Apollo Hospitals, Jubilee Hills, Hyderabad. We are incorporating the feedback from the Pilot Study to improve the performance of the tool.

Introduction

The Gen AI Discharge Summary is an innovative artificial intelligence-based system developed to streamline and enhance the generation of comprehensive discharge summaries. Designed by Apollo Hospitals, this system is crafted to efficiently navigate and simplify the discharge process, significantly reducing waiting times for all discharges. Leveraging Differentiated Databases and Large Language Models (LLM) in a healthcare and clinical context, it summarizes and generates medical information with a high degree of accuracy. This advanced technology contributes to a more efficient and less time-consuming discharge workflow, ultimately improving the overall patient experience.

Why is Gen AI Discharge Summary different?

- This tool captures all the relevant inputs required for a discharge summary throughout the Inpatient stay in the hospital and generates a summary of all inputs within a few minutes when prompted by the Physician.
- It can generate the report in multiple languages in the patient's native tongue.
- The current speed of complete Discharge Summary draft generation is within 1-2 minutes.

Interpretation & Adoption Message

1. AI Algorithm + Clinicians – The Gen AI: Discharge Summary has been built as an adjunct tool for physicians and is crafted to efficiently navigate and simplify the discharge process, significantly reducing waiting times for all discharges.
2. Risk Identification and prevention – The Gen AI: Discharge Summary contributes to a more efficient and less time-consuming discharge workflow, ultimately improving the overall patient experience.
3. Where to use –
    - IPD Discharge Summaries.
    - Billing and Insurance Documentation.
    - Integration with Med Mantra for faster drafting.
    - Speeding up the documentation process.

- Customized regional language support.

How to Use (For Clinician Only) -

1. Provide Appropriate –
   - Diagnosis
   - Surgery Details
   - Labs
   - Radiology
   - Treatment Summary
   - Major Medications
   - Discharge Medication
   - Discharge Examination
   - Special Instructions
   - Self Care
   - Appendix

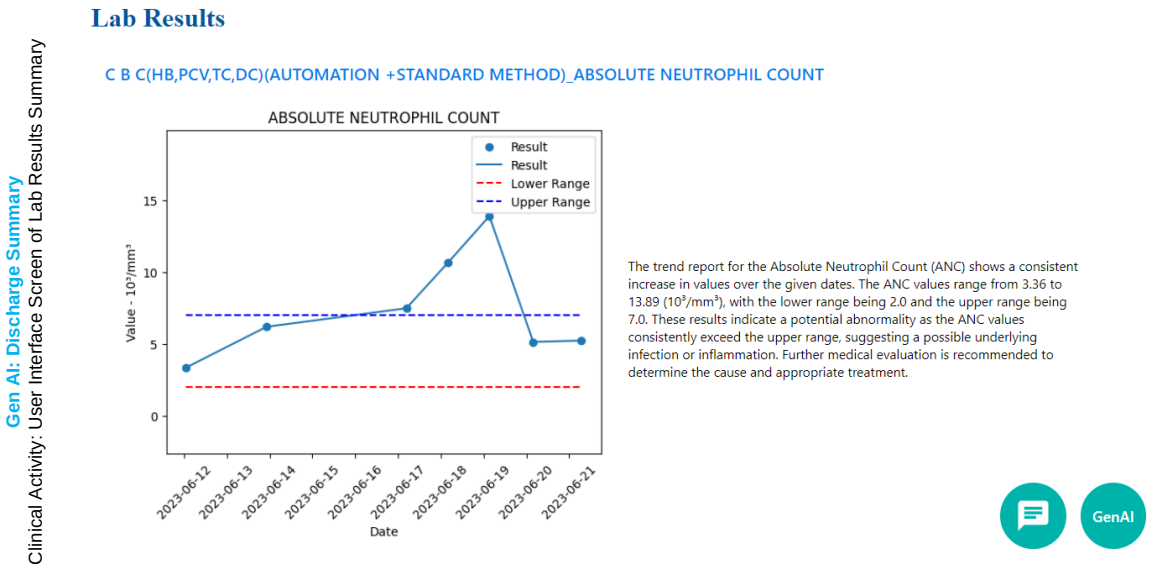


Figure 1. (Summary) Track report of a Parameter in Lab Results

The above figure depicts the trend graph of a parameter in Lab Results generated by the Gen AI Discharge Summary model & it Illustrates how the parameter changed for a patient during their visit and enables effective analysis of the values.

