Indexical Fields: Encoding, communicating and coordinating

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Abstract

This paper explores how doctors use documents to share their knowledge. By combining the previously distinct lenses of communicative genres and linguistic analysis of indexical structures, I explore the relationship between doctors' communication and coordination practices and their encoding of patient care in medical documents. Drawing on a 15-month ethnographic study in a pediatric hospital, the paper focuses on how two doctors compose medical records and use two distinct information systems. The analysis suggests that the doctors use medical documents to index the temporal, spatial, and participatory dimensions of their knowledge sharing. The indexical analysis suggest that doctors through their encoding of patient histories build indexical fields which support not only their communication practices, but also their ongoing coordination of work practices in complex distributed organizational settings.

Keywords: communication genres; indexical field; coordination; medical informatics.

Suggested track: The role of information technology in knowledge management and collaboration. Alternatively: Practice-based perspectives on knowledge and learning

Vignette: Two patients, two doctors, two information systems

Around four o'clock on a February afternoon in Kiltham Hospital an infant boy, Dylan, lies in a small transparent plastic crib. Two doctors and a medical student are simultaneously leaning over Dylan, three stethoscopes pressed to his chest listening, eyes turned to the ceiling. The medical student and two doctors, an intern and a senior resident, finish their exam and turn to the other infant in the room, Anna. Like Dylan, she has been admitted for bronchiolitis. Both infants spent several weeks in the hospital, first in the intensive care unit (ICU) and then transferred to their current beds in a regular pediatric department, 10 East. The intern, Marc, a newly minted doctor in his first year of medical residency, and the senior resident, Elisabeth, in the fourth year of her residency, turn to Anna's mother sitting weary-looking beside Anna's crib.

Elisabeth says, "We know this has been a long ordeal for all of you; but we think Anna will be ready to go home tomorrow or the day after."

Marc continues: "I will put the discharge papers together and the nurse will help you get ready to go home."

After they have assured Anna's mother that her baby will be fine, Marc, Elisabeth, and the medical student all head for the doctors' conference room. The medical student grabs a clean Progress Note sheet at the nursing station. Behind the glass walls, known as the "aquarium," Marc, the intern, and Elizabeth, the senior resident, each find a computer terminal. Marc logs on to the "House Officer Sign-Out" (HOSO), an on-line system. Elisabeth logs into the senior resident note system. They each start updating their notes on Dylan, Anna and the other patients they have seen since 7:00am. Marc will never read the senior resident's notes and vice-versa. Neither of these documents becomes part of the official medical record, nor do Marc's and Elisabeth's supervisors access those two information system to evaluate or compensate them for their work.

Introduction: Document content, communication and coordination

At first glance it seems counterintuitive, if not counterproductive, that the senior resident and the intern would not use the same information system to document their care. Elisabeth spends most of the day in close collaboration with Marc and three other interns. They gather for rounds in the morning, see new patients together, go to radiology rounds, have noon conferences, and share meal breaks. In the afternoon the senior resident works closely with one or more of the interns in the team's conference room writing notes or going to patient rooms for joint interviewing and patient examination. As in Dylan and Anna's cases, it is not uncommon to see a medical student, an intern, and a senior resident all bent over the same child, each with their stethoscopes on the young patient's chest.

These groups obviously share practices, they regard themselves as teams, yet they do not share the same document genres. Marc documents Dylan's and Anna's histories in the HOSO and Elisabeth documents it in the Senior Notes. One can observe comparable documenting practices among the nurses and other physicians involved in Dylan's and Anna's care. Each healthcare provider typically maintains multiple records of patient care.

Such observations irk the medical informatics community which has worked for the past three decades to develop universal patient-centered records – placing all relevant information about a patient's history at doctors' and nurses' fingertips. Today, despite extensive effort to develop universal and integrated record systems, one finds that individual settings, departments, and sub-disciplines within healthcare facilities have implemented their own information systems. Emergency departments will typically have one electronic record system, the Intensive Care Unit (ICU) another, outpatient care a third, and nurses (in some hospitals) yet another nurse-use-only online record system; rarely do these systems communicate.

The problem speaks to a larger theoretical question of how the content of medical documents, on the one hand, relate to doctors' communication and coordination, on the other hand. The medical informatics literature largely separates these two areas. One body of literature focuses on the encoding and storage of medical knowledge. Research in this field tends to emphasize ways in which one can improve the accumulation and sorting of data in the course of a patient's trajectory (Hasman, Safran, & Takeda, 2003; Tange, Hasman, Robbé, & Schouten, 1997). The other body of work approaches medical documents as communication and coordination devices (Ash, Stavri, Dykstra, & Fournier, 2003; Berg, 2003; Kapland, 2001; Schmidt & Simone, 1996; Timmermans & Berg, 2003). Each of these approaches to medical documents are valuable contributions to our understanding of why healthcare providers use documents. But, we are left wondering how these two perspectives interrelate. For instance, do some storage and encoding schemes go hand-in-hand with specific communication patterns and work practices? Answers to such questions would help us explain Marc's and Elisabeth's case. These two doctors clearly share practices and communication patterns, why don't they also share information systems? The question becomes, how does the encoding of patient care in the HOSO and Senior Note systems relate to Marc's and Elisabeth's daily work and knowledge sharing practices?

In this paper, I attempt to address this question by integrating recent IS literature on communicative genres with linguistic analysis of indexical structures encoding the relation between objects and their context.

