

Preoperative Investigations: Practice Guidelines from the Indian Society of Anaesthesiologists

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PREAMBLE

Preoperative investigations are essential for planning, stratification, optimisation and perioperative management of patients undergoing surgical procedures and to improve patient outcomes. However, preoperative investigation practices are not uniform despite published guidelines from professional bodies across the globe, due to various factors including socio-economic, demographic and medico-legal considerations.^[1-9] The practices prevalent in the Indian subcontinent involve ordering from minimal needed to battery of investigations.^[1,3,7,10-13] With the advent of auto analysers, the practice of ordering of battery of investigations has become more prevalent. Often, many of these investigations may not influence the perioperative management and outcomes.^[3,12,14,15] With widespread availability of ultrasound, more anaesthesiologists are getting trained

in the perioperative use of ultrasound. Exploring the utility of ultrasound for predicting possible difficult airway, therefore, was also considered. There are no available guidelines on the time frame of the validity of previous investigation reports (Validity Time for Previous Investigations - VTPIN), when a patient is scheduled for surgery. Taking these considerations into account, the Indian Society of Anaesthesiologists (ISA) endeavoured to formulate evidence-based practice guidelines for preoperative

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investigations. The guidelines are prepared to promote judicious ordering of preoperative investigations, with focus on the perioperative management strategies. The guidelines are expected to aid in better patient outcomes considering the geographic, demographic, socio-economic and medico-legal aspects.

Uniform ordering of investigations will not be appropriate in all surgical populations. The investigations ordered depend upon the type and urgency of surgery (elective, semi-elective, emergency), patient's current physiological status, associated co-morbidities and the medications. The ordering of preoperative investigations also considers the complexity of the surgery as categorised, for example by the National Institute of Clinical Excellence (NICE) based on invasiveness of the surgery as minor, intermediate and major or complex surgery.^[4] The ordering of the investigations needs to be individualised in patients scheduled for emergency surgery, specialised surgical interventions (such as cardiothoracic, vascular, neurological, transplant surgery) and in those with severe systemic disease.

Separate guidelines are required to address paediatric, obstetric and bariatric population as they have specific pathophysiological considerations.

Hence, the practice guidelines from the ISA on preoperative investigations are aimed at patients with American Society of Anesthesiologists physical status (ASA PS) 1 and 2, scheduled for elective surgery.

These guidelines should not be substituted for good clinical judgement (based on detailed history, clinical evaluation and review of medications) and the attending anaesthesiologist may consider individualising the decision on further investigations.

Tests for viral markers including coronavirus disease 2019 (COVID-19) are 'screening modalities' and are not considered for formulating the current guidelines. The ordering of preoperative investigations may have been by an anaesthesiologist not attending to the management of the patient on the day of the surgery and it is imperative on the attending anaesthesiologist to review the reports rationally and proceed with anaesthetic management.

Focus of the guidelines

These clinical practice guidelines provide recommendations for routine preoperative

investigations in ASA PS 1 and 2 patients scheduled for elective surgical procedures. The guidelines also focus on the validity in terms of time frames for previously performed investigations when the patient is scheduled for a surgical procedure.

The normal range of laboratory tests is derived from samples collected from apparently healthy persons and subjecting their results to statistical tests to determine the mean and range of the values. A 95% confidence interval refers to the probability that the laboratory test reports conducted on healthy persons will fall within this predefined range, 95% of the times. In other words, it also means that there is a 5% probability of a healthy person's report falling outside this defined range.^[16] False positive reports can contribute to unnecessary delay, referral, and further evaluation.^[7] Detailed history and clinical evaluation should therefore, precede ordering preoperative investigations.

METHODOLOGY

The proposal from SBB for formulating the practice guidelines for preoperative investigations was approved by the general body of the ISA. The Core Committee (CC) consisting of the President and Secretary, ISA along with 7 other members (SBB, HSS, PD, RG, SK, UG, ZA) was constituted. An expert group consisting of 17 members with academic standing in the speciality spread across India and a biostatistician, was formed to assist the CC in formulation of the guidelines.

For the purpose of these guidelines, routine preoperative investigations are defined as those tests which may influence the perioperative anaesthetic management and outcome in patients scheduled for elective surgeries independent of the specific clinical condition.

For the current guidelines, expert consensus was sought to categorise common elective surgical procedures, based on the invasiveness and duration of surgery. The CC prepared a list of commonly performed surgical procedures and conducted an anonymous survey among the expert group using Google form. The experts were asked to categorise each elective surgical procedure as minor, intermediate or major. Their responses were collected, tabulated and as per the consensus (defined as agreement of $\geq 75\%$), the surgical procedures were categorised into appropriate sections [Table 1].

The CC performed review of literature, identified the major aspects related to the topic and framed 10 preliminary research questions (RQs) based on population, intervention, comparator and outcomes (PICO). Each RQ was allotted to a focused group of two to three experts and dedicated virtual meetings were held subsequently to refine and finalise the RQs. Subsequently, each of these expert groups performed further review of published evidences and discussed with the CC.

A literature search was conducted for relevant full-text articles in the English language published between 01 January 2010 and 25 November 2021. The search was conducted with compatible keyword combinations in online databases PubMed, Embase, Google Scholar and Cochrane Library [Table 2]. All studies with patient population scheduled for elective non-speciality surgery were included provided the study population consisted of either ASA PS 1 and/or 2. Studies where ASA PS 3 patients constituted <5% of the total study population or where the population included ASA PS 1, 2 and higher but categorisation of data and outcomes was available separately for ASA PS 1 and 2 patients, were also included [Table 3].

Meta-analyses and systematic reviews published after January 2010 were reviewed for references for relevant studies. Furthermore, bibliography of each identified study was scanned for additional relevant references. Those studies that assessed the cost impact as the only outcome or did not mention the ASA grading of the study population were excluded. Published guidelines, narrative reviews, editorials, opinions and correspondence articles were excluded though they were scanned for relevant references.

The CC reviewed each searched original research article for its relevance for inclusion in systematic review. As part of the evidence collection and analysis process, randomised controlled trials, cohort studies, cross-sectional studies and case control studies were considered suitable for the systematic review. Each individual group of experts tabulated the important data from the collected evidence. Systematic review of included studies was conducted and feasibility of meta-analysis of the same was explored. Where there was lack of data/missing information in the articles, the corresponding authors were contacted through e-mail to seek raw data. Quality of evidence based on the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach was

Table 1: Examples for categorisation of surgical procedures based on invasiveness and duration of surgery

Minor	Intermediate	Major
Superficial debridement surgery	Open inguinal hernia repair	Modified radical mastectomy
Fibroadenoma breast excision	Laparoscopic hernia repair	Flap reconstruction surgery
Haemorrhoidectomy	Laparoscopic appendectomy	Total thyroid excision and neck dissection
Gynaecological dilatation and curettage	Laparoscopic cholecystectomy	Wertheim's hysterectomy
Closed reduction of fractures and dislocations	Varicose vein stripping	Arthroscopic shoulder reconstruction
K-wire insertion/removal	Benign thyroid excision	Spine fixation surgery
Minor urological procedures (cystoscopy, ureteroscopy, stenting)	Below knee amputation	Joint replacement surgery
Cataract surgery	Benign hysterectomy	Femur fracture fixation
	Arthroscopic knee reconstruction	
	Tibia/forearm fracture fixation	
	Transurethral resection of prostate	
	Adenotonsillectomy	
	Functional endoscopic sinus surgery	

The list of surgical procedures is endless. A list of common surgical procedures are categorised based on the consensus opinion and the same are provided in the table above

ascertained and appropriate certainty level (High, Moderate, Low or Very Low) was provided for each article and for the systematic review.^[17] If the certainty level of evidence was graded as very low or low, a 'weak' recommendation was made, and a 'strong' recommendation was made if the certainty level of evidence was graded as high or moderate.

A three-step Delphi methodology was followed to arrive at consensus on the recommendations^[18] [Figure 1]. Prior to round one of Delphi, the CC prepared draft recommendations for each RQ along with evidence summary tables containing data of all the studies included for the systematic review [Tables 4 and 5].

Round One: RQs along with the draft recommendations and the collected evidences were sent by e-mail (via anonymous Google Survey Form) to each of the 16 subject experts. They were asked to provide responses as 'accept' or 'reject' or 'review' for all the draft recommendations. When review was opted, experts were to comment if any clarification or modification was required. The completed responses from the

Table 2: Search strategies for published evidence

Search duration: 01 January 2010 to 25 November 2021
Databases
PubMed, Cochrane Library, Embase, Google Scholar, Scopus
Search Words
Prevalence and Anaemia and Preoperative or Prior to surgery; Prevalence and Anaemia and India and Preoperative or Prior to surgery Preoperative or Prior to surgery and investigations or tests or laboratory or radiology or ECG or Electrocardiogram or mortality or morbidity CBC or Complete blood count or TLC or Leukocyte count or Platelets or WBC or White blood cell count or Haemoglobin or Haematocrit and Preoperative or Prior to surgery Renal function tests and Preoperative or Prior to surgery, Serum creatinine and Preoperative or Prior to surgery, Kidney function tests and Preoperative or Prior to surgery, eGFR and Preoperative or Prior to surgery Liver function tests and Preoperative or Prior to surgery±mortality±hospital stay±morbidity Bilirubin and Preoperative or Prior to surgery±mortality±hospital stay±morbidity Blood sugar or Blood glucose or glycaemic level or glycemic level and Preoperative or Prior to surgery Coagulation profile or PT or APTT or INR and Preoperative or Prior to surgery Serum electrolytes or Serum sodium or Serum potassium and Preoperative or Prior to surgery ECG or Electrocardiogram and Preoperative or Prior to surgery Chest X-Ray and Preoperative or Prior to surgery Validity or Acceptable duration and Preoperative investigations; Validity or Acceptable duration and Preoperative tests; Validity or Acceptable duration and Preoperative and Laboratory or Radiology or ECG or Electrocardiogram
ECG - 12 lead electrocardiogram, CBC - complete blood count, TLC - total leukocyte count, WBC - white blood cell, eGFR - estimated glomerular filtration rate, PT - prothrombin time, aPTT - activated partial thromboplastin time

Table 3: Inclusion and exclusion criteria

Inclusion criteria
Studies with ASA PS 1 and/or ASA PS 2 patients scheduled for elective surgery
Studies where ASA PS 3 patients constituted <5% of the total study population
Studies where the population included ASA PS 1, 2 and higher but categorisation of data and outcomes was available separately for ASA PS 1 and 2 patients.
Exclusion criteria:
Studies that did not mention the ASA grading of the study population
Studies on preoperative investigations with cost analysis as the sole outcome measure
Studies involving only cardiovascular surgery, thoracic surgery, neurosurgery, transplant surgery
Published guideline, narrative reviews, editorials, opinions, correspondence articles
ASA PS - American Society of Anesthesiologists Physical Status

experts were returned to the CC. Affirmation as 'accept' or 'reject' for each draft recommendation by 75% or more experts was considered as a *consensus*. If the affirmation to accept or reject was less than 75% and if 'review' option was opted for, those recommendations were revised as per the suggestions.