2. Output –
   a. Generates a comprehensive summary of given input components
   b. The final approval for this summary rests with the Physician in charge.
   c. The goal is to ensure that the output is standardized and confirmed by the Physician before dispatch.

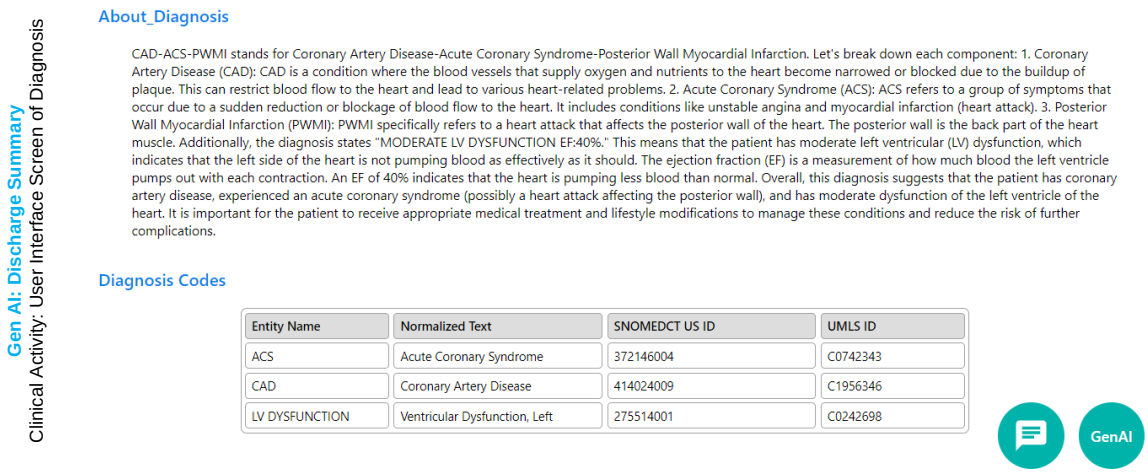


Figure 2. Detailed Diagnosis of the patient including Standard Codes

The above figure represents the generated output of the Gen AI Discharge Summary model which is a comprehensive explanation about the patient's diagnosis along with the Entity Identification of diagnosis (Entity name), Normalized text, and Diagnosis Codes including SNOMEDCT US ID and UMLS ID.

