

# Constructing a Chinese Medical Conversation Corpus Annotated with Conversational Structures and Actions

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## Abstract

Overuse of antibiotics and the attributed bacterial resistance is one of the most serious global public health crises today. Previous research reported that patients' advocacy for antibiotic treatment was consequential on antibiotic over-prescribing. To investigate how the advocacy and other factors contribute to antibiotic over-prescribing, qualitative and quantitative analysis of doctor-patient conversation can yield valuable findings. In this paper, we introduce AMed (Annotated Corpus of Medical Conversations), a manually transcribed corpus of medical dialogue in Chinese pediatric consultations, with annotation of conversational structures and actions. Based on the annotation, a significant association between patient request for antibiotic and antibiotic over-prescribing is discovered. As this corpus is the first with annotation of conversational structures and actions on medical consultation conversations in Chinese, it can be a valuable resource for discourse and dialogue research in general, and for the understanding of human collaboration and negotiation behavior in clinical consultations in particular. Furthermore, findings from analyses of the corpus can shed light on ways to improve physician-patient communication in order to reduce antibiotic over-prescribing.

**Keywords:** Conversation Analysis, physician-patient communication, antibiotics over-prescribing

## 1. Introduction

Overuse of antibiotics and the attributed bacterial resistance is one of the most serious global public health crises today. Multiple and rising levels of resistance are found worldwide; some of the common illnesses become fatal again as the old drugs become ineffective and the pipeline for developing new antibiotics become dry (Laxminarayan et al., 2013). The antibiotic overuse crisis is extremely severe in China. The country was the second largest consumer of antibiotics in the world during 2000-2010 (Boeckel et al., 2014), and its bacterial resistance has reached alarming levels (Xiao et al., 2012). As a result, antibiotic overuse is an extremely severe and urgent problem in China. On average, 138g antibiotics were consumed per person a year in 2012—ten times that consumed in the United States (Yuan, 2014). One main contributor to antibiotic overuse is the high prescription rate of antibiotics, which was over 50% in outpatient care according to a previous study (Wang et al., 2014). A study in 784 health institutions across the country found that antibiotics were prescribed twice as many as recommended by the WHO standard (Li et al., 2012). Overall, antibiotic prescription rates were over 50% in outpatient care; 75% of the patients were prescribed one antibiotic, and 25% were prescribed two or more antibiotics (Wang et al., 2014). With increasing global travel and exchange, antibiotic overuse in China is not only a domestic issue but also has a global impact.

Over-prescribing of antibiotics can be resulted from interaction-generated problems (e.g., misunderstanding in communication) that has little to do with sound medical judgment (Macfarlane et al., 1997). In a series of studies on doctor-parent interaction in the US pediatric setting, Stivers (Stivers, 2007) found that, besides overt advocacy, parent communication actions such as diagnosis resistance and treatment resistance are frequently perceived by physicians as expecting antibiotics, even when parents do not

report actual expectations. This is consequential, as physicians are significantly more likely to prescribe inappropriately, when they perceive parental expectations for antibiotics (Mangione-Smith et al., 1999).

Compared to the US and the UK, research on medical conversation in Chinese clinical setting and its impact on antibiotic over-prescribing is limited, partly due to difficulty in obtaining conversational data in clinical settings, let alone a corpus where patient (or caregiver) communication actions and physician's prescribing decisions can be annotated and analyzed. To address this problem, we have built a corpus of naturally occurring conversations with rich annotations of conversational structures, physician-caregiver communication actions, as well as antibiotic prescribing outcomes. The results showed that caregivers' conversational actions such as advocacy for antibiotics indeed has a strong association with physicians' antibiotic prescriptions.

## 2. Methodology

As a theoretical framework and analytical method, we use Conversation Analysis (hence after, CA) to investigate the proposed research problem. CA is a method developed in sociology for research on human social interaction as a form of small-scale social institution (Sidnell et al., 2013). In this section, we provide a brief overview to CA and highlight how its main concepts are adopted in annotating conversational structures and actions in our corpus.

