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Review

Postoperative fatigue (POF): An underestimated complication after surgery

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Abstract

Background Postoperative fatigue (POF) is a prevalent yet underestimated complication after surgery, significantly affecting patients' recovery, daily functioning, and overall quality of life. As one of the most common and distressing postoperative symptoms, POF can persist for months, placing a substantial burden on patients, their immediate environment, and the healthcare system.
Objective This narrative review explores the definition, incidence, and clinical significance of POF, examines its underlying processes, and discusses the role of anesthetists in its management.
Methods A comprehensive analysis of the literature was conducted to evaluate the incidence, clinical relevance, contributing factors, and pathophysiology of POF, its assessment methods, and potential management strategies.
Results POF is a highly prevalent condition influenced by psychological, sociocultural, and biological factors. Proposed mechanisms include the inflammatory surgical stress response, perioperative muscle catabolism, psychological distress, and the influence of patient expectations. Nonetheless, the precise pathophysiological pathways remain incompletely understood and warrant further investigation. While multiple fatigue questionnaires are available, each comes with advantages and limitations. Potential strategies for reducing POF, such as prehabilitation, nutritional optimization, and tailored anesthetic techniques, show promise, but direct evidence supporting their efficacy remains limited.
Conclusion Future research should focus on elucidating the underlying mechanisms of POF, developing standardized assessment tools to identify high-risk patients, simplifying postoperative follow-up as well as early detection, and evaluating evidence-based strategies for prevention and management of POF. Enhancing the recognition and management of POF may improve postoperative outcomes, overall recovery, and patients' quality of life after surgery while decreasing healthcare expenses.

Keywords: **Postoperative complications, fatigue, anesthesia, perioperative care, muscle weakness.**

Introduction

Postoperative fatigue (POF) is a common yet often overlooked complication after surgery, significantly affecting patients' recovery, daily functioning, and overall quality of life[1-3]. Despite advancements in surgical and anesthetic techniques as well as perioperative care, POF remains one of the most frequently reported postoperative symptoms, sometimes persisting for months after surgery[2-4]. Unlike pain, which is routinely assessed and managed in the perioperative period, fatigue is less systematically addressed, even though it can be equally or even more distressing[3,4].

POF is a multifaceted experience influenced by a complex interplay of psychological, social, cultural, and biological processes[5]. Mechanisms such as the inflammatory surgical stress response, muscle wasting, emotional distress, and patient expectations all contribute to its development[5]. However, the exact causes and pathways leading to POF remain incompletely understood. Additionally, POF varies among surgical populations, with some surgical groups experiencing higher fatigue levels than others[2].

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The lack of standardized assessment methods and targeted interventions further complicates the management of POF[6]. Although several fatigue measurement tools exist, there is no consensus on the most effective approach for routine clinical use. Moreover, while strategies such as prehabilitation[7-9], nutritional optimization[8,10], and tailored anesthetic techniques[11,12] show promise in reducing POF, direct evidence linking these interventions to a reduced incidence of POF remains limited.

This narrative review explores the definition, incidence, and clinical significance of POF. It investigates its underlying pathophysiological mechanisms and discusses the role of the anesthetist in its prevention and management. It also highlights existing knowledge gaps and outlines the possible directions for future research needed to improve the recognition and management of POF, ultimately improving postoperative outcomes, enhancing overall recovery, and patients' quality of life after surgery.

Methods

For this narrative review, relevant literature was gathered through a broad search in academic databases, including PubMed and Embase. Search terms included, among others, postoperative fatigue, perioperatively acquired muscle weakness, surgical stress response, fatigue assessment, and fatigue questionnaires. As this is a narrative review, no predefined search strategy, or formal inclusion and exclusion criteria were applied. Additionally, the reference lists of key publications were screened to identify further relevant sources. This approach ensured the inclusion of both recent and relevant studies within the scope of this review. The search covered articles published up to April 2025.

Understanding postoperative fatigue

Definition and characteristics

POF is a subjective experience following surgery, often described as a sense of exhaustion, weakness, or overwhelming tiredness, being physical, mental, and emotional[1,2,13]. When present, POF is often reported by patients as one of their most severe and distressing postoperative complaints[3,4]. It may be characterized by intense fatigue, difficulty concentrating, an increased need for rest, excessive sleepiness or drowsiness, a general lack of energy, or a combination of these symptoms[3,14].