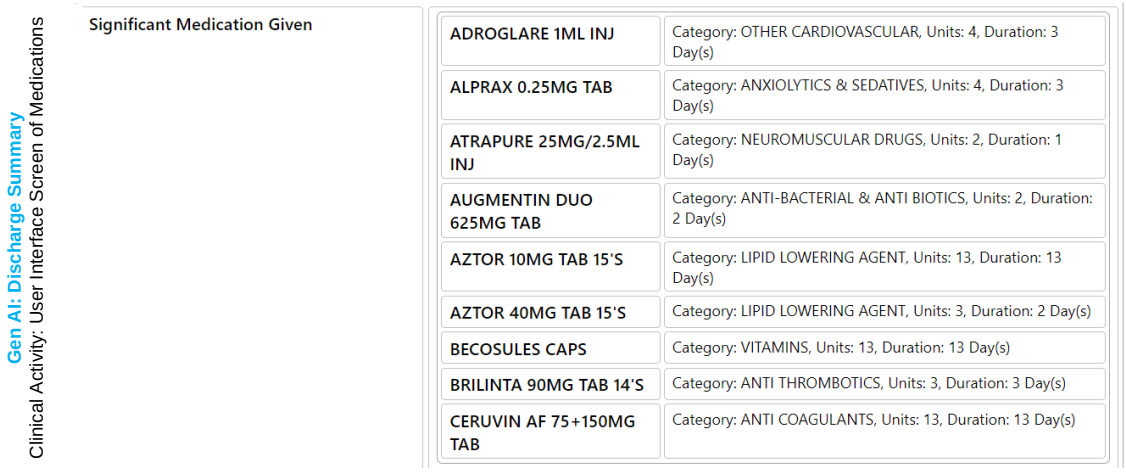


Figure 3. Description of Medications with the original list of given Medications

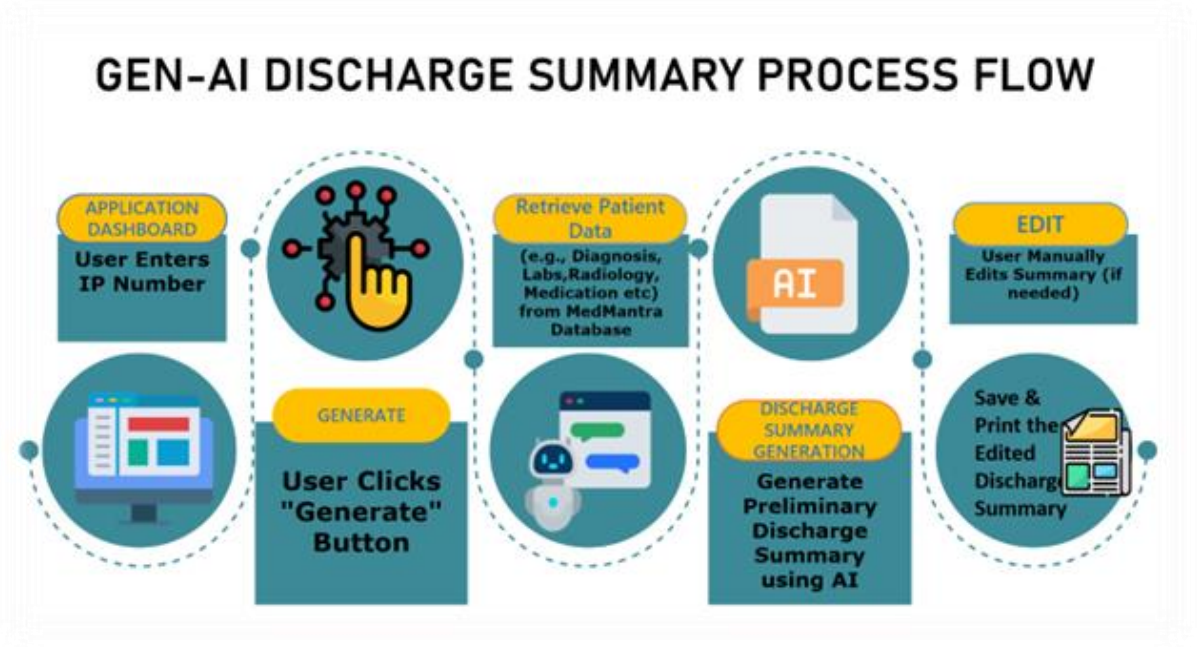
The above figure represents the generated output of the Gen AI Discharge Summary model which is a comprehensive detail about listed significant Medications given to the patient with the Category of the medication, Units & Duration of medication.

3. Disclaimer
    a. Gen AI Discharge Summary is currently ongoing Phase 1 – Pilot Study with the retrospective discharge summaries which is confined within the Med Mantra Database at Apollo Hospitals, Jubilee Hills, Hyderabad. We are incorporating the feedback from the Pilot Study to improve the performance of the tool.
    b. This is not a diagnostic tool and it does not guarantee the accuracy of the result and cannot be independently acted upon.
    c. To ensure the information in the report is up to date, accurate, and correct, the Doctor shall be consulted for interpretation of the report.

d. Apollo Hospitals and its Staff do not offer any assurance on the information made available or be liable for any loss or damage as the said report is based on the AICVD Cardiac Risk Score without any intervention from their side.

