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Frailty and Short-Term Mortality Following Emergency Laparotomy: Identifying Predictors of Potentially Futile Surgery

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Abstract:

Frailty is an important determinant of outcomes following emergency laparotomy, especially in the older population more prone to having reduced physiological reserve. This review explores the association between frailty and postoperative mortality and morbidity, compares commonly used frailty assessment tools, and examines its role in perioperative risk prediction and identification of potentially futile surgery. Current evidence consistently demonstrates that frailty is associated with increased 30-day, 90-day and one-year mortality, major postoperative complications, prolonged

hospitalisation, functional decline, loss of independence, and discharge to higher levels of care. Frailty can also provide prognostic information beyond chronological age and conventional risk models such as NELA and P-POSSUM, supporting its incorporation into routine perioperative assessment. Importantly, frailty should be used as to inform multidisciplinary decision-making, shared discussions, perioperative planning, and assessment of expected functional recovery. Current evidence supports a shift from mortality-focused risk assessment towards patient-centred evaluation of survival, independence and quality of life. Further research is required to standardise frailty assessment, integrate it with established risk prediction models, and develop validated approaches for identifying patients unlikely to achieve meaningful benefit from emergency laparotomy.

Keywords: Frailty, Emergency laparotomy, Clinical Frailty Scale, Postoperative outcomes, Surgical futility, Risk prediction

Abbreviations

- ASA - American Society of Anesthesiologists
- CFS - Clinical Frailty Scale
- ELF - Emergency Laparotomy and Frailty
- EmSFI - Emergency Surgery Frailty Index
- mFI - Modified Frailty Index
- NELA - National Emergency Laparotomy Audit
- P-POSSUM - Portsmouth Physiological and Operative Severity Score for the Enumeration of Mortality

Introduction:

Frailty is a multisystem loss of physiological reserve that reduces the ability to tolerate acute and everyday stress, particularly among older adults. It is an important determinant of a patient's ability to withstand surgical intervention and influences postoperative outcomes, and is distinct from multimorbidity. Although conditions such as diabetes, heart failure, and chronic kidney disease do contribute to a reduced physiological reserve, their presence does not necessarily equate to frailty. Conversely, a patient with relatively few diagnosed medical conditions may still be frail, as it reflects the cumulative decline of multiple physiological systems. As these systems function interdependently, progressive deterioration reduces the body's capacity to respond to and recover from physiological stress [2].

One of the principal features associated with frailty is sarcopenia, characterised by loss of muscle mass and strength. This may impair mobility, respiratory function, and postoperative recovery, while increasing the risk of respiratory complications and prolonged intensive care admission. Frailty is also associated with chronic low-grade inflammation, which may impair recovery and increase susceptibility to organ dysfunction. The body's ability to respond appropriately to surgical stress and

maintain physiological homeostasis is further reduced by endocrine changes and impaired immune function. Cognitive impairment is another important component affecting memory, decision-making, adherence to treatment, nutritional intake, and recognition of postoperative complications. Poor nutritional status, which is common among frail patients, may also contribute to muscle weakness, impaired wound healing, and reduced immune function [3].

The clinical importance of frailty becomes particularly evident during emergency surgery because of the limited window to optimize the patient's physiological condition before intervention. Emergency laparotomy is a high-risk procedure (threefold increase in complications and fivefold higher mortality compared with elective surgery) typically performed for life-threatening conditions and it places substantial physiological demands on the body, requiring increased cardiovascular function, activation of immune and endocrine responses, and mobilisation of energy reserves for tissue repair. Patients with adequate physiological reserve can generally adapt to these demands, whereas frail patients may be unable to compensate effectively, and they are more likely to develop organ failure, require prolonged intensive care, and experience higher postoperative mortality. When the risk of death is high and survival may be accompanied by functional deterioration, sustained dependence, or institutionalisation, the potential benefits may be outweighed by the associated burdens, raising the possibility of being a non-beneficial intervention [2].

Several studies have demonstrated a strong association between frailty and adverse surgical outcomes. A systematic review by Leiner et al., involving approximately 562,000 patients, found that frailty was associated with prolonged hospitalisation and increased hospital readmission [2]. These findings suggest that reduced physiological reserve has a substantial influence on recovery following emergency laparotomy. Similar associations have been reported across different countries, institutions, and patient populations, with frail patients consistently demonstrating higher rates of postoperative complications and mortality following emergency surgery. Consequently, preoperative frailty assessment can help clinicians determine the most appropriate treatment strategy and anticipate postoperative needs. Two individuals of the same age may have markedly different levels of physiological reserve, with some older adults remaining functionally independent while others develop frailty at an earlier stage. However, currently audit systems are proving inadequate in assessing quality of life, functional status, and cognition, making it difficult to identify procedures that are unlikely to provide meaningful benefit [1,2,3,8,9].

