Use of Headings and Classifications by Physicians in Medical Narratives of EHRs

An evaluation study in a Finnish hospital

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Keywords
Electronic health records, medical informatics, documentation, classification

Summary

Objective: The purpose of this study was to describe and evaluate patient care documentation by hospital physicians in EHRs and especially the use of national headings and classifications in these documentations

Material and Methods: The initial material consisted of a random sample of 3,481 medical narratives documented in EHRs during the period 2004-2005 in one department of a Finnish central hospital. The final material comprised a subset of 1,974 medical records with a focus on consultation requests and consultation responses by two specialist groups from 871 patients. This electronic documentation was analyzed using deductive content analyses and descriptive statistics.

Results: The physicians documented patient care in EHRs principally as narrative text. The medical narratives recorded by specialists were structured with headings in less than half of the patient cases. Consultation responses in general were more often structured with headings than consultation requests. The use of classifications was otherwise insignificant, but diagnoses were documented as ICD 10 codes in over 50% of consultation responses by both medical specialties.

Conclusion: There is an obvious need to improve the structuring of narrative text with national headings and classifications. According to the findings of this study, reason for care, patient history, health status, follow-up care plan and diagnosis are meaningful headings in physicians' documentation. The existing list of headings needs to be analyzed within a consistent unified terminology system as a basis for further development. Adhering to headings and classifications in EHR documentation enables patient data to be shared and aggregated. The secondary use of data is expected to improve care management and quality of care.

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Introduction

The structure and content of electronic health records (EHR) have been developed for some time [1-5]. EHR refers here to an information repository where all patient data including medical narratives are stored in digital form. It contains retrospective, concurrent, and prospective information to support the continuity, efficiency and quality of health care [6]. Medical narratives include all qualitative and semi-quantitative clinical textual data entered by the physician and traditionally recorded as natural prose [1]. Recently there has been widespread interest in standardizing the content and structure of EHR in national projects in many parts of the world and the European Union has also focused on such activities [7, 8].

The amount of structured or coded data relative to unstructured (narrative, free) data is one of the challenges in EHR development work. Standardization of data in EHRs not only enables several different functions in the decision-making process of patient care to be fulfilled, but also supports decision-making in management and health policy. In the decision-making process of patient care delivery, standardization of the EHR content and use of coded data facilitates automated aggregation and summarization of data with reuse of this data in discharge summaries, referrals and computer-aided decision support. Standardization of data moreover enables aggregation and reuse of data for administrative purposes, statistical analysis or clinical research [2-4]. The standardization of EHR data also facilitates health information exchange (HIE) and integrated care between health care providers [4, 9]. Despite several benefits of using structured or coded data in documentation in EHR systems, the use of structured or coded data met resistance from physicians [10-12]. The barriers related to the use of classifications in physicians' documentation were a change in traditional documenting style and the usability problems associated with EHR systems [10-12]. Moreover, physicians' lack of computer skills and a lack of proper support and training were noticed to influence the adoption of EHR systems [11, 13]. On the other hand the lack of data standardization and difficulties in data exchange between the information systems secondary to this lack of standards are barriers to accept EHR systems [11].

Health information technologies (HIT) and applications such as EHR systems have been shown to improve quality of care by increasing adherence to guideline or protocol-based care, enhancing disease surveillance and decreasing medication errors [14]. Standardizing the content of EHRs also improves the quality of documented information [15]. Furthermore, EHR systems increase physician satisfaction when they are designed to provide assistance for online consultations, information support, or reminders and to help in decision-making [16]. Moreover, EHR systems have been shown to influence the content of the patient documentation [15, 17]. EHR systems should help physicians to record all essential issues and automatically copy without re-typing the contents of separate data, e.g. prescriptions or referrals, to patient records [17]. Copying text with re-typing text has been the major source of physicians' documentation entry errors. Such errors could be reduced when encounters are recorded only once, history and physical information are coded for later use and note generation is organized around problems [18]. In order to achieve these benefits, the structure and content of EHRs should be standardized and decision support functions embedded in EHR systems.

EHRs have consisted of mostly unstructured, narrative text but also of structured or coded data [1-4, 19]. The way data is structured in EHRs affects how information may be extracted from them. Currently the only way to reach unambiguous comprehension of medical narratives is to structure the text with headings and to store the text itself as controlled expressions with the help of a controlled vocabulary [1]. The free text form gives rise to barriers in searching, summarization, decision support, or statistical analysis. Information extraction from narrative documents of an EHR is still rarely in use outside laboratories where information extraction systems have been developed [20]. In the future natural language processing techniques in information extracting or retrieval could improve the use of free text.

