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CHAPTER 4

Medical terminology in the Western world

Current situation

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This chapter first describes the fundamentals of medical concept formation, the different types of medical concepts and the specific properties of medical terms. We provide an overview of the most important types of terminologies (controlled vocabularies) and databases and recent medical terminology standardization activities at the national and international levels (CEN/TC 251). We introduce the domain of medical linguistics as a field of study that is concerned with specific aspects of medical language to enable the computer-aided recording, storage, and retrieval of medical data. The following types of terminologies and databases will be described in greater detail: anatomical and nosological nomenclatures, coding systems (International Classification of Diseases (ICD), Systematized Nomenclature of Medicine (SNOMED), indexing systems (Medical Subject Headings (MeSH)), thesauri and metathesauri (Unified Medical Language System (UMLS) and the bibliographic database Medline (Medical Literature Analysis and Retrieval System Online). We conclude with a discussion of science popularization strategies for general health texts in terms of intralingual translation between Language for Specific Purposes (LSP) and Language for General Purposes (LGP), as well as implications for interlingual translation of medical terminology for lay readers.

Keywords: medical terminology, medical databases, controlled vocabularies, medical terminology standardization, medical linguistics, science popularization, lay-friendliness, health information texts, Language for Specific Purposes (LSP), Language for General Purposes (LGP), intralingual translation, explicitation

1. Historical background of medical terminology

Like any other scientific domain, the field of medicine is characterized by its own language and vocabulary, which are the result of a centuries-old development. In fact, the specific features of modern medical language can only be understood against the historical background and context in which it gradually evolved. We therefore start with a brief overview of the milestones in the development of medical language from its very beginning until today (the data are taken from Eckart 2015; Institut für

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Geschichte der Medizin 2008; Montalt and Gonzalez-Davies 2007; Van Hoof 1998, and Wulff 2004).

The oldest written sources of Western medicine are the Hippocratic writings from the 4th and 5th centuries BC, which already contain numerous medical terms such as "*apoplexy*" ('stroke'), "*catarrh*" ('downflow') or "*diarrhea*" ('throughflow') (Wulff 2004, 187; Institut für Geschichte der Medizin 2008, 7). The Greek medical tradition continued in the Roman period, during which highly relevant Greek manuscripts were produced. The most prominent medical authority representing this period is Galen (129–210 AD). Greek remained the language of medicine in the Roman period until the beginning of the first century AD. An important turning point was the publication of *De Medicina* (between 25–35 AD), the only remaining part of the encyclopedic treatise by Aulus Cornelius (Celsus 2015) written in Latin. This work gives us not only comprehensive access to all the medical knowledge of that time, but it also addresses "universal" terminological issues such as the lack of Latin equivalents for most Greek medical terms. From a linguistic point of view, it is particularly interesting how Celsus approached this terminological problem, which is no less relevant today, be it for other language pairs. Wulff (2004, 187) describes this approach as follows: First, Celsus used Greek terms in their original grammatical and orthographic forms (e.g. "*pylorus*", "*eileos*") in his Latin text. Subsequently, he naturalized Greek words, writing them with Latin letters and replacing Greek endings by Latin ones (e.g. "*stomachus*", "*brachium*"). Finally, he translated the highly metaphorical Greek anatomical terminology into Latin by provoking the same metaphorical associations, such as "*dentes canini*" (Greek "*kynodontes*", 'dog teeth') and "*caecum*" (Greek *to*"*typhlon*", 'the blind gut').

During the Middle Ages, many of the classical Greek medical texts were translated into Arabic. While original medical writings in Arabic have also been produced, only a few Arabic terms (e.g. "*nucha*", 'nape') are preserved in Western medical terminology. During the Renaissance (15th and 16th centuries), the era of medical Latin started with the translation of Greek and Arabic medical writings into Latin. In this period, Latin also became the language of anatomy (some Greek terms such as "*diaphragm*" and "*condyles*" were Latinized later).[1] During the subsequent centuries almost all important medical works were published in Latin (e.g. Vesalius' *De humani corporis fabrica* in 1543), and Latin became the international scientific *lingua franca* playing the same role that English occupies today. In this era the medical vocabulary expanded through the creation of numerous hybrid Greek and Latin medical terms (so-called neoclassical compounds composed from combining forms derived from

1. Anatomical terms are generally in Latin, whereas Greek terms for anatomical parts are reserved for clinical use (Institut für Geschichte der Medizin 2008, 40).

classical Latin and ancient Greek roots).[2] Examples are terms for diseases such as "gastritis", which is composed of the morphemes "*gaster*" (from the Greek "*γαστ ΄ηρ*") for 'stomach', and "*-itis*" for 'inflammation', and surgical terms such as "*cholecystectomia*" ('removal of the gallbladder'), which consists of the Greek roots "*chole*" ('bile', 'gall'), "*kystis*" ('bladder') and "*tome*" ('to cut'), the Greek or Latin prefixes "*ec-*", "*ek-*"/ "*e-*", "*ex-*" ('out(ward)'), and the Latin suffix "*-ia*" ('act, condition'). These neoclassical compounds are still an integral part of the modern medical language.

Gradually, the role of the national languages for medical communication gained importance at the expense of Latin.[3] In the Netherlands, for example, Simon Stevin coined numerous medical Dutch equivalents for Latin and Greek terms (Crezee 1997, 1). Latin and Greek terms became mixed into general language resulting in specialized language "varieties" such as medical Dutch, English, French, German, Italian, and many others (Wulff 2004, 188). Most of those national medical languages were only used within the linguistic community of the country itself, except for French, German and English, which for some time replaced Latin as vehicles for international communication. As most of the medical terms, which found their way into the national languages, were derived from medical Latin, there are many correspondences between the different national medical languages. Yet, there are systematic differences that still persist. For example, in Germanic languages (such as German, Dutch, and the Scandinavian languages) anatomical terms and disease names are often imported directly with their original Latin endings (e.g. "*Nervus*/nervus musculocutaneus" and "*Ulcus*/ulcus ventriculi"), whereas these terms in Romance languages are usually "naturalized" according to the norms of each particular language (e.g. "le nerf musculocutané" and "ulcère gastrique" in French). English is a special case: although it is a Germanic language a considerable part of its vocabulary is of Romance origin, so that medical English tends to follow the Romance pattern except in placing the adjective before the noun (e.g. "the musculocutaneous nerve" and "gastric ulcer"). It should be noted, however, that in medical practice there are no fixed rules for endings (Wulff 2004, 187). So, English-speaking doctors may also accept direct loans with Latin endings (e.g. "*medulla oblongata*" and "*diabetes mellitus*"), and German doctors may naturalize the Latin terms (e.g. "Koronararterien" for "Arteriae coronariae") or translate them into German (e.g. "Magengeschwür" instead of "Ulcus ventriculi").

In the modern era medical terminology was heavily influenced by French and English. Examples of French influences are more particularly to be found in therapeutic

2. New Latin comprises many such words and is a substantial component of the technical and scientific lexicon of English and other languages, including international scientific vocabularies.

