

2012 i2b2 Temporal Relations Challenge Annotation Guidelines

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1 Introduction

This document describes the annotation guidelines for the 2012 i2b2 temporal relations challenge. The text annotated for this challenge comes from de-identified discharge summaries. The goal of the annotation is to mark up temporal information present in clinical text in order to enable reasoning and queries over the timeline of clinically- relevant events for each patient.

This annotation involves marking up three kinds of information: events, temporal expressions, and temporal relations between events and temporal expressions. The latter would involve (1) anchoring events to available temporal expressions, and (2) identifying temporal relations between events. The first task is to identify all clinically relevant events and situations, including symptoms, tests, procedures, and other occurrences. The second task is to identify temporal expressions, which include all expressions related to time, such as dates, times, frequencies, and durations. Events and temporal expressions have a number of attributes (such as type of event or calendar value of the temporal expression) that need to be annotated. The final task is to record the temporal relations (e.g. before, after, simultaneous, etc.) that hold between different events or between events and temporal expressions. You can follow any order as you annotate different layers of information, but typically, you would want to annotate events and temporal expressions prior to annotating the temporal relations. Please see Section 5.1.4 on further suggestions for annotation strategy.

These guidelines should be used as follows. Section 2 provides a Quick Start guide for the annotation. After reading the Quick Start section, you should be able to start annotating. Sections 3-7 contain the full annotation guidelines, giving further information for each tag and attribute type. They should serve as reference for problematic cases. Finally, Appendix 1 contains a "cheat sheet" for different annotation tags and their attributes, i.e. a quick reference with examples that you may want to keep open as you work on the annotation.

Another important thing to note is that the texts you will be annotating will be automatically pre-processed, i.e., they will contain some annotations of text spans and attributes. Please keep in mind that these annotations are generated automatically, so you will need to verify their correctness. Also, the tags that are added manually will have the most common attribute value selected by default. These also need to be verified manually. Appendix 2 describes the attribute values assigned by default to different tags.

Acknowledgements

The annotation guidelines presented in this document were developed based on the temporal annotation guidelines from several sources:

1. The clinical temporal relation annotation guidelines from the THYME project¹, and specifically, the Simplified THYME Guidelines developed by Will Styler, Guergana Savova, Martha Palmer, and James Pustejovsky based on the THYME project guidelines, served as the main starting point for the present guidelines.
2. ISO TimeML, as well as the original TimeML annotation guidelines created by Roser Sauri, Jessica Littman, Bob Krippen, Robert Gaizauskas, Andrea Setzer, and James Pustejovsky (<http://timeml.org>).
3. Concept and assertion annotation guidelines from the 2010 i2b2/VA challenge evaluation.

The version of the guidelines presented in this document was developed at SUNY/Albany and MIT by Weiyi Sun,

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2 Quick Start

As stated above, the goal of this project is to create a manually annotated medical corpus, in which the clinical events and time expressions, as well as temporal relations between them are explicitly marked. The annotation task involves three steps: 1. Identifying time expressions in the text; 2. Identifying clinical events; 3. Determining the temporal relations between time expressions and clinical events, as well as between events. For this, the guidelines specify four tags, TIMEX3, EVENT, SECTIME, and TLINK. TIMEX3 and EVENT are used to represent time expressions and events respectively. SECTIME is used to represent the creation time of each section. TLINK is used to annotate temporal relations.

Each tag has a set of attributes that need to be specified in annotation as well. The attributes specify different properties of each tag, e.g., type of event, time value associated with a time expression, etc. For ease of annotation, the most common attribute value for a given attribute is typically selected by the annotation tool when the tag is created. Default values for different attributes are summarized in Appendix 2.

In this section, we will briefly introduce each of these entities with examples in Sections 2.1 – 2.3, followed by a quick tutorial (Sections 2.4 – 2.8) demonstrating how to annotate these entities with the MAE (Multi-document Annotation Environment) toolkit (the program that we use in the project to do annotation).

2.1 EVENT

In addition to temporal expressions marked by the TIMEX3 tag, we need to mark events that are mentioned or described in the text, which is done using the EVENT tag. In a medical record, anything that is relevant to the patient's clinical timeline is an event. These include clinical concepts, such as laboratory tests, medical problems, administered or proposed treatments, diagnoses, patient's complaints and so on (see Section 3). EVENTS also have attributes, including:

- type (occurrence/evidential/test/problem/treatment/clinical_dept)
- polarity (positive or negative),
- relation to section creation time (before, after, and others – see Appendix 1)

Note: Relation to section creation time is specified in the *sec_time_rel* attribute of the EVENT tag. In this tutorial, we will relate all the EVENTS to the discharge date. In the actual annotation, each document will contain two sections: 'History of Present Illness' clinical history and hospital course. The EVENTS in clinical history need to be related to the Admission date, and the EVENTS in hospital course need to be related to the Discharge date.

You will need to identify all the EVENTS in a clinical record, and specify the values for the above three attributes values for each EVENT. For example, the following sample text contains the EVENTS below marked in blue:

Admission Date :

09/14/2001

Discharge Date :

09/21/2001

This 56 year old male patient complained of increasing chest pains over the last three to four weeks prior to his admission. Initially the pain was only occasional, and happened every few days lasting twenty to forty seconds. At noon 09/17/01, the patient was started on Diltiazem 120mg q.d. after calling his cardiologist.

- [Admission] is clearly a clinically important action, so it needs to be marked as an event. The *sec_time_rel* attribute marks the temporal relation of the EVENT comparing to the section creation time (see Section 3.2.1 for detail). In this example, we treat the text from line 5 to the end as 'hospital course' section. Since the text "Admission" is not in clinical history or hospital course section, its section time is undetermined. We define its *sec_time_rel* as "OVERLAP" (same for the 'Discharge' event in 'Discharge Date' below) All the other attributes of this EVENT should be left at their default values.
- [Discharge] is also an event. Its *sec_time_rel* is defined as "OVERLAP" because it is in neither clinical history nor hospital course section. All the other attribute values are default.
- [complained] describes the patient's action of reporting a symptom, which is also a piece of clinically significant information. It should therefore be marked as an event. This event belongs to the 'hospital course' section. The section time is discharge date. Thus the *sec_time_rel* of this EVENT is "BEFORE". Its *type* is "EVIDENTIAL" because the word "complain" here specifies the source of information, that is, that it is something reported by the patient. All the other attribute values are default.
- [increasing chest pains] is a symptom. Its *type* attribute should be "PROBLEM". Its *sec_time_rel* is "BEFORE". All the other attribute values are default.
- **Note that whenever we mark an event, we include the entire base noun phrase in the span of the event. However, any prepositional phrases that are part of the noun phrase should not be marked.**² For example: The patient has [an intermittent cough] with a small amount of sputum.
- [admission] appears again in this text. Even though it refers to the same event as the first time, we still need to annotate it. Now, this event locates in the hospital course section. Thus, the *sec_time_rel* is "BEFORE", and all other attributes are default.
- [pain] also needs to be annotated as an event. Its *type* attribute is "PROBLEM". Its *sec_time_rel* is "BEFORE". All the other attribute values are default.

² We follow the practice of span annotation adopted in the 2010 i2b2/VA challenge guidelines for concept annotation.

- Note: the verb “started” here is NOT marked as an event, because it does not provide new information about the patient’s clinical timeline. The only information that the verb “started” conveys is that the medication Diltiazem is started at a certain time, which can be fully expressed by using a “BEGUN_BY” TLINK (see Section 2.3 for details).
- “Diltiazem” is a treatment (medication). Its “type” attribute is “TREATMENT”. Its *sec_time_rel* is “BEFORE”. All the other attribute values are default.
- “calling” is an EVENT. When we mark a verbal EVENT, we usually just mark the verb itself. The *sec_time_rel* of this EVENT is “BEFORE”. All the other attribute values are default.

2.2 TIMEX3

Temporal expressions are phrases that contain time information. The types of temporal expressions that we need to mark include date, time, duration and frequency. We use the TIMEX3 tag to annotate a temporal expression (Below the term TIMEX3 and “temporal expression” are used interchangeably). A TIMEX3 tag has three main attributes: type (date/time/duration/frequency), val (value of the TIMEX3) and mod (more, less, approximate and so on). See Appendix 1 for a quick summary of these attributes and their values along with illustrating examples.

You will need to identify all the TIMEX3s in a clinical record, and specify the three attribute values for them. For example, the TIMEX3s in the following sample text are marked in red. Note that due to the nature of clinical notes, the texts that we will be annotating will often contain typos, grammatical errors, sentence fragments, ad-hoc abbreviations and many other deviations from the standard written English, which you will need to take into account during the annotation.

Admission Date :

09/14/2001

Discharge Date :

09/21/2001

This 56 year old male patient complained of increasing chest pains over the last **three to four weeks** prior to his admission. Initially the pain was only occasional, and happened **every few days** lasting **twenty to forty seconds**. At **noon 09/17/01**, the patient was started on Diltiazem 120mg **q.d.** after calling his cardiologist.

- [09/14/2001] is a DATE TIMEX3. Its *type* attribute should be set to “DATE”. Its *val* attribute should be set to “2001-09-14” (see Section 4 for details about temporal value representation). Its *mod* attribute should be set to “NA” (not applicable).
- [09/21/2001] is also a DATE TIMEX3. Its *type* is “DATE”. Its *val* is “2001-09-21”. Its *mod* attribute is “NA”.
- [three to four weeks] is a DURATION TIMEX3. Its *type* is “DURATION”. The *val* attribute is “P3.5W” (period of 3.5 weeks). Since 3.5 weeks is an approximation of “three to four weeks”, you would need to select “APPROX” (Approximate) as the value for the “mod” attribute.
- [every few days] is a FREQUENCY TIMEX3. Its *type* is “FREQUENCY”. The *val* is “RP2D” (repeat every 2 days). Its *mod* is also “APPROX”.
- [twenty to forty seconds] is a DURATION TIMEX3. Its *type* is “DURATION”. The *val* is “PT30S” (period of 30 seconds). Its *mod* is “APPROX”.