Round Two: The revised draft recommendations along with the summary of expert opinions from round 1 were circulated by e-mail (via anonymous Google Survey Form) to each expert for the second round to seek a consensus. Similar methodology as per round 1 was followed.

Round Three: This was an open virtual meeting of all experts along with the CC where consensus was reached for the unresolved draft recommendations through 'show of hands' and active deliberations. These were suitably redrafted as per the suggestions from the experts. After reaching consensus, the recommendations were made final.

Overall, from conception to the formulation of guidelines, the CC held 2 physical meetings and 63 virtual meetings among themselves and 48 virtual meetings with the experts.

The summary of the final recommendations [Table 6] was presented to the Governing Council and General Body of ISA and was formally approved.

To know the prevailing practice patterns of ordering the preoperative investigations among Indian anaesthesiologists, the CC prepared a structured questionnaire for the survey which was subsequently validated by independent experts. This questionnaire was circulated among the 5838 delegates of the national conference of ISA conducted from 25 to 28 November, 2021.

GUIDELINES AND RECOMMENDATIONS

Complete blood count

In ASA PS 1 and 2 patients scheduled to undergo elective surgery, will routine preoperative complete blood count testing change anaesthetic management or patient outcomes after surgery?

Literature review regarding complete blood count (CBC) revealed that some of the available studies had tested individual components of CBC, that is, haemoglobin or haematocrit, total and differential leukocyte count and platelet count, while others had tested CBC as a whole.^[3,11-13,19-24]

Anaemia is a global health issue with a prevalence rate of approximately 14% in ASA PS 1 and 2 preoperative patients.^[3,11-13,19-27] This can contribute to adverse events such as tachycardia, arrhythmias, increased

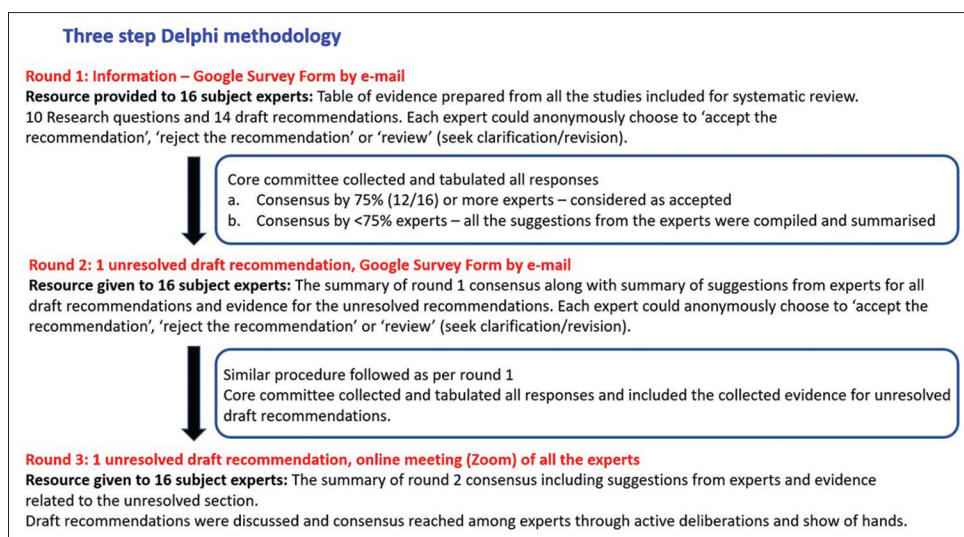


Figure 1: The three-step Delphi method

risk of infection, heart failure in the perioperative period. It can also contribute to increased duration of hospital stay, rates of intensive care admission and blood transfusion, which carry their own associated risks.

Few of the studies have used haemoglobin as the parameter reflective of anaemia while few have used haematocrit. For the purpose of current guidelines, 'haemoglobin' is uniformly used as the investigation parameter. Nine studies (n = 27697) tested the effects of preoperative haemoglobin/haematocrit on immediate perioperative outcomes [Table 4].^[3,11-13,19-23] Most studies included combinations of minor, intermediate and major surgeries. Review of evidence indicates the need for haemoglobin testing preoperatively in patients scheduled for intermediate to major surgeries. However, evidence was equivocal regarding minor surgeries. There was no evidence on outcomes related to increased haemoglobin levels.^[20]

Both leukocytosis and leukopenia can potentially contribute to adverse outcomes in the perioperative period. Among four studies that tested TLC (n = 25817),^[11-13,20] leukocytosis was associated with adverse outcomes in patients undergoing intermediate and major surgeries. However, leukopenia did not influence the perioperative outcomes.^[20] [Table 4].

The abnormal platelet counts may influence the perioperative management strategies and outcomes. Low platelet counts may have adverse implications for both central neuraxial and peripheral nerve blocks. Three studies (n = 24617) reported no influence on the

perioperative outcome with platelet count $<1.5 \times 10^6/\text{mm}^3$.^[11,12,20] Increased platelet counts also can have adverse implications related to thrombotic mechanism. Three studies (n = 24617) reported no influence on the perioperative outcome with platelet count $>4.5 \times 10^6/\text{mm}^3$ [Table 4].^[11,12,20] However, extreme levels of platelet count in these patients were not reported. Identifying the lowest and highest levels of platelet counts with respect to uneventful perioperative outcomes could be the focus of future research.

When central or peripheral nerve blocks are planned, the practitioner is advised to refer to the latest guidelines on regional anaesthesia and anticoagulation. The guidelines related to the influence of various drugs from the alternative systems of medicine which may have effect on platelet count or functioning needs to be considered.^[28]

Regarding CBC testing, two studies (n = 153) involving minor and intermediate surgeries did not report any adverse outcomes.^[23,29] Among those with abnormal CBC, in three studies (n = 1444) involving minor, intermediate and major surgeries, 131 patients required further investigations, delay, or referral, 7 patients required postponement of the scheduled surgical procedure or change in management approach and 12 patients required blood or blood product transfusion^[3,24,30] [Table 4].

The evidence was favouring CBC for intermediate and major surgeries when individual component data was taken together with CBC. Based on the existing evidence and practices among anaesthesiologists and

Table 4: Evidence summary for complete blood count, renal function, liver function, serum electrolytes, coagulation profile, blood glucose, 12-lead electrocardiogram, chest X-ray

Author details, year, type of study	Population	Invasiveness of surgery	Outcomes assessed	Results and conclusions	Level of evidence
Haemoglobin					
Sobia Khan ^[19] 2012, Pakistan Observational Study DOI: 10.4236/ojanes. 2012.24034	n=385 Age: 18-60 years Ambulatory surgery	Minor	Prevalence of anaemia Impact of anaemia in terms of case cancellation, case rescheduling, unplanned blood transfusion or unplanned hospital admission for evaluating or correcting anaemia or to treat the perioperative complications attributable to anaemia	Low Hb in 74 patients No influence on outcomes	Very low
Sarah Sears ^[20] 2020, USA Retrospective cohort study DOI: 10.1016/j.ejogrb. 2020.03.041	Total=24,752 n=22,896 46.4±9.3 years Benign hysterectomy	Intermediate	Composite complication rate	Hct <34.9, n=3248 None required preoperative transfusion Low haematocrit is a predictor of postoperative complications Odds Ratio - 2.74 (1.92-3.79) Hct >44.5%, n=1006	Low
Naghi Abedini ^[22] 2019, Iran Cross-sectional study Web link: http://aacc.tums.ac.ir	n=230 Above 65 years Major orthopaedic surgery	Major	Postoperative haemoglobin levels and requirement for blood transfusions	All patients were normal Most of them had >10% fall in Hb postoperatively 67 required postoperative blood transfusion	Very low
Sulaiman Alazzawi ^[23] 2012, UK Retrospective cohort study DOI: 10.1258/shorts. 2011.011130	Total=127 n=95 16-60 years Orthopaedic trauma surgery	Minor Intermediate	Clinical significance of abnormal tests and alteration in patient management	Low Hb=31 Abnormal tests did not have any influence on outcomes evaluated	Very low
Obada Hasan ^[21] 2021, Pakistan Case control study DOI: 10.1016/j.amsu. 2021.102439	n=670 0->65 years Elective orthopaedic intermediate and major surgery	Intermediate Major	Influence on surgical plan: >24 h delay or cancellation of surgery after admission	Abnormal haemoglobin level OR 1.65 95% CI (1.01-2.71) No influence on outcome	Very low
Hemant Vanjare ^[3] 2020, India Observational study DOI: 10.18231/j.ijca. 2020.089	n=500 27-48 years	Minor Intermediate Major	Minor impact: referral, delay, further investigations Major impact: Postponement, change in the on-going management, altering the anaesthetic procedure and monitoring plan	Low haemoglobin=252 Minor impact: 131 patients Major impact: 3 patients	Very low
Ashish K. Kannaujia ^[12] 2020, India Observational study DOI: 10.15190/d.2020.11 C G Jayachandran ^[13] 2017, India Cross sectional study DOI: 10.17354/ijss/2017/341	n=1271 19-78 years Elective orthopaedic surgery, GS, gynaecology, urology n=1150, 3-50 years	Minor Intermediate Major Minor Intermediate Major	Referral to specialist, repeat or new tests ordered, postponement of surgery or change in anaesthetic plan Further investigations Change in management plan	Low haemoglobin=197 Transfusion: 3 Blood arranged: 9 Iron therapy and postponement: 4 Low Hb=26 Change in management approach for 4 patients	Very low
Total Leukocyte Count					
Sarah Sears ^[20] 2020, USA Retrospective cohort study DOI: 10.1016/j.ejogrb. 2020.03.041	Total=24,752 n=22,896 46.4±9.3 years Benign hysterectomy	Intermediate	Composite complication rate	High TLC = 798 was a predictor of postoperative complications Odds ratio 2.11 (1.53-3.09) Low TLC: 1874 patients	Low

Contd...