3. In some countries such as Denmark and Germany medical Latin was still in use by the middle of the 19th century (Wulff 2004, 187).

terminology such as "*bandage*", "*dragée*", "*drainage*", "*lavage*", "*pincette*", "*pipette*", etc., all well-known terms which have been incorporated into many other languages. The development of English as the international means of communication in Western medicine started in the 1950's; today it is a generally accepted fact that English is the preferred language for international medical communication, both in oral (e.g. medical conferences) and written (e.g. publications) forms. The modern medical *lingua franca* is English, as was the case for Latin in the medieval period. As described by Wulff (2004, 187) in greater detail, new *up-to-date* medical terms are mostly (American and British) English loan-words[4] (such as "bypass", "compliance", "clearance", "pacemaker", "rooming in", "screening", "scanning", etc.) that are left unchanged and used in the national language or –depending on the target language politics– translations (such as the French "pontage" for English "bypass" or German "*Magengeschwür*" for Latin "*ulcus ventriculi*"). It is noteworthy that, contrary to what one would expect, also these borrowed terms may cause problems depending on the target languages' linguistic rules. Examples are the use of capital or non-capital letters – which is more particularly relevant in German: English loan nouns such as "pacemaker" are written with a capital ("Pacemaker") in analogy with German nouns ("*Herzschrittmacher*") – and issues such as hyphenation, gender, and inflection. Moreover, some terms have different meanings depending on the context in which they are used, which causes potential misunderstandings. An example is the English term "compliance", which means "lung plasticity" in addition to (the more commonly known) "patient's readiness to collaborate". In some cases, mixed terms are also created combining a native word stem with an English one such as the German noun "*Kammerstiffness*", which is derived from the English form "chamber stiffness" (the native equivalent is "*Kammersteifigkeit/Kammersteifheit*") (Karenberger 2015, 24). The added value of such combined forms remains, however, questionable.

2. Medical language

The language of medicine is, first, a natural language. Unlike formal artificial languages (e.g. the language of chemistry or mathematics), it is based on the syntax of general language and its vocabulary, which is extended by a huge number of specialized terms denoting domain-specific concepts such as "cardiac attack", "obesity", "cell membrane", etc. These terms constitute the vocabulary of medicine, which in turn comprises the different intersecting domain vocabularies of the numerous medical (sub-)specializations, such as anatomy, surgery, physiology, gynecology, etc. (Sadegh 2015, 59).

4. At present American English represents a significantly higher percentage of the (bio)medical literature compared to British English.

The language of medicine is also a living language that is constantly subject to changes due to the high dynamicity that characterizes the medical domain (Institut für Geschichte der Medizin 2008, 12). On the one hand, new concepts, and thus terms, emerge on an almost daily basis due to continual biomedical research, the development of innovative therapies and procedures, and the emergence of new diseases such as *Sick Building Syndrome* (SBS) (describing a range of symptoms linked to longer stays in buildings harmful to health), *Chronic Fatigue Syndrome* (CFS), and *Multiple Chemical Sensitivity* (MCS), just to mention a few examples. A virtually endless number of potential new concrete and abstract concepts must be named, providing a wealth of terms to be integrated into the medical vocabulary. This process of terminologization is of utmost importance, as it enables the organization of all medical knowledge into conceptual systems each of which reflects the specific features of the many medical specializations and sub-specializations which have been developed in modern medicine (Montalt Gonzalez 2007, 230). The estimated size of the actual medical vocabulary amounts to about 200,000 terms (Karenberger 2015, 19), including terms for drugs, body parts, organs and organ parts and functions, and terms for diseases, medical investigations and surgical procedures.

On the other hand, medical terms may also disappear or be used with a different meaning. An example is the term "hysteria", which derives from the Greek cognate of "uterus", "ὑστέρα" ('hystéra') (King 1993), referring originally to nervous disorders linked with diseases of the female sexual and reproductive organs.[5]

It can be said that the medical language has since its emergence been characterized by its openness to influences from other languages. Today's medical terminology reveals a very varied picture that consists of many linguistic elements taken from other than Greco-Latin sources, especially English. Although classical terms still represent the foundation of medical terminology, also words from general language, abbreviations and acronyms, eponyms, slang and jargon words (partially derived from terms), synonyms, metaphors and metonyms, and made-up words are substantial parts of today's medical language. Also, variants of medical language, so-called sociolects, which are used in hospitals and by different medical schools, play an important role. The following examples in German and English illustrate the diversity of modern medical terminology (the German examples are taken from Karenberger 2015, 19ff.):

(1) Words from general language with a change in meaning: "(*Krankheits*)*herd*" (literally: 'stove' for 'focus or source of a disease'), "(*Herz*)*flimmern/heart flutter*" (for 'cardiac fibrillation'), "*Umstimmung/transposition*" (for 'reversal of predisposition')

5. In modern medicine, the term is replaced by more accurately defined categories, such as *conversion disorder*.

(2) Foreign words with semantic narrowing such as "*Inspiration*/*inspiration*" (for 'deep breathing') and "(*Mikroben*)*kultur*/(*microbial*) *culture*", "*Influenza/influenza*", "*Shunt/shunt*", and "*Lavage/lavage*"

(3) Abbreviations such as "*i.v*". (for 'intravenous'), "EKG/ECG" (for 'electrocardiograph')

(4) Acronyms (initialisms) such as "HIV" (for 'Human Immunodeficiency Virus'), "AIDS" (for 'Acquired Immune Deficiency Syndrome'), "CT" (for 'computer/computerized tomography'), "MRI" (for 'Magnetic Resonance Imaging'), "SIDS" (for 'Sudden Infant Death Syndrome'), "*Prion/prion*" (for 'Proteinaceous infectious particle')

(5) Eponyms (diseases, procedures, anatomical parts, etc. named after a person) such as "*Alzheimer*(*-Krankheit*)/Alzheimer's (disease)", "Parkinson/Parkinson's", "Hodgkin/Hodgkin's (disease)", "*Billroth-I-Operation*/*Billroth I* (or Billroth's operation I)", "*Eustachische Röhre*/Eustachian tube" ('auditory tube')

(6) Slang and jargon words, which are mostly used in clinical settings; an example are abbreviations used for surgery planning as "*Wurm*" for '*Blindarmoperation*' / 'appendectomy' or "T.E." for '*Mandeloperation*' / 'tonsillectomy' (Porep & Steudel 1983, 18)

(7) Synonyms such as "*Pfeiffer-Drüsenfieber*"/"*Mononucleosis infectiosa*"/ "*Infektiöse Mononukleose*"/"*Knutschkrankheit*" and "Pfeiffer glandular fever"/ "*mononucleosis infectiosa*"/ "*infectious mononucleosis*"/"kissing disease"

(8) Metaphors (substitution of one term for another based on formal analogy) such as "*Ohrmuschel*/ear shell" (for 'pinna', 'outer ear'), "*Kleinhirnwurm*/*dorsal vermis*" (for 'cerebrellum'), "*Rabenschnabelfortsatz*" (for 'coracoid process') and metonymies (substitution of one term for another based on contiguity) such as "*Elephantiasis*/*elephantiasis*" (for 'lymphatic filariasis') and "*Fischschuppenerkrankung*/fishskin disease" (for 'ichthyosis')