The data in EHRs can be organized in a variety of ways including time-oriented, problem-oriented, and source-oriented approaches. In the time-oriented EHR, the data are presented in chronological order. In the problem-oriented medical record (POMR), progress notes are taken for each problem of the patient, and each problem is described according to the subjective information,

objective information, assessments and plan (SOAP) [1, 4]. Progress notes could also have a SOAP structure, but are not problem-oriented [1]. In the source-oriented record, the content of the record is arranged according to the source of information i.e. where and how information was obtained, e.g. notes on visits, X-ray reports and blood tests. Within each section, the data are reported in chronological order [1, 4]. It has also been noted that the problem-oriented way of organizing information should be accompanied by a source- and time-oriented approach [21]. Moreover, EHRs with structured format have been shown to be more comprehensive than free format EHRs. Physicians need to adhere to agreed structures in order to achieve benefits and the granularity of these structures must be of the appropriate level [22]. Medical narratives e.g. medical history and physical examination have been stored in different granularities as free text, in paragraphs by organ system, or divided into separate observations and even single findings. Moreover, medical narratives have been presented as controlled expressions or partly as free text and controlled expressions [1]. Information management of medical narratives demands organization of the content. The organization of medical narrative data affects the speed but not the completeness of information retrieval [23].

The major focus of HIT evaluation studies in 1982-2002 has been on the appropriateness of care, efficiency of work processes, user satisfaction and software quality. The quality of documented (input) or processed (output) information has been the focus in only 12.9% (N = 983) of studies [24] and particularly on coded data e.g. classifications such as ICD 10 [15, 25]. Based on recent review with an emphasis on data attributes that are important to quality measurement most studied data attributes were data accuracy, data completeness and data comparability and studies focusing on granularity, timeliness and comparability is needed [26].

Studies focusing on structure of clinical information have been assembled in lists with a variety of headings [27-29]. A minimal set of headings have been proposed as national standard to facilitate effective communication of clinical information in the United Kingdom [27]. In Sweden health care professionals documented a variety of headings resulting in need of harmonizing record headings into a unified list in the context of a common medical concept system [28]. Furthermore, the structure of clinical document has been studied as part of standardization work by the European Committee for Standardization (CEN) in order to standardize coarse-grained information in EHRs to satisfy basic needs of clinical communication and data exchanging between information systems [29].

In Finland, paper-based patient records have been a longitudinal (continuing) collection of patient data. Different health care specialties and professionals have developed their own types to document care in the paper-based patient record. The lack of a unified documentation approach finally led to a national proposal to generate a unified paper-based patient record structure including proposals for the names of documents and headings which serves as a good basis for a unified national EHR. However, transforming the paper-based record into digital form by merely digitizing the narrative text does not yield the benefits that could be achieved with EHR. In this transformation it is essential that the structure, headings and classifications are also transformed and modified according to the EHR system structure and contents.

The unified content of an EHR, as well as the legal requirements for patient record documentation [30], have been defined in a national EHR development project [31]. The unified content of EHR consists of documents. Within the documents, meaningful sets of data are organized into groups according to the clinician's actions. These groups of data items have headings. Headings provide the context for narrative text e.g. [27, 28, 32] and under these headings belong core data elements (coded data entries) which require the use of vocabularies, nomenclatures and classifications. The list of multiprofessional national headings (names, codes and descriptions) [33] is available through the national code server [34]. The unified content of EHR has been defined on the basis of proposals for paper-based patient records and information content of EHR systems. Agreement on the national unified structure of the EHR was reached by means of nationwide consultation and expert groups, which represented different domain experts: physicians, nurses, computing specialists, statisticians, administration and researchers. The aim is to achieve semantic interoperability of health care information systems. The national recommendations and guidelines were laid down in 2007 [31]. The HL7 Finland Association has defined how this information is to

be expressed in the CDA R2 structure [35], which has been adopted as the standard for data exchange.

The way data is structured in information systems and how headings and classifications in medical narratives are used depends on the EHR systems. In information systems core data elements can be documented as whole structured components e.g. lists for diagnoses, surgical procedures and medication or as structured templates for risk factors, medical statements, living will, tissue donor will or standardized instruments for functional status. Moreover, there may be several information systems e.g. a laboratory information system or radiological information system in which tests and examinations are documented using national nomenclatures. Otherwise core data may be documented in medical narratives under headings using classifications and complementary narrative text (see ▶Fig 1). Physicians mainly dictate their documentation to be transcribed by audiotypists. Physicians document short notes during their ward rounds or encounters. Physicians recorded patient data as free text structuring these notes with headings.

