

MITRE / FLUX NOTES **SELECTED CONCEPTS v13.6: LOWERING BURDEN, EXPANDED CONCEPTS**
EDWIN CHOI, DANIEL REEVES, JUHAN SONIN, 20.APR.2018



AUTOCOMPLETE

TEXT-BASED EASING

We've discussed several ways to simplify and ease the entry of the note and improve capture of structured data at the same time. Here, we identify 6 specific mechanisms, of varying complexity. We also identify some prerequisites for implementation.

follow-up regarding Ductal carcinoma of...
10 April 2018 Dr. Free2 Will
Dana Farber Cancer Institute X Close

ASSESSMENT

Magnus is responding well to the Tamoxifen. Because it is causing serious fatigue, we will change the dosage to 30 mg.

Identify existing tag/shortcut without a decorator

Infer missing tags using SHR structure

Infer missing tags using contents

Autocomplete using synonym sets

Auto-capture using phrase recognition

Out-of-order context capture

TEXT-BASED EASING



I) Identify existing tag/shortcut without a decorator

This is pretty straightforward. It requires a bit more processing to constantly hunt for completions. Perhaps it only makes suggestions with 3+ letters, unless there is an open context.

she is exhibiting toxi

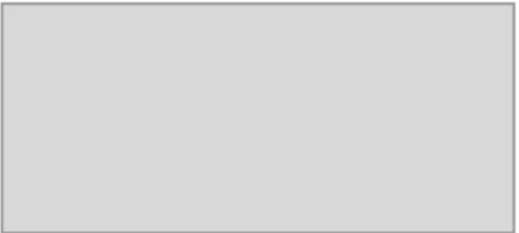
toxicity
Toxifen

she is exhibiting toxicity, f

fatigue
febrile neutropenia

she is exhibiting toxicity, fatigue,

TEXT-BASED EASING



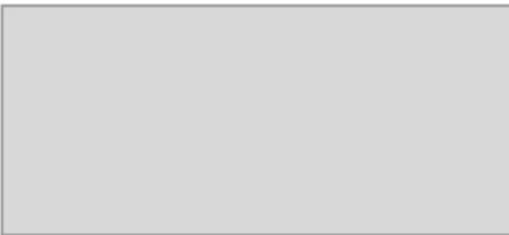
2) Infer missing tags using SHR structure

Requires representation/knowledge of structure. More processing to watch for tags down-tree of current contexts.

she is exhibiting fat

fatigue | toxicity

TEXT-BASED EASING



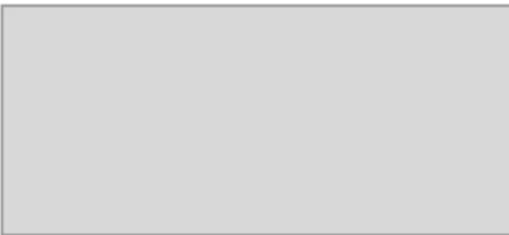
3) Infer missing tags using contents

Identify a switch of context by using the contents of fields, such as the name of a medication. Entities must have specific fields whose contents are monitored by completion engine.

she is current taking Tamox



TEXT-BASED EASING



4) Autocomplete using synonym sets

Tags or fields are assigned synonym sets. Alternatively, an nlp engine is trained to identify synonym sets from clinically relevant definitions. Shown are a simple example, where the synonym to identify against is already in the current context, and a more complex one where the synonym has no context.

- a) She exhibits fatigue. I attribute this lethargy

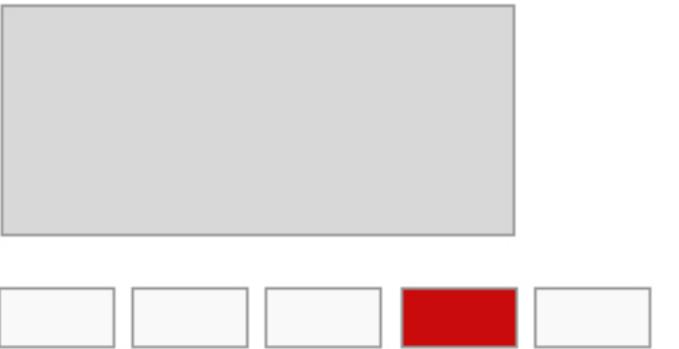
reference toxicity : fatigue

She exhibits fatigue. I attribute this lethargy

- b) She exhibits lethargy.

capture toxicity : fatigue

TEXT-BASED EASING



5) Auto-capture using phrase recognition

Negative statements are identified using an nlp engine. This also requires an identification in the schema of negation flags. Note: I cannot figure out how negatives or sessions of conditions are represented in the SHR.

she does not exhibit fatig

fatigue | toxicity : fatigue
fatigue | negate toxicity : fatigue

she denies fatig

fatigue | toxicity : fatigue
fatigue | negate toxicity : fatigue

More flexible intent recognition. One possibility is identifying synonym sets for tags or groups of tags, and using an nlp engine to match the text against those "handmade" sets. Another possibility is fully training the engine against bodies of existing notes.