Author details, year, type of study	Population	Invasiveness of surgery	Outcomes assessed	Results and conclusions	Level of evidence
Ashish K. Kannaujia ^[12] 2020, India Observational study DOI: 10.15190/d.2020.11	n=1271 19-78 years Elective orthopaedic surgery, GS, gynaecology, urology	Minor Intermediate Major	Referral to specialist, repeat or new tests ordered, postponement of surgery or change in anaesthetic plan	Abnormal TLC=32 No influence on the outcomes	Very low
C G Jayachandran ^[3] 2017, India Cross sectional study DOI: 10.17354/ijss/2017/341	n=1150 3-50 years	Minor Intermediate Major	Further investigations Change in management plan	High TLC = 21 Change in management approach in 5 patients	Very low
Platelets Sarah Sears ^[20] 2020, USA Retrospective cohort study DOI: 10.1016/j.ejogrb.2020.03.041	Total=24,752 n=22,896 46.4±9.3 years Benign hysterectomy	Intermediate	Composite complication rate	Platelets <1.5 x 106/mm3=276 Platelets >4.5 x 106/mm3=445 No influence on outcomes	Low
Alka Chandra ^[11] 2014, India Retrospective cohort study	Total=500 n=450 15-50 years Cholecystectomy and hernia repair	Intermediate	Change in anaesthetic plan Delay/cancellation of surgery	Decreased platelets: 34 None of the patients had any change in anaesthetic management plan or delay/cancellation of surgery	Very low
Ashish K. Kannaujia ^[12] 2020, India Observational study DOI: 10.15190/d.2020.11	n=1271 19-78 years Elective orthopaedic surgery, GS, gynaecology, urology	Minor Intermediate Major	Referral to specialist, repeat or new tests ordered, postponement of surgery or change in anaesthetic plan	Decreased platelets=6 No influence on the outcomes	Very low
Complete Blood Count Philip Pastides ^[29] 2011, UK Observational study Sulaiman Alazzawi ^[23] 2012, UK Retrospective cohort study DOI: 10.1258/shorts.2011.0111130	Total=64 n=58 Orthopaedic surgery Total=127, n=95 16-60 years	Minor Intermediate	Preoperative/postoperative plan change or requiring follow up	Deranged=0	Very low
Hemant Vanjare ^[3] 2020, India Observational study DOI: 10.18231/ij.jca.2020.089	n=500 27-48 years	Minor Intermediate Major	Clinical significance of abnormal tests and alteration in patient management	Deranged=31 No influence on outcomes	Very low
Danielle de Sousa Soares ^[24] 2013, Brazil Cross sectional study DOI: 10.1016/S0034-7094(13)70215-0	Total=800 n=781 1-45 years	Minor Intermediate Major	Minor impact: referral, delay, further Investigations Major impact: Postponement, change in the on-going management, altering the anaesthetic procedure and monitoring plan Change in approach: new tests ordered/referral to specialist/postponement of surgery	Deranged=252 Impact on outcomes=134 Minor impact: 131 patients Major impact: 3 patients Deranged=13 Change in outcome=1	Very low

Contd...

Author details, year, type of study	Population	Invasiveness of surgery	Outcomes assessed	Results and conclusions	Level of evidence
Akwasi Antwi-Kusi^[30] 2019, Ghana Cross sectional study DOI: 10.4236/ijcm.2019.106027	Total=165 n=163 50 years mean age	Minor Intermediate Major	Delay or postponement Change in anaesthetic management plan	Deranged=41 Affecting outcome=15 Delay/cancellation=3; blood/product transfusion=12	Very low
Renal Function Tests Sarah Sears ^[20] 2020, USA Retrospective cohort study DOI: 10.1016/j.ejogrb.2020.03.041	Total=24,752 n=20,915 46.4±9.3 years Benign hysterectomy	Intermediate	Composite complication rate	High creatinine >1.2 mg/dL: 115 Odd's ratio - 1.62 (0.96-2.75) No influence on outcomes	Low
Alka Chandra ^[11] 2014, India Retrospective cohort study	Total=500 n=250 15-50 years Cholecystectomy and hernia repair	Intermediate	Change in anaesthetic plan Delay/cancellation of surgery	Deranged=2 No influence on the outcomes	Very low
Philip Pastides ^[28] 2011, UK Observational study	Total=64 n=58 Orthopaedic surgery	Minor Intermediate	Preoperative/postoperative plan change or requiring follow-up	Only blood urea was tested and all had normal blood urea, did not have any impact on outcome	Very low
Hemant Vanjare ^[3] 2020, India Observational study DOI: 10.18231/ij.jca.2020.089	Total=500 n=499 27-48 years	Minor Intermediate Major	Minor impact: referral, delay, further Investigations Major impact: Postponement, change in the on-going management, altering the anaesthetic procedure and monitoring plan	Deranged=17 Minor impact was observed in 11 patients	Very low
Ashish K. Kannaujia ^[12] 2020, India Observational study DOI: 10.15190/d.2020.11	Total=1271 n=1008 19-78 years Elective orthopaedic surgery, GS, gynaecology, urology	Minor Intermediate Major	Referral to specialist, repeat or new tests ordered, postponement of surgery or change in anaesthetic plan	Deranged=3 High creatinine 1 (1.9), no change in plan Borderline: 2 (nothing done)	Very low
Danielle de Sousa Soares ^[24] 2013, Brazil Cross sectional study DOI: 10.1016/S0034-7094 (13) 70215-0	Total=800 n=441 1-45 years	Minor Intermediate Major	Change in approach: new tests ordered/referral to specialist/postponement of surgery	Deranged=0 No influence on outcome	Very low
C G Jayachandran ^[13] 2017, India Cross sectional study DOI: 10.17354/ijss/2017/341	Total=1150 n=1104 3-50 years	Minor Intermediate Major	Further investigations Change in management plan	Deranged=9 Change in management plan: 3	Very low
Akwasi Antwi-Kusi ^[30] 2019, Ghana Cross sectional study DOI: 10.4236/ijcm.2019.106027	Total=165 n=125 average age 50 years	Minor Intermediate Major	Delay or postponement Change in anaesthetic management plan	Deranged=18 Transfusion of blood/products=4 No changes=14	Very low

Contd...

Table 4: Contd...					
Author details, year, type of study	Population	Invasiveness of surgery	Outcomes assessed	Results and conclusions	Level of evidence
Sivesh K Kamarajah ^[61] 2018, UK Prospective observational study DOI: 10.1155/2018/5710641	n=370 50-70 years Elective gastrointestinal surgeries	Minor Intermediate Major	Impact of preoperative estimated glomerular filtration rate (eGFR) and postoperative outcomes	Deranged=26 OR 1.06 (0.42-3.24) No adverse impact on outcome	Low
Serum electrolytes Sarah Sears ^[20] 2020, USA Retrospective cohort study DOI: 10.1016/j.ejogrb.2020.03.041	Total=24,752 n=20,915 46.4±9.3 years Benign hysterectomy	Intermediate	Composite complication rate	Serum Sodium <133 mEq/L (n=476) Odds ratio - 0.72 (0.65-1.28) Serum Sodium >144 mEq/L (n=206) Odds ratio - 1.33 (0.87-2.04) No influence on outcomes	Low
Danielle de Sousa Soares ^[24] 2013, Brazil Cross sectional study DOI: 10.1016/S0034-7094 (13) 70215-0	Total=800 n=88 1-45 years	Minor Intermediate Major	Change in approach: new tests ordered/referral to specialist/postponement of surgery	Deranged=2 (serum sodium and serum potassium) No influence on outcomes	Very low
C G Jayachandran ^[13] 2017, India Cross sectional study DOI: 10.17354/ijss/2017/341	Total=1150 n=426 3-50 years	Minor Intermediate Major	Further investigations Change in management plan	Deranged=14 Change in management in 5	Very low
Akwasi Antwi-Kusi ^[30] 2019, Ghana Cross sectional study DOI: 10.4236/ijcm.2019.106027	Total=165 n=94 Mean age 50 years	Minor Intermediate Major	Delay or postponement Change in anaesthetic management plan	Deranged=3 Blood transfusion in 1 (Blood transfusion may not have any association with electrolytes)	Very low
Liver Function Tests Sarah Sears ^[20] 2020, USA Retrospective cohort study DOI: 10.1016/j.ejogrb.2020.03.041	Total=24,752 n=17450 46.4±9.3 years Benign hysterectomy	Intermediate	Composite complication rate	Albumin <3.5 g/dL in 276 [1.13 (1.03-1.25)] Serum glutamic oxaloacetic transaminase >40 IU/L in 261 [0.82 (0.75-1.11)] Total Bilirubin >1.0 mg/dL in 176 [1.03 (0.98-1.10)] Alkaline Phosphatase >140 IU/L in 54 [0.99 (0.97-1.02)] No influence on the outcomes	Low
Alka Chandra ^[11] 2014, India Retrospective cohort study	Total=500 n=275 15-50 years Cholecystectomy and hernia repair	Intermediate	Change in anaesthetic plan Delay/cancellation of surgery	Deranged=24 No influence on anaesthetic plan or change/cancellation	Very low
Philip Pastides ^[26] 2011, UK Observational study	Total=64 n=43 >18 years Orthopaedic surgery	Minor Intermediate	Preoperative/postoperative plan change or requiring follow up	None had abnormal result No influence on outcomes	Very low

