Introduction

The Pre-Anesthesia AI Tool, a Novel Deep Learning (Neural Network) Model crafted by Apollo hospitals with over 40 comprehensive input parameters, is designed for use in cost-effective settings to enhance triage and resource allocation. Leveraging clinical and laboratory parameters during Pre-Anesthesia Assessment, this innovative system accurately predicts crucial surgical outcomes, including surgery duration, blood loss, and postoperative patient placement, achieving an accuracy of 92%.

Why Pre-Anaesthesia AI different?

1. A total of 205476 patients' data (mean age, 52 years; 39% female) were used which were acquired in 2022 from 7 regions for model development and testing.
2. Bayesian Deep Learning based Pre-Anaesthesia Assessment Tool (Accuracy - 88 to 92%)
3. Predicts Surgical Duration (Major Surgeries), Blood Loss, and Post Operative Patient Placement
4. Feedback loop from Patient Outcome
5. Comprehensive and Holistic Risk Assessment covering 40+ Input Parameters

Interpretation & Adoption Message

1. AI Algorithm + Clinicians - This risk assessment tool has been built as an adjunct tool for physicians to estimate Key Surgical Outcomes for patients during Pre-Anesthesia Checks.
2. Risk Identification and Clinical Decision Trajectories -This Risk Assessment tool provides an estimation of Surgical Duration, Blood Loss, and post-operative patient placement based on clinical and laboratory parameters during Pre-Anesthesia assessment. This model is built to ensure that it can be used in low-cost settings to improve resource allocation.
3. Where to use - The Pre-Anaesthesia AI model has been prepared for use in all departments who have been admitted for surgery.

How to Use (For Clinicians Only) –

1. Provide Appropriate –

    a. Demographic Details
    b. Obtain Patient Consent

2. Risk Factors Included –

    a. Personal/VS – Age | Gender | Height | Weight | BMI
    b. Current medical History – lung disease | Respiratory Disease | Arrhythmia | Coronary Artery Disease | Heart Failure | CNS| Immunocompromised
    c. History - Family History | Previous CAD | Diabetes mellitus* | Hypertension* (*Diagnosis or Medication)
    d. Heart Related Attributes - Heart Rate | Systolic BP | Diastolic BP | Cardiac Symptoms| Rhythm | Respiratory Rate New! – Psychological Stress
    e. Anesthesia Assessment - ASAPS | Pre-op ward | Saturation | Airway intervention | Chest Imaging | OSA Score | MET Score
    f. Lab - Haemoglobin | Platelet | INR | Lymphocyte | WBC | Creatinine
    g. Surgical Details – Surgery Speciality | Free Text Surgery

3. Output

    a. Surgery Duration
    b. Surgery Blood loss
    c. Risk Attributes for post-operative ward
    d. Clinical Decision Support System (What Next to Do)
        i. Lab Investigations
        ii. Treatment Goals

Workflow of Pre-anaesthesia App:

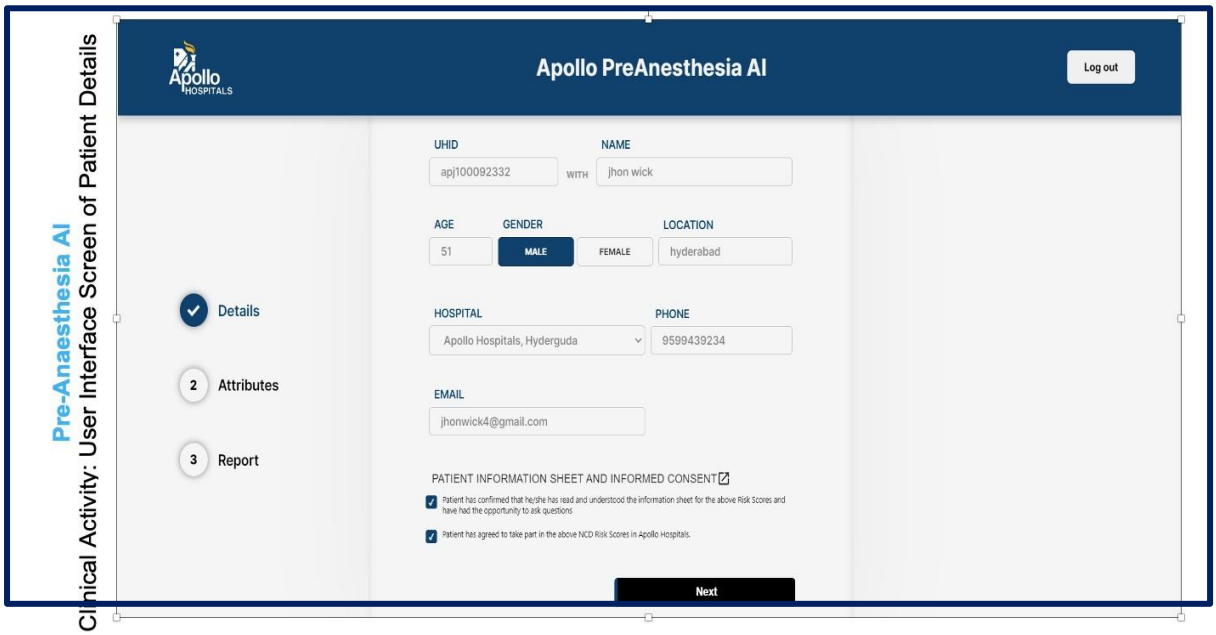


Figure 1: Patient details Dashboard: The first step to use the Pre-Anaesthesia AI App is to log into the Doctor Dashboard using your unique credentials. After login, fill in the Patient Details and take the consent from the patient.