I am prescribing Tamoxi

Tamoxifen | add medication

Note that some of this inference isn't necessary to make relevant suggestions. There are only so many things you can do with a medication, for example. If it is a new medication, there is one obvious action, add it.

TEXT-BASED EASING



6) Out-of-order context capture

In natural English, modifiers are often placed before the object. The SHR is structured such as modifiers are logically placed further down the tree from the contexts they describe. This mechanism will require whole sentence parsing to connect the dependencies in the language with the SHR structure.

due to her medication, she is exhibiting mild fat

fatigue | toxicity : fatigue

due to her medication, she is exhibiting mild fatigue.

infer fatigue : attribute : treatment

Natural descriptions of inferences

Above the popup messages are less than natural. They are indicating the hierarchy of the information that is being captured. In a more advanced system, the capture would be phrased in a more natural way.

due to her medication, she is exhibiting mild fatigue.

attribute fatigue to treatment

ASSISTIVE POINT OF SALE

INTERACTION FLOW OF THE ASSISTIVE POS

Provider has generated most of the note by using a template. Some sections such as the review of systems or assessment and planning, are empty, and the provider has to fill them either manually or by using the POS.



Debra24
Hernandez98Aj

Date of birth
5 Apr 1966 (51)

Admin. sex
Female

Location

Boston, MA

Condition

Ductal carcinoma of the breast

View



Debra24 search...



Dr. Jraker299 referred ms. Debra24 Hernandez98Aj due to pain in left breast. Dr. Jraker299 is ms. Debra24 Hernandez98Aj's primary care physician for 12 years.

Summary



Ms. Debra24 Hernandez98Aj is a 51-year-old menopausal non hispanic or latino woman with invasive ductal carcinoma of the breast, diagnosed on 13 January 2012. Her most recent status, recorded on 15 May 2017, is of worsening, disease progression based on pathology, imaging, and symptoms.

She underwent a lumpectomy. She underwent a sentinel lymph node biopsy on 20 September 2012 which revealed infiltrating poorly differentiated ductal carcinoma, stage IV, estrogen receptor 0, etc.

diagnostic mammogram on 4 October 2013 revealed a 2 cm mass in the right breast at 7 o'clock and an

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10 April 2018

Dr. Free2 Will

Dana Farber Cancer Institute



Recent procedures:

She underwent right lumpectomy with Dr. Ford on March 12, 2018. Pathology report on March 16, 2018 showed no residual disease, 0/2 SLNs, pathological complete response pCR, stage pT0N0.

12 Review of systems:

Allergies:

dairy

Medications:

lisinopril 20mg tablet, Take 1 tablet by mouth daily

ibuprofen 600mg tablet, Take 1 tablet by mouth three times daily as needed with food

hydrocortisone 2.5% ointment, twice daily as needed

Physical exam:

GENERAL: Very pleasant woman, appears stated age, dressed in hospital scrub uniform, well nourished and in no acute distress.

VITAL SIGNS: Blood pressure 142/70, pulse 90 per minute, respirations 18 per minute, oxygen saturation 96% and temperature 97.4.

11 captured

Remove unfilled elements and sign



Review of Systems
12 corrections

Select problems present

Headache

Blurry vision

Double vision

Fever

Cough

Shortness of breath

Abdominal pain

Nausea

Vomiting

Loss of appetite

Etc...

Finished problem selection



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Review of systems:

Patient denies: headache, blurry vision, fever, cough, shortness of breath, nausea, vomiting, loss of appetite.

Patient reports: double vision and abdominal pain.

Allergies:

dairy

Medications:

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ibuprofen 600mg tablet, Take 1 tablet by mouth three times daily as needed with food

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GENERAL: Very pleasant woman, appears stated age, dressed in hospital scrub

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Remove unfilled elements and sign



Review of Systems
0 corrections needed

Select problems present

Headache

Blurry vision

Double vision

Fever

Cough

Shortness of breath

Abdominal pain

Nausea

Vomiting

Loss of appetite

Etc...

