Does the electronic patient record support the discharge process? A study on physicians' use of clinical information systems during discharge of patients with coronary heart disease

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Abstract

This study has been performed in order to categorise and measure usage of different information sources and types in a well defined stage of clinical work. The underlying motivation is to improve computer-supported presentation and retrieval of relevant information and to be able to evaluate the functionality of a future improved interface to the electronic patient record (EPR). By observing 52 discharge processes and categorising information types and sources, we have observed that the paper chart is used as a primary source of information about recent events and procedures, while the EPR is mostly used for retrieving background information and verification. Direct communication with other clinicians and the patient is also important during the discharge process. Results from an additional survey show that the physicians report greater use of the EPR than the result from the observational study. The study clearly indicates that there is a large potential for improved EPR systems that support the physicians in their work regarding discharge of patients, especially in the future planning part of the discharge.

Keywords: *Computerised medical record systems; patient discharge; discharge planning; observation*

This paper describes a study that was conducted in order to investigate to what extent clinical information systems – in particular, the electronic patient record (EPR) system – support clinicians in critical and information intensive tasks such as patient discharge. The study was performed at a Norwegian university hospital in 2004. The underlying motivation behind the study was to improve computer-supported presentation and retrieval of relevant information and to be able to evaluate the functionality of a future improved interface to the EPR. By studying how and where relevant information is represented in current clinical information systems, and the cost of retrieving that information, an impression can be gained of how the EPR system supports – or does not support – the physicians in a specific situation. This study is a step towards a more complete survey of information usage in several clinical situations, which is necessary when developing future situation-aware and user-friendly interfaces to clinical information systems.

EPR systems and other electronic information systems are extensively used in Norwegian hospitals, although as yet only a few hospitals are 'paperless' and paper based information systems are essential in most patient-centred work (Lærum, Ellingsen & Faxvaag 2001). The most obvious reasons for the limited use of EPR systems are that today's systems do not support the healthcare workers' real needs because the systems are not always available, they are not integrated with other clinical systems, they do not support the clinical procedures performed by the different healthcare workers, and they are not context sensitive or adaptable to individual needs (Dahl, Sørby & Nytrø 2004; Sørby, Melby & Nytrø 2002).

In order to be able to develop better EPR interfaces that really support physicians in their patient-centred work, it is necessary to investigate how current information systems are used. This is complicated and time-consuming, as every physician has his or her own working style or pattern, and each patient has an individual investigation and treatment plan based on their condition, previous illnesses and other important factors. However, at least two stages of a hospital stay are to a certain degree well defined and predictable; hospital admission and discharge. In this study, we focused on the discharge of patients in one particular hospital ward. The discharge process includes preparations and writing a preliminary discharge summary, the physician then conducts a discharge conversation with the patient, and finally writes or dictates a concluding discharge summary. The discharge summary serves as a basis for further treatment and follow-up of the patient when transferred from hospital specialist to primary care. The quality and content of discharge summaries have been discussed in several studies (Archbold et al. 1998; Solomon, Maxwell & Hopkins 1995; van Walraven & Rokosh, 1999; Wilson et al. 2001). However, few systematic evaluations to investigate to what extent EPR systems and other clinical information systems are used in the discharge process have been performed.

The underlying research questions of the study were:

1. To what extent does the EPR system support the physicians in the discharge process?
2. Is the physicians' work, in relation to the discharge of patients, characterised by regularity?
3. What areas of the discharge process can be improved by appropriate computer support?

Our main hypothesis was that the EPR system does not satisfy the physicians' information needs during the discharge process, and thus is not preferable to other information sources. We also presumed that the discharge process to a certain extent is characterised

by regularity. Our third hypothesis was that certain areas of the discharge process can be improved by appropriate computer support.