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- [noon 09/17/01] is a TIME TIMEX3. Its *type* is "TIME". The *val* is "2001-09-17T12:00". Its *mod* is "NA".
- [q.d.] is a FREQUENCY TIMEX3. Its *type* is "FREQUENCY". The "val" is "RP1D" (repeat every day). Its *mod* is "NA".

Each section has a special temporal expression called "section creation time". The discharge summaries records that we work with in this project usually contain two sections: clinical history and hospital course. The section time for clinical history is defined as the admission date, while the section time for hospital course is defined as the discharge date. Thus, in this entry, both "09/14/2001" and "09/21/2001", in addition to being TIMEX3s, also need to be labeled as SECTIMEs (see Section 6).

2.3 TLINK

Once you have identified TIMEX3s and EVENTS, you will need to identify the temporal relations between them. For instance, in the sentence:

At **noon 09/17/01**, the patient was started on **Diltiazem 120mg q.d.** after **calling** his cardiologist.

The EVENT [Diltiazem] is clearly related to the TIMEX3 [noon 09/17/01], because [Diltiazem] starts at [noon 09/17/01]. We use the TLINK tag to specify such relation. The TLINK tag has a *type* attribute, whose value can be BEFORE, AFTER, SIMULTANEOUS, OVERLAP, BEGUN_BY, ENDED_BY, DURING or BEFORE_OVERLAP (see Appendix 1). In this example, the TLINK between EVENT [Diltiazem] and TIMEX3 [noon 09/17/01] is "BEGUN_BY".

TLINK can also be used between two EVENTS. In this sentence, EVENT [Diltiazem] happens after EVENT [calling]. So you would create a TLINK between these two EVENTS, with the type "AFTER".

One entity (TIMEX3 or EVENT) can be involved in more than one temporal relation. For example, EVENT A can have a TLINK with EVENT B, and at the same time be linked with TIMEX3 C by another TLINK. **To avoid conflict, only one TLINK is allowed between the same pair of entities**, e.g. EVENT A cannot be BEFORE and DURING EVENT B at the same time.

You should use the following strategy to assign TLINKs:

- a. If there is a local temporal expression, link or anchor to that:

Smith had [chest pains] on [Sept 29] . (Event anchored to Timex)

- b. If there is an explicit relation between EVENTS, represent it:

[Chest pains] occurred before [admission]. (Event to Event)

- c. If there is no temporal expression, assume the section time (admission date or discharge date) is the anchor and describe the temporal relation between an EVENT and the section time in the EVENT's *sec_time_rel* attribute

Section Time=Sept 29, 2011

Patient experienced [chest pain]. (Event is related as prior to section time. It's *sec_time_rel* is BEFORE).

2.4 Using the Annotation Tool

In this annotation project, we will use a toolkit called Multi-purpose Annotation Environment Tool (MAE) for the annotation. Before you can run MAE, you need to make sure that Java is installed on your system ([download Java](#)). Once you have Java installed, on Windows, you simply double-click on

the "Mae_v0.9.1.jar" file, and on Mac or Unix run the command "java -jar Mae_v0.9.1.jar" (under the directory where you unzipped it) in a terminal window. The following window will appear upon the launch of the program.

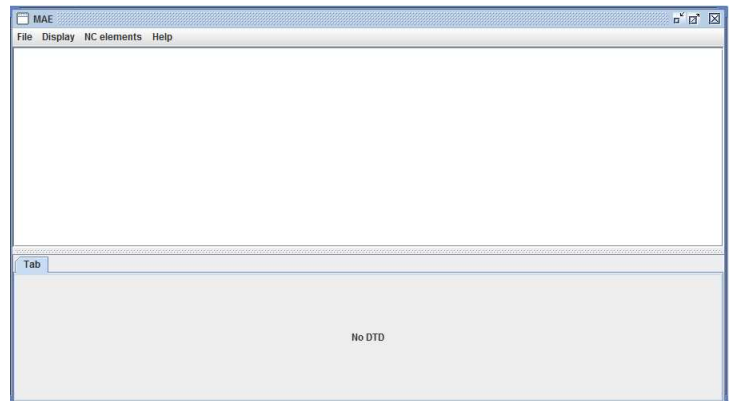


Figure 1. MAE Launch Page

To start the annotation, you need to first load the annotation schema into MAE. This is a DTD file called "TempAnnotation.dtd". Click on the "File" menu and select "Load DTD". In the pop-up window (Figure 2), navigate to the "sample" folder and select the "TempAnnotation.dtd", and click the "Open" button to load the DTD. Notice that four tabs appear in the bottom screen, "EVENT", "TIME3", "SECTIME", and "TLINK", which means that the loading was successful. You will need to load this DTD file every time you launch MAE.

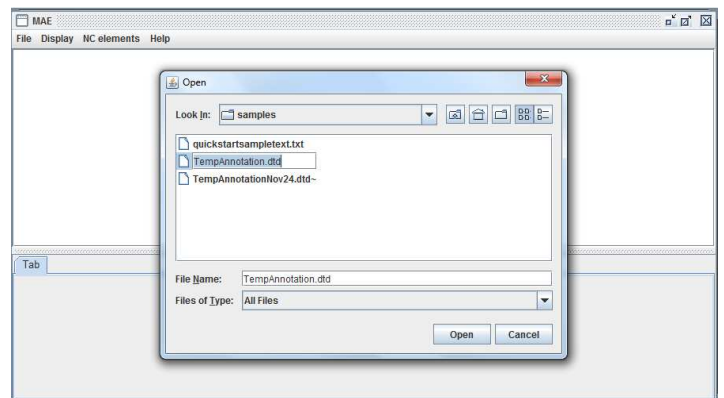


Figure 2

Once the DTD is loaded, we can open a text file and start our annotation. Click on the "File" menu again and select the file that you want to annotate. For this tutorial, let us choose the

"quickstartsampletext.txt". The text will be loaded to the text area of the screen. Now we can begin the annotation!

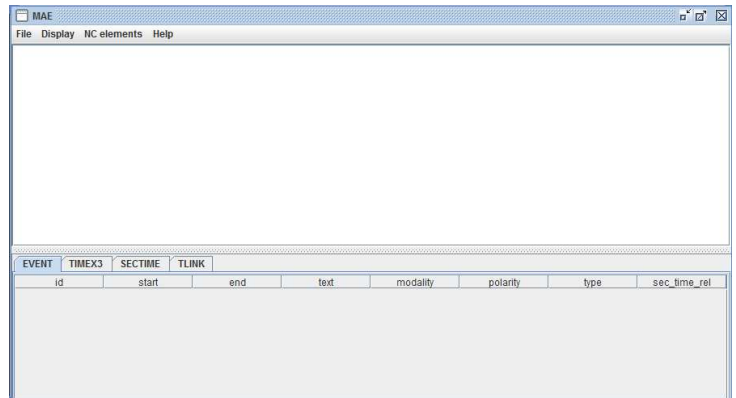


Figure 3

2.5 Annotating a TIMEX3

To annotate a temporal expression, select the span of text, right click on it, and choose "TIMEX3" from the drop-down menu.(Figure 4)

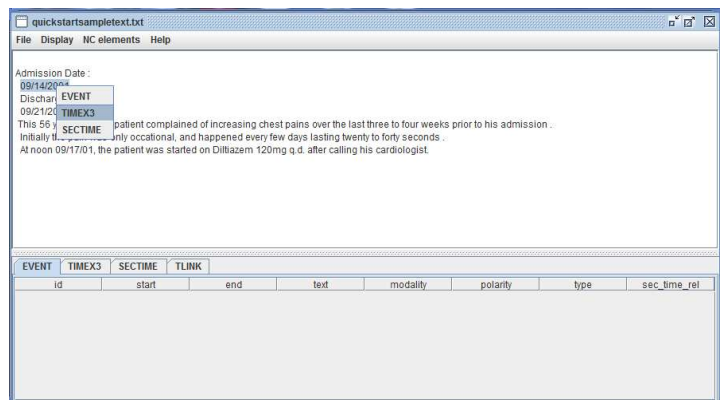


Figure 4

You will notice that the text "09/14/2001" will be highlighted in a different color. If you click on the "TIMEX3"

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tag in the bottom screen, you will notice a new line inserted into the table. The columns of the table list several attributes of the TIMEX3 (see Section 4). For this particular TIMEX3, we need to type in the value of the date in the *val* field, but will leave all the other attribute fields as they are. To enter the date, click on the cell under the *val* column, and type in "2001-09-14".

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Do the same for all of the other temporal expressions. To change the *type* or *mod* attribute of your TIMEX3, you would click on the default attribute and select the desired value from the drop-down list. After all the TIMEX3s in this text are annotated, your screen should look like this:

| EVENT | TIMEX3 | SECTIME | TLINK | id | start | end | text | type | val | mod |
|-------|--------|---------|-------|----|-------|-----|-------------------------|-----------|------------------|--------|
| T0 | | 20 | 30 | | | | 09/14/2001 | DATE | 2001-09-14 | NA |
| T1 | | 50 | 62 | | | | 09/21/2001 | DATE | 2001-09-21 | NA |
| T2 | | 145 | 164 | | | | three to four weeks | DURATION | P3.5W | APPROX |
| T3 | | 245 | 259 | | | | every few days | FREQUENCY | RP2D | APPROX |
| T4 | | 268 | 291 | | | | twenty to forty seconds | DURATION | PT30S | APPROX |
| T5 | | 299 | 312 | | | | noon 09/17/01 | TIME | 2001-09-17T12:00 | NA |
| T6 | | 357 | 361 | | | | q.d. | FREQUENCY | RP1D | NA |

Figure 5

2.6 Annotating an EVENT

Similarly, to annotate an EVENT in MAE, select the span of the text that you want to mark as an EVENT, and then right click on it. Choose "EVENT" from the pop-up menu. In our sample text, let's mark the EVENTS as shown in blue in Figure 6.

| EVENT | TIMEX3 | SECTIME | TLINK | id | start | end | text | modality | polarity | type | sec_time_ret |
|-------|--------|---------|-------|----|-------|-----|------------------|----------|----------|------------|--------------|
| E0 | 1 | 10 | | | | | Admission | FACTUAL | POS | OCCURRENCE | BEFORE |
| E1 | 33 | 42 | | | | | Discharge | FACTUAL | POS | OCCURRENCE | OVERLAP |
| E2 | 84 | 104 | | | | | complained | FACTUAL | POS | EVIDENTIAL | BEFORE |
| E3 | 108 | 131 | | | | | increasing chest | FACTUAL | POS | PROBLEM | BEFORE |
| E4 | 178 | 187 | | | | | admission | FACTUAL | POS | OCCURRENCE | BEFORE |
| E5 | 202 | 210 | | | | | the pain | FACTUAL | POS | PROBLEM | BEFORE |
| E6 | 341 | 350 | | | | | Diltiazem | FACTUAL | POS | TREATMENT | BEFORE |
| E7 | 368 | 375 | | | | | calling | FACTUAL | POS | OCCURRENCE | BEFORE |

Figure 6

2.7 Annotating a TLINK

To annotate a TLINK, you would hold down the "ctrl" button (or "command" on Mac) and click on the two entities that you would like to link. A pop-up window will appear. Select the first entity (e.g. TIMEX3) in the "Link from" field, the second entity (e.g. EVENT) in the "Link to" field, and select TLINK in the "Link Type" field. Then click "Create" Link. The attributes of TLINK can be edited under the TLINK tab in the bottom screen. For more detail on the different relation types expressed by TLINKs, please refer to Section 5 .