Finished problem selection



INTERACTION FLOW OF THE ASSISTIVE POS

Provider has now filled most of the note with the necessary content. They now toggle back to the assistive POS mode to scan and double check their note to make sure everything is accurate.



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Close



3 corrections

response pCR, stage

Tumor size

Tis	T0	T1
T2	T3	T4

Node size

N0	N1mi	N1
N2	N3	

Ignore

Patient's appetite

Loss of appetite
Appetite is normal

Ignore

1 Recent procedures:

She underwent right lumpectomy with Dr. Ford on March 12, 2018. Pathology report on March 16, 2018 showed no residual disease, 0/2 SLNs, pathological complete response pCR, stage

2 Review of systems:

Patient denies: significant headache, blurry vision, double vision, fever, cough, shortness of breath, abdominal pain, nausea, vomiting

Patient reports: Numbness and tingling of extrem.

Allergies:

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Loss of appetite

Appetite is normal

Ignore

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Did you mean:
Numbness and tingling of extremities.


Ignore

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Summary

Timeline

Medication

Allergies

Labs

Social

Disease status



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0 corrections needed

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Sign note

BREAKING DOWN THE ASSISTIVE POS

The following pages describe the microinteractions and features needed to reach the POS example interaction shown on the previous pages.

Tracking # of corrections within the note

Indicate # of corrections needed for a particular section.

Tracking # of corrections within the POS

Indication of the # of corrections needed for note or section.

Populate the POS by tracking the viewing area of the note

POS follows where the provider is currently viewing in the note.

Hover highlight

Hovering over a suggestion in POS highlights the relevant text or element to be corrected in the clinical note.

Ignore suggestion

Selecting "ignore" in the assistive POS turns that associated clinical note text or element into unstructured text.

Showing data context

In the assistive POS, show 2 words before and after the data element to be corrected, to show its clinical note context.

DATA: Missing data elements

Areas of the clinical note may have required data in order for the note to be complete (billing, eCQMs, etc).

DATA: Missing attributes

System identifies missing attributes from a structured data element (enrollment, tumor size, adverse event, etc).

DATA: Incomplete spelling

Identifying in the clinical note, and representing in the assistive UI, incorrect spelling of structured data element.

DATA: Impossible values

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POS UI: One selection

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POS UI: Multi-selection

A UI for making multiple possible selections from a list of values to fill in a missing attribute.

POS UI: Selection among many

A UI for picking among a long list of possible selections for a missing attribute.

POS UI: Missing date

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ASSISTIVE POS INTERACTION ELEMENTS

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Number of corrections

Assistive POS for:

Missing data elements
Missing attributes
Misspellings

When a particular section's "number of corrections needed" is clicked, the number of corrections refers to only that section of the note.

12 Review of systems:



Name of section

Number of corrections

Assistive POS for:

Missing data elements
Missing attributes
Misspellings

The concept of note "sections" requires further exploration.

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Assistive POS should populate based on:

Current view area of the note and after

AND

Order of corrections identified within that view



4 corrections



correction 2

correction 3

correction 4

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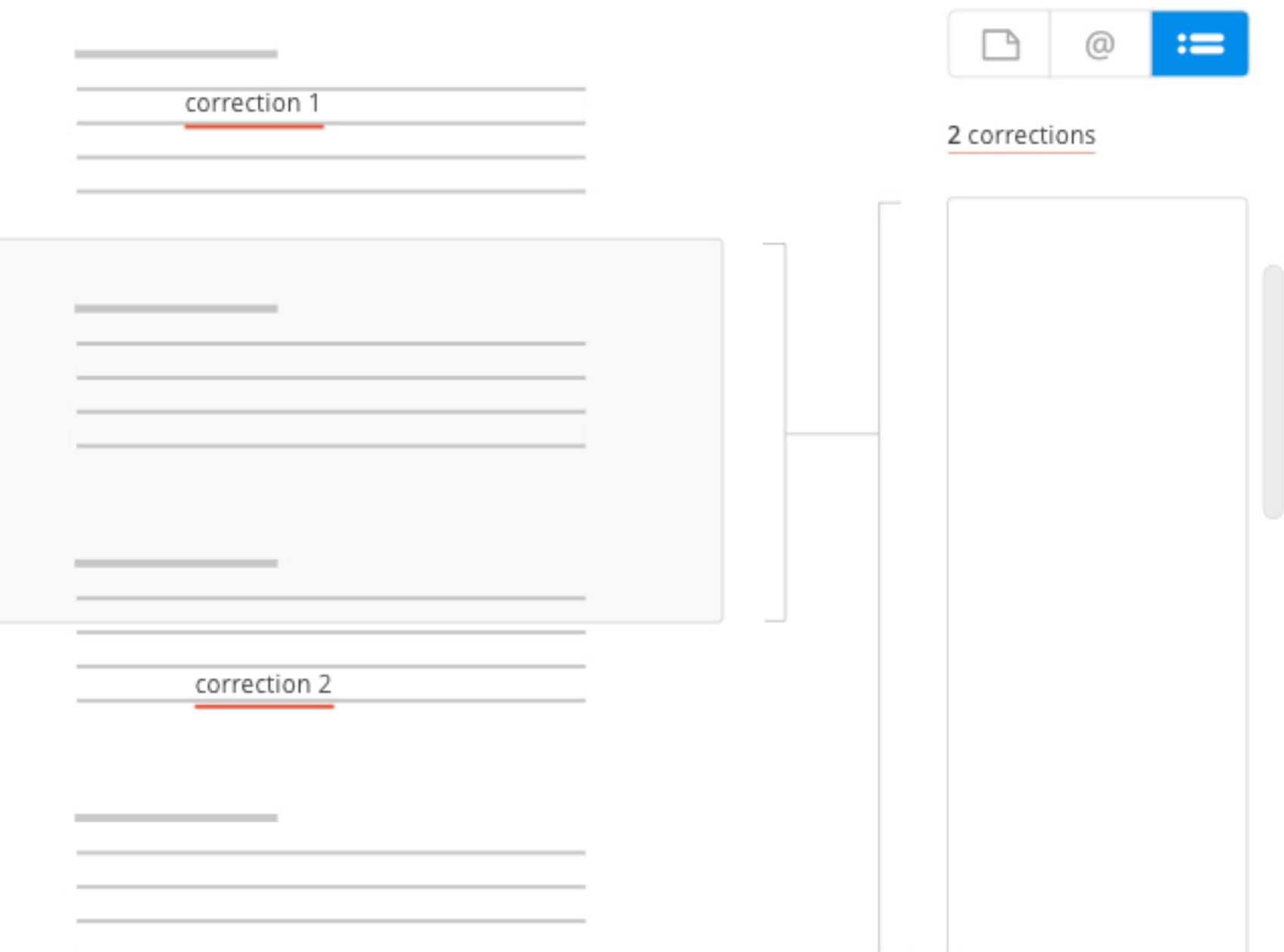
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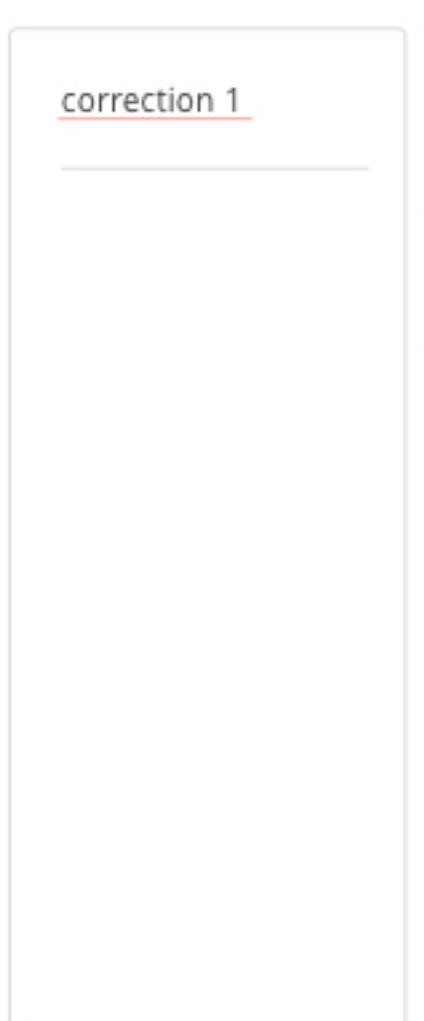
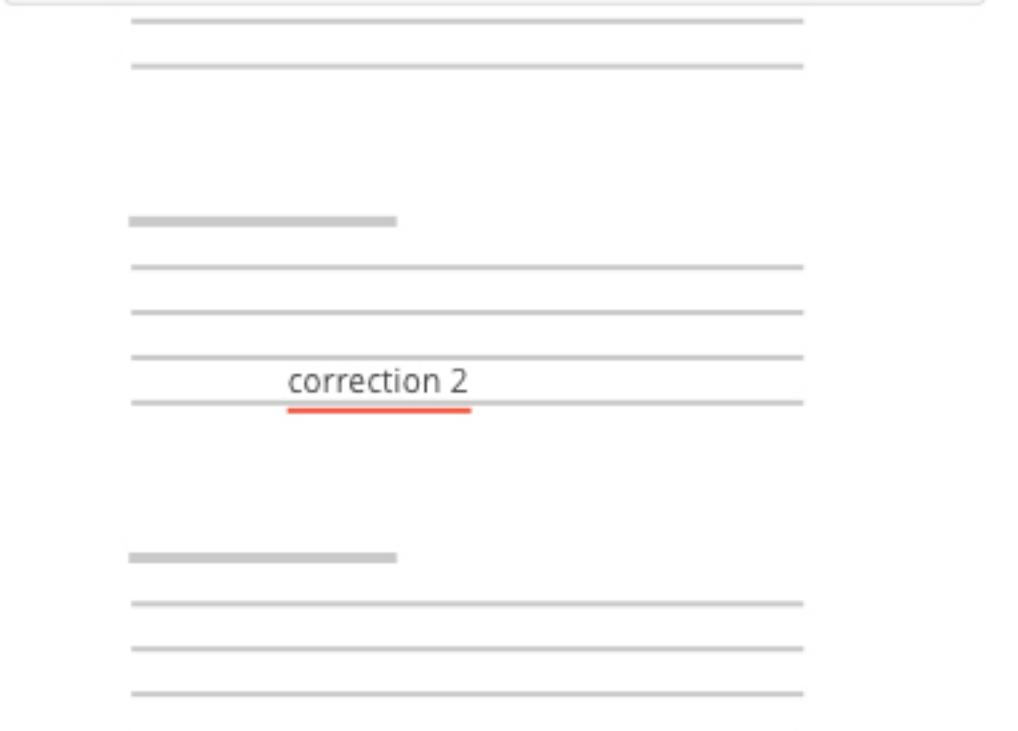
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Follows the motif of the left hand minimap