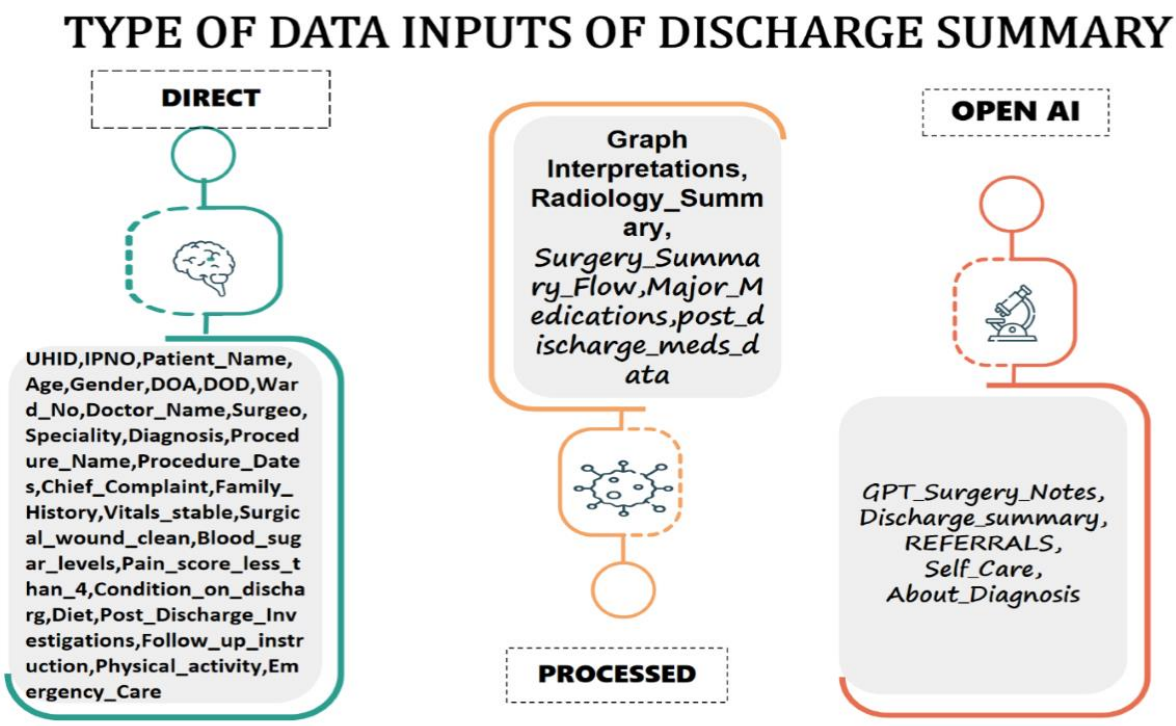
Research

Discharge Summaries play a crucial role in healthcare by providing a concise and comprehensive overview of a patient's hospital stay. However, existing discharge summaries have several limitations that impact their effectiveness and readability. Therefore, Gen AI Discharge Summary is built to streamline the process and make the process flow of generating Discharge Summary more comprehensive and less time-consuming, which in turn can help in bringing down the waiting time for all the discharges significantly.