### 2.1. Conversational Structures

CA views conversation as a structural product of human social interaction with order at all points (Sacks et al., 1974). The main idea is that 'a course of action' can be thought of as built up out of basic adjacency pairs, which can be expanded in order to accomplish projected actions and activities (Schegloff, 1968). Conversational structures are analyzed at three levels (Schegloff, 2007):

- **Adjacency Pairs:** how two adjacent turns are organized as pairs, in which the ‘first pair parts’ (FPPs) project ‘second pair parts’ (SPPs) of a related type (e.g., question-answer, request-grant). Adjacency pair is the most pervasive and basic mode of organization in conversation (Schegloff, 2007).
- **Sequences:** how a sequence of turns is organized in a trajectory, through which courses of action are enacted coherently and orderly. For example, ‘*Are you free tonight?*’ can be understood as preliminary to a base adjacency pair of invitation-acceptance. Sequences are the vehicle for getting activities accomplished.
- **Overall Organization:** how multiple, ordered sequences are organized to accomplish particular project (e.g., a medical project normally involves five ordered activities - problem presentation, information-gathering (history-taking and/or physical examination), diagnosis, treatment, and closing).

In our corpus, we annotate the first two levels with Adjacency Pair Part (APP) and Sequence Link (SL) as explained in Section 3.3., and leave the annotation of overall organization to future work.

## 2.2. Conversational Actions

CA also provides a systematic analytical method for analysis of participants’ conversational actions. Actions in CA can be understood as the ‘main job’ that a turn is performing. To understand the primary action of a turn, analysts look at both its sequential position and grammatical composition (Schegloff, 2007). For instance, a turn (e.g., ‘*Isn’t it raining?*’) can be understood as doing the action of answering to a question (e.g., ‘*Are we going to the game?*’) primarily because of its sequential position (i.e., as a second pair part in an adjacency pair).

Based on CA, we identify and annotate several types of physician-caregiver conversational actions such as caregivers’ requesting actions for antibiotic treatment and physician’s treatment recommendations, as explained in Section 3.4..

## 3. Corpus Construction

In this study, we created an Annotated Corpus of Medical Conversation (AMed) consisting of medical conversations with CA-style annotation.

### 3.1. Data Collection

To construct the corpus, we video-recorded 318 pediatric consultations from five hospitals in China between Sept. 2013 and Dec. 2013. Due to its pediatric setting, the conversations were mostly between physicians and patients’ caregivers, where the caregivers could be parents, grandparents, or other relatives. We call each conversation (i.e., a video-recording of a complete medical consultation) a visit. Table 1 shows statistics of the raw data.

**Ethical Consideration:** All research procedures were reviewed and approved by the UCLA IRB (Ref# 13-000748).

Item	Number
# of Visits	318
# of Hospitals	5
# of Physicians	9
# of Patient (accompanied by caregivers)	318
Average length of a visit	4.9 minutes
Total length of the recordings	26 hours

Table 1: Statistics of the raw data

All identifiable information (e.g., person, institution, location names) has been removed from the corpus.

In the rest of the section, we provide details of our annotation scheme. Table 2 shows an example of annotation. Most annotation is at the turn level (all the columns in Table 2 except *Speech text*), but there is annotation inside the *Speech text* column (see Section 3.2.) and at the visit level (e.g., meta data for each visit, not shown here).

The meta data for each visit includes visit type (whether a visit is an acute visit or a follow-up visit) and unique identifiers (IDs) of the hospital, physicians, patients, and caregivers. The detail of hospitals (e.g., hospital type), physicians (e.g., gender and age range), caregivers (e.g., gender, relation to the patient, age range), and patients (e.g., gender) are stored in separate files.

### 3.2. Speech to Text

Following Jeffersonian transcribing system (Jefferson, 2004), we transcribe video-recordings of physician-caregiver conversation to capture both what is said and how it is said. The transcription is done in two passes: the first pass transcribes the Chinese verbatim of a turn, and the second pass transcribes speech production features (e.g., intonations and prolongations) and non-verbal activities of a turn (e.g., nodding, conducting a physical examination). Table 3 shows the list of transcribing symbols of the Jeffersonian convention. The punctuation marks in the text are transcribing symbols, and they are used to represent the speech production features.

