Physicians' Progress Notes

The Integrative Core of the Medical Record

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Abstract This paper examines physicians' progress notes, an artifact that, in spite of its obvious importance in the coordination of cooperative work in clinical settings, has not been subjected to systematic study under CSCW auspices. While several studies have addressed the role of the medical record in patient care, they have not dealt specifically with the role, structure, and content of the progress notes. As a consequence, CSCW research has not yet taken fully into account the fact that progress notes are coordinative artifacts of a rather special kind, an open-ended chain of prose texts, written sequentially by cooperating physicians for their own use as well as for that of their colleagues. We argue that progress notes are the core of the medical record, in that they marshal and summarize the overwhelming amount of data that is available in the modern hospital environment, and that their narrative format is uniquely adequate for the pivotal epistemic aspect of cooperative clinical work: the narrative format enables physicians to not only record 'facts' but also—by filtering, interpreting, organizing, and qualifying information—to make sense and act concertedly under conditions of uncertainty and contingency.

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Introduction

The institution of the medical record is under increasing pressure. Driven by advances in pharmaceutical, diagnostic, surgical, anesthetic, clinical, prosthetic, physiotherapeutic, and other technologies, the clinical profession is undergoing a process of radical specialization. At the same time, as a result of the very same advances in medical technologies people live longer and the percentage of patients with chronic diseases is consequently rising steadily (Strauss et al. 1985; Parekh and Barton 2007). The combined effect of these developments is that the medical record becomes bloated and fragmented: (a) the sheer volume and heterogeneity of the record increases with the repertoire of diagnostic and therapeutic technologies; (b) the medical record becomes partially replicated as chronic patients are in the care of increasingly specialized medical professionals; (c) the rising prevalence of multimorbidity further exacerbates the growth and disintegration of the record, as many patients are being treated for multiple diseases at the same time (e.g., diabetes and heart disease). The result is that the cost of coordination increases and with that the risk of error (Hewett et al. 2009); and (d) these issues are again aggravated by increasing reliance on patient work, especially by moves towards telemedicine and other forms of patients' self-monitoring, which potentially will generate enormous volumes of data to be integrated into the medical record.

In view of these developments, it seems safe to state that the institution of the medical record is in a crisis (Bansler et al. 2011).

An obvious strategy in response to this calamity is to develop Electronic Patient Record systems (EPR) in the form of comprehensive computer-based documentation systems that prioritize standardized records (Rosenbloom et al. 2011). However, while notable progress has been made with respect to administrative patient records (i.e., repositories of data for purposes of bureaucratic accountability), when it comes to the medical record very little has been achieved in practice, in spite of enormous investments (e.g., Clarke et al. 2001; Stead and Lin 2009). The implicit assumption that the medical record can be subjected to digitalization in much the same way as administrative records have been, has turned out to be quite naive.

The idea of an EPR system is fraught with serious difficulties simply because the medical record is not just any organizational record. As pointed out already 50 years ago by Garfinkel and Bittner, in their study of psychiatric records, administrative and clinical records are organized by entirely different kinds of logic. In an administrative record system 'information may be repeated for the sake of expediency', because 'the statement of a present state of a bank account does not add any information to what can be readily gathered from the account's earlier state and the subsequent deposits and withdrawals': 'If the two do not match, this points irrefutably to some omission. The record is governed by a principle of relevance with the use of which the reader can assess its completeness and adequacy at a glance'. In contrast, a clinical record works in a different way:

> A subsequent entry may be played off against a former one in such a way that what was known then, now changes complexion. The contents of a folder may jostle each other in bidding to play a part in a pending argument. It is an open question whether things said twice are repetitions, or whether the latter has the significance, say, of confirming the former. The same is true of omissions. Indeed, both come to view only in the context of some elected scheme of interpretation (Garfinkel and Bittner 1967, pp. 204 f.).

That is, to make progress we have to understand the specific ways in which the medical record is constructed in an ongoing process of aggregation and arrangement of test results and observations, of offering hypotheses and suggestions, of deduction and allusion, of explicit reference and tacit omission.

The point of departure in this line of research is to recognize that the medical record as an institutional practice is immensely complex and variegated. This has been brought home, quite cogently, in fact, by number of CSCW studies that have addressed the coordinative practices of clinical staff with special emphasis on the role of the medical record in these practices (e.g., Hartswood et al. 2003; Bossen 2006; Bansler and Kensing 2010; Fitzpatrick and Ellingsen 2013). A key finding emerging from these studies is that the medical record is better conceived of as a distributed system, an ecology of artifacts (Fitzpatrick 2004; Bardram and Bossen 2005; Schmidt et al. 2007). The medical record is a heterogeneous assembly of specialized representational and coordinative artifacts, typically spatially distributed and only occasionally and temporarily aligned spatially, and in any event only partially organized in a folder ('the working medical record', to borrow an apt phrase from Fitzpatrick 2004). That is, what has been established is that the medical record, as an 'ordering system', is adapted to support the high degree of specialization of clinical work.

However, in the analyses of the medical record, CSCW studies have generally treated the progress notes as just one entity among many. As a result, CSCW research in this area has not yet taken fully into account the fact that progress notes are a coordinative artifact of a rather special kind, a complex artifact consisting of a series of prose texts, written sequentially by doctors to facilitate and document their collaborative process of medical reasoning (as well as for administrative, legal, and research purposes). It is, if such a metaphor can be allowed, the black hole at the center of the galaxy of a multitude of coordinative and representational artifacts and practices.