Method

The study was carried out in the Department of Cardiology at a large Norwegian university hospital (922 beds) during the period March to September 2004. The first part was an observational study of physicians' work regarding discharge of patients, including preparations and writing a preliminary discharge summary, conducting discharge conversations with the patients, and dictating final discharge summaries. Every physician working in one particular ward (15 beds) during the study period participated in the observational study. This ward takes care of patients suffering from coronary heart disease. Most of them are undergoing extensive heart examinations such as percutaneous coronary intervention during their hospital stay. The patients who were followed in this study were mainly suffering from angina pectoris or heart failure, and the investigation of their heart disease typically led to hospital stays of three to five days.

Several information systems, both paper based and electronic, are used in this ward. The most important paper based systems are the patient chart and the patient record.

The *patient chart* is a binder that contains the most essential information regarding the current hospital stay of one or several patients in the ward, such as printouts of the most recent laboratory and test results, medication charts, and plans for further treatment (Ellingsen & Monteiro, 2003; Sørby, Melby & Nytrø 2002).

The patient record contains old information about previous hospital stays. Other paper based systems are reference books such as *Physician's Desk Reference* (PDR) and *ICD-10 codes overview*, *personal notes*, and *patient lists.* The main electronic information systems include the EPR system, the Patient Administrative System (PAS), an integrated interface to a Picture Archiving and Communications System (PACS), Laboratory Information Systems (LIS), and various specialist systems.

The observations were conducted by two medical students who performed non-participatory observations of physicians during the discharge process. The medical students were interested in medical informatics, but they had little or no prior research experience.

The observational study was followed up by a survey distributed to every physician at the Department of Cardiology, totalling 30-40 physicians. The survey was carried out in order to validate the results of the observational study. The survey is further explained below.

Observational study

The observational study (also described in Sørby et al. 2005) took place during the period of March to June 2004. The participants included two chief physicians with many years of experience in the ward, three medium experienced senior residents, three newly hired assistant residents, and one young house physician. Both male and female physicians were among the participants.

A total of 52 discharge processes were studied, and the observers spent 100 hours in total in the hospital ward. The medical students followed one physician at a time, observing the physician's work concerning the discharge of patients. During the first week of the study, the two medical students observed 10 discharge processes together in order to coordinate their observation notes and to agree on a standard for the remaining observations. The observers used a note-taking form partly based on a form described in a textbook on task analysis for interface design (Hackos & Redish 1998: pp. 270-271). The form was changed twice during the study, based on the students' experiences and feedback. The changes of the form only led to easier note-taking for the students, and had no effect on the content or the quality of the resulting observation forms.

The first main part of the form included nine columns; one for each known/expected information source. The sources were paper based and electronic patient records, the patient chart, ICD-10 code overview, X-ray reports or pictures (including other picture results such as CT and MR), PAS (not integrated with the EPR), PDR, colleagues, and patient. Personal notes were an important additional information source for some physicians. During the observations, the appropriate table cells were marked 'X' with an exception for the ICD-10 codes and the PDR which existed both on paper ('P') and electronically ('E'). In addition, the columns marked 'Supplementary information' could be used if several sources were used to find, control, verify, or check consistency of some information. In order to focus on patient-specific information, and eliminate regular use of static reference tools, we have omitted PDR and ICD-10 usage from the further analysis.

The second main part of the form was used to describe the information that was retrieved from the selected information source. The last main part included a field for the observers' personal comments or questions, as it is important to separate their own thoughts and interpretations from the 'objective' observations noted in the 'Information' column (Hackos & Redish 1998). The forms were filled in chronologically, from top to bottom. In addition to the notes taken by the observers, a few of the discharge processes were videotaped for further analysis.