The transcribing of the speech production features relies on annotators’ judgment by comparing to the surrounding talk, e.g., a timed silence is annotated if there is a noticeable period of silence longer than a natural beat of silence. More specifically, a silence is transcribed as an individual turn if there is a recognizable completion point of the turn, both grammatically and pragmatically; while a short period of silence is transcribed as a pause within a turn, if there is a possible completion point at the Turn-Construction-Unit (TCU) boundary though the turn is recognizable as incomplete either grammatically or pragmatically. **Non-verbal activities** are transcribed when 1) there is a large chunk of silence AND the speakers are involved in the activity which may prevent them from talking; or 2) there is a nodding or head-shaking, which has pragmatic meaning but may be understood as lack of response if not transcribed.

The de-identification procedure is operationalized through wrapping the identifiable information (e.g. speaker name, institution name, region/area name, etc.) with the symbol ‘@’. This procedure enables deletion of the identifiable in-

TID	PR	APP	SL	Speech text	Action	Outcome
83	D	1	0	轻度的贫血。哦，你先给他吃点消炎药吧，[好吧， Mild anemia, ok? You give him some oral antibiotics to take, ok?	B2	
84	M	2	83	[家里有头孢。 We have Cephalo at home.	C1	D1
85	D	1	84	行。(.)退烧药呢? Ok. What about fever medicine?		
86	M	2	85	>退-退烧药要开一瓶.< Fever medicine, we ' ll need one bottle.		
87	D	1	86	哦。(.)溃疡的呢? 喷喉咙的药有吧,= Ok. What about ulcer medicine? You have the spray medicine for his throat?		
88	M	1	87	=那个: 利巴韦林是也, That Ribavirin, right?		
89	D	2	88	嗯。 Yeah.		
90	M	2	87	有呢。 Yes, we do.		

Table 2: An example of AMed annotation. TID: Turn ID; PR: Participant Role (M: Mother, D: Doctor); APP: Adjacency Pair Part; SL: Sequence Link; Action: Conversational Action; Outcome: Prescribing Outcome.

Symbol	Description
,	Continuing or slightly rising intonation.
.	Falling or terminal intonation.
?	Rising intonation.
=	Utterances are latched or ran together, with no gap of silence.
-	Preceding sound is cut off or interrupted.
[	Onset of overlapping talk, in pairs of adjacent turns.
:	Preceding sound is extended or stretched.
><	Talk with increased pace relative to surrounding talk.
<>	Talk with decreased pace relative to surrounding talk.
(1.0)	Silence measured in seconds, e.g., 1 second.
(.)	A micropause less than 0.2 second.
((Cough))	Nonverbal activities, e.g, Cough.
@N@	Representation of participants' identifiable information for confidentiality.

Table 3: The list of Jeffersonian transcribing symbols. The last row is a new symbol we added to replace identifiable information for the sake of privacy.

formation with automatic methods.

During the transcription, a conversation is broken into turns, and each turn is automatically assigned a **Turn ID**, which is a sequential number indicating the position of the turn in the conversation. Each turn is also given a **Participant Role** (RP), which is a label in a pre-defined label set, indicating the role of the speaker in this conversation (e.g., label *D* for doctor, and *M* for mother of the patient). The PR label is particularly informative when a conversation involves more than two participants.

Two annotators transcribed for each case and the transcripts were then verified by a third person (the first author).

### 3.3. Annotation of Conversational Structure

To annotate adjacency pairs and the sequences in a conversation (see Section 2.1.), we add two labels at each turn:

Adjacency Pair Part (APP) and Sequence Link (SL).

APP has two possible values: '1' being FPPs, which initiate some exchange, and '2' being SPPs, which responds to some prior FPPs. For instance, in Table 2, the doctor's treatment recommendation (TID:83) is a FPP, which initiates a recommendation and projects an acceptance from the mother as a SPP (TID:84), and their APPs are 1 and 2, respectively.