Now, a body of literature outside of CSCW has undertaken what has so far not been done in CSCW, namely, to investigate the discursive nature of medical work by employing the notion of 'narration' in order to express an essential characteristic of the practices to which progress notes belong (e.g., Montgomery Hunter 1991; Atkinson 1995; Montgomery Hunter 1996, 2006; Greenhalgh et al., 2009). So far, this literature has provided a very important contribution to our understanding of the medical record in general and the progress notes in particular—by grasping their role against the background of the nature of medical reasoning. Montgomery Hunter refers to this as narrative case-based reasoning:

> Case narratives supplies a workable medium for representing knowledge that is time- and context-dependent […]. Physicians must know the facts of pathophysiology, the biological

> 'laws', but they cannot start there. They start instead with the individual patient: the symptoms and signs and answers to questions that fill out the story of the illness presented to medical attention […]. Narrative's sequential presentation unfolds the tactful, tactical deployment of knowledge and experience relevant to determining what is wrong with one particular patient and deciding what action to take on her behalf (Montgomery Hunter 2006, p. 46).

That is, the challenge the physician faces is to understand what is wrong with a particular patient in light of general knowledge obtained from medical textbooks, scientific papers, and electronic media as well as clinical experience and available epidemiological evidence. This poses a challenge not just because of the incompleteness of medical knowledge but also because each patient has particular characteristics and because the available patient-related evidence in many cases is ambiguous and incomplete (Berg 1992). Under these circumstances, narrative provides a means for physicians to make sense of the patient's situation, impose some order on events, and explore possible cause-effect relationships:

> From the designation of certain details as relevant 'facts' and certain occurrences as 'events' to the use of rhetorical strategies in the representation and description of those facts and events, story-telling is concerned with the construction and interpretation of meaning (Montgomery Hunter1996).

The narrative aspect of medical discourse, and of the progress notes, is embedded within an overall interventionist logic, a logic of—possibly ongoing—diagnostic work and treatment. When a patient presents with a complaint, the physician will listen to the patient's story, ask questions, possibly conduct a physical examination, and in doing so transform the patient's initial story into a *medical* narrative emphasizing possible diagnosis and action (Berg 1992; Davenport 2011). At morning Conf.s this tentative medical narrative ('the case') will be shared with other members of the medical team, discussed, elaborated and perhaps compared with other similar cases (Atkinson 1995); and at every handover—e.g., when a patient is transferred to another ward—the story is retold, albeit often in a highly abbreviated version, but always with a view to possible diagnosis and action. Further versions or excerpts of this story may be shared with nurses, laboratory technicians, radiologists, and other clinicians who, in turn, may construct their own narratives which interpret and make sense of the data they produce (e.g., X-ray images) in light of the overall medical narrative (Rooksby and Kay 2003). The point here is that images and laboratory data require an appropriate context to be meaningful: 'the lab data, so to speak, never speak for themselves. Those various data are delivered framed by some sort of narrative about this patient, however truncated, however impersonalized a form it might take' (Waymack 2009, p. 220).

The notion of 'narration' has been very productive and illuminating, in bringing out and emphasizing the deeply narrative character of clinical discourse and reasoning. Surprisingly, however, the narrative approach has so far focused on oral communication among physicians, with a few notable exceptions, especially Pamela Hobbs' sociolinguistic study of the use of evidential markers in progress

notes (2003).[1] This research suggests that progress notes are written in a discursive manner that allows authors to not only record data but to determine what is taken to be 'fact'; to select what is considered pertinent data; to qualify data in terms of certainty; to relate, aggregate, and organize data into a coherent exposition; and to make observations and suggestions in the infinitely subtle syntactic affordances offered by the prose genre (e.g., Poirier and Brauner 1990; Hobbs 2003). It is equally surprising, if not more, that the fact that physicians' progress notes are produced in a cooperative effort, as an integral part of coordinating and integrating the cooperative effort of providing medical treatment, has hardly been investigated (for an exception, cf. Svenningsen 2004). The purpose of the present study is to begin to unpack this strategically important coordinative practice.

Method and Data

The study we present in the following developed as a thread within a rather large four-year research project conducted in collaboration with physicians and lab technicians at the cardiology clinic of Rigshospitalet, the university hospital of Copenhagen. The focal point of the project was the treatment of patients with chronic heart failure by means of Implantable Cardioverter Defibrillators (ICDs), an advanced type of pacemaker that uses electrical pulses or shocks to help control life-threatening arrhythmias, especially those that can cause sudden cardiac arrest. Furthermore, it can store data about events that in turn can be downloaded wirelessly and transmitted to the hospital. The project involved, first of all, in-depth field studies to investigate existing documentation practices: observing the downloading of data from devices, tracing interpretation and migration of ICD data within the clinic, observing the use of medical records in consultations and interventions (Mønsted et al. 2011). Moreover, the project aimed at and involved the design and experimentation with prototypes for enhanced cooperation and information sharing among clinicians and between clinicians and patients (Bansler et al. 2010).