2 corrections



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follow-up regarding Ductal carcinoma of...

10 April 2018

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Close



4 corrections

2 Review of systems:

Patient denies: significant headache, blurry vision, double vision, fever, cough, shortness of breath, abdominal pain, nausea, vomiting

Patient reports: Numbness and tingling of extrem.

Patient's appetite

Loss of appetite

Appetite is normal

Ignore

Allergies:

dairy

Numbness and tingling of extrem.

Medications:

lisinopril 20mg tablet, Take 1 tablet by mouth daily

ibuprofen 600mg tablet, Take 1 tablet by mouth three times daily as needed with food

hydrocortisone 2.5% ointment, twice daily as needed

Did you mean:

Numbness and tingling of extremities.

Physical exam:

GENERAL: Very pleasant woman, appears stated age, dressed in hospital scrub uniform, well nourished and in no acute distress.

VITAL SIGNS: Blood pressure 142/70, pulse 90 per minute, respirations 18 per minute, oxygen saturation 96% and temperature 97.4.

2 captured

Remove unfilled elements and sign



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Remove unfilled elements and sign

response pCR, stage



Tumor size

Tis	T0	T1
T2	T3	T4

Node size

N0	N1mi	N1
N2	N3	

Ignore

Patient's appetite

Loss of appetite
Appetite is normal

Ignore

Numbness and tingling of extrem.

Did you mean:

Numbness and tingling of extremities.

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Indicate # of corrections needed for a particular section.

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follow-up regarding Ductal carcinoma of...

10 April 2018

Dr. Free2 Will

Dana Farber Cancer Institute

Close



4 corrections

1 Recent procedures:

She underwent right lumpectomy with Dr. Ford on March 12, 2018. Pathology report on March 16, 2018 showed no residual disease, 0/2 SLNs, pathological complete response pCR, stage

2 Review of systems:

Patient denies: significant headache, blurry vision, double vision, fever, cough, shortness of breath, abdominal pain, nausea, vomiting

Patient reports: Numbness and tingling of extrem.

Allergies:

dairy

Medications:

lisinopril 20mg tablet, Take 1 tablet by mouth daily

ibuprofen 600mg tablet, Take 1 tablet by mouth three times daily as needed with food

hydrocortisone 2.5% ointment, twice daily as needed

Physical exam:

GENERAL: Very pleasant woman, appears stated age, dressed in hospital scrub

2 captured

Remove unfilled elements and sign

response pCR, stage

Tumor size

Tis	T0	T1
T2	T3	T4

Node size

N0	N1mi	N1
N2	N3	

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The visual indication of the number of suggested corrections decrease in the actual clinical note, for the relevant section

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“ACTIVE” POS

Clicking on a particular section upon note generation, opens up a list of corrections for data elements required for reporting/billing/etc.