Document genres and indexical fields

Recent IS literature has applied the genre concept to analyze organizational communication (e.g., memos, meetings, reports, training sessions, resumes, etc.) and its relation to work practices (W. J. Orlikowski & Yates, 1994; Wanda J. Orlikowski &

Yates, 1998; Päivärinta, 2001; Yates & Orlikowski, 2002). Orlikowski & Yates define genres by their socially recognized purpose, form, participants, time and place of communicative interaction (e.g., why, what, how, who/m, when, and where). A genre established within a particular community serves as an institutional template for social interaction. It offers an organizing structure that community members can use to facilitate their everyday social interactions. The HOSO and Senior Note represent organizational genres that choreograph interactions among doctors. Each document genre serves as an interaction template which Marc and Elisabeth draw on when communicating and coordinating their work practices with colleagues. However, such genre analysis leaves us with little concept of how the encoding of content in those document genres relate to the socially recognized types of communication and coordination practices. IS genre analysis largely relies on the classification of document types and interviews with their users to describe the purpose, form, participants, time and place expectations associated with individual genres. They do not specify if or how the particular encoding schemes structuring the content articulate with the socially recognized expectation about participants, times and places for interaction.

In order to introduce content and encoding schemes into our concept of genres as typified social action I turn to the notion of indexicality found in linguistic anthropology and in particular the work by William Hanks (Hanks, 1996, 2000a, 2000b). The term indexicality refers to the context-dependency of language utterances and include such varied phenomena as indicators of verbal etiquette (marking deference and demeanor), the referential use of pronouns (I, you, we he, she, etc.) demonstratives (this, that), and deictic adverbs (here, there, now, then) (Hanks, 2000a:124). In each of these cases, the interpretation of the indexical form depends strictly on the context in which it is uttered. For instance, a doctor in the emergency room asks a nurse at the nursing station where he can find Mr. Jones. The nurse responds: "I think you can find him down there." The forms "I, you, him, there" are indexical because they must be interpreted in relation to the situation of utterance. The doctor would have been left rather perplexed had he received the same answer from a disembodied voice over the emergency room's intercom. Thus, the identical utterance form, if spoken in another situation, could pick out different speaker, addressee, object of reference (him) and place (down there). A linguistic form is indexical when it stands for its object neither by resemblance to it, nor by sheer convention, but by continuity with it. In this way, the indexical and what it stands for are in a sense co-present in the context of communication. The indexical encodes the relations between objects and context (e.g.,

proximal, distal, speaker, addressee, simultaneous, antecedent) (Hanks, 2000a:124). It is this link to context that allows the doctor to understand the nurse without the latter having to give a detailed description of the context.

What makes this possible is the directive function of indexicals, whereby they direct an addressee to particular participants, places, times, or objects. For instance, the nurse's utterance "down there" indexes her current location in the nursing station as a ground from which she makes reference to the patient laying on a gurney down the hallway. One could argue that the nurse demarcates an interactive field that provides the context for her communication. This point becomes particularly important when we introduce documents as expressive mediums, part of the form through which practices are realized and communication accomplished. Written communication builds around indexical elements to the same degree as face-to-face communication. People may use a document to index their communication within one very limited context or to point out relations across multiple participants, times, and places. It is this ability to build indexical structures with references to participants, places and times (who, when, where) that allows people to anchor their communication in an interactive field. One could argue that the nurse defines the context for her communication with the doctor by demarcating, what I will call an "indexical field" of her utterance. An indexical field is a referential structure that encodes the relations between objects and context.

An indexical field demarcates two dimensions: 1) the relationship between the interacting parties and 2) the relation between the interacting parties and the object of reference (e.g., a patient, an object, a place, or a temporal rhythm) (Hanks 1996: 182). First, the degree of access between the interacting parties plays an important role in defining a document's indexical field and the text-to-context relations it delineates. People's access can vary in degrees of mutual perceptibility or prior knowledge. The interacting parties may have face-to-face interactions with one another or their relationship may be defined by great distance. They may share a common knowledge and full set of referents based on prior experience together, or they may never have met. All those factors affect the use of deictics and the indexical field demarcating particular communicative practices. Second, the relationship between the interacting parties and the object of referent can vary greatly. The relationship to the referent may be characterized by a common knowledge or a more or less asymmetric access. Both parties may interact with the referent, e.g. a patient, on a daily basis, or one doctor could be reporting on his or her relation to the patient to another physician who has no prior knowledge of that patient. These aspects of the situation help define the indexical

field of particular communicative genres and the structure of individual deictics and the way they map the interactive space.

In summary, given the contiguity that an indexical field builds between document content and context, those linguistic structures must be defined relative to local standards of co-presence and socially recognized types of communicative actions habitually enacted by organizational members to realize particular communicative or collaborative purposes. This implies that the indexical field encoded in a particular document is highly culture-specific and cannot be understood apart from the broader genre expectations associated with a community. In other words, the genre framework as formulated by Yates and Orlikowski can serve as a foundation for analysis of the indexical structures embedded in a document. The question becomes: how does a document's indexical field serve as a resource for the socially recognized types of communication and coordination practices habitually enacted by organizational members to realize particular communicative and collaborative purposes?

Methodology and case

I draw my empirical case from a 15-month, multi-sited ethnographic study in several pediatric health care settings, following patients from primary care clinics to emergency rooms, and in-patient units in a US metropolitan area. In this larger study I focused on the collaboration among doctors, nurses, and clerical workers, specifically the practices that go into documenting patients' care. The doctors and nurses were the actors of that study. They cared for patients that moved through the locales they inhabited. The method and analytic methods are described in more detail elsewhere (Østerlund, 2003, 2004).