It was evident from the outset that ICDs and similar implanted monitoring technologies already had had significant impact on the medical record as an institution, in that it had become further fragmented, while the network of clinicians in need of being able to access the data, at some level of aggregation and interpretation, had expanded. One of the key issues therefore became to understand the ways in which medical records, both at the cardiology clinic of Rigshospitalet and at a major regional hospital, were structured, maintained, aligned, and used. A selection of ten patient records (the central patient folders as well as 'satellite' archives, altogether about 5,000 pages) were examined and from that study, as well as from observations of consultations, the pivotal role of the progress notes in

[1] For a kindred study of the discharge letter, cf. Winthereik and Vikkelsø (2005).

the medical record became obvious. A subset of medical records concerning five patients was therefore selected and the progress notes in these subjected to systematic scrutiny in order to understand their dual role as a coordinative and representational artifact. The present paper reports on the investigation of just one of these, namely, a series of progress notes concerning one patient. It was chosen because it was the most rich or complex and therefore the most telling. In other words, the case is exemplary.

In order to bring out the role of the progress notes in physicians coordinative practices and the way in which the format of the notes affords that role, we focus on how the physicians use narrative to make sense of the available evidence, construct plausible cause-and-effect relationships, and express degrees of certainty and uncertainty in very nuanced ways, and in doing so, we attempt to identify the structural, linguistic, and substantive conventions that guide the composition of progress notes, that is, what JoAnne Yates and Wanda Orlikowski have termed 'genre rules' (1992).

Progress Notes: An Example

In order to study the structure and content of progress notes, we shall here follow the acute hospitalization of an elderly man, Mads Jensen,[2] for cardiac (heart) rhythm disturbances. He has a long history of heart disease and has been hospitalized several times in the past for heart failure (at different hospitals). Diagnosed with *paroxystic atrial fibrillation*, which is the most common cardiac arrhythmia and gives rise to irregular heart rhythm that occurs only occasionally, Mads Jensen takes several kinds of medicine for controlling his arrhythmia. In this case, the hospitalization lasted 29 days. He was first admitted to a local general hospital (referred to below as the 'General Hospital') for 5 days and later transferred to Rigshospitalet—We focus on the series of paper-based progress notes produced in the course of the 5 days he was at the General Hospital, altogether 13 pages of typewritten text.[3]

Acute Hospitalization

Mads Jensen is admitted to the cardiology department at the General Hospital by ambulance on 27 May, in the evening, with the diagnosis of *atrial fibrillation with increased heart rate* and promptly treated with an intravenous injection of

[2] All names, dates, and other identifying information have been changed.

[3] At the time of the study, progress notes at the hospital in question were dictated digitally by the physician, typically immediately after examining the patient, for instance upon admission or during a ward round, and later typed by a medical secretary, printed out, and added to the patient's medical record (today they are also available in electronic form). The notes are usually recorded daily, but for patients in critical care, notes are typically made several times a day.

Amiodarone (Cordarone[4])—an antiarrhythmic agent used for various types of tachyarrhythmias (cardiac arrhythmia which give rise to increased heart rate). This has an immediate positive effect and slows the ventricular frequency to about 80 beats per minute. However, very soon he develops sweating and seizures and has cardiac arrest. Resuscitation is initiated according to the hospital's guidelines for advanced life support[5] (ALS) and after 6 min treatment he has restoration of spontaneous circulation. He is still unconscious and the physicians decide to transfer him to the Intensive Care Unit (ICU) for therapeutic cooling to reduce the risk of brain injury. The admission note reports[6]:

27.05.2009 21:15 CWARD

Admission

64 year old male admitted w.d. atrial fibrillation with rapid heart rate.

Previous

Known with paroxystic atrial fibrillation, treated with ablation in fall 2006.
30.01.07 CAG done at GH without indication for revascularization.
Ventriculography with normal LVEF.
Has reportedly mainly been treated at LOH, according to his son he has been hospitalized at LOH for most of 2006.
Furthermore had PCI.

Present

Is reported with fast atrial fibrillation, comes in with broad complex tachycardia, as mentioned known with left bundle branch block, in acutely bad shape, respiratorically and circulatory. Is awake and has communicated with the staff. Complains of nausea and would like a bag to throw up in. Due to fast, broad complex tachycardia there is given

rp. inj. Cordarone 300 mg as bolus IV

with good effect on the ventricular frequency, which falls to about 80. Continued broad QRS complexes. Pt becomes pale and cold sweating, gets seizure like twitches in the face and the extremities. Pt becomes unconcious and his respiration fails, cardiac arrest is diagnosed and basic resuscitation 30/2 is commenced. Scope shows bradycardia down to 30. There is given

rp. inj. Atropin 3 mg IV
and after 4 min inj. Adrenalin 1 mg IV

Pt has a decent systolic BP between 110 and 140. Does not wake up at all and is intubated. Has still has seizures with grimacing movements in the head-neck region, pt conferred with HM, pt is transferred to ICU for cooling.
There is an ABG with pH 6.9, PCO2 9.2, PO2 10, BE—16.9, N 138, K 3.8, glucose 15.6, lactate 9.5.
Provisional biochemistry: Leuc. 17.8, thromb. 220, Hb 8.3.