The purpose of this study was to describe and evaluate patient care documentation in EHRs by hospital physicians from two medical specialties and especially the use of national headings and other classifications before national recommendations were implemented in EHR systems. Specifically we examined

1. What physicians have documented in consultation requests and consultation responses in EHRs?
2. To what extent do physicians use headings and classifications when structuring these consultation requests and consultation responses in EHR?
3. How do physicians' documentations differ between consultation requests and consultation responses and between neurological and surgical care specialties?

These specialties are representative for operative and clinical models of care within hospitals.

Methods

This retrospective, descriptive review of medical narratives was carried out by analyzing EHR data collected 2004 and 2005 before the national recommendations for unified structure had been approved. The EHR system was used from 2000 until the end of 2009 by healthcare professionals in the North Karelian Central Hospital in Finland. This EHR comprises several data components and information systems, which are integrated into a common solution environment. The medical narratives in this EHR system are presented in chronological order and recorded both as free text and as free text separated with headings. The use of classifications such as ICD 10 is possible within the documentation. The physicians have been able to use the local headings and classification since the implementation of the EHR system. Physicians either enter text in the EHR system or dictate their documentation to be transcribed by audiotypists. The data entry method does not influence to use of headings or classifications in documentation. Physicians also dictate headings and classifications e.g. "patient history, 21 year old girl, diagnosis made 2006, diagnoses insulin-dependent diabetes mellitus."

The data collected for this study included anonymous medical narratives from a department of neurology that formed a subset of a wider randomly retrieved EHR dataset from surgical and neurological care specialties in the same hospital. The initial data collection included 3,481 medical narratives from neurological (n = 2,368), surgical (n = 970), and physical and rehabilitative medical (n = 143) specialties. The final data (n = 1,974) was limited to consultation requests and consultation responses between neurological and surgical specialists since the number of medical narratives included as operation summaries (n = 36) or consultations between physical and rehabilitative medicine and neurological medicine (n = 143) was insufficient for purposes of analysis. Furthermore, requests for physiotherapy and mobile device services (n = 1,210) are distinct from consultations between surgical and clinical specialties and have been mainly documented using free text.

We decided to compare two medical specialties that represent both operative and clinical models of care and comprise differences in how physicians document [36]. The physicians recorded 1-12 progress notes per patient during one or more patient care episodes. The medical narratives included clinical consultation notes (n = 2,235) in the form of requests for consultation to another

specialist apart from the department or consultation responses to another medical specialty. These medical consultation responses were also applied to discharge summaries to organizations that had initiated the referral to hospital.

A formative, standard-based evaluation method was applied. The frame of reference standard for the evaluation was the set of multiprofessional national headings and other classifications determined to be meaningful in physicians' documentation. The set of headings covers patient history (medical, family and social history), health status (physical findings), reason for care, treatment goals, outcomes of care, risk factors, life style (health pattern), vital signs, health problems, diagnoses, surgical procedures, tests and examinations, medication, preventive measures, medical statements, functional status, technical aids, living will, tissue donor will, consultation, rehabilitation, discharge summary, follow-up care plan. Under the headings physicians could document core data elements (coded data entries) which require the use of vocabularies, nomenclatures and classifications e.g. the Classification of Diseases and Related Health Problems (ICD 10) and the NOMESCO Classification of Surgical Procedures (▶Fig. 1).

The physicians' medical narratives were first analyzed using deductive content analysis and in order to answer research questions 1 and 2 categorized according to national headings. In order to answer research question 3, the evaluation criteria were developed. The evaluation criteria according to which content of the medical narratives was rated on a scale from 0 to 2 were: 0 indicating use of plain narrative text, 1 indicating use of one or more headings and 2 indicating use of one or more headings and classifications in documentation. Thereafter, the frequencies of the headings and data elements were calculated. For the comparison of the documentation content between consultation requests and consultation responses among surgical and neurological care specialties, a non-parametric test – the Mann-Whitney U-test – was used, since the data were not normally distributed. $p<0.001$ was considered statistically very significant. The data were analyzed using statistical software SPSS® 14.0 (Statistical Package for the Social Sciences; SPSS Inc., Chicago, IL, USA). The study design is shown in ▶Fig 2.

Results

A total of 1,974 consultation requests and responses to these from 871 patients were documented in the EHRs (▶Fig. 2). The frequencies of documented narrative data are shown in ▶Table 1 and they demonstrate frequent use of such sets of data as patient history and health status, which both surgeons and neurologists included in nine out of ten documented medical narratives.