Discussion:

The Clinical Relevance of Frailty

Frailty is a multidimensional state of reduced physiological reserve and increased vulnerability to physiological stress. Although its prevalence increases with advancing age, frailty should not be considered synonymous with chronological ageing, as individuals of the same age may have substantially different physiological reserves and functional capacities. This distinction is clinically important because frailty incorporates domains such as mobility, functional independence, cognition,

nutritional status, and overall physiological function that are not adequately captured by chronological age or conventional measures of comorbidity [2,4,5]. Consequently, frailty has emerged as an important determinant of postoperative outcomes and provides prognostic information beyond age alone.

A substantial body of evidence demonstrates the association between frailty and postoperative mortality. Leiner et al., conducted a meta-analysis and systematic review, that included 482,000 emergency surgical patients across 21 studies, and deduced that frailty was associated with almost threefolds higher odds of 30-day mortality (OR 2.76, 95% CI 2.21-3.45). When assessed using the Clinical Frailty Scale (CFS), the association was even stronger, with almost four times the odds of 30-day mortality (OR 3.85, 95% CI 2.83-5.24). Frailty was also associated with increased in-hospital mortality, 90-day mortality, prolonged hospitalisation, postoperative complications, greater intensive care utilisation, readmission and functional dependence following discharge [2]. Similarly, a systematic review focusing on older adults undergoing emergency general surgery found that frailty was associated with significantly increased 30-day, 90-day and one-year mortality, as well as postoperative complications, prolonged hospitalisation and greater dependency following discharge [3].

The association between frailty and adverse outcomes is not limited to mortality. A meta-analysis involving more than one million patients across 35 studies found that preoperative frailty was associated with more than twice the risk of postoperative morbidity, together with a sixfold increase in early postoperative mortality and a threefold increase in long-term mortality [4]. Evidence from emergency surgical populations similarly demonstrates substantially higher rates of postoperative complications among frail patients. In a prospective cohort study using the Emergency General Surgery-specific Frailty Index, frailty was associated with a 7.3-fold increase in the likelihood of postoperative complications, whereas chronological age was not significantly associated with complications [7]. These findings reinforce that physiological vulnerability, rather than age alone, is an important determinant of postoperative morbidity.

Importantly, the relationship between frailty and adverse outcomes appears to follow a dose-response pattern. Increasing frailty severity is associated with progressively poorer postoperative outcomes rather than representing a simple distinction between frail and non-frail patients [1-3]. Lee et al. reported that 30-day mortality increased from 11.1% in non-frail patients to 24.0% in mildly frail patients and 27.4% in those with moderate to severe frailty. Similarly, Ramsay et al. demonstrated increasing odds of 30-day mortality with higher CFS scores, while other studies using the Modified Frailty Index (MFI) have reported comparable findings [1,2]. Frailty has also remained independently associated with mortality after adjustment for age, comorbidities and other recognised perioperative risk factors. Youssef et al. reported that patients with a CFS score ≥4 had more than nine times the odds of 30-day mortality after adjustment for age, body mass index and comorbidities (adjusted OR 9.33, 95% CI 3.10-28.05) [1]. This further supports frailty as an independent measure of biological vulnerability rather than simply a marker of older age or comorbidity burden.

The effects of frailty also extend beyond the immediate postoperative period. The use of 30-day mortality as a measure of surgical outcomes is widely accepted, however, it may inadequately account for the long-term consequences of emergency surgery. Patients who survive the initial postoperative period may subsequently experience recurrent complications, readmission, functional decline, increasing dependence, and death. Leiner et al. Documented that frail patients had more than a threefold increase in the odds of 90-day mortality (OR 3.63, 95% CI 2.37-5.57), similarly, evidence from the 2024 BJS Open systematic review reported that higher CFS scores were linked to increased rates of 90-day mortality [1,2]. The increased risk persists into the first postoperative year. Vilches-Moraga et al. reported one-year mortality of 59.5% among patients undergoing emergency laparotomy with CFS scores of 5-9 compared with 28.9% among those with CFS scores of 1-4 ($p = 0.002$). Recent studies have similarly found that frailty is associated with double the risk of one-year mortality, even when accounting for other demographic and clinical factors [1,2].