Ideally, an adjacency pair consists of two adjacent turns; however, that is not always true in actual conversation. Here are some exceptions:<sup>1</sup>

- An adjacency pair can be incomplete, as the SPP of an adjacency pair is oriented as needed by speakers but sometimes not provided. A lack of or delayed production of a SPP may generate implications for understanding such as socially dispreferred actions (Pomerantz, 1984).
- An adjacency pair can be separated by various forms of sequence expansions, in order to deal with a wide range of contingencies in accomplishing the projected actions (Schegloff, 2007). For instance, in Table 2, the adjacency pair formed by Turn 87 and 90 are separated by another pair, Turn 88 and 89. Here, the second pair is dealing with understanding problems of the FPP of the first pair. We call the second pair an **insert expansion** of the first pair.
- A turn can be linked to multiple turns, when there are multiple speakers. For instance, when a doctor asks

<sup>1</sup>One complication that we will not get into detail here is that, within each turn, there could be multiple Turn-Construction-Units (TCUs) (Sacks et al., 1974); each of the TCUs can take different APP and SL values. Since our primary focus in this study concerns with conversational actions that are often performed at the turn level, the current APP/SL/Action annotation is at the turn level, but our annotation scheme can be easily extended to the TCU level if needed.

a question and the question is answered by two caregivers, this leads to an adjacency pair with one FPP and two SPP turns.

Given these exceptions, APP labels alone will not be sufficient to indicate adjacency pairs. To solve this problem, we give each turn another attribute called **Sequence Link (SL)**. If a turn is the SPP of an adjacency pair, its SL will be the Turn ID of the FPP of the pair. Recall that in Conversation Analysis (CA), a sequence is a cluster of turns that are organized to accomplish particular courses of action or activities. If a turn is the FPP of an adjacency pair, its SL will be the Turn ID of the closest left neighbor in the same sequence.

The SL value of the first turn in a sequence is zero, indicating the beginning of a sequence. For instance, in Table 2 the physician has just delivered a diagnosis (not shown in the excerpt), the SL of Turn 83 is annotated as 0, showing this turn starts a new sequence about treatment recommendations.

Together, APP and SL indicate the locations of adjacency pairs and the sequences in the conversation. A sequence consists of a base adjacency pair and all of its expansions, and the first turn in a sequence has value 0 for SL. Three most common sequence expansion forms (Schegloff, 2007) are **insert expansion** (mentioned above), **pre-expansion** and **post-expansion**.

- Pre-expansion. For example, a pre-invitation sequence consists of a Q-A pair preceding the projected base invitation pair.

Pre-expansion A: *Are you free tonight?* B: *Yeah.*

Base pair A: *Let's go to a movie!* B: *Ok.*

- Insert Expansion. For example, a request-grant/reject base sequence can be intervened by a repair adjacency pair.

Base FPP A: *Could you pass me the salt?*

Insert FPP B: *Huh?*

Insert SPP A: *Could you pass me that table salt?*

Base SPP A: *Sure!*

- Post-expansion. For example, the third turn in the conversation below is produced after the production of the base adjacency pair SPP, registering the speaker's understanding of the sequence closing.

Base pair A: *Shall we call it a day?* B: *Ok.*

Post-expansion A: *Alright.*

### 3.4. Conversational Actions Related to Antibiotic Treatment Negotiation

To investigate how physician-caregiver conversation affects antibiotic over-prescribing, we identify three types of conversational actions at the turn level:

**Caregivers' request for antibiotics** in the form of (A1) explicit requests for antibiotic treatment, (A2) statements of desires for antibiotic treatment, (A3) inquiries about antibiotic treatment, and (A4) evaluations of past treatment.

The four requests differ in their overtness in turn design and degree of caregiver agency in instigating the request.

**Physicians' treatment recommendation** in the form of (B1) pronouncements, (B2) proposals, (B3) preference-inquiries, The three forms of treatment recommendations vary in physicians' deontic authority in proposing the treatment. Besides, we also add a flag to indicate whether the physician recommends antibiotics to the patient in this turn.