HPI

Medications

Reason for Visit

Allergies

Active POS populates right context tray based on data capture needed within each of these sections to:

Capture eCQM measures

Report fo CMS, insurance/payers

Review of Systems

Physicam Exam

Assessment & Plan

Data required for billing/reimbursement

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One selection example:

#ER

Receptor

#HER2

Receptor

The associated data element that the attribute is connected to is underlined in the note



1 correction

well as #ER was found

ER

Positive

Negative

Ignore

Output:

well as #ER Positive was found

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Multi-selection example:

#disease status

Status
Reason
Reference date
As of date

#toxicity

Grade
Adverse Event
Attribution



1 correction

disease is Worsening,
disease progressing

Reason for disease status

Pathology
Imaging
Symptoms
Physical exam
Markers

✓ Finish selection

Ignore



1 correction

is Worsening, disease
progressing based on

Reason for disease status

Pathology
Imaging
Symptoms
Physical exam
Markers

✓ Finish selection

Ignore

Output:

disease is Worsening,
disease progressing
imaging, symptoms
based on

Multi-select requires the user to specify when they are done with their selection

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Selection among many example:

#toxicity

Grade

Adverse Event

Attribution



Toxicity of Grade 3, based on

Adverse event

Search shortcuts

Febrile neutropenia

Fatigue

Generalized muscle weakness

Anemia

Diarrhea

Nausea

Ignore



Toxicity of Grade 3, based on

Adverse event

Search shortcuts

Diarrhea

Arthralgia

Papulopustular rash

Bone marrow hypocellular

Disseminated intravascular coagulation

Acute coronary syndrome

Ignore

Output:

Toxicity of Grade 3, Diarrhea, based on

Displaying a limited number of results to avoid overwhelming the user

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Structured attribute example:



1 correction

based on #imag.

Did you mean:
based on #imaging.



Ignore

Output:

based on #imaging

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Structured attribute example:



1 correction

based on #imag.

Did you mean:
based on #image CT....



Ignore

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Structured data element example:



1 correction

the patients #stag was found

Did you mean:
the patients #staging
was found



Ignore

Output:

the patients #staging was found

Multi-selection:



1 correction

the patients #staging
was found

Tumor size

Tis	T0	T1
T2	T3	T4

Node size

N0	N1mi	N1
N2	N3	

Ignore

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Impossible value example:



1 correction

Blood pressure 420/70,
pulse was

Re-enter blood pressure:

Systolic / 70

Ignore

Any values within a correct range are autofilled in the re-entry form

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Incomplete review of systems data:



1 correction

Patient has an appetite



Ignore

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Date example:

#enrollment
Clinical trial
#Date

#deceased
#Date



1 correction

The patient #enrollment
in PATINA

Date

Choose a date

Ignore

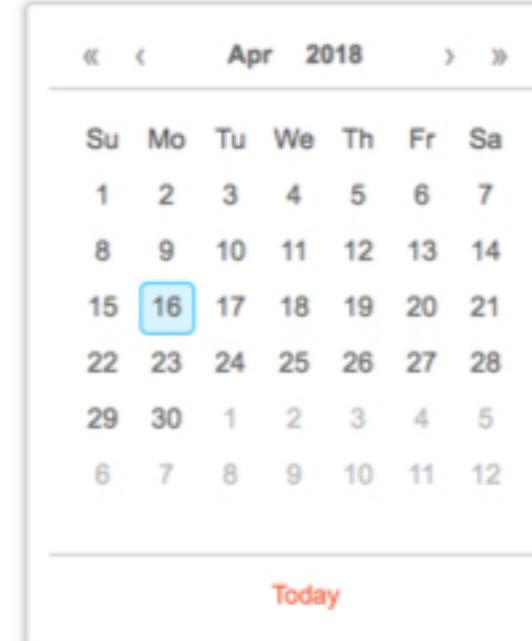


1 correction

The patient #enrollment
in PATINA

Date

4/16/18



Output:

The patient #enrollment 4/16/18
in PATINA

The date is inserted right after
the data element that needed
correcting

Calendar pickers work for events
close to the current time.

UI defaults to current date when
calendar is open. Select the date
to confirm.

IDENTIFYING NEXT STEPS FOR POS

The following is a tentative approach towards building an assistive POS system. It is prioritized based on estimates of high value for low effort, that also provide a stepping stone towards a more robust POS.