Christian Nielsen/gl

[4] Amiodarone is the active ingredient in Cordarone (and other brand name drugs). In this context it is to be taken as a synonym of Cordarone.

[5] Advanced Life Support (ALS) is an emergency procedure performed to manually support breathing and circulation with the aim of preserving intact brain function until the patient has a return of spontaneous circulation (ROSC) or is declared dead.

[6] The excerpts from the progress notes have been translated from Danish by the authors.

This note recounts a quite dramatic episode, but is otherwise unremarkable in that it follows a fairly standard structure and is written in the usual format and style of progress notes in this hospital. It illustrates several important features of progress notes. First, we notice the standardized layout with headers and indentations that allow the reader to quickly locate information of interest. Second, the note is clearly identified by the acronym of the ward (CWARD, the cardiology department), the name of the dictating physician (Christian Nielsen), the initials of the medical secretary who typed it (gl), and date and time. Third, the note is written in a technical language using medical terms and standard abbreviations such as Pt (Patient) and PCI (Percutaneous Coronary Intervention). Furthermore, initials and local abbreviations are often used instead of the full names of people and organizational units (e.g., GH for General Hospital). Fourth, the note is written in a concise format and it relies heavily on the reader's background knowledge, both of medicine and of local circumstances such as the organization of the region's hospital system. For instance, no reason is given for the decision to cool down the patient, because this is a standard procedure for patients with cardiac arrest.

The structure of the note follows a common pattern: chief complaint, typically one sentence that introduces the patient and the principal reason for the admission; the medical history prior to the current admission (under the heading 'Previous'); a short account of the current admission (under the heading 'Present'); the physical examination of the patient, which in this case is quite rudimentary and leads directly to the initiation of treatment; and finally a rather truncated assessment and plan, which simply states that the patient should be cooled down. Quite unusually, however, the note ends by listing a number of laboratory findings.

It is characteristic that the account given in the note locates the current episode in the temporal framework of the overall illness trajectory of the patient and constructs a chronology that identifies significant events and arranges them in a logical order. The turning point in the narrative is the sudden onset of sweating and seizures leading to cardiac arrest, which is described quite graphically. No explanation for the cardiac arrest is given, but the narrative hints at the possibility that it is caused by the injection of Cordarone (Amiodarone).

Transfer to the Intensive Care Unit

Mads Jensen is then transferred to the Intensive Care Unit (ICU) at the hospital where therapeutic hypothermia (cooling) treatment is initiated. After the transfer, a new admission note is added to his medical record, this time composed by an intensive care physician. This admission note has many similarities with the previous one. The layout and style of writing is the same and it follows the same overall structure, beginning with the chief complaint and ending with the assessment and plan.

This admission note recounts the story of how Mads Jensen was admitted to the hospital with atrial fibrillation, how he developed cardiac arrest after treatment

with Amiodarone IV, and how he was resuscitated and transferred to the ICU. But this time the story is retold with more emphasis on the patient's neurological state and the risk of brain damage due to insufficient oxygen supply during the cardiac arrest and less emphasis on the patient's cardiological problems:

> **Present**
> Pt admitted tonight by ambulance due to AF with 1:1 conduction. General condition affected by this. In addition dilated unresponsive pupils observed. In the admission room at C 23, Cordarone is given and pt becomes momentarily unresponsive, has generalized tonic–clonic seizures and goes into clinical cardiac arrest. In the beginning what looks like VT, but before we get to give a shock, then asystole. Pt is given chest compressions, ventilated and atropin 3 mg and adrenalin 1 + 1 mg are administered. Pt is intubated. After 6 min. of ALS pt has spontaneous circulation again. GCS 3. Gets intermittent jerks, is grimacing on the tube and increases to GCS 6. First ABG with pH 6.92, PCO2 9.21, PO2 10.1, BE 16.9, lac. 9.5. Infusion with bicarbobate 100 ml. is administered. Transferred to ICU, where cooling, sedation is commenced. Bladder catheter and an arterial line are inserted and a 5-lumen CVC is placed in the right sided external jugular vein (right side due to marevan[7]).

First, it is noted that the patient had 'dilated unresponsive pupils' when admitted to the hospital, which can be a sign of brain injury. Second, it is recorded that 'GCS [is] 3′ immediately after the successful resuscitation and that it later increases to 6. GCS is an acronym for the *Glasgow Coma Scale,* a neurological scale that aims to give a reliable, objective way of assessing the state of consciousness of a person.[8] Third, many of the specific cardiological data, such as information about EKG readings, blood pressure and heart rate, are omitted from this version of the story, and the evocative account of how the patient starts sweating and develops severe muscle seizures is replaced by the matter-of-fact statement that the patient develops 'generalized tonic–clonic seizures'.

During the night the ICU staff succeeds in stabilizing the patient, but he is still sedated and cooled down to 32 °C. At midnight, after 24 h of hypothermia treatment, they begin slowly warming him up again and the next morning (29 May) he is awake and able to communicate by nodding his head as sign of yes or no, although still partially sedated. However, the ICU physicians now have a new worry: the patient's white blood cell count is rising (sign of infection) and he has developed a pleural effusion (accumulation of water in the chest cavity) that could be caused by pneumonia. They decide to immediately start antibiotic treatment.