Frailty is also associated with outcomes that extend beyond survival. Frail patients experience higher rates of major postoperative complications, greater requirements for critical care, prolonged hospitalisation, readmission and discharge to higher levels of care [1-4]. A meta-analysis demonstrated that frail patients undergoing major abdominal surgery were less likely to be discharged directly home and were more likely to require institutional care and subsequent readmission [4]. Functional decline represents another important consequence. Evidence from older surgical populations demonstrates that postoperative complications are associated with increased functional decline, including deterioration in mobility, cognitive function, nutritional status, and activities of daily living [7]. Therefore, the impact of frailty should be considered multidimensional, encompassing mortality, morbidity, functional independence, discharge destination and quality of life rather than survival alone.

These findings have important implications for perioperative risk assessment. Conventional measures such as chronological age, ASA classification and physiological risk scores remain valuable but may not fully capture the reduced physiological reserve characteristic of frailty [2,5]. Frailty assessment can therefore provide additional information regarding a patient's ability to tolerate physiological stress and recover following major surgery. The CFS is particularly useful because it provides a rapid assessment of baseline function, mobility, independence and cognition and can be incorporated into clinical practice without requiring extensive investigations or complex calculations [5,12]. Information obtained through frailty assessment can subsequently inform perioperative planning, including critical care requirements, nutritional support, rehabilitation, discharge planning and discussions with patients and families regarding expected outcomes.

Importantly, identification of frailty should not be interpreted as an automatic indication to withhold surgery. Rather, it provides clinicians with a more comprehensive assessment of the potential benefits and burdens of an intervention. The combination of increased mortality, postoperative morbidity, functional decline, prolonged dependence, and greater requirements for institutional care means that survival alone may not represent a meaningful surgical outcome for every patient [1-4]. Frailty assessment can therefore support shared decision-making by allowing clinicians to provide more

realistic estimates of postoperative survival and recovery and to consider outcomes that are important to individual patients, including preservation of independence and quality of life [2,5].

Overall, current evidence consistently demonstrates that frailty is independently associated with short-term and long-term mortality, postoperative morbidity, functional decline, prolonged hospitalisation, readmission and loss of independence across surgical populations [1-4,7]. Its prognostic value extends beyond chronological age and conventional measures of surgical risk, while increasing frailty severity is associated with progressively poorer outcomes. These findings establish frailty as an important component of perioperative risk assessment and provide the clinical basis for examining its particular relevance in emergency laparotomy, where acute surgical pathology, limited opportunity for optimisation and an increasingly older surgical population may further amplify the consequences of reduced physiological reserve.

Frailty in Emergency Surgery

Along with the ongoing demographic shift towards an ageing surgical population, frailty is increasingly recognized as an important factor among patients undergoing emergency laparotomy. According to the data from the national emergency laparotomy audit (NELA) that included 93,415 patients, the median age of patients who underwent emergency laparotomy was found to be 67 years with 57% of the patients being 65 years or older [9]. This analysis covered NELA years 1 to 4 (1 December 2013-30 November 2017), however recent data reported that there was a higher proportion of older patients undergoing emergency laparotomy, with 64.5% being 60 years of age or older[9]. This demonstrates that an increasing proportion of emergency laparotomy patients are older adults. The UK ELF study protocol similarly underscored that ageing populations are accompanied by increasing levels of multimorbidity, polypharmacy, and cognitive impairment, which contributes to greater complexity in the preoperative and perioperative decision-making [5,7,9].

Patients undergoing emergency laparotomy usually present with frailty, cognitive impairment, physiological decline, sarcopenia, functional impairment, and other age-related syndromes. Observational analysis from NELA demonstrated that these factors contribute to poorer postoperative outcomes compared with younger patients [9]. A higher American Society of Anesthesiologists (ASA) grade, hypoalbuminaemia, and predicted 30-day mortality exceeding 5% observed in Older adults reflect their physiological vulnerability. Predicted mortality also increases progressively with age, with up to 94% of patients aged 85 years or older classified as high risk according to the NELA risk model [9]. Increasing frailty severity further reduces physiological reserve and is associated with progressively greater operative risk [7]. This reinforces the importance of distinguishing frailty from chronological age, as even with individuals of similar ages the physiological vulnerability is not guaranteed to be uniform

Frail patients are disproportionately represented in emergency laparotomy cohorts due to their limited ability to withstand acute surgical stress which is driven by their reduced physiological reserve [5,7]. Patients undergoing emergency laparotomy may present with a wide range of physiological disturbances depending on the underlying pathology, making this a heterogeneous population [10]. Despite this heterogeneity, frailty should be considered an independent indicator of surgical risk and formally assessed during preoperative evaluation [10]. Available evidence consistently demonstrates that frail patients have greater vulnerability and therefore require early identification followed by appropriate multidisciplinary management [5,7,10]. Nevertheless, the challenges that are encountered in the rapid and consistent application of frailty assessment in emergency settings alongside the availability of frailty assessment tools, include acute presentation, time restraints, insufficient clinical information, and the impracticality of obtaining more detailed frailty variables during an emergency admission[1,2,3,8,9].

