

DESIGNING THE DAY-TO-DAY METHOD

Development of the summarization structure took about six months. Much of the approach was adapted from our prior work [16]. One of the authors (VH) interviewed 30 internists and residents to understand their workflows when writing the discharge summary. A critical observation was that the documentation burdens for physicians are primarily still within these three sections (HPI / daily narrative / follow-ups) of the discharge summary, as the Epic EHR system could pull forward the other content as a template from the Epic Chronicles database.

Furthermore, physicians primarily view these three sections as the most trusted and important content describing a patient’s medical care, and yet oftentimes it can be buried within the templated note structure. Physicians manually write the daily narrative section by constructing a few sentences each day. For each day or interval, a different physician will write a new appended summary sentence. By discharge, the daily narrative is chronologically constructed from each of those interval summaries. We designed our automated daily narrative summary to mirror how physicians write it today.

For this paper, we determined not to provide detail about the design formulation given word length constraints. We also wanted to make sure we gave adequate attention to the constrained beam search method for improving clinical factuality.

CRITERIA FOR PHYSICIAN EVALUATION

Table 5. Definitions for each metric provided to the two physicians for the clinical evaluation protocol.

Metric	Definition
Quality	Rate the summary of what you view as a well-written discharge summary hospital course. Keep in mind that the intended purpose of the discharge summary, as set out by CMS and the Joint Commission, is to clearly communicate a patient’s care plan to the post-hospital care team.
Readability	The language and grammar is what would be expected of a trained physician. The intended audience for the summary is the post-hospital care team (usage of medical terminology, abbreviations, and syntax is acceptable if a general physician could understand them).
Factuality	All information presented is accurate and factually correct.
Completeness	The summary includes the relevant clinical events that occurred during the patient stay. Assess the summary on the standard for not missing any key clinical information that would be detrimental to the patient’s post hospital care if the downstream provider were not informed.

SUMMARIZATION DATASET STATISTICS

Table 6. Statistics about the NewYork-Presbyterian/Weill Cornell Medical Center summarization datasets.

Dataset	Total Notes	Avg. Notes Per Admit (+- Sd.)	Avg. Sentences Per Note (+- Sd.)	Avg. Words Per Note (+- Sd.)	Avg. Words Per Summary (+- Sd.)
Hospital Chart	234,916	116 (+/- 158)	52 (+- 63)	1.5k (+/- 150.3k)	591 (Sd. +/- 597)
HPI	6,600	1 (+- 0)	12 (+/- 11)	205 (+- 150)	44 (+- 20)
Daily Narrative	71,115	48 (+- 71)	53 (+/- 66)	793 (+- 700)	12 (+- 8)

PROVIDER TYPE DISTRIBUTION

Table 7. The distribution of provider types over the total notes for the daily narrative dataset.

Provider Type	Note Count
Attending	22899
Fellow	5833
Medical Student	1238
Nurse Anesthetist	4
Nurse Practitioner	997
Nutritionist	3638
Pharmacist	252
Physician Assistant	7780
Psychologist	16
Resident	28444
Scribe	14

EXAMPLE DISCHARGE SUMMARY HOSPITAL COURSES

Table 8. Example of an automated summary and a separate physician-written summary of the hospital chart that were evaluated by two board-certified physicians with the criteria listed in Table ?? . PHI has been redacted.

Automated Summary				Physician-Written Summary			
<p>[AGE] year old woman with history of HTN, HLD, Hypothyroidism, and hyperparathyroidism who presented to GBG Adult Emergency on [DATE] after having an incidental findings of an expansile, peripherally hyperdense, centrally hypodense mass in the left paramedian frontal lobe and extending contralaterally across the midline. While in the emergency department the patient was seen by neurosurgery. MRI brain without contrast was completed on [DATE] which showed a large, centrally necrotic, extra-axial mass centered along the right mid falx with broad-based dural attachment of the left anterior falx and the left frontal convexity, measuring 6.1 x 4.2 cm (AP x TV x CC; series 800, image 51). Ophthalmology was consulted on [DATE] to rule out disc edema. Taken to OR for Left frontal craniotomy for resection of parasagittal meningioma (a modifier 22 will be added given the massive size of the lesion which was encased in pericallosal artery) on [DATE] with Dr. [PHYSICIAN]. Pt deemed stable for transfer to Neurosurgery floor [DATE]. Patient deemed safe for discharge home on [DATE].</p>				<p>[AGE] year old female with headaches and multiple punctate subacute strokes, and presumed cerebral amyloid angiopathy. She presented on [DATE] with confusion for 2 days as well as lethargy. CTH founds a R frontal ICH extending into corpus callosum with 2mm midline shift. Platelets 333. She was admitted to the Neuro-ICU for close monitoring. She was treated with nicardipine ggt for BP goal. She was seen by neurosurgery who did a brain biopsy of her right temporal area [DATE] to differentiate inflammatory CAA disease vs non-inflammatory phenotypes. She was then treated empirically with IV solumedrol 1g daily [DATE]. Her neurological symptoms improved and she was transferred to stepdown neurology. She requested to have her final doses at home as an outpatient and was discharged home to receive her final doses of methylprednisone at home on [DATE] with an infusion company. She will follow with Dr [PHYSICIAN] on discharge. Home infusion for completion of Solumedrol x 2 days.Home services to include: nursing for assessment and teaching,PT for gait training and OT for ADL training.</p>			
Average Evaluation Ratings							
Quality	Readable	Factual	Complete	Quality	Readable	Factual	Complete
7.5	8.5	8	8	8.5	9	9.5	8
Physicians' Review Comments							
<p>The surgery was performed by a different physician. The ophthalmology findings are missing. An incidental finding from brain imaging should reference the reason she was having brain imaging in the first place.</p>				<p>Echo results missing. MRI brain, MRA head, CTA head results missing. In mentioning the need for a nicardipine drip, it would have helped see information about the blood pressures during the admission that may have required that intervention.</p>			