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A UI for picking among a long list of possible selections for a missing attribute.

POS UI: Missing date

Identifying in the clinical note, and representing in the assistive UI, missing date attributes. A date picker UI should be present.

CONTEXT TRAY INTERACTION

CONTEXT: Considerations

Primary / Immediate Goals

Capturing or referencing structured data

- Interface must be crystal clear as to what context is active as the user is typing or selecting a shortcut
- Context tray must be kept clean and usable
- User must be able to control the context without awkwardly deleting and restructuring sentences
- Restrictions on user should be minimized. No unnecessary restrictions regarding context access when no ambiguities exist.
- User should be encouraged, via UI, to clarify the context

Reviewing note

- Context of references and captures must be clear

Future Goals

Capturing or referencing structured data

- System identifies and warns user about ambiguous context usages
- Non-standard words can be used to swap context

CONTEXT:Approaches

Primary / Immediate Applications

Capturing or referencing structured data

- The method of choosing the context should be consistent between typing and dictation.
- The current context is a state of the editor. It is not a state of the note at each location.
- The default state of the editor is determined by the content of the note and the cursor location.
- The user can override the default context through typing, menu selection, or explicit dictation commands.
- Only available/active contexts are shown in the context tray. Clear nesting of the hierarchy removes ambiguity of which context is being referenced by a shortcut.
- When capturing or referencing data by typing, the active context is indicated by styling relevant text.

Future Applications

Capturing or referencing structured data

- Arbitrary text can be assigned contextual meaning. Ex: “the breast cancer” can be assigned to be a reference to the appropriate context.
- The above assignments are suggested or applied automatically.

CONTEXT TRAY: Clarity

The shortcuts are divided into two sections. The top holds the top level options, such as templates, actions, and access to the record. They are separated from the hierarchy of active contexts by a horizontal line.

Below the line are contexts active at the cursor location. Some contexts are mutually exclusive, such as conditions and medications. Those contexts don't appear together.

Some contexts are not mutually exclusive such as object member capture contexts like `#toxicity` and `#staging`, as their member shortcuts do not collide and there are no ambiguities. Different types of lists, like conditions and medications are also not exclusive. So, they can be available simultaneously. Still, only one menu may be open at a time.



Search shortcuts

- > TEMPLATES
- > SNIPPETS
- > PATIENT
 - @ name
 - @ age
 - @ conditions
 - # enrolled
 - @medications



Search shortcuts

- > TEMPLATES
- > SNIPPETS
- > PATIENT
 - > Invasive ductal...
 - # toxicity
 - # staging
 - @ something
 - # some 2



Search shortcuts

- > TEMPLATES
- > SNIPPETS
- > PATIENT
 - > Invasive ductal...
 - > Toxicity
 - grade
 - #Grade 1
 - #Grade 2
 - adverse effect
 - #Febrile ...
 - > Staging
 - > Coumadin

Remove note

Remove note

Remove note

CONTEXT TRAY: Clarity

Each **active context** is styled for emphasis in the note at all times.

follow-up regarding Ductal carcinoma of...
10 April 2018

Dr. Free2 Will
Dana Farber Cancer Institute

Close



yadayada Fracture
yadayada Invasive ductal carcinoma of the breast
yadayada Tomoxafin
yadyada **Coumadin**
sneaky text that might confuse me with other structured data.
yadayada **Invasive ductal carcinoma of the breast**
Now I know just what the active contexts are as I type without looking at the tray.

The most recently activated context is automatically opened in the tray. In this case that is the cancer condition.

Search shortcuts

- > TEMPLATES
- > SNIPPETS
- > PATIENT
- > Invasive ductal...
 - # toxicity
 - # staging
 - @ date of diagn...
 - # some 2
- > Coumadin

Remove note

CONTEXT TRAY: Clarity

follow-up regarding Ductal carcinoma of...
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Close



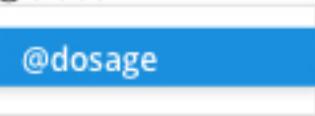
Search shortcuts

- > TEMPLATES
- > SNIPPETS
- > PATIENT
- > Invasive ductal...
- ▼ Coumadin
 - @ frequency
 - @ dosage
 - @ start date
 - # change order
 - # stop

yadayada Fracture
yadayada Invasive ductal carcinoma of the breast
yadayada Tomoxafin
yadyada **Coumadin**
sneaky text that might confuse me with other structured data.
yadayada **Invasive ductal carcinoma of the breast**

Now I know just what the active contexts are as I type without looking at the tray.