The contents of the 52 observation forms were coded into matrices (one matrix per observation) containing information sources versus information categories. In order to ensure consistency, one of the students performed the coding of all the observation forms. The information categories were adapted from a discharge summary template suggested by the Nor-

1: Distribution of total number of information elements retrieved from human, paper based, and electronic information sources

Information categories	Information sources: Human (Doctors, nurses, patient)	Paper based (Record, chart, notes)	Electronic (EPR, X-ray, PAS)	Sum
Patient administrative information: biographical data, family/social history	34	72	15	121
Past clinical information: allergies, previous illnesses, reason for referral	18	55	23	96
Present clinical information: diagnosis and procedure, progress and treatment, findings and examination results	17	164	61	242
Future clinical information: assessment, follow-up, medications, info to next of kin, medical certificate	82	121	26	229
Other: unanswered tests, function level	2	1	0	3

wegian Centre for Informatics in Health and Social Care (Ree 2002). During analysis of the results, most of the information categories were divided into four disjunctive groups of different temporal significance:

- *Future clinical information*: Information that pertains to plans and future patient care. This group contains the categories Assessment, Follow-up, Medications, Info to next of kin, and Medical certificate.
- *Present clinical information*: Information about current state and hospital treatment. This group contains the categories Diagnosis and procedure, Progress and treatment, Findings and Examination results.
- *Past clinical information*: Historic/permanent patient information. This group contains the categories Allergies, Previous illnesses, and Reason for referral.
- *Patient administrative information*: Information not related to the patient's current hospital stay: biographical data and family/social history.

Survey

In order to validate the findings from the observational study and to gain insight into potential differences between perceived and actual use of different information sources during the discharge process, a survey was distributed among the physicians at the Department of Cardiology shortly after the observations were finished. The survey consisted of a few questions on one page and a form similar to the form used in the coding of the observations. The questions were:

1. Position (Head Physician, Resident or Other).
2. Working experience (Number of years/months at department of cardiology, Number of years/months at any hospital).
3. Did you participate in the observational study? (No, Yes, 1-3 times or Yes, more than 3 times).
4. Do you have any general comments regarding the EPR system or other clinical information systems that are used at your workplace?
5. Do you use a determined procedure or sequence in your work regarding discharge of patients, and do you experience that the available information systems are supporting these tasks?
6. What sources do you use when you gather various types of information in relation to discharge of patients (including preparations, discharge conversations, and discharge summaries)? (Values: 0 [never] 1 [sometimes], 2 [often]. The values were plotted into tables consisting of information types versus information sources).

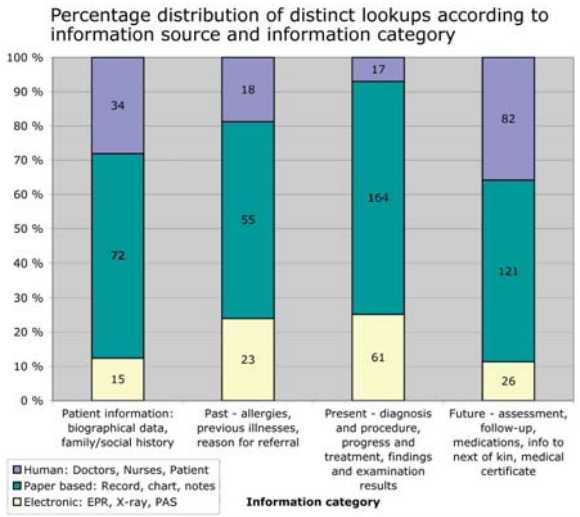
Appendix A shows an example of a survey response (translated from Norwegian).

The survey was distributed by email to every physician at the department. The physicians could fill in and deliver the survey electronically or on paper. The survey was also presented and distributed at a morning meeting where the chief physician urged the other physicians to respond to the survey. The time usage for filling in the survey was estimated to be approximately 10-15 minutes. After the first distribution of the survey, seven physicians responded. The survey was once again mentioned at the department's morning meeting and re-distributed by email in September, which led to another nine answers. In total, the survey was distributed to between 30 and 40 physicians (the exact number of recipients is not known due to the rotation scheme of the residents and the house physicians, and hence corresponding variations in the email lists at the time of the initial distribution and the re-distribution and reminders).

