# *Building Dialogue Corpora for Nursing Activity Analysis*

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## *Abstract*

In this paper, we introduce our corpora under development, which are recorded in a real environment. These corpora comprise dialogues collected in hospitals with the aim of developing a nursing service support system through a comprehensive understanding of nursing activities. We use the corpora to analyze how nurses perform their nursing duties and how they express the performance of their tasks. To understand nursing activities, we investigated nursing services and the relevant medical charts by using the corpora. In the paper, we show features and promising applications of the corpora.

## *1 Introduction*

Recently, medical malpractice has become a serious social problem(Kohn, Corrlgan and Donaldson, 1999). The Japanese Ministry of Health, Labor and Welfare has reported that nursing teams are most frequently involved in medical accidents in hospitals(Healthcare Safety Promotion Network Project, 2001). The Japanese Nursing Association also states in its guidelines that nurses are encouraged to make nursing reports and to analyze the cause of accidents, which is helpful to prevent their recurrence. However, it is very difficult for nurses to make a detailed record during their working hours.

We have been developing a nursing service support system based on nurses using wearable computers. The system is designed to record nursing activities and to give warnings when necessary. We will analyze the collected data to analyze the sequence of their tasks and to quantify their workload for the purpose of preventing medical accidents. To create such a support system, we need to acquire in-depth knowledge of nursing activities closely. As a first step, we are collecting nurses' dialogues in hospitals, building dialogue corpora, and analyzing the terms in the corpora used to carry out nursing work.

We have already collected data on nursing tasks in a specific hospital by using special devices to record voice data. As a next step, we transcribed conversation recorded by the devices. Since then, we have been building dialogue corpora in actual work sites. The corpora include various conversations with doctors, nurses, patients, and so on. We generally exchange information, update information, and share knowledge by conversation. We believe that some medical accidents might occur due to miscommunication. That is, nurses typically exchange patients' information during conversation in clinical meetings, while at the same time taking care of patients and other nursing activities.

On the other hand, huge corpora have been

built from various voice data and text data(Kyoto Text Corpus, ; K. Maekawa, 2003). Furthermore, many types of tags have been developed for effective using of huge corpora(H. Koiso et al., 2000; M Araki, et al., 1999). However, since the traditional dialogue corpora were mostly recorded on a trial basis, their topics were usually fixed in the corpora, and word usage and meaning of terms were only defined clearly in one of them. In the real field, word usage, topics, and the meaning of terms could not easily be fixed. Furthermore, the corpora have different features from those of the real field data. For example, actual conversations include many types of miscommunications, misunderstanding, a resolution of the misunderstanding, and so on. Consequently, corpora built from such actual conversations can be reflected by miscommunication or misunderstanding. Therefore, it is difficult to analyze the real field data by rules built from the traditional corpora.

In this paper, we focus on the corpora of the voice data recorded by the special devices, and to analyze the voice data to understand nursing activities. For developing a nursing service support system, we checked the corpora and other information such as medical charts, describe features of the corpora and their availability.

## 2 Corpora Collection

### 2.1 E-nightingale Project

In medical sites, higher levels of knowledge and wider experience are needed for using sophisticated medical devices and, in turn, for accommodating a diverse aging society. It is said that insufficient knowledge and experience both influence the performance of medical professionals and causes malpractice. On the other hand, by promoting the use of wearable sensors and environment sensors, it is possible to collect a huge amount of data on actions in the real world. Accordingly, some attempts have been made to utilize knowledge obtained by analyzing daily actions in the course of developing sensors for education and accident prevention.

If important information could be obtained by analyzing nursing activities automatically recorded by wearable computers, it would be possible to automatically and more correctly make nursing reports. Furthermore, if the nursing reports could be objectively analyzed, the cost of investigating nursing practices could be kept down and more effective survey research on nursing activities could be conducted. Furthermore, it would be possible to protect nurses from malpractice claims by distinguishing between nursing activities during normal situations and during emergencies.

To exploit this potential, we launched the "E-nightingale project" to share and construct knowledge obtained by analyzing the daily actions and experiences of nurses. This project aims to develop the following technologies:

1. ***To observe and understand daily nursing activities.***
2. ***To build a knowledge base through understanding these activities.***
3. ***To utilized the necessary knowledge when it's actually needed.***

### 2.2 Obtained Voice Data of Nurses' Activities

We have recorded various action data by wearable computers designed to analyze nursing activities in hospitals(N. Kuwahara, et al., 2003; N. Kuwahara, et al., 2004). Wearable computers can collect various types of data such as location, passometer results, and posture inclination. In our previous research, we used passometer, location, and cue words to grasp nursing activities. We could understand the nursing activities of a particular nurse but could not understand the relations and information flow among staff in a hospital.