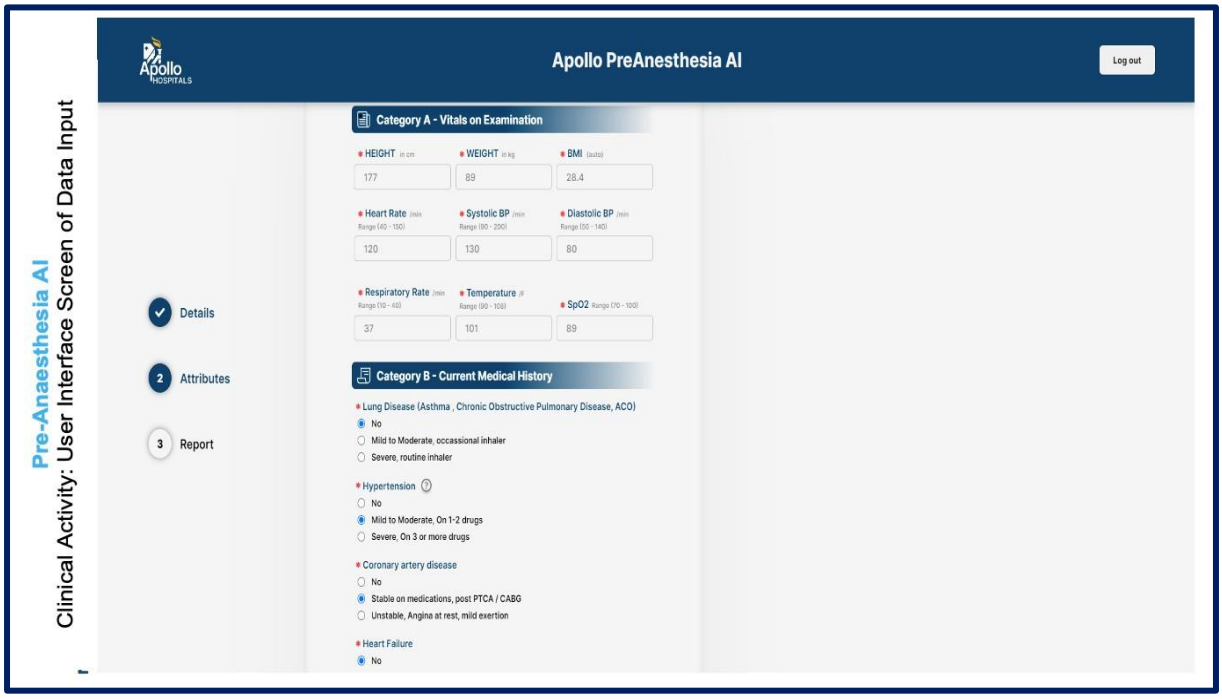


Figure 2: Entry of the vitals on examination and General Medical History

Figure 3 – Entry of Anesthesia-specific fields in the input characteristics followed by Lab Parameters and type of surgery

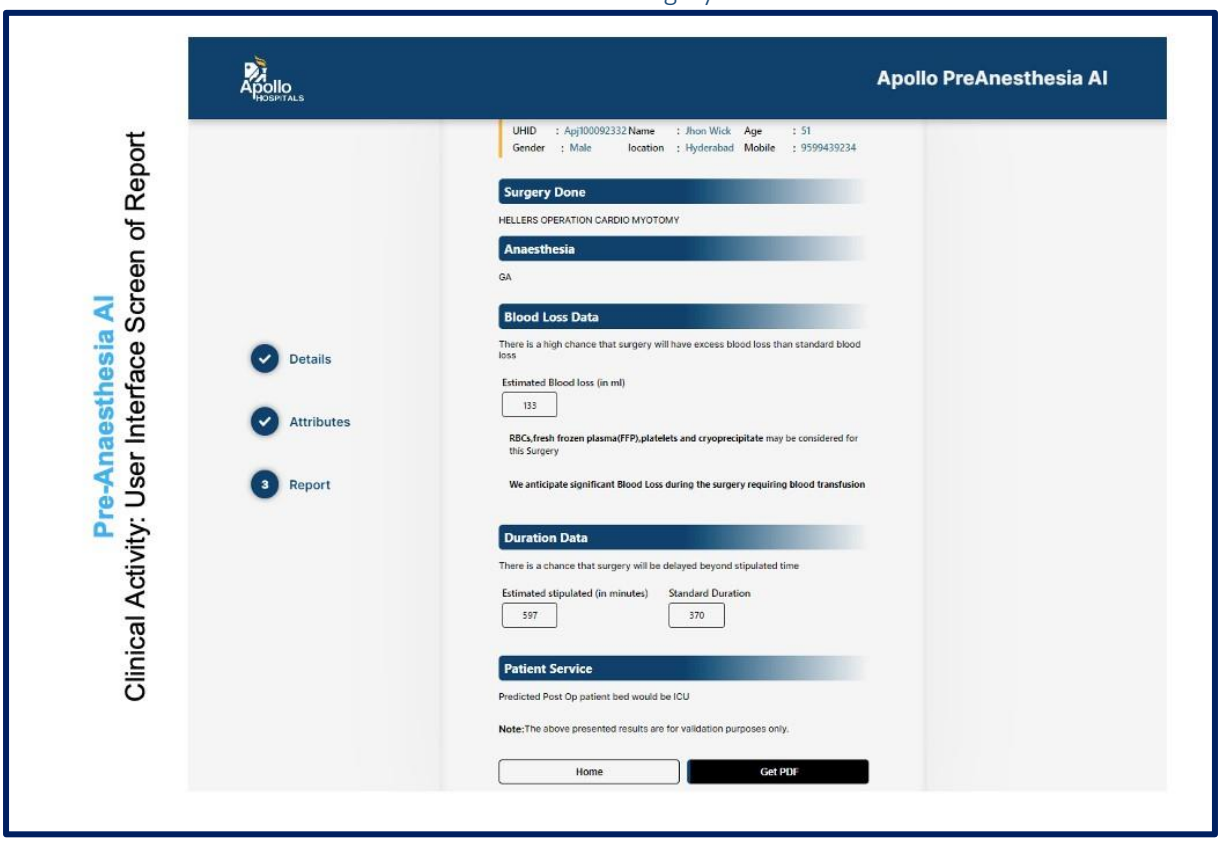
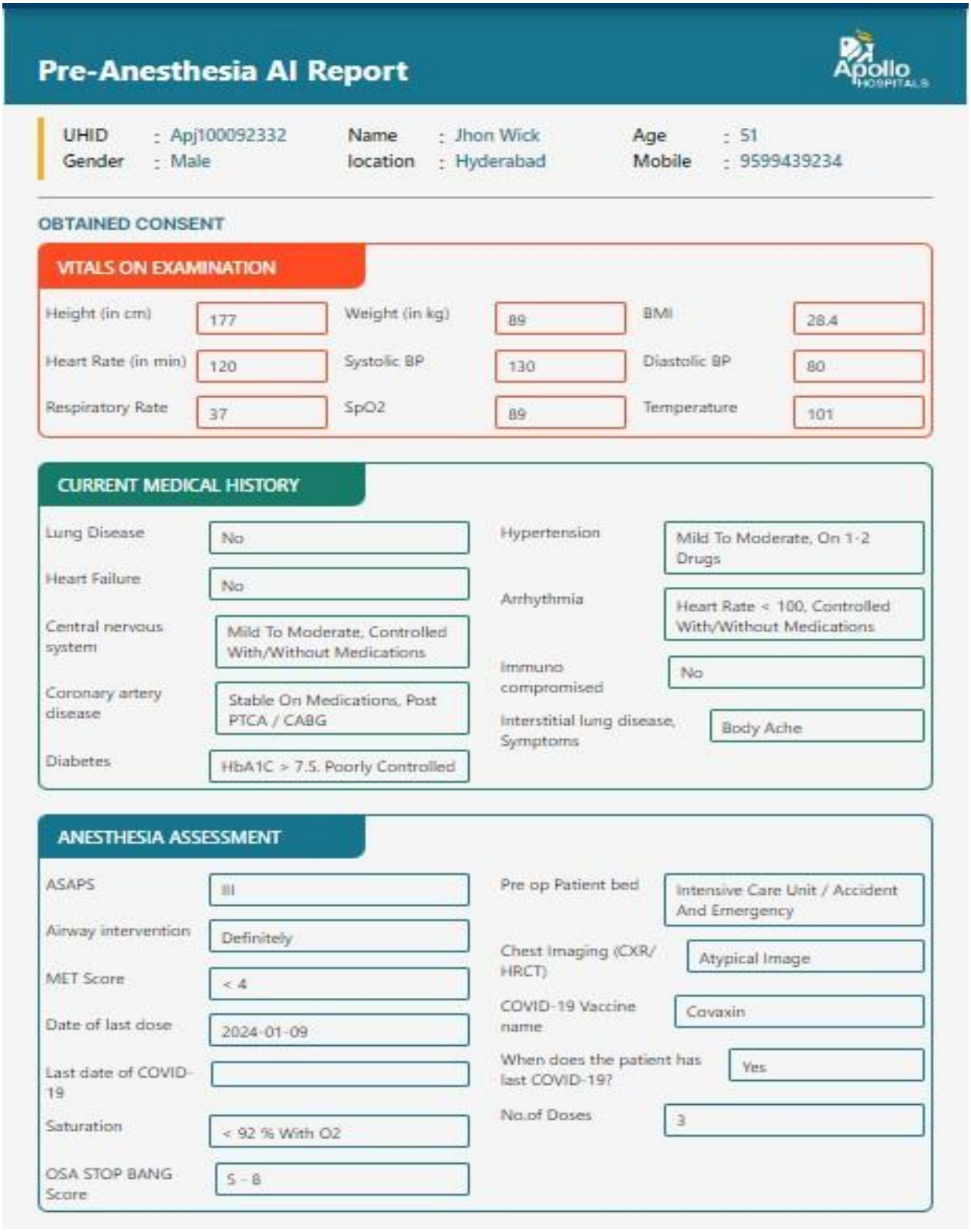


