Refinement and validation of observational and data analysis techniques to measure communication patterns in clinical settings

Report to the New South Wales Department of Health

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Executive Summary

This report documents work undertaken to further develop, refine and test the Communication Observation Method (COM) aimed at measuring communication patterns in clinical settings. This project is part of a two-year research programme being undertaken by the Centre for Health Informatics at the University of NSW to examine communication behaviours within the clinical setting [1].

The observational method is based on the work of Coiera and Tombs [2] and follows on from a communications study entitled '*Communication behaviours and information exchange patterns in clinical settings'* [3]. Both studies provided evidence of the value of this methodology in measuring communication patterns within clinical organisations and identifying communication practices that may be amenable to improvement.

Aims
The overall aim of this project was to produce detailed documentation on the validated methods. In addition, a data entry and analysis package was to be developed in order to facilitate the use of the methodology by other researchers. To achieve these aims the following steps required completion:

- Collection of a new observational data set to allow comparison with previous data.
- Refinement and development of communication event and attribute definitions to provide a more comprehensive coding system.
- Conduction of reliability studies on the observational techniques and coding processes.
- Design of a data entry system and analysis process.
- Production of a detailed manual describing the COM to allow dissemination and use of the method.

Process
The report describes the collection of a new data set and subsequent creation of the current protocols for our observational methods and data analysis techniques. This involved initial improvement of the data collection through equipment modification and maximising inter-observer reliability through pilot data collection and training sessions. These data were then used to enable the development of a more comprehensive coding system, which are documented in detail in our accompanying *Communication Observation Method Manual* [4].

Following software review, an Access database and Excel spreadsheet template were developed to improve the data entry and analysis stages. Reliability studies were applied to the coding process; this helped to remove ambiguities from our developed protocol, and reflected a high degree of inter-rater agreement.

The results of the 2000 and 2001 studies were reviewed together. Overall, trends shown in the two data sets were similar. High rates of interruption, time spent in communication and use of synchronous channels by clinicians highlighted by the 2000 study are reflected in the 2001 data set.

Conclusion

Outcome measures such as the reliability results and comparison of the 2000 and 2001 data sets give confidence to the robustness of our methodology, with the revised method allowing:

- Further and more fine grained analysis of the data
- The application of the revised methodology to new areas in the healthcare sector
- The dissemination of our methods and research findings.

SECTION 1

Introduction

This report presents work undertaken to develop, refine and test the Communication Observation Method (COM) aimed at measuring communication patterns in clinical settings.

In 1996, Coiera and Tombs [2] undertook an observational study of communication behaviours in a hospital setting in the UK. The study presented a new approach to investigating the communication patterns of clinicians. This initial study identified that physician teams in hospital were subject to high levels of communication interruption. Clinicians also appeared to bear a much higher communication load than appeared necessary, given that accessing information sources rather than asking questions of people could accomplish many tasks.

In 2000, this method was modified and applied to two emergency departments in NSW [3, 5]. That study presented data that suggested communication processes continued to be of concern, due to the high communication loads carried by individual clinicians. For example clinical subjects spent 80% of their time in communication, with 30% of all communication events classified as interruptions. In addition it was found that medical staff spent around 15% of communication time involved in two or more overlapping conversations, highlighting high levels of multitasking amongst clinicians (see *Glossary* in *Appendix 1*). Consequently an urgent need was highlighted by this study to measure communication loads within the NSW healthcare system and to develop appropriate systems to improve communication. Both studies provided evidence of the value of the COM in measuring communication patterns within clinical organisations and identifying potential mechanisms to improve communication.

The next stage in this research is to focus on the refinement and testing of the COM to ensure robustness and transferability to other researchers interested in carrying out similar work. This required completion of the following steps:

1. Collection of a new observational data set to allow comparison with previous data.
2. Refinement and development of communication event and attribute definitions to provide a more comprehensive coding system.
3. Conduction of reliability studies on the observational techniques and coding processes.
4. Design of a data entry system and analysis process.
5. Production of a detailed manual on the COM.

Throughout this document reference will be made to our *Communication Observation Method Manual* [4].

SECTION 2

Methodological Review

Process

The aims of the methodological review were to refine, develop and document the Communication Observation Method (COM) (Figure 1).

The process involved the collection of a new set of data from which definitions and coding categories were further developed. Reliability studies were applied to the data gathering, mark-up and coding techniques. In addition, data entry and analysis tools were developed.

The collection of a new data set from a similar setting (an emergency department) was necessary to compare and validate the results from the 2000 study. In this way the reliability over time, overall robustness and transferability of the methodology was tested. In this case, transferability occurs when the documented description of the methodology allows others to evaluate the applicability of the method to other contexts [6].

The outcome 'deliverables' of this process were a reliable and transferable methodology for observational studies of communication behaviours in a clinical setting, data entry and analysis tools and a manual containing detailed documentation of the methodology.

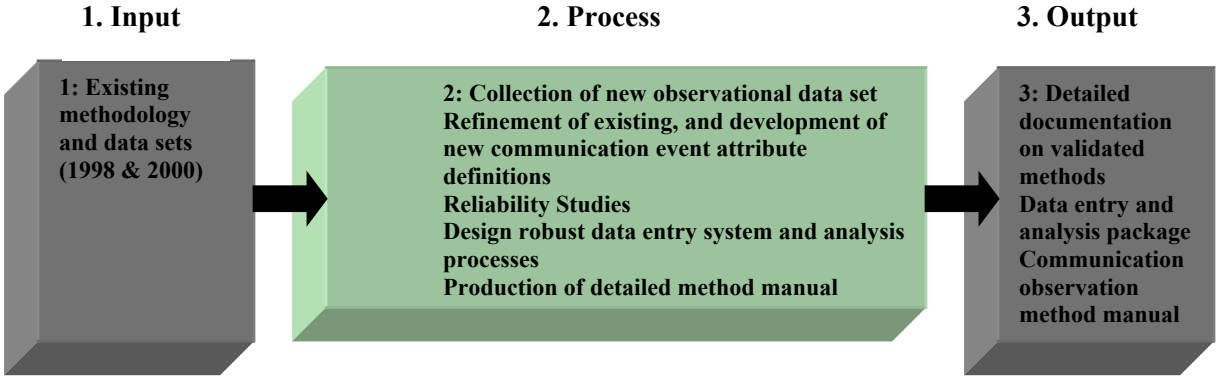


Figure 1. Process of methods review

The following sections will give an overview of the COM, a brief description of the 2001 data collection, discuss the refinement of the mark-up and coding stages, describe the development of the data entry and analysis tools, discuss the reliability studies and finally compare the 2000 and 2001 data sets.

Overview of the Communication Observation Method (COM)

The COM aims to measure the communication patterns within clinical organizations. This is done through the observation of the routine work of individual clinicians. As the clinician goes about their work, for a given time period, all communication interactions are recorded by an observer and audio taped. This captures information about who the clinician is communicating with, the channel of communication, the purpose of the communication interaction, the type of communication interaction and who is initiating the communication event. Following the data collection phase, the data are transcribed, marked up, coded, entered into a database and then further analysed (Figure 2).

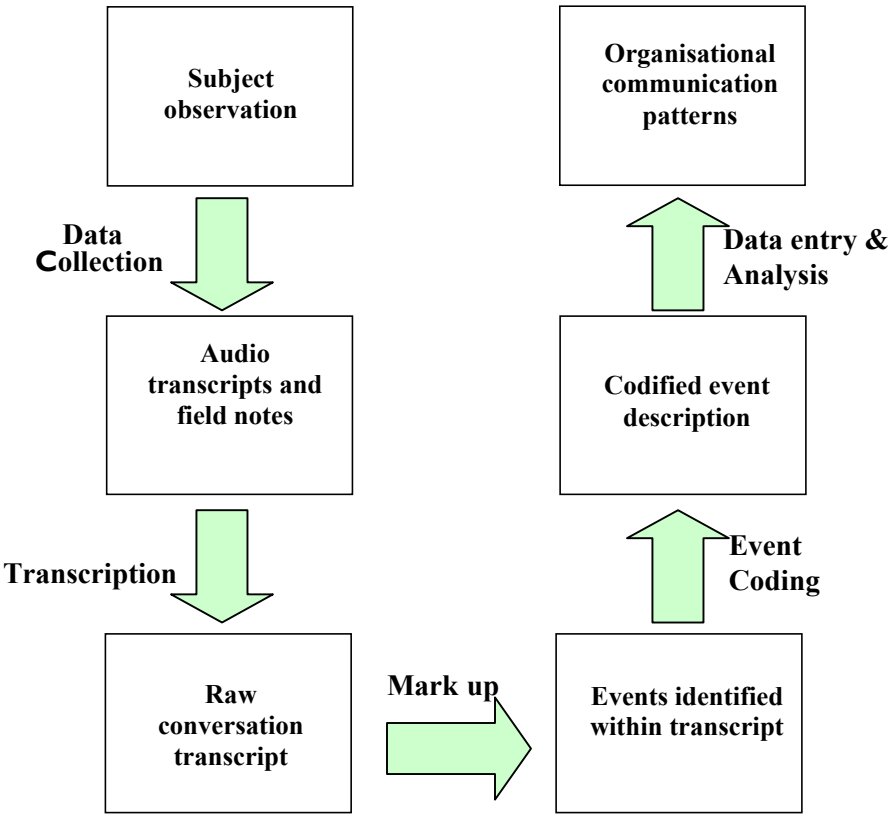


Figure 2. Communication Observational Method

Data collection 2001

A new data set was collected between July and September 2001. This enabled the researchers involved to replicate the 2000 communication study.

The study was undertaken in the emergency department of a large metropolitan teaching hospital in Sydney, NSW. Initially, a pilot study was carried out to test equipment and measure inter-observer reliability. Four nurses and four medical officers participated in the project. Participants in the study were recruited on a voluntary basis following a series of information sessions. Subjects were shadowed for 2 to 4 hrs hours by the researcher during the morning, afternoon or night shift of varying days of the week. A total of 20 hours of activity was observed. Ethics approval was sought and obtained from both the hospital and the University of New South Wales.

Data collection was improved through the modification of the recording equipment used, replacing the tape recorder with the more discreet mini disc player. The device was small, light and easily portable and assisted in minimising clinicians' reactivity to the observer's presence.

Transcription, coding and analysis

Recorded conversations were transcribed verbatim into a word processing package. The researchers then coded the events according to a prescribed list of rules. The data were entered into an Access database and further analysed using Excel and SPSS.

A total of 19 hours and 52 minutes of contact time with the subjects was observed and analysed. Within that time, 831 distinct communication events were identified, 302 by medical staff and 529 by nursing staff. A communication event occurred when a study subject was observed to communicate a message to others. Thus, face to face discussions, telephone conversations, messages on paper, or entry of text into a form or the medical records all were counted as distinct communication events.

This study provided the basis for reviewing and refining each of the steps in the observation, data classification and analysis procedures. Comparison of the data from the 2001 and 2000 studies are discussed at the end of this section.

Mark-up and Coding

The goal of the mark-up and coding stage is to identify and label communication events captured in the transcripts and field notes. The input into this phase is the raw data set that consists of the field notes written by the observer and the transcripts of the conversations of each subject. The output of this phase is a refined data set that consists of a set of coded communication events and attributes.

The basic element of communication process description is the *communication event.* Each transcript is marked-up into a sequence of individual communication events, each representing a unique interaction between the observed subject and their colleagues.

The set of descriptors or *attributes* that we use to describe a communication event are:

- *Event identification number* eg 123
- *Start time* – hh:mm:ss
- *End time* – hh:mm:ss
- *Role* of each agent involved in the event eg triage nurse
- *Channel of communication* eg telephone
- *Type of interaction* eg give request
- *Purpose of event* eg plan patient treatment
- *Initiation or interruption*– whether or not the event has been initiated by the observed subject

To successfully mark-up and code the raw data into events with their attributes it is necessary to have a set of definitions and rules that can be applied consistently to produce valid and reliable results. As part of the review, definitions and rules were discussed, agreed upon and signed off by the communications research team.

The original list of coding rules documented in the 2000 study consisted of ten briefly described rules plus estimates. Our *Communication Observation Method Manual* [4] richly describes twenty-six coding rules as well as giving a full description of each stage of the COM.

Initially, rules and definitions from the 2000 study were reviewed and, where appropriate, refined. For example, Table 1 shows the evolution of the coding rules for the reading and writing of patient medical records.

2000	2001
If the subject was reading or writing in the notes the 2nd party was taken as the notes	When reading or writing in the notes the second party is coded as ‘staff unknown’

Table 1. Extract of Coding Rules

On review, it was also apparent that more explicit definitions were needed to identify the beginning and end of events. Table 2 summarises the current definitions of beginning and end of events.

Identifying the beginning and end of communication events
While the notion of an event seems discrete, it may be difficult in practice to determine that a new event has started, or that a current event is over. A new event occurs either when: • A communication act starts in an otherwise event free period. This is the easy case, where nothing is happening, and then one of the observed parties starts communication. • During a period of communication, there is a change in the purpose, channel or participants in the conversation. An event terminates when: • The end of a communication event can be explicitly indicated in the transcript, for example - RN2: I'll just pop him in there; RN1: Ok, thank you. • One event directly follows on from another event. The beginning of the new event is also the end of the previous one, for example: *Event 1* 10 53 01 RN2: Do you want a hand moving her down? *End event 1* 10 53 05 RN1: Thanks that would be great. *Event 2* 10 53 05 RN3: Is Lignocaine out of stock? • The subject is no longer primarily committed to the current event's purpose. • In cases when event termination is unclear, it is useful to discuss and gain consensus with another involved researcher.

Table 2. Extract from manual: Beginning and end of communication events

Purpose of communication events

Communication events are carried out to achieve some goal or purpose. The communication event can be associated with the completion of a task, like ordering a test. In our analyses, we capture purpose in our data by focussing on the task with which the communication event is associated.

Assigning purpose to communication events allows us to identify whether some tasks are more responsible for problems in communications than others, or if there are general problems with the overall communication systems in an organization. For example, if interruption levels are high across all tasks within the purpose category, then we infer that there probably is a general process causing the interruptions. If a specific task carries

a disproportionate load of interruptions, then we would focus attention on understanding what was going on in the organization when that task was occurring.

There is no 'correct' set of purpose labels that can be used across all organizations, as the nature of work varies considerably both between organizations, and indeed between different roles within an organization. Consequently, prior to commencing analysis there is a need to develop a list of appropriate labels for the analysis of a given organization.

The category labelled 'purpose' in the 2000 study contained a mixture of event purposes (eg get result, order test) as well as broader types of interactions that occurred within the events (eg give information, receive information).

With the purpose labels already identified from the 2000 study, a preliminary analysis of two observations was undertaken to see if the transcripts identified new tasks that were not in the initial list. In addition, some already established tasks were modified to effectively capture common tasks within the purpose category. We therefore iteratively developed a working task list to be used for the analysis of the whole corpus.

To separate the broader types of communication interactions from the purpose, a new category *interaction type* was developed (Figure 3). Separating a domain-independent communication attribute (interaction type) from a domain specific-attribute (purpose) improves the generalisability of the method to other domains.

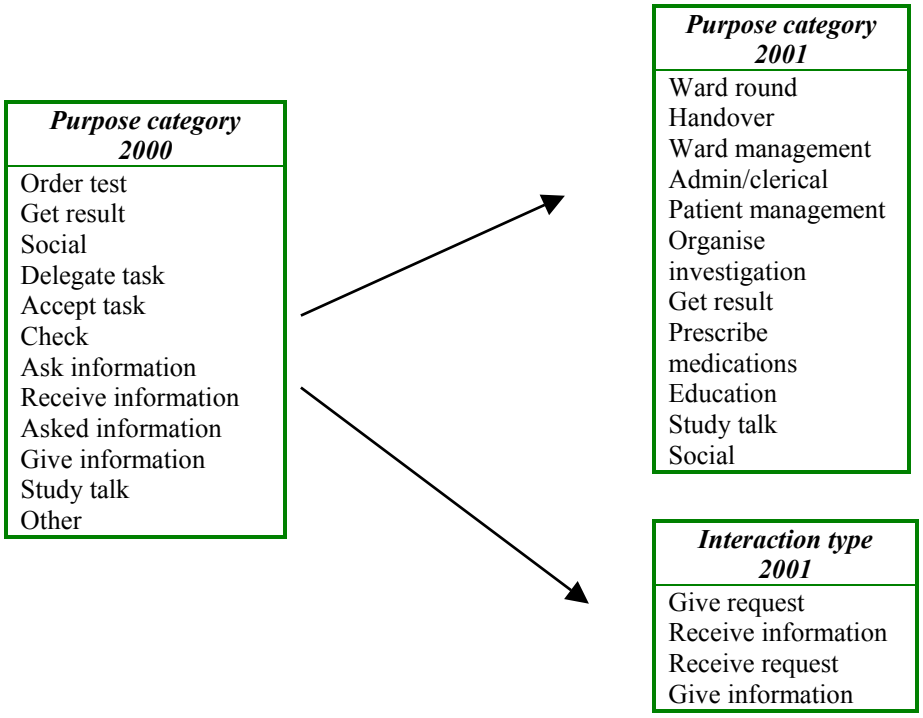


Figure 3. Modification of purpose category

Roles of those communicating
The role of an individual is often captured in their organisational title, for example Nurse Unit Manager. These distinctions are important at the analysis stage. In the 2000 study the analysis was at a coarse level and the extent to which roles were compared was only across professions (i.e. medical or nursing). By identifying and labelling observed clinicians specific roles, for example, registrar, registered nurse co-ordinator, floor registered nurse, resident or intern, finer grained analysis of specific roles in relation to other variables is now possible.

Channel of communication
Each event has its '*channel of communication*' coded. In most cases this will be a straightforward process of identification from a pre-defined list of common channels. Table 3 covers the majority of channels that may be present in the clinical setting.

Face to face conversation	Computer request form
Telephone	Paper medical record
Video-conference	Electronic medical record
Pager	Notice board
Voicemail	White board
E-mail	Computer
Post-it note	Paper source
Letter	Staff communication book
Fax	Admissions book
Paper request form	Text book

Table 3. Channels of communication

Some channel sources were not as straightforward as expected. For example, there are many ways to page someone. One could call up a telephone paging service, dial up a pager service using a local system, or send a page using email or text messaging service. In all these cases it was agreed that the *final delivery channel* is the pager. It is possible to develop codes that capture the complexity of both the various ways a message is created and then delivered, potentially involving multiple communication channels and communication services. However, for the purposes of our present analysis, events are coded according to the final delivery channel only, recognising that in some situations a more detailed analysis would be needed. Thus a letter of discharge that is typed on a computer will be classified by its ultimate delivery mechanism and therefore coded as 'letter'.

In the 2000 study in some cases the second party and channel were being coded with the same label. For example,

2000	Coding
If the subject was reading or writing in the patient notes	Channel = notes Second party = notes

was changed to:

2001	Coding
If the subject was reading or writing in the patient notes	Channel = patient medical record Second party = staff unknown

The refinement of coding categories allows for a more fine-grained analysis to be undertaken and enables more specific questions such as 'how does clinical role affect communication channel choice' to be addressed.

Data entry and analysis tools

As part of the overall methodological review the data entry and analysis software were examined and revised.

Review of existing software

The data entry and analysis software used in the 2000 study consisted of an Excel spreadsheet with separate worksheets containing templates for the various data entry categories. Data for each category (event times, second party, channel, purpose) were entered into separate worksheets and a fifth worksheet contained a summary of results.

Limitations of this system included: an unfriendly data entry format that made the data entry process time consuming and prone to error. Once entered, the data were not easily audited or manipulated making it difficult to conduct statistical analysis.

A search for other appropriate existing software applications was undertaken. However, none were found that would adequately meet the needs of the project. For example the software package NVIVO was examined. Whilst it contained certain characteristics such as the ability to code directly from the transcript text, it was unable to adequately code, in order, large amounts of data with specified attributes.

As a result of not finding an already existing appropriate data entry and analysis tool it became apparent that we would need to design and build our own software. We opted for designing and building a database using Microsoft Access. One of the reasons Access was chosen was that it has flexible and user-friendly data entry forms that can be readily modified (Figure 4). The advantage of using an already established application is that it provides an accessible and widely used software package. This was an important consideration as one of the aims of the project was to provide accessible software that

could be widely disseminated. There is potential in the future for more sophisticated and customised software to be developed but this was beyond the scope of the current project.

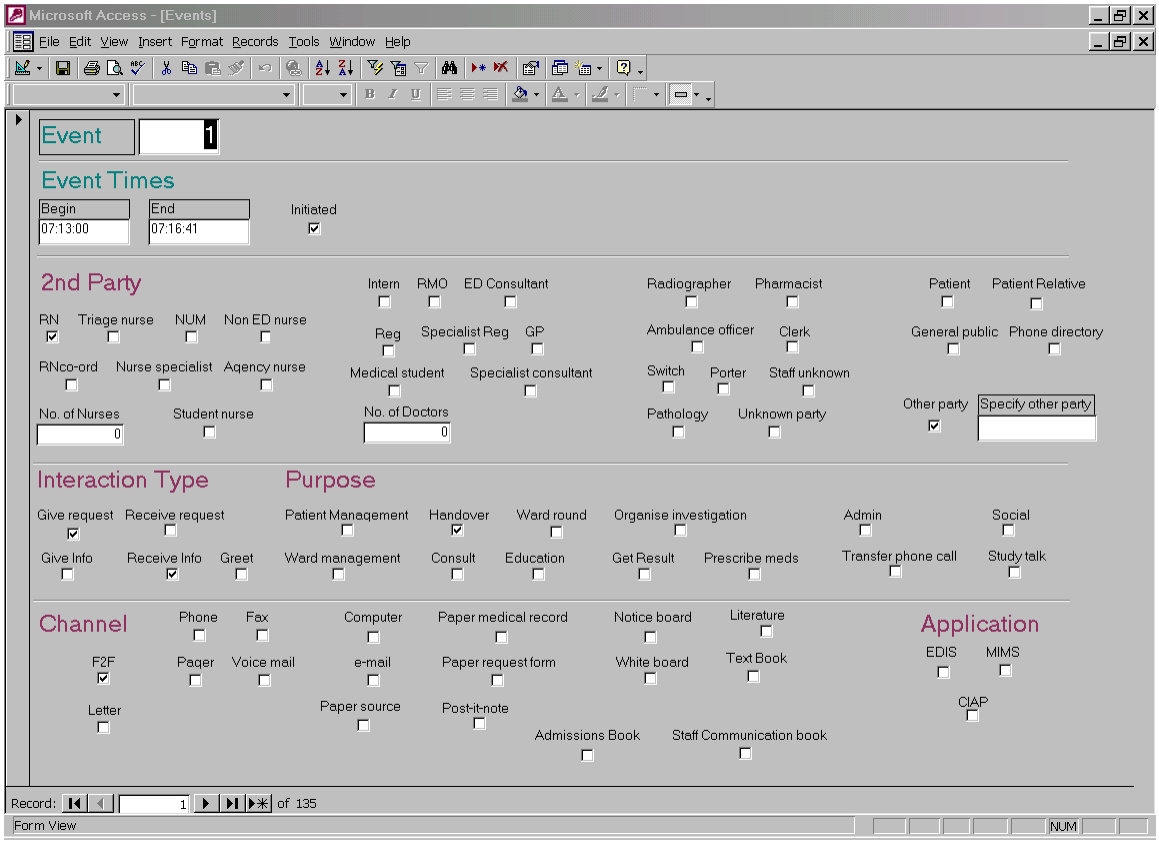


Figure 4. Data entry screen in Access Database

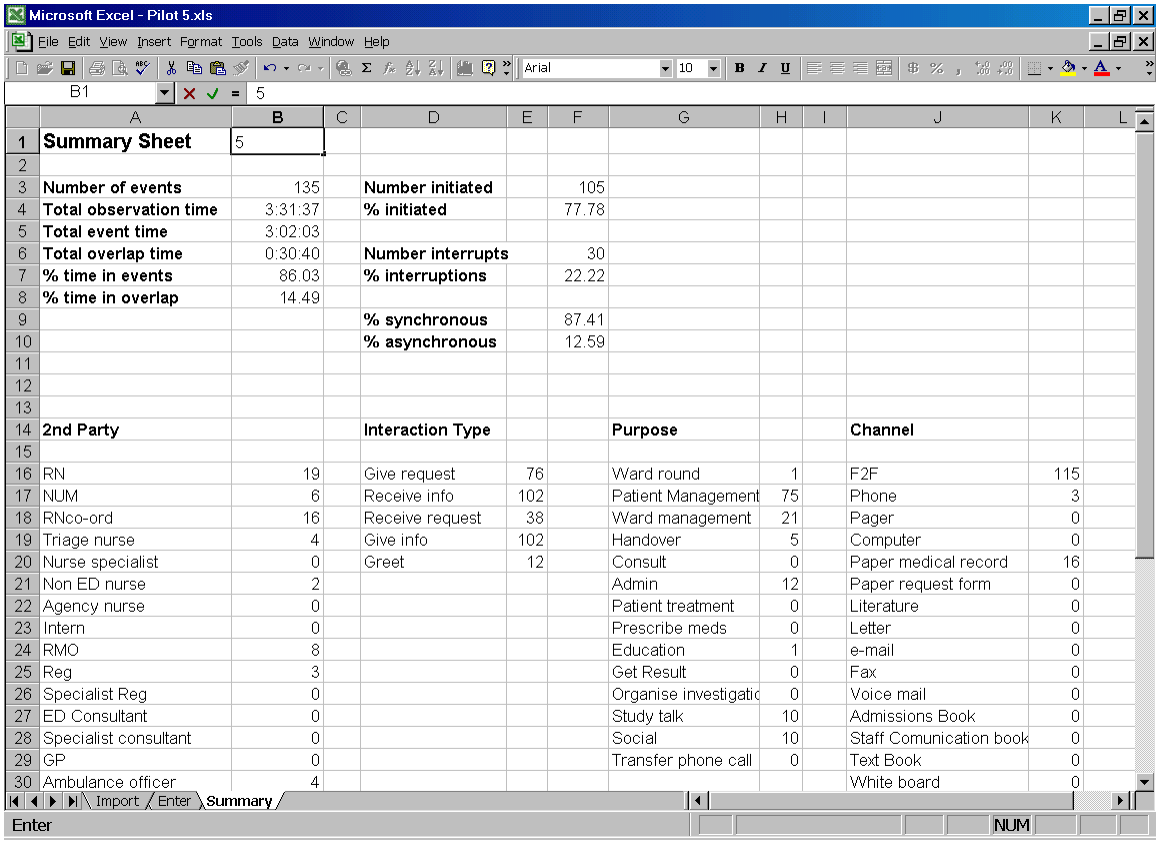
Each data entry screen contains descriptive attributes that can be assigned to a single event. The beginning and end times together with the event number are entered and then a simple tick box system of data entry enables the input of the remaining coded attributes.

The attribute labels can be modified to suit the needs of individual researchers through the design function in Access.

Data analysis

Whilst the Access database application is particularly good for data-entry purposes it has limited analysis capabilities. It is therefore necessary to export the data into specific analysis packages.

For summary purposes we have created an Excel spreadsheet template (Figure 5). For other statistical analysis the Access data can be imported into SPSS or similar applications.



Microsoft Excel - Pilot 5.xls

File Edit View Insert Format Tools Data Window Help

B1 = 5

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Summary Sheet**	5										
2												
3	**Number of events**	135		**Number initiated**		105						
4	**Total observation time**	3:31:37		**% initiated**		77.78						
5	**Total event time**	3:02:03										
6	**Total overlap time**	0:30:40		**Number interrupts**		30						
7	**% time in events**	86.03		**% interruptions**		22.22						
8	**% time in overlap**	14.49										
9				**% synchronous**		87.41						
10				**% asynchronous**		12.59						
11												
12												
13												
14	**2nd Party**			**Interaction Type**			**Purpose**			**Channel**		
15												
16	RN	19		Give request	76		Ward round	1		F2F	115	
17	NUM	6		Receive info	102		Patient Management	75		Phone	3	
18	RNco-ord	16		Receive request	38		Ward management	21		Pager	0	
19	Triage nurse	4		Give info	102		Handover	5		Computer	0	
20	Nurse specialist	0		Greet	12		Consult	0		Paper medical record	16	
21	Non ED nurse	2					Admin	12		Paper request form	0	
22	Agency nurse	0					Patient treatment	0		Literature	0	
23	Intern	0					Prescribe meds	0		Letter	0	
24	RMO	8					Education	1		e-mail	0	
25	Reg	3					Get Result	0		Fax	0	
26	Specialist Reg	0					Organise investigatic	0		Voice mail	0	
27	ED Consultant	0					Study talk	10		Admissions Book	0	
28	Specialist consultant	0					Social	10		Staff Comunication book	0	
29	GP	0					Transfer phone call	0		Text Book	0	
30	Ambulance officer	4								White board	0	

Import / Enter / Summary

Enter NUM

Figure 5. Summary sheet in Excel

Reliability

An aim of this study was to test the reliability of the COM. Reliability was tested at two stages: data collection and coding of transcripts.

Data Collection

Determining and maximising inter-observer reliability: To ensure that different observers carried out the same procedures during observations, training sessions for the observers were conducted prior to the data collection phase. This consisted of three one-hour trial data collections in the emergency department. The field notes were reviewed in order to confirm that the appropriate and relevant data were being collected and the equipment used correctly. Additionally, one of the trial observations involved two observers simultaneously collecting data, with the field notes compared on completion. This process enabled the measurement of observer reliability [7] and confirmed that the observers were consistent in following the same observational guidelines.

Coding of transcripts

Determining and maximising inter-rater reliability: As there were two coders involved in the coding process, it was necessary to determine inter-rater reliability. Using trial data each observer marked up 50 communication events and then compared which events were marked up with the same start and end time. Using the first 20 of the 50 events we then compared the coding of attributes within events (i.e. second party, channel, interaction type, purpose, interrupt/initiated). Where there were discrepancies, we discussed the reasons for differences and took the opportunity to improve definitions and rules. The categories for coding were all revisited to ensure any ambiguities were removed. Inter-rater reliability was calculated using percentage agreements between the two coders [7].

The results from the inter-rater reliability studies are presented below in Table 4:

	% Agreement
Event classification (n =50)	92

Event attributes (n = 20)	% Agreement
Channel	100
Second party	100
Purpose	100
Interrupt/initiate	100
Interaction type	95

Table 4. Inter-rater reliability results

There was a high degree of concordance between the researchers in identifying events (92%) and in assigning event attributes (95-100%). Whilst there are no universal recommendations for specific standards to evaluate reliability, a review of the literature

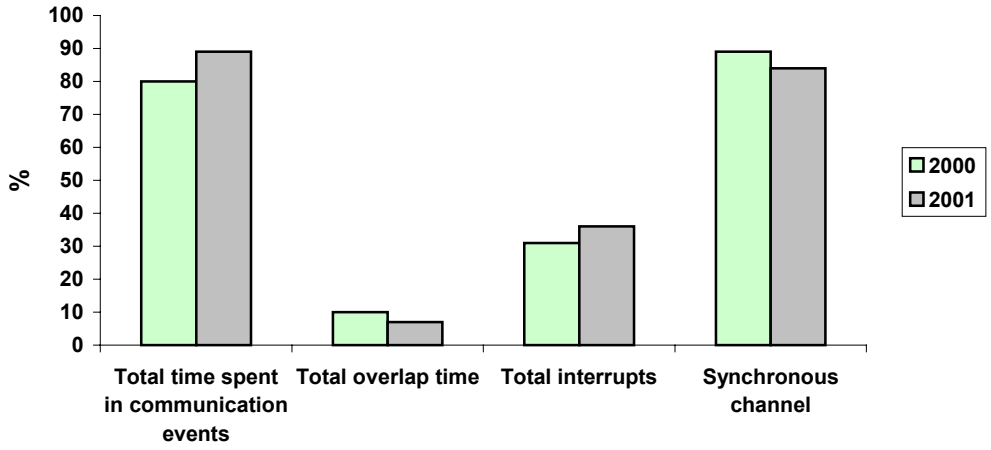
suggests that a high percentage agreement (usually above 80 percent) reflects a good standard of reliability [8]. In addition, transferability of the COM has been enhanced through thick description of our observational methods in our manual [9].

Comparison of 2000 and 2001 Data

On completion of the review of methods, the results from the 2000 and 2001 studies were compared. A table showing this comparison can be found in *Appendix 2*. Overall, trends shown in the two data sets were similar. High rates of interruption, time spent in communication and use of synchronous channels by clinicians highlighted by the 2000 study are reflected in the 2001 data set (Figure 6).

Some variations can be explained by changes in method. For example suspended recording time in the 2000 study was not subtracted from overall recording time, therefore affecting the overall percentage of time spent in communication by the clinician. Another example of change to the method included the development of a new category, 'interaction type' and further refinement of the 'purpose' category. As a result of these changes, direct comparison between the 2000 and 2001'purpose' attributes was not meaningful.

Figure 6. 2000 & 2001 Data Comparison



It is encouraging that, although our method has been modified, the data sets, in general, have remained comparable. This suggests that the communication measures are robust, relatively unchanged over a period of time.

SECTION 3

Future Directions

This review process has produced a refined and validated observational method that measures communication patterns within clinical settings.

The revised method will allow us to:

- **Further analyse the gathered data**
  The revision of the method, in particular the mark up, coding and analysis stages, will enable us to conduct a deeper analysis of the existing data. For example it is now possible to correlate both channel choice and clinical role thus enabling us to look more closely at patterns of communication. Further, a deeper analysis of the data will support the identification and development of interventions that could potentially improve hospital communication processes.

- **Apply our revised methodology to new areas in the healthcare sector**
  New data gathering studies can be applied to other health sectors and new issues can be addressed. For example, investigation into the communication patterns that occur between the primary and tertiary care sectors.

- **Disseminate our methodology and research findings**
  The detailed *Communication Observation Method Manual* [4] will allow dissemination of our method throughout the state. The manual and software will be made available on the Web. Dissemination will also occur through the publication of specific reports in major referred journals, and presenting at conferences and departmental briefings.

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Appendix 1

Glossary of terms

A ***communication event*** is the basic element of the communication process description. A communication event consists of:

- a set of **messages**
- between a **sending agent**
- and one or more **receiving agents**
- for a **purpose**
- via a **communication channel**

Attributes of a communication event:

- ***Role*** of each agent involved in the event eg triage nurse
- ***Channel of communication*** (either synchronous or asynchronous) eg telephone
    - *Synchronous communication*: When two parties exchange messages across a communication channel at the same time, e.g. telephone.
    - *Asynchronous communication*: When communication exchange does not require both parties to be active in the conversation at the same time e.g. email
- ***Type of interaction*** describes broad categories of information exchange eg give request, give information
- ***Purpose of event*** eg patient handover

Other definitions related to communication events:

- ***Interruption***: A communication event where the subject did not initiate the conversation, and in which a synchronous communication channel was used.
- ***Multitasking***: A period when two or more concurrent communication events occurred.

Appendix 2

Results of 2000 and 2001 data sets

		2000		2001	
Sample:		6 Doctors		4 Doctors	
		6 Nurses		4 Nurses	
Observation Time:		35:13:00		19:52	
Total Communication Events:		1286		831	
Communication loads					
		2000	%	2001	%
Total time spent in communication events:		28:12:00	80.08%	17:40:07	88.94%
	Doctors		78.70%		91.86%
	Nurses		81.70%		86.60%
Total overlap time:		3:48:00	10.00%	1:28:03	6.83%
	Doctors		14.60%		6.83%
	Nurses		6.70%		7.82%
Total number interrupts:		393	30.60%	295	35.50%
Interrupts per hour:		11.2		14.8	
	Doctors	208	33.30%	107	35.43%
	Interrupts per hour	11.1		12.4	
	Nurses	185	28.00%	191	36.11%
	Interrupts per hour	11.2		17.4	
Channels:	Synchronous	1141	88.72%	700	84.24%
	Face-to-face	1055	82.00%	634	76.29%
Face-to-face	Doctors		76.60%		71.80%
	Nurses		87.10%		78.80%
Informal info sources: (phone+f2f+pager)		1141	88.72%	700	84.24%
	Doctors	537	85.92%	242	80.13%
	Nurses	604	91.38%	458	86.58%
Formal info sources:		163	12.70%	125	15.04%
	Doctors		14.20%	51	16.89%
	Nurses		10.40%	74	13.99%

		2000		2001	
Purpose:					
Order investigation			1.50%	10	1.20%
Get result			2.17%	14	1.68%
Interaction Type*:			% total events		% total events
Give info	Doctors	139	22.4	240	79.47
	Nurses	237	35.85	381	72.02
Receive info					
	Doctors	41	6.56	196	64.90
	Nurses	107	16.19	385	72.78
Give request					
	Doctors	159	25.44	181	59.93
	Nurses	204	30.86	324	61.25
Receive request					
	Doctors	130	20.8	127	42.05
	Nurses	121	18.31	211	39.89

* Each communication event could have multiple classifications.