The cause of his heart arrest is also still unresolved and therefore they send for a cardiologist to perform an echocardiography (a cardiac ultrasound) and assess the patient's cardiac condition. The cardiologist arrives at noon and after examining the patient, he dictates a comprehensive progress note.

The note starts, once again, by reviewing the patient's history—but this time the primary focus is on his heart troubles, which are discussed in much more detail

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[7] An oral anticoagulant. Marevan is the Danish brand name for this drug (Warfarin).

[8] The scale provides a score in the range 3–15, in which progressively higher scores indicate higher levels of consciousness. Patients with scores of 3–8 are usually said to be in a coma.

than before. The note confirms some information, for instance that Mads Jensen, according to his family, took Cordarone tablets for his atrial fibrillation, but it also questions previous information about his having a coronary angioplasty at some point (referred to as a PCI, percutaneous coronary intervention, in the progress notes).

Furthermore, the note adds two new pieces of information about his heart problems. It describes how he has been free of symptoms until 4 months ago, but then began having episodes of difficulty breathing and rapid heart beating, and it discusses in detail an ECG printout from the ambulance, which has not been mentioned before.

After the review of the patient's recent medical history follows a discussion of the most likely reason for the heart arrest. First, it is pointed out that cardiac telemetry (i.e., long term in-hospital monitoring of the heart rhythm) conducted after the cardiac arrest shows 'severe prolongation of the QT interval,[9] up to 600 ms, which confirms the suspicion of an acute Amiodarone effect'. Second, it is noted that a test carried out the same morning shows that the level of troponin T (a cardiac protein which is leaked into blood during cardiac injury) is normal, 'which weighs against the suspicion of acute ischaemic genesis and consequently against the suspicion of ventricular arrhythmia'. However, no firm conclusion is reached:

> On ward C23 perceived as circulatory instable, which is why IV Amiodarone was administered. At first, it apparently stopped the SVT, but also caused SA block leading to severe bradycardia and clinical cardiac arrest.
> Subsequent telemetry shows severe prolongation of the QT interval, up to 600 ms, which confirms the suspicion of an acute Amiodarone effect.
> Biochemical measures this morning show normal troponin T, which weighs against the suspicion of acute ischaemic genesis and consequently against the suspicion of ventricular arrhythmia.

The note ends with a cardiological assessment and plan. The 'most probable' diagnosis is recorded as 'paroxystic atrial fibrillation and atrial flutter that despite Cordarone are being conducted with a high rate to the ventricles'. Consequently, the cardiologist recommends that the patient resumes taking his usual Amiodarone (Cordarone) tablets as soon as possible. At the same time, he warns against giving more bolus injections (the injection of a drug in a high quantity, called a bolus) of Amiodarone.

Life Threatening Crisis

Mads Jensen's condition seems to be improving and the expectation is that he can be discharged from the ICU and transferred back to the cardiology ward within a day or two. However, after the morning round the next day (30 May), the

[9] The QT interval is measured on an electrocardiogram (ECG).

physician is very concerned about his infection. She notes that 'Pt has rapidly increasing biochemical markers of infection, possibly stemming from pneumonia', despite treatment with antibiotics. She decides to call for a microbiological specialist, who thinks it is too early to tell whether the antibiotics are effective or not and advises to 'wait and see'.

The next morning (1 June), Mads Jensen has difficulties breathing and his condition deteriorates rapidly. The physician has a strong suspicion that the patient in fact has pneumonia and that it is getting out of control.

Four hours later, the same physician notes that Mads Jensen has developed atrial fibrillation and speculates whether the underlying cause is heart failure or sepsis, a severe, potentially fatal complication to bacterial infections where the infection triggers a variety of delirious disease processes causing manifestations such as bleeding, coagulation and shock:

01.06.2009 14:00 ICU

Increasingly circulatory unstable, AF 130-150. Could be caused by worsening heart failure, but it could also be due to worsening septic condition.
[…]

He decides to call for a cardiologist. The cardiologist tries three times to restore a normal heart rhythm with DC cardioversion,[10] but without success, and then recommends trying to regulate the atrial fibrillation (i.e., decrease the pulse rate) by giving three IV injections of Digoxin at 6 h intervals—despite the bad experience with the Amiodarone bolus 4 days earlier, which led to his cardiac arrest.

The digitalization is without effect and the next morning (2 June), after consultations with a cardiologist, the ICU physician decides to transfer Mads Jensen to Rigshospitalet, which is better equipped to treat heart failure and sepsis.

Functions and Genre-characteristics of Progress Notes

As the case should show, the medical record should be conceived of as far more than a set of records, or an 'ecology' of artifacts, but rather as a rather special ordering system in which the progress notes perform an essentially epistemic function and in that capacity serve as the integrative force at the center of the cloud of orbiting inscriptions and artifacts.

Physicians' progress notes are produced in an open-ended, enormously variegated, and essentially contingent, epistemic process (Strauss et al. 1985; Atkinson 1995; Montgomery Hunter 2006). The notes concerning a particular patient constitute a working document that 'records the core narrative of the patient's medical

[10] DC (Direct Current) cardioversion is a medical procedure by which a cardiac arrhythmia is converted to a normal rhythm, using electricity. It is performed by giving the heart an electric shock, at a specific moment in the cardiac cycle. In contrast, pharmacologic cardioversion, uses antiarrhythmia medication instead of an electrical shock.

care' as it unfolds over time (Hobbs 2003, p. 454). They serve both as a tool for thinking for the individual physician, enabling him or her to make sense of the patient's past history and current condition, and as a coordinative artifact used by physicians, nurses, and other health care professionals.