The CFS, adopted by the ELF study, defines a score of ≥5 as frailty and it indicates a reduced physiological reserve leading to increased vulnerability [5]. The existing guidance by NELA recognises that frailty is an independent marker of high surgical risk, especially with regard to postoperative complications and mortality [7,10]. Frailty assessment has been recommended for patients aged 65 years and older undergoing emergency laparotomy using validated tools such as the CFS [10]. Importantly, NELA further emphasises that patients living with frailty should be considered high-risk despite not meeting the 5% calculated mortality risk threshold [10]. This reflects the limitations of conventional risk models, which may not fully capture functional vulnerability, cognitive impairment, physiological reserve, or the likelihood of recovery following surgery.

Although there is an increased recognition of fragility, this does not invariably guarantee specialist perioperative care. Approximately one-third of older or frail patients are fortunate to currently receive specialist geriatrician input following surgery. This highlights a disparity between identifying high-risk frail patients and the multidisciplinary care attained by these patients that is required to manage their increased vulnerability. Additional obstacles that prevent effective implementation include inadequate care pathways, shortages in the workforce, limited access to geriatricians and advanced practitioners, especially outside regular working hours, funding constraints, and the need for further multidisciplinary training among surgical, anaesthetic, and geriatric teams. Therefore, the evidence indicates that for an improved use of frailty assessments routine screening alone is insufficient and should be complemented with appropriate integration of its findings into surgical decision-making, informed consent, post-operative planning, rehabilitation and the allocation of perioperative resources [1,2,3,8,9,10].

An additional limitation in the current evidence base is the incomplete description of patients who are considered for emergency laparotomy but ultimately managed non-operatively. NELA has emphasized that these patients may be classified under categories such as non-operative emergency laparotomy instead of high-risk populations [9]. Their exclusion from operative cohorts is important when interpreting improvements in operative mortality, as reported operative mortality represents patients

who ultimately underwent surgical intervention and does not capture those considered for surgery but managed without an operation [9]. Better characterisation of this population may therefore provide important information when evaluating the full spectrum of emergency laparotomy decision-making and the potential benefits and limitations of operative treatment.

With the continued aging of the emergency surgical population, the integration of frailty assessment into emergency laparotomy guidelines is a crucial step in achieving accurate risk stratification and informed surgical decision-making. However, effective implementation requires more than identifying frailty; assessment findings must be translated into multidisciplinary care, appropriate resource allocation, realistic counselling, and postoperative planning [7,10]. The continuing gap between recognition of frailty and delivery of specialist care, together with the underrepresentation of non-operatively managed high-risk patients in current datasets, demonstrates important limitations in existing emergency laparotomy pathways and provides a basis for further evaluation of frailty in predicting postoperative outcomes and potentially non-beneficial surgery.

Comparison of Frailty Assessment Tools

There are multiple frailty assessment tools, but no single gold standard instrument has been universally established. Mostly the evidence is taken from observational studies. According to studies it involved different patient groups still the results were similar, frail patients had worst outcomes after the surgery. And this suggests that frailty is closely linked with the worst surgical outcome. Incorporating frailty assessment before emergency laparotomy therefore provides an opportunity to identify high-risk patients, anticipate intensive care and nutritional needs, plan rehabilitation and discharge, and facilitate more informed discussions with patients and their families regarding expected outcomes [2]. Several frailty assessment tools have been developed using different conceptual models, including clinical judgement, cumulative health deficits, functional impairment, and comorbidity burden. The assessment tool should provide accurate information and also it should be fast and practically for bedside use. Mostly in the emergency situation where decisions must be made within a particular time frame.