Figure 4 - Patient Output: Considering all the input parameters given, the model gives an output of Surgery Duration, Surgery Blood loss, Risk Attributes for the post-operative ward, Clinical Decision Support System (What Next to do), Lab Investigations and Treatment Goals

Printed Report



Pre-Anesthesia AI Report

UHID	: Apj100092332	Name	: Jhon Wick	Age	: 51
Gender	: Male	location	: Hyderabad	Mobile	: 9599439234

OBTAINED CONSENT

VITALS ON EXAMINATION

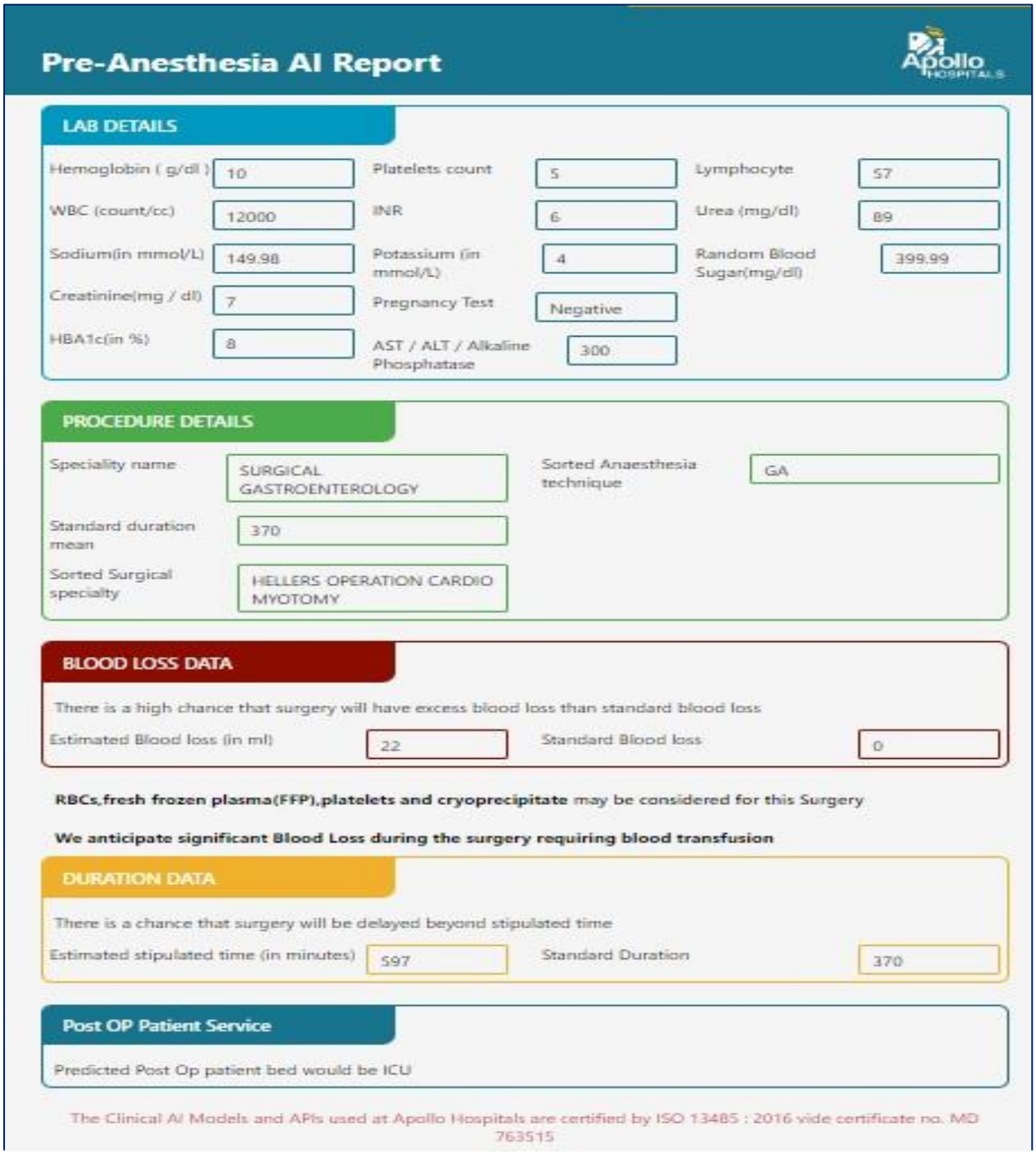
Height (in cm)	177	Weight (in kg)	89	BMI	28.4
Heart Rate (in min)	120	Systolic BP	130	Diastolic BP	80
Respiratory Rate	37	SpO2	89	Temperature	101

CURRENT MEDICAL HISTORY

Lung Disease	No	Hypertension	Mild To Moderate, On 1-2 Drugs
Heart Failure	No	Arrhythmia	Heart Rate < 100, Controlled With/Without Medications
Central nervous system	Mild To Moderate, Controlled With/Without Medications	Immuno compromised	No
Coronary artery disease	Stable On Medications, Post PTCA / CABG	Interstitial lung disease, Symptoms	Body Ache
Diabetes	HbA1C > 7.5, Poorly Controlled		

ANESTHESIA ASSESSMENT

ASAPS	III	Pre op Patient bed	Intensive Care Unit / Accident And Emergency
Airway intervention	Definitely	Chest Imaging (CXR/ HRCT)	Atypical Image
MET Score	< 4	COVID-19 Vaccine name	Covaxin
Date of last dose	2024-01-09	When does the patient has last COVID-19?	Yes
Last date of COVID-19		No.of Doses	3
Saturation	< 92 % With O2		
OSA STOP BANG Score	5 - 8		



Pre-Anesthesia AI Report

LAB DETAILS

Hemoglobin (g/dl)	10	Platelets count	5	Lymphocyte	57
WBC (count/cc)	12000	INR	6	Urea (mg/dl)	89
Sodium(in mmol/L)	149.98	Potassium (in mmol/L)	4	Random Blood Sugar(mg/dl)	399.99
Creatinine(mg / dl)	7	Pregnancy Test	Negative		
HBA1c(in %)	8	AST / ALT / Alkaline Phosphatase	300		