The Gen AI Discharge Summary components are broadly classified into three types:

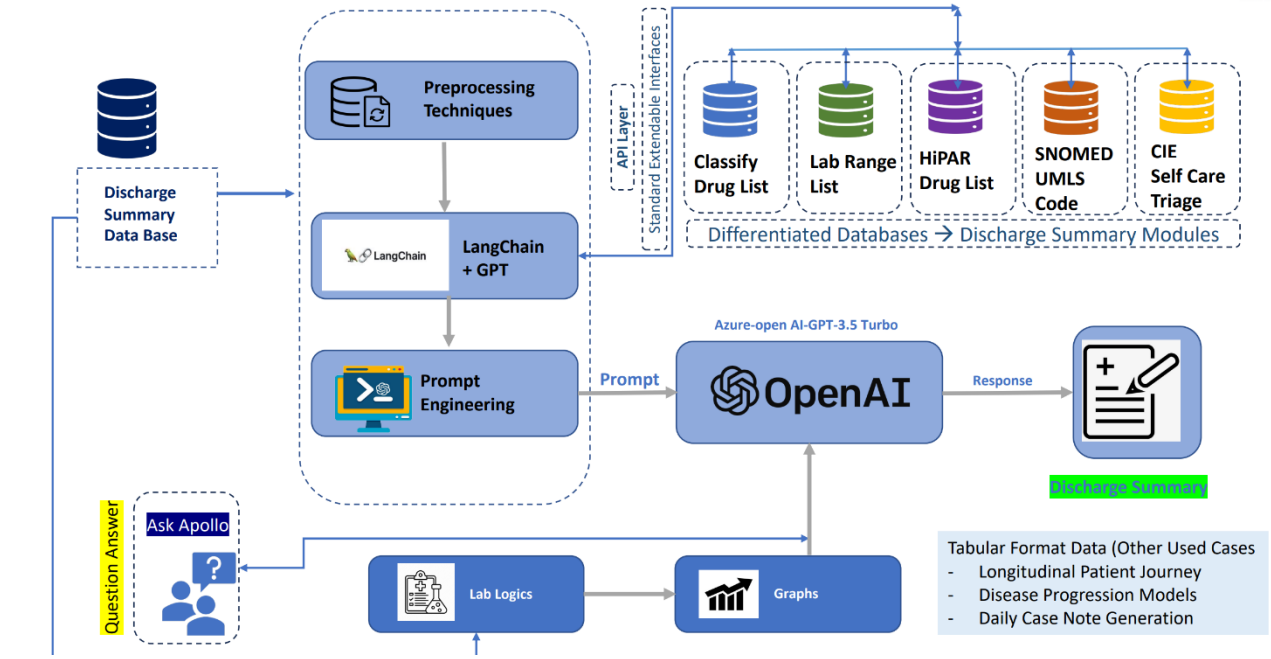
1. Direct Fields– the discharge data is taken as it is from the Medmantra, without making any changes to the input.
2. Processed – the discharge data is taken from the database and processed further to give a cohesive interpretation as an output in an easy-to-understand language.
3. Open AI – the discharge data is generated by the Gen AI by taking relevant inputs in the prompt.