Dialogues between nurses are very important in the performance of nursing activities and maintaining staff relations. Dialogues between nurses

and other people, such as patients, doctors, and patients' family, are also important for obtaining a variety of conversation behaviors more efficiently. We believe that we can understand not only nursing activities but also conversation mechanisms by developing and analysing corpora of nurses' dialogues.

Therefore, we have conducted experiments to collect voice data of nurses talking during their activities. Our reasons and aims for focusing on voice data are as follows:

- To more effectively make lengthy recordings than sensors with consumer model IC recorders
- To obtain many data, such as medical charts, in addition to voice data
- To collect and unify terms of nursing activities for developing a support system
- To collect natural dialogue data for clarification of conversation mechanisms and information flows
- To examine the appropriate sensors for understanding voice data
- To comprehend problems in actual field recording

In the following section, features of voice data collected in experiments are explained in detail.

#### *2.2.1 Voice Data during Clinical Meetings*

During nurses' shift changes, they hold clinical meetings to discuss patient information, in the process modifying and confirming this information. Furthermore, if problems occur in their work area, they hold brief conferences to solve the problems by discussing their experiences.

We have recorded nurses dialogues in clinical meetings and brief conferences by using special devices. At the same time, we have obtained such information as who participated in the clinical meetings and brief conferences.

In the hospital where we carried out our experiments, clinical meetings are held in the morning and the evening time for about 20 minutes to one hour. The brief conferences are held at lunch time for about 30 minutes. Collected data were 80 trials for a one-week experiment. The entire recording time was about 20 hours. We made transcriptions of the collected data. Some sample data are shown in table 1[1]

The transcription was made by four staff members, including an experienced specialist in making transcriptions, a nurse who had worked in hospitals for three years or longer, a pharmacist, and a part-time employee, and it was assumed that the latter three had no experience working in the field of transcription.

#### *2.2.2 Event-driven Voice Data*

To understand nursing activities, a one-day schedule of nursing activities should be recorded and analyzed. However, it is difficult to transcribe all such recorded data. Therefore, we recorded the voice data of nursing activities along with clues annotated by nurses using the special devices.

To obtain voice data in hospitals, we developed an IC-recorder, a microphone with an event button, and an intermediate control box with a buzzer. The event button is used for explicit voice annotation when nurses start or complete a task. When the button is pushed, the buzzer sounds once and its sound is recorded, and then nurses record their tasks at the moment by speaking short sentences. The buzzer is also set to sound periodically (every 10 minutes) to prompt nurses to make voice input about their ongoing tasks. Simple signal processing can extract and classify event-driven and periodic voice records, as well as nurse call rings.

Event-driven voice data recording is very use-

[1]Time indicated elapsed time from the time when the experiment starts. NurseID indicates the nurses participating in the conversation. In this table, there are two nurses in the conversation. Utterance is the transcription of voice data.

Table. 1: Dialogue Transcription Example

| Time | Nurse ID | Utterance |
|---|---|---|
| 00:57:19 | A | The drip infusion is still being given, isn't it? Not yet? |
| 00:57:20 | B | Yes. It's still dripping now. |
| 00:57:22 | A | Ah, until when? |
| 00:57:24 | B | Until tomorrow. Until 6 o'clock. |

ful for accurately recording nursing activities. In addition, this approach can record nursing activities at the desired time. As a result, time information can be easily observed, and we can collect objective data on nursing activities. Therefore, our approach improves the efficiency of research on time utilization.

In one department of a hospital, we have conducted experiments on collecting data of nursing work through voice annotations. The nurses work in three shifts, assigned to primary patients of each ward. All nurses were given instructions on the usage of our devices. The entire recording time was about 500 hours. Collected data were gathered from 39 trials for a one-week experiment involving 15 nurses using our devices. We also made transcriptions of the collected data. Some sample transcriptions are shown in Table.2. The transcription was also made by four staff members as mentioned above in 2.2.1.

## *3 Features of the Corpora*

As discussed in the previous sections, we focus on dialogue data such as natural conversations collected in daily life or work. We can observe the following features in the corpora.

- People in the conversations come from various levels of social status.
- Conversations are conducted in various places or situations.
- There are certain relationships or dependencies between the current conversation and the previous conversations.
- Conversations on similar topics are repeated.

For example, nurses engage in conversation not only with other nurses but also with patients, families of patients, and doctors. Naturally, they behave according to their social role. As a result, features of conversation will be different. Examples of such differences are shown as follows:

- Conversations between doctors and nurses include formal and many medical terms.
- Among nurses at meetings, formal and many abbreviated expressions of medical terms.
- Among nurses, informal and many abbreviated expressions of medical terms.
- With patients, families of patients and nurses, formal and many words expressing medical terms in simple words.

Nurses exchange and share information on their patients depending on their work situations. The conversations are made in nurse stations, beside a patient's bed, in a clinic, and so on. Sometimes conversation begins from necessity and other times it begin when nurses happen to encounter.