PROCEDURE DETAILS

Speciality name	SURGICAL GASTROENTEROLOGY	Sorted Anaesthesia technique	GA
Standard duration mean	370		
Sorted Surgical specialty	HELLERS OPERATION CARDIO MYOTOMY		

BLOOD LOSS DATA

There is a high chance that surgery will have excess blood loss than standard blood loss

Estimated Blood loss (in ml)	22	Standard Blood loss	0

RBCs,fresh frozen plasma(FFP),platelets and cryoprecipitate may be considered for this Surgery

We anticipate significant Blood Loss during the surgery requiring blood transfusion

DURATION DATA

There is a chance that surgery will be delayed beyond stipulated time

Estimated stipulated time (in minutes)	597	Standard Duration	370

Post OP Patient Service

Predicted Post Op patient bed would be ICU

The Clinical AI Models and APIs used at Apollo Hospitals are certified by ISO 13485 : 2016 vide certificate no. MD 763515

Disclaimer

a. This is not a diagnostic tool and it does not guarantee the accuracy of the result and cannot be independently acted upon.
b. This Risk score and Clinical Algorithm is a general guideline for Physicians. Any additional laboratory investigations, Diagnostic Imaging, Treatment, or Patient Education related to lifestyle management is under the Physician's discretion.

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 Pre-Anaesthesia AI without any intervention from their side.
e. By usage of Pre-Anaesthesia AI, it is deemed that the beneficiary of this service has agreed to get the same done at his own risk and further agrees with this disclaimer without any limitation or any clauses or sub-clauses.

Research

Multivariable multicenter study at Pre-Anesthesia Checks using Bayesian Deep Learning to predict Surgical Duration, Blood Loss, and Patient Placement. (Pre -Anesthesia AI Tool)

Authors; Dr Sujoy Kar, Dr Saikat Sengupta, Bharath Potla, Jospin Dhivya, Chetana Korrapati, Dr Triyanka Tiu, Dr Sangita Reddy

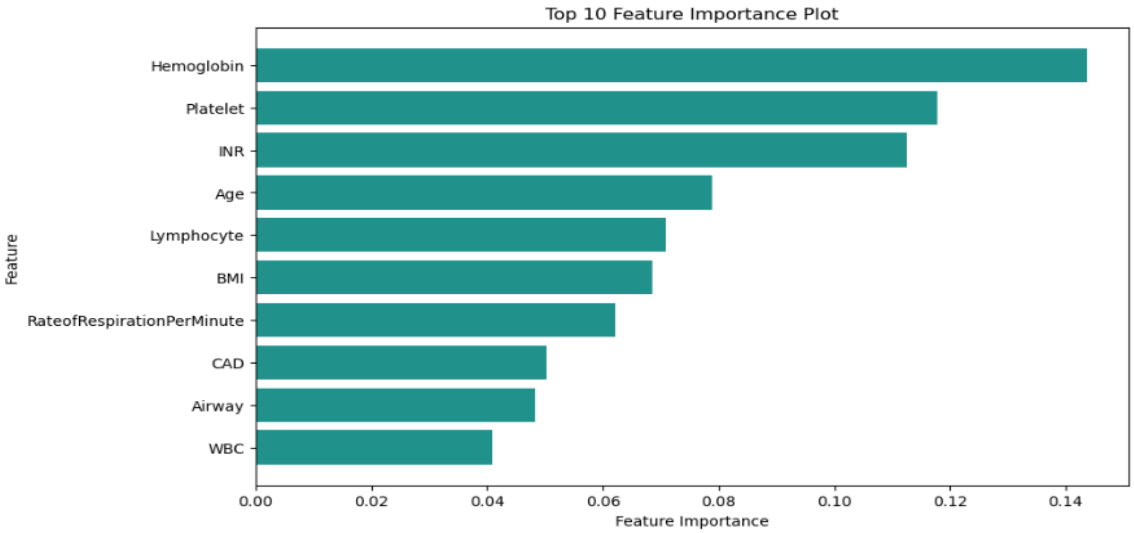
Institution: Apollo Hospitals Group

Introduction: The Pre-Anesthesia AI Tool, Bayesian Deep Learning algorithms, has been developed at Apollo Hospitals with the integration of 33 comprehensive input parameters collected at pre-anesthesia check. This model is specifically designed to accurately predict procedural outcomes such as surgical duration, blood loss, and postoperative patient placement with an accuracy rate of 92%. The objective of this study is to develop a tool for comprehensive and holistic risk assessment of patients undergoing Pre-Anesthesia checkups in different surgical specialties.

Materials & Methods: The tool is developed with pre-anesthesia data of over 2,05,100 patients undergoing surgeries from eight centers of the group over a period from Jan 2022 to Jun 2023, and further validated with a validation cohort of 38027 patients. The data includes anonymized demographic information and 33 input features including vitals, medical history of the cardiovascular, respiratory, and central nervous system, underlying coagulopathies, liver and kidney diseases; diagnoses, anesthesia assessment, and lab features. The tool employs regression models such as the Linear Neural Network and Bayesian Neural Network to predict surgical duration and blood loss. Additionally, for predicting postoperative patient placement the eXtreme Gradient Boost (XGB) classification model is employed.

Results: The tool achieved an adjusted R^2 of 0.92 [CI 0.909 – 0.939] in predicting duration, an adjusted R^2 of 0.66 [CI 0.649 – 0.671], for operative blood loss, and an AUC of 0.83 [CI 0.819 – 0.841], predicting Post-Operative ward placement. The model also includes a feedback loop from patient outcomes, ensuring continuous improvement and refinement of the tool. BMI [5.54 (CI 5.42 – 5.65)], INR [4.74 [CI 4.65 – 4.84)], and Heart Failure [1.41 (CI 1.32 – 1.50)] are among the important odds ratios for longer surgical duration (>20% higher than upper limit)

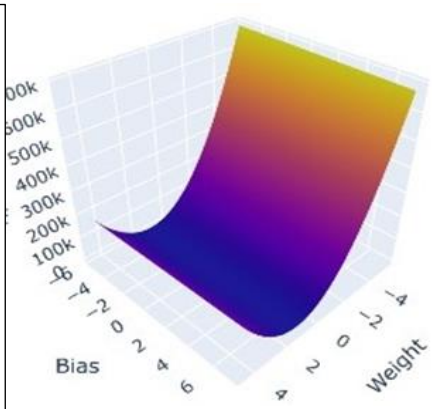
Conclusion: The Pre-Anesthesia AI Tool serves as a Software as a Medical Device (SaMD) for physicians, aiding in the preoperative planning process by integrating algorithms. This ISO 13485-certified tool contributes to Improved patient outcomes and operational efficiency.