**Response to treatment request/recommendation** are either non-acceptance (C0) or acceptance (C1).

In addition to those action types, we also record whether a patient is prescribed with antibiotics in a visit, which is either yes (D1) or no (D0). We call it **prescribing outcomes**. We annotate the prescribing outcome at the turn level, although it stands for the physician's final prescribing outcome at the visit level.

### 3.5. Additional Annotation

The transcribed text is automatically segmented into words using an in-house CRF word segmenter trained on the Chinese Penn Treebank (Xia et al., 2000). A small subset of the corpus (about 25 visits) is also translated into English for users who might be interested in cross-lingual dialogue research. Note that the transcribing symbols annotated in the Chinese text layer are not carried over to the English translation as the word order in two languages can be quite different. In addition, as previously mentioned, we store meta data that specifies information such as hospital id, physician id, gender and age ranges of the physician and the caregivers.

For all the types of annotation discussed in this section, speech-to-text was done by two annotators for each visit and the transcripts were then verified by a third person (the first author). The inter-annotator agreement is 91%.<sup>2</sup> Other types of annotation were done by one person.

## 4. Results

We have completed the annotation of the corpus and conducted some preliminary studies on the association between participants' actions and the prescribing outcomes.

### 4.1. Corpus Statistics

Table 4 summarizes the statistics of the corpus. The corpus contains nearly 40K turns with 470K Chinese characters, which is considerably large in terms of manually annotated natural human conversations. On average, each visit has three participants (the physician might talk to more than one caregiver), and the turns form 63 adjacency pairs which are grouped into 29 sequences, suggesting that topic shift occurs frequently in an efficiency-driven medical context.

### 4.2. Physician-caregiver Conversation Actions and Prescribing Outcomes

To allow comparison with research conducted in similar settings and designs (Stivers, 2007), we restrict our statisti-

<sup>2</sup>The character error rate is 8.9% when treating one transcript as the reference.

Total # of Chinese characters	468,162
Total # of Chinese words	270,042
Total # of visits	318
Total # of turns	39,216
Total # of non-verbal turns	5,815
Avg. # of Chinese words per visit	849.19
Avg. # of turns per visit	123.32
Avg. # of non-verbal turns per visit	18.29
Avg. # of adjacency pairs per visit	63.28
Avg. # of sequences per visit	28.66

Table 4: Statistics of the annotated corpus.

Request Type	# of Visits Observed	% of Visits Observed
(A1) Explicit requests	10	5.35
(A2) Desire statements	14	7.49
(A3) Inquiries	50	26.74
(A4) Evaluations	26	13.90
Total	100	53.48

Table 5: Caregiver’s requesting actions in the 187 acute visits. There could be more than one instance of requesting action in one visit.

cal analyses and report distribution of the conversation actions and prescribing outcomes to **acute visits**. Out of 318 visits, 187 are considered *acute visits*. Table 5 shows the distribution of caregivers’ requesting actions in the corpus. The first column is the numbers of visits that contain a caregiver’s requesting action, and the second column is the percentage of visits that contain a requesting action.

Table 6 shows the distribution of prescribing outcomes of the acute visits with respect to whether the caregivers make antibiotics requests during the visit. Running  $\chi^2$  test on the data shows that caregiver’s requesting action is highly correlated with prescribing outcome ( $\chi^2 = 13.14, p < 0.001$ ). In addition, the association between caregiver’s requesting actions and prescribing outcome is even more significant, if the caregiver’s treatment advocacy is for the specific treatment modality of IV antibiotics ( $\chi^2 = 21.08, p < 0.001$ ).

## 5. Discussion

This study makes contributions in three areas, as explained below.