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Author details, year, type of study	Population	Invasiveness of surgery	Outcomes assessed	Results and conclusions	Level of evidence
Sulaiman Alazzawi ^[23] 2012, UK Retrospective cohort study DOI: 10.1258/shorts. 2011.011130	Total=127 n=38 16-60 years	Minor Intermediate	Clinical significance of abnormal tests and alteration in patient management	Deranged=3 No influence on outcomes	Very low
Hemant Vanjare ^[3] 2020, India Observational study DOI: 10.18231/j.jica. 2020.089	Total=500 n=484 27-48 years	Minor Intermediate Major	Minor impact: referral, delay, further investigations Major impact: Postponement, change in the on-going management, altering the anaesthetic procedure and monitoring plan	Deranged=33 Minor impact in tested=21	Very low
Akwasi Antwi-Kusi ^[30] 2019, Ghana Cross sectional study DOI: 10.4236/ijcm. 2019.106027	Total=165 n=48 50 years mean age	Minor Intermediate Major	Delay or postponement Change in anaesthetic management plan	Deranged=10 Transfusion of blood/blood products=3 No changes=7	Very low
Coagulation Profile (PT, INR, aPTT)					
Sarah Sears ^[20] 2020, USA Retrospective cohort study DOI: 10.1016/j.ejogrb. 2020.03.041	Total=24,752 n=15,643 (both PT/INR and aPTT) 46.4±9.3 years Benign hysterectomy	Intermediate	Composite complication rate	aPTT>35 seconds n=177 Odds ratio - 0.87 (0.76-1.15) PT/INR>1.5 n=8 Odds ratio - 2.69 (1.71-3.85) No influence on outcomes No deranged values	Low
Philip Pastides ^[29] 2011, UK Observational study	Total=64 n=42 >18 years (coagulation profile) Orthopaedic surgery	Minor Intermediate	Preoperative/postoperative plan change or requiring follow up		Very low
Sulaiman Alazzawi ^[23] 2012, UK Retrospective cohort study DOI: 10.1258/shorts. 2011.011130	Total=127 n=13 16-60 years (coagulation screen)	Minor Intermediate	Clinical significance of abnormal tests and alteration in patient management	Deranged=0	Very low
Obada Hasan ^[21] 2021, Pakistan Case control study DOI: 10.1016/j.amsu. 2021.102439	n=670 (PT, INR, aPTT), 0-65 years Elective orthopaedic intermediate and major surgery	Intermediate Major	Influence on surgical plan: >24 h delay or cancellation of surgery after admission	Multivariable analysis for coagulation factors associated with change in surgical plan. 1.10 (0.85-1.43)	Very low
Danielle de Sousa Soares ^[24] 2013, Brazil Cross sectional study DOI: 10.1016/ S0034-7094 (13) 70215-0	Total=800 n=709 (BT, PT, aPTT and platelet count) 1-45 years	Minor Intermediate Major	Change in approach: new tests ordered/referral to specialist/postponement of surgery	Deranged=11 (did not specify the abnormal tests) Change in approach=8	Very low
C G Jayachandran ^[13] 2017, India Cross sectional study DOI: 10.17354/ijss/2017/341	Total=1150 n=724 3-50 years (coagulation profile)	Minor Intermediate Major	Further investigations Change in management plan	Deranged=12 (not specified the tests) Change in management=3	Very low

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Author details, year, type of study	Population	Invasiveness of surgery	Outcomes assessed	Results and conclusions	Level of evidence
Akwasi Antwi-Kusi ^[30] 2019, Ghana Cross sectional study DOI: 10.4236/ijcm.2019.106027	Total=165 n=13 Mean age 50 years Coagulation studies	Minor Intermediate Major	Delay or postponement Change in anaesthetic management plan	Deranged=6 (not specified the test) No influence on outcomes	Very low
Blood Glucose Alka Chandra ^[11] 2014, India Retrospective cohort study Danielle de Sousa Soares ^[24] 2013, Brazil Cross sectional study DOI: 10.1016/S0034-7094 (13) 70215-0 C G Jayachandran ^[13] 2017, India Cross sectional study DOI: 10.17354/ijss/2017/341	n=500 15-50 years Total=800 n=548 1-45 years Total=1150 n=838 3-50 years	Intermediate Minor Intermediate Major Minor Intermediate Major Minor Intermediate Major	Change in anaesthetic plan Delay/cancellation of surgery Change in approach: new tests ordered/referral to specialist/postponement of surgery Further investigations Change in management plan Delay or postponement Change in anaesthetic management plan	Deranged=0 Deranged=10 Change in approach=2 Deranged=21 Change in management=4 All results normal No change/impact	Very low Very low Very low Very low Very low
Akwasi Antwi-Kusi ^[30] 2019, Ghana Cross sectional study DOI: 10.4236/ijcm.2019.106027	Total=165 n=18 Mean age 50 years	Minor Intermediate Major	Delay or postponement Change in anaesthetic management plan	Deranged=3 Minor impact - referral	Very low
Hemant Vanjare ^[3] 2020, India Observational study DOI: 10.18231/ijca.2020.089	Total=500 n=495 27-48 years	Minor Intermediate Major	Minor impact: referral, delay, further investigations Major impact: Postponement, change in the on-going management, altering the anaesthetic procedure and monitoring plan	6 Non-diabetics: 1 had mild increase, nothing needed; 5 referred for control of high BG	Very low
Ashish K. Kannaujia ^[12] 2020, India Observational study DOI: 10.15190/d.2020.11	Total=1271 n=995 19-78 years Elective orthopaedic surgery, GS, gynaecology, urology	Minor Intermediate Major	Referral to specialist, repeat or new tests ordered, postponement of surgery or change in anaesthetic plan	ECG abnormalities, n=38 (LAD; non-specific ST-T changes, RBBB T inversion in few leads Slurred R in inferior leads) Change in plan: 0	Very low
12-lead electrocardiogram Alka Chandra ^[11] 2014, India Retrospective cohort study Danielle de Sousa Soares ^[24] 2013, Brazil Cross sectional study DOI: 10.1016/S0034-7094 (13) 70215-0	Total=500 n=420 15-50 years Total=800 n=583 1-45 years	Intermediate Minor Intermediate Major	Change in anaesthetic plan Delay/cancellation of surgery Change in approach: new tests ordered/referral to specialist/postponement of surgery	ECG abnormalities, n=40 Change in approach=3	Very low

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Author details, year, type of study	Population	Invasiveness of surgery	Outcomes assessed	Results and conclusions	Level of evidence
C G Jayachandran ^[3] 2017, India Cross sectional study DOI: 10.17354/ijss/2017/341	Total=1150 n=778 3-50 years	Minor Intermediate Major	Further investigations Change in management plan	ECG abnormalities, n=23 Further treatment=7	Very low
Hemant Vanjare ^[3] 2020, India Observational study DOI: 10.18231/ij.jca.2020.089	Total=500 n=492 27-48 years	Minor Intermediate Major	Minor impact: referral, delay, further investigations Major impact: Postponement, change in the on-going management, altering the anaesthetic procedure and monitoring plan	ECG abnormalities, n=41 Minor impact=38 Major impact=1 (A case cleared from cardiology for ECG abnormality, developed fresh changes on the table, due to which it was postponed) No impact=2	Very low
Ashish K. Kannaujia ^[2] 2020, India Observational study DOI: 10.15190/d. 2020.11	Total=1271 n=583 19-78 years Elective orthopaedic surgery, GS, gynaecology, urology	Minor Intermediate Major	Referral to specialist, repeat or new tests ordered, postponement of surgery or change in anaesthetic plan	ECG abnormalities, n=54 Sinus tachycardia (14 patients) Poor progression of R wave (13 patients) Low voltage complex (10 patients) Old myocardial infarction (7 patients) ST changes in one lead (4 patients) Right or left axis deviation (6 patients) Cardiology referral=13	Very low
Chest X-ray Alka Chandra ^[11] 2014, India Retrospective cohort study	Total=500 n=470 15-50 years	Intermediate	Change in anaesthetic plan Delay/cancellation of surgery	CXR abnormalities, n=52 Prominent bronchovascular markings, calcified lesions suggestive of old healed Koch's, fibrotic bands, emphysematous changes and signs of chronic obstructive airway disease Mild intraoperative bronchospasm=10 (bronchodilators and steroids) A few patients, who had no positive history nor any CXR findings, also developed bronchospasm which could be linked to lighter plane of anaesthesia. Impact=0	Very low
Danielle de Sousa Soares ^[24] 2013, Brazil Cross sectional study DOI: 10.1016/S0034-7094 (13) 70215-0	Total=800 n=496 1-45 years	Minor Intermediate Major	Change in approach: new tests ordered/referral to specialist/postponement of surgery	CXR abnormalities, n=6 Impact/influence: 0	Very low
C G Jayachandran ^[3] 2017, India Cross sectional study DOI: 10.17354/ijss/2017/341	Total=1150 n=821 3-50 years	Minor Intermediate Major	Further investigations Change in management plan	CXR abnormalities, n=18 Change in management=8	Very low

Contd...

Table 4: Contd...