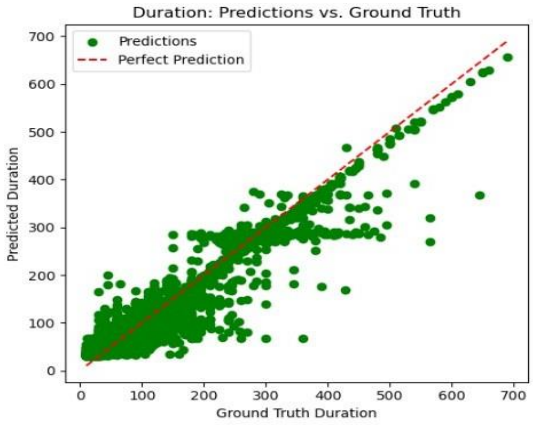
Surgery Duration |Test Set: 205100 & 33 Features | Validation Set: 38027 & 33 Features

Models	MSE	R^2	Adjusted R^2
Linear Neural Network	1111.99	0.877	0.86
Bayesian Neural Network	669.83	0.926	0.926
Test Set Performance	811.78	0.911	0.910

Surgery Duration Surface Plot



Surgery Duration Scatter Plot



References

- Lam, Sean Shao Wei, et al. "Estimation of Surgery Durations Using Machine Learning Methods-A Cross-Country Multi-Site Collaborative Study." *Healthcare (Basel, Switzerland)* vol. 10,7 1191. 25 Jun. 2022, doi:10.3390/healthcare10071191
- Kayis, Enis et al. "Improving prediction of surgery duration using operational and temporal factors." *AMIA ... Annual Symposium proceedings. AMIA Symposium* vol. 2012 (2012): 456-62.

- Stepaniak, Pieter S., et al. "Modeling Procedure and Surgical Times for Current Procedural Terminology-Anesthesia-Surgeon Combinations and Evaluation in Terms of Case-Duration Prediction and Operating Room Efficiency: A Multicenter Study." Anesthesia & Analgesia, vol. 109, no. 4, 2009, pp. 1232-1245. DOI: 10.1213/ANE.0b013e3181b5de07.
- Garside, N., Zaribafzadeh, H., Henao, R., et al. "CPT to RVU conversion improves model performance in the prediction of surgical case length." *Scientific Reports*, vol. 11, 2021, p. 14169. DOI: 10.1038/s41598-021-93573-2.
- Wardhana, Aditya et al. "Preoperative Blood Loss Prediction Formulas in Burn Surgeries: A Review." *Journal of burn care & research: official publication of the American Burn Association* vol. 44,3 (2023): 641-648. doi:10.1093/jbcr/irac109

Ethics Perspective:

Title	Development and Validation of multivariable prediction model using Machine Learning to predict the risk of Blood Loss, Surgery Duration etc before Pre Anesthesia stage.	Centers	India – Apollo Hospitals – Chennai , Hyderabad , Bangalore , Kolkata , Mumbai ,Nashik , Delhi
Principal Investigators	Sujoy Kar, Dr Saikat Sengupta, Bharath Potla, Jospin Dhivya, Chetana Korrapati, Dr Triyanka Tiu, Dr Sangita Reddy	Institutional Ethics Committee Approval	MAY 2020 (Kolkata) Others – applied for
Data	Retrospective – 2022	Safety	Model advocates post operative outcomes that are interpreted by clinicians through safe Machine (API) – Human (Clinician) Interaction
Sample Size + Missing Data	2,05,476 SURGERY DATA	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 Group – Male to Female –61:39– Time Period – 2022 Automation Bias addressed at API Clinical Use	Accuracy + Efficacy	Classification Metrics - R2 of Surgery Duration prediction Model -0.92 R2 of Blood loss prediction Model –0.66 AUC of Patient Placement-0.83
Risk Groups / Out put	Surgery duration prediction –Blood loss prediction-Post Operative patient placement	Informed Consent	Yes – Template & Protocol (Prototype Attached)
Model Specification	Deep learning Model	API – Ease of Use + Interpretation	Flows to Clinical Algorithm Standard Clinical Definitions + Lab Units Used
Clinical Algorithm Update (Version)	Version 1 –November 2021	Validation + Peer Review	Ongoing
Intellectual Property Rights (IPR)	Patent No|202441065934	Certifications & Compliance	ISO 13485:2016 Certification | MD 763515 CDSCO Application No| Apollo-Hyder-TE/M/MD/007509

Frequently Asked Questions

Where can the physicians use the pre-anesthesia AI?

The Pre-Anesthesia AI model has been prepared for anaesthetists to use at all Surgical Specialties for patients who are admitted for surgery in the next 7 days.

What are the key risk factors considered in predicting surgery duration and blood loss?

The predictive model takes into account a variety of factors, including patient demographics such as age and gender, medical history (previous surgeries and chronic conditions), preoperative health status (vital signs and laboratory results), details of the surgical procedure (complexity and type), Anesthesia-related factors, surgeon expertise, operative details (estimated blood loss and incision type), intraoperative complications, and aspects of postoperative care. These factors collectively contribute to a comprehensive analysis aimed at predicting surgery duration and blood loss accurately.

How does patient history impact the prediction model?

Patient history plays a crucial role in the prediction model. Factors such as the number and type of previous surgeries, chronic medical conditions, and any adverse reactions or complications with prior Anesthesia contribute to understanding the patient's baseline health and potential risk factors for the current surgery.

What is the Output and Follow-Up for the Risk Score?

The output is a prediction of patients' Surgery duration their blood loss and the post-operative patient placement.

What role does the complexity of the surgical procedure play in the model?

The complexity of the surgical procedure is a significant factor influencing both surgery duration and blood loss. More complex surgeries tend to take longer and may involve greater blood loss. The type of surgery, along with specific details related to the procedure, is considered to provide a nuanced understanding of the anticipated challenges and risks.

How does the model consider postoperative care in predicting outcomes?

The quality of postoperative care is considered a factor in the prediction model. The level of care provided after the surgery can impact recovery and may influence the overall outcomes, including factors like reduced complications and improved patient recovery times.

Does this contradict the Physician’s view?

No, the predictive model is not intended to contradict the views of physicians. Instead, it serves as a complementary tool to aid healthcare professionals in making informed decisions. The model incorporates data-driven insights from a diverse range of factors to provide a comprehensive analysis. However, it is crucial to emphasize that the model does not replace the expertise and clinical judgment of physicians. Instead, it aims to enhance decision-making by offering additional information for consideration. Collaboration between the predictive model and physicians ensures a holistic approach to surgical planning, where both data-driven insights and medical expertise contribute to optimal patient care.

How does one ensure the accuracy of the Predictive Pre-Anesthesia AI tool?

To ensure the information in the report is up to date, accurate, and correct, the Doctor shall be consulted to interpret the report. Additionally, the input data should be accurate and as per the conventional metrics used.

What are the disclaimers for the use of this tool?

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 Pre-Anesthesia AI tool without any intervention from their side.

By usage of the Pre-Anesthesia AI Model, it is deemed that the beneficiary of this service has agreed to get the same done at his own risk and further agrees with this disclaimer without any limitation or any clauses or sub-clauses.

Can the report be shared with other clinicians?
Yes, each patient shall get a printed report or PDF copy which can be kept by the patient maintaining privacy and confidentiality.

Definitions

Pre-Anesthesia

A Pre-Anesthesia evaluation tool is a structured instrument or checklist used by healthcare professionals to systematically assess patients before undergoing anesthesia and surgery. It helps gather relevant patient information, identify potential risks, and develop an individualized anesthetic plan. The tool aims to improve patients' safety, optimize perioperative care, and ensure the best possible outcomes.