Patient history and health status describe information vital to decision-making and patient care and includes such information as medication, functional status, surgical procedures, medical statements about sick leave, health patterns e.g. information about smoking or alcohol consumption, technical aids, vital signs, risk factors or results of laboratory tests or radiology examinations.

Information on diagnosis and follow-up plan were by default documented less often in requests than in the consultation responses. The initial low frequency of documented diagnoses in requests for consultation (27% for surgeons and 11% for neurologists) increased in consultation responses to 64% and 56% respectively. However, at this stage almost half of the patients included in interactive consultation work-up lacked a documented working or definite diagnosis.

The frequency of surgeons and neurologists documenting follow-up plans in consultation responses increased by 31% and 41% from neurologists consultation requests. This improvement approaches the frequency increase in the documentation of the diagnoses in consultation responses, i.e. 37% and 45% respectively by both medical specialties.

The physicians also recorded information in the medical narratives such as patient history documentation on risk factors (n = 92), health patterns (n = 281), technical aids (n = 165), and medical statements (n = 46), but due to the limited number of observations this data is not included in ▶Table 1.

Use of headings and other classifications in the free text of medical narratives

Roughly one third (40%) of the medical narratives recorded in EHRs by neurologists and 48% by surgeons included headings in the medical narrative free text of consultation requests or consultation responses. The frequency in the use of headings was lower when the physicians documented requests for consultation in the EHR (33% and 14% for surgeons and neurologists respectively) compared to consultation responses (63% and 72% respectively). (▶Fig. 3).

The number of headings used when structuring medical narratives varied across consultation notes. In some documentation only one heading was used, but in some notes the narrative text was structured with eight headings.

Patient history documentation text was structured in some cases by more detailed headings using problems (n = 26), medication (n = 29) and test results (n = 2). As part of the health status documentation detailed headings for tests and examinations (n = 16) were applied using radiology or laboratory codes for ECG or Chest x-ray.

Diagnoses, surgical procedures and reason for care were documented using internationally established classifications in consultation notes between medical specialties.

In the surgical specialty ICD 10 codes were used for diagnosis documentation in 27% (n = 489) of requests for neurological consultation, but conversely in 64% (n = 445) of consultation responses to neurological consultation. In the neurological specialty 11% of consultation requests (n = 581) and 56% of consultation responses (n = 459) to surgical medicine included ICD 10 codes.

The NOMESCO Classification of Surgical Procedures was utilized by surgeons in only one consultation request and in 29 case notes (7%) of their consultation response documentation (n = 445).

Functional status (n = 13) and vital signs (n = 9) were described applying scores of standardized instruments for patient history or health status documentation in neurological and surgical care specialties. Standardized instruments used in functional status documentation were the Mini Mental Status Examination (n = 11) used to screen for cognitive impairment. The Neuropathological Assessment of Alzheimer's Disease and Other Dementias (CERAD) (n = 1) and the New York Heart Association (NYHA) functional classification system (n = 1) to assess the stage of heart failure related symptoms to everyday activities and the patient's quality of life were also used. Vital signs were described using standardized instruments for pain and state of consciousness in the documentation; i.e. the Visual Analogue Scale for pain (n = 4) and the Glasgow Coma Scale (n = 5) to assess the patient's state of consciousness.

Comparisons of physicians' documentation between consultation requests and consultation responses and between neurological and surgical care specialties

Physicians' documentations differ between consultation requests and consultation responses and between neurological and surgical care specialties. There were significant differences ($p<0.001$) in the frequency of use of several narrative documentations such as patient history, follow-up care plan and diagnosis documentation between consultation requests or consultation responses to these, both among and between medical specialties (▶Table 1).

There were statistically significant differences ($p<0.001$) in the use of headings and classifications between the consultative processes within specialties. For reason for care and patient history headings were more readily documented in requests for consultation by surgeons than in their consultation responses to neurologists, but for health status, diagnosis and follow-up plans neurologists' consultation responses included more appropriately structured headings than their requests for consultation (▶Table 2).

Diagnoses and surgical procedures were more often coded or classified in the documentation of the specialists responsible for responses to consultation than the specialists accountable for documenting the requests for consultation (▶Table 2).

Discussion

The purpose of this study was to describe and evaluate how physicians documented patient care in EHRs and how they applied headings and classifications before national recommendations were implemented in EHR systems.