Author details, year, type of study	Population	Invasiveness of surgery	Outcomes assessed	Results and conclusions	Level of evidence
Hemant Vanjare ^[3] 2020, India Observational study DOI: 10.18231/ijica.2020.089	Total=500 n=500 27-48 years	Minor Intermediate Major	Minor impact: referral, delay, further investigations Major impact: Postponement, change in the on-going management, altering the anaesthetic procedure and monitoring plan	CXR abnormalities, n=25 Minor impact: 21 Major impact: 1 [In one patient with abnormal CXR regional anaesthesia was administered instead of initially planned General Anaesthesia (GA)]	Very low
Ashish K. Kannaujia ^[2] 2020, India Observational study DOI: 10.15190/d.2020.11	Total=1271 n=345 19-78 years Elective orthopaedic surgery, GS, gynaecology, urology	Minor Intermediate Major	Referral to specialist, repeat or new tests ordered, postponement of surgery or change in anaesthetic plan	CXR abnormalities, n=27 Prominent broncho-vascular markings, healed tuberculosis, early bronchiectatic changes, mild cardiomegaly None required any change/no impact	Very low
Miscellaneous* Alka Chandra ^[11] 2014, India Retrospective cohort study	n=500 15-50 years Cholecystectomy and hernia repair	Intermediate	Change in anaesthetic plan Delay/cancellation of surgery	Deranged Hb/total leukocyte or differential count=32.5% No change in anaesthetic management plan No delay/cancellation of surgery	Very low
Sulaiman Alazzawi ^[23] 2012, UK Retrospective cohort study DOI: 10.1258/shorts.2011.011130	Total=127 n=95 16-60 years	Minor Intermediate	Clinical significance of abnormal tests and alteration in patient management	Deranged blood urea and electrolytes=7 Only blood urea was tested No influence on outcomes in the seven who had abnormal results	Very low
Obada Hasan ^[21] 2021, Pakistan Case control study DOI: 10.1016/j.amsu.2021.102439	n=670, 0-65 years Elective orthopaedic intermediate and major surgery	Intermediate Major	Influence on surgical plan: >24 h delay or cancellation of surgery after admission	Urea, creatinine and electrolytes combined data provided Matched Adjusted Odd's ratio 0.89 (0.71-1.12)	Very low

Total - total number of patients included in the study; n - number of patients tested; CBC - complete blood count; Hb - Haemoglobin; Hct - Haematocrit; RFT - renal function test; LFT - liver function test; PT - Prothrombin time; aPTT - Activated Partial Thromboplastin Time; ECG - 12-lead electrocardiogram; CXR - Chest X-ray *Miscellaneous: Combined data of two or more tests provided without segregation

Table 5: Evidence summary for preoperative sonographic airway assessment to predict difficult laryngoscopy

Study	Population and design	Parameters	Objectives	Results/outcomes	Level of evidence
Srikar Adhikari, ^[49] 2011, Omaha Observational study doi: 10.1111/j.1553-2712.2011.01099.x	51 patients, 53.1 (±13.2) years	USG measurements of tongue and anterior neck soft tissue at hyoid bone level and thyrohyoid membrane level.	To find utility of USG parameters in determining difficult laryngoscopy and to examine the association between sonographic measurements and clinical difficult airway screening tests	Poor CL: 6 The sonographic measurements of anterior neck soft tissue were greater in the difficult laryngoscopy group at the level of the hyoid bone and thyrohyoid membrane. No significant correlation was found between sonographic measurements and clinical screening tests.	Very Low
C. M. Hui, ^[50] Canada, 2014 Observational study doi: 10.1111/anae.12598	100 patients, >17 years 52.1 (15.5) years	A small-footprint, high-frequency curved array probe was used to obtain sublingual ultrasound images to note whether or not the hyoid bone could be visualized on the images.	Test the hypothesis that inability to visualize the hyoid bone on sublingual ultrasound correlates with difficult laryngoscopic view and, by extension, difficult intubation.	Poor CL view=11 Sublingual USG was better predictor of poor CL than any of the clinical parameters used for airway assessment.	Very low
Jinzhong Wu, ^[51] China, 2014 Observational study DOI: 10.12659/MSM.891037	203 patients, 20-65 years	Anterior neck soft tissue thickness at hyoid bone (DSHB), thyrohyoid membrane (DSEM), and anterior commissure (DSAC) levels	To determine if these USG airway measurements can predict poor CL view	Poor CL: 28 Strong positive correlation observed between DSHB and DSEM was observed.	Very low
Basak Ceyda Meco, ^[52] 2015, Turkey Observational study DOI: 10.1016/j.bjane.2014.06.004	50 patients 47±9 years	Thyromental distance, MMP, neck circumference, range of neck movements were correlated with USG measurements of thyroid volume, and chest X-ray features of signs of invasion or compression or tracheal deviation. CL and IDS were evaluated at intubation	To evaluate the effects of thyroid-related parameters assessed preoperatively by surgeons via ultrasonography and Chest X-ray on intubation conditions.	Patients were classified into 2 groups: G1 (19 patients): IDS 0 and G II (31 patients): IDS 1-5. Except for MMP, no other parameter correlated with difficult intubation. USG assessed thyroid volume was not useful as a predictor of difficult intubation.	Very low
Pawel Andruszkiewicz, ^[53] Poland, 2015 Observational study doi: 10.7863/ultra.15.11098	199 patients, 52.9±8.3 years (older than 18 years) Easy: CL 1,2 Difficult: CL 3,4	Nine sonographic parameters imaged from the submandibular view, including the hyomental distance in neutral and extended positions, hyomental distance ratio, tongue cross-sectional area, tongue width, tongue volume, tongue thickness-to-oral cavity height ratio, and floor of the mouth muscle cross-sectional area and volume, were analyzed	To evaluate the effectiveness of 9 airway sonographic parameters imaged from the submandibular view as predictors of difficult laryngoscopy	Poor CL was observed in 22 patients HMDE, hyomental distance in extension; HMDN, hyomental distance in the neutral position; HMDR, hyomental distance ratio, tongue volume and tongue cross-sectional area correlated significantly with difficult airway	Very low
Preethi B Reddy, ^[54] India, 2016 Observational study DOI: 10.4103/0019-5049.193660	100 patients; 18-70 years	Ultrasound measurements of the anterior neck soft tissue thickness at the level of the hyoid (ANS-Hyoid), anterior neck soft tissue thickness at the level of the vocal cords (ANS-VC) and ratio of the depth of the pre-epiglottic space (Pre-E) to the distance from the epiglottis to the mid-point of the distance between the vocal cords (E-VC) were obtained.	To determine the utility of ultrasonography in predicting CL grade	More than one attempt at intubation: 13 USG measurement of the ANS-VC is a potential predictor of difficult intubation. A value of more than 0.23 cm is more sensitive than the physical parameters such as MP class, TMD and SMD in predicting a CL Grade of 3 or 4.	Very low

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Study	Population and design	Parameters	Objectives	Results/outcomes	Level of evidence
J. Pinto, ^[65] 2016, Portugal Observational study DOI: 10.1016/j.jcr. 2016.01.029	74 adult patients Age: 55.23±18.07 57.47±11.10	Skin to epiglottis distance by ultrasound measurement	To evaluate the use of US measured distance from skin to epiglottis (DSE) for difficult laryngoscopy prediction	Poor CL: 17 Increasing DSE was strongly associated with difficult laryngoscopy.	Very low
W. Yao, ^[66] China, 2017 Observational study DOI: 10.1093/bja/ae×051	2254 patients; 18-90 years	Ratios of tongue thickness to thyromental distance were calculated to investigate the potential predictive value of their combination. The primary outcome was difficult tracheal intubation.	Investigated the predictive value of tongue thickness to predict difficult tracheal intubation	Poor CL and difficult laryngoscopy: 142 and difficult tracheal intubation: 51. Tongue thickness>6.1 cm was an independent predictor for difficult tracheal intubation.	Very low
Weidong Yao, ^[67] 2017, China Observational study DOI: 10.1213/ ANE:0000000000001528	484 patients 53±14 48±14	Mandibular condylar mobility was assessed by sonography through condylar translation measurements. The condylar translation prediction criterion for difficult laryngoscopy was≤10 mm. The condylar translation was correlated with CL	To observe sonographic assessment of ability of mandibular condylar mobility to predict difficult laryngoscopy	Poor CL: 41 The condylar translation≤10 mm proved to be an independent predictor of difficult laryngoscopy by a multivariate logistic regression.	Very low
Aruna Parameswari, ^[68] 2017 India DOI: 10.4103/joacp.JOACP_166_17 Observational study	n=130 Age: 18-60 years	USG measurements: Transverse view: width of the tongue, the cross-sectional area of the floor of the mouth, the anteroposterior thickness of the genioid muscle, the skin to hyoid, and the skin to epiglottis distance. Mid-sagittal view: cross-sectional area of the tongue and the mentohyoid distance	To find correlation between preoperative sonographic airway assessment parameters and the Cormack-Lehane (CL) grade at laryngoscopic view in adult patients.	Poor CL: 12 CL 3=12 CL 4=0 Skin to epiglottic distance and volume of the tongue were found to correlate better than other parameters in predicting poor CL view.	Very low
Shelly Rana, ^[69] 2018 India Observational study DOI: 10.4103/sja.SJA_540_17	n=120 Age: 20-60 years	USG measured the depth of the pre-epiglottic space (Pre-E), the distance from the epiglottis to the midpoint of the distance between the vocal cords (E-VC)	To evaluate the efficacy of pre E/E-VC, HMDR for predicting difficult laryngoscopy	Poor CL: 28 USG measured pre E/E-VC>1.77 cm and HMDR <1.085 appears to have high predictive value for difficult laryngoscopy.	Very low
Simin Abraham, ^[60] 2018 India Observational study DOI: 10.1007/s12663-018-1088-1	n=137 Age: Easy: 29.11 (10.525) Difficult: 32.10 (10.878)	Small foot print probe: hyoid bone, thyrohyoid distance, hyomental distance normal and extended, distance from base of tongue to hyoid bone, thickness of submental region, distance from epiglottis to hyoid bone, distance from skin fat pad thickness to thyroid cartilage, and vocal cords	To predict the difficulty in intubation preoperatively using ultrasonography.	Poor CL: 10 USG measured hyomental distance<1.09 cm was a predictor of difficult laryngoscopy	Very low

Contd...