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2464262/

1. BMI: Body Mass Index (BMI) is a person's weight in kilograms (or pounds) divided by the square of height in meters (or feet).
   Source: Body Mass Index (BMI) | Healthy Weight, Nutrition, and Physical Activity | CDC

Vital Signs Definition

2. Hearth Rate: Heart rate, is the number of times the ventricles of the heart contract and relax (that is, beat) per minute or other unit of time.
3. Systolic blood pressure (SBP): Systolic blood pressure, the top number, measures the force the heart exerts on the walls of the arteries each time it beats
4. Diastolic Blood pressure: Diastolic blood pressure, the bottom number, measures the force the heart exerts on the walls of the arteries in between beats.
5. Rate of Respiration/Respiratory rate (ROR): Respiratory rate is also known as your breathing rate. This is the number of breaths you take per minute.
6. Temperature: Body temperature is measured by a clinical thermometer and represents a balance between the heat produced by the body and the heat it loses
7. SPo2: SpO2 stands for Saturation of Peripheral Oxygen, a measure of how much oxygen is bound to hemoglobin in the blood. In this study, the majority of the Oxygen Saturation (>92%) is determined by pulse oximetry – which is a non-invasive method that uses a sensor attached to the finger or earlobe to measure the oxygen saturation indirectly.

Sources:

- Heart rate | Description, Monitoring, & Facts | Britannica
- Blood pressure chart: What your reading means - Mayo Clinic
- How to measure your respiratory rate - Mayo Clinic

- Body temperature | definition of body temperature by medical dictionary (thefreedictionary.com)
- What is SpO2? | Pulse Oximetry | What is The Normal SpO2 Level? (somatechnology.com)

8. Forward Fill Imputation Technique: When dealing with time series data or datasets containing missing values, forward fill involves replacing those missing data points with the most recent known value. This approach assumes that the value remains constant until a new observation becomes available. The type of forward filling used in this model is the last Observation Carried Forward while we continue to test other methods like Time Dependent Iterative Imputation

Source : Jakobsen, J.C., Gluud, C., Wetterslev, J. et al. When and how should multiple imputations be used for handling missing data in randomized clinical trials – a practical guide with flowcharts. BMC Med Res Methodol 17, 162 (2017). https://doi.org/10.1186/s12874-017-0442-1

Omer Noy, Ron Shamir, et al. Time-dependent Iterative Imputation for Multivariate Longitudinal Clinical Data

https://doi.org/10.48550/arXiv.2304.07821

9. Diabetes Mellitus

The American Diabetes Association (ADA) defines diabetes mellitus as follows

a. A fasting plasma glucose (FPG) ≥126 mg/dl. Fasting is defined as no caloric intake for at least 8 hr.
b. Symptoms of hyperglycemia and a casual (random) plasma glucose ≥200 mg/dl. Classic symptoms of hyperglycemia include polyuria, polydipsia, and unexplained weight loss. (At the time of diagnosis as a diabetic, B cell function is at 25% to 30%.)
c. An oral glucose tolerance test (OGTT) with a plasma glucose ≥200 mg/dl 2 hr after a 75 g (100 g for pregnant women) glucose load.
d. A haemoglobin A1c (HbA1c) value ≥6.5%.

In the context of the study, data collection method, and overall clarity, please follow the –

a. Patient with no history of diabetes and previous record of normal FPG / OGTT / HbA1c – Select NO
b. Patient with a history of diabetes and a current record of HbA1c <7.5% - Select Controlled (this is irrespective of a patient under / not under medication/treatment)
c. Patient with a history of diabetes and a current record of HbA1c ≥7.5% - Select Uncontrolled (this is irrespective of a patient under / not under medication/treatment)

Source – ACP Guideline 2018 - American Diabetes Association. Standards of Medical Care in Diabetes2018 Abridged for Primary Care Providers. Clin Diabetes. 2018 Jan;36(1):14-37. Doi: 10.2337/cd170119. PMID: 29382975; PMCID: PMC5775000.

10. Hypertension

Normal blood pressure (BP) in adults can be defined as systolic BP <120 mm Hg and diastolic BP <80 mm Hg.
Prehypertension is defined as systolic BP between 120 and 139 mm Hg or diastolic between 80 and 89 mm Hg.

Hypertension can be divided into

Stage 1: systolic BP from 140 to 159 mm Hg or diastolic BP from 90 to 99 mm Hg and

Stage 2: systolic BP ≥160 mm Hg or diastolic BP ≥100 mm Hg.

Source - Giles TD, Materson BJ, Cohn JN, Kostis JB. Definition and classification of hypertension: an update. J Clin Hypertens (Greenwich). 2009 Nov;11(11):611-4. doi: 10.1111/j.17517176.2009.00179.x. Erratum in: J Clin Hypertens (Greenwich). 2010 Jan;12(1):13. PMID: 19878368; PMCID: PMC8673286.

11. Coronary Artery Disease

Coronary artery disease (CAD) is a common type of heart disease that affects the blood flow to the heart muscle. It is caused by the buildup of plaque, a fatty substance, in the walls of the coronary arteries, which supply oxygen and nutrients to the heart. This plaque can narrow or block the arteries, reducing the blood supply to the heart and causing chest pain, shortness of breath, fatigue, or heart attack.
Source: https://www.cdc.gov/heartdisease/coronary_ad.htm

12. Heart Failure

According to the Universal Definition and Classification of Heart Failure, heart failure (HF) is a clinical syndrome with symptoms and/or signs caused by a structural and/or functional cardiac abnormality and corroborated by elevated natriuretic peptide levels and/or objective evidence of pulmonary or systemic congestion.
The classification of HF includes four stages:

i. At risk for HF (Stage A): Patients with risk factors for developing HF, such as hypertension, diabetes, obesity, or coronary artery disease, but without structural heart disease or symptoms of HF.
ii. Pre-HF (Stage B): Patients with structural heart disease, such as left ventricular hypertrophy, left ventricular dysfunction, or valvular heart disease, but without symptoms of HF.
iii. Symptomatic HF (Stage C): Patients with structural heart disease and current or prior symptoms of HF, such as dyspnea, fatigue, or edema. iv. Advanced HF (Stage D): Patients with refractory HF require specialized interventions, such as mechanical circulatory support, continuous inotropic infusion, or palliative care.

The classification of HF also includes subgroups based on left ventricular ejection fraction (LVEF):

- HF with reduced ejection fraction (HFrEF): Symptomatic HF with LVEF ≤40%.
- HF with mid-range ejection fraction (HFmrEF): Symptomatic HF with LVEF 41-49%.

- HF with preserved ejection fraction (HFpEF): Symptomatic HF with LVEF ≥50%.
- HF with improved ejection fraction (HFimpEF): Symptomatic HF with a baseline LVEF ≤40%, a ≥10-point increase from baseline LVEF, and a second measurement of LVEF >40%.

Source:

Gregory Gibson, MD; Vanessa Blumer, MD; Robert John Mentz, MD, FACC; Anuradha (Anu) Lala, MD,

FACC, Universal Definition and Classification of Heart Failure: A Step in the Right Direction from Failure to Function; Jul 13, 2021 https://www.acc.org/latest-incardiology/articles/2021/07/12/12/31/universal-definition-and-classification-of-heart-failure.

Classes and Stages of Heart Failure | American Heart Association. https://www.heart.org/en/healthtopics/heart-failure/what-is-heart-failure/classes-of-heart-failure.