2.8 Saving your work

To save your annotation, click on "File" menu and select "Save file as XML". We will save the file as "quickstartsampletext.xml" under the sample folder. Next time, when you are ready to continue your annotation, use the "Load File" function under "File" menu to load the xml file, and continue your work.

3 Clinically Relevant Events: The <Event> Tag

We use the EVENT tag to mark the events mentioned or described in the medical record that are significant to the patient's clinical timeline. These include but are not limited to the symptoms, diseases, treatments, tests, events involving admission/transfer/discharge to(from) clinical departments, and so on. Below are some examples:

The patient was [transfused] with [radiated Leuco] three units .

The patient was previously [admitted] for [cardiac and pulmonary disease] .

Dr. Lawrence performed [the surgery] .

This section is divided into two subsections. Section 3.1 introduces how to mark an EVENT. It contains instructions on how to decide whether a phrase is an EVENT or not, and how to determine the span of an EVENT. Section 3.2 introduces the attributes of the EVENT tag, including *sec_time_rel*, *type*, *polarity*, and *modality*.

3.1 How to Annotate EVENTS

What is an EVENT?

Candidates for EVENTS include verb phrases, adjective phrases, noun phrases, and in some cases, even adverbs. Naturally, verb phrases that describe clinically relevant actions are considered EVENTS. For example, in "the patient reports a headache", the verb "reports" refers to a clinically relevant action of the patient's complaint, and hence is counted as an EVENT. More examples for verbal EVENTS can be found in section 3.1.2 below. An adjective phrase can be an EVENT, too, if it describes a clinically relevant state of the patient. For example, in "the patient is stable after the surgery", the adjective "stable" is an EVENT. A Noun phrase can also be an EVENT if a) it is a clinical concept (treatment, problem, test or clinical department), e.g., the phrase "a headache" in the example above is considered an EVENT, because it is a clinical problem; or b) it is the noun form of an action or a state, e.g., in "on admission, the patient swallows with difficulty", "admission" is an EVENT because it is the noun form of a clinically relevant action --"admit"; the word "difficulty", describing a state of swallowing, is also an EVENT. Similarly, adverbs can be marked as EVENTS if they are the adverb form of an action or a state, e.g. in "reportedly, the patient is doing well", both "reportedly", the adverb form of a "report" action, and "well", the adverb form of a state, are considered as EVENTS.

So far, it may sound as if everything can be an EVENT. Then what is the ultimate test to determine whether a phrase is an EVENT or not? A general test that we can use is to see a) whether the phrase is clinically important to the current medical record, and b) whether the phrase can be anchored to a clinical timeline. If

both answers to the two questions are yes, then the phrase is most likely an EVENT (with few exceptions, such as dosage information, which we will explicitly point out in the paragraphs below). For example, in "the patient speaks only Spanish and was admitted ...", the words "speaks" or "Spanish" are not quite relevant in the clinical sense, and thus, will not be marked as EVENTS; the phrase "the patient" is clinically relevant, but it refers to a person (in contrast to an action or state), and cannot be anchored to a timeline, and hence is not an EVENT, either.

How do we annotate an EVENT?

As we have seen in Section 2.6, each EVENT "consumes" a string of text. The text associated to an EVENT is called the "span" of the EVENT. As we have said, EVENTS are usually phrases or words. Thus, the following are NOT allowed in EVENT annotation under this guideline: 1) Overlapping spans. Two EVENTS sharing a common word are not allowed. For example, in "the patient [swallows with [difficulty]]", marking both "swallows with difficulty" and "difficulty" as EVENTS is not valid, and the correct annotation should be "[swallow] with [difficulty]". 2) Span across two or more sentences. A span that is assigned across sentences is not valid. In another word, an EVENT must be a continuous string of text within a single sentence.

What not to mark as EVENTS?

Besides the general test of EVENT that we provided above, there are some additional rules, or exceptions to the general test.

1) The dosage information of medication or other treatment, and the numerical result of a clinical test are not included in the EVENT span. For example, in "the patient was given three units of [blood transfusion]", "blood transfusion" is a clinical treatment and needs to be marked as an EVENT, but the dosage information "3 units of" should not be included in the EVENT span.³ Similarly, in "on [admission], [his hematocrit] is 26.8.", the numeric value of "26.8" is not marked as EVENTS either.

2) Location of a clinical problem/test/treatment within the patient's body is not marked as an EVENT, for a similar reason as above. For example, in "he was [diagnosed] with [needle biopsy] on either side of the prostate", the location "on either side of the prostate" is not marked as EVENTS.

3) Some verbs whose sole purpose is to introduce another verb/noun/adjective/adverb phrase, are not marked as an EVENT. Auxiliary verbs, such as "be", "has", "may", "will" and so on, fall into this category. For example, in "on [admission], [his hematocrit] is 26.8.", the auxiliary verb "is" is not an EVENT. There are other verbs that are also used to introduce other phrases. For example, in "the patient was given 3 units of [blood transfusion]", the word "given" does not provide any additional information, but rather just introduces the [blood transfusion] EVENT, and hence, it should not be marked as an EVENT.

Dr. Lawrence performed [the surgery].

(The word "performed" here should not be marked as an EVENT, because the purpose of this word is just to introduce the EVENT "surgery". Adding "perform" as an EVENT would not provide any additional

The reasons for this are 1) this is consistent with the 2010 i2b2/VA challenge concept annotation, and 2) the dosage and test results for some of our data have been annotated separately in another task and can be linked back to the treatment/test EVENTS.

information.)

He underwent [radical retropubic prostatectomy].

(*Similar to the previous example, the word "underwent" should not be marked as an EVENT, either.*)

- 4) Aspectual words, such as "start", "begin", "initiate", "stop", "remove" and so on, are not marked as EVENTS. Instead, we will use TLINKs to express the temporal relation that they convey. (Please refer to Section 7.3 for details).

[Enteral feedings] were initiated on 05-24-99 .

(*"initiate" does not need to be marked as an EVENT. We will use a TLINK ([Enteral feedings] BEGUN_BY [05-24-99]) to describe the "initiate" relation.*)

So far, we have talked about the general definitions and rules for EVENT annotation. In the following subsections, we will discuss further details of each class of EVENTS, the rules of determining EVENT spans, and give more examples to help you better understand the concept. Section 3.1.1. talks about annotating EVENTS related to clinical concepts, namely, clinical problems, tests, and treatments. Section 3.1.2 describes how to annotate EVENTS corresponding to the patient's stays in different clinical units within the hospital. Section 3.1.3 discusses the spans of other verb/noun/adjective/adverb EVENTS.

3.1.1 EVENTS Related to Medical Concepts

Some EVENTS in clinical narratives require special attention during the annotation. These are EVENTS that are based on clinical concepts, including tests, problems and treatments. Tests include the exams, laboratory tests, and their results. Problems include symptoms, complaints, diseases, and diagnoses. Treatments include medications, surgeries and other procedures. During the annotation, when you encounter a concept that falls into one of these categories, you need to mark it as an EVENT and indicate which of the three categories (tests /problems /treatment) it belongs to in the EVENT *type* field.

Tests include any clinical lab tests, exams, and their results. When you annotate test EVENTS, you just mark the test name, not the numerical result values. For example:

A [CT scan] showed that she had...

On admission, the patient had a [white blood cell count] of 43,700.

Problems include the patient's complaints, symptoms, diseases and diagnoses. For example:

Patient had [respiratory distress].

She reported some [shortness of breath].

Make sure that each EVENT corresponds to a single concept, e.g. in "she denies fever, chills or headache", [fever], [chills] and [headache] denote separate EVENTS, so grouping them into a single EVENT would be incorrect.

Treatments include medications and other procedures. As with tests, we only mark the name of the medication, but not the dosage. Here are some examples:

She was given further [mechanical ventilatory support]

On 8/30/2001, the patient was [extubated] in the operating room

[Ativan] p.r.n. was given for this.

3.1.2 EVENTS Related to Clinical Departments

We also mark as EVENTS patients' stays in different clinical units within the hospital. The clinical units involved in the patient's treatment present important information about the patient's clinical timeline, and thus need to be annotated. The *type* attribute for such events is *clinical_dept*, and it is used to mark the clinical unit/service/practice name. For example, if the text mentions that a patient was admitted to the emergency room, then to ICU and then to the medical floor, we will mark [emergency room], [ICU] and [medical floor] as EVENTS, and the event type will be *clinical_dept*. Here are some more examples:

The patient underwent an uncomplicated recovery in the [intensive care unit].

The patient was taken to the [operating room] and underwent an orthotopic liver transplant .

3.1.3 Other EVENTS

In this section, we will discuss the annotation of EVENTS that do not belong to the clinical concept category in 3.1.1. We separate them according to their part of speech, and call them verb phrases, noun phrases, adjectival phrases, and adverbs.

Verb phrases

We annotate verb phrases as EVENTS if they convey clinically important information. When we mark a verbal phrase as an EVENT, we usually just mark the main verb. Below are some examples.