This study demonstrated that physicians documented medical narratives mostly as free text, although the recordings also included set of data that belong under the national headings and core dataset, i.e. reason for care, patient history, health status, follow-up care plan and diagnosis. There exists a fundamental trade-off between the quantity of structured data that will be documented and the tolerance of physicians of EHR systems that inhibit their expression in narrative text. It is evident that medical narratives exist partly as free text, e.g. a medical history demands a looser structure than capturing physical examinations in templates. However, the utilization of patient documentation could improve if free text were structured by headings and discharge summaries included data elements of physical examinations in the form of structured notes from the EHR. The coded data enhances understanding, facilitates sharing of information, reduces errors in documentation and enables the reuse of documented data in referrals or discharge summaries [18]. When physicians used headings in structuring medical narratives the application of different headings varied between notes in both care specialties. A lack of headings relating to consultation requests is evident due the fact that definite diagnoses and follow-up care plan is not known in this phase of care process. Headings such as patient history, health status and follow-up care plan were mainly applied. This conforms to the SOAP structure and in these cases patient care was easy to follow. On the other hand information granularity of medical narratives affects the speed of information retrieval. Some degree of granularity of medical narratives is required for optimal information retrieval [23]. Physicians must have good computer skills and knowledge to use an EHR system. Besides documentation in EHR system must be easy and support physicians workflow [11-13] before fine granularity headings could use in medical narratives. The use of headings as synonyms such as treatment plan and follow-up care plan detracts from the applicability of national list of headings. In addition, in some notes physicians used even more detail than in the national headings, such as names for radiological examinations. The use of synonyms or detailed headings in documentation demand mapping all used headings to standardized concepts using reference or interface terminologies [13]. In Finland the use of reference or interface terminologies need translation of international terminology before some could be used.

It is nevertheless surprising that headings are not more commonly used in practice although they have been for years included in proposals for the unified structure of paper-based records in Finland and used in patient records. Furthermore, national headings for EHR resemble for the most part the proposals for the unified structure of paper-based patient records. On the other hand, in proposals for the unified structure of paper-based patient records headings are defined by specialties and also include more detailed headings than the national headings for EHR. The granularity of national headings for EHR may be unfamiliar to some end-users and as a consequence have remained vague for physicians and they used other terms or detailed headings in documentation [27]. Furthermore, physicians also used headings that are not found among the national headings e.g. decursus and distribution of documents, while some national headings were not used at all.

However, sharing patient data between health care professionals and exchanging data between healthcare organizations requires unified terminology in documentation and a national consensus on headings. Unified headings could be promoted by implementing templates into information systems and offering these to the user. Furthermore, in the national development work some headings need to be considered, since they may represent relics from the paper-based patient record era, e.g. distribution of documents. The national headings are based on proposals for unified paper based records and used as headings in EHR systems. This study evaluated only a subset of national headings designated meaningful in physicians' documentation. In the future physicians' use of headings needs to be analyzed at the same time in relationship to other health care professionals' use and modeled within the context of a unified terminology system [28] in order to ascertain whether internationally approved terminology e.g. LOINC can unambiguously define headings of EHR systems [32].

Converting paper-based records into digital format does not automatically accrue benefits that could be achieved by EHRs. EHRs also change the way physicians document medical care and all the headings proposed for the unified structure of paper records need not to be used, e.g. physicians rewrite in EHRs results of laboratory tests, radiology examinations or medication. This may date back to an era when laboratory and radiology information systems were not integrated into EHR systems or EHR systems did not include separate medication components. Physicians' workload is reduced when test results from separate information systems are linked to medical narratives in EHR systems and physicians only document conclusions based on these results. It is noteworthy that risk factors are documented in only a few medical narratives. This may be due to separate software components for managing patient's risk factors in EHR systems.

In medical narratives the use of classifications was rare. Earlier observations have indicated that only coded data may be applied in decision support functions [16] or reused for secondary purposes in data warehouses to compile disease registers or in statistical analyses until natural language processing techniques are in practice [1, 20]. According to our results classifications were used only in the documentation of diagnoses by both medical specialties and surgical procedures in the surgical specialty. This may be due to national statistical demands, since diagnoses and surgical procedures are mandatory information for national statistics. Moreover, some standardized instruments were used for patients' functional status assessment and the scores of these were documented in the medical narratives. In the future one challenge is to implement such standardized instruments as part of EHR systems in order to ensure unified information.

Physicians used headings and classifications more often in consultation responses than in consultation requests from some other care specialty. This may be because consultants are usually more experienced clinicians than are residents or assistant physicians and clinical experience have an effect on documentation practices. It may also be due to the fact that consultation responses are sometimes applied as such for discharge summaries. The use of headings and classifications was more comprehensive in the surgical specialty than in the neurological specialty. This finding is consistent with an earlier study which also reported differences between medical specialties in documentation [36]. The differences in documentation are probably due to departmental cultures and differences in workflows between different medical specialties.