In a way that is similar to a scientific community's evolving repertoire of papers (apart from the imperative to act that is defining of clinical work), some entries serve to present bits of fact (similar to research notes), other entries serve to outline treatment plans or strategies (research problems and hypotheses), while other entries again serve to review what has been learned so far. Written over time by several clinicians, often from different specialisms, in a highly distributed process, the progress notes serve to reflect ongoing external developments, to select and counterpose bits of data, to formulate hypotheses as to causation, to suggest lines of action, etc. The epistemic function of the progress notes is clearly reflected in the way progress notes are composed and formatted. The conventions guiding their form and substance have developed over more than a century and today play a cardinal role in medical practice. It is therefore useful to conceive of the format of progress notes as a specific 'genre' of clinical communication (next to discharge letters, lab reports, etc.). In the words of Yates and Orlikowski, a 'genre' functions in a given community as an 'institutionalized template' (2002, p. 15) for communicative action, by establishing a set of taken-for-granted expectations that influence both how communicative artifacts are routinely composed, interpreted, and understood. In fact, and as illustrated in the previous section, physicians' progress notes constitute an established and well-defined genre of clinical communication, with a wide normative scope, governing how physicians organize, record, and share their observations and thoughts (Hobbs 2003). From the case we can distill a set of important genre-specific features of the progress notes are:

(1) The format is concise. The notes are written in medical language using highly specialized terminology as well as shorthand, acronyms and abbreviations—some of which are standardized and common while others are more local and idiosyncratic. Therefore, understanding the text requires a great deal of background knowledge concerning not only common medical terms and procedures, but also local circumstances and resources. As pointed out by Hobbs (2003), a progress note is a 'condensed text' in which 'the reader's background knowledge supplies the cohesion that is provided by explicit linkage in other contexts' (Hobbs 2003).
(2) The notes have a standardized layout and are clearly identified by date and time, author, and transcriber. The main body of the note is divided into sections with relatively standardized headings as a guide for readers and indentations are used to accentuate prescriptions and orders and make it easy to spot them in text.
(3) The composition of the notes follows a common pattern. They are typically organized into the following sections: (a) past medical history, (b) history of present illness, (c) laboratory data, images and results from the physical examination of the patient, (d) assessment, and (e) plan. However, progress

notes are written in a variety of formats and vary much in length and detail. Admission notes are quite comprehensive and, in addition to the above mentioned sections, they usually also contain sections that describe the chief complaint (i.e., the reason for hospitalization or for transfer to another ward or hospital), allergies, medications on admission, tobacco and alcohol use. The daily progress notes, on the other hand, may vary from lengthy and very thorough to rather short or even quite rudimentary, depending on the clinical situation or task at hand.

(4) Substance, organization and style varies from one medical specialism to another. Each group of specialists addresses 'concerns that reflect the unique philosophy and skills of that professional group' (Poirier and Brauner 1990). The cardiologists, for instance, focus on cardiovascular disease and hone in on such issues as blood pressure, heart rate and stroke volume, while the ICU physicians usually have a broader perspective, taking a more systemic approach to treatment. In other words, the progress notes embody the complexity of medical work in the hospital setting and, consequently, they lack 'the ultimate cohesiveness of a *single* author or point of view' (Poirier and Brauner 1990). For instance, in the previous section, we saw how different specialists—while adhering to the conventions of the progress note genre—construct noticeably different clinical narratives, each foregrounding certain events and types of data.

(5) It is characteristic of the progress notes we have analyzed that doubt, uncertainty, and ambiguity are very much present in them. Physicians must regularly act upon uncertain, incomplete, and even contradictory evidence, and the process of diagnosis and treatment is therefore, in the words of Poirier and Brauner, often 'fraught with ambiguity and inconclusiveness' (Poirier and Brauner 1990). This essential uncertainty of medical practice is reflected in the physicians' writing. They are clearly wary of drawing unfounded or premature conclusions about the source of the patient's problems and, consequently, they often present their hypotheses and conclusions as tentative and provisional, for instance by hedging their statements with adverbs such as 'possibly', 'probably', and 'presumably'. Furthermore, the physicians carefully express their degree of trust in the recorded information by marking it for both source and mode of knowing (factual, firsthand, or reported) and, sometimes, even by explicitly questioning its trustworthiness. They do so by following writing conventions that 'key grammatical forms to the sources of information' (Hobbs 2003). The patient's own report of his or her symptoms is, for instance, marked as indirect discourse, while information stemming from other health professionals is reported in the agentless passive voice. So-called objective information, that is, information which is 'deemed to be directly observable or independently verifiable', is conventionally reported as facts (Hobbs 2003).

The progress notes mediate the integrative discourse in which the ensemble of clinicians collectively make sense of the myriad inscriptions on multitudes of

artifacts associated with the medical record and express what they collectively take to be the state of the world at the time of writing.