The present paper narrowly focuses on two physicians, two documents, and two patients, as outlined in the introductory vignette. Marc and Elisabeth record their history in two different documents, the senior residents' Senior Note (Figure 1A and B) and the interns' HOSO (Figure 2). To protect the privacy of both healthcare providers and patients I have changed all names, dates, institutional identifiers (e.g., record numbers, phone numbers, department names, and institutional names), and sometimes the gender of my informants. The examples of records included in Figure 1 and 2 below are excerpts from field notes that did not contain any patient, clinician, or institutional identifiers. Those identifiers were never copied from the originals in the process of the fieldwork.

PEDIATRIC TEAM B
Wednesday, February 23, 2002

SENIOR RESIDENTS	INTERNS	MEDICAL STUDENTS	ATTENDINGS
Elisabeth Lave #124	Marc Bergger #343	Heinrich Schreiber #89	Pat Dreier, M.D. (ASSN) #482
Oscar Hanks #1193	Donna Ito #129	John Van Fennen #87	Tina Law, M.D. (Teaching) #104
Pei Lin #1268	Gabriel Callon #432	Chingning Lo #43	
Roger Moore #1596	Jennifer Latour #987	Jonghoon Kim #34	

Daily	7:30 am	Work Rounds	10E Conference Room	253-4931
	9:30 am	Radiology Rounds	10E Ward	253-8931
	10:00 am	Senior Rounds	10E Fax	253-9318
Tuesday	12:00 pm	Team Rounds	PTB Senior Call Room	E53-598
Friday	12:00 pm	Moe Conference		

10 E	Jones, Dylan	123	ASSN	Marc	1 mo RSV bronchiolitis, ASD, PPS
10 E	Carlile, Jim	667	PHA	Donna	12 do UTI, persistent fever, leukocytosis
10 E	McGill, Dede	564	HPHC	Donna	3 yo cervical adenitis
10 E	Arc, Noah	251	PHA	Marc	11 month fever, tachypnea,? acidosis
10 E	Finnen, Maria	759	ASSN	Marc	5 wo RSV+ bronchiolitis, ICU transfer
10 E	Bush, George	228	PHA	Oscar	5 mo RSV+ bronchiolitis, ICU transfer
10 E	Panama, Anna	126	PHA	Marc	2 month old vomiting/cough, hx of FTT
10 E	Hague, Anna	846	ASSN	Marc	5 wo RSV + bronchiolitis, ICU transfer.
10W	Tyre, Marcy	352	HVMA	Oscar	4 wk mild bronchiolitis, murmur, social
10 W	Willey, Vienna	998	IMMUNO	Oscar	8 yo ataxia telangletasia, pulmonary AVM
11 E	Yate, Deborah	674	ARMS	Donna	9 do conjunctivitis, r/o sepsis
11 E	Kim, Jooh	375	ASSN ?	Marc	6 mo bronchiolitis
11 E	Johnson, Lotte	242	ASSN	Donna	7 do r/o sepsis
11 E	Deed, Graham	442	ASSN	Jen	3 yo RML pneumonia, first RADexacerbation
11 E	Mogadi, Chenge	889	PHA	Jen	9 y/o HSV vaginitis
12 S	McDonald, Mike	764	RHEUM	Oscar	15 yo SLE, worsening BUN, left foot pain
12 S	Cetina, Virginia	372	ASSN	Donna	10 yo viral meningitis
12 S	Potter, Forrest	115	ASSN	Marc	11 wk old with Salmonella bacteremia
12 S	Georgia, Natalia	151	RHEUM	Donna	15 yo MCTD, LLL pneumonia
12 S	Penn, Sean	785	HEME	Jen	14 yo Hgb SS, VOC (necklabd pain)
12 S	Li, Jean	874	HEME	Marc	7 yo Hgb SS, abdominal VOC, s/p ICU
12 S	Fisher, Hugh	659	ASSN	Marc	9 mo Trauma X, shaken-baby syndrome
PB	Annaby, Sheena	097	HEME	Jen	15 yo Hgb SS, abdominal VOC, NO study

Fig. 1.A. Excerpt from Senior Notes Showing First Page

Jones, Dylan   123   ASSN   2/16   Marc   1 mo RSV bronchiolitis, ASD, PPS

1 mos old presented with cough x3 days, question of decreased PO and vomiting. Got r/o
sepsis for fever in ER. Recently admitted 2/7 for rule-out sepsis. In ER, taking pedialyte PO, 37.6, 172,
48-88, 100%. Not wheezing, no G/F/R. CXR with RML atelectasis. WBC=11.4 (28P,55L,4Bd),
Hct=31.5, Plt=455. Bicarb 18. UA neg. Lytes wnl. Urine and blood cultures pending. Mom and child
live in a shelter. PMH Born FT 7lbs 5 oz. On 01-15, reportedly 8 lbs 12 oz. On admission 7 lb 14 oz.
?FTT

RESP: increased interstitial markings prob due to pulm edema, now resolved; ?patch infiltrates c/w
Chlamydia; vapo nebs prn. Initially thought the tachypnea was due to CHF. Gave Lasix. On 2/18, had
RR to 110. Gave Alb and Vaponebs with out improvement. ABG showed 7.45/24.9/127/17. CXR
showed hyperinf SSA. Transferred to ICU. Tachypnea improved. Respond to Vaponebs but not
albuterol. On RA with good sats. RSV came back Positive!