(9) Made-up words such as "ELISA" ('enzyme-linked immunosorbent assay' denoting a substance testing method), and "PEEP" ('positive end-expiratory pressure') denoting the pressure in the lungs above the atmospheric pressure that exists at the end of expiration. (Studdert, Gay & Blood 2012)

3. Challenges related to medical language

The described linguistic features of medical language have both advantages and disadvantages (Karenberger 2015, 20). Eponyms, for example, denote a concept in a precise and pregnant manner, contrary to alternate expressions, which in most cases would be much more awkward and for which proper understanding would also require solid historical knowledge. A nice example is the eponym "Apgar-Index/Apgar score" that efficiently denotes the method invented in 1952 by the anesthesiologist Virginia Apgar to evaluate the health of newborns. A disadvantage is that the meaning of eponyms cannot be derived from their morphological structure and that eponyms are also often used inconsistently across different languages, such as the German eponym "*Röntgenstrahlen*" vs. the Anglo-American term "x-rays". This is the reason why since the 1960's comprehensive lexical resources have been developed with definitions of eponyms used in the anatomical and clinical domains (Eckart 2015, 19). Global reference works for eponyms are the dictionaries of Forbis and Barolicci (2004) and Winkelmann (2009).

The lack of international consistency is more particularly manifest with respect to medical abbreviations and acronyms. An example is the acronym AIDS and the corresponding French acronym "SIDA" ('*Syndrome Immuno-Déficitiaire Acquis*'). The potential ambiguity of many abbreviations is another shortcoming. For example, the German abbreviation "OP" means, depending on the context, "*die Operation*" ('operation'), "*der Operationssaal*" ('operating room') or "*Originalpackung*" ('original packaging of drugs'). Another example is the abbreviation "*s.i.*", which means either "*sine indicatione*" ('of the location') or "*semis interna*" ('internal half') depending on the context in which it is used. Another problem is the proliferation of synonyms for many medical terms: in principle, synonymy is a linguistic means that enriches the clinical language since it allows subtle differentiations, for example, which specific element of a term's meaning is highlighted, or which stylistic level is addressed. The German synonyms cited above for the viral infection called "glandular fever" ('Drüsenfieber') illustrate the potential of medical synonymy. This infection predominantly affects young adults and can be termed in different ways depending on the respective focus (see Karenberger 2015, 21): diseased body part ("*Pfeiffer-Drüsenfieber*"), disease type ("*Mononucleosis infectiosa/Infektiöse Mononukleose*"), the leading symptom ("*Monozyten-Angina/Lymphoidzell-Angina*"), the most frequent mode of transmission ("*Knutschkrankeit*/kissing disease"), and the age group concerned ("Teenager-*Fieber*").

It is noteworthy that there is no straightforward one-to-one relation between concept and term (i.e. one term refers to one concept) in medical terminology in a few cases, contrary to what is recommended by traditional terminology theory. Rather, depending on the medical area, a many-to-one relation may exist between term and concept. This is especially the case for clinical terminology, which – depending on the national language – uses numerous synonyms for one and the same concept. Examples are the English term "typhoid fever" that has the German equivalents "*Typhus*", "*Typhus abdominalis*", "*Bauchtyphus*", "*typhoides Fieber*" or "*enterisches Fieber*", all of which refer to one and the same concept <typhus>. This stands in sharp contrast to the anatomical nomenclature (see Section 4.1), which adheres strictly to the one concept-one term principle. The contrasting relation – one to many – occurs when one term may be used to refer to different concepts, such as the term "surgery", which – depending on the context – may refer to the surgical procedure or the room in which it is performed. The scope of synonymous and polysemous medical terms represents a risk as well since potential misunderstandings may be caused without sufficient contextual information. A well-known example is the German eponym "*Morbus Paget*", which denotes two completely different diseases: (1) a disease of the bones, also called "*Osteitis deformans*" ('Paget's disease of bones'), and (2) a specific manifestation of breast cancer ('Paget disease of the nipple') (Wermuth 2013).

The unstable term-concept relation in medical language is mainly related to the lack of consistent term definitions, which is a recognized shortcoming in the medical field. Many medical concepts are, in fact, complex and cannot be defined precisely, which entails that for a few concepts no exact scientific definition can be provided. An example cited by Sadegh (2015, 45) is the concept of <baldness>, which cannot be defined precisely (by indicating the maximum number of hairs, for instance). On the other hand, many medical concepts *can* be defined precisely, and the various actors within the medical field (students, researchers, physicians) are encouraged to define new terms in unambiguous and clear ways.

4. Medical nomenclatures, clinical terminologies and coding systems

The principal aim of medical language is to optimize communication between experts working within their specialist subject areas. For this purpose, nomenclatures, vocabularies, terminologies and coding have been developed to support the effective communication among medical experts and the recording of patient data, whether on paper or, increasingly, via an electronic medical record. These systems are the subject of research in the fields of Medical Information and Library Sciences and medical linguistics, a subdiscipline of medical informatics and information sciences that focusses on natural language processing of medical linguistic data (Sadegh-Zadeh 2015, 61ff). In the following sections we describe some of the most popular systems (for a detailed introduction to health informatics in general, and the various medical terminologies and coding systems see Coiera 2015).

4.1 Medical nomenclatures

Medicine comprises many specializations, and the vocabulary of each is carefully and deliberately designed by domain experts. Depending on the specialization, medical terms are more or less standardized. Due to the domain-dependent differences, a distinction can be made between so-called controlled vocabularies or nomenclatures on the one hand, and clinical terminologies on the other (Institut für Geschichte der Medizin 2008, 12; Karenberger 2015, 22; Sadegh-Zadeh 2015, 63ff). A nomenclature (literally 'a list of names') is a naming system for a given domain formed according to strict linguistic rules. The terms are collected and created by domain experts, and approved by scientific authorities. The aim is to standardize the use of the domain language to support monosemy and to avoid ambiguity. In the medical domain, there are two important types of nomenclatures (Sadegh-Zadeh 2015, 63ff): the anatomical nomenclature denoting bones, organs, and cells; and nosological nomenclatures denoting diseases and symptoms.

4.1.1 The anatomical nomenclature

The so-called *Nomina anatomica*[6] are an integral component of the medical language and shared cross-linguistically by all medical communities. This standardized anatomical terminology was established in 1895, and consists of approximately 8,000 internationally agreed anatomical terms and expressions (Karenberger 2015, 22) in Latin. Other specific features are (1) mononymy of terms (a single term for a single anatomical structure); (2) term formation according to established rules periodically reviewed by a commission; (3) the use of Latin as the official nomenclature language (only a minor part of the medical terminology –in essence the anatomical terms – is still used in its original and unchanged Latin or Latinized form such as "*scapula*", "*humerus*", etc.). These normative rules and regulations do not provide for eponyms and synonyms, which are, nevertheless, frequently used in clinical language (see Section 4.1.2). In 1998, the *Nomina Anatomica* were replaced by the *Terminologia Anatomica* (TA), which is the foundation of the *International Nomina Anatomica* (INA), which has been and continues to be the valid international standard on human anatomic terminology.[7] It was developed by the Federative Committee on Anatomical Terminology (FCAT) and the International Federation of Associations of Anatomists (IFAA) (Thieme 1998). The Anatomical Nomenclature consists of about 6,000 defined terms formed by means of about 400 Greek and 200 Latin roots (Institut für Geschichte der Medizin 2008, 12).