Study	Population and design	Parameters	Objectives	Results/outcomes	Level of evidence
Sze Man Mandy Chan, ^[61] 2018, Hong Kong Observational study DOI: 10.1177/1024907917749479	113 patients, >17 years (19-84 years)	Measurement of the distance from the epiglottis to the anterior vocal folds (Pre-E/aVF) ratio	To investigate the accuracy of using the ratio of pre-epiglottis space distance (Pre-E) and the distance between the epiglottis and the vocal folds (Pre-E/E-VF) measured by the ultrasound to predict potential difficult airway in the Chinese population.	Difficult CL: 39 Compared to the other clinical tests (TMD, Neck/TMD and Mallampati score), the USG assessment method had the lowest negative likelihood ratio	Very low
Burak Yildiz, ^[62] 2019, Turkey Observational study DOI: 10.36472/msd.v6i12.329	136 adults >18 years 49.71±13.61 years	The Modified Mallampati classification, thyromental distance, sternalmental distance, and CL scores were recorded. Sonographic measurements included pre-epiglottic space (PES), the distance between the midpoints of vocal cords and epiglottis (EVC). The ratio was interpreted.	Main outcome is to determine the sensitivity and specificity of the upper airway ultrasound for the prediction of a potentially difficult airway	The sonographic measurements of airway could not predict the difficult intubation any better than the clinical tests.	Very low
Avani Shah, ^[63] 2020 India Observational study DOI: 10.21088/ijaa. 2349.8471.7120.1	n=100 Age: >18 years	Ultrasound distance from skin surface to anterior commissure of vocal cord (DSVC)	To evaluate the ability of preoperative ultrasound assessment of anterior neck soft tissue thickness in predicting difficult laryngoscopy	Poor CL: 23 DSVC>0.51 cm predicted difficult CL reliably	Very low
Anil Kumar N, ^[64] 2020 India Observational study DOI: 10.18231/ij. jca. 2020.118	n=60 Age: 15-65 years	USG measured depth of posterior 1/3rd of tongue	To evaluate USG measured depth of posterior 1/3 tongue's ability to predict difficult laryngoscopy	Poor CL: 12 Suprathyoid USG depth>5.8 cm predicted difficulty during laryngoscopy.	Very low
Mamta Gupta, ^[65] India, 2020 Observational study DOI: 10.4103/BJOA.BJOA_119_20	120 patients 18-70 years	Ultrasonography (USG) assessment included preepiglottic space (PES), thyromental distance (HMD), distance from skin to the hyoid bone-skin (DSHB), and distance from skin-to-epiglottis midway between the hyoid bone and thyroid cartilage distance from skin to epiglottis midway (DSEM).	To evaluate USG parameters predictive value for difficult laryngoscopy	DL was present in 22.50% of patients. Compared to those with easy laryngoscopy, patients with DL had lesser HMD and comparable DSHB, DSEM, and PES. Among the various USG parameters for predicting DL, DSHB had highest sensitivity and HMD had highest specificity.	Very low
B. S. Abdelhady, ^[66] 2020, Egypt Observational study DOI: 10.1080/11101849.2020.1768631	80 patients 18-60 years	Three parameters: MMP, thyromental distance and ultrasound-measured distance from skin to epiglottis at the level of thyrohyoid membrane.	To evaluate ultrasound-measured distance from skin to epiglottis for prediction of difficult laryngoscopy in Egyptian population	DSE had a better predictive power than any of the involved preintubation screening tests (MMP and thyromental distance) to predict a difficult laryngoscopy	Very low

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Study	Population and design	Parameters	Objectives	Results/outcomes	Level of evidence
Cristina Petrisor, ^[67] 2020 Romania Observational study DOI: 10.3390/diagnostics10030140	n=139 (non-obese) Age: 19-89 years	Mid-sagittal plane in the submandibular region CL probe: HMDRecho was obtained from the ratio of the hyomental distance with the head placed in maximal hyperextended position and the hyomental distance measured with the head in neutral position	To describe the correlation between clinically measured hyomental distance ratio (HMDRclin) and the ultrasound measurement (HMDRecho) in patients with and without morbid obesity and to compare their diagnostic accuracy for difficult airway prediction.	Poor CL: 9 HMDRecho correlated better with poor CL grade.	Very low
Rodrigo Thadeu Cei Pedroso, ^[68] 2020 Brazil Observational study DOI: 10.15761/TAS.1000103	n=144 Age: 18-60 years	USG distances measured: chin-hyoid, skin-hyoid, skin-epiglottis midpoint, skin-thyroid cartilage, skin-anterior commissure of the vocal cords and skin distance-cricoid cartilage	To investigate the validity and applicability of ultrasonography as a diagnostic test for difficulties in intubation	Difficult laryngoscopy: 29 Clinical parameters predicted difficult mask ventilation better than the USG parameters Difficult intubation: the USG measured distances i.e., skin-cricoid, skin-epiglottis and hyoid-ment showed higher predictive value for detecting difficult intubation.	Very low
Hongwei Ni, ^[69] 2020, China Observational study DOI: 10.1186/s12871-020-01053-3	211 patients >18 years 51.55±14.60 54.48±12.29 years	Ultrasound was utilized to measure the distance between the skin and thyroid cartilage (DST), the distance between the thyroid cartilage and epiglottis (DTE), and the distance between the skin and epiglottis (DSE) in the parasagittal plane.	The main objective of this study was to explore the value of laryngeal structure measurements for predicting a difficult laryngoscopy.	Poor CL: 44 DSE≥2.36 cm predicted difficult laryngoscopies.	Very low
Rishabh Aganwal, ^[70] 2021 India Observational study DOI: 10.4097/kja. 20114	n=1043 Age: 18-60 years	Tongue thickness (TT), invisibility of hyoid bone (VH), and anterior neck soft tissue thickness from the skin to thyrohyoid membrane (ST) and hyoid bone (SH) were measured by sublingual and submandibular ultrasonography	To evaluate the effectiveness of aforesaid ultrasonographic parameters in predicting DI	Poor CL: 35 Difficult laryngoscopy and intubation: 58 (> 2 attempts at intubation or alternate devices) SH had better accuracy than the remaining three ultrasonographic parameters A combined model that included all four parameters offered better diagnostic profile than each one of them.	Very low

CL - Cormack Lehane grade, USG - Ultrasonography, IDS - Intubation Difficulty Scale, MMP - Modified Mallampati Class

Table 6: Practice Guidelines from the Indian Society of Anaesthesiologists on preoperative investigations

Recommendation 1: Preoperative complete blood count testing is suggested for patients undergoing minor, intermediate and major surgery

Recommendation 2a: Preoperative serum creatinine estimation is NOT suggested for patients undergoing minor surgery

Recommendation 2b: Preoperative serum creatinine estimation is suggested for patients undergoing intermediate and major surgery

Recommendation 3: Preoperative serum sodium and potassium estimation is NOT suggested for patients undergoing minor, intermediate and major surgery

Recommendation 4a: Preoperative liver function testing is NOT suggested for patients undergoing minor and intermediate surgery

Recommendation 4b: Preoperative liver function testing is suggested for patients undergoing major surgery

Recommendation 5: Preoperative coagulation profile (PT/INR and aPTT) testing is NOT suggested for patients undergoing minor, intermediate and major surgery

Recommendation 6: In non-diabetic patients, preoperative blood glucose estimation is NOT suggested when scheduled to undergo minor, intermediate and major surgery.

Recommendation 7a: In non-cardiac patients, preoperative 12-lead electrocardiogram testing is suggested at age 45 years and above, when scheduled to undergo minor and intermediate surgery

Recommendation 7b: Preoperative 12-lead electrocardiogram testing is suggested for all patients undergoing major surgery

Recommendation 8a: Preoperative chest X-ray testing is NOT suggested for patients undergoing minor surgery

Recommendation 8b: Preoperative chest X-ray testing is suggested for patients aged 50 years and above, undergoing intermediate and major surgery

Recommendation 9: Routine preoperative ultrasonographic airway assessment is NOT suggested for predicting difficult laryngoscopy.

Recommendation 10a: The acceptable validity time (VTPIN) for a previously performed normal complete blood count, renal function tests, liver function tests, coagulation profile, is suggested to be 2 months provided the clinical condition of the patient has not changed in the intervening period.

Recommendation 10b: The acceptable validity time (VTPIN) for a previously performed normal 12-lead electrocardiogram and chest X-ray, is suggested to be 12 months provided the clinical condition of the patient has not changed in the intervening period.

These clinical practice guidelines provide recommendations for routine preoperative investigations in ASA PS 1 and 2 patients scheduled for elective surgical procedures.

Routine preoperative investigations are defined as those tests which may influence the perioperative anaesthetic management strategy and outcome in patients scheduled for elective surgeries independent of the specific clinical condition.

These guidelines should not be substituted for a good clinical judgement (based on detailed history, clinical evaluation and review of the medications) and the attending anaesthesiologist may consider individualising the decision on further investigations.

Few examples:

A patient scheduled for transurethral resection of prostate requires testing for serum electrolytes considering the influence of the surgical procedure where absorption of irrigation fluids may alter the electrolyte levels.

A patient receiving diuretics or angiotensin converting enzyme inhibitors may require testing for serum electrolytes.

A patient scheduled for liver biopsy or gall bladder procedure may require liver function tests.

A patient with respiratory symptoms may require chest X-ray irrespective of the age or nature of surgery.

Table 6: Contd...

When regional anaesthetic procedures are planned, the practitioner is advised to refer to the latest guidelines on regional anaesthesia in patients on anticoagulants. The guidelines related to the influence of various drugs from the alternative systems of medicine which may have effect on coagulation needs to be considered.

The statements are intended to guide the practitioners of anaesthesiology and healthcare establishments on judicious ordering of investigations in the preoperative period.

the hospital set ups, it was suggested by the experts that preoperative CBC would be of high utility with respect to management and outcomes for minor surgeries also.

Online survey conducted as a part of this guideline formulation showed that of the total 1169 survey respondents, majority (n = 753) were in favour of ordering CBC as a preoperative investigation rather than individual components. Majority of the respondents, that is, 998, 1052, 1169 also practiced ordering CBC prior to minor, intermediate and major surgeries respectively [Supplementary Appendix 1, available online].