A limitation of this study is that it was conducted in one health care environment, in a central hospital in Finland, and the data included medical narratives from two care specialties. However, these specialties represent both operative and clinical models of care and therefore different practices. The results may not be strictly generalizable to other health care environments, such as primary care or university hospitals. Furthermore, the evaluation criteria were defined for this study and had not been tested before. However, the evaluation of the physicians' medical narratives showed that physicians mainly used narrative text in documentation and use of national headings and other classifications was rare. The challenge is to promote the use of headings and other classifications in medical documentation by educating the users and by improving the acceptance of the national headings and classifications. The commitment of physicians to use an agreed structure and appropriate level of granularity of structure is essential [27]. One possibility to promote the use of headings and classifications is to embed clinical decision support functions in EHR systems [14] and also to reuse coded data to derive benefits from EHRs. Classifications or structuring notes with headings could improve the completeness of patient records and data retrieval from them [1, 22]. Management must commit to the implementation process so that physicians are able to produce valid standardized data for patient care and the data can be reused for statistical and administrative purposes. The standardization of data in EHR is moreover essential to the exchange of information between health organizations [4, 9].

Conclusion

Physicians mostly documented medical narratives as free text. Less than half of the medical narratives by surgeons and neurologists recorded in EHR were structured with headings. According to the findings of this study reason for care, patient history, health status, follow-up care plan and diagnosis are meaningful headings in physicians' documentation. Diagnoses were documented

using ICD 10 codes in over 50% of consultation responses in both care specialties. There were differences in the use of headings and other classifications between the consultative process and specialties. Surgeons used headings more readily for reason for care and medical history in consultation requests than in responses to neurologists, but for health status, diagnosis and follow-up plans neurologists' responses included more appropriately structured headings than consultation requests by them. The need to map national heading list within a unified terminology system is clear in order to find out the basis for its further development.

The need for future evaluation research on EHR content and use in different care specialties and health care settings is obvious after the implementation of national headings and other classifications in EHR systems. There is a challenge to promote the use of headings and classifications in medical documentation by finding a balance between narrative and structured text and also ensuring physicians' commitment to use the agreed structure in their documentation. The use of agreed headings and unified terminology in documentation enables shared understanding of patient data and data exchange between health organizations. The use of unified headings in patient documentation is a new practice and the need for training and on-going support for physicians is evident. The training and commitment of management will improve the acceptance of national headings and classifications and reduce change resistance resulting from changes in workflows and differences in departmental cultures. Standardized EHR system with built-in headings, pick lists and checklist mapping to classifications/coded data and local-to-standard code conversion tables will improve the acceptance of national headings and classifications in order to physicians don't have to memorize technical nomenclatures and can document all required information easily.

Conflict of Interest

The authors declare to have no conflict of interest.

Human subjects' protections

Approval for this research was granted by the Director of the North Karelian Hospital District. No patients were directly involved in the study and the patient data were anonymous; a unique patient identifier was assigned to each record at the study site. This ensured the confidentiality and privacy of patient records.

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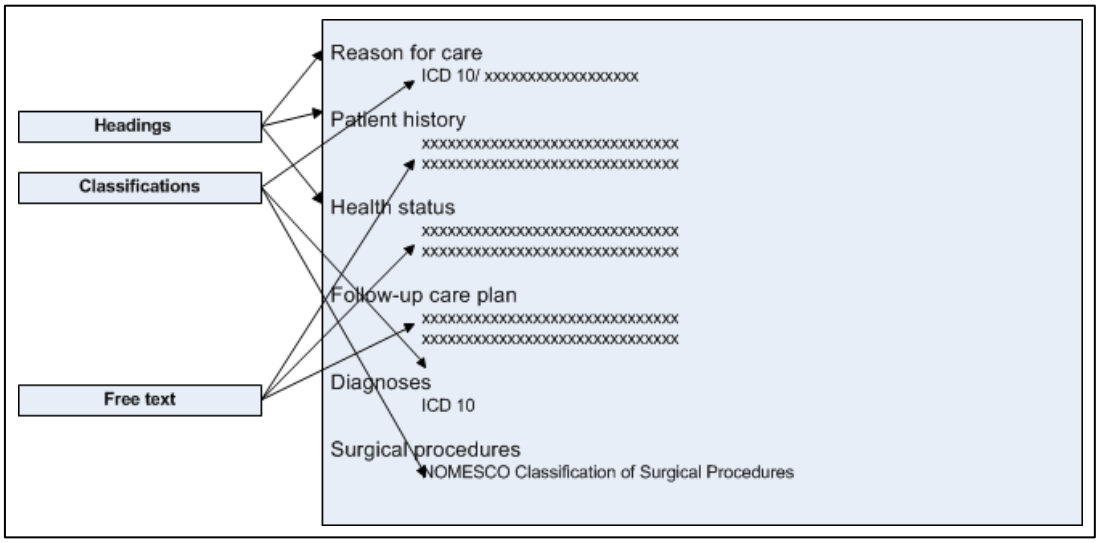

Fig. 1 Example of the use of headings and classifications in medical narratives of EHRs

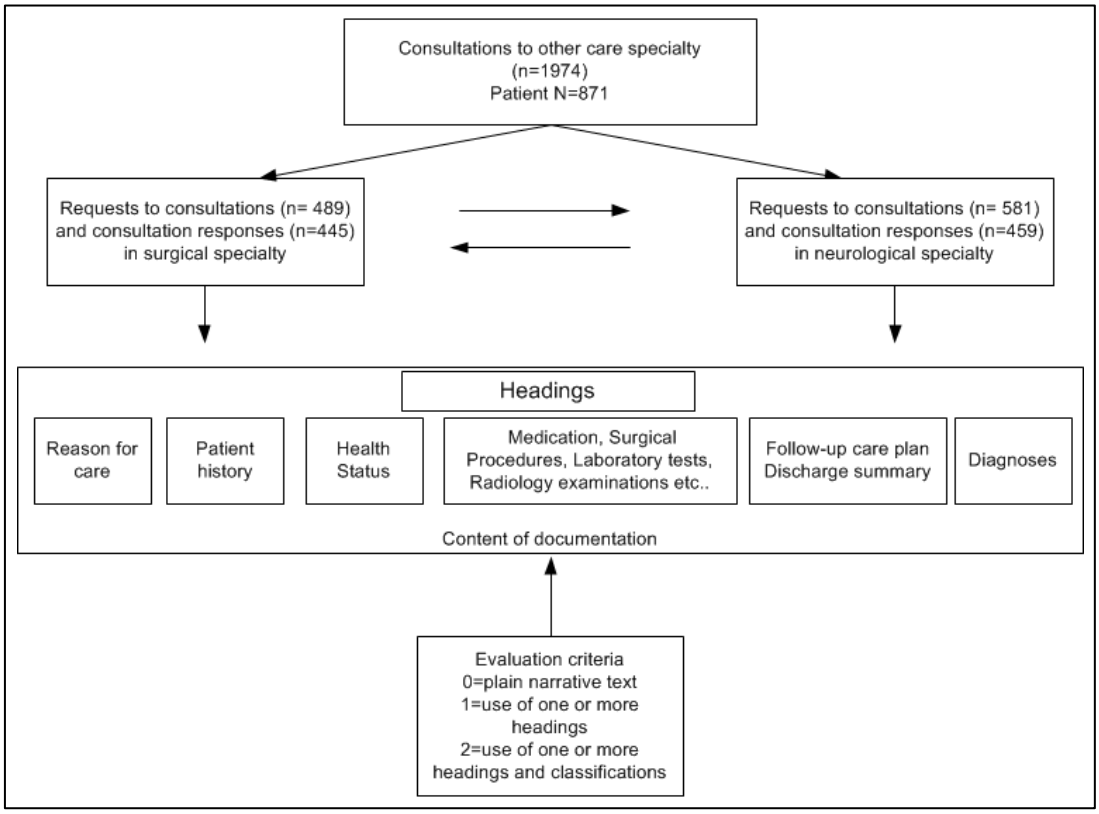

Fig. 2 Study design, flow diagram and application of the evaluation criteria

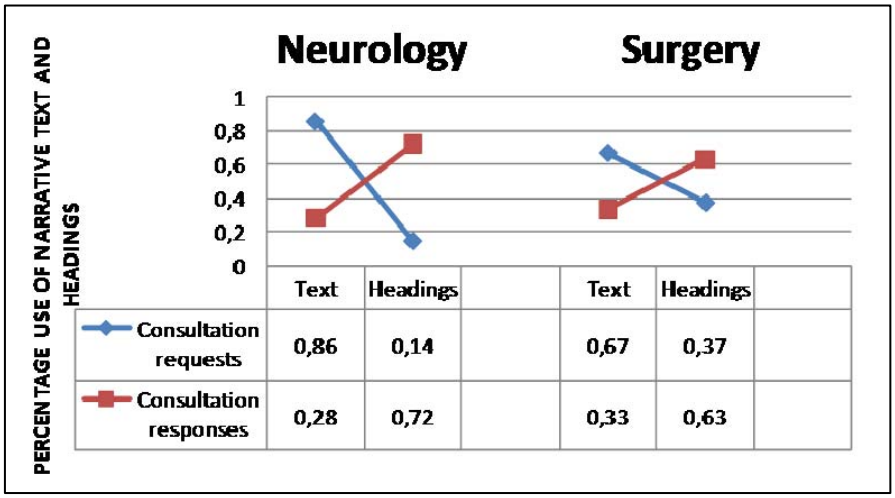

Fig. 3 Use of plain narrative text and headings within requests for consultation and consultation responses in care specialties