### 5.1. A new scheme for annotating conversation

Our work explores a new annotation scheme for coding conversational structures and actions. For conversation

Prescriptions	w/ Request	w/o Request	Total
Antibiotics	72	28	100
Non-antibiotics	39	48	87
Total	100	87	187

Table 6: Distribution of prescribing outcomes by occurrence of caregiver’s requesting action.

structures, while the existing theories have recognized that utterances in conversation has higher-level forms of hierarchical structures (Grosz and Sidner, 1986; Carletta et al., 1997), most of the existing schemes have only implemented annotations of conversational structures at turn level or between a pair of turns (e.g., by distinguishing Forward Communicative Function and Backward Communicative Function (Core and Allen, 1997; Jurafsky et al., 1997)). Informed by the Conversation Analysis (CA) theory and approach, our annotation scheme allows us to capture hierarchical structures of conversation at several levels, including turn, adjacency pair, sequence, and overall organization.

For conversational actions, most of the existing annotation schemes of dialog acts (DAs) were based on speech act theory (Core and Allen, 1997; Jurafsky et al., 1997; Stolcke et al., 2000; Hoxha et al., 2016); however, it was found that comprehension of indirect speech acts were very difficulty with the available schemes, primarily due to the fact that classifications of actions were based on the surface format of an utterance. Based on CA theory of actions in conversation, which considers the sequential position of a turn as critical for action recognition and ascription, our annotation scheme allows classifications of actions based on a turn’s structural position in conversation. It thus entails great flexibilities for annotating indirect conversational actions.

### 5.2. A new annotated corpus of conversations

As far as we know, AMed is the first corpus consisting of naturally occurring clinical conversations in Chinese which are manually transcribed and annotated with conversational structure and actions. Upon releasing, the corpus can be used not only for research of general purposes such as conversational understanding, modeling human social behavior of cooperation and coordination, but also for more specific purposes such as identifying risk factors for antibiotic over-prescribing.

### 5.3. Understanding the impact of caregivers’ behavior and prescribing outcome

Antibiotic over-prescribing and bacterial resistance has been considered as one of the biggest global public health crises today. The problem is particularly severe in China. Most of the existing research argued that antibiotic over-prescribing in China was driven by financial incentives tied to physicians’ prescriptions; thus a substantial amount of social resources flew to address the problem from the supply side. However, little is known whether caregivers’ demands for antibiotic prescriptions play a role.

Our findings show that caregivers’ requesting actions are significantly associated with physicians’ antibiotic prescriptions. It presents empirical evidence to show that over-prescribing can also be resulted from caregiver advocacy for antibiotics in physician-patient/caregiver communication. In addition, our findings reveal that compared to caregivers in American pediatric context, the Chinese caregivers not only demand for antibiotic prescriptions, but also use more overt forms of advocating actions more frequently. Studies in similar setting in the U.S. showed that although the American caregivers also use similar actions to advocate for antibiotics in medical consultations, these

actions were only observed 9% of the time. Moreover, among the four types of advocating actions, the most overt form of requesting actions (i.e., explicit requests) were observed in 5.35% of the Chinese consultations; in comparison, this action was observed in less than 1% of the time in the American context (Stivers, 2007; Stivers, 2002). These findings thus have important implications for reducing antibiotic over-prescribing in China. Intervention measures such as providing physicians with trainings of communication skills to resist caregiver pressure are likely to produce desirable outcomes.

## 6. Conclusion and Future Work

In this paper, we present a manually transcribed and annotated corpus of medical conversation in Chinese clinical setting, aiming to contribute a high-quality language resource for research on treatment decision-making in clinical setting and antibiotic over-prescribing in pediatrics. The results proved our hypotheses that communication in medical consultations is significantly associated with medical decision outcomes such as antibiotic over-prescription. It thus provides basis on which effective intervention measures (e.g., public health education campaign, physician training of communication skills) can be devised in order to address the issue.

In addition, our proposed work provide an unique and valuable resource for research relevant to conversational understanding, treatment decision-making in doctor-patient communication, as well as antibiotic over-prescribing.

For future work, we will expand our annotation scheme to mark overall organization of the conversations, and test the usefulness of the scheme on conversations from other domains. For the AMed corpus, we plan to extend that by adding more data and also examine additional factors in clinical interaction that may lead to antibiotic over-prescribing.

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