13. Arrhythmia

An arrhythmia is a problem with the rate or rhythm of the heartbeat. It can be too fast, too slow, or irregular. Arrhythmias can affect the blood flow to the heart and other organs, and may cause complications such as stroke or heart failure.
Arrhythmias are often categorized into four groups:

i. Extra beats: These are additional beats that occur in the upper or lower chambers of the heart. They may cause palpitations or skipped beats. Examples are premature atrial contractions, premature ventricular contractions, and premature junctional contractions.
ii. Supraventricular tachycardias: These are fast heart rhythms that originate in the upper chambers of the heart. They may cause symptoms such as chest pain, shortness of breath, or fainting. Examples are atrial fibrillation, atrial flutter, and paroxysmal supraventricular tachycardia. iii. Ventricular arrhythmias: These are fast or chaotic heart rhythms that originate in the lower chambers of the heart. They are usually life-threatening and require immediate medical attention. Examples are ventricular fibrillation and ventricular tachycardia.
iv. Bradyarrhythmias: These are slow heart rhythms that may result from problems with the natural pacemaker of the heart or the electrical conduction system. They may cause symptoms such as fatigue, dizziness, or low blood pressure. Examples are sinus node dysfunction and atrioventricular block.

Source: American Heart Association. https://www.heart.org/en/health topics/arrhythmia/about-arrhythmia . Categories of Arrhythmias | The Texas Heart Institute. https://www.texasheart.org/hearthealth/heart-information-center/topics/categories-of-arrhythmias/.

14. Lung Disease

Definition and classification of COPD and asthma:

i. Chronic Obstructive Pulmonary Disease (COPD) is a group of diseases that cause airflow limitation and inflammation of the airways. It is usually caused

by exposure to noxious particles or gases, such as cigarette smoke. COPD is diagnosed by a post-bronchodilator FEV1/FVC ratio of less than 70%. The severity of COPD is classified by the degree of airflow obstruction, measured by the percentage of predicted FEV1[1].

ii. Asthma is a chronic inflammatory disorder of the airways that causes variable and recurrent symptoms, such as wheezing, coughing, and shortness of breath. It is often triggered by allergens, irritants, or infections. Asthma is diagnosed by the presence of bronchial hyperresponsiveness, which can be assessed by a bronchodilator or a methacholine challenge test. The severity and control of asthma are determined by the frequency and intensity of symptoms, the use of rescue medication, and the level of lung function[2].

iii. Asthma-COPD overlap syndrome (ACOS) is a condition that has features of both asthma and COPD. It is characterized by persistent airflow limitation, eosinophilic inflammation, and increased reversibility of airway obstruction. ACOS is more common in older patients, smokers, and those with a history of asthma. The diagnosis of ACOS is based on clinical criteria, such as a history of asthma before the age of 40, a history of allergies, and a positive bronchodilator response of more than 12% and 200 mL[3][4].

Source:

COPD and Asthma | World Allergy Organization. https://www.worldallergy.org/education-andprograms/education/allergic-disease-resource-center/professionals/copd-and-asthma.

Asthma & COPD Overlap: Definitions, Measures | Journal of COPD Foundation. https://journal.copdfoundation.org/jcopdf/id/1142/Asthma-and-Chronic-Obstructive-PulmonaryDisease-Overlap-The-Effect-of-Definitions-on-Measures-of-Burden.

15. Central Nervous System Disorder

Central nervous system (CNS) disorders are a group of neurological conditions that affect the brain and spinal cord, which together form the CNS. CNS disorders can be classified according to the primary location affected, the primary type of dysfunction involved, or the primary type of cause. Examples of CNS disorders are: Traumatic brain injury (TBI), Spinal cord injury (SCI), Infectious diseases, Degenerative diseases, Structural defects and Tumors.

CNS disorders can cause various degrees of disability, depending on the severity, location, and type of the condition. Disability can be measured by using different scales or criteria, such as the

International Classification of Functioning, Disability and Health (ICF), the Glasgow Coma Scale (GCS), or the Disability Rating Scale (DRS). Disability can affect the quality of life, independence, and social participation of people with CNS disorders.

Source: Hopkins Medicine CNS https://www.hopkinsmedicine.org/health/conditions-and-diseases/overviewof-nervous-system-disorders

16. Immunocompromised state

An immunocompromised state is a condition where the immune system is weakened or impaired, making it less able to fight off infections and diseases. There are many causes and types of immunocompromised states, such as:

i Primary immunodeficiencies: These are genetic or congenital disorders that affect the development or function of one or more components of the immune system, such as B cells, T cells, natural killer cells, or complement system. Examples are common variable immunodeficiency, severe combined immunodeficiency, and DiGeorge syndrome[12].

ii Secondary immunodeficiencies: These are acquired conditions that result from external factors that damage or suppress the immune system, such as infections, medications, treatments, or diseases. Examples are HIV/AIDS, chemotherapy, organ transplantation, diabetes, and malnutrition.

iii Autoimmune diseases: These are disorders where the immune system mistakenly attacks the body's own tissues, causing inflammation and damage. Examples are rheumatoid arthritis, lupus, and multiple sclerosis

iv Allergic diseases: These are conditions where the immune system overreacts to harmless substances, such as pollen, dust, or food, causing symptoms such as sneezing, itching, or anaphylaxis. Examples are asthma, eczema, and food allergies

Immunocompromised states can be classified according to the severity, duration, and reversibility of the immune dysfunction. For example, some immunodeficiencies are mild and transient, while others are severe and permanent. Some immunosuppressive drugs or treatments can be stopped or reduced, while others are lifelong. Some autoimmune or allergic diseases can be controlled or cured, while others are chronic or progressive. Immunocompromised states can increase the risk of infections, cancers, and complications from vaccines or other medical procedures. Therefore, it is important to prevent, diagnose, and treat immunocompromised states, as well as to protect immunocompromised individuals from exposure to harmful agents.

Sources https://www.yalemedicine.org/news/what-does-immunocompromised-mean. https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-who-areimmunocompromised.html.

17. Allergies

"Allergy" is defined as "a hypersensitivity reaction initiated by proven or strongly suspected immunologic mechanisms".

Source

World Allergy.Org: https://www.worldallergy.org/education-and-programs/education/allergicdisease-resource-center/professionals/food-allergy

18. Respiratory Disease

Respiratory distress may be a result of disorders of the extrathoracic or intrathoracic airways (intrinsic or extrinsic compression-obstruction), alveoli, pulmonary vasculature, pleural spaces, or thorax.

Source: Nelson Pediatric Symptom-Based Diagnosis, 2018
https://www.sciencedirect.com/topics/medicine-and-dentistry/respiratory-distress

19. Cardiovascular Symptoms

Cardiovascular diseases (CVDs) affect your heart and blood vessels. Cardiovascular disease symptoms can vary depending on the cause Chest pain (angina).

Chest pressure, heaviness or discomfort, sometimes described as a “belt around the chest” or a “weight on the chest.”

Shortness of breath (dyspnea).

Dizziness or fainting.

Fatigue or exhaustion.

Source: Cleveland Clinic Cardiovascular Disease
https://my.clevelandclinic.org/health/diseases/21493cardiovascular-disease

20. Thyroid Disease

Thyroid disease is a medical condition that affects the thyroid gland, a small organ located in the front of the neck, wrapped around the windpipe (trachea). The thyroid gland produces hormones that play a role in many different systems throughout the body. When the thyroid gland makes either too much or too little of these important hormones, it’s called a thyroid disease. There are several different types of thyroid disease, including hyperthyroidism, hypothyroidism, thyroiditis, and Hashimoto’s thyroiditis. Symptoms of thyroid disease can include changes in heart rate and body weight.