The @dosa



Remove note

When a completion box is open, the context tray reflects the currently selected item. The appropriate menu is opened, and the corresponding contexts are styled for emphasis.

CONTEXT TRAY: Switching by tray

Only one condition is active/available in the context tray. The active condition can be changed via a menu accessible by an icon at each element in the tray.

The hover behavior in the menu continues to be emphasis. In addition to the hovered item, the parent contexts also emphasize.

The screenshot illustrates a medical software interface with two context trays and a tooltip. On the left, a context tray displays icons for file, user, and settings. Below it is a search bar and a list of items: TEMPLATES, SNIPPETS, PATIENT, and Invasive ductal... (with a dropdown arrow). A red circle highlights the dropdown arrow. An arrow points from this tray to a tooltip on the right. The tooltip shows a list of conditions: Fracture (highlighted in blue), Invasive ductal c..., # some 2, and Coumadin. The main workspace shows a note about follow-up regarding Ductal carcinoma of the breast, dated 10 April 2018, signed by Dr. Free2 Will from Dana Farber Cancer Institute. The note contains the text "yadayada Fracture" and "yadayada Invasive ductal carcinoma of the breast". A cursor hovers over the condition "Fracture" in the tooltip. On the far right, another context tray is partially visible with similar icons and a search bar.

follow-up regarding Ductal carcinoma of...
10 April 2018
Dr. Free2 Will
Dana Farber Cancer Institute
Close

yadayada Fracture
yadayada Invasive ductal carcinoma of the breast
the fracture was diagnosed on |

Search shortcuts

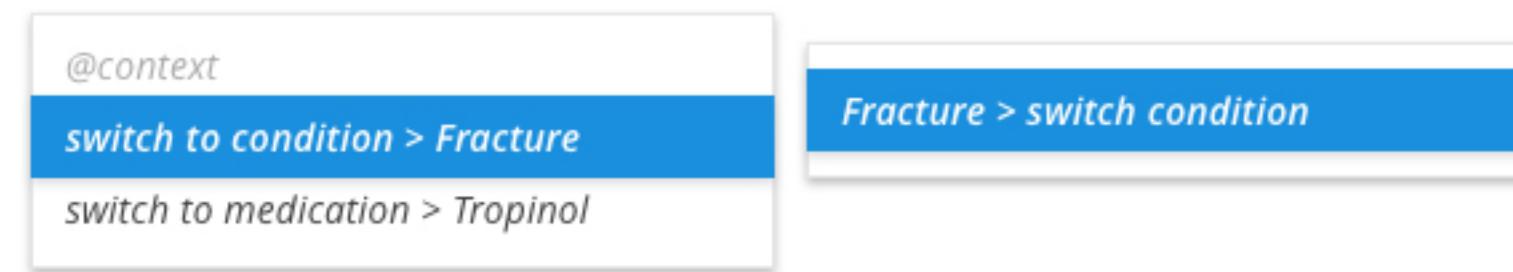
> TEMPLATES
> SNIPPETS
> PATIENT
▼ Invasive ductal... ▾

Fracture
Invasive ductal c...
@ date of diag.
some 2
another thing
> Coumadin

Remove note

CONTEXT: Switching by shortcut

Shortcuts are available to switch between mutually exclusive contexts, such as conditions. Here, it is accessed through the @condition shortcut, but another options are simply @context or @*[name of context] (shown at right)



follow-up regarding Ductal carcinoma of...
10 April 2018

Dr. Free2 Will
Dana Farber Cancer Institute



Search shortcuts

- > TEMPLATES
- > SNIPPETS
- > PATIENT
- ✓ Invasive ductal...
 - # toxicity
 - # staging
 - @ date of diagn...
 - # some 2
- > Coumadin

yadayada Fracture
yadayada **Invasive ductal carcinoma of the breast**
the fracture was diagnosed on @condit



Remove note

CONTEXT: Switching by shortcut

The shortcut changes the context state of the editor, and leaves no trace in the editor. The new context state is reflected in the styling and menu.

follow-up regarding Ductal carcinoma of...
10 April 2018

Dr. Free2 Will
Dana Farber Cancer Institute



Search shortcuts

- > TEMPLATES
- > SNIPPETS
- > PATIENT
- Fracture
 - # toxicity
 - @ date of diag...
 - # some 2
 - # another thing
 - > Coumadin

yadayada **Fracture**

yadayada Invasive ductal carcinoma of the breast

the fracture was diagnosed on

Remove note