Ethics Perspective

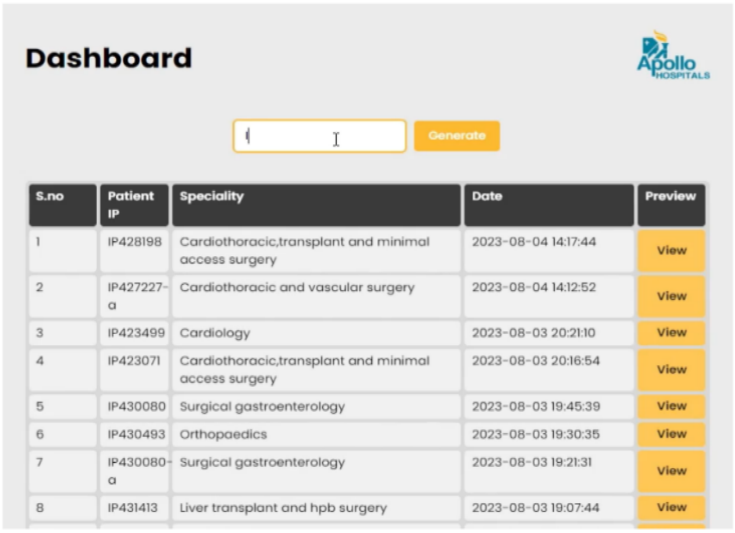
Title	Generating Discharge summary using EMR data leveraging Generative AI Large Language Models. (Gen AI Discharge Summary)	Centers	India – Apollo Hospitals – Hyderabad (Jubilee Hills)
Principal Investigators	Sujoy Kar ,Bharath Potla	Institutional Ethics Committee Approval	Applied for
Data	On going Phase 1 pilot with Retrospective data Differentiated database, HIPAR drug list, Lab range list	Safety	Gen AI Discharge Summary streamline the process and make the process flow of generating Discharge Summary more comprehensive which interpreted by clinicians through safe Machine (API) – Human (Clinician) Interaction
Sample Size + Missing Data	Retrospective Discharge Summaries	Inclusiveness & Fairness	At admission data includes clinical comorbidities & conditions | No socioeconomic discrimination
Personal Health information	De-identified all PHI during analysis, model building, API hosting and Prospective Use	Privacy & Confidentiality	Data secured at Apollo Azure Tenant with all relevant compliance + conforming to laws
Addressing Bias (Geographical / Ethnic / Temporal / Gender etc.)	Multiethnic – All Adult Population Automation Bias addressed at API Clinical Use	Accuracy + Efficacy	The generated discharge summaries consistently meets the intended context and conveys information effectively. While quantitative metrics are not available, the qualitative evaluation indicates a strong performance
Risk Groups /Outcome	Gen AI powered Discharge Summary Generation	Informed Consent	Yes – Template & Protocol (Prototype Attached)
Model Specification	Pretrained LLM (Azure open AI –GPT - 3.5,4)	API – Ease of Use + Interpretation	Flows to Clinical Algorithm Standard User Manual
Clinical Algorithm Update (Version)	Version 1 – MARCH 2023	Validation + Peer Review	In process
Certifications	ISO 13485:2016 Certification | MD 763515	Regulatory Compliance	CDSCO Application No| Apollo-Hyder-TE/M/MD/007509

Architecture for Unit Discharge Summary Generation



Key Features and Dashboard

- **Key Features:**
- Dashboard for generated discharges
- Edit: Edit for each component
- Print Option
- Save as PDF document



S.no	Patient IP	Speciality	Date	Preview
1	IP428198	Cardiothoracic,transplant and minimal access surgery	2023-08-04 14:17:44	View
2	IP427227-a	Cardiothoracic and vascular surgery	2023-08-04 14:12:52	View
3	IP423499	Cardiology	2023-08-03 20:21:10	View
4	IP423071	Cardiothoracic,transplant and minimal access surgery	2023-08-03 20:16:54	View
5	IP430080	Surgical gastroenterology	2023-08-03 19:45:39	View
6	IP430493	Orthopaedics	2023-08-03 19:30:35	View
7	IP430080-a	Surgical gastroenterology	2023-08-03 19:21:31	View
8	IP431413	Liver transplant and hpb surgery	2023-08-03 19:07:44	View

Frequently Asked Questions

Introduction

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Why is Gen AI Discharge Summary different or What is the advantage of this?

- This tool captures all the relevant inputs required for a discharge summary throughout the in-patient stay in the hospital and generates a summary of all inputs within a few minutes when prompted by the Physician.
- It can generate the report in multiple languages in the patient's native tongue.
- The current speed of complete Discharge Summary draft generation is within 1-2 minutes.

What is the Interpretation & Adoption Message

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Where can the physicians use the Gen AI Discharge Summary tool?

- IPD Discharge Summaries.
- Billing and Insurance Documentation.
- Integration with Medmantra for faster drafting.
- Speeding up the documentation process.
- Customized regional language support.

What are the risk factors of using a Third-Party Tool i.e., Enterprise Service – Azure Open AI?