Incidence

POF is one of the most prevalent yet most underestimated and overlooked postoperative symptoms following surgery, impacting a wide range of surgical patients. Notably, when asking patients actively, POF is reported more often than any other postoperative symptom, including pain3. It often persists beyond the acute recovery phase, with a significant prevalence still observed 3 to 6 months postoperatively[1,2,5,15,16]. It is especially highly prevalent following major abdominal, gynecological, and cardiac procedures, as well as following minor surgeries, though it appears less common following orthopedic surgery[2,17]. In patients who underwent major abdominal surgery, research has shown that 92% of patients experienced some level of fatigue immediately after surgery, with 10% feeling fatigued up to 3 months later[18]. In a cohort of patients undergoing major gynecological surgery, specifically hysterectomy, 74% reported moderate to severe fatigue within the first few weeks postoperatively. By 2 months after surgery, 29% continued to experience moderate fatigue, while 12% reported severe fatigue. On average, fatigue persisted for approximately 6 months in this group[3]. In a surgical cohort of patients undergoing coronary artery bypass grafting, 54% of patients reported fatigue 3 weeks postoperatively, with 30% of patients still reporting some degree of fatigue up to 6 weeks postoperatively[19].

Clinical relevance

Despite its high prevalence and severe impact on overall recovery, POF remains a largely ignored complaint in clinical practice. In the postoperative trajectory, anesthetists and other healthcare providers mainly focus on managing acute postoperative pain, postoperative nausea and vomiting (PONV), and immediate surgical complications. Hereby, it is important to note that pain intensity, PONV, and quality of recovery are all part of the standardized endpoints in perioperative care, which were recently updated, but there is no outcome assessor related to fatigue as part of the defined endpoints[20]. POF is highly prevalent and clinically relevant due to its profound physical and emotional impact. Patients experiencing POF report a general sense of sluggishness, overwhelming tiredness, a significantly reduced energy level, and the frequent need to rest between tasks[1-3,14]. This fatigue moderately to severely affects patients' ability to complete daily activities and is the symptom reported to interfere most with daily routines such as housekeeping, family care, and returning to work, all of which can lead to feelings of frustration, hopelessness, difficulty concentrating and mental fog[1-3,14].

Besides its physical and emotional impact, POF also has socioeconomic consequences. Many patients experiencing fatigue postoperatively face extended absence from work, greater dependence on caregivers and healthcare resources, and, in some cases, even prolonged hospital stays[2,3]. However, evidence and available research on the implications of POF are limited due to its underrecognized nature. These factors highlight the broad implications of POF beyond individual well-being. To fully understand the burden of POF in terms of physical and emotional impact as well as socioeconomic consequences, further research is needed.

Underlying mechanisms of POF

The exact mechanisms underlying POF remain poorly understood. The concept from Christensen has been the most widely accepted for a long time. Christensen's concept proposed that POF results from a combination of factors, namely the catabolic effect of the surgical stress response, reduced nutritional intake, and decreased physical activity[21,22]. However, this concept solely addresses the biological aspect. Since POF is defined as a collection of physical and physiological symptoms, the underlying mechanisms are thought to be multifactorial, involving an interplay of psychological, sociocultural, and biological processes. An overview is shown in Figure 1[1,5].

Mechanisms: POF and psychological processes

The psychological processes of POF are a complex interaction of emotional states, individual expectations, and cognitive interpretations of symptoms[5,23-25]. Somatization is one explanation for POF1, 5, 25. After surgery, patients may experience fatigue due to the stress of hospitalization, limitations in mobility, and general pre- and perioperative anxiety[23,25,26]. These emotional responses can be interpreted by patients as physical fatigue[1].

Additionally, cognitive-behavioral factors, such as how patients interpret their symptoms, their beliefs about recovery, and their coping mechanisms, influence POF[1,18,25,27-29]. Patients who expect surgery to lead to improvements, which is mostly the case in patients undergoing elective orthopedic surgery (i.e., joint replacement surgery) with an expected improvement in mobility, may experience less fatigue due to their optimism about anticipated outcomes[1,5,17,24,25,30]. In contrast, those undergoing surgical procedures with less immediate visible benefits, like abdominal, gynecological, or cardiac surgeries, report feeling more fatigued[1,5,24].

Furthermore, evidence suggests that patients who firmly believe in the importance of staying active generally feel less fatigued in the late postoperative phase, highlighting the power of mindset and motivation in influencing recovery[5]. Interestingly, the expectation of fatigue itself is a stronger predictor of POF than the physical limitations or risks associated with surgery[5,15,31].

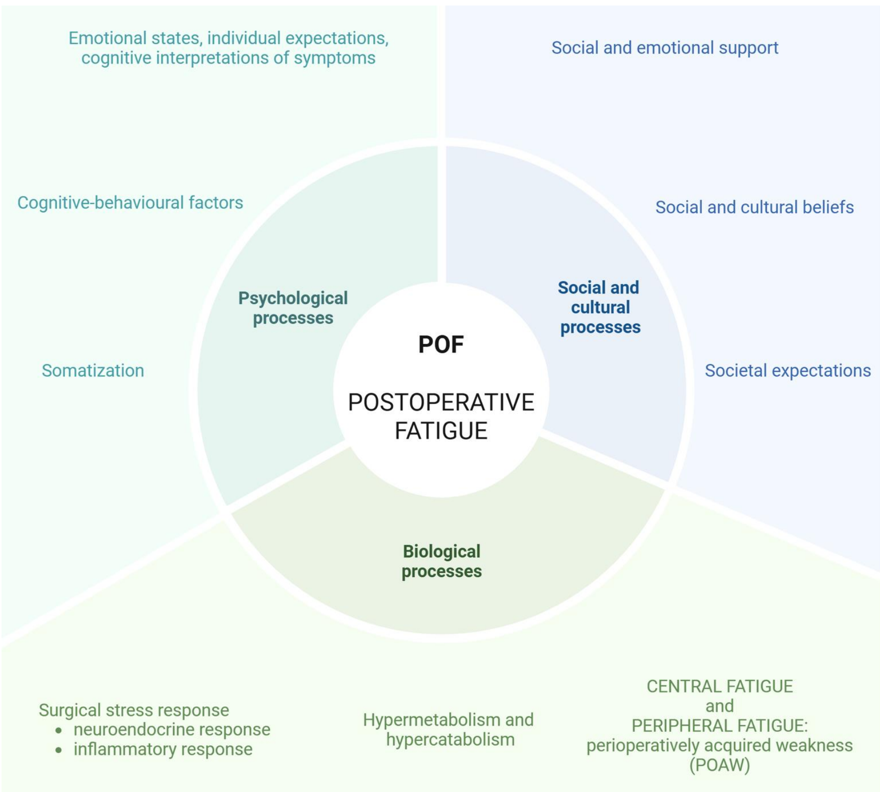

Fig. 1 — Overview of the underlying processes of postoperative fatigue.

Early fatigue may be linked to somatization, as patients respond to the stress of surgery by interpreting negative emotions as physical tiredness. In contrast, fatigue that persists into the later stages of recovery may be influenced more by cognitive-behavioral factors as patients manage their symptoms and the recovery process. This interplay between psychological and motivational factors suggests that POF is not solely a physical response to surgery but is also closely linked to a patient's emotional and cognitive response to their surgical experience[1,5,15,25,32].

Mechanisms: POF and social and cultural processes

Social and cultural processes also significantly influence the experience of POF, affecting patients' recovery after surgery[1,5,25]. Social support, often considered beneficial in recovery, plays a complex role. While emotional support from family and friends can enhance a patient's sense of well-being, it may unintentionally reinforce a slower recovery by encouraging patients to rest more or avoid physical activity due to concerns of their relatives for their well-being. Research has shown that while higher social support correlates with better emotional outcomes, it has not been conclusively linked to reduced POF and, in some cases, can even contribute to greater fatigue if it promotes inactivity[1,5,25,33-36]. Culturally, patients and healthcare providers often perceive fatigue as an inevitable part of major surgery, reinforcing the expectation that a prolonged recovery is normal[5,25]. This expectation can create a feedback loop, where the assumption of prolonged fatigue influences patient behavior, resulting in delayed mobilization and prolonged periods of convalescence[5,25].

Thus, POF and prolonged recovery may reflect socially and culturally constructed beliefs about health, rest, and recovery. This suggests that POF is partially reinforced by societal expectations surrounding the surgical experience[1,5].

Mechanisms: POF and biological processes

Surgery induces a surgical stress response, triggering a complex cascade of neuroendocrine metabolic and inflammatory reactions. The degree of this response is determined by factors such as the extent, invasiveness, and duration of the surgical procedure[37-41]. The stress response is characterized by a hypermetabolic and hypercatabolic state, which is a non-specific response in an attempt to maintain homeostasis during the perioperative period37,40,42. This state of hypermetabolism and hypercatabolism is driven by increased levels of catabolic hormones such as catecholamines, glucagon, and cortisol, and results in metabolic changes leading to increased mobilization of energy substrates, including glucose, fatty acids, and amino acids37, 39, 40, 42-44. An overview of these processes is shown in Figure 2.

By activating these processes, the surgical stress response contributes to POF by inducing both central fatigue, as a result of alterations in the functioning of the central nervous system (CNS), and peripheral fatigue, which is related to muscular changes[1,45-49].

Central fatigue is a result of neuroinflammatory responses, neurotransmitter imbalances, and brain-peripheral crosstalk[50-52]. Peripheral inflammatory signals, mainly pro-inflammatory cytokines, influence pathways on the level of the brain through both neural and humoral pathways. Neural transmission via afferent interoceptive fibers, particularly vagal afferents, can trigger changes within the brain, causing subjective feelings of fatigue[50,52]. Direct entry of cytokines through circumventricular organs or blood-brain barrier disruption can induce neuroinflammatory processes in certain brain areas, contributing to the development of fatigue[50,52,53]. Additionally, shifts in neurotransmitter balances, particularly serotonin and dopamine, further influence fatigue. Surgical stress increases CNS tryptophan availability by promoting peripheral lipolysis, potentially leading to elevated serotonin levels in the CNS and inducing feelings of fatigue, reduced motivation, and increased sensitivity to pain and discomfort[45-47,54]. Meanwhile, cytokines influence the synthesis and reuptake of dopamine, leading to decreased dopamine availability in relevant brain regions[55]. This altered balance of neurotransmitters leads to a rise in the central serotonin-to-dopamine ratio, further promoting feelings of fatigue[47]. These mechanisms underscore the complex interplay between inflammatory responses, both peripheral and central, metabolic changes, and CNS functioning in the development of central fatigue.

Peripheral fatigue, also referred to as perioperatively acquired muscle weakness (POAW), is another significant contributor to POF. It is primarily driven by skeletal muscle dysfunction, which is characterized by a reduction in both the maximum force a muscle can produce and overall endurance[48,56,57]. This process is the result of muscle wasting and metabolic changes occurring during the perioperative period. A key factor in this process is surgery-induced protein catabolism[37,40,42-44]. Elevated levels of catabolic hormones promote muscle proteolysis to mobilize amino acids for tissue repair and immune function[37,40]. This muscle breakdown is further accelerated by elevated inflammatory cytokines, such as IL-6 and TNF-α[37,39,40,43,49]. Oxidative stress, nutrient depletion, and prolonged

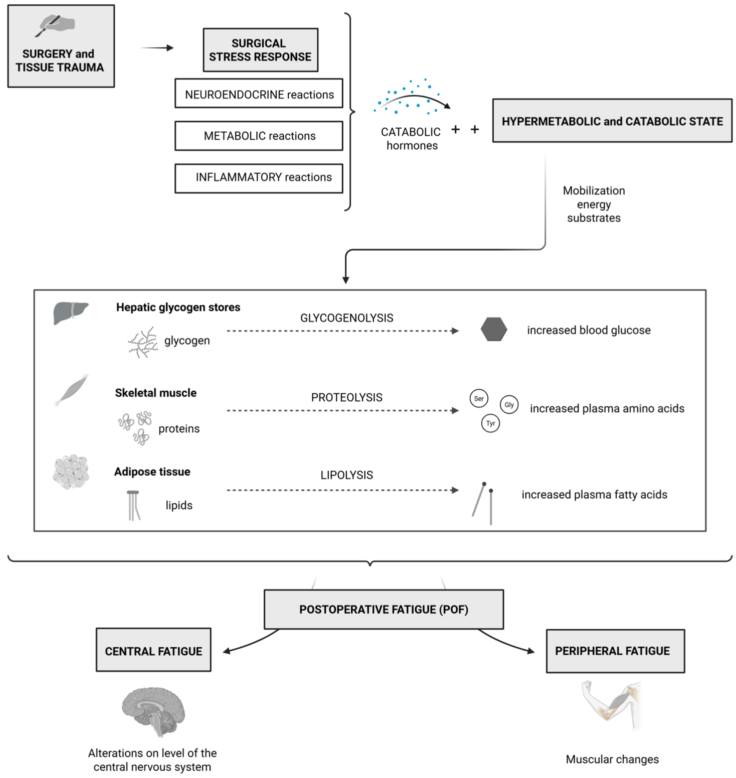

Fig. 2 — Overview of the surgical stress response-induced hypermetabolic and catabolic state.

postoperative immobilization further impact muscle wasting[49,58-62]. Beyond these physiological changes, hormonal imbalances and microRNAs play an essential role in regulating muscle metabolism, more specifically, the balance between muscle catabolism and anabolism, following surgery[49,63-67]. Their involvement highlights the complex mechanisms underlying POAW.

Peripheral fatigue, presented as POAW, is not only a measurable condition following surgery but also a clinically relevant postoperative comorbidity. The significance of POAW in surgical recovery is supported by findings from Lachmann et al., who reported a 16% reduction in handgrip strength following surgery under general anesthesia (GA)[56]. A comparable decline has also been observed in patients undergoing bilateral total hip arthroplasty[11]. Furthermore, in orthopedic surgery, handgrip strength has been shown to predict early ambulation, functional outcomes, and the risk of complications[57,68]. Similarly, in both orthopedic and gastrointestinal surgeries, acute muscle wasting has been associated with increased mortality[68-70].

Should we routinely measure POF, and how?

Given its high prevalence and impact on recovery, routine assessment of POF could be a valuable addition to perioperative care. Despite its significance, POF is often overlooked and rarely assessed systematically, typically overshadowed by more immediate postoperative concerns such as pain and postoperative nausea and vomiting. Integrating fatigue assessment into routine perioperative evaluation could improve patient-centered perioperative care by facilitating the early identification of patients at risk and guiding targeted interventions to reduce the impact and effects of POF. However, fatigue is inherently subjective, as is pain, making consistent definition and measurement challenging[4,14]. It is often considered a multidimensional construct, typically categorized into two main dimensions, namely, physical and mental fatigue[14].

A multitude of fatigue assessment tools and questionnaires exist, ranging from general fatigue scales to more specific postoperative instruments6. Commonly used measures for research purposes include the Postoperative Fatigue Scale (PO-FS)[71], the Christensen Fatigue Scale (ChrFS)[72], and the Chalder Fatigue Questionnaire (CFQ)[14] (Table I).

In 2006, a measure specifically developed for fatigue research was presented, namely the 31-item Identity-Consequences Fatigue Scale (ICFS)[73]. The PO-FS is an abridged version of this scale[71]. It consists of 10 items assessing three dimensions: performance of daily activities, fatigue intensity, and vitality. The PO-FS does not include a mental or cognitive dimension. The scale is scored from

Table I. — Overview assessment tools for POF.

Assessment tool	Dimensions assessed	Ease of use	Applicability to perioperative care
Postoperative Fatigue Scale (PO-FS)	▪ Performance of daily activities ▪ Fatigue intensity ▪ Vitality	Moderate 10 items Scoring from 0-100	▪ Highly specific for postoperative patients ▪ Lacks mental fatigue assessment
Christensen Fatigue Scale (ChrFS)	▪ Physical fatigue	High Simple 1-10 NRS with verbal anchors	▪ Quick and practical screening tool ▪ Lacks mental fatigue assessment ▪ Limited detail for comprehensive fatigue assessment
Chalder Fatigue Questionnaire (CFQ)	▪ Physical fatigue ▪ Mental fatigue	High 11 items on a 4-point scale 7 items physical fatigue 4 items mental fatigue	▪ Well-validated ▪ Sensitive to both physical and mental fatigue ▪ Suitable for perioperative use and outcome tracking

0 to 100, with higher scores indicating greater fatigue severity[6].

The ChrFS is a simple one-dimensional numeric rating scale (NRS). Patients are asked to rate their fatigue on a scale from 1 to 10, with four verbal anchors (fit – slightly tired – tired – fatigued) guiding responses[6,72]. Its primary advantage is its simplicity and ease of use, making it a practical tool. However, due to its focus on physical fatigue, it does not differentiate between different aspects of POF, limiting its use in comprehensive fatigue assessments.

The CFQ is a questionnaire for measuring the extent and severity of fatigue within both clinical and non-clinical populations. It was originally designed for chronic fatigue syndrome (CFS) research and general fatigue assessment in community settings[14]. The questionnaire has been revised and is now being used more widely outside CFS to assess fatigue more broadly and to measure the severity of fatigue or tiredness rather than just CFS[4,14]. As a short questionnaire, phrased in simple language with a straightforward answering system, the CFQ provides a brief tool to measure both physical and mental fatigue. In the questionnaire, 11 items are answered on a 4-point scale ranging from asymptomatic to maximum symptoms, such as ‘better than usual’, ‘no worse than usual’, ‘worse than usual’, and ‘much worse than usual’. The items are grouped into physical fatigue (7 items) and mental fatigue (4 items)[4,6,14]. The global score can be determined using either a bimodal (0-1) or a continuous (0-3) scale. It has been established that when using the bimodal scale (scale range 0-11), a global binary fatigue score of 3 or less represents no fatigue, with scores of 4 or more equating severe fatigue[4,6]. When using the continuous scale (scale range 0-33), a cut-off point of ≥ 16 has been identified for clinically significant fatigue in patients recovering from surgery[6].

While each of these assessment tools has advantages and disadvantages, the CFQ stands out due to its validated nature, its ability to capture both physical and mental fatigue, and, as such, offers the most comprehensive assessment. Furthermore, due to its nature, it is sensitive to changes in fatigue, being in the physical or mental realm, making this questionnaire suitable in clinical settings as an outcome measurement tool in interventional trials. PO-FS is highly specific to the postoperative setting, but needs further validation, and the ChrFS provides a quick single-question screening.

In addition to subjective fatigue scales, objective measures such as handgrip strength testing could complement fatigue evaluation by providing insights into POAW, which is an important contributor to peripheral fatigue[56,74,75].

Integrating these tools into routine perioperative care could enhance recovery monitoring, guide targeted interventions, and ultimately improve postoperative outcomes.

The role of the Anesthesist in PF

Several factors contributing to the development of POF are potentially modifiable, particularly during the perioperative period. Anesthetists play a crucial role in optimizing conditions that may help reduce the onset and severity of POF through various strategies aimed at minimizing the physiological, metabolic, and psychological factors that contribute to fatigue.

Preoperative assessment

A comprehensive preoperative assessment is essential to identify patients at risk for POF, allowing for the implementation of tailored strategies that can minimize its impact[75,76]. Certain patient populations might be more susceptible to developing POF, including patients with preexisting fatigue, sarcopenia, reduced functional status, frailty, advanced age, and multiple comorbidities. Scoring systems such as the ASA (American Society of Anesthesiologists) classification and the Charlson Comorbidity Index (CCI) are routinely used to assess overall surgical risk[77,78], but their direct correlation with POF remains unclear. In addition to routine patient and surgical risk assessments, fatigue-specific tools like the CFQ could provide valuable preoperative information on baseline fatigue levels, potentially aiding in risk stratification and predicting recovery outcomes. Preoperative optimization should include addressing factors such as nutrition, sleep, and anxiety – each of which can significantly affect POF. Additionally, educating patients about the normal course of fatigue and setting realistic expectations for recovery can empower them and help reduce distress related to fatigue during the recovery process[5,24,25].

Preoperative interventions such as prehabilitation, which focuses on improving physical conditioning and muscle strength, can prepare patients for the physical demands of surgery and potentially reduce the severity of fatigue afterward. While prehabilitation has demonstrated benefits in improving functional reserves and facilitating early postoperative mobilization, a direct effect on reducing POF or muscle weakness has yet to be established[7-9,63,79].

Similarly, nutritional optimization, which is a cornerstone of modern perioperative care, ensures that patients receive adequate protein and caloric intake starting preoperatively. This to support metabolic demands and promote muscle homeostasis. The widespread adoption of Enhanced Recovery After Surgery (ERAS) protocols has highlighted the importance of tailored nutritional plans to support recovery[8,10,80]. However, like prehabilitation, the direct impact of nutritional interventions on POF has yet to be demonstrated.

Optimizing anesthesia during surgery

Although surgical techniques are not directly determined by the anesthetist, they do play a crucial role in postoperative outcomes and recovery. Advances in surgical techniques have, together with ERAS protocols, contributed significantly to reducing hospital length of stay, surgical complications, and hospital readmissions[81]. Minimally invasive procedures, such as laparoscopic and robotic-assisted surgeries, are associated with reduced tissue trauma when compared to open procedures, which reduces the inflammatory surgical responses that can exacerbate muscle weakness and contribute to POF[82,83]. But again, a direct impact on POF has yet to be demonstrated.

Notably, the anesthetist can influence postoperative outcomes through the choice of anesthetic regimen. For example, neuraxial techniques such as epidural and spinal anesthesia can dampen the surgical stress response by blocking the neuroendocrine cascade that activates the hypothalamic-pituitary-adrenal (HPA) axis40. In patients undergoing cardiac surgery, thoracic epidural anesthesia combined with GA has been shown to suppress the catecholamine response during cardiopulmonary bypass and up to 24 hours postoperatively[84]. Similarly, in abdominal aortic surgery, epidural anesthesia combined with GA reduces the intraoperative increase in cortisol levels compared to GA alone[40,85]. In patients undergoing hip surgery, combined spinal and epidural anesthesia, when compared to GA, reduces perioperative protein catabolism[12]. It is, however, unknown if this dampening of the stress response and its activated processes results in reduced POF. A proof-of-concept study investigating the effect of spinal anesthesia in patients undergoing hip arthroplasty on POAW, as compared to GA, found that spinal anesthesia reduced POAW, which was linked to a reduction in the stress response[11]. It is unclear if this reduction in POAW also results in reduced POF, therefore, further research is needed. Furthermore, spinal anesthesia is not a feasible anesthetic technique for many major surgical procedures, particularly those associated with a higher risk of POAW and POF.

Given their anti-inflammatory properties and ability to modulate the stress response, corticosteroids might be able to reduce POF[38]. The acute inflammatory response to surgery is often excessive, especially following major surgery, leading to elevated levels of pro-inflammatory cytokines, which contribute to muscle wasting, POAW, central fatigue, and POF in general. By suppressing these inflammatory mediators, corticosteroids could potentially reduce muscle wasting, POAW, central fatigue, and POF in general[38]. Corticosteroids are known to reduce pain, inflammation, and PONV, but their specific impact on POF is unclear[86-88]. Further research is needed to clarify their potential role in reducing POF.

Postoperative management

Postoperatively, anesthetists should actively monitor patients for fatigue and be proactive in the management of POF. This may include optimization of pain management strategies to facilitate early mobilization, which can help reduce fatigue. In addition, ensuring nutritional support postoperatively and early feeding could potentially help in alleviating fatigue[59,89]. Collaborative efforts within a multidisciplinary team, as emphasized by ERAS protocols[90], are essential in maintaining muscle homeostasis and potentially reducing fatigue in the postoperative period.

By integrating these strategies into perioperative care, anesthetists can reduce the risk of POF, thereby improving patient recovery and quality of life after surgery.

Limited evidence on perioperative and anesthetic strategies

Despite the theoretical rationale supporting these perioperative and anesthetic strategies, direct evidence linking these strategies to measurable reductions in POF remains limited. Several factors contribute to this overall scarcity of direct evidence. First, fatigue is inherently difficult to study due to its subjective, multidimensional nature and the lack of a standardized definition and measurement tool. Moreover, POF is often regarded as a normal and expected part of the postoperative convalescence period, which leads to underrecognition and underreporting in both clinical practice and research. Consequently, POF has received significantly less attention than other postoperative concerns such as pain or postoperative nausea and vomiting.

Knowledge and research gaps in POF

While significant progress has been made in understanding POF, there remain several knowledge gaps in the current body of evidence. Research has provided valuable insights into the psychological, social, cultural, and biological mechanisms contributing to POF. However, the exact interplay between these processes, as well as a deeper understanding of the various biological processes involved, remains poorly understood.

Available research focuses on specific surgical populations, particularly abdominal, gynecological, and orthopedic surgical patients, with limited data on fatigue experiences in other surgical groups. Additionally, there is a lack of research exploring POF across different demographic groups, such as patients of different age groups or those with preexisting comorbidities.

Despite growing recognition of POF's significant impact on recovery, targeted interventions to prevent or reduce fatigue remain poorly defined. While preoperative optimization strategies, including tailored nutritional plans, prehabilitation, and specific anesthetic techniques, show promise, direct evidence linking these interventions to a measurable reduction in POF is still sparse. The same is true for perioperative anesthetic techniques and postoperative interventions, highlighting the need for a surge in studies investigating potential perioperative treatments such as corticosteroids for this disabling complication.

Therefore, large and specifically designed trials are essential to guide the integration of POF management strategies into routine perioperative care, ultimately improving patient outcomes, overall recovery, and quality of life after surgery.

Hypothetical study design

To guide future research and address the current lack of systematic data on POF, we propose several hypothetical study designs.

First of all, to evaluate the incidence of POF and its association with quality of life after surgery in a broad range of surgical interventions, we suggest a prospective observational cohort study that assesses fatigue using both subjective and objective measures, specifically the CFQ and HGS testing. Quality of life should be measured with validated questionnaires, such as the Quality of Recovery (QoR) scale and the 5-level EQ-5D-score. Fatigue should be measured preoperatively and at multiple postoperative time points to track its trajectory over time. This study would include a range of surgical populations to allow for a comparative analysis of the incidence of POF and its severity across different patient groups. Inclusion of demographic and clinical variables such as age, baseline characteristics, and comorbidities, would be helpful in the identification of risk factors associated with POF. The results of such studies could help identify high-risk patient groups that may benefit most from targeted perioperative strategies.

Secondly, findings from the observational studies could inform the design of several randomized controlled trials to evaluate the effectiveness of specific perioperative strategies in reducing POF in high risk patient groups. These strategies, outlined in "The Role of the Anesthetist" section may include prehabilitation, nutritional optimization, locoregional or neuraxial anesthetic techniques where feasible, corticosteroids, etc. Patients could be randomized to receive either standard perioperative care or a specific intervention. The primary outcome would again focus on POF, measured using CFQ, as well as measurements of early recovery after surgery and quality of life after surgery.

This stepwise research approach would help gain more evidence on the clinical relevance of POF and the potential of anesthetic and perioperative strategies to improve POF and overall postoperative recovery.

Conclusion

Postoperative fatigue is a highly prevalent yet often underestimated and overlooked concern after surgery that significantly impacts patients' physical and mental well-being. Despite its high prevalence and important burden on recovery, POF remains poorly understood. The underlying pathophysiology of POF involves psychological, social, cultural, and biological processes. While research has provided valuable insights into these mechanisms, critical gaps remain, particularly in understanding the complex interplay between these processes, the relative contribution of each factor, and their influence on other postoperative functional outcomes and overall recovery.

Implementing pre- and postoperative routine fatigue assessment by the CFQ could potentially help detect patients at risk for developing POF and help to identify patients who develop POF early on in the recovery trajectory, since these patients possess a higher risk for postoperative complications and longer hospital stays.

Additionally, while interventions such as prehabilitation, nutritional strategies, and optimized anesthetic techniques show potential in preventing and reducing POF, direct evidence linking these approaches to improved fatigue outcomes is still lacking.

Addressing these knowledge gaps requires further research focusing on diverse surgical populations and demographic groups to establish standardized subjective and objective assessment protocols as well as new evidence-based interventions. Gaining a more comprehensive understanding of POF will allow clinicians, particularly anesthetists, to integrate targeted strategies into perioperative care, ultimately enhancing patient recovery and quality of life after surgery.

Future research should aim to develop personalized and multidisciplinary approaches to POF management, ensuring that fatigue is recognized as a critical component of postoperative recovery rather than an inevitable and ignored consequence of surgery. Proactively addressing the problem of POF will not only benefit individual patients but also reduce healthcare burdens, including prolonged hospital stays, increased need for additional care, and delayed return to work.

A limitation of this review is its narrative nature, which does not follow a formal systematic methodology and may introduce selection bias. However, the narrative approach allowed for a broad, integrative overview of postoperative fatigue, particularly from the perspective of the anesthetist, highlighting clinical relevance, assessment methods, and practical considerations.

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