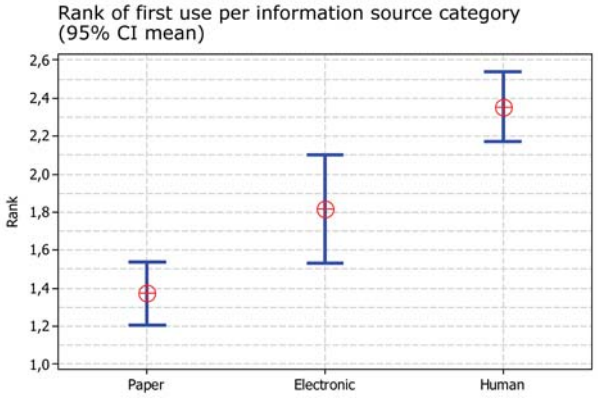
Results

The results from the observational study are presented below according to information categories and sources, followed by the survey results.

2: Percentage distribution of information elements retrieved from human, paper based and electronic information sources



3: Mean rank of first use per information source category



The human information sources were mainly used as third choice (average rank: 2.36), often in order to verify data collected from other information sources.

Observational study: information categories

During the 52 discharge processes, a total of 735 information elements were identified, 688 of these were patient specific and belonged to one of the four information categories mentioned in above. Appendix B shows the total numbers of information types versus information sources. Box 1 shows the distribution of the information elements categorised in the three groups of information systems: human, paper based, and electronic. Box 2 shows the relative distribution of the information elements retrieved from the different information sources.

Observational study: information sources

The EPR was used as an information source in 27 of the 52 observed discharge situations, while the patient chart was used in 51 of 52 situations. The number of sources used in the discharge processes varied from one to nine (average: 3.77 sources), while the number of information elements varied from only two to 25. By analysing the sequences of first time usage of each information source type (i.e., paper based, electronic or human) for every observation, we were able to calculate mean values for each of the information source types. The resulting numbers are shown in Box 3. The results of this analysis show that paper based information systems were most often used as primary sources (average rank: 1.37), while the electronic sources were often used as secondary sources (average rank: 1.82), for example, when the physicians could not find the expected information in the available papers. To what extent the electronic information sources were used varied a lot, depending on the individual physicians. The younger physicians showed a tendency to use the EPR as a primary information source more often than the more experienced and older physicians.

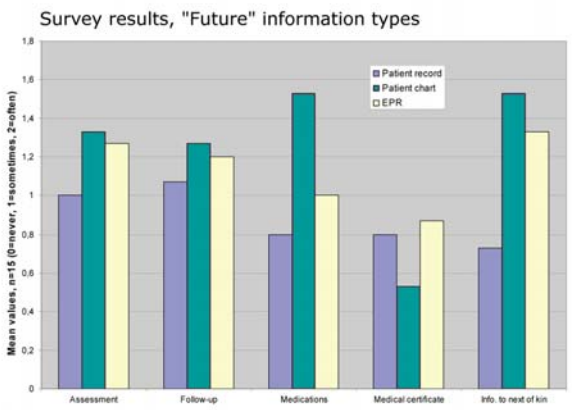
Survey results

A total of 16 physicians responded to the survey; among them where eight head physicians and eight residents. Seven head physicians and eight residents completed the survey. One additional head physician responded but reported that he had not been involved in the discharge of patients lately and hence did not complete the survey. Eleven of the respondents had not participated in the observational study, one head physician had been observed between one and three times, and three of the residents had been observed more than three times. The residents had been working in the department between three months and two years, while their clinical experience varied from one year to 10 years. The head physicians' experience in the specific department varied from five to 20 years.