4.1.2 Nosological nomenclature and clinical terminologies

In contrast to the anatomical terminology, clinical terms designating pathologies, diagnoses and therapies are much less standardized, and there are no generally valid regulations regarding the formation of clinical terms. Most clinical terms with Greco-Latin origin are naturalized (i.e. adapted to the phonology, spelling, and grammar of the target language). An example is the German term "*Koronararterien*", which is

6. Since the first publication in 1895 several revisions of the *Nomina anatomica* have been made. The currently valid version is *Terminologia Anatomica* (Thieme 1998).

7. Due to the publishing practices prevailing in the medical domain an English nomenclature has meanwhile also been introduced in parallel with the Latin anatomical terms.

the naturalized form of the Latin term "*arteriae coronariae*". An obvious advantage of naturalized clinical terms is that they allow synthetic descriptions of complex states of affairs (Van Hoof 1998, 49), as illustrated by the naturalized Greek-Latin term "*hematogenous metastasis*", which means "the spread of a cancer from one organ or body part to another through the bloodstream". Moreover, in clinical use most anatomical terms are named after the person who first described the given anatomical part (Institut für Geschichte der Medizin 2008, 12). Examples are anatomical eponyms such as "Eustachian tube" for "*tuba auditiva*" (naturalized as 'auditory tube'), which is named after the sixteenth-century anatomist Bartolomeo Eustachi, and "*Kohlrausch's-fold*" for "*plica transversa recti media*", which is named after the the nineteenth-century German physician Otto Kohlrausch. In addition, language-specific eponyms are used as well (for example to designate syndromes). Eponyms are morphologically not transparent, in contrast to the terms which consist of Greek and Latin formants (more than 500 word roots, combining forms, prefixes, suffixes) (Van Hoof 1998, 49), which can be understood internationally. The deviating national terminological practices in the clinical usage of medical language inevitably impede seamless international communication. This is the reason why for some time there have been various attempts to develop internationally agreed clinical and pathological terminologies, in which the designations for diseases, symptoms and syndromes are classified and numbered in order to facilitate their standardized documentation. It should be mentioned that the terminological variety in the clinical domains creates problems for translators as well (Stahl 1992, 265).

Two prominent nosological nomenclatures in English are the *International Nomenclature of Diseases (IND)* initiated by the Council for International Organizations of Medical Sciences (CIOMS) (Bankowski & Robb-Smith, 1978), and the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* published by the American Psychiatric Association since 1952. The aim of these nomenclatures is to reduce ambiguity in the designation of (mental) diseases, but there are some doubts as to their effectiveness. Reasons given by Sadegh-Zadeh (2015, 63ff) and Karenberger (2015, 22) are that: (1) the English language is not used in medicine worldwide; (2) there is no internationally recognized clinical terminology standard; and (3) disease names require universally valid definitions, which in practice do not exist (see also Section 2). In fact, most diseases have several designations, and only in a few cases does one term designate several diseases (thus there is no monosemy nor mononymy; see Rogers 2005, 1850). This seems logical if we consider that disease concepts are highly culture-dependent. Ultimately, the specific cultural practices of a society will determine what is considered an illness. A well-known example is the concept of homosexuality, which for a long time was (and in some cultures still is) synonymous with disease. Another example is the term "schizophrenia", which for a long time had different meanings in German, French, and English (Stahl 1992, 265).

The differences between the controlled *Nomina Anatomica* and clinical language/terminology can be summarized as follows (Table 1, taken from Karenberger 2015, 22):

Table 1. Differences between Nomina anatomica and clinical language/terminology (Karenberger 2015, 22)

Feature	***Nomina anatomica***	**Clinical language / terminology**
International validity	Yes	No
Etymology of the term elements	Predominantly Latin	Predominantly Greek
Terms from modern languages	No	Relatively high portion
Multiple designations	No	High portion
Eponyms	No	High portion

In conclusion, clinical medicine as a branch of medicine is constantly changing, and its practice is culturally-dependent. These factors make it particularly difficult to standardize.

4.2 Coding and classification systems

Next to nomenclatures and clinical terminologies, different medical coding and classification systems have been developed that are designed to support a standardized computerized medical language for global use. These systems allow describing, classifying, and coding medical terms and concepts by means of common clinical terminology. The International Classification of Diseases and Related Health problems, usually shortened to International Classification of Diseases (ICD), is one of the most popular and widely used systems. It was originally established by the World Health Organization (WHO 2016) to enable epidemiological statistics about morbidity and causes of death (Wermuth 2005; Wermuth 2006; Wermuth 2009; Sadegh-Zadeh 2015, 63ff). ICD is a mono-hierarchical classification (in contrast to SNOMED CT; see Section 4.4), which means that a single classification feature is used each time to form the different subclasses. This coding system is important since it provides a common language for reporting and monitoring diseases, which allows data to be compared and shared in a consistent and standardized way between hospitals, regions and countries, and over periods of time. Furthermore, the system facilitates the collection and storage of data for analysis and evidence-based decision-making. Users include physicians, nurses, other providers, researchers, health information managers and coders, health information technology workers, policy-makers, insurers and patient organizations. The ICD provides hierarchically ordered alpha-numeric codes for the classification of diseases and other health data (such as signs, symptoms, abnormal findings, complaints, social circumstances, and external causes of injury or disease). The computer-readable codes are followed by a short description (rubric) of the code's meaning in natural language (e.g. *K35.2 Acute appendicitis with generalized peritonitis*). Today, the classification is primarily used to enable the computer-based storage and retrieval of diagnostic and health information for clinical, epidemiological and quality purposes. Also, decisions about government funding and resource allocation are based on the recorded data. There are regular revisions of ICD, and all WHO Member States are expected to use the most recent version for reporting death and disease. Currently its 11th web-based revision is in use (ICD-11) (WHO 2012a, 2012b). ICD has been translated into 43 languages.

4.3 Combined system: Medical terminology and coding system

In the medical domain, systems are also used that combine clinical terminology with coding schemes. The most prominent of these is the Systematized Nomenclature of Medicine Clinical Terminology (SNOMED CT), released in 2002. SNOMED CT is a logic-based health care terminology, which originated from the Systematized Nomenclature of Pathology (SNOP) issued in 1965 by the College of American Pathologists (CAP) for anatomical and morphological descriptions. It is the most comprehensive, multilingual clinical healthcare terminology worldwide, and is used in the electronic health record (EHR) (Stearns et al. 2001).[8] Its main goal is to enable users to encode different kinds of health information in a standardized way, thus ultimately improving patient care. SNOMED CT currently contains more than 311,000 active concepts.