Of course, the progress notes do not stand alone. They only make sense as part of the ongoing conversation and coordination among physicians (and other clinicians) about possible diagnosis, treatment options and prescribed therapies (Garfinkel and Bittner 1967; Conn, et al. 2009). As Atkinson (1995) has pointed out, the practice of medicine constitutes to a large extent an oral culture. Physicians constantly talk with each other, with other health professionals, and with patients—in clinical Conf.s, during ward rounds, in the hallway, by telephone, and so on. Nevertheless, the written progress notes provide a common point of reference, which is of crucial importance given the highly distributed and around-the-clock nature of hospital work. They serve as the 'primary means of communication among treaters who are not co-present with each other' and allow them not only to coordinate their actions but also to share their thoughts and observations concerning diagnosis and treatment (Hobbs 2003). According to Atkinson (1995), there is a 'close relationship between written and oral accounts' (Atkinson 1995, p. 91) of patient care constructed by physicians. Physicians refer to the progress notes (and other written materials) when discussing the patient with their colleagues and the outcome of these discussions may in turn be recorded in subsequent progress notes. Several examples of this are present in Mads Jensen's medical record. Finally, physicians share vast amounts of medical knowledge and they rely heavily on this background knowledge when dictating and reading progress notes: 'Background knowledge operates as a reciprocally shared resource, with speakers assuming its availability to recipients in designing their utterances, and recipients assuming that this assumption has in fact been made, and interpreting the message accordingly' (Hobbs 2002, p. 267).

Discussion

As we have shown in the previous sections, progress notes are far from being idiosyncratic scribbles or 'glob[s] of free text' (McDonald 1997) as one medical informatics researcher disdainfully has put it. On the contrary, they constitute a well-defined genre, with elaborate rules for composing different kinds of notes (e.g., admission notes) and for conveying attitudes towards recorded information (e.g., degree of reliability). This is not to say that there is no variation in how different physicians dictate their notes. Although genres shape communicative action in organizations, genre rules are not rigid and they do not create a 'binding constraint' on the substance and form of the progress notes (Yates and Orlikowski 1992, p. 306). As we have seen, the genre rules are flexible enough to allow for significant and systematic differences in both content and structure of progress notes from one specialism to another. Furthermore, there are also individual variations in how physicians dictate their notes, and the rules can always be bent or

broken, dependent on the circumstances and the information the physician may wish to convey.

Nevertheless, progress notes have their own distinctive format and style that enable experienced physicians to exchange information and thoughts efficiently. The genre rules guide authors in composing notes and they orient readers to how they should read and what they should look for and expect to find where. Thus, in a study of physicians' ways of reading medical records, Nygren and Henriksson (1992) found that the 'format, layout and other textural features' provided 'effective guidance in the process of searching, reading and assessing the relevance of different items of information in the record' and allowed them to skim through even quite voluminous notes rather easily (Nygren and Henriksson 1992, p. 1).[11] This is presumably not just because the conventions of the genre impose a certain degree of standardization, but also because they, as Hobbs has put it, promote an 'economy of form' (2003, p. 471) without superfluous details or explanations, which allows physicians to convey a great deal of information in a few words.

The progress notes articulate the 'core narrative' of the patient's illness and medical care (Kay and Purves 1996; Hobbs 2003). It is not the patient's story, but a medical case narrative, authored by the involved physicians as part of their effort to diagnose and treat the patient's illness: 'The medical record contains the medical discourse of at least one physician talking, so to speak, to him- or herself about the possibilities of diagnosis and treatment, a process which can be fraught with ambiguity and inconclusiveness' (Poirier and Brauner 1990, p. 31).

The construction of a case narrative necessarily implies a selection and ordering process, and this can only be done from a certain perspective and for a specific purpose. During the reasoning process, the physician sifts through the available evidence in the form of the patient's own account of the course of illness, the results from the physical examination, biochemical laboratory results, X-rays, pathology reports, etc., assesses its credibility, identifies important 'events', 'signs', and 'symptoms', and arranges them in a certain order to construct a recognizable medical story. The function of the case narrative is to give meaning to an otherwise intractable collection of data by establishing causal relations between selected events, signs, and symptoms, thereby allowing these to 'take their meaning by belonging to, and contributing to, the story as a whole' (Mattingly 1998, p. 46). The structure of the narrative serves to: 'emphasize or de-emphasize certain story-events, to interpret some and to leave others to inference, to show or to tell, to comment or to remain silent, to focus on this or that aspect of an event or character' (King 1992. Cited in Kay and Purves, 1996, p. 76).

In sum, progress notes are not a literal recording of what happened along the patient's illness trajectory, but rather a highly selective account of events, findings, and thoughts, as seen from a certain—interventionist—perspective. They function as a cognitive artifact that facilitates memory and recall and they enable

[11] The study did not focus exclusively on the progress notes, but on the traditional medical record as a whole, that is, including lab reports, X-rays, etc. contained in the patient's folder.

collaborative sense-making and coordination of actions in a highly complex, distributed work practice.

This insight has important implications for the design of electronic patient record systems. To be truly useful in clinical practice, such technologies must accommodate physicians' need for composing and sharing medical narratives, hypotheses, reflections, elaborations, plans of action, etc. in a straightforward and flexible way. However, the dominant design philosophy runs counter to this requirement. Extending the database technologies that were developed for administrative record systems, it emphasizes structured data capture at the expense of flexibility and expressivity, because data standardization according to a predefined scheme of types is a prerequisite for computer facilities such as decision support, quality assurance, workflow automation, as well as secondary use of data for research and administrative purposes.