Clinical Frailty Scale (CFS)

The most widely used frailty assessment tool in emergency situations is CSF. It assesses baseline functional status, mobility, independence, cognition, and fitness of the patient, generating a score from 1 (which the patient is very fit) to 9 (where patient is terminally ill) [12]. Unlike chronological age, the CFS provides an overall assessment of physiological vulnerability and functional reserve. Because it used routine clinical information to proceed, it allows rapid bedside assessment and allows the physician to take rapid decisions in emergency situations.

According to scoping review which was by Church et al. it showed 183 studies and found that CFS identified clinical outcomes in 74% of cases, including mortality, complications, functional decline, cognition, mobility, and duration of hospital stay.Mortality was the most frequently predicted

outcome, with predictive associations reported in 87% of relevant studies [12]. Across diverse healthcare settings this study supports the clinical utility of CFS.

There is also substantial evidence supporting its use specifically in emergency laparotomy. In the multicentre ELF study, the CFS was selected as the sole frailty assessment tool because of its simplicity and ease of use [5]. Alder et al. demonstrated that patients with a CFS score ≥5 had significantly higher short- and intermediate-term mortality following emergency laparotomy. The predictive performance of the CFS improved further when combined with P-POSSUM, achieving an AUROC of 0.89, demonstrating the complementary value of frailty assessment and conventional surgical risk models [6].

NELA confirms the use of the CFS in routine emergency laparotomy practice. Current guidelines recommends that the patients aged 65 years and older should do frailty assessment using CSF before emergency laparotomy [10]. According to the 2024 report frailty was assessed in 84.8% of eligible patients, indicating that frailty assessment was widely used across the national audit. Frailty was also recognised as an independent indicator of high operative risk requiring enhanced perioperative management [10].

Modified Frailty Index (mFI)

The mFI is available in an original 11-item version (mFI-11) and an abbreviated 5-item version (mFI-5). It measures predefined comorbidities and functional impairments using cumulative deficit model. mFI provides useful prognostic information but still it relies on availability of detailed clinical and comorbidity data. Therefore in emergency laparotomy, incomplete medical information and the need for quick decisions makes it difficult to use routinely at bedside. Hence it is more used in research and retrospective risk modelling than clinical decision making.

Emergency Surgery Frailty Index (EmSFI)

EmSFI was introduced specially for emergency surgical populations by adding variables linked to chronic frailty and acute surgical presentation. As it was designed for emergency situation, it may be useful for identifying risk in these patients. However, it requires assessment of multiple clinical variables and is consequently more time-consuming and complex to calculate than the CFS. Limited external validation has also restricted its incorporation into emergency laparotomy guidelines compared with the CFS.

Comparative Predictive Accuracy and Practical Application

Frailty assessment tools can identify patients at high risk of poor outcomes after the surgery but they differ in how convenient they are to use in clinical practice. CSF shows strong predictive performance for mortality, post surgical complications, long stay in hospitals, and functional decline while needed only for rapid bedside assessment. When it is combined with established surgical risk scores like P-

POSSUM [6]. According to different studies in healthcare settings it shows that it consistently predicts the outcomes and supports its use in clinical practice [12].

The difference between both mFI and EmSFI is that mFI needs detailed clinical information about the patients condition which may not always be available in emergency situation, and EmSFI is specially designed for emergency surgeries but requires more information and has been studied less. Therefore both the tools are less suitable for routine emergency laparotomy assessment.

In conclusion, still emergency laparotomy needs rapid risk assessment despite limited time and incomplete medical history. Frailty tools which requires very less information and less resources are more practical at the bedside use than which requires detailed information and complex calculations. The CSF provides a good balance of simplicity, rapid bedside use, prognostic performance, validation. The mFI and EmSFI may still use in for research and comprehensive risk modelling but current study shows CSF is the best tool for routine frailty assessment in emergency surgery.

Integrating Frailty into Risk Prediction Models

Predicting risk in emergency laparotomy has traditionally used scoring systems such as the National Emergency Laparotomy Audit (NELA) and the Portsmouth Physiological and Operative Severity Score for the Enumeration of Mortality (P-POSSUM). These models uses the information like patients history to estimate the risk of death and helps the physician for decision making. However, they do not fully capture the reduced physiological reserve and functional vulnerability associated with frailty, which has emerged as an important independent predictor of postoperative outcomes [8].

The importance of incorporating frailty into risk assessment is recognised by NELA. The Ninth NELA Patient Report documented preoperative mortality risk assessment in 84.6% of patients during the 2021–2023 audit period. Although NELA classifies patients with a predicted mortality risk of ≥5% as high risk, it also recommends routine frailty assessment using the CFS in patients aged 65 years and older. Importantly, patients living with frailty should be considered high risk even when their calculated mortality risk is below the 5% threshold [10]. This reflects the potential for conventional risk models to underestimate vulnerability in patients whose physiological reserve is reduced despite having a lower calculated mortality risk.