The patient [reports] [the pain] began at 4:00 p.m.

The patient will [follow-up] with [Cardiology].

Note that some verbs whose only purpose is to introduce other EVENTS, do not need to be marked.

Ativan p.r.n. was given for this. (*"given" should not be annotated*)

The patient underwent an uncomplicated recovery in the [intensive care unit]. (*"underwent" should not be annotated.*)

Adjectival phrases

EVENTS usually express state information about the patient. When annotating adjectival phrases, we include both the adjective and its modifying adverb (except "no" or "not").

At that time , [the pain] was [unremitting].

She was never [hypoxic]. (*"never" should not be included*)

This would occur whenever he was [awake].

Adverbs

Sometimes, we will mark adverbs as EVENTS as well. For adverb EVENTS, we mark the full adverbial phrase.

The patient did [very well] in the postoperative course.

The patient [reportedly] had chest pain. ([reportedly] is an evidential EVENT.)

Noun phrases

When we annotate noun phrases as EVENTS, we take the entire base noun phrase. Prepositional phrases within the noun phrase should not be included in the same span.

She also has [a cough] with a small amount of [white sputum].

This is a 65-year-old female with a history of [recent exacerbation] of [lower extremity edema]

3.2 Attributes for EVENT

Just marking the span of each EVENT is not enough. In order for the annotation to be useful in text analysis, we need to describe each EVENT in more detail. These details are coded in the 4 attributes of the EVENT tag, including section time relation, type, polarity, and modality.

3.2.1 *Sec_time_rel* attribute

The *sec_time_rel* attribute stands for "section time relation". Section time refers to the section creation time, that is, the time at which that section of the record was written. More specifically, the discharge summary records in this annotation project contain two sections that require annotation: they are the clinical history section and the hospital course section. We define the section time of the clinical history section to be the date of admission because usually this section is written on the admission date. The section time of the hospital course section is defined to be the discharge date for the same reason.

For each EVENT, the *sec_time_rel* attribute records whether the EVENT happens before, after or whether it overlaps with the section creation time. That is, for every EVENT in the history section, we will mark whether it happened before, after or whether it overlapped with the admission date, and for every EVENT in the hospital course section, we will mark whether it happened before, after or whether it overlapped with the discharge date.

The *sec_time_rel* attribute is, in fact, a temporal relation. It links every EVENT to either the admission date, or the discharge date, depending on which section this EVENT appears in the text. This attribute is very important, and it does not have a default value. The annotator must select a *sec_time_rel* for each EVENT. It must not be left blank.

The four attribute values that the *sec_time_rel* attribute can take, are BEFORE, AFTER, OVERLAP and BEFORE_OVERLAP.

3.2.1.1 BEFORE

An EVENT is assigned a BEFORE *sec_time_rel*, if the EVENT ends before the section creation time (admission or discharge date). The *sec_time_rel* of the following EVENTS will be marked as BEFORE:

He was diagnosed with needle biopsy on either side of the prostate.

(This sentence was taken from a "History of Present Illness" section. The section time is the admission date of this record. The EVENT [diagnosed] and [needle biopsy] both happened before the patient was admitted to this department. So the sec_time_rel for both EVENTS are BEFORE)

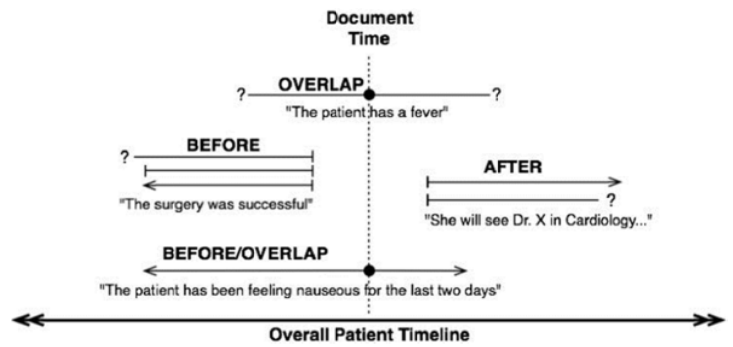


Figure 7: [From Styler et al. 2012, Draft Simplified THYME Guidelines.] Schematic view of all the *sec_time_rel* values relative to SECTIME.

3.2.1.2 OVERLAP

The *sec_time_rel* of an EVENT is OVERLAP if the EVENT occurred or was observed at section creation time (i.e. on admission date or discharge date).

She also has [a cough] with a small amount of [white sputum].

(This sentence is from "History of Present Illness"; these symptoms occur at about the same times as the admission. So the sec_time_rel of these symptoms are OVERLAP.)

Note the OVERLAP does not imply exact simultaneity. For further discussion, see section 5.2.1.3.

3.2.1.3 AFTER

If an EVENT begins after the section creation time (admission date or discharge date), its *sec_time_rel* is AFTER.

The patient will [follow-up] with [Cardiology].

(This sentence is taken from the "Hospital Course" section. The EVENT "follow-up" will happen after the discharge date. Thus, its sec_time_rel is AFTER.)

3.2.1.4 BEFORE_OVERLAP

This value should be used if an EVENT has been happening for an indeterminate period of time prior to the section creation time and continues at the section creation time. For example:

This is a 65-year-old female with a history of [recent exacerbation] of [lower extremity edema]

(This sentence is taken from the "History of Present Illness" section. The EVENTS "recent exacerbation" and "lower extremity edema" both started before the admission date, and they continued until after the admission date. Thus, their sec_time_rel attribute should be set to BEFORE_OVERLAP.)

3.2.2 Type attribute

As outlined above, we will use six EVENT types to categorize different kinds of EVENTS: TEST, PROBLEM, TREATMENT, CLINICAL_DEPT, EVIDENTIAL and OCCURRENCE. The first three values correspond to different categories of clinical concept EVENTS (clinical tests, symptoms, diagnoses, medications, surgeries and so on). The CLINICAL_DEPT value is used to mark the clinical units that the patient is admitted into. The EVIDENTIAL type is for EVENTS that have an 'evidential' nature, that is, if the EVENT describes the source of the information (e.g. CT [shows], the patient [complained] and so on). If an EVENT does not fall in to the above five categories, it will be marked as an "occurrence" – OCCURRENCE is the default value for EVENT type. In our data, TEST, PROBLEM, and TREATMENT EVENTS will be pre-annotated, based on previous manual annotation of clinical concepts in this data.

3.2.2.1 TEST

The "TEST" EVENT type is used for clinical tests (laboratory and physical), and test results. When tagging a TEST EVENT, we annotate the full name of test (or test result) but we don't include the numerical test result value. For example, in "White blood count is 380", we mark "white blood count" as an EVENT, but do not include the value 380. Here are some examples of TEST EVENTS:

[His preoperative workup] was completed and included [a hematocrit] of 42 .

(Both [His preoperative workup] and [a hematocrit] are "TEST" type EVENTS. Note that the numerical value of the hematocrit test result is not included in the EVENT span.)

3.2.2.2 PROBLEM

The "PROBLEM" EVENT type includes patient's complaints, symptoms, diseases, and diagnoses. Below are some more examples of PROBLEM EVENTS:

The patient is a 69 year old [diabetic] who underwent [an APR] in 1995 for [rectal carcinoma]

(Both [diabetic] and [rectal carcinoma] are "PROBLEM" type EVENTS, while [an APR] is a TREATMENT.)

3.2.2.3 TREATMENT

The "TREATMENT" EVENT type includes medications, surgeries and other procedures. Similar to "TEST" EVENTS, we only mark the name of medication, but not the dosage information. For example, in "Levaquin 750 mg p.o. q. day", we just annotate "Levaquin" as a TREATMENT EVENT. Below are some more examples of TREATMENT EVENTS:

He underwent [exploratory laparotomy] and [left hepatectomy] and [cholecystectomy]

([exploratory laparotomy], [left hepatectomy] and [cholecystectomy] are all TREATMENTS.)

3.2.2.4 CLINICAL_DEPT

The "CLINICAL_DEPT" type is used to mark the clinical unit/service/practice name. During the patients' hospital course, they usually get transferred to different practice units, e.g. a patient may arrive in the emergency room first and then be transferred to the ICU, and then to the medical floor. These transfers are important information about the patient's clinical timeline, and thus need to be annotated. Please refer to the examples below:

The patient underwent an uncomplicated recovery in the [intensive care unit].

The patient was taken to the [operating room] and underwent an orthotopic liver transplant .

3.2.2.5 EVIDENTIAL

Verbs of showing, reporting or demonstrating should be annotated as EVENTS, as the source of information can be just as important as the information itself in a clinical context. Evidential EVENTS are represented by verbs (or noun/adjective derived from these verbs) that specify the source of information:

The patient [reportedly] had [chest pain].

([reportedly] is an EVIDENTIAL EVENT.)

[His arterial blood gas] [showed] [a respiratory acidosis] with [a PCO2] of 71 .

([showed] is an EVIDENTIAL EVENT.)

He [complains] of headache.

([complains] is an EVIDENTIAL EVENT)

3.2.2.6 OCCURRENCE

Occurrence is the default value for EVENT types. It is used for all the other kinds of clinically relevant events that occur/happen to the patient. Below is an example of OCCURRENCE EVENT:

He was [readmitted] for [sternal wound infection]

([readmitted] is an OCCURRENCE EVENT)

3.2.3 Polarity attribute

The *polarity* attribute marks whether an EVENT is positive or negative. For example, in “the patient reports headache, and denies chills”, the EVENT [headache] is positive in its polarity, and the EVENT [chills] is negative in its polarity. Each EVENT must be either POS (positive) or NEG (negative). Since fewer EVENTS are negative, the default value for EVENT *polarity* in the MAE tool is POS.

3.2.3.1 POS

Most of the EVENTS have POS polarity value, that is, the EVENT is not negated. It is to be noted that an EVENT can be POS even if it did not actually occur (e.g. if the EVENT is hypothetical, or proposed.)

The patient [reportedly] had [chest pain].

[His arterial blood gas] [showed] [a respiratory acidosis] with [a PCO2] of 71.

He was [readmitted] for [sternal wound infection]

[Surgical option] was [suggested] by the doctor. But the family [decided] to follow [conservative treatment] after [discussion].