SNOMED CT is multi-hierarchical and multi-axial (meaning that concepts may have more than one superordinate concept) and includes three types of components: (1) *concepts*, (2) *descriptions*, and (3) *relationships*. Concepts represent "clinical thoughts", i.e. all kind of objects (concrete and abstract) occurring in health care processes that need to be recorded. Each concept has a unique machine-readable numerical concept code or so-called concept ID (concept identifier) that identifies the clinical terms (primitive or defined) used to designate that concept. For example, the concept 22298006 refers to *Myocardial infarction*. Concepts are further described by various clinical terms or phrases, called *Descriptions*, which are divided into *Fully Specified Names* (FSNs), *Preferred Terms* (PTs), and *Synonyms*. SNOMED CT is based on the terminological principles elaborated by traditional terminology science (Cabré 1998;

8. In 2007, the International Health Terminology Standards Development Organization (IHTSDO) acquired the intellectual property rights to all versions of SNOMED. IHTSDO is a non-profit standards development organization located in London (UK) with 29 international members that works on behalf of the health care system. Its objective is to improve health care by determining global standards for health terms that must support the safe, accurate and effective exchange of health information. As of 31 December 2016, the trading name of the terminology is Snomed International (IHTSDO 2016).

Kageura 2002; Picht & Draskau 1985) and the established ISO 704 (2009) and ISO 1087-1 (2000) standards. The concepts are organized from the general to the more detailed into acyclic taxonomic (is-a) hierarchies. For example, *Viral pneumonia* IS-A *Infectious pneumonia* IS-A *Pneumonia* IS-A *Lung disease*. Concepts may have multiple parents, for example <*Infectious pneumonia*> is also a child of <*Infectious disease*>. The taxonomic structure allows data to be recorded and later accessed at different levels of aggregation. SNOMED CT concepts are linked by approximately 1,360,000 links. These so-called relationships link concepts to other concepts whose meaning is related in some way or another. These relationships provide formal definitions and other properties of the concept (e.g. kind of relationship, causative agent, finding site, pathological process, etc.). This means that the meaning of concepts is not explained by textual definitions, but must be derived from the formal representation composed of an attribute/value combination. For example, the concept <cellulitis of foot>, may be represented in several ways. The concept has two superordinate concepts (IS-A relationships), namely <disorder of foot> and <cellulitis of leg>. It points simultaneously to (1) a concept in the Inflammatory Disorder sub-hierarchy by means of an attribute relationship composed of the attribute *associated morphology* + the value *cellulitis* chosen among the Inflammatory Disorder sub-hierarchy concepts; (2) a concept in the Body Structure hierarchy by means of an attribute relationship composed of the attribute *finding site* + the value *foot structure* chosen among the Body Structure concepts. If so desired, it is entirely possible to generate textual concept definitions based on these hierarchical and defining attribute relationships.

Concepts are represented by one fully specified name (FSN). The FSN is a unique unambiguous description of the concept's meaning and is only used in SNOMED CT. For example, "*Hematoma*" ('morphologic abnormality') is an FSN that represents what the pathologist sees at the tissue level, whereas "*Hematoma*" ('disorder') is an FSN that indicates the clinical diagnosis of a hematoma by a general practitioner. The FSNs (realized in English) are not supposed to be translated as they function as a kind of "metalanguage" by means of which the concept can be referred to. Each concept is also represented by one suggested default preferred term (PT) and many synonyms. The PT is the term used in clinical settings. As SNOMED CT is also a multi-axial terminology concepts may have more than one superordinate concept. For example, the concept <excision of fragment of bone> belongs to the Procedure hierarchy, but has also two immediate superordinate concepts: it is (1) a type of <excision of bone>, as well as (2) a type of <removal of bone fragments>.

SNOMED CT is designed for implementation in software applications that serve the needs and objectives of end-users. In fact, SNOMED CT is used in different computer applications such as Electronic Health Record Systems, Computerized Provider Order Entry (e.g. E-Prescribing or Laboratory Order Entry), catalogues of clinical services (e.g. for Diagnostic Imaging procedures), knowledge databases used in clinical decision support systems (CDSS), Remote Intensive Care Unit Monitoring, Laboratory Reporting, Emergency Room Charting, Cancer Reporting and Genetic Databases.

The terminology is intended to support the representation of detailed clinical information contained in electronic clinical records in a way that can be processed automatically. The potential benefits of SNOMED CT are situated on different levels and include aspects such as the provision of clinical information at the level of detail needed for delivering health care, facilitating data sharing and recording of information by different people in different locations, unambiguous interpretation due to the standardized terminology, and many others. SNOMED CT is intended to be used worldwide and therefore needs to be translated into other languages and dialects. Currently translations are available in American English, British English, Spanish, Danish and Swedish. Other translations (incl. Dutch, French and German) are underway.

4.4 Metathesaurus

The *Unified Medical Language System* (UMLS) is a (bio-)medical metathesaurus[9] (i.e. a thesaurus providing information on other thesauri) developed by a multidisciplinary team of the US National Library of Medicine (NLM) (Sadegh-Zadeh 2015, 67). It provides a huge set of files and software that brings together many health and biomedical vocabularies and standards to enable interoperability between computer systems. The objectives of UMLS are to enable health care professionals and researchers to access and integrate electronic biomedical information from a variety of sources (Lindberg et al. 1993) and to develop applications, such as electronic health records, classification tools, dictionaries and language translators.

4.5 Indexing system

"Indexing" means indicating a publication's subject(s) by means of keywords ("descriptors") (Sadegh-Zadeh 2015, 68). The most popular indexing tool used in the (bio)medical domain is the *Medical Subject Headings* (MeSH), a controlled vocabulary developed and maintained by the US National Library of Medicine (NLM) for indexing articles, books, and other material stored in the database PubMed.[10] PubMed comprises more

9. A thesaurus, from the Greek "*θησαυρ´ος*" ('thesaur´os') for "treasure", is a *treasury of words*, i.e. a controlled vocabulary and terminology, denoting objects or relations in a domain and consisting of systematized lists of synonyms, antonyms, and otherwise related terms. A *metathesaurus* is a thesaurus about several other thesauri (Sadegh-Zadeh 2015, 67).

10. The second part of the acronym PubMed ("Med") refers to the MEDLINE database (which PubMed searches); the first part ("Pub") may be interpreted as either *public* (PubMed is the free version of MEDLINE) or as *publisher* (PubMed includes links to publisher websites).(National Center for Biotechnology Information, n.d.).

than 26 million citations for biomedical literature from MEDLINE, life science journals, and online books. Citations may include links to full-text content from PubMed Central and publisher websites. Its main purpose is to facilitate subject access, thus supporting literature search in the (bio)medical domain (Coletti & Bleich 2001).

4.6 MEDLINE

MEDLINE (Medical Literature Analysis and Retrieval System Online, or MEDLARS Online) is a database of bibliographic references and abstracts on life sciences and biomedical topics. It includes bibliographic information for articles from academic journals covering medicine, nursing, pharmacy, dentistry, veterinary medicine, health care, biology and biochemistry, as well as fields such as molecular evolution. The database is compiled by the US National Library of Medicine (NLM) and is available on the Internet. It is searchable via the search engine accessing PubMed.

5. Recent national and international medical terminology standardization activities

The International Organization for Standardization (ISO) develops and publishes International Standards, which are defined as "documents that provide requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose" (ISO 2016). The standards are developed by field experts who work together in Technical Committees (TCs). ISO/TC 215 sets the standards for health informatics and plays a central role regarding the standardization of medical terminology systems. This committee is responsible for the standardization of Health Information and Communications Technology (ICT), to facilitate the compatibility and interoperability between independent healthcare systems. It consists of several Working Groups (WG), each dealing with an aspect of Electronic Health Records (EHR): Architecture, Frameworks and Models (WG 1), Systems and Device Interoperability (WG 2), Semantic Content (WG 3), Security, Safety and Privacy (WG4), and Pharmacy and Medicines Business (WG6). Since the beginning of the standardization activities 170 standards and other deliverables have been developed by ISO/TC 215.

In the European Union, standardization in the area of Health ICT is performed by the CEN/TC 251 (Commission for European Normalization/Technical Committee 251). The goal is to achieve compatibility and interoperability between independent systems and to enable modularity in Electronic Health Record systems. The two Working groups Enterprise and Information and Technology and Applications stipulate the requirements for health information structures for supporting clinical and administrative procedures, and develop the technology behind interoperable systems. Moreover, safety, security and quality requirements fall within their area of responsibility. An overview of the published CEN/TC 251 standards is available online at www.cen.eu.

In summary, we can conclude that medical nomenclatures, clinical terminologies and coding systems play a significant role in medical communication. Initiated and developed by experts from different domains, the various systems are approved by scientific and professional associations (as in the case of the anatomical nomenclature) or by national and international authorities and organizations (e.g. NLM and WHO).

6. Science popularization and lay-friendliness in health information texts

Following our review of various aspects of medical terminology mainly in its scientific context in the previous sections, in this section we introduce some important issues related to the use of medical terminology in general health communication for patients and other lay target readers. The relevance of appropriate terminology usage in health information documents for this target group is obvious, as patients and other affected lay readers need to be informed in ways that ensure correct interpretation and understanding as well as therapeutic compliance. This requires significant adaptations between the highly specialized scientific medical register or Language for Specific Purposes (LSP) and the register of general language use or Language for General Purposes (LGP). But as health communication in the latter case still conveys specialized knowledge (and hence concepts or terminology), albeit to a non-specialized target group, health communication texts intended for the general public often occupy an intermediate position between LSP and LGP, depending on their precise function. Thus, for instance a public information brochure on a healthy daily diet will be closer to the LGP end of the continuum, whereas patient information leaflets with medicines for specific medical conditions will be situated more towards the other end, as they contain features of both LGP texts and LSP texts, notably concerning concepts and terminology usage. In this sense patient information leaflets (henceforth PILs) might be considered a specific type of LSP. They convey information which is directly relevant for the patient derived from the more specialized Summary of Product Characteristics documents (SmPCs), which provide comprehensive information on the available knowledge and evidence for specific medicines. SmPCs are a specific type of document required within the European Commission before any medicinal product is authorized for marketing and are written by and for specialists.

The use of medical terminology in health information documents for non-specialist readers, more specifically PILs, will be discussed mainly on the level of intralingual register-specific translation. But interlingual translation of medical terminology in health information documents for non-specialists also has some important implications on the level of technicity in terminological variants (and hence non-specialist understanding) for specific target languages, as discussed briefly below. Our discussion is based on one pilot study and one more extensive study of PILs, and on one comparative pilot study of PILs and the SmPCs from which they were derived. For all three studies a range of different criteria were analyzed within the context of broader research questions. The studies analyzing PILs departed from the intercultural research question into different levels of *uncertainty avoidance* (UA), one of Hofstede's (2001) values for intercultural comparison. The PIL-pilot study compared ten PILs (five in original English and five translated into German) for medicines for the treatment of hypertension and insomnia, which were issued by the European Medicines Agency (EMA). The second study compared 24 PILs (12 English and 12 Dutch translations) for the treatment of infections and tumors. All PILs were also taken from the EMA website (www.ema.europa.eu/ema/).

The pilot study on intralingual translation is based on a comprehensive comparison of different linguistic levels in the SmPC and the PIL for a medicinal product for the treatment of essential hypertension and the prevention of severe cardiovascular problems. Not all specialist information in the SmPC is directly relevant for patients. Consequently, the PIL contains approximately half the number of words of the SmPC. Transferring the relevant information from the SmPC to the PIL also involves the use of a different structure and order of the information. The SmPC includes the following main sections, with additional subsections, as stipulated by the EMA: (1) Name of the medicinal product, (2) Qualitative and quantitative composition, (3) Pharmaceutical form, (4) Clinical particulars, (5) Pharmacological properties, and (6) Pharmaceutical particulars. The PIL structure also follows an EMA template, published by the Quality Review of Documents (QRD) group and includes the following sections: (1) What [name of medicine] is and what it is used for, (2) What you need to know before you take [name of medicine], (3) How to take [name of medicine], (4) Possible side effects, (5) How to store [name of medicine], (6) Contents of the pack and other information. In addition to the QRD-template, the EMA has also issued the updated *European Guideline on the readability of the labelling and package leaflet of medicinal products for human use*(2009), which includes general recommendations for language use and style.

In the SmPC – PIL pilot study we found different strategies to incorporate specialized information and terms into general language in the form of more widely known words or lay terms. When we consider the adaptive strategies for terms or concepts in the SmPC to the PIL in Examples (10) and (11), we find the adaptation from a more complex noun phrase with postmodifier ("type two diabetes mellitus with documented target organ damage") in the SmPC to a simplified simple noun phrase with a single adjective premodifier with general reference ("high risk") in example (10). "High risk diabetes" in the PIL offers a summarizing gloss of the information from the SmPC, including implications for the patient (i.e. "high risk"). In example (11), however, we see the adaptation from a simple premodified noun phrase ("peripheral arterial disease") in the SmPC to a more complex noun phrase with both a coordinated premodifier ("reduced or blocked") and a coordinated postmodifier ("to the heart and legs") in the PIL. The noun phrase "reduced or blocked blood supply to the heart or legs" provides an explanatory (but not a scientific) definition for the lay reader. When we consider example (12) from the PIL, we see two different science popularization strategies in one and the same sentence concerning the order in which specialized or scientific terms and the elucidating lay terms are presented to the reader, viz. *lay term + scientific term* as well as *scientific term + lay term*. In example (13) the reference to a scientific term is introduced metalinguistically by means of the verb "called" and the quotation marks ("a condition called "orthostatic hypotension"). Interestingly, the ensuing explanation for the PIL-reader is not limited to an explanatory definition, but includes information on the conditions ("on standing up from a sitting or lying position") and immediate results ("resulting in dizziness or faintness").

(10) type two diabetes mellitus with documented target organ damage (SmPC)
→ high risk diabetes (PIL)

(11) Peripheral arterial disease (SmPC)
→ reduced or blocked blood supply to the heart or legs (PIL)

(12) Low blood pressure (hypotension) [lay term + scientific term], likely to occur if you are dehydrated (excessive loss of body water) [scientific term + lay term] or have salt deficiency due to diuretic therapy ('water tablets') [scientific term + lay term]. (PIL)

(13) If you suffer from a condition called "orthostatic hypotension" (a drop in blood pressure on standing up from a sitting or lying position resulting in dizziness or faintness) your condition may worsen if you take X in combination with […] (PIL)

While enhanced explanatory definitions as in example (13) may certainly be informative and useful for patients, it seems advisable to implement some rules for uniformity in science popularization strategies for expressing medical concepts and terms in general health documents. Various science popularization strategies are possible, and were observed in the PIL-pilot study. Table 2 summarizes possible science popularization strategies.

Table 2. Science popularization strategies in patient information leaflets (PILs)

Science popularization strategy		Explanation
(a)	scientific term + lay term	
(b)	lay term + scientific term	
(c)	scientific term only	no lay term or explicitation added
(d)	lay term only	no scientific term or explicitation added
(e)	scientific term + explicitation	
(f)	lay term + explicitation	

Example (12) above illustrates options (a) and (b) from Table 2. And examples (11) and (13) include explicitations with scientific terms (option e) (see below for a working definition of an explicitation). Options (c) and (f) from Table 2 are illustrated in examples (15) and (14) respectively below. An example of option (d) in a PIL is the use of the term "bile obstruction" only in a PIL (scientific term "*cholestasis*").

These science popularization strategies were observed in the PILs of the pilot study in the broader context of *uncertainty avoidance* as a measure of people's behaviour and risk management. The *Uncertainty Avoidance Index* (UAI) compares different national cultures with regard to the extent to which their members feel threatened by uncertain or unknown conditions (Hofstede 2001, 161). Uncertainty avoidance is also relevant **in texts and contexts where patients find themselves exposed to new (medical) conditions** and treatments. Various linguistic analytical criteria were applied to compare and assess the degree of uncertainty avoidance in English and German PILs from the EMA website (see Verplaetse & Wermuth 2014), most notably the criteria of epistemic and non-epistemic modality. But also degrees of science popularization through explicitation and lay terminology can contribute to a higher level of uncertainty avoidance, as these strategies help to ensure that the reader or patient understands the message better, thus increasing correct therapeutic compliance and medicine intake. Uncertainty avoidance through science popularization and explicitation was subsequently the focus of a study on specialized versus lay terminology in 24 PILs from the EMA website for the treatment of infections and tumors (12 PILs in English and their Dutch translations) (see Lambrechts and Verplaetse forthcoming).

The study into degrees of uncertainty avoidance through science popularization and explicitation departed from the hypothesis that the Dutch PILs contain more explicitation of specialized medical terminology than the original English PILs in view of the markedly higher UAI for Dutch speaking nations recorded by Hofstede (2001) compared to the UAI for Anglo-Saxon countries. This was studied in the context of general readability of PILs. Readability may be defined on the basis of different criteria, including syntactic complexity and lexical density, but also terminology and the level of terminological or lexical technicity. In the context of health documents for patients, the relevant assessment of readability is manifested in therapeutic compliance and correct medicine intake by patients. The study analyzed terminological or lexical technicity, rather than syntactic aspects. The term "lay-friendliness" is used henceforth to refer to this general property of readability.

According to Directive 2004/27/EC of the European Parliament (amending Directive 2001/83/EC on the Community code) relating to medicinal products for human use, only one language version is required to be tested for lay-friendliness. However, what constitutes lay-friendly word choice (as opposed to specialized terminology) may differ from one language to another. In a comparison of English and Dutch, the historical integration of Latin-based words in the general lexis of English narrows the distance with Latin-based scientific terminology. This is not the case for Dutch to the same extent, despite the fact that both are classified as Germanic languages. Thus, to analyze the use of levels of scientific specialization or technicity, different criteria need to be considered for these two languages. A word was generally classified as a scientific term in the Dutch PILs if it was a Latin-based term. But especially for English, since many Latin-based words have penetrated the common lexicon, we may need to apply the additional criterion that a Latin-based term is classified as a scientific term (e.g. "*urticarial*" for 'hives') if another (non-Latin based) lay term is available as well (e.g. "hives" for 'urticaria'). In some cases, no common non-Latin based term is available for English. In contrast, for a word to be classified as a lay term, in the Dutch PILs, the main criterion was that it was not Latin-based. The term "anaemic", for instance, is commonly used in English (e.g. "he's anaemic"), even in general language use, whereas a person would not commonly be described with this Latin-based term in Dutch, the common Dutch lay expression being "*hij lijdt aan bloedarmoede*", which contains the words "blood" and "deficiency" (Dutch term "*bloedarmoede*"). And although the term "iron-deficiency" is available in English, the medical condition is referred to as "iron-deficiency anaemia", and both "anaemia" and "anaemic" are also commonly used in general language in English. (See also Askhave & Zethsen's (2011, 16) recommendation to replace Latin-based medical terms which are part of general English language with other terms when translating into other languages where the Latin-based terms may be incomprehensible or very formal for lay readers).

With reference to the status of words or word groups in PILs it may be argued that both scientific terms as well as lay terms can be labelled "terms" as they both designate concepts from the specialized medical domain. A detailed consideration of this point would fall beyond the scope of the present chapter, however.

The categories of specialized terms and lay terms differ from explicitations, which may contain prepositions, conjunctions or relative pronouns and verbal constructions and may even constitute entire sentences. The following examples further illustrate the use of scientific terms, lay terms and explicitations, and the different possible combinations thereof which occur in the English and Dutch PILs (refer to Examples (11), (12) and (13) and options (a), (b) and (e) from Table 2).

(14) Eczema (inflamed, red, itchy and dryness of the skin with possible oozing lesions)

(15) Inflammation of the veins and formation of blood clots in the veins which could lead to blockage of blood flow to your lungs causing difficulty breathing, chest pain and palpitations.

"*Eczema*" in example (14) was classified as a lay term. Not only do most lay people have a fair idea of what "*eczema*" refers to, but there is also another lesser-known Latin-based term for the general class of conditions referred to as "*eczema*": "*dermatitis*". The term "*eczema*" is explained further (option (f) from Table 2: *lay term +*

explicitation). The use of coordinated adjectival "and" nominal explicitation in this example is stylistically noteworthy with respect to linguistic coherence and uniformity (or lack thereof). Another example of a *lay term + explicitation* in PILs is "cardiac murmur" ('abnormal heart beat sounds'); "Cardiac murmur" is considered a lay term as it could be replaced by the scientific term "*soufflé*".

In Example (15) the term "palpitations" is presented without further explicitation in one specific PIL (option c from Table 2: *scientific term only*). "Palpitation" is a scientific term according to the Medicines and Healthcare Products Regulatory Agency (MHRA) of the UK. Many lay readers will indeed need some explicitation with this term. This is presented in different ways in the corpus (Examples (15a to 15d)).

(15) a. palpitations (when you can feel your heart beat)
b. palpitations (strong heartbeat you can feel in your chest)
c. palpitations (awareness of a forceful heartbeat which may be rapid or irregular)
d. palpitations (pounding heart beat)

The stylistic difference resulting from addressing the reader / patient directly with the second person pronoun in (15a) and (15b) as opposed to the impersonal nominalisations in (15c) and (15d) is noteworthy, notably in the light of the importance of "role relations" which are expressed in PILs (see Verplaetse & Wermuth 2014). In all four explicitations with the scientific term *palpitations* in Example (15) the explicitation (logically) follows the scientific term. When both a scientific term and a lay term are available, the Dutch Medicines Evaluation Board (*College ter Beoordeling van Geneesmiddelen* (CBG)) recommends to use the lay term first, followed by the scientific term between brackets, if mention of the latter is significant or necessary in the PIL (*lay term + scientific term*). When no lay term exists for a scientific term the CBG recommends the use of explicitation following the scientific term between brackets (*scientific term + explicitation*).

Returning to the research question which prompted an analysis of medical terminology in PILs in terms of *uncertainty avoidance* through lay-friendliness in English versus Dutch, one of the conclusions is that any increased *uncertainty avoidance* in the Dutch translated PILs compared to the English PILs was not achieved through more explicitation. Rather, the results showed a noticeably higher number of lay terms in the Dutch PILs, as opposed to more scientific terms in the English PILs, arguably promoting greater therapeutic compliance and medicine intake. In addition, the English PILs contain markedly more Latin-based lay terminology (see Verplaetse and Lambrechts forthcoming for full details).

The matters and examples discussed in this section above provide an introductory account of the relevance and challenges of science popularization in medical and general health information texts. Lay-friendliness in this context is situated on different levels, which involve different intralingual register-specific science popularization strategies, including lay terminology as well as explicitation. Different strategies and considerations also apply for register-specific adaptations on an interlingual level.

7. Summary

This chapter started with a brief overview of the history of Western medical terminology, which provides basic insight in its Greek and subsequent Latin origins. Medical terminology in the Western world is rooted in a Greek tradition, which we can trace back to the Hippocratic writings of the 4th and 5th centuries BC. The Greek medical tradition was continued in the Roman period, where Greek remained the language of medicine at first. In the 1st century AD, Celsus' *De Medicina*, published in Latin, constituted a turning point. The author's approach for gradual adaptation of Greek medical terms to Latin forms is of great interest. The Middle Ages also saw the translation of Greek medical texts into Arabic, and although original Arabic medical writings existed, few Arabic terms have been preserved in modern Western medical terminology. In the Renaissance, medical Latin flourished. Greek and Arabic texts were translated into Latin, and Latin became the standard language for many anatomical terms. In subsequent centuries, virtually all major medical works were published in Latin, so that Latin effectively became the international *lingua franca* for medicine, comparable to the status of English as a *lingua franca* for science and medicine today. Medical terminology expanded and adopted so-called neoclassical terms, or hybrid Greek and Latin forms. Gradually, however, national languages started to play a more important role in medical communication, notably French and English, which in turn both assumed a more international role in Western medical communication. Since the 1950's English has become the *lingua franca* for medical terminology. And like the terminological acculturation of medical Latin over Greek at the beginning of the Western calendar, the use and integration of English medical terms into other, national languages is an interesting process. Today's medical evolutions result in a highly dynamic medical language, which needs to integrate new concepts and terms. In this process of *terminologizing* words from general language, abbreviations and acronyms, eponyms, slang and jargon words, synonyms, metaphors and metonyms, and neologisms, are integrated in modern medical language and terminology, extending and complementing the original classical Greek and Latin foundation.

The wealth of medical terminology, including new forms of medical terminologization as well as relatively new terms, provides many advantages as well as some challenges, as described and illustrated in Section 3. These relate to a lack of international consistency as well as an unstable term-concept relation. Notably eponyms, abbreviations and acronyms represent problematic areas. The fact that no one-to-one concept term relation applies in many cases (except for anatomical terms) is a recognized shortcoming in the medical field, which may be attributed to a lack of consistent term definitions. The scope of synonymous and polysemous terms in the medical field obviously entails the need for correct contextual information. Misunderstanding and other risks might result when insufficient contextual information is available. But numerous medical concepts *can* be defined precisely, and the various actors within the medical field are encouraged to define new terms in unambiguous and clear ways.

Medical language is a natural language, and medical terminology, like any domain specific terminology, aims to optimize communication between experts working in the field. Electronic storage, accessibility and retrieval of patient data is a modern development which has been added to modern medical practice. Effective use of medical information in electronic form requires medical terminology in the form of concept systems. Various nomenclatures, vocabularies, terminologies and coding systems have been developed to support the effective communication among medical experts and the recording of patient data. Systems in the fields of Medical Information and Library Sciences and information sciences, including medical informatics and medical linguistics, focus on natural language processing of medical linguistic data for this purpose. Section 4 described some of the most popular health informatics systems. With the need for compatibility and interoperability of terminology between independent systems, national and international medical terminology standardization activities have been initiated by the respective standardization bodies.

Apart from optimization of communication between medical experts and compatibility or interoperability of (electronic) patient data and other professional health informatics, communication between medical experts or professionals on the one hand and patients or other impacted lay people on the other is also an important aspect of medical language in general. The transfer of knowledge from the specialized domain of medicine to the general domain entails science popularization strategies. Our analyses of patient-information leaflets (PILs) and specialized Summary of Product Characteristics documents (SmPCs) have provided insights into intralingual translation in the medical domain between the registers of medical LSP and LGP. In this respect we have argued that these two registers constitute the extreme ends of a continuum, especially for the medical domain, as specialized knowledge, and hence terminology, needs to be transferred to a non-specialist register. This is due to the very nature of medicine, which involves (lay) people and their bodily or mental conditions. As a result, some text types (e.g. PILs) may be situated at an intermediate position on the continuum. On the level of interlingual translation, we also notice different implications in terms of what constitutes lay terminology or specialized terminology for different languages. To a great extent this can be attributed to the different diachronic relations to Latin, the historical medical *lingua franca*, in different languages.

8. Conclusions

From the account in this chapter we believe that both further developments of systems for unambiguous and interoperable expert medical terminology in many languages, as well as science popularization of relevant expert medical knowledge in general health communication texts for lay target groups, deserve further attention. In the former case, on the expert medical level, the challenges of current and newly developing medical terminology to be tackled originate in a lack of international consistency as well as unstable term-concept relations. In this respect, we call for increased efforts by all actors within the medical field towards consistent, unambiguous and precise term definitions for new medical terms. In the latter case, we also call for consistency in the use of science popularization strategies for intralingual translation on different ends of the continuum between medical LSP and LGP. In addition, on the interlingual level we call for special attention by translators of medical texts for lay readers to what is perceived and categorized as lay terminology versus specialized terminology in different languages.

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