Evidence suggests that frailty provides prognostic information beyond conventional risk scores. Youssef et al. found that frailty, defined as CFS ≥4, was the strongest predictor of 30-day mortality following emergency laparotomy, with an adjusted odds ratio of 9.327 (95% CI 3.101–28.054; $p<0.0001$). This exceeded the predictive contribution of the NELA score, P-POSSUM, and ASA classification. Frail patients also had substantially higher 30-day mortality than fit patients (41.7% vs 4.0%). Notably, chronological age was not an independent predictor after adjustment, further supporting the importance of physiological reserve rather than age alone [8].

Frailty should therefore be viewed as complementary to, rather than a replacement for, established risk prediction models. NELA and P-POSSUM provide information regarding physiological derangement and operative severity, whereas frailty assessment provides additional information about baseline functional status, physiological reserve, and the likely ability to tolerate and recover from surgical stress. Combining these domains may therefore provide a more comprehensive assessment of risk than either approach alone [8,10]. This is really important in emergency laparotomy, where decisions about surgery and postoperative critical care often needs to be done quickly.

The value of frailty assessment also extends beyond improving the accuracy of mortality prediction. Estimating the risk help with discussions about surgery, postoperative critical care, consultant involvement, and recovery. Assessing frailty helps physician to explain the risk of the surgery, postoperative complications, death and have a shared decision making with the patient and families [8]. In specific patients when surgery is unlikely to provide meaningful benefit then non-operative or palliative care can be discussed which can be effective. Frailty should not, however, be used as an isolated determinant of whether surgery is offered.

Frailty assessment can also guide the organisation of perioperative care once a high-risk patient has been identified. Early recognition may facilitate involvement of geriatricians, anaesthetists, physiotherapists, dietitians, specialist nurses, and rehabilitation teams, while allowing clinicians to anticipate increased requirements for critical care, nutritional support, rehabilitation, and discharge planning [8,10]. For the frail patients the 2024 NELA report recommends consultant-led care, specialist geriatric involvement and appropriate critical care [10]. For this reason frailty assessment helps not only to predicts risk but also to plan right treatment for different patients. Still these recommendations are not followed. NELA reports shows that only one-third of frail or older patients receives specialist geriatric care after the emergency laparotomy [9,10]. This demonstrates the gap between recognising frailty and providing the right care to the patient. On the whole, frailty should be used together with other risk scores rather than using it alone. Frailty gives extra information about the patients health, which may not fully shown by NELA, P-POSSUM or chronological age. Its incorporation may therefore improve risk stratification, perioperative counselling, multidisciplinary planning, and allocation of postoperative resources [8,10]. However, most of the evidence is based on observational study and further research is needed to be done to determine how frailty should be incorporated into existing prediction models and also that interventions based on frailty can directly improve outcomes following emergency laparotomy.

Frailty and the Identification of Potentially Futile Surgery

For older patients living with frailty, emergency laparotomy is one of the highest-risk procedures in general surgery [9,10]. The current evidence presented in this review demonstrates that frailty is consistently associated with mortal postoperative complications, prolonged hospitalisation, functional decline, loss of independence, readmission, and discharge to higher levels of care [1,2,3]. As such, the unfavourable consequences of emergency laparotomy in frail patients extend beyond the patient's

survival of the initial operation. As a result, interest has increased in the concept of a surgery being deemed as a potentially futile surgery, where, surgical futility is defined by perioperative death, and also by the failure to achieve outcomes that are meaningful to the patient, including survival with acceptable functional recovery, preservation of independence, and quality of life [1,2].

The traditional assessment of emergency laparotomy outcomes has focused predominantly on short-term mortality, particularly 30-day mortality [9,10]. However, the evidence discussed above demonstrates that frailty is associated with adverse outcomes extending well beyond this period, including longer-term mortality, complications, readmission, functional decline and increasing dependence [1–4]. Survival at 30 days may therefore not represent a successful outcome if it is followed by permanent institutionalisation, severe disability, or substantial loss of independence. Assessing the potential benefit of emergency laparotomy should consequently consider not only the probability of survival, but also the likelihood of recovery to a level of function that is acceptable to the patient.

Frailty provides an important framework for this assessment because it reflects biological vulnerability and reduced physiological reserve rather than chronological age alone. A frