



Systematic Review / Meta-analysis

Preoperative investigations for elective surgical patients in a resource limited setting: Systematic review



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ABSTRACT

Background: Preoperative investigation for surgical patients is important to check for conditions that may affect surgical outcome. It helps the anesthetist and surgeon to plan perioperative anesthesia and surgical management appropriately. However, 60–70% of laboratory tests before surgery are not really required. This review was conducted to develop evidence-based recommendations on preoperative investigations for patients waiting for surgery in a resource limited setting.

Methods: After formulating the key questions, scope, and eligibility criteria for the articles to be included, advanced search strategy of electronic sources from data bases and websites was conducted. Duplication of literatures was avoided by endnote. Screening of literatures was conducted with proper appraisal. This review was reported in accordance with the preferred reporting items for systematic reviews and meta-analysis (PRISMA) 2020 statement.

Results: A total of 553 articles were identified from data bases and websites using an electronic search. 75 articles were removed for duplication and 223 studies were excluded after reviewing titles and abstracts. At the screening stage, 82 articles were retrieved and evaluated for eligibility. Finally, 46 studies met the eligibility criteria and were included in this systematic review.

Conclusion: and recommendation: Selective laboratory ordering reduces the number and cost of investigations. Preoperative tests should be guided by the patient's clinical history, co-morbidities, and physical examination. Patients with signs or symptoms of certain types of disease should be evaluated with appropriate testing. Therefore, adherence to recommendations of guidelines on preoperative investigation is important for good surgical outcome and patient satisfaction.

1. Introduction

Preoperative patient assessment is an essential part of anesthesia care. The use of routine laboratory investigations before elective surgery is beneficial and cost-effective when they are correlated with the patient's history and physical examination resulting in better detection and determination of co-morbidities and are often required to supplement information for perioperative risk stratification [1–3].

The pre-operative preparation of patients undergoing any surgery involves a multidisciplinary approach. The anesthetists assess the patient's fitness for surgery and the surgical team assesses the appropriateness of the surgery [3]. Patients admitted to hospital for elective surgery commonly undergo a preoperative investigations, such as complete blood count (CBC), renal function tests, blood glucose level,

urinalysis, chest x-ray (CXR) and an electrocardiography (ECG) [4,5].

Ordering of preoperative tests occurs before surgical procedures to check for conditions that may affect treatment. This can help the anesthetist and surgeon to make decisions regarding the course of treatment and preoperative or postoperative management. literatures showed that 60–70% of laboratory tests ordered before general surgery are not really required [6,7]. Perioperative tests can sometimes be ordered unnecessarily, this can cause delays in treatment and inefficiency in planning surgical care. Inappropriate ordering of routine preoperative tests can also lead to high costs of health care services [5].

The practice of indiscriminate test ordering is a problem that affects more than 30 million procedures, with a conservatively estimated direct cost above 18 million USD [7]. The additional cost incurred by un-indicated tests in our institution was 13.89% of the total cost for the

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tests [3]. This suggests that unnecessary laboratory testing during preoperative preparation of patients is still common and leading to substantial excess costs [3,8].

The application of guidelines would reduce costs. Economic analysis estimates that a reduction of 63% in cost per patient for preoperative tests by introducing guideline criteria (from €69 to €26) [4]. Preoperative diagnostics to the recommendations of the guideline of the Austrian Society of Anesthesiology would lead to annual savings of 10–35 m€ in Austria [9]. Note that most laboratory and diagnostic tests (e.g., hemoglobin, potassium, coagulation studies, chest x-rays, electrocardiograms) are not routinely necessary unless a specific indication is present [10].

The aim of this review is to develop an evidence-based protocol for ordering of preoperative investigation for patients awaiting surgery in a resource limited setting.

2. Rationale of the review

Preoperative investigations were found to be beneficial and cost-effective when they had been correlated with the patient's history and physical examination. Obtaining the results of investigations of symptomatic patients can help clinicians to confirm diagnoses, assess the severity and progression of diseases, and predict the prognoses [4]. In contrast, performing preoperative investigations in asymptomatic patients or healthy patients like American society of Anesthesiologists physical class I (ASA I) may lead to many disadvantages due to the weak ability of preoperative investigations to predict adverse postoperative outcomes, the low impact of tests on clinical management, and the tests incur a huge and unnecessary expenditure [11].

This review provides a clear and comprehensive evidence-based working protocol on ordering of preoperative investigations in a different way from the existing guidelines since it is more recent and it includes thyroid function test (TFT) which is not included in most guidelines and it will decrease the problem of unnecessary ordering of investigation in a resource limited setting.

The application of the institute's guidelines should decrease the number of laboratory tests and consequential costs with no untoward events, especially when applied to low-risk patients [7,12,19]. The development of this evidence-based working protocol could make the actions of the physicians or divisions more predictable and presumably of higher quality and also reduces unnecessary tests that may lead to extra cost burden, delay in surgery and occasional harm to the patient.

3. Methods

3.1. Search strategy

After formulating the key questions, scope, and eligibility criteria for the evidences to be included, a comprehensive search strategy of electronic sources was conducted. Terms like 'investigation', 'laboratory', 'surgery', and 'preoperative' were keywords of the review question. Synonyms of the keywords were identified from national library of medicine via medical subject headings (MeSH) browser. Keywords were combined by a boolean operators "AND" or "OR" appropriately. We applied search terms in combination as: 'preoperative investigation' OR 'preoperative laboratory' AND 'surgery'.

The literatures were searched using advanced searching methods from data bases like cochrane library, Pub Med, scopus, embase and websites such as google scholar. The electronic literature search was performed from 15 May 2022 to 1 June 2022. All of the accessible studies that had been published in English language from inception up to 1 June 2022 were included in this systematic review.

Duplication of literatures was removed by endnote. Further screening of literatures was conducted based on the level of significance by proper appraisal of the title, abstract and full text of the articles. A total of 46 articles were included and reviewed. The strength of evidence

and grade of recommendation was made based on WHO 2011 level of evidence (Table 1).

This review was reported in line with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2020 criteria [47] (Fig. 1). This review was registered in research registry with unique identifying number of reviewregistry1405.

3.2. Eligibility criteria

All studies that reported preoperative investigations for an elective surgical patient, English language reporting, had full text available for search and took place across the globe were included in this systematic review. Those studies that reported duplicated sources, unrelated research, case reports, and articles with no full text available with attempts to contact the corresponding author via email were excluded in this systematic review.

3.3. Study selection

Three independent authors selected the candidate articles for the study, which were exported in to Endnote reference manager software to remove duplicates, and independently screened the titles and abstracts (BA, HY, and BY). Any disagreement was resolved through discussions lead by a third author.

3.4. Study quality assessment

The two independent authors appraised the standard of the study using AMSTAR 2 methodological quality appraisal checklist. Any disagreement was discussed and resolved by the authors. The critical analysis checklist has 16 parameters [48]. The quality of this review after critical appraisal of its method was reported as high.

3.5. Level of evidence and degree of recommendations

4. Results

4.1. Study selection

A total of 553 articles were identified from data bases and websites using an electronic search. Of these articles, 75 were removed for duplication and 223 studies were excluded after reviewing their titles and abstracts. At the screening stage, 82 articles were retrieved and evaluated for the eligibility. Finally, 46 studies related to preoperative investigations were included in this systematic review (Fig. 1).

4.2. Description of included studies

Out of 82 articles retrieved, 46 met the eligibility criteria and were included in the final systematic review. Out of all articles included, 13 were systematic reviews, 8 were systematic reviews and meta-analyses, 12 were guidelines, 6 were cross-sectional and 7 were cohort studies.

5. Discussion

This systematic review provides evidence-based recommendations on preoperative investigations for elective surgical patients waiting surgery in a resource limited setting. This review will guide clinicians to order an appropriate investigation as early as possible.

The indication for preoperative tests should be individualized according to the patients' co-morbidities and diseases, as well as the type of the planned surgery. This review includes appropriate indications for the application of the following tests: electrocardiography (ECG), chest x-ray, complete blood count (CBC), electrolyte, renal function test

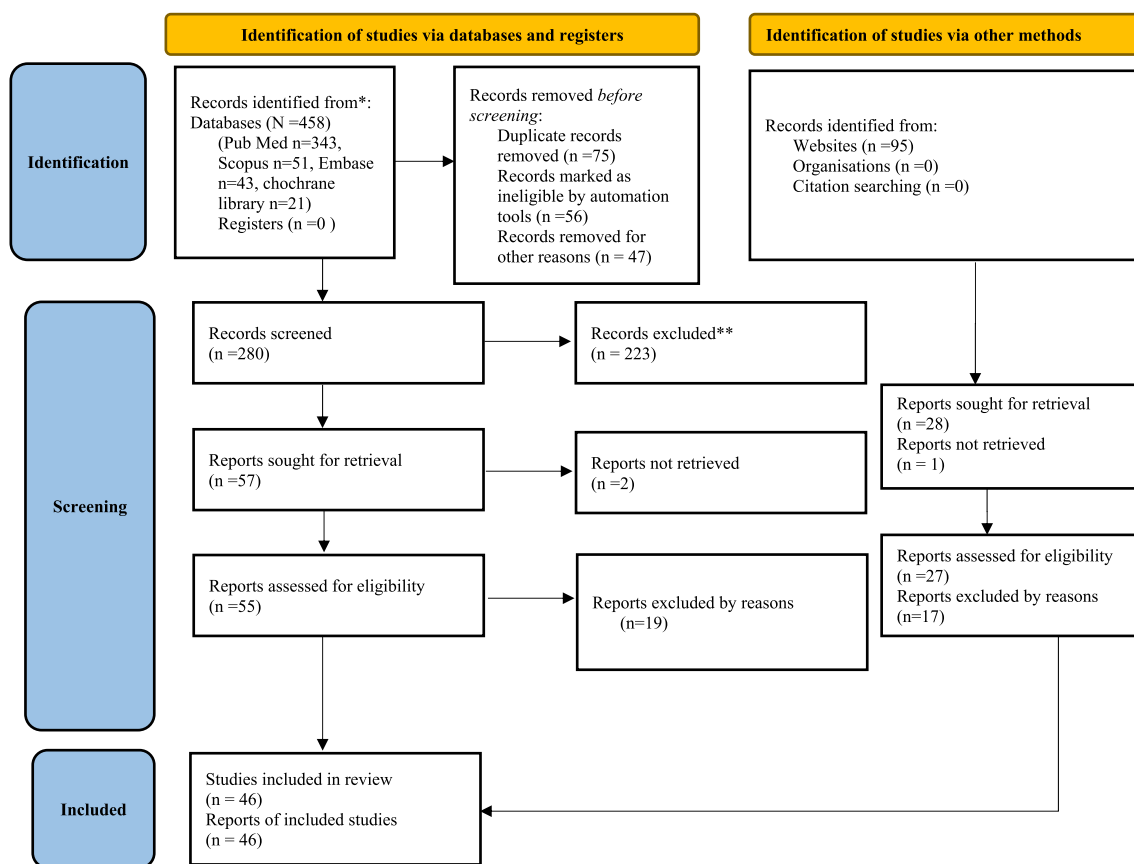


Fig. 1. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2020.

Table 1
Good clinical practice, GCP, WHO, 2011.

Level of evidence	Types of evidence	Degree of recommendation
1a	Meta analysis, systematic review of RCTs, Evidence based guidelines	Strongly recommended and directly applicable
1b	Systematic review	Highly recommendable and directly applicable
1c	Randomized control/clinical trials	Recommended and applicable
2a	Systematic review of cohort or case control studies	Extrapolated evidence from other studies
3a	Non analytical studies like case report and case series, clinical audit, commentaries and expert opinions	Extrapolated evidence from other studies

(RFT), coagulation tests, echocardiography and thyroid function test (TFT), computed tomography (CT) scan and magnetic resonance imaging (MRI).

5.1. Complete blood count (CBC)

Many literature review regarding complete blood count (CBC) shows 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 [21,22]. A clinical practice guidelines showed that complete blood count is not recommended as routine in asymptomatic individuals [5,13,16,23], and complete blood count is suggested in patients with history of anemia or other hematologic diseases or liver diseases, when anemia is suspected during physical examination or when chronic diseases associated with anemia are present and when moderate or high-risk

surgeries (Table 4) if a need for transfusion is anticipated. Clinical characteristics to consider as indications for such tests include type and invasiveness of procedure, patients with liver disease [5,13,23,24] extremes of age, and history of anemia, bleeding, and other hematologic disorders, chronic cardiovascular, pulmonary, renal, or hepatic disease and malignancy [5,23,25].

A Cochrane systematic review shows that preoperative medical testing did not reduce the rate of intraoperative or postoperative medical adverse events (compared to selective or no testing) after cataract surgery [26].

5.2. Chest X-Ray

Routine chest x-rays are not needed for asymptomatic patients but, clinical practice guidelines recommend requesting a chest x-ray is indicated in patients with a history or diagnostic tests suggestive of cardio-respiratory diseases, medium to major surgeries (Table 4), mainly intra-thoracic and intra-abdominal surgeries, and those older than 50 years of age who are scheduled for upper abdominal, thoracic, or abdominal aortic aneurysm surgery [13,15]. Patients with new or unstable cardiopulmonary signs or symptoms are indicated for preoperative chest radiography [25,27–29] however, ordering a chest x-ray is not recommended as routine in asymptomatic individuals [5,9,13,30].

5.3. Electrocardiography (ECG)

Guidelines recommend that routine electrocardiogram (ECG) is not indicated for individuals who are waiting low-risk surgeries and preoperative assessment of patients with no history or symptoms of heart disease [13,29,31–33] and no ECG report should be repeated if it has been done within the past 3 months [34]. Guidelines recommend that ECG is indicated for patients who have risk factors and are scheduled for

intermediate or high-risk surgery (Table 4), for patients who have no risk factors, and above 65 years of age and are scheduled for intermediate-risk surgery, patients classified under ASA 1 (Table 3) with major or complex surgery [5,31,33]. It is also reasonable to consider ECG in patients with history and/or abnormalities on physical examination suggestive of cardiovascular disease [13,16,27]. ECG is considered for patients of any age with diabetes, hypertension, chest pain, congestive heart failure, smoking history, peripheral vascular disease, disability and morbid obesity [29,35].

5.4. Electrolyte and renal function tests (RFT)

A clinical practice guidelines and systematic review stated that there is no evidence that justified routine testing for renal function,

Table 2
Summary of evidence-based recommendations on ordering of preoperative investigation for elective surgery.

Preoperative investigations	Indications and recommendations
Complete Blood Count (CBC)	<ul style="list-style-type: none"> • Patients with a history of anemia or history suggesting recent blood loss or anemia • Patients with ASA I and ASAII undergo major and complex surgery • Hematologic diseases or liver diseases • Moderate/high-risk surgeries if a need for transfusion is anticipated • Chronic cardiovascular, pulmonary, renal, or hepatic disease and malignancy
Chest X-Ray	<ul style="list-style-type: none"> • Patients with a history or diagnostic tests suggestive of cardio- respiratory diseases • Medium to major surgeries, mainly intra-thoracic and intra-abdominal surgeries • Patients with new or unstable cardiopulmonary signs or symptoms
Electrolyte and Renal function test (RFT)	<ul style="list-style-type: none"> • Patients with kidney disease, diabetes mellitus, hypertension, liver failure and heart failure • Patients taking digoxin, diuretics, ACE inhibitors, or angiotensin receptor blockers
Electrocardiography (ECG)	<ul style="list-style-type: none"> • Patients who have risk factors and are scheduled for intermediate- or high-risk surgery • Patients classified under ASA I with major or complex surgery, people aged over 65 • Patients with known Heart disease, CHF other risk factors for cardiac disease • Diabetes, hypertension, morbid obesity • Patients with signs and symptoms of cardiovascular disease
Coagulation Profile Tests (PT, APTT, INR)	<ul style="list-style-type: none"> • Patients with chronic liver disease having intermediate or major or complex surgery • Patients on anticoagulation therapy • A bleeding history, including detail of family history, previous excessive post-traumatic or post-surgical bleeding • A known or clinically suspected bleeding disorder
Echocardiography	<ul style="list-style-type: none"> • Known or suspected valvular heart diseases with important clinical manifestations • If person has a heart murmur and any cardiac symptom or signs or symptoms of heart failure (breathlessness, pre-syncope, syncope or chest pain) • If thyroid dysfunction is suspected • If TSH is low, order FT3 and FT4 • If TSH is high, order FT4 only
Thyroid function test (TFT)	<ul style="list-style-type: none"> • brain tumor, • Arteriovenous malformations • Lymphadenopathy • Disc pathology • Complex bone fracture • screening colon and lung Cancer
Computed tomography (CT) Scan	<ul style="list-style-type: none"> • patients having vascular anomalies • tumors and masses • neurodegenerative disorders and dementias • pituitary fossa pathology • cardiomyopathy
Magnetic resonance imaging (MRI)	

Table 3
ASA physical status classification system (2020).

ASA Physical Status Classification	Definition
ASA I	A normal healthy patient like Healthy, nonsmoking, no or minimal alcohol use
ASA II	A patient with mild systemic disease like well-controlled DM/HTN, mild lung disease
ASA III	A patient with severe systemic disease Such as Poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40)
ASA IV	A patient with severe systemic disease that is a constant threat to life like shock, sepsis

electrolytes, or urine analysis in asymptomatic subjects without a history of renal disease or electrolyte disorder [9,13,36]. It is reasonable to consider electrolyte and renal function test (RFT) in patients who have exposure to nephrotoxic agents, or require cardiac risk stratification like revised cardiac risk index and also for patients having hypertension, renal disease, diabetes, pituitary or adrenal disease, digoxin or diuretic therapy, or other drug therapies affecting electrolytes [13,16,17].

5.5. Coagulation profile tests

A systematic review shows that there is no valid evidence suggesting that routine preoperative coagulation testing that lead to a change in clinical management or outcome in asymptomatic patients [9].

A clinical practice guidelines recommend that coagulation studies should be performed in patients with active bleeding, a known or clinically suspected bleeding disorder, medication risk (e.g., anticoagulant), prolonged biliary obstruction, liver disease, history of abnormal bleeding, malnutrition, known history of anticoagulation abnormalities or other conditions associated with acquired coagulopathies [5,13,16,31]. It is recommended that bleeding risk should be assessed based on personal and family history of hemorrhagic diathesis, and based on physical examination [13,37,38].

5.6. Echocardiography

A clinical practice guidelines show that in asymptomatic patients without signs of cardiac disease or electrocardiographic abnormalities, routine echocardiography is not recommended in patients undergoing intermediate or low-risk surgery [13,14,18]. It is recommended for patients with clinically suspected moderate or greater degrees of valvular stenosis or regurgitation will undergo preoperative echocardiography if there has been either no prior echocardiography within 1 year or a significant change in clinical status or physical examination since last evaluation [14,32]. It is reasonable for patients with dyspnea of unknown origin to undergo preoperative evaluation of left ventricular (LV) function [32]. Clinical and echocardiograph evaluation is recommended in all patients with known or suspected valvular heart disease (VHD), who are scheduled for elective intermediate or high-risk non-cardiac surgery (Table 4) [13,14,32]. Resting echocardiography is considered if

Table 4
Grades of surgery.

Minor	Intermediate	Major or complex
✓ excising skin lesion	✓ primary repair of inguinal hernia	✓ Total abdominal hysterectomy
✓ draining breast abscess	✓ Excising varicose veins in the leg	✓ endoscopic resection of prostate
	✓ Tonsillectomy or adenotonsillectomy	✓ Lumbar discectomy
	✓ knee arthroscopy	✓ Thyroidectomy
		✓ Total joint replacement
		✓ Lung operations
		✓ Colonic resection
		✓ Radical neck dissection

the patient has a heart murmur and any cardiac symptom (including breathlessness, pre-syncope, syncope or chest pain) or signs or symptoms of heart failure [5].