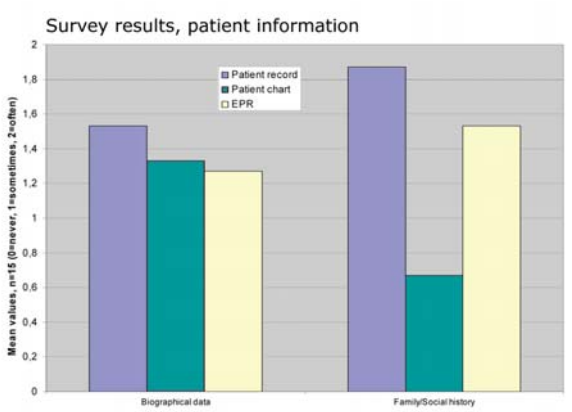
The answers to questions four and five of the survey varied to some extent. To summarise, the physicians were mainly satisfied with the EPR system when it works as intended. However, most of them found it cumbersome and time-consuming that different systems like PACS systems and the EPR are not integrated and hence they need to switch between several systems to get access to all relevant information about one patient. A few of the respondents reported that they did not use the system much because they already knew most of the important information and/or the nurses printed out the necessary information from the various information sources prior to the discharge process. Most of the physicians reported that to a certain degree they use a fixed procedure when discharging the patients, but only two of the respondents answered whether the available information systems support the discharge process. The answer to this question was respectively 'sometimes' and 'yes'.

The results of question six were summarised in one table. Some of the findings from this question are shown in Boxes 4 and 5. Box 4 shows the mean values of the physicians' responses regarding future clinical

4: Survey results: mean values of physicians' use of patient record, patient chart and EPR for retrieving future clinical information



5: Survey results: mean values of physicians' use of patient record, patient chart and EPR for retrieving patient administrative information



information types while Box 5 shows the corresponding patient administrative information types.

Many of the physicians completing the survey reported that they used the EPR system often (value 2) to find most of the relevant information types. Some also reported surprisingly little use of the patient chart.

Discussion

The study presented in this paper was performed in order to investigate how physicians, exemplified by cardiologists, use various information sources in the patient discharge process. All the patients in the study had been treated for similar heart diseases, such as angina pectoris or heart failure, but there were large variations in their previous medical histories and thus the volume of the patient records and, for instance, the extent of medication of each patient. Consequently, these factors had implications for the complexity of the physicians' work regarding the discharge process. This is clearly shown in the individual observational notes, as they vary from only two information elements to 25. The results of the observational study show that *Patient administrative information* is almost constant, and has surprisingly low reliance upon electronic sources (12%); the main sources for this information type are the paper record and chart. The high percentage of human sources can be interpreted as need for validation of information (and patient identity). Historic patient information (*Past clinical information*) is mainly taken from paper sources, which is costly and difficult to find in old, and often large, records. The paper chart is obviously the most convenient source of *Present clinical information*, in addition to actually remembering the patient and the course of actions. Human sources are surprisingly little used, even if they are easily available. There is considerable variation in work style; we have seen an effect of physicians writing personal notes, later used in addition to chart and other tools. Much of the *Future clinical information* is about plans regarding future treatment and medication (involving colleagues and the patient), and the necessary assessment and decisions are often made during the discharge process. We have also seen that development of medication plans and prescriptions involve searches in *many* separate sources that frequently are inconsistent and incomplete (Rognstad & Straand, 2004).

Due to the limited time during which the students performed the observations, not every observation included the entire discharge process. Most of the observations, however, included the physician's preparation for the discharge conversation, including writing a preliminary discharge summary. Most observations also included the discharge conversations, but due to time pressure of the physicians, the final discharge summaries were not always written immediately after the discharge conversations, and hence some observations do not include the writing and dictating of these summaries. However, this also means that some discharge summaries were written separately, some time after the patient left the hospital and possibly by a different physician from the one who performed the actual discharge of the patient. A few of these situations were also observed and are included in the analysis.