On the other hand, as argued earlier, current coordinative practices in clinical settings, based on paper-based medical records, are not sustainable. They are crumbling under their own weight. Nor is it a tenable strategy to replicate the flexibility of the conventional practices of composing progress notes by offering 'free text'. This approach risks under-exploiting the potential of computing technology, for instance capabilities for creating hypertext links to laboratory tests or diagnostic images, for setting up notifications and automatic alerts, for presenting data in different ways dependent on the user's perspective, and for easy lookup of information, keywords or codes while entering data (cf., e.g., Wilcox et al. 2010). Worse, as pointed out in a recent editorial in *The American Journal of Medicine*, a simple replication of traditional practices combined with the copy-and-paste function of EPR may have the 'insidious consequence' that 'the narrative' is lost: 'Because charts have become capacious warehouses of disorganized, irrelevant, or erroneous data, the story of the patient and the patient's illness is no longer easy to read or likely to be read. In a most compelling and perhaps unintended way, we are witnessing the "death" of the health record narrative, as many of us have known it' (Siegler and Adelman 2009, p. 495). This may lead to frustrated physicians and the creation of informal records, sometimes referred to as 'parallel charts' (Siegler and Adelman 2009), 'shadow charts' (Wears 2008), or 'cheat sheets' (Varpio et al. 2006), and even, in the worst case, to medical errors and patient harm.

Moreover, the existing progress notes genre has its own weaknesses. The genre was created at a time when the division of labor in medicine was less developed and typical illness trajectories were shorter and less complicated. Thus, originally, progress notes were primarily meant to support communication and collaboration within small, relatively homogeneous groups of physicians for a comparatively short period of time. In the hospital of today, this situation is radically changed because of the increasing prevalence of chronic diseases and the continued growth of specialization in medicine. Patients with chronic diseases often have complicated, protracted courses of illness and require treatment from multiple medical specialists. The result is that a typical patient's progress notes may span years or even decades and contain hundreds of entries from different medical experts.

When the notes swell to such proportions, they become quite unmanageable and nearly impossible to browse, read, and absorb in any meaningful way—not just because of their sheer size and number of entries, but because of the diversity of content and authorship, and the fact that physicians from different medical specialties speak different languages, both literally and figuratively. This is not an entirely new development (cf. Poirier and Brauner 1990), but it has accelerated markedly over the past decades due to the rapid growth in medical technology and knowledge, which has spurred specialization and challenges the implicit assumption of 'background knowledge' (Hobbs 2002, 2003). Thus, physicians from different specialisms may have trouble understanding each others' progress notes (Bansler et al. 2010).

The obvious route to explore is to impose a certain degree of structure on the notes by dividing them into labeled and standardized segments, e.g., sections, fields, and paragraphs (Tange et al. 1998; Tange 1999; Johnson et al. 2008). Such documents are sometimes referred to as 'semi-structured', indicating that they impose certain 'restrictions on the clinician (standard fields for data entry), while allowing freedom of expression within those units (free text paragraphs)' (Johnson, et al. 2008, p. 55). According to Johnson et al., such an approach may 'improve completeness and accuracy of clinical narrative'; it may help physicians 'to locate data efficiently' by 'displaying documents in labeled chunks or paragraphs'; and it may allow for the construction of new documents, e.g., summaries or overviews, by reusing data and text from designated fields of existing documents. Imposing a higher degree of structure on the progress notes may thus both improve the quality of the narrative and make it easier to navigate and browse long documents (Johnson et al. 2008, p. 55). It does not, however, solve the problem of communication between different medical specialisms.

Yet another approach might be to aim for a much deeper integration of computational functionality in the design of the progress notes editor, for instance, by providing dynamic support to the physicians in their task of composing progress notes in the form of an underlying computational interpreter that, based on a nomenclature and possibly a classification scheme, recognizes key terms as they are being types, offers possible synonyms, and allows the physician to confirm or disconfirm the interpretation. Such interpreter facilities are well-known from text-composition technologies as exemplified by online spelling checkers and dictionaries, as well as by the 'autocompletion' and semi-automatic formatting facilities of advanced text editors such as source code editors. The potential advantage would be to retain the current degree of expressivity and flexibility while at the same time providing for cross-indexation with other forms of documentation (e.g., links) and facilitating rigorous indexation and classification of clinical data, for instance for secondary use. The challenge here lies in making the coordinative protocols, in the form of the underlying nomenclature and classification scheme, accessible for cooperative maintenance. That is, it must be possible for physicians at a particular clinic (or at a given hospital, or at some higher organizational level) to negotiate and maintain the standard nomenclature or classification scheme. However, these ideas are simply just ideas.

The overall conclusion must be that there is still much we do not know about the role of narratives in clinical discourse and that there are still many open questions about how to incorporate medical narratives in the EPR. Although the paper-based progress notes genre is widespread today, it is difficult to see what the electronic equivalent should look like and what exactly its role should be in relation to the structured or coded data in the record. Consequently, there is a strong need for more field-based innovation and experimentation to develop and test new approaches to the design of EPR systems.

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