CV: CXR with heart size upper limits nl, 4Ext BPs nl, R sided axis on EKG. Liver edge down, ECHO
with large ASD, and left PPS and RV hypertension. On floor, tried to diurese with lasix. Now stopped.
Cardio following – now things resp issues not cardiac. F/u in clinic for ASD.

FEN: newborn screen wnl; came in only 3.6 kg. Lost 0.8 kg after diuresis. Looks cachetic with
decreased muscle bulk. ?poor nutrition,. W/U for FTT. They placed an NJ tube in ICU due to resp
distress and FTT issues. Started Prosobee at 5 cc/hr/ (hx of rash with Enfamil). Nutrition consult. Also ?
GERD due to hx of back arching – started Zantac. Increased to full feeds on floor. NJT pulled and now
po feeding, gaining weight.

ID: cultures pending; started on erm for ?atypical – changed to Azithro in ICU x 5 days (ends 2/24); rsv
positive.

SOCIAL: 443 8700 x987 Peter NP. Mother lives in a shelter. 2 step-children SW involved.

Hague, Anna   846   ASSN   2/15   Marc   5 wo RSV + bronchiolitis, ICU transfer.

5 week old FT/LGA previously healthy with RSV + bronchiolitis transported from Common Hospital
1/29, in ICU intubated 1/29 to 2/12 (on Hifi for portion), transferred to floor 2/15.

Pulm: Wean O2 prn. Pulm consulted regarding weaning of diuretics. Attempted to d/c but developed
fluid overload requiring Lasix 1 mg/kg so restarted. Now on room air.

CV: H/o murmur. Echo showed PPS. Currently stable.

ID: RSV+. Trach cultures grew S. aureus (sensitive to oxac & clinda), S pneumoniae, and Morazella.
On Zosyn and Vanco in ICU initially, changed to Unasyn and Ampicllin, d/c 2/11. Now afebrile off
antibiotics, Eye d.c PSA and serratia. Gentamicin & Ilotycin eye ointment.

GI: On NJ continuous feeds when transferred from ICU. Now on po feeds.

FEN: In ICU, high HC03 (40's) due to lasix. Chlorothiazide & spironolactone PNJT q 12 hrs,follow
lytes qD. Bicarbs down to 30s. May need to go up on diuretics b/c UOP not great.Heme: Hct 29.

Neuro: On methadone and ativan taper. Low NAS scores so d/c'd 2/17. Increased sweaty and irritable
on 2/19, NAS score 11 – given small dose of Ativan.

Dispo: Discharge pending when off 02, full feeds, and sedatives weaned.

Fig. 1.B Excerpt from Senior Notes Showing Two Entries

KILTHAM HOSPITAL
HOUSE OFFICER SIGNOUT
Wednesday, February 23, 2002 06:56:12

10 E	Dylan, Jones	123	PTB	2/16	3.6Kg	43 Days	Dreier, Patrick	Begger, Marc

PROBLEMS: BEGAN   ENDED
    RSV BRONCHIOLITIS   2/16/02
    LARGE ASD   2/17/02
PROCEDURES: DATE
    ECHOCARDIOGRAPHY   2/17/02
MEDICATIONS:
    RACEMIC EPINEPHRINE 0.25CC NEBS PRN
    AZIHIROMYCIN
    ENFAMIL FORMULA-RASH
ALLERGIES: NKDA
PLAN/ON CALL SCUT:
    6 wk old boy s/p ICU for RSV bronchiolitis, now w/ remaining FTT, ASD and GERD
    symptoms

    Resp: On RA. On azithromycin for 5d course for Chlamydial pneumonia
    CVR: ASD stable, felt to be playing role in FTT picture
    GI: On Zantac, ad lib po feeds. Nutrition consult. Follow for sx reflux
    Cards: ASD stable, cards following.
    Soc: SW consult. Parents in shelter, in need of support. Appropriately concerned.
PLAN/ON CALL SCUT:
    NONE
DISCHARGE CRITERIA:
    NONE

10 E	Hauge, Anna	846	PTB	1/28	5.6Kg	2 Mos	Dreier, Patrick	Begger, Marc

PROBLEMS: BEGAN   ENDED
    RESP DISTRESS   2/23/02
    RSV BRONCHIOLITIS   2/23/02
PROCEDURES: DATE
    NONE
MEDICATIONS:
    ALBUTEROL PRN
    TYLENOR PRN
ALLERGIES:
    NKDA
PLAN/ON CALL SCUT:
    NONE
DISCHARGE CRITERIA:
    NONE

Fig. 2. Excerpt from HOSO Showing Two Entries

Analysis: The HOSO and Senior Note and their indexical fields

In this section I will compare and contrast the HOSO and Senior Note along the two dimensions of an indexical field: 1) the relation between the interacting parties, and 2) the relation among the interacting parties and their object of reference.

Interacting parties: Participants, spatial field, and temporal field

In this and the following section I look for differences and commonalities in the text-to-context relations across these two document genres as they build an indexical field with references to author, addressees, signatures and other participants (Who); references to places, place-names, locative descriptions, spatial deictics and markers (Where) and dates, temporal deictics; and other temporal markers (When).

Participatory field. Different genres correspond to distinct conceptions of the addressers and addressees. The addresser or addressee may be an individual, a social group, contemporaries, successors, an unconcretized Other, or a combination (Hanks 2000: 151). In the Senior Notes and HOSO we do not find any explicit address apart from the name of each document genre. Senior notes addresses senior residents and House Officer Sign Out (HOSO) addresses house officers, the latter being physicians in Kiltham's residence programs, including interns (first year residence), second and third year residence. In Kiltham interns predominantly use the HOSO. Equally important and in contrast to the majority of medical documents, neither the Senior Notes nor the HOSO identify the speaker. We find no signatures or specification of who tailored these documents. In the HOSO we do find Marc's name in the header to Dylan and Anna's entries as the "Intern." This does not mean that Marc is the sole author of the record; simply that he is in charge of these two patients during his rotation in the Pediatric Team B.