The nine physicians that participated in the study varied in age, gender and experience, both as clinicians and in the specific ward. Every physician had his or her own established working pattern, and this varied a lot from individual to individual. In similar studies, prospective participants have been excluded if they had less than, for instance, one month of experience in the ward being studied (Brown, Borowitz & Novicoff 2004). In our study, however, no such exclusion criteria were used, as we regard physicians with little experience of particular interest since they are even more dependent on appropriate information systems than the more experienced physicians. Even though the number of physicians participating in the study is limited, the sample is fairly representative as it included every physician working in the specific ward during the observational study period.

The quality of observational studies depends to a large extent on the observers; their knowledge of the

domain, and their ability to transform the observations into data and written information that can be analysed. The subjects being observed might also be affected by the presence of the observers. However, by using medical students as observers, the intention was to minimise this problem, as the physicians are used to being followed by students and house physicians. The note-taking form that was developed prior to and iterated during the study helped the students in structuring their observations, and at the same time it allowed for comments and questions that could be discussed later.

The physicians completing the survey reported that they used the EPR often to find most information types. Some also reported little use of the patient chart. This corresponds poorly with the more than 50 observed discharge processes where the patient chart is used in approximately 50 percent of the enquiries and the EPR in only about 10 percent. The main reasons for this discrepancy might be related to the design of the survey and the physicians' personal interpretations of the questions. This is also one of the reasons why using surveys as a means of evaluating the use of information systems is difficult. One example of this is when the value 2 ('often') is used for the information source EPR; does this mean that the physician often used the EPR system to find information, or that a nurse had done it and printed the information, or that the physician thought that he or she has used a lot of *time* to find information in the EPR system? Another aspect that needs to be taken into consideration when comparing the results of the survey and the observational study is that only four of the survey respondents had participated in the observational study, and so it is only possible to use the survey as an additional source of information regarding the physicians' use of the various clinical information systems.

Despite the weaknesses in the methods used in the study and the dissimilarities between the observational study and the survey mentioned above, the analysis of more than 50 different discharge processes gives a good impression of how the various information sources are used in the discharge process at the Department of Cardiology. Even though this is a very limited study performed in only one hospital ward, this department is one of the most complex departments in the hospital, characterised by high activity and large variations in the patients' illness patterns; it is thus expected to be fairly representative of Norwegian hospital departments. At the time of study, all main regional hospitals in Norway used the same EPR system product.

The analysis of the results has so far not been used for more qualitative descriptions of the discharge process. However, the analysis clearly shows that the EPR and other clinical information systems are not integrated into the clinical practice, as they are still not preferred to paper based systems even if they are available and contain the needed information. This means that there is an obvious need for improved user interfaces to these systems that would make it easier for the physicians to retrieve and produce relevant information when preparing and performing the discharge of patients.

Conclusion

Our research hypotheses were to a large extent confirmed. The analysis of the observations shows that today's EPR system is not preferable to paper based information systems, as the current EPR system was not designed to support the discharge process in particular. The analysis also shows that the discharge process is predictable to a certain degree, but with large individual variations due to different working patterns of the various physicians, and also due to large variations in the patients' illness histories. This was also confirmed by the survey results. We have seen examples of discharge processes where the physician has known the patient well and most information has been retrieved from the physician's memory, while other situations have required the physician to search for information in up to nine different information sources. A new and improved EPR system would be preferred by every physician in every discharge situation in order to provide the most recent and correct information; hence it has to be simple and easy to use but also flexible and adaptable in order to support the different working styles of individual users.

Acknowledgments

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Appendix A: Example of survey answer (translated from Norwegian)

Survey: Physicians' use of various information sources in discharge of patients

Completed surveys can be delivered to *<person>, <place>*

1. Position and ward:

Resident	X
Chief physician	
Other (please specify)	Changed department in May

2. Working experience:

Number of years/months at dept. of cardiology	8 months
Number of years/months at any hospital	2 ½ years

3. Did you participate in the observational study?

No	
Yes, 1-3 times	
Yes, more than 3 times	X

4. Do you have any general comments regarding the EPR system or other clinical information systems that are used at your workplace? (Keywores: Satisfied/not satisfied, reasons why the systems are much/little used etc.)