Source: Cleveland Clinic thyroid disease https://my.clevelandclinic.org/health/diseases/8541-thyroid-disease

21. Gastrointestinal Disease

Gastrointestinal disease is a medical condition that affects the gastrointestinal (GI) tract, which is the passage that runs from the mouth to the anus. The GI tract is responsible for digestion, breaking down food so the body can absorb and direct nutrients to keep you healthy. There are two types of gastrointestinal diseases: functional and structural. Functional GI diseases are characterized by chronic (long-term) GI symptoms that arise due to the function or dysfunction of the digestive system. The most common functional GI diseases include irritable bowel syndrome (IBS), acid reflux, indigestion, colon cancer, and hemorrhoids. Structural GI diseases, on the other hand, are caused by physical changes to the GI tract, such as inflammation, ulcers, or tumors. Some examples of structural GI diseases include Crohn’s disease, ulcerative colitis, and diverticulitis. Symptoms of gastrointestinal disease can vary depending on the type of disease, but may include abdominal pain, bloating, constipation, diarrhea, nausea, and vomiting.

Source: Very well Health Gastrointestinal Diseases
https://www.verywellhealth.com/gastrointestinaldiseases-5216782

22. Blood Disorder

A blood disorder is a medical condition that affects one or more parts of the blood, such as red blood cells, white blood cells, platelets, or plasma. Blood disorders can be broadly classified into two categories: noncancerous and cancerous. Noncancerous blood disorders are conditions that affect blood cells and platelets and cause issues that may increase the risk of blood clots or make you bleed more than normal. Examples of noncancerous blood disorders include Von Willebrand disease, an inherited bleeding disorder, and Prothrombin gene mutation, an inherited blood clotting disorder. Cancerous blood disorders, on the other hand, are caused by the abnormal growth of blood cells in the bone marrow or lymphatic system. Examples of cancerous blood disorders include leukemia, lymphoma, and myeloma. Symptoms of blood disorders can vary depending on the type of disorder, but may include fatigue, weakness, shortness of breath, and easy bruising or bleeding.

Source: Cleveland Clinic blood disorder https://my.clevelandclinic.org/health/diseases/21545-blood-disorders

23. Pre-Op Patient Bed
The term Pre-op refers to the period of time before a surgical procedure when a patient is prepared for surgery. The Pre-op patient ward is the area of a hospital where patients are held before surgery. During this time, patients may undergo a variety of tests and procedures to ensure they are healthy enough to undergo surgery. These tests may include blood work, imaging scans, and other diagnostic tests. Patients may also meet with their surgeon, anesthesiologist, and other members of the surgical team to discuss the procedure and ask any questions they may have. Once the patient is cleared for surgery, they will be taken to the operating room.

Source: Nurse info https://nurseinfo.in/preoperative-nursing-care/

24. Airway Intervention
Airway intervention is a medical procedure that involves the assessment, planning, and series of medical procedures required to maintain or restore an individual's ventilation, or breathing. The goal of airway intervention is to maintain an open airway so that air can flow from the nose and mouth into the lungs. Airway intervention is an essential skill for clinicians in critical situations and is fundamental to the practice of emergency medicine. Lack of airway management in situations where it may be required can lead to reduced blood oxygen levels in individuals and can be life-threatening. Airway intervention may be required for individuals in a variety of circumstances, ranging from simple choking to complicated airway obstruction. Depending on the particular circumstance, various different types of airway management may be performed. Basic airway management may be used alone for mild airway obstructions, such as choking, or in combination with other airway management techniques. In some cases, if the individual is unresponsive to these techniques, they may require cardiopulmonary resuscitation (CPR), as chest compressions, when compared to abdominal thrusts, can produce higher airway pressures to resolve the obstruction.

Source: Osmosis Airway intervention https://www.osmosis.org/answers/airway-management

25. Saturation saturation refers to the amount of oxygen that is bound to haemoglobin in the blood, expressed as a percentage of the maximal binding capacity . Oxygen saturation is an important measure of respiratory function and is often used to assess the severity of respiratory diseases such as chronic obstructive pulmonary disease (COPD) and asthma. Normal oxygen saturation levels range from 95% to 100%.

Source: Medical dictionary https://medical-dictionary.thefreedictionary.com/oxygen+saturation

26. OSA Score
The Apnea-Hypopnea Index (AHI) is a diagnostic tool used to determine the presence and severity of obstructive sleep apnea (OSA). It quantifies the severity of sleep apnea by counting the number of apneas and hypopneas during sleep. Apneas are periods when a person stops breathing and hypopneas are instances where airflow is blocked, causing shallow breathing. The AHI represents the average number of apneas and hypopneas you experience each hour during sleep. The AHI is measured on a numeric scale and scores for adults are divided into three categories, which correspond to different levels of OSA severity:

Mild: An AHI of at least five events per hour, but fewer than 15.
Moderate: An AHI of at least 15 events per hour. Severe: An AHI of at least 30 events per hour.

Source: Sleep Foundation OSA Score https://www.sleepfoundation.org/sleep-apnea/ahi

27. MET Score

MET stands for Metabolic Equivalent of Task. It is a measure of the energy expended during physical activity relative to the energy expended at rest. One MET is defined as the energy expended while sitting quietly at rest. The MET score is used to describe the intensity of physical activity and is calculated by dividing the rate of energy expended during an activity by the resting metabolic rate. The higher the MET score, the more intense the activity. For example, walking at a moderate pace has a MET score of 3.5, while running at a moderate pace has a MET score of 7.5. The MET score can be used to help individuals plan and monitor their physical activity levels.

Source: Healthline MET https://www.healthline.com/health/what-are-mets

28. Covid 19

COVID-19 is an infectious disease caused by the SARS-CoV-2 virus. It was first identified in Wuhan, China in December 2019 and has since spread globally, resulting in a pandemic. The disease primarily spreads through respiratory droplets when an infected person coughs, sneezes, or talks. The most common symptoms of COVID-19 include fever, cough, and shortness of breath, but other symptoms such as fatigue, body aches, and loss of taste or smell may also occur. Most people infected with the virus will experience mild to moderate respiratory illness and recover without requiring special treatment. However, some people may develop severe symptoms and require hospitalization. The risk of severe illness is higher among older adults and people with underlying medical conditions such as cardiovascular disease, diabetes, chronic respiratory disease, or cancer.

Source: World Health Organization https://www.who.int/health-topics/coronavirus

29. Surgical Speciality

A surgical specialty is a field of medicine that focuses on the operative management of various diseases and conditions. Each surgical specialty has its own unique focus and requires specialized training and expertise. For example, a general surgeon is trained to manage a broad spectrum of surgical conditions affecting almost any area of the body, while a cardiothoracic surgeon specializes in the surgical management of conditions affecting the heart, lungs, and other organs in the chest.

Source: Medical professionals Surgical Speciality https://www.facs.org/for-medical-professionals/education/online-guide-to-choosing-a-surgical-residency/guide-to-choosing-a-surgicalresidency-for-medical-students/faqs/specialties/