Recommendation 1: Preoperative complete blood count testing is suggested for patients undergoing minor, intermediate and major surgery

Renal function tests

In ASA PS 1 and 2 patients scheduled to undergo elective surgery, will routine preoperative renal function testing change anaesthetic management or patient outcomes after surgery?

Among the renal function tests, serum creatinine is more specific than blood urea and even the estimated glomerular filtration rate (eGFR) calculation is based on the serum creatinine value and hence serum creatinine was considered as the main parameter, changes in which may influence the outcome.

Out of the 11 available studies [Table 4],^[3,11-13,20,21,23,24,29-31] 9 studies estimated serum creatinine.^[3,11-13,20,21,24,30,31] Two studies involving intermediate surgeries (n = 21165) and one study (n = 670) involving intermediate and major surgeries showed abnormal creatinine to have no influence on outcomes.^[11,20,23] Six studies (n = 3547) involving all three surgery categories, showed adverse outcomes in 18 patients having high preoperative serum creatinine levels.^[3,12,13,24,30,31] Two studies involving minor and intermediate surgeries that tested blood urea only (n = 153) did not report any adverse outcomes^[23,29] [Table 4].

Hypoxaemia, haemodynamic instability, direct organ handling, technique and duration of the procedures

Contd...

are some of the factors which can contribute to acute kidney injury in the perioperative period in intermediate and major surgeries.^[32,33] The consensus among the experts was in favour of ordering preoperative serum creatinine before intermediate and major surgeries to guide the patient management.

Online survey conducted as a part of this guideline formulation showed that of the total 1169 survey respondents, 474, 771 and 1112 respondents preferred to get preoperative RFT in minor, intermediate and major surgeries, respectively [Supplementary Appendix 1, available online].

Recommendation 2a: Preoperative serum creatinine estimation is NOT suggested for patients undergoing minor surgery.

Recommendation 2b: Preoperative serum creatinine estimation is suggested for patients undergoing intermediate and major surgery.

Serum electrolytes

In ASA PS 1 and 2 patients scheduled to undergo elective surgery, will routine preoperative serum electrolytes (Na, K) testing change anaesthetic management or patient outcomes after surgery?

Alterations in serum sodium and serum potassium may be associated with medical and surgical disorders, drug intake and have a potential to affect the anaesthetic management and the outcomes.^[34-37] One study involving intermediate surgeries (n = 20915),^[20] and two studies involving minor and intermediate surgeries (n = 765) did not report any adverse outcomes related to deranged serum electrolytes.^[21,23] Three studies involving all three categories of surgeries (n = 608), showed influence on outcomes in five patients with deranged serum sodium.^[13,24,30] Evidence with outcomes related to altered serum potassium independently were not available [Table 4].

Online survey conducted as a part of this guideline formulation showed that of the total 1169 survey respondents, 233, 453, 1040 respondents preferred to get preoperative serum electrolytes in minor, intermediate and major surgeries, respectively [Supplementary Appendix 1, available online].

Recommendation 3: Preoperative serum sodium and potassium estimation is NOT suggested for patients undergoing minor, intermediate and major surgery.

Liver function tests

In ASA PS 1 and 2 patients scheduled to undergo elective surgery, will routine preoperative liver function testing change anaesthetic management or patient outcomes after surgery?

Liver function tests (serum albumin, serum bilirubin, alanine aminotransferase (ALT), aspartate aminotransferase (AST) and alkaline phosphatase) assess the synthetic and metabolic functions of the liver (PT/INR is a sensitive marker for synthetic function of the liver; it is addressed under coagulation profile as a separate parameter). Low albumin levels have been reported to be independent predictors of the perioperative outcomes.^[38,39]

On evidence review, six relevant studies (n = 18338)^[3,11,20,23,29,30] for preoperative liver function tests (LFT) were identified of which four studies conducted on patients undergoing minor and/or intermediate surgery (n = 17806) did not show any influence of LFT on outcomes.^[11,20,23,29] In two studies involving patients scheduled for minor, intermediate and major surgeries (n = 532), among patients who had altered preoperative LFT, 21 patients required further investigations, referral or delay, while three patients required blood transfusion.^[3,30] Individual components of LFT did not have any adverse impact on the outcomes as reported in a study conducted on patients undergoing intermediate surgeries (n = 17450)^[20] [Table 4].

Online survey conducted as a part of this guideline formulation showed that of the total 1169 survey respondents, 106, 300 and 904 respondents preferred to get preoperative LFT in minor, intermediate and major surgeries, respectively [Supplementary Appendix 1, available online].

Recommendation 4a: Preoperative liver function testing is NOT suggested for patients undergoing minor and intermediate surgery

Recommendation 4b: Preoperative liver function testing is suggested for patients undergoing major surgery

Coagulation profile

In ASA PS 1 and 2 patients scheduled to undergo elective surgery, will routine preoperative coagulation profile (Prothrombin Time/International Normalised Ratio, activated Partial Thromboplastin Time) testing

change anaesthetic management or patient outcomes after surgery?

Abnormalities in preoperative coagulation tests (PT/INR, aPTT) may influence the perioperative management strategy.^[40-42]

One study involving intermediate surgeries (n = 15643),^[20] two studies involving minor and intermediate surgeries (n = 55),^[23,29] and one study involving intermediate and major surgeries (n = 670),^[21] did not report adverse outcomes related to abnormal coagulation profile. In three studies involving all three categories of surgeries (n = 1446),^[13,24,30] change in approach or change in management plan was observed in 11 patients with abnormal preoperative coagulation reports [Table 4].

When regional techniques are planned in patients on anticoagulants, the practitioner is advised to refer to the latest guidelines on regional anaesthesia and anticoagulation. The guidelines related to the influence of various drugs from the alternative systems of medicine which may have effect on coagulation needs to be considered.^[28]

Online survey conducted as a part of this guideline formulation showed that, of the total 1169 survey respondents, 460, 811 and 1056 respondents preferred to get preoperative coagulation profile in minor, intermediate and major surgeries, respectively [Supplementary Appendix 1, available online].

Recommendation 5: Preoperative coagulation profile (PT/INR and aPTT) testing is NOT suggested for patients undergoing minor, intermediate and major surgery.

Blood glucose

In ASA PS 1 and 2 non-diabetic patients scheduled to undergo elective surgery, will routine preoperative blood glucose estimation change anaesthetic management or patient outcomes after surgery?

Patients are considered as non-diabetic if during preanaesthetic evaluation, there is no history, finding or previous investigation report suggestive of diabetes mellitus. In such patients, role of preoperative blood glucose estimation on perioperative outcomes needs to be evaluated. In one study involving intermediate surgeries (n = 500), no patient had abnormal blood glucose.^[11] In five studies involving

all three categories of surgeries (n = 2894), amongst patients with elevated blood glucose preoperatively, eight required referral and six needed a 'change in approach'^[3,12,13,24,30] [Table 4].

Detection of single increased blood glucose level during preoperative investigation in patients without diabetes mellitus and its potential influence on major outcomes such as cancellation, infection in the cited evidences were considered by the experts, followed by further deliberations before arriving at the recommendation.

Online survey conducted as a part of this guideline formulation showed that of the total 1169 survey respondents, 748, 863 and 1083 respondents preferred to get preoperative blood glucose estimation in minor, intermediate and major surgeries, respectively [Supplementary Appendix 1, available online].

Recommendation 6: In non-diabetic patients, pre operative blood glucose estimation is NOT suggested when scheduled to undergo minor, intermediate and major surgery.

12-lead electrocardiogram

In ASA PS 1 and 2 non-cardiac patients scheduled to undergo elective surgery, will routine preoperative 12-lead electrocardiogram testing change anaesthetic management or patient outcomes after surgery?

Preoperative 12-lead electrocardiogram testing can detect pre-existent or ongoing myocardial ischaemic changes, endocardial or pericardial pathology and may also reflect electrolyte disorders and underlying co-morbidities.^[3,11,12] One study involving intermediate surgeries (n = 420) reported no adverse outcome in patients with ECG changes.^[11] Four studies involving all three categories of surgeries (n = 2436) reported ECG changes resulting in minor impact (further investigation, referral or delay) in 58 patients and a change in approach in 3 patients. One patient required postponement of the surgical procedure due to new onset ECG changes in the operating room^[3,12,13,24] [Table 4].

Non-cardiac status of a patient is reflected by the absence of history, clinical findings or reports suggestive of cardiovascular disease. The incidence of cardiovascular diseases increases with age.^[43,44] The cardiovascular disease death rate in India is much higher than the global average.^[45,46] When patients at risk as per these evidences (by age) present for incidental surgery, cardiac events are more likely to be encountered in the

perioperative period.^[47] Published evidence along with this information was considered and deliberated by the experts before arriving at the recommendations.

Online survey conducted as a part of this guideline formulation showed that of the total 1169 survey respondents, 609, 834 and 1110 respondents preferred to get preoperative 12-lead ECG test in minor, intermediate and major surgeries, respectively. Majority (932/1169) of the ISA members were in favour of designating an age criterion for routine preoperative ECG testing. Among these 932 respondents, majority (n = 837) were in favour of ECG testing at 45 years of age and above [Supplementary Appendix 1, available online].

Recommendation 7a: In non-cardiac patients, preoperative 12-lead electrocardiogram testing is suggested at age 45 years and above, when scheduled to undergo minor and intermediate surgery.

Recommendation 7b: Preoperative 12-lead electrocardiogram testing is suggested for all patients undergoing major surgery.

Chest X-ray

In ASA PS 1 and 2 patients scheduled to undergo elective surgery, will routine preoperative chest X-ray testing change anaesthetic management or patient outcomes after surgery?

Preoperative chest X-ray findings have the potential to influence the perioperative management but the utility of this investigation needs to be considered in view of the radiation hazards. In one study involving intermediate surgeries (n = 470), 10 patients with abnormal preoperative chest X-ray findings developed mild intraoperative bronchospasm.^[11] In 4 studies involving all 3 categories of surgeries (n = 2162), among those with abnormal preoperative chest X-ray findings, minor impact (further investigations, referral or delay in starting the procedure) was observed in 21 patients and a change in management required in 9 patients^[3,12,13,24] [Table 4].