Information on patients should smoothly be transferred from one shift nurse to the next shift nurse. As a result, conversations dealing with the same or similar matter should have certain relationships and dependencies. For example, topics related to the same patient and the same operation patterns of a certain disease repeatedly appeared in our corpora. For example, "to test blood sugar levels", in Table 2, appeared whenever the patients finished a meal.

Table. 2: Transcription Example for Nursing Activities

| Time | Utterance |
|---|---|
| 11:28:11 | I'm going to prepare a set of drip infusion for Abe-san. |
| 11:32:01 | I've finished preparing the drip for Abe-san. |
| 11:32:04 | I'm going to test blood sugar levels of Naya-san and Kuwahara-san. |
| 11:33:48 | I've finished testing blood sugar levels of Naya-san and Kuwahara-san. |

## 4 *Applicability of the Corpora as Spoken Language Corpora*

In this section, we discuss the applicability of the obtained corpora as spoken language corpora and a strategy to build a set of ontologies from them.

We have already manually generated around 30 hours of corpora for event-driven data and 4 hours of dialogue corpora at clinical meetings.

To understand nursing activities from event-driven data, we used tags to understand situations. We assumed that key information to evaluate a situation included time, place, medication, disease and the person's name. Therefore, we extracted the person's name, medication and disease from our corpora by using a named entity recognition tool.

Named entity recognition is useful for extracting such information as the person's name, company name, date, and place name. Named entity recognition tools have been developed in research on information extraction, machine translation, and so on. There are two types of named entity recognition: rule-based recognition and statistics-based recognition. We believe that some connections with personal name, for example "さん, さま, くん (Mr/Ms)", are determined at some level, and our target is data that can be exploited to make hand-crafted rules such as medical charts, attendance sheets and so on. Therefore, we studied how to extract personal name, medication and disease using a rule-based named entity recognition tool. NExT is a well-known tool in Japan for rule-based named entity recognition. We used the NExT version 0.82 (NExT a Named Entity Extraction Tool, 2002), which can be download from the Mie University web site. The NExT tool utilizes Chasen version 2.3.3 for morphological analysis and ipadic version 2.7.0 as a dictionary(Morphological Analysis System ChaSen, 2003). The dictionary includes many medicine names, diseases, personal names, and place names.

### *4.1 Tags in the Corpora*

Next, we extracted personal names, medication, and diseases from the corpora and tagged the corpora to better understand situations. For example, the WHO tag means a speaker, in this case a nurse as a subject using our special device, the WHOM tag means a hearer, the PT tag means the person or patient name mentioned, and the PLACE tag means the place where the communication is conducted. The TIME tag indicates the absolute time calculated from the IC recorder's elaped time and the experiment's start time. The MED tag means medication, and the DIS tag indicates the disease name. Table 3 shows a sample of the corpora.

We manually extracted the person name for WHO, WHOM, and PT from the transcription with medical charts. Person names were also extracted by a named entity recognition tool to check the NExT accuracy. Also, we evaluated PLACE by ambience sounds of voice data and schedule of nursing activities. In addition, we manually extracted medication and disease for MED and DIS.

It should be noted that we are analyzing words specialized to nursing activities in the primitive corpora. Nursing terms include daily used terms for expressing work that supports patients' daily

Table. 3: Corpora Example

| Elapsed Time | TIME | PLACE | Utterance |
|---|---|---|---|
| 11:28:11 | 18:28:11 | Nurse Station | ＜ WHO=nurseID ＞ I ＜/WHO ＞'m going to prepare a set of drip ＜ MED ＞ infusion ＜/MED ＞ for ＜ PT ＞ Abe-san ＜/PT ＞. |
| 11:32:01 | 18:32:01 | Nurse Station | ＜ WHO=nurseID ＞ I ＜/WHO ＞'ve finished preparing the drip for ＜ PT ＞ Abe-san ＜/PT ＞. |
| 11:32:04 | 18:32:04 | Room 401 | ＜ WHO=nurseID ＞ I ＜/WHO ＞'m going to test blood sugar levels of ＜ PT ＞ Naya-san ＜/PT ＞ and ＜ PT ＞ Kuwahara-san ＜/PT ＞. |
| 11:33:48 | 18:33:48 | Room 401 | ＜ WHO=nurseID ＞ I ＜/WHO ＞'ve finished testing blood sugar levels of ＜ PT ＞ Naya-san ＜/PT ＞ and ＜ PT ＞ Kuwahara-san ＜/PT ＞. |

lives as well as medical terms specialized for the particular medical situation. Furthermore, some medicine and disease names are different from the expressions used in from dictionaries, since our corpora include colloquial expressions. Moreover, it is difficult to tag some expressions that have the same meaning.