Electronic record is practical. But it is very bothersome that one has to log into four different programs to get information about one specific patient (The Laboratory answers program rarely function via DocuLive). Useful to have ICD-10 codes electronic.

5. Do you use a determined procedure or sequence in your work regarding discharge of patients, and do you experience that the available information systems are supporting these tasks?

Generally quite similar sequene. I use a lot of information that is available on paper at preparation for discharge (patient chart). Practical and good quality assurance to be able to get x-rays answers directly via the computer.

Please turn the page and fill in the table on the other side

6. What sources do you use when gathering various information types in relation to discharge of patients (preparations, conversation and discharge summaries)? Values: **0** (never), **1** (sometimes), **2** (often).

Information sources⇒ / **Information type ⇓**	Patient record (paper based)	EPR	Patient chart	ICD-10 codes (paper based)	ICD-10 codes (electronic)	ICD-10 codes (persoal list)	Wise-Web/ PACS	PAS (patient administrative system)	PDR (paper based)	PDR (electronic)	Colleagues	Nurses	The patient	Personal notes
Biographical data	2	1	1										1	
Diagnosis and procedure	2	2	2		2	2	2				2	1		1
Allergies	2	1	2										2	
Previous illnesses	2	2	2										1	
Family/social history	2	2											1	
Reason for referral	2	2	2										2	
Progress and treatment	2	2	2								2	1	1	1
Unanswered tests (absent answers to relevant tests/examinations)							2				2			2
Functional level												2	2	
Findings and examination results	2	2	2				2				1			2
Assessment	1	2	2								2		2	
Plans for follow-up														
Medications		2	2										2	
Medical certificate													2	
Information to next of kin		1	1								1	1	2	
Comments: (The reason why some sources are used little, specific types of information that require searching many sources, other comments)	Expert knowledge, judgement, holistic evaluation, talks/discussions during rounds and at morning meetings/heart meetings/x-rays meetings are also important in the process.													

Thank you for finding time to complete the survey!

Appendix B: Total distribution of information types versus information sources

Information types	Information sources: Patient record	EPR	Patient chart	ICD-10 (p)	ICD-10 (e)	X-ray	PAS	PDR (p)	PDR (e)	Colleagues	Nurses	Patient	Notes	ICD-10 (personal list)	Sum	%
Biographical data	2	11	58	0	0	0	0	0	0	0	1	22	0	0	94	12.8
Diagnosis and procedure	3	8	12	15	6	0	0	1	0	2	0	0	1	6	54	7.3
Allergies	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0.1
Previous illnesses	14	15	18	0	0	0	0	0	0	0	0	14	0	0	61	8.3
Family/social history	3	4	9	0	0	0	0	0	0	0	0	11	0	0	27	3.7
Reason for referral	4	8	18	0	0	0	0	0	0	0	0	4	0	0	34	4.6
Progress and treatment	3	22	52	0	0	0	0	0	0	1	0	10	0	0	88	12.0
Unanswered tests	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0.1
Functional level	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0.3
Findings and ex. results	1	10	92	0	0	12	9	0	0	4	0	0	0	0	128	17.4
Assessment	0	7	15	0	0	7	0	0	0	7	0	1	0	0	37	5.0
Follow-up	0	5	8	0	0	0	1	0	0	5	0	23	0	0	42	5.7
Medications	7	6	88	0	0	0	0	16	0	8	0	34	0	0	159	21.6
Medical certificate	0	0	2	0	0	0	0	0	0	0	0	3	1	0	6	0.8
Info. to next of kin	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0.1
Sum	37	96	374	15	6	19	10	17	0	27	1	125	2	6	735	99.8
%	5.0	13.1	50.9	2.0	0.8	2.6	1.4	2.3	0	3.7	0.1	17.0	0.3	0.8	100	

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