5.7. Thyroid function test (TFT)

A clinical practice guideline recommends that thyroid stimulating hormone (TSH) alone is an appropriate first test for people in whom thyroid dysfunction is suspected. Subsequent tests are only needed if TSH is abnormal. Free thyroxin (FT4) is considered if the TSH suggests hypothyroidism and both FT4 and FT3 are considered if the TSH suggests hyperthyroidism. This approach reduces unnecessary testing compared with simultaneous TSH, FT4 and FT3 testing for all patients. However, tests should be done in a way to minimize potential delays and the need for additional appointments. Tests may need repeating when new symptoms develop or worsen, but this should not be within 6 weeks of the last test because this is unlikely to provide new information [20].

5.8. Computed tomography (CT) scan

A systematic review and meta-analysis shows that computed tomography (CT) scan is indicated in cancer screening, staging and follows up like brain tumor, arteriovenous malformations, and detection of significant coronary artery disease [39]. CT scan is also recommended as the essential technique in the initial assessment of patients with lung cancer suspicion [40] lymphadenopathy, disc pathology, and complex bone fracture, and for screening colon and lung cancer. CT scan is used to guide in tissue extraction from different organs to take biopsies adequately and to assist during surgical procedures [41–43].

5.9. Magnetic resonance imaging (MRI)

Magnetic resonance imaging (MRI) has a particular use in neurosurgery, where it has improved the safety and outcomes for tumor resection, epilepsy surgery and the insertion of deep brain stimulators [44].

A systematic review and meta-analysis recommends that MRI is indicated in patients having vascular anomalies, tumors and masses, neurodegenerative disorders and dementias, pituitary fossa pathology [45] multiple sclerosis (MS), cerebrovascular disease, neuro-oncology, epilepsy and neurodegenerative diseases [44], and cardiomyopathy [46].

6. Areas of controversy

There are areas of controversies in evidences regarding to ordering preoperative ECG related with aging, the Brazilian society of cardiology, 2011 stated that preoperative ECG is recommended for all patients older than 40 years [13]. Other evidence based guidelines suggested that ECG is indicated for all patients aged 65 and over which is strongly recommended [5,14].

7. Limitation of the review

This review provides evidence-based recommendations on preoperative investigations for patients awaiting surgery in a resource limited setting. This review will guide the physicians to order an appropriate preoperative laboratory investigation.

However, this review was conducted from different articles that are not homogenous in methods and study type. Moreover, this work emphasizes on the qualitative review of recommendations on ordering of preoperative investigations. Therefore, we recommend future researchers to conduct a meta-analysis of studies on ordering of preoperative investigations before surgery.

8. Conclusion and recommendation

Preoperative laboratory investigations have a direct influence on anesthetic and surgical management, but often are requested as a routine rather than medical necessity. The routine tests other than escalating cost of surgical care have no benefit to patients. The decision to order preoperative tests should be guided by the patient's clinical history, co-morbidities, and physical examination. Patients with signs or symptoms of certain types of disease should be evaluated with appropriate testing, regardless of their preoperative status.

Clinical guidelines recommend that health care providers should consider patients' clinical risk factors when deciding whether or not to use preoperative testing. Selective test ordering reduces the number and cost of preoperative investigations. Pre-operative testing based on the clinical condition of the individual patient will give significant financial benefits without compromising patient safety and quality of healthcare. Ordering preoperative investigations based on recommendations of guidelines is very essential (Table 2). Therefore, adherence to evidence-based working protocol on preoperative investigation is important to have efficient and good surgical outcome.

Ethical approval

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Author contribution

Admass BA, Tawye HY, BY Ego and Ahmed SA developed key questions and keywords, analyzed the results of the search, prepared and revised the manuscript. All authors approved the final manuscript for publication.

Registration of research studies

1. Name of the registry: reviewregistry
2. Unique Identifying number or registration ID: reviewregistry1405.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): <https://www.researchregistry.com/browse-the-registry/#registryofsystematicreviewsmeta-analyses/>.

Consent

Not applicable.

Guarantor

Biruk Adie Admass, Hailu Yimer Tawye, Berhanu Yilma Ego and Seid Adem Ahmed are all responsible for this work.

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Declaration of competing interest

No conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2022.104777>.

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