(All of the EVENTS above have POS polarity. Note that judging from the context, the [Surgical option] in the last example did not actually happen, nonetheless, the polarity of [Surgical option] is still POS, because it is not negated in the sentence.)

3.2.3.2 NEG

If an EVENT is negated by words such as “not”, “deny”, and so on, its polarity is NEG.

He [felt] [well] without [fevers] , [chills] or [rigors] .

(The polarity for [fevers] , [chills] and [rigors] is NEG.)

3.2.4 Modality attribute

The modality attribute is used to describe whether an EVENT actually occurred or not. Annotation of modality is adapted from the i2b2 2010 challenge guidelines for assertion annotation.⁴ Recall that the polarity attribute simply marks whether an EVENT is negated in the sentence or not. In the example, “[Surgical option] was [suggested] by the doctor.”, the “[Surgical option]” EVENT has a POS polarity, but the EVENT did not actually happen. In order for us to differentiate these EVENTS from EVENTS that actually occurred, the contextual modality attribute is introduced.

The modality attribute can take four possible values: FACTUAL, CONDITIONAL, POSSIBLE and PROPOSED. FACTUAL is assigned to EVENTS that actually happened (or will happen) or absolutely didn’t happen (or won’t happen). Both CONDITIONAL and POSSIBLE EVENTS are hypothesized to have or will occur(red). PROPOSED is assigned to EVENTS that are suggested, or recommended but may or may not happen.

3.2.4.1 FACTUAL

This value is assigned to facts, i.e. EVENTS that actually happened (is happening, or will happen). For EVENTS with NEGATIVE polarity, this value corresponds to the situation when something did not happen (is not happening, or will not happen). The default value for the modality attribute is FACTUAL.

3.2.4.2 CONDITIONAL

This value is assigned to EVENTS that are hypothesized to happen under certain conditions. This value should be used both for (1) an EVENT that may happen under certain conditions, and (2) an EVENT that serves as a condition for another EVENT occurring.

[Ativan] 0.25 to 0.5 mg IV q 4 to 6 hours prn [anxiety]

(Both Ativan and anxiety are CONDITIONAL events – they may or may not happen)

If the patient experiences [wheezing] or [shortness of breath], administer [oxygen] through a nasal tube

([wheezing], [shortness of breath], and [oxygen] are all CONDITIONAL events)

The patient has [coughing spells] when he [climbs] three flights of stairs .

(Note that neither [coughing spells] or [climbs] are CONDITIONAL, because we know for a fact that they had actually happened. They are both FACTUAL)

3.2.4.3 POSSIBLE

This value is assigned to EVENTS that are hypothesized to have occurred. It should be used to annotate EVENTS that are likely or possible, guesses or conjectures by doctors, etc.

This is very likely to be [an asthma exacerbation].

([an asthma exacerbation] is a POSSIBLE event.)

Doctors suspect [an infection] of the lungs.

We suspect this is not [pneumonia]

This is probably not [cancer]

([an infection], [pneumonia] and [cancer] are POSSIBLE events)

3.2.4.4 PROPOSED

The "PROPOSED" modality type is assigned to EVENTS that are proposed or suggested but may or may not actually happen. Typical examples of "proposed" EVENTS include patient's preferences and doctor's recommendations.

The infectious disease service 's [recommendations] included [tapering the steroids]

([tapering the steroids] is a PROPOSED EVENT.)

4 Temporal Expressions: The <TIMEX3> Tag

In this section, we describe how to identify and annotate temporal expressions. Temporal expressions include all references to points in time, time periods, durations, and frequencies. You will need to mark up all the text spans that contain such references. For example:

His hematocrit was checked [two weeks] prior to admission

She reports a 5 pound weight loss over [the past several months]

The patient was brought to the operating room on [05-04-1998].

4.1 How to annotate TIMEX3

Determining the span for TIMEX3 is straightforward. We just mark the entire temporal expression. The prepositions before or after the temporal expression phrase are usually not included in the TIMEX3 span. We will mark four types of temporal expressions: date, time, duration and frequency. We will discuss each type in the next section. Here are some examples of temporal expressions we will need to annotate:

He had decompensation of his cirrhosis in [2005]

Within [the first few days] after the surgery , his liver function tests were elevated

She has been ambulating on her own [several times a day] .

4.2 Attributes for TIMEX3

The TIMEX3 tag contains three attributes. The *type* attribute specifies if the temporal expression is a date, time, duration or frequency. The *val* attribute quantifies the value of the temporal expression. Finally, the *mod* attribute adds additional modifying information about the temporal expression.

4.2.1 Type attribute

The *type* attribute has four possible values: DATE, TIME, DURATION and FREQUENCY.

4.2.1.1 DATE

Date is the most common temporal expression in the discharge summaries that we will work with. Any temporal expression that specifies an exact date, a month or a year, will be categorized as a TIMEX3 of *type* "DATE". For example:

The patient was brought to the operating room on [05-04-1998].

Since [March], he has not experienced any symptoms.

He had decompensation of his cirrhosis in [2005]

4.2.1.2 TIME

Some temporal expressions specify the time point within a day, e.g., 3pm, 4:55, and so on. These temporal expressions are categorized as TIMEX3s of *type* "TIME". For example:

The patient was taken to the operation room at [10 o'clock].

At [09-26-2001 5:00pm], the patient passed away.

4.2.1.3 DURATION

Another TIMEX3 type that often appears in the records is a duration. TIMEX3s of *type* "DURATION" are temporal expressions that specify a period of time. For example:

Within [the first few days] after the surgery , his liver function tests were elevated

His hematocrit was checked [two weeks] prior to admission

She reports a 5 pound weight loss over [the past several months]

4.2.1.4 FREQUENCY

In clinical records, the frequency of symptoms or medication usage is important information, and hence should be annotated. These are annotated with TIMEX3 of *type* "FREQUENCY".

She has been ambulating on her own [several times a day] .

The patient was discharged to home on Amiodarone 200 mg [daily]

The patient was started on Propafenone 300 mg [t.i.d.]

4.2.2 *Val* attribute

We use a wide variety of phrases and expressions when we describe temporal information. For example, we can easily come up with a number of ways to describe Dec 25 2010, e.g. 2010-12-25, 12/25/2010, last Christmas. These various forms of temporal phrases need to be normalized in order for machines to understand and process them. The purpose of the *val* (i.e. value) field of the TIMEX3, is to store the temporal information in a standard, normalized format. More specifically, we use the ISO 8601 standard⁵ to encode the temporal information in these guidelines. We will discuss the encoding in detail in the following sections.

For each TIMEX3 entity, you need to determine its value representation based on the rules below, and fill out the "VAL" field in MAE.

4.2.2.1 Date Value Representation

The format of calendar date in ISO 8601 is: [YYYY]-[MM]-[DD] (without the brackets). If the temporal expression doesn't include the exact date information, the format [YYYY]-[MM] is allowed. If the temporal expression only includes the year information, you can simply put [YYYY] in the *val* field.

The patient was brought to the operating room on [05-04-1998]. (*val*="1998-05-04")

More information about the ISO 8601 standard can be found at:
http://en.wikipedia.org/wiki/ISO_8601

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Since [March], he has not experienced any symptoms. (*val*="2005-03", the year information here is derived from the context)

He had decompensation of his cirrhosis in [2005] (*val*="2005")

4.2.2.2 Time Value Representation

We use the extended time format of ISO 8601 for annotation, specified as: [hh]:[mm]:[ss]. [hh] (without the brackets) ranges from 00 to 24 (where 24 is only used to represent the end point of a calendar day, and the hours are zero-padded, e.g. 9 am -> 09); [mm] and [ss] both range from 00 to 59, zero-padded, and represent minutes and seconds respectively. For reduced accuracy, [ss] and/or [mm] can be omitted, i.e. [hh] and [hh]:[mm] are allowed.

A combined date and time representation follows the format [YYYY]-[MM]-[DD]T[hh]:[mm]:[ss]. In your annotation, if a time expression can be anchored to a specific date, as is usually the case (see the examples below), make sure to include the date information in the *val* field as well.

Examples:

The patient was taken to the operation room at [10 o'clock].

(If the date of the operation can be determined from the context (which is usually the case), then the date info should be included in the val field, the val = "2004-09-27T10:00". Otherwise, val = "T10:00")

At [09-26-2001 5:00pm], the patient passed away. (*val* = "2001-09-26T17:00")

Midnight on Dec 20, 2001 (*val* = 2001-12-20T24:00).

(NOTE: "2001-12-20T24:00" is Dec 20, 2001, the end of day; "2001-12-21T0:00" is the beginning of Dec 21, 2001. These two notations therefore describe the same time point.)

4.2.2.3 Duration Representation

Durations are temporal expressions that describe a period of time, e.g. for eleven days, for half a year. The syntax of duration representation is P[n][Y/M/W/D]. So, "for eleven days" will be represented as "P11D", meaning a period of 11 days. The [n] field doesn't have to be an integer; "P0.5Y" is a valid notation for a period of half a year. The designators can be combined to express a compound period, so "P2M3D" means a period of 2 months and 3 days. As tabulated below, the designator "M" can mean both "month" and "minute". In order to differentiate, we use the "T" designator to signal time periods, e.g. "P20M" = 20 month, "PT20M" = 20 minutes.

| designator | meaning | designator | meaning |
|------------|---------|------------|---------|
| P | Period | T | Time |
| Y | Year | H | Hour |
| M | Month | M | Minute |
| W | Week | S | Second |

D Day

Below are some examples:

Within [the first few days] after the surgery , his liver function tests were elevated (*val* = "P2D", the phrase 'few days' or 'a couple days' are mapped approximately to 2 days with the APPROX mod(in section 4.3).)

His hematocrit was checked [two weeks] prior to admission (*val* = "P2W")

She reports a 5 pound weight loss over [the past several months] (*val* = "P3M" mod = "APPROX")

4.2.2.4 FREQUENCY Representation

The frequency of events can be represented by using the ISO 8601 repeated intervals. The ISO repeated interval syntax is: R[n][duration], where n denotes the number of repeats. When the n is omitted, the expression denotes an unspecified amount of repeats. For example, "once a day for 3 days" is "R3P1D" (repeat the time interval of 1 day (P1D) for 3 times (R3)), twice every day is "RP12H" (repeat every 12 hours). In clinical text, we may see frequencies such as p.r.n (take as needed), which can be represented by "R" (repeat for unspecified times of unspecified duration).

The patient was discharged to home on Amiodarone 200 mg [daily] (*val* = "RP1D")

The patient was started on Propafenone 300 mg [t.i.d.] (*val* = "RPT8H")

She has been ambulating on her own [several times a day] . (*val* = "RPT8H", *mod* = "APPROX")

B.i.d. (twice daily) (*val* = RPT12H)

Od/o.p.d. (once daily) (*val* = RPT24H)

q.a.d. (every other day) (*val* = RPT48H)

4.2.3 Mod attribute

Sometimes additional information regarding the temporal value of a time expression may be expressed by a modifier. The *mod* attribute captures this information. The *mod* attribute can take the following values:

1. "NA": the default value, no relevant modifier is present;
2. "MORE", means "more than", e.g. over 2 days (*val* = P2D, *mod* = MORE);
3. "LESS", means "less than", e.g. almost 2 months (*val* = P2M, *mod*=LESS);
4. "APPROX", means "approximate", e.g. nearly a week (*val* = P1W, *mod*=APPROX);
5. "START", describes the beginning of a period of time, e.g. Christmas morning, 2005 (*val*= 2005-12-25, *mod*= START).
6. "END", describes the end of a period of time, e.g. late last year, (*val* = 2010, *mod* = END)
7. "MIDDLE", describes the middle of a period of time, e.g. mid-September 2001 (*val* =2001-09, *mod*= MIDDLE)

4.3 Annotating Relative Time

In natural language, we do not always use absolute date/time (with explicit calendar date or time information). Instead, we often use relative time or date, such as, "last Friday", "my 21st birthday", "one day prior to admission", and so on. These relative temporal expressions also need to be marked as TIMEX3s. Below are some examples:

On [the day] of discharge his hematocrit was 27.4 compared to 27.9 from [the previous day].

The patient is [now] in stable condition.

In order to determine the actual temporal value of relative TIMEX3es, we need to anchor the relative TIMEX3s and to their corresponding absolute TIMEX3s/EVENTs. We will discuss in detail how to mark such temporal relations and how to specify the *val* field for relative TIMEXes in Chapter 5.1.3.

5 Temporal Relations: The TLINK tag

Now that we have discussed the annotation of EVENTS and TIMEX3s, we introduce a relation tag, TLINK, that is used to mark temporal relations between EVENTS and TIMEXs. TLINKs can be used to indicate a connection between two EVENTS, between an EVENT and a TIMEX3, and in the case of relative TIMEX3, also between two TIMEX3s.

5.1 How to Annotate TLINK

We add a TLINK between two entities if there is a temporal relation between them. For example, in "His hematocrit was checked [two weeks] prior to admission", the testing of [His hematocrit] occurs before the [admission]. The duration [two weeks] begins at the point when the hematocrit is checked, and ends at the time of admission. These relations can be specified using TLINKs.

The TLINK tag has two attributes, *type* and *explicit*. The *explicit* attribute specifies whether the temporal relation is explicitly stated in the text, or is an inference made by the annotator. The *type* attribute specifies what kind of temporal relation exists between the two entities. In our annotation, we will use eight types of temporal relations: before, after, simultaneous, overlap, begun_by, ended_by, during, and before_overlap. Details about these types will be specified in Section 5.2.

In Section 5.1.1, we will talk about how to assign TLINKs between EVENTS and TIMEX3s. Section 5.1.2 describes how to assign TLINKs between two EVENTS. TLINKs between two TIMEX3s are only used to annotate relative TIMEX3s. In Section 5.1.3, we will explain how to use TLINKs to annotate relative TIMEX3's relation to other TIMEX3s and EVENTS. Of course, we don't have to assign a TLINK to every pair of entities (EVENT or TIMEX3). In 5.1.4, we will summarize the strategy for how to choose whether a particular temporal relation should be annotated.

5.1.1 Anchor EVENTS to Local Temporal Expressions

In order to create a patient's clinical timeline, we need to link the relevant clinical EVENTS to a point in the timeline. So it is important to mark relations between EVENTS and local TIMEX3s. If a temporal relation between an EVENT and a TIMEX3 is stated locally, it needs to be marked. For example:

He had [chest pains] on [Sept 29] .

([chest pains] SIMULTANEOUS with [Sept 29])

He has a history of [multiple pulmonary infections] prior to [2007].

([multiple pulmonary infections] BEFORE [2007])

5.1.2 Add Temporal Relations Between EVENTS

Temporal relations between two EVENTS also need to be marked. If there are clear relations between EVENTS within a sentence, we need to annotate such relations:

The patient was initially [admitted] to the [medical service] prior to [his coronary artery bypass graft] .

([admitted] BEFORE [his coronary artery bypass graft], [medical service] BEGUN_BY [admitted])

[An aortogram] revealed [a Debakey class I aortic ascending aneurysm].

([a Debakey class I aortic ascending aneurysm] BEFORE_OVERLAP [An aortogram])

Sometimes, temporal relation exists between EVENTS in adjacent sentences as well, which also needs to be annotated.

He had a [drop] in [hematocrit] to the low 20s.

2 units of [red blood cells] were transfused.

(the transfusion of red blood cell was a consequence of the drop in hematocrit: [red blood cell] AFTER [drop])

In other cases, temporal relations exist between EVENTS that are separated by several sentences. One of such cases is co-reference– two different phrases refer to the same event. We use “SIMULTANEOUS” TLINK type to annotate co-reference relations (see 5.2.1.2 for detail).

The patient was initially [admitted] to the [medical service] prior to [his coronary artery bypass graft]

.....

The patient was given [stress dose steroids] prior to [his surgery] .

(“his surgery” and “his coronary artery bypass graft” refer to the same EVENT, and thus need to be linked using a SIMULTANEOUS TLINK.)

In other cases, if a clear temporal relation between EVENTS in non-adjacent sentences exists, it also needs to be marked:

[His preoperative workup] was completed and included [a normal white count].

...

On 09-05-96 the patient was brought to the [operating room]

([His preoperative workup] BEFORE [operating room])

5.1.3 Anchor Relative TIMEX3s

As we have mentioned in 4.3, we sometimes encounter relative temporal expressions such as, “last Friday”, “one day prior to admission”, and so on. Relative dates/times need to be anchored to some absolute date or time to determine their exact value.

To fully express a relative time, two pieces of information need to be provided: (1) the relationship (TLINK) between the relative TIMEX3 and the absolute TIMEX3 (or EVENT) that it anchors to, and (2) the actual value (when mapped to an absolute point in time) of the relative TIMEX3. The first piece of information is captured by the TLINKS that we assign to the relative TIMEX3s and the corresponding absolute TIMEX3s/EVENTS. The

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second piece of information is captured by the *val* field of the TIMEX3. In other words, after we annotate a relative TIMEX3, we need to calculate its actual temporal value (e.g. the exact date of 'last Friday'), and TLINK the relative TIMEX3 to an absolute TIMEX3 or EVENT.

Below are some examples of how to annotate relative TIMEX3s of type "DATE":

[Today], [September 26th , 2001] , the patient remains afebrile and hemodynamically stable.

(TIMEX3 [Today] type="DATE", val="2001-09-26")

(TIMEX3 [September 26th , 2001] type="DATE", val="2001-09-26")

(TLINK TIMEX3 [Today] to TIMEX3 [September 26th, 2001], type="SIMULTANEOUS")

on [the day] of admission

(TIMEX3 [the day] type="DATE", val="2001-09-17")

(TLINK EVENT [admission] to the admission date TIMEX3, type="DATE", val="2001-09-17")

(TLINK TIMEX3 [the day] to EVENT [admission], type="SIMULTANEOUS")

On [the day] prior to admission, the patient's Flagyl was changed to Clindamycin.

(TIMEX3 [the day] type="DATE", val="2001-09-16")

(TLINK EVENT [admission] to the admission date TIMEX3, type="DATE", val="2001-09-17")

(TLINK TIMEX3 [the day] to EVENT [admission] , type="BEFORE")

On [the day] of discharge his hematocrit was 27.4 compared to 27.9 from [the previous day].

(TIMEX3 [the previous day] type="DATE", val="2001-09-25")

(TLINK EVENT [discharge] to the discharge date TIMEX3, type="DATE", val="2001-09-26")

(TLINK TIMEX3 [the previous day] to EVENT [discharge], type="BEFORE")

The patient is [now] in stable condition.

(TIMEX3 [now] type="DATE", val="2001-09-26")

(This sentence is written at the time of discharge, the discharge date TIMEX3 is [2001-09-26] type="DATE", val="2001-09-26")

(TLINK TIMEX3 [now] to discharge date TIMEX3, type="SIMULTANEOUS")

Some absolute temporal expressions that specify time may not include any information about the date. However, if the date can be determined, it still needs to be included in the *val* field of the relative TIMEX3. Below are examples of how to annotate relative TIMEX3s of type "TIME".

First EKG at [03:36 a.m.] was at a rate of 161.

(TIMEX3 [03:36 a.m.] type="TIME", val=2001-09-17T03:36)

(TLINK EVENT [admission] to the admission date TIMEX3, type="DATE", val="2001-09-17")

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(TLINK, TIMEX3 [03:36 a.m.] to EVENT [admission], type="OVERLAP")

The team was called at [6:30 in the morning] by bedside and found the patient having no respirations.

(TIMEX3 [6:30 in the morning], type="TIME", val="2001-09-26T06:30")

(This sentence is written at the time of discharge, the discharge date TIMEX3, type="DATE", val="2001-09-26")

(TLINK TIMEX3 [6:30 in the morning] to the discharge date TIMEX3, type="OVERLAP")

For temporal expressions that indicate durations, we use the *val* field to record the length of the time period (P[n][Y/M/W/D]). Either the starting point or the ending point of the period denoted by a duration TIMEX3 should be anchored to an absolute TIMEX3 or to an EVENT using TLINK. Below are some examples:

Acute bleed is unlikely considering the patient's stability over [the last week] in the hospital.