### *4.2 Nursing Terms Featured in the Corpora*

In this section, we describe some expressions that express controversial features for tagging.

For instance, in general "せんがん (sengan)" means "洗顔 (washing face)," but if it is narrated before surgery in ophthalmology, it means "洗眼 (washing eye)." "自立する (jiritsu-suru)" means "standing walk" if it is narrated in a conversation among nurses, but it means "to earn one's living by oneself" in general, as when it is narrated in a conversation between a nurse and a patient's family. Thus some words have multiple meanings according to the situation. As a result, sometimes nurses, especially novice nurses, experience misunderstanding in their communications. Another example is "ほりゅう (horyu)", which means "suspend giving medicine" or "keep a sting stung". Therefore, we think we will be able to gather many words that have multiple meanings when we check the collected corpora. This will allow us to build or extend the contents of a dictionary of multiple-meaning expressions.

In our studies. we also observed the following cases:

- multiple expressions
  - "咳 (seki)" and "咳嗽（gaisou）" mean tussis and coughing
  - "尿 (nyou)" and "ハルン (harun)", and "おしっこ（oshikko)" mean urine and pee
  - "糖尿 (tounyou)" and "ディアベ (diabe)" and "DM" mean sugar diabetes (diabetic mellitus)

  These types of expressions are used to hide the real meaning from patients, and they're sometimes used because the expression is currently fashionable.

- abbreviated expressions
  - "アン（an）" means ampule
  - "ミリ （miri)" means milliliter or milligram
  - "分２ (bun-ni)" means half or two times
  - "ノボアール (nobo-aaru)" means Novolin R, which is a medication for diabetes

  These types of expressions seem to be used for quick communication. In particular, medications are sometime shortened into shorter words, such as Novolin R into R only.

These expressions are relatively frequently used and sometimes seem to cause nursing accidents or incidents due to miscommunication.

We think we will be able to obtain many concepts that have multiple expressions and abbre-

viated expressions by checking the collected corpora. Then we could build or extend contents of a multiple-expression concept dictionary and an abbreviated-expression dictionary.

To develop a support system for nursing activities, we should standardize technical nursing terms. However, there are many types of terms used in typical nurses' dialogues. For example, nurses uses

- admission to a hospital expressed as "AD"
- "AD" originates from "admission" in English
- discharge from hospital expressed as "エント (ento)"
- "エント (ento)" originates from entlassen in German

Furthermore, there are many new medicines used in hospitals. It is difficult to uniformly manage these new words. The standardization of nursing terms thus has many problems.

We think that even ambiguous words can be understood if we recognize nurses' working situations by using the information of many types of sensors. This would require using a position sensor to identify nurses' working locations as well as who is participating in conversations. We could supplement missing information and complete or correct ambiguous information by referring to such information from sensors.

### *4.3 Feature as Spoken Language Corpora*

A chronological relationship or dependency map among nurses can be accurately obtained by referring to nursing records and medical charts. Conventional dialogue corpora can only offer one-to-one conversations, permitting only a simple analysis. In addition, it is easy to make a wrong analysis.

On the other hand, if we analyze our corpora with a chronological relationship or dependency among nurses, we can discover true features of conversation phenomena. For instance, person A exchanges information with person B, but person B misunderstands person A's information. Person B conveys the information to person C. Then C realizes B's misunderstanding and informs B so that B can correct the information. Thus we can obtain communication patterns between more than two persons who do not know each other's situation.

To utilize the dictionaries obtained from our corpora and sensor information, we can build a set of ontologies for conversations between multiple persons. In building a set of ontologies, the mechanism of conversations can be clarified, and a method for finding points of mistakes given ambiguous expressions can be examined.

In this paper, we focus on nursing vocabularies and nursing activities. Of course they are slightly different from general terms and general situations, but these corpora and dictionary-building techniques can be applied to general terms and situations between spoken language and written language.

In finishing the transcription of the clinical meetings and event-driven data, we are building the corpora. Here we note that it is difficult to tag MED and DIS because there are multiple expressions and abbreviated expressions. We need to develop a way to designate standard expressions from the multiple and abbreviated expressions.

## *5 Conclusion*

In this paper, we introduced our E-nightingale project. We also showed voice data collection in a real workplace such as a hospital and discussed the importance and potential of generating corpora from this data.

In the next step, all of the collected voice data will be made into corpora, and tags will be made to construct knowledge based on experiences from conversation corpora. Furthermore, we will develop methods to build corpora from collected data automatically. From this corpora, we will develop a system to analyze actual dia-

logues and activities in a real nursing situations by utilizing multi-sensor information.

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NExT — Named Entity Extraction Tool. http://www.ai.info.mie-u.ac.jp/ñext/next_en.html.

ChaSen — Morphological Analysis System. http://chasen.naist.jp/hiki/ChaSen/