Senior Notes and the HOSO are communal documents where a distinct social group constitutes each genre's collective addresser and addressee. Most likely three or four senior residents have been involved in the writing of Dylan and Anna's histories. Likewise, Marc did not write all parts of the HOSO. For instance, if we return to the day where Marc and Elisabeth examine Dylan and Anna we find that in the late afternoon, just before going home, Marc signs-out his patients to one of his fellow interns, Donna, who is staying in the hospital overnight. They use the HOSO to structure their conversation. Overnight, Donna uses the HOSO to structure her activities. And if

anything happens to Dylan or Anna, she will add the event to the HOSO. Elisabeth shares her notes in the Senior Notes on-line system with other seniors only.

On her on-call nights, Elisabeth covers for not only patients at Pediatric Team B but also two other departments. When the senior residents in those other units sign-out, Elisabeth prints out a new version of the Senior Note containing all patients currently in all these three units. The Senior Note printout can easily contain 30-40 patients. Elisabeth builds on other senior residents' entries rather than writing Dylan and Anna's histories anew. Senior residents in the ICU most likely wrote parts of these two histories; Elisabeth and other senior residents later edit those earlier entries to make them reflect the current status of a patient. When I first started my field research these practices puzzled me a great deal. One late afternoon I asked a senior resident why he just spent 45 minutes editing entries originally initiated by other senior residents. He responded:

> "I'm anal. I want the notes to follow a specific setup. No empty spaces. Look at this one [pointing to a particular voluminous patient entry on the screen]. It's so long that you think that it's a complicated case, but it's just a 4 month old with bronchiolitis."

In short, Senior Notes and the HOSO stand out as communal documents where authors and addressees overlap and individual contributors take on the role of contemporaries and successors interchangeably. People spend hours making factual changes but also minute modifications to the records' lengths and style – thereby adhering to communal genre requirements about how best to signal, for instance, the potential workload involved in each case.

Where the HOSO and Senior Notes contain no explicit speaker and address they do contain references to the current community of participants or contemporaries. At the beginning of the Senior Note we find a table listing the names of senior residents, interns, medical students, and attendings. The four senior residents named on the left hand side are all contemporaries to the current record and this group of patients. Elisabeth's name goes first signaling that she is currently in charge of the patients admitted to Pediatric Team B. The other three senior residents all cover for her on different nights of the week. In the HOSO we would get a comparable sense of the author/addressee contemporaries if we printed out the entire HOSO for Pediatric Team B. If we read the right hand side of the headers for each patient we would find the

names of the four interns on Marc's team. Each of them would be assigned as responsible for a portion of those patients.

Apart from the names of senior residents and interns involved in their respective communal system of "addressivity" we find a host of names referring to other *participants*. These include names of medical students, attending physicians, patients, acronyms for various medical services (e.g. Cardiac, Heme, etc.) and other professional groups (e.g., social workers). In contrast to the implicit composition of speakers and addressees among the interns and senior residents, we find an explicit structure referring to other collaborators, their interdependencies.

Starting with the Senior Notes, the top of the document includes four column table listing, not only the senior residents producing and using the senior notes, but also the interns, medical students and attending physicians with whom they currently collaborate on Pediatric Team B. The table demarcates a group of contemporaries to the present document. The sequence of the four columns hints at the power relations among the four groups. The senior residents oversee the work of the interns, who manage and mentor the medical students. The attending physicians watch over the entire team by taking on a supervisory role. One attending physician is responsible for the patients not attended to by their private physician or other sub-specialties, in this case Patrick; the other, Law, supervised the teaching of the medical students. Given that the attending physicians hold the ultimate responsibility for patient care one may expect to find them in the first column. However, the senior residents' "ownership" of the record most likely explains this inconsistency in the sequencing. In summary, the table recaps the interacting parties. It goes beyond the relations among speakers and addressees by including the interacting parties involved in the care for a group of patients.

Spatial field. Elisabeth's Senior Notes contain an explicit structure demarcating the spatial dimensions for her collaboration with the other members of Pediatric Team B. Following the table we find on the right hand side a list of three important places and their phone number: 1) Pediatric Team B uses the 10 East Conference Room as their base for writing records, hanging out and working rounds. 2) The conference room is located on the 10 East Ward next to the nursing station where all calls to the ward gets directed. 3) The PTB Senior Call Room is where senior residents hope to catch a few hours of sleep when they are on-call at night.

We also find a number of less explicit spatial markers embedded in the first section of the Senior Note. First, notice the pager numbers follow the physicians' and medical students' names in the first table. One can consider these pager numbers a spatial reference to mobile individuals or what Mizuko Ito calls "networked localities" (Ito, 2001). Building on the idea of networked locales one could also read the patients' record numbers in the third column as spatial references. Physicians often find that a patient's record number is a more reliable locator than their name, the latter often being misspelled or the same name held by several patients. Second, we find a blurring of the distinction between place and participants in the fourth column in the senior note's table of content. This column summarizes the service in charge of each patient. PHA is the hospitals outpatient clinic and a physical place. In contrast, IMMUNO stands for immunology. This sub-specialty does not have its own clinic per se where patients go. The immunology team moves from ward to ward to consult on specific patients. Much like the pager numbers these names refer to specific social spaces and participants, which may and may not be associated with a physical place.