(TIMEX3 [the last week], type="DURATION", val="P1W")

(TIMEX3 discharge date, type="DATE", val="2001-09-26")

(TLINK TIMEX3 [the last week] to the discharge date, type="ENDED_BY")

Over [the few days] prior to admission, the patient exhibited increased lethargy.

([the few days] type="DURATION", val="P2D", mod="APPROX")

(TLINK EVENT [admission] to the admission date, type="DATE", val="2001-09-17")

(TLINK TIMEX3 [the few days] to EVENT [admission], type="ENDED_BY")

His hematocrit was 35 on admission and fell to 28 [overnight].

(TIMEX3 [overnight], type="DURATION", val="P12H", mod="APPROX")

(TLINK EVENT [admission] to the admission date, type="DATE", val="2001-09-17")

(TLINK TIMEX3 [overnight] to EVENT [admission], type="BEGUN_BY")

The patient was transferred to the floor on September 25. [Last night], the patient had frank melanotic stools times four.

(TIMEX3 [Last night], type="DATE", val="2001-09-25", mod="END")

(Section creation time, the discharge date, type="DATE", val="2001-09-26")

(TLINK TIMEX3 [Last night] to section creation time, the discharge date, type="ENDED_BY")

5.1.4 When to create TLINKS and when not to

If there are N entities (EVENTs and TIMEX3s) in the record, there are roughly N² pairs of entities—and therefore, possible TLINKs. We do not have to (and it is also impossible to) annotate all pairs of entities. In this section, we will discuss when not to create TLINKs, and summarize the overall strategy for creating TLINKs.

When not to create TLINKs:

First of all, we do not need to mark duplicate relations that can otherwise be derived from existing TLINKs. For example, if we recorded that A is before B, and B is before C, it can be derived from these two relations that A is also before C. The last TLINK (A before C) does not need to be created. In fact, after the manual annotation is completed, a transitive closure algorithm will be run on the annotated TLINKs to generate all derived TLINKs (links like A before C in this case). Note that in the example above, if we annotate A as being before C, and B before C, the relation between A and B cannot be derived from the existing TLINKs. The two annotations are not equivalent. Be careful when you choose which subset of TLINKs to annotate so as not to leave out any temporal information.

Secondly, if a temporal relation between the EVENT and the admission or discharge date has already been specified in the *sec_time_rel* of the EVENT, it does not need to be marked. Recall that in the "History of Present Illness" section of the record, the section time is the admission date, and for each EVENT in this section, its temporal relation with the admission date has already been recorded. So is the relation between an EVENT in the hospital course section and the discharge date. These relations do not need to be duplicated in the TLINKs.

Lastly, the temporal relations between two DATE type TIMEX3s do not need to be marked. For example, if Oct 1, 1996 and Oct 24, 1996 are two TIMEX3s in the record, we don't have to annotate the temporal relation [Oct 1, 1996] before [Oct 24, 1996]. A post-annotation process will automatically take care of relations like this. However, temporal relations between DATE type TIMEX3s and DURATION type TIMEX3s need to be marked (see section 5.1.3 for details).

TLINK Strategy

The following summarizes the overall strategy that you should follow for creating TLINKs for EVENTS:

- a. If there is a local temporal expression, link or anchor to that:

He had [chest pains] on [Sept 29]. (Event anchored to Time)

- b. If there is an explicit relation between EVENTS, represent it:

[Chest pains] occurred before [admission]. (Event to Event)

- c. If there is an implicit relation between EVENTS, mark it:

*73 yo M transferred from Newton-Wellesley Hospital hospital for epidural abscess
([epidural abscess] BEFORE_OVERLAP [transferred])*

- d. If there is no temporal expression, assume the section creation time is the anchor, and mark the *sec_time_rel* attribute of the EVENT to record this relation. No additional TLINK is needed.

Admission date: Sept 29, 2011

Patient experienced [chest pain].

(the sec_time_rel of the EVENT is BEFORE, no additional TLINK is required.)

5.2 Attributes for TLINK

We define two attributes for the TLINK tag: the *type* attribute and the *explicit* attribute. The *type* attribute specifies what kind of temporal relation exists between the two entities, and the *explicit* attribute specifies whether the temporal relation is explicitly stated in the text, or is an inference made by the annotator.

5.2.1 Type attribute

The type attribute has eight possible values: BEFORE, AFTER, OVERLAP, SIMULTANEOUS, BEGUN_BY, ENDED_BY, DURING and BEFORE_OVERLAP.

NOTE: all of the relation types below can be assigned to two EVENTS, an EVENT and a TIMEX3, or two TIMEX3s. When we describe the relation types below, we may use EVENT to EVENT as an example to avoid repeated descriptions, but please keep in mind that they are applicable to EVENT to TIMEX3 and TIMEX3 to TIMEX3 as well.

5.2.1.1 BEFORE

Similarly to the BEFORE value in *sec_time_rel*, we assign BEFORE value for temporal relations between EVENT A and EVENT B, if A happens before B.

The patient was given [stress dose steroids] prior to [his surgery] .

([stress dose steroids] BEFORE [his surgery])

He had [another serious concussion] prior to [August 17].

([another serious concussions] BEFORE [August 17])

5.2.1.2 AFTER

AFTER is assigned when EVENT A happens after EVENT B. Alternatively, you may mark it as EVENT B BEFORE EVENT A.

The patient was given [stress dose steroids] prior to [his surgery] .

([his surgery] AFTER [stress dose steroids])

He had [another serious concussion] prior to [August 17].

([August 17] AFTER [another serious concussions])

5.2.1.3 SIMULTANEOUS⁶

The SIMULTANEOUS relation is used to describe the fact that two things happen at exactly the same time. It is more precise than OVERLAP (see Section 5.2.1.4). We use this relation in the following two scenarios:

1. To indicate that two EVENTS/TIMEX3s refer to the same thing (coreference):

The patient was taken to the operating room and underwent an [orthotopic liver transplant] .

In order to aid in optimization of the patient 's fluid status , the patient was on continuous Baker dialysis during [the procedure] .

(the [orthotopic liver transplant] and the [the procedure] refer to the same thing, thus the temporal relation between them is "SIMULTANEOUS")

The patient 's serum creatinine on [the day] of [discharge] , on [2013-05-06] , was 1.9

([the day], [discharge] and [2013-05-06] all refer to the same date. So the relations among them are "SIMULTANEOUS")

⁶ In the evaluation, SIMULTANEOUS and OVERLAP TLINK types will be merged because of the difficulty for annotators to distinguish them.

2. To mark the relation between two different entities (EVENT or TIME3) that begin at exactly the same time and end at the same time.

The patient 's [INR] on [admission] was 2.4 , with his [PT level] being 18.9 .

(These two tests happen on the same date, and from the context, we know that the finer granularity (exact time) of these texts are not important. Thus these two EVENTS will both be marked as "SIMULTANEOUS" to the [admission])

Note that "exactness" here is a relative notion. In a different context, we may be interested in a different temporal granularity. In other words, we don't require that the two events must be perfectly synchronized to be marked them as SIMULTANEOUS. For example, if a patient took medicine A and medicine B at noon today, one may argue that the two actions of taking medicine did not necessarily happen at the same time, as the patient may have put one pill in his/her mouth before the other. However, in this context, it is not clinically important which pill the patient took first. It is sufficient to know that both were taken at noon - so we can treat these two events as SIMULTANEOUS.

In our corpus, we will see many instances of anchoring EVENTS to DATE TIME3s, e.g. "the CT scan dated 2001-09-17, and physical examination on the same day". If we only care about the date when the test was performed, we can treat these two events as SIMULTANEOUS - they are simultaneous on the granularity of date (although we know for a fact that these two events happen at different times on that day). However, if the patient had two physical exams on the same day, and the clinical narrative needs to distinguish the points in time when they happened, then they should not be annotated as SIMULTANEOUS, but rather, treated according to the order recorded in the narrative.

5.2.1.4 OVERLAP

The OVERLAP relation is assigned when two EVENTS (or an EVENT and a TIME3, or two TIME3s) happen at almost the same time, but not exactly. It is the default relation that we use when we decide that there exists an overlapping temporal relation between two EVENTS or an EVENT and a TIME3, and the relation is not SIMULTANEOUS or DURING. We use overlap in the following scenarios:

1. Two EVENTS (or an EVENT and a TIME3, or two TIME3s) happen at roughly the same time:

He recently developed fatigue and dyspnea

([fatigue] OVERLAP [dyspnea])

She denies any [fevers] or [chills]

([fevers] OVERLAP [chills])

In the following example, it is easy to see that the events in question are overlapping, but not simultaneous:

For the past couple of months, the patient has had [a non-healing right dorsal foot ulcer] which started as [a pin hole] and later developed to [Stage II].

([a non-healing right dorsal foot ulcer] OVERLAP [a pin hole])

([a non-healing right dorsal foot ulcer] OVERLAP [Stage II])

([a pin hole] BEFORE [Stage II])

2. Special case: we use "OVERLAP" to describe the relation between an EVENT and its modifying FREQUENCY TIME3.

The ulcer was managed conservatively at Har Hospital by Dr. Holes with [Silvadene] [b.i.d].

([Silvadene] OVERLAP with [b.i.d.])

5.2.1.5 BEGUN_BY

If EVENT A begins when EVENT B happens, the relation from EVENT A to EVENT B is 'BEGUN_BY'. For example:

The patient was started on [Diltiazem] 120mg q.d. after [calling] his cardiologist.

([Diltiazem] BEGUN_BY [calling])

He was closely followed from [his admission] through to [his discharge] by [the renal service]

([the renal service] BEGUN_BY [his admission])

On [postoperative day #1], he was started on [Percocet] two tabs po. [q4h].

([Percocet] BEGUN_BY [postoperative day #1])

5.2.1.6 ENDED_BY

If EVENT A ends at the time point of EVENT B, the relation from EVENT A to EVENT B is ENDED_BY.

[His nasogastric tube] was discontinued on [05-26-98].

([His nasogastric] ENDED_BY [05-26-98])

[His symptoms] were resolved after [the surgery].

([His symptoms] ENDED_BY [the surgery])

5.2.1.7 DURING

If the temporal span of EVENT A is completely contained within the span of EVENT B, the relation from EVENT A to EVENT B is DURING.