Table 1 Frequencies of most commonly documented set of data in medical narratives (N=1974). Differences in the use of these data sets are compared between consultation requests and consultation responses within the specialty and between specialties applying for comparison the Mann Whitney U-test.

	Surgery (n = 934)					Neurology (n = 1040)					Difference between neurologists' requests and surgeons' consultation responses	Difference between surgeons' requests and neurologists' consultation responses
	Requests for neurological consultation (n = 489)		Consultation response to neurological requests (n = 445)		Difference within surgical specialty	Requests for surgical consultation (n = 581)		Consultation response to surgical requests (n = 459)		Difference within neurology specialty		
	n	%	n	%	p	n	%	n	%	p	p	p
Reason for care	262	54	168	38	<0.001	235	40	145	32	<0.01	ns.	<0.001
Patient history	479	98	395	89	<0.001	567	98	427	93	<0.001	<0.001	<0.001
Medication	145	30	63	14	-	178	31	107	23	-	-	-
Functional status	210	43	105	24	-	230	40	250	54	-	-	-
Surgical procedures	193	39	125	28	-	220	38	132	29	-	-	-
Vital signs	171	35	145	33	-	207	36	191	42	-	-	-
Tests and examinations	150	31	148	33	-	217	37	186	41	-	-	-
Health status	439	90	381	86	ns.	511	88	409	89	ns	ns	ns
Medication	50	10	75	17	-	65	11	116	25	-	-	-
Functional status	235	48	112	25	-	179	31	326	71	-	-	-
Surgical procedures	35	7	40	9	-	33	6	15	3	-	-	-
Vital signs	143	29	143	32	-	192	33	190	41	-	-	-
Tests and examinations	226	46	201	45	-	268	46	212	46	-	-	-
Follow-up care plan	308	63	418	94	<0.001	317	55	442	96	<0.001	<0.001	<0.001
Medication	29	6	108	24	-	16	3	84	18	-	-	-
Functional status	1	0	0	0	-	0	0	11	2	-	-	-
Surgical procedures	47	10	195	44	-	149	29	32	7	-	-	-
Vital signs	5	1	9	2	-	3	1	29	6	-	-	-
Tests and examinations	110	22	176	40	-	87	15	227	49	-	-	-
Diagnoses	133	27	284	64	<0.001	62	11	255	56	<0.001	<0.001	<0.001

Table 2 Use of headings and classifications in requests for consultation and consultation responses by surgeons and neurologists is compared within and between specialties applying the Mann Whitney U-test. (n=1974)

	Surgery (n=934)					Neurology (n=1040)					Difference between neurologists' requests and surgeons' consultation responses	Difference between surgeons' requests and neurologists' consultation responses
	Requests for neurological consultation (n = 489)		Consultation response to neurological requests (n = 445)		Difference within surgical specialty	Requests for surgical consultation (n = 581)		Consultation response to surgical requests (n = 459)		Difference within neurology specialty		
Rating dimension	n	Score[1]	n	Score[1]	p	n	Score[1]	n	Score[1]	p	p	p
Reason for care	100	0.20	26	0.06	<0.001	41	0.07	16	0.03	<0.05	ns.	<0.001
Patient history	111	0.22	34	0.08	<0.001	48	0.07	53	0.08	ns.	ns.	<0.001
Health status	127	0.26	122	0.27	ns.	55	0.09	231	0.48	<0.001	<0.001	<0.001
Follow-up plan	100	0.20	95	0.21	ns.	38	0.06	120	0.25	<0.001	<0.001	<0.05
Diagnoses	133	0.54	284	1,28	<0.001	62	0.21	255	1,11	<0.001	<0.001	<0.001
Surgical procedure	1	0	32	0.14	<0.001	0	0	0	0	-	<0.001	ns.
Decursus	29	0.06	9	0.02	< 0.01	13	0.02	27	0.06	< 0.01	ns.	ns.
Distribution	0	0	31	0.07	<0.001	1	0	44	0.10	<0.001	<0.001	<0.001

[1]Scores: 0 = plain narrative text, 1 one or more headings was used, 2 one or more headings and classifications was used

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