Temporal field. As in the case of the spatial references the Senior Note starts out by demarcating an explicit temporal structure for their work in Pediatric Team B. With a glance at the top of the senior note we learn that the daily work for the senior residents structure around working rounds at 7:30, radiology rounds at 9:20 and Senior rounds at 10:00. All the members of Pediatric Team B outlined in the table participate in work rounds and radiology rounds. During those rounds the team will go over each patient case, typically initiated by the intern or a medical student, recounting the patient's history and progress. After Radiology rounds the group splits up. The senior residents will go to their Senior Rounds while the rest of the team starts working on individual patient cases. In the late afternoon Elisabeth will sign-out to the senior resident staying over night. Marc will sign out to the intern staying in the hospital over night. If they are on call themselves, the other senior residents or interns will sign out their cases to them.

These two communal document genres become an integrated part of the hospital's staggered structure of coverage where staff groups in sequential shifts will overlap with one another for several hours or just 15 minutes. The notes help smooth transitions by providing incoming doctors with immediate sources of information and reference from the moment the outgoing staff members leave the hospital. This explains why house-officers make an extra effort to write particularly detailed notes in the HOSO and Senior Notes on the last day of their rotation. Interns strive to discharge all their patients but if

that is not possible they write to capture as much detail as possible to make it easier for the next intern to take over their patients.

At this point, one may ask why the HOSO does not contain a comprehensive mapping of the participants, temporal and spatial structures making up its indexical field compared to the Senior Note. The key question here is the degree to which interns have access to interns and senior residents have access to senior residents. We find many granulations of mutual access and the question becomes: to what degree do the interns share mutual perceptibility and prior knowledge about their space of interaction compared to the senior residents? The answer is embedded in their spatial and temporal fields. For the five weeks Marc and his three other interns are on rotation in Pediatric Team B they share collaborators, spatial structure and temporal rhythm. Every morning they listen as they each present old and new patients. At night they cover for each other. In contrast, Elisabeth works within the interaction field of Pediatric Team B during the day, but at night she covers for other teams with different participants, spatial and temporal structures. When on-call at night, Elisabeth prints out a fresh senior note demarcating her new and larger space of interaction. Marc and his fellow interns do not need to be reminded of the spatial and temporal dimension of their interaction field every time they look at their HOSO. It is the same for several weeks and in case they should forget they do keep a log of it on a large whiteboard in the 10 East conference room where they typically type up their notes. Elisabeth does not share such a symmetric space with her fellow senior residents.

The Referent: Dylan and Anna's histories

The second dimension of the HOSO and Senior Note's indexical field involves the relation among collaborators and the patient. The HOSO and Senior Note operate with two levels of relations between the referent and collaborators. The two genres can be read as a compilation of individual patient histories, each specifying the relationship between caregivers and a patient. The HOSO and Senior Notes also present all patients as one object of referent, which is a compilation of all patients currently admitted to Pediatric Team B. This means that Marc and Elisabeth not only read their notes when addressing individual patient issues; they use the records to give them an overview of their current workload, i.e. all the patients admitted to the team. In other words, the object of referent can be seen as either an individual patient or a patient cohort. Within the limited space of this paper will focus on the individual patient

histories and the indexical field those narratives outline in the interactions between physicians and patients.

Participatory field. The HOSO and Senior Note outline another level of participants in the body of Dylan and Anna's histories. These participants do not have enduring relationships with the members of Pediactic Team A. Their interactions are defined by the requirements of individual patient's cases. For instance, Dylan's Senior Note history mentions four groups following his case: "Cardio following," "Nutrition consult," "Peter NP," "SW involved" (i.e., social work). In contrast to the earlier section of the senior note, we find no proper nouns designating particular participants, with the exception of Peter, a nurse practitioner in the shelter where Dylan's mother lives. The same is the case in Anna's history. We learn that the pulmonary team has been consulted (i.e., "Pulm consulted"). The lack of proper names referring to the physicians involved from the different services may be explained partly by the loose relationship between the consulting services and the members of Pediatric Team B. Furthermore, the members of each subspecialty rotate through their teams. The Pulmonary team coming up to 10 East to check on Anna could easily be composed of different individuals from one day to the other. In contrast, the nurse practitioner, Peter has promised to follow up on Dylan's case when he returns to the shelter, an arrangement that has been set up by the nurses on Dylan's unit, 10 East.

We recall that the Senior Note provides a comprehensive mapping of current collaborators and their interdependencies. Interns do not use the HOSO to outline the medical students, senior residents, and the teaching attending physician with whom they are currently working on Pediatric Team B. Yet, when it comes to Dylan and Anna's actual patient history we find little variation in the specification of participants and their relation to the patient – despite the vast difference in length and detail between the senior note and HOSO. For instance, we notice that regardless of the glaring lack of detail in Anna's HOSO history all it misses is a reference to the pulmonary consult involved when she was weaned off diuretics. The senior note does not mention any other participants in the body of the history. Interns would most likely not regard this as an oversight but simply as a fact that is no longer relevant to Anna's current care. In other words, it seems equally important to senior residents and interns alike to index the relationship between caregivers, including themselves, and the individual patients.