[His preoperative workup] was completed and included [a normal white count]

([a normal white count] DURING [His preoperative workup])

He remained in [the Intensive Care Unit] for [two days].

([the Intensive Care Unit] DURING [two days].)

5.2.1.8 BEFORE_OVERLAP

Similar to the "BEFORE_OVERLAP" relation in the *sec_time_rel* attribute of EVENTS, a "BEFORE_OVERLAP" TLINK is used where EVENT A has been happening for an indeterminate period of time prior to and continues at the time of the second EVENT.

The patient had an undocumented history of [possible atrial fibrillation] prior to admission.

([possible atrial fibrillation] BEFORE_OVERLAP [admission])

By [postoperative day # 7] , she was [tolerating] [a regular diet].

([a regular diet] BEFORE_OVERLAP [postoperative day # 7])

5.2.3 *Explicit attribute*⁷

In the narratives, some temporal relations are stated in an explicit way, such as “the surgery was on 2009-09-27” (the surgery SIMULTANEOUS with 2009-09-27), and ‘the patient transferred to ICU after the surgery’ (transferred AFTER the surgery), while other temporal relations are more subtle, and require the annotator’s inference and judgment to determine them, e.g., ‘the patient fell down the stairs resulting in a hip fracture’ (fell BEFORE a hip fracture). To distinguish explicit TLINKs from implied ones, we introduce an *explicit* attribute for each TLINK. The annotator needs to select “YES” in the *explicit* field for explicit temporal relations, and “NO” for implied relations.

Let us discuss in detail which TLINKs can be categorized as “explicit”, and which ones are considered implied.

5.2.3.1 YES

Explicit temporal relations are those that are clearly stated in the narratives, and can be identified without any inference. A simple rule to test whether a TLINK is explicit or not is to check if there is a signal word or phrase, such as “after”, “before”, “post-operatively”, “start”, and so on, which indicate the existence of the temporal relation. Please refer to the following examples:

- Explicit anchoring an EVENT to a local TIMEX

The patient was taken to the operating room on 2013-10-29 for a CABG x5 .

([the operating room] SIMULTANEOUS [2013-10-29], the signal word here is “on”)

- Explicit temporal relations between EVENTS:

He did well in the ICU.

([well] DURING [ICU], the signal word here is “in”)

He was taken immediately post-operatively to the CSRU.

([the surgery] BEFORE [the CSRU], the signal word is “post-operatively”)

Pt states he has been receiving chemotherapy up until 1 week ago.

([chemotherapy] ENDED_BY [1 week ago], the signal is “up until”)

- Aspectual verbs, such as “start”, “end”, “change”, “terminate” and so on, are usually signals for explicit BEGUN_BY/ENDED_BY relations

On post-op day #3, the patient 's pacing wires were removed

([the patient's pacing wires] ENDED_BY [post-op day #3], the signal words are “on” and “removed”)

- Some relative time TLINKs are explicit if the relative time is clearly anchored to another TIMEX

Pt states he has been receiving chemotherapy up until 1 week ago.

⁷ The *explicit* attribute is added in the later half of the annotation effort. Only the 90 records in the corpus that were annotated after the attribute was introduced, contain the *explicit* attribute.

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(NOT EXPLICIT: [1 week ago] ENDED_BY [admission]. There is no signal word to explicitly anchor [1 week ago] to [admission])

One week before admission, the patient stopped receiving chemotherapy.
([One week] ENDED_BY [admission], explicit, the signal word is "before")

5.2.3.2 NO

All of the TLINKS that are not explicit, are implied TLINKS, including but not limited to the following:

- Temporal relations derived from causal relations:

73 yo M transferred from Newton-Wellesley Hospital hospital for epidural abscess
([epidural abscess] BEFORE_OVERLAP [transferred])

- Evidential EVENTS:

The MRI showed L3-4 osteomyelitis
(L3-4 osteomyelitis] BEFORE_OVERLAP [The MRI])

[Coronary angiography] [showed] [a stenotic coronary arteries], and [a stent] was placed.
([a stenotic coronary arteries] BEFORE [Coronary angiography])

- Other inferred relations:

He was [discharged] home on [post-op day #6] in stable condition with [a foley catheter] and [leg bag] .
([discharged] SIMULTANEOUS with [post-op day #6] is explicit; [discharged] OVERLAP with [stable condition]/[foleycatheter]/[leg bag] are implied)

6 SECTIME Annotation

We define two types of section times: "ADMISSION" and "DISCHARGE". Essentially, these are the admission date and discharge date in the patient's record. In our data, no other section times are present.

The "ADMISSION" SECTIME is used in the "History of Present Illness" section of the discharge summary. In other words, for all the EVENTS in the patient's medical history section, the EVENT's *sec_time_rel* specifies its relation to the admission date. For all the other sections in the discharge summary, the "DISCHARGE" SECTIME is used, i.e. the *sec_time_rel* attribute for every EVENT specifies its relation to the discharge date.

7 Special Cases

7.1 Aspectual verbs

Aspectual verbs are verbs that indicate the aspect of another EVENT. Some examples of these verbs are "begin", "start", "end", "stop" and so on. In this annotation task, we do not mark these verbs as EVENTS, instead, we use BEGUN_BY and ENDED_BY TLINKS to indicate the aspectual changes to the existing EVENTS.

[His nasogastric tube] was discontinued on [05-26-98].
(the verb "discontinued" itself is not marked as an EVENT, instead we use TLINK [His nasogastric tube] ENDED_BY [05-26-98] to convey this information.)

7.2 Preoperative and Postoperative EVENTS

In discharge summaries, we often see words that have the "pre-" or "post-" prefix, such as "preoperative work up", "postoperatively" and so on. These words are signals for a BEFORE or AFTER TLINK relation that needs to be marked.

[His preoperative workup] was completed and included [a normal white count].

On 09-05-96 the patient was brought to the [operating room]

([His preoperative workup] BEFORE [operating room])

[The surgery] was performed on 07-26-03.

Postoperatively, the patient had no [complication].

([The surgery] BEFORE [complication])

In very rare cases, the words "preoperative" or "postoperative" appear, but in the text, there is no reference to the operation. In such cases, when there is no text span ("the surgery" or the "operation") to which we can assign an EVENT tag, we will mark the word "preoperative" or "postoperative" itself as an EVENT to serve as a surrogate to the missing reference to the operation, and use BEFORE or AFTER TLINK to link the pre- or post-operative EVENT to the word "preoperative" or "postoperative" itself.

8. REFERENCES

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Appendix 1. Attributes: Quick Reference and Examples

- **TIMEX3**: annotating temporal expressions, including dates (absolute and relative), time, duration, and frequency.

- Type: DATE|TIME|DURATION|FREQUENCY

- TIMEX Value Reference Table:

| designator | Meaning | designator | meaning |
|------------|---------|------------|---------|
| P | Period | T | Time |
| Y | Year | H | Hour |
| M | Month | M | Minute |
| W | Week | S | Second |
| D | Day | | |

- Examples:

nausea for [nearly two weeks].(type=DURATION, val=P2W, mod=APPROX)

For the next [12 hours].(type=DURATION, val=PT12H)

[20 minutes] ago. (type=DURATION, val=PT20M)

- FREQUENCY:

- Value: R[n][duration]

[n]: the number of repeats

[duration]: interval of repetition.

If [n] is left out, it means unspecified amount of repeats.

- Examples:

vomited [twice] (val = R2) before the surgery.

Twice a day for 3 days (val = R6P12H)

Od/o.p.d. (once daily) (val = RP24H)

q.a.d. (every other day) (val = RP48H)

- Mod: NA | APPROX | MORE | LESS | START | END | MIDDLE | APPROX

- NA: the mod attribute is not applicable;
- MORE: more than, e.g. over 2 days (val = P2D, mod = MORE);
- LESS: less than, e.g. almost 2 month (val = P2M, mod = LESS);

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- APPROX: approximate, e.g. nearly a week (val = P1W, mod = APPROX);
- START: the beginning of a period of time, e.g. Christmas morning, 2005 (val= 2005-12-25, mod= Start).
- END: the end of a period of time, e.g. late last year, (val= 2010, mod = END)
- MIDDLE: the middle of a period of time, e.g. mid-September 2001 (val=2001-09, mod=MIDDLE)

• **EVENT: for clinically related EVENTS**

- type: OCCURRENCE | EVIDENTIAL | TEST | PROBLEM | TREATMENT | CLINICAL_DEPT .
- EVIDENTIAL: EVENTS that involve designating the source of information, such as tell, note, show, etc.
- OCCURRENCE: Anything that is not ASPECTUAL or EVIDENTIAL, belongs to the OCCURRENCE group.
- sec_time_rel: BEFORE | AFTER | OVERLAP | BEFORE_OVERLAP
 - "History Of Present Illness" uses "ADMISSION" date as SECTIME
 - Other sections use "DISCHARGE" date as SECTIME
- polarity : POS | NEG
- modality : FACTUAL | CONDITIONAL | POSSIBLE | PROPOSED

• **SECTIME: document or section creation time**

- Type: ADMISSION | DISCHARGE
- Val: same as TIMEX3

• **TLINK: temporal relations between EVENTS, TIMEX3s and SECTIMES**

- Type: BEFORE | AFTER | SIMULTANEOUS | OVERLAP | BEGUN_BY | ENDED_BY | DURING | BEFORE_OVERLAP
- Examples:
 - OVERLAP:** [Levaquin] 750 mg p.o. [q. day] will restart today ([Levaquin] OVERLAP [q.day])
 - DURING:** An ENT performed the [myringotomy] during Friday's [surgery]. (myringotomy DURING surgery)

Appendix 2. Default Values for Attributes

When tags are created in the annotation tool, some attributes are assigned default values. These values need to be manually changed or verified for each tag. We give the default values for different attributes below.

| Tag | Attribute | Default value |
|--------|--------------|---------------|
| EVENT | type | OCCURRENCE |
| | sec_time_rel | BEFORE |
| | polarity | POS |
| | modality | FACTUAL |
| TIMEX3 | type | DATE |
| | val | |
| | mod | NA |
| TLINK | type | |
| | explicit | NO |