Keeping in mind the privacy laws and compliance with them, the third-party tool does not get any patient-related information. All the patient-related data are completely removed before sending it to the third party, especially when it comes to the unstructured data of the discharge summaries, even if there's any patient identifier in the middle of the sentence, it is removed before the processing.

- Data is not used to train Enterprise Service – Azure Open AI
- Data stored only for 30 days – compliance
- PII is not shared with the Azure Open AI

What are the Inputs or Components?

Component	Type (App/ API)	Field	Type	Med Mantra input	Output	Comments
1. Patient Details	App	UHID	`Direct			Information is not sent to Open AI, all the patient information is masked, and we have the option to unmask - when required.
		IP NO	Direct			
		Patient Name	Direct			
		Age	Direct			
		Gender	Direct			
		DOA	Direct			
		DOD	Direct			
		Ward No	Direct			
		Doctor Name	Direct			
		Surgeon	Direct			
		Specialty	Direct			
2. Diagnosis	API	Diagnosis	Direct, Text Analytics model to get SNOMED, UMLS, normalization	Diagnosis	General explanation of diagnosis, normalization, SNOMED, UMLS	If diagnosis information is not available, the desired output can't be generated
3. Surgery	API	Procedure name	Direct			
		Procedure Dates	Direct			
		GPT_Surgery_Notes	Enterprise Service – Azure Open AI	Surgery notes, free text surgery	Generate surgery Notes summary based on the given inputs	If surgery information is not available, the desired output can't be generated
4. Details	App	Chief Complaints	Direct			
		Family History	Direct			
5. Labs	API	Tables, Graphs, Graph Interpretations	Tables-Direct, Graphs-Processed, Interpret-Enterprise Service –	Lab Data-Test, Parameter Name, result, lab ranges, dates	Generate graphs if more than 3 occurrences of the same lab, and	If lab ranges/results/dates are missing, graphs can't be generated

			Azure Open AI		provide interpretation of the graph	
6. Radiology	API	Radiology Summary	processed and Enterprise Service – Azure Open AI	Service name, date, result	Generate radiology summary	
7. Treatment Summary	API	Discharge summary	Enterprise Service – Azure OpenAI	Diagnosis, discussion, age, gender	Generate discharge summary from the input fields	
		Surgery_Summary_Flow	Processed and Enterprise Service – Azure OpenAI	OT Start, End time, Surgery Speciality, Bed Information, DOA, DOD	Generate patient flow by taking all the inputs	
		REFERRALS	Enterprise Service – Azure OpenAI	Referrals, primary consultant, referred consultants	Generate a small summary	
8. Major Medications	API	Major Medications	Processed, drug category BD.	Medications, item name, dosage, quantity, date	Add the category to each medication	Not sent to the Enterprise Service – Azure OpenAI
9. Discharge Medication	API	post_discharge_meds_data	Processed, drug category DB	Medications, item name, dosage, quantity, date	Add the category to each medication	Not sent to the Enterprise Service – Azure OpenAI
10. Discharge Examination	App	Vitals stable	Direct			
		Surgical_wound_clean	Direct			
		Blood_sugar_levels	Direct			

		Pain_score_less_than_4	Direct			
		Condition_on_discharge	Direct			
11. Special Instructions	App	Diet	Direct			
		Post_Discharge_Investigations	Direct			
		Follow_up_instruction	Direct			
		Physical activity	Direct			
		Emergency Care	Direct			
12. Self Care	API	Self Caré	Enterprise Service – Azure OpenAI	Diagnosis, discussion, age, gender, surgeries undergone	Generate a patient-personalized self-care advise	If inputs are not available, patient-specific self-care advice can't be generated
		Self-Care in Advice Telugu	Microsoft Translate Engine		Generate a patient personalized self-care advice in regional languages	Not sent to the Enterprise Service – Azure OpenAI
13. Appendix	API	About Diagnosis	Enterprise Service – Azure OpenAI	Diagnosis	General explanation of diagnosis, normalization, SNOMED, UMLS	If diagnosis information is not available, the desired output can't be generated
		Diagnosis Codes	Text Analytics Model	Diagnosis	General explanation of diagnosis, normalization, SNOMED, UMLS	If diagnosis information is not available, the desired output can't be generated

What is the Output?

- Generates a comprehensive summary of given input components
- The final approval for this summary rests with the Physician in charge.

- The goal is to ensure that the output is standardized and confirmed by the Physician before dispatch.

What are the challenges faced by the existing process?

- *Text Formatting Issue:* Discharge summaries use all capital letters, hindering readability and risking misunderstandings.
- *Poor Clinical Information Presentation and Omissions:* Clinical details are not easily distinguishable in current summaries, and the omission of certain details like diagnosis, etc makes it challenging to generate a holistic discharge record.
- *Medication Representation Gaps:* Important medications may be missed or poorly represented, increasing the risk of errors.
- *Lab Parameters Inconsistencies*: Key lab parameters are inconsistently and inadequately presented, limiting post-hospitalization condition understanding.
- *Spelling Errors* are also very frequently seen in the existing Discharge Summaries, making it hard for the tool to identify them, leading to multiple entries for the same terminology. This can lead to duplication as the tool identifies each term with different spellings as a unique term.

What is the Limitation?

Although, at present, the discharge summaries are being generated on retrospective data. There might be minimal errors – such as incorrect acronyms.

Is this Gen AI Discharge Summary editable by the Clinicians?

Yes, The Gen AI Discharge Summary is editable by clinicians during the draft stage.
Clinicians can edit each component individually for their final review.
The Demographics and prescription modules are the only non-editable sections.

Is this a diagnostic tool?

This tool is not for diagnosis but is intended to expedite the generation of discharge summaries. It needs a physician's approval before being dispatched to the patient.

Does this contradict the Physician’s view?

No, this tool does not go against the perspective of physicians. On the contrary, it helps streamline their workflow by minimizing the time required for documentation.

How does one ensure the accuracy of the Gen AI Discharge Summary tool?

When the input data is sufficient and comprehensive, the generated Discharge Summary will exhibit good quality. However, there is room for enhancing accuracy in Version 1 of the tool, and we plan to make improvements following validation by physicians.

Is this a substitute for the existing Discharge Summary process or Physician advice?

Not. This is not a replacement for the current Discharge Summary process or Medical Advice from the physicians. Instead, it serves as a supplementary tool utilizing the patient's clinical features and medical history and does not replace any diagnostic tests or professional advice.

What are the disclaimers for the use of this tool?

This tool is not for the patients.

It is not a diagnostic tool, and it is essential to consult a doctor, as they have the ultimate authority and expertise.

What are the various components generated using Enterprise Service – Azure Open AI GPT?
Various components are generated using Enterprise Service – Azure Open AI GPT, including surgery notes summaries, patient flow, referrals, and radiology summaries. It's important to note that fields such as patient demographics remain unchanged and are not transmitted to Enterprise Service – Azure Open AI for processing. The personal information of the patient is not sent to the Azure Open AI.
The Apollo Hospital data was not used in the training of the tool.

What happens if the inputs are inadequate or incomplete to generate summaries using Enterprise Service – Azure Open AI?
If the inputs are inadequate or incomplete, it may impact the quality of the generated summaries using Enterprise Service – Azure Open AI. It's important to note that this system, which was developed using retrospective data, assumes that all required input data is readily available for optimal performance.

Will the current version support prospective scenarios?
The current version is specifically designed for generating summaries in a retrospective scenario. We are capturing the direct as well as the edited data. We are actively collaborating with consultants to explore more options.

How can we adapt it to prospective scenarios by assessing the availability of relevant data?
Template & Guidelines – The Gen AI Discharge Summary follows a standardized and easy-to-read template and guidelines.
Doctors' Feedback for every component of the Discharge Summary is valuable for us to optimize the tool for the future.