Some of the radiographic changes may not be of relevance such as those indicative of older pathology (tuberculosis, obstructive and restrictive lung diseases). The chest imaging can also reveal certain cardiovascular and pulmonary changes attributable to the impact of smoking, pollution or cardiac disorder and tend to have cumulative effect with increasing age. Minor radiographic changes observed in younger individuals may not impact the

perioperative management.^[48] These factors along with the evidences were collectively considered and deliberated by the experts during Delphi consensus, prior to arriving at the recommendations.

Online survey conducted as a part of this guideline formulation showed that of the total 1169 survey respondents, 319, 602 and 982 respondents preferred to get preoperative chest X-ray testing in minor, intermediate and major surgeries, respectively. Approximately 51% (598/1169) of the respondents to the online survey were in favour of age based routine chest X-ray testing in patients scheduled for surgery. Though majority (n = 561), were in favour of routine chest X-ray testing in patients aged 45 years and above, 239 among them were in favour of testing at patient age at or above 60 years [Supplementary Appendix 1, available online].

Recommendation 8a: Preoperative chest X-ray testing is NOT suggested for patients undergoing minor surgery.

Recommendation 8b: Preoperative chest X-ray testing is suggested for patients aged 50 years and above, undergoing intermediate and major surgery

Airway

In ASA PS 1 and 2 patients scheduled to undergo elective surgery, will routine preoperative ultrasonographic airway assessment predict difficult airway?

Increasing accessibility of ultrasonogram (USG) for the anaesthesiologists has enabled its utility for preoperative airway assessment. Preliminary data suggests that USG would be one of the important preoperative airway assessment tools. Airway ultrasonography could predict difficult laryngoscopy more reliably than the clinical parameters in 20 out of the 22 studies^[49-70] [Table 5]. These studies had used varied USG parameters as predictors of difficult airway. With the available evidences, a specific parameter or a combination of parameters to predict a difficult airway cannot be suggested. Since airway ultrasound is an evolving field, further research may be able to conclusively demonstrate the USG parameters that have high sensitivity and specificity for predicting difficult laryngoscopy.

Recommendation 9: Routine preoperative ultrasonographic airway assessment is NOT suggested for predicting difficult laryngoscopy.

Validity time for previous investigations (VTPIN)

In ASA PS 1 and 2 patients scheduled to undergo elective surgery, what is the validity time for previous investigations provided the patient's underlying condition remains stable in the intervening period?

The Validity Time for Previous Investigations (VTPIN) refers to the acceptable interval from the time of previous testing for any purpose, to current preoperative evaluation.

One study (n = 235010) concluded that normal blood test reports (CBC, LFT, RFT, serum sodium, and coagulation profile (PT/INR, aPTT) obtained within the last 2 months from the date of surgery did not differ significantly in their influence on the outcomes studied compared to those which were performed within 1 or 2 weeks prior to surgery.^[71] A retrospective cohort study (n = 932)^[72] considered the preoperative test reports (CBC, blood glucose, RFT, coagulation tests, ECG and chest x-ray) obtained for the first surgical procedure and compared with the test reports obtained for re-interventions (6-84 months interval). The preoperative test reports obtained for second surgery performed 12 months after the first intervention, remained largely unaltered and minor alterations did not have any influence on the outcomes.

Recommendation 10a: The acceptable validity time (VTPIN) for a previously performed normal complete blood count, renal function tests, liver function tests, coagulation profile, is suggested to be 2 months provided the clinical condition of the patient has not changed in the intervening period.

Recommendation 10b: The acceptable validity time (VTPIN) for a previously performed normal 12-lead electrocardiogram and chest X-ray, is suggested to be 12 months provided the clinical condition of the patient has not changed in the intervening period.

Limitations and evidence updates

Non-availability of randomised controlled trials and inadequacy of data in the available studies (definitions, outcomes, follow-up, testing pattern, etc.) were major limitations for performing the meta-analysis. The certainty level for the available literature was low or very low and hence the recommendations formulated for all the RQs are weak.

After the formulation of the final recommendations, the core committee reviewed additional publications

satisfying the original search strategy (25 November 2021 till 03 May 2022). In one study (n = 170, age 15-45 years), majority of the patients were routinely tested for CBC, RFT, serum electrolytes, blood glucose, 12-lead electrocardiogram and chest X-ray. In those patients where reports were abnormal, there was no influence on the outcomes. The categorisation of patients in terms of the nature of surgery was not available.^[73] Four studies (n = 2700) concluded preoperative ultrasonographic airway assessment to be a better assessment tool for predicting difficult laryngoscopy compared to routinely used clinical parameters.^[74-77]

One study (n = 150, 18-60 years) concluded that preoperative ultrasonographic airway assessment was not superior to clinical evaluation in predicting difficult laryngoscopy.^[78] The outcomes from these additional evidences were in agreement with the formulated recommendations. Hence, these guidelines stand valid with the latest evidence.

A ready reckoner is recommended to be downloaded for display for educational and clinical purposes (eg, in pre-anaesthesia check-up clinics, wards and other areas) [Supplementary Appendix 2, available online].

The seven members of the core committee: SBB – S Bala Bhaskar, HSS – Harsoor SS, PD – Pradeep A Dongare, RG – Rakesh Garg, SK – Sudheesh Kannan, UG – Umesh Goneppanavar, ZA – Zulfiqar Ali.

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Conflicts of interest

There are no conflicts of interest.

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**“ANAESTHESIA A COMPLETE SPECIALITY- WE ARE THE LIFELINE”
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SUPPLEMENTARY APPENDIX 1

Appendix 1

Survey Data - Preoperative Investigations (Indian Society of Anaesthesiologists)

Work place of the delegates	Numbers
Government Medical College Hospital/Teaching Institute	411
Private Medical College Hospital	226
DNB / NB Teaching Hospital (Government)	19
DNB / NB Teaching Hospital (Private)	150
Non-DNB Corporate Hospital	162
Freelance - Single	177
Freelance - Group Practice	24
Total	1169

Delegates experience in anaesthesiology	Numbers
< 3 years (postgraduate)	142
3-6 years	220
6-12 years	245
12-25 years	355
>25 years	207
Total	1169

Separate protocol for preoperative investigations at workplace	Numbers
Yes	710
No	459
Total	1169

Opinion about ordering a battery of preoperative investigations	Numbers
Yes	275
No	894
Total	1169

Do you consider cost benefit before ordering preoperative tests?	Numbers
Yes	1110
No	59
Total	1169

Opinion about package system of ordering preoperative tests	Numbers
Yes	310
No	859
Total	1169

Does your hospital follow package system for preoperative tests?	Numbers
Yes	300
No	869
Total	1169

Preference regarding ordering complete blood count (CBC) or individual tests (Haemoglobin, Total and differential leukocyte count, platelets)	Numbers
CBC	753
Individual testing	416
Total	1169

Preoperative investigations ordering preferences depending on invasive nature of surgery	Minor surgery (Numbers)	Intermediate surgery (Numbers)	Major Surgery (Numbers)
Complete Blood Count (CBC)	998	1052	1169
Renal Function Tests (RFT)	474	771	1112
Serum electrolytes (Sodium, Potassium)	233	453	1040
Liver Function Tests (LFT)	106	300	904
Coagulation profile	460	811	1056
Blood glucose	748	863	1083
Urine analysis	183	255	563
Thyroid profile	69	173	567
12-lead electrocardiogram	609	834	1110
Chest X-ray	319	602	982

Would you decide to order 12-lead electrocardiogram (ECG) based on age of patient?	Age cut off preference	Numbers
Yes: 932	<45 years	95
No: 237	45-60 years	759
Total: 1169	>60-80 years	77
	>80 years	1

Would you decide to order 12-lead electrocardiogram (ECG) based on age of patient?	Age cut off preference	Numbers
Yes: 598	<45 years	37
No: 571	45-60 years	322
Total: 1169	>60-80 years	207
	>80 years	32

Preoperative Investigations: Practice Guidelines from Indian Society of Anaesthesiologists (ISA)*



Nature of Surgery		Complete Blood Count (CBC)	Renal Function Tests (Serum Creatinine)	Liver Function Tests (LFT)	12 Lead Electrocardiogram (ECG)	Chest X-ray (CXR)	Serum Electrolytes (Na ⁺ , K ⁺) Coagulation Profile Blood Sugar	Preoperative routine airway ultrasound evaluation for predicting difficult airway (laryngoscopy)
Minor					≥ 45 years			
Intermediate					≥ 45 years	≥ 50 years		
Major					All	≥ 50 years		
VTPIN (Validity Time for Previously done Investigations)		2 months	2 months	2 months	12 months	12 months		

* For non-diabetic ASA PS 1 and 2 adults scheduled for elective surgery, based on the nature of the surgery

- Green Boxes: Investigations to be ordered routinely.

- Amber Boxes: Investigations to be considered on an individual basis, as per patient evaluation.

(The attending anaesthesiologist may consider individualising the decision on further investigations. Eg: patients receiving diuretics or patients scheduled for monopolar TURP surgery require serum electrolytes estimation; patients with features suggestive of underlying active lower respiratory pathology may require Chest X-ray irrespective of age; patients on anticoagulant medication require coagulation profile testing)

Minimum investigations to be done in non-diabetic ASA PS 1 and 2 patients prior to elective surgery

- Minor surgery – CBC, 12 lead ECG (for all patients aged ≥ 45 years)
- Intermediate surgery – CBC, Serum Creatinine, 12 lead ECG (for all patients aged ≥ 45 years), CXR (for all patients aged ≥ 50 years)
- Major surgery – CBC, Serum Creatinine, LFT, 12 lead ECG (for all patients aged ≥ 45 years), CXR (for all patients aged ≥ 50 years)

VTPIN: Blood investigations (2 months), 12 lead ECG (12 months) and CXR (12 months)

1. Additional investigations to be considered by the attending anaesthesiologist on an individual basis, as per patient evaluation.

2. Repeat investigations within VTPIN to be considered if there is a change in patient physiology.