Spatial field. In Dylan and Anna's individual histories we find a number of place names – many of which are repeated several times. In the Senior Notes Dylan's history, for instance, mentions the ICU three times, and the floor and shelter two times. Reading those place names within their individual sections we find that they are organized to connote Dylan's trajectory through a number of locales but seen through the lenses of relevant organ systems. The first section summarizing his past and present medical history refers to the ER and the shelter where he lives with his mother. In the next section (i.e., RESP.) we learn that he was transferred to the ICU. The CV section (cardiac vascular) mentions "the floor," Cardio, and F/u in Clinic (follow-up in Clinic). "The floor" refers to his current admission to a general pediatric unit, 10 East. The FEN section refers to ICU, Nutrition, and the floor. The ID section mentions the ICU, and the final section refers to the social worker team and the Shelter.

Anna's history offers a comparable sequencing of place-names: Common Hospital => ICU => Floor; Pulmonary consult; ICU; ICU; ICU => Discharge pending. We notice that this by no means provides an accurate depiction of her care trajectory; yet, it offers a general sense of her move from Common Hospital transferred to Kiltham's ICU, transferred to the floor and now pending her discharge from the hospital. The repetition of ICU highlights that most of the significant event took place here. Similarly, the header explicitly states that she is an ICU transfer. To the senior residents this is important information that will prompt their attention. Otherwise, infants with bronchiolitis do not receive much attention during the winter months. The number of admission with this diagnosis is so high that their care is regarded as routine and something worth little consideration from the senior residents.

The HOSO presents noticeable few place-names compared to the senior note. Anna's case stands out by containing no place names apart from the reference to 10 East in the header. Dylan's history does reference his stay in the ICU and the current involvement of nutrition, cardiac team, social workers, and the shelter where his mother lives. However, we do not get a sense of the trajectory spelled out in the senior notes from ER over ICU to floor later to be followed in clinic. Furthermore, there is no repetition of place-names within the history.

Temporal field. The different spatial fields demarcated in the two document genres relate closely to their temporal orientation. The trajectories sketched in the Senior Note are a temporal organization of places and participants. The Senior Note characterizes the relationship between physicians and patients as temporally organized around a

sequence of locations involving different participants. In contrast, the HOSO offers a here-and-now framing of the relation among participants, places, and patient.

We find three main types of temporal references in the HOSO and Senior Notes: dates, temporal deictics (e.g., now, recently, currently), and references to the frequency of specific activities (e.g., how often to administrate medication). The header of both HOSO and Senior Notes summarize Dylan and Anna's admission date and their age. The admission date plays an important role in patient care as it pertains to reimbursement and the physicians' general sentiment of how long time a patient should be in the hospital given the severity of his or her ailment. Frequently, a senior resident or attending doctor will state some variation of the following comment during morning rounds from: "This kid has been here for more than a week. We need to get him rolling." Translated this means that the intern should start working hard on getting the patient ready for discharge.

Dylan and Anna's age can be found just before their chief complaint (e.g. their diagnosis). The location is not random. Physicians regard a four-week-old baby with bronchiolitis very differently than a one-year-old with bronchiolitis. Infants, and in particular prematurely born children, are vulnerable to respiratory diseases and can quickly get gravely sick and require intensive care as in Dylan and Anna's cases. A toddler admitted with bronchiolitis typically stays only a few days. The exact age does not seem to matter a great deal as one often finds variation in the age reported. We notice that the senior note reports Dylan and Anna's ages as one month and five weeks respectively whereas the HOSO gives Dylan's age as 43 days, and Anna's as two months.

We find another set of temporal references in the body of the histories. Marc's HOSO includes dates under the sections, problems and procedures. This builds a temporal field where the date of a procedure, the beginning and end of a problem is the paramount issue at hand. What matters to the interns are when a problem started, or rather was diagnosed, and whether the problem has been resolved. What happens in between does not seem to be essential in the context of the HOSO. The Senior Notes does not demarcate quite as narrow a temporal field. Dylan and Anna's histories contain the dates of several important events. For instance, we learn that Anna was transported from Common Hospital on January 29, intubated in the ICU between January 29 and February 12, and transferred to the floor (i.e., 10 East) on February 15. Likewise, the senior history provides the dates for a number of different events such as

the discontinuation of some of her medication on February 11. In comparison, the HOSO only provides the names of medication currently administrated.

If we introduce temporal deictics into our analysis of the Senior Notes we find that each paragraph builds around a past-present structure. Consider the GI section where I have highlighted the temporal deictics, "when" and "now."

GI: On NJ continuous feeds *when* transferred from ICU. *Now* on po feeds.

The excerpt follows a past-present structure – explaining that Anna received nutrition through a tube at the time she was transferred from the ICU to 10 East. Now the tube has been removed and she gets her food by mouth. Most of the other paragraphs follow the same structure. The first part of the paragraph summarizes a number of past events and/or test results; a date or temporal deictic typically specifying the timing of the event. The section closes with a description of the current state of affairs, for instance: "now on room air;" or "currently stable."

Dylan's and Anna's histories in the HOSO contain only one such example. In line 12 Dylan's entire hospital trajectory is summarized in one sentence. The remaining sections simply recap the current state of affairs. We learn nothing about past medication or test results. The only other temporal reference we find in Dylan's HOSO history is the frequency by which his medication should be given. Even this is not spelled out very carefully. We learn that he should be given Racemic Epinephrine "when needed" (i.e. PRN). We do not learn how often he should get Azihromycin – only that it should be given for five days. The Senior Notes tend to be more specific, as for instance, in line 16 of Dylan's history: "Started Prosobee at 5cc/hr."

