tool for the evaluation of training programs, translations, updating proposals of ICD, special adaptations and their conversions to ICD, new classifications and nomenclatures, statistical presentations, and so on.

The ultimate purpose of the development of a tool for the linguistic and conceptual analysis will be to provide classification centers with an instrument for their own work: the development and maintenance of classifications. Since the WCC does not exist any more (cf. section 1.1.), the methodology has to be further developed elsewhere. Phase 3 of this final report has an open end.

^j = software. The Classification Workbench (p. 9) may be considered as the predecessor of this linguistic tool. SPET can handle analytical statements and conversions between classifications of surgical procedures, SPET can not handle non-analytical statements and ditto classification conversions.

5. Standards, tools and data bases

Which standards (1), tools (2) and data bases (3) should ideally make up an integrated system that is meant for the one-time recording and exchange of data in health care in a country? In order to reach an integrated system this question has to be answered. Only then a consent of assignment of the different activities to the involved contributors can be expected. In table 4 an overview is given of the levels of users' needs and the corresponding activities by standardization bodies, terminology services and maintenance services for users.

Table 4

<i>Users' needs^k</i>	Standardization bodies	Terminology services	maintenance services
<i>Domains</i>	Enactment of domains	Choice guided by intrinsic and extrinsic characteristics	
<i>Identification of perceivable objects</i>	Enactment of the identification of objects	Method for the unique identification of objects with same sets of characteristics	e.g. consecutive code numbers for organizational units, patients
<i>Concepts of objects</i>	Enactment of types of characteristics of concepts	Development and maintenance of types of characteristics	e.g. code numbers for medicaments with different sets of characteristics
<i>Users' classifications</i>	Enactment (and maintenance) ^l of national classifications	Terminological phrases of analytical statements in national standards	e.g. conversions between national standards and users' classifications of procedures in health care
<i>Users' terms</i>	Enactment (and maintenance) of Dutch terms in international classifications	Knowledge analysis of all kinds of statements in international standards	e.g. conversions between Dutch terms in international standards and users' terms for diseases, injuries, impairments

The first column indicates the needs of users regarding the elements for which an integrated system should function. It also shows that consensus within professional groups is necessary, i.e. professional standards. These 'standards' do not form part of the integrated system, they are the own responsibility of every single professional group. Furthermore, their code numbers and conversions, referring to (inter)national standards have to be maintained by their own maintenance services in order to keep pace with the continuously developing professional standards. A standardization body has - supplementary to this - three kinds of activities:

- translation, enactment and maintenance (of updates) of national and international standards;
- coordination of the knowledge analysis of these standards;
- consultancy to maintenance services of users' groups which request to authorize their code systems and conversions as parts of the integrated system.

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^k Consensus within professional groups

^l Consensus between users' groups

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