Given that the interns are responsible for patients' medication one might expect that they would record the dose and frequency more carefully in their notes. However, the interns use a separate order sheet and medication chart for this specific purpose, which also serves as a means of communication with the nurses. Giving too much detail on medication in the HOSO would lead to needless repetition. The senior residents do not use the order sheets, so to them it becomes valuable to specify the temporal structure of medication administration.

Comparable to Dylan's case, Anna's HOSO history provides a snapshot of the current state of affairs: Her respiratory distress and bronchiolitis are considered cured on today's date and she receives only medication if needed (i.e., PRN). Anna's HOSO

history is a signal to Marc and his fellow interns that Anna is ready to go home and that she requires little if any medical attention. Dylan, in contrast, calls for significantly more involvement and collaboration with several different subspecialties.

Conclusion: Encoding, communicating and coordinating Care

The HOSO and Senior Note contain many common features and references to participants and their relations to patients. Nevertheless, our analysis reveals important variations in the two genres indexical fields. The HOSO builds a here-and-now indexical field for a small group of interns working closely together on a day-to-day basis. The HOSO does not concern itself with a description of past places and events. It emphasizes the current tasks at hand. Much like an itinerary the HOSO outlines the day's activities facing Marc and his colleagues. The interns have relatively symmetric access to the knowledge about Anna and Dylan and their past medical history. In contrast, the senior residents' "interactive field" change when they go from their day work in e.g. Pediatric Team B to covering for other senior residents' teams at night. The senior residents do not share the same degree of symmetric access to the patients. Elisabeth knows a great deal about Dylan and Anna, which she shares with Marc and the other interns. But, at night she covers for other senior residents and must care for patients she knows little or nothing about. While the interns have a high degree of access to each other and a symmetrical access to their object of reference, the senior residents have neither. They do not work shoulder to shoulder with the other senior residents during the day, and they do not see the same patients. With their Senior Notes, the senior residents build a fine grained indexical field around which they can communicate and coordinate. If we look at the first dimension, the relationship between the interacting parties, the Senior Notes contain an explicit structure for the senior residents' current collaborators and the temporal and spatial arrangements under which they work. In terms of the second dimension, the relations between the interacting parties and the patient, the histories take into account the lack of relevant knowledge about patients like Dylan and Anna. To account for this lack of symmetrical knowledge, the history builds an indexical field that specifies the times and places of the patient's past and present care, tests results, medication, etc. To one of Elisabeth's fellow senior residents on-call at night Anna's HOSO history does not make much sense. The HOSO stands out as opaque – maybe even misleading. Apart from Elisabeth, the senior residents do not know what Marc and three other interns know – that Anna, despite the horrible hospital trajectory she has been going through the past few weeks, is set to go home. To them Anna's history in the HOSO reads as a patient

who has recovered from her bronchiolitis and requires little if any attention. On Marc's part, why should he spend valuable time dissecting the Senior Note to figure out what the current status of Anna's case is when he can simply glance at the HOSO and go to work?

Returning to the questions posed in the introduction, we can now argue that the way Marc and Elisabeth encode their care support differently configured fields of relations to collaborators and patients. Each document genre builds an indexical field unique to the specific user group. First, these two collective on-line documents summarize two different configurations of collaborators and contemporaries working with an ever-changing group of patients. Second, Elisabeth and Marc use the Senior Notes and the HOSO respectively, to demarcate the temporal and spatial structure of their communication practices. When do they have to meet with what people? The use of each document takes place at certain times and places and Elisabeth and Marc share their notes with a different set of collaborators.

The senior residents and interns build into their information systems indexical structures supporting their unique work practices. The production and use of the HOSO and Senior Notes help the two groups structure where they need to go within the hospital, and in relation to what collaborators and patients. Those documenting practices structure their use of both time and place. At night Elisabeth typically attends to other patients than Marc in different parts of the hospital, and is subject to different temporal rhythms. Furthermore, the two groups do not focus on the same aspects of care. The interns carry out the scut work and the HOSO gives the times and places where tests should be taken, procedures preformed and patients seen. The senior residents use their documents to give them an overview of a patient's care trajectory. In short, the Senior Notes and HOSO serve two groups requiring different mappings of relationships and itineraries for work practices. The HOSO and Senior Notes do not solely map out the stable positions among the different interacting parties and their objects of reference. As itineraries they take time and movement into consideration.

The importance of a document genres' indexical field may explain why the medical informatics community has not succeeded in implementing global patient-centered medical record systems. Such large-scale systems do not allow their users to tailor an indexical field for their interaction. The encoding schemes embedded in those systems are not flexible enough to allow physicians to build indexical fields designed to support their unfolding communication and coordination practices. Physicians' resistance to

medical informatics, then, cannot be explained by a general technophobia among doctors, as much research assumes, but simply that physicians (and nurses) resist interventions that disrupt the details of their daily itineraries and take away their ability to fine-tune their communication and coordination with specific constituencies of colleagues. To put it differently, the indexical elements embedded in the formal structure of language serve as resources for our evolving practices. Doctor builds into their encoding of patient histories indexical fields that support their communication and coordination practices in complex and fluid organizational settings. Through their everyday practices Marc and Elisabeth build indexical fields that permit them to situate their practices across time and many different organizational units involving an ever-changing group of participants. Those linguistic structures embedded in their document genres are windows into the unfolding dynamics of their communication and everyday work practices. Such a focus call for a shift of attention in IS design where we take into account the use of indexical structures. It allows us to re-conceive the dream of the universal patient-centered record, and help the field of medical informatics build systems that better serve doctors' and nurses' daily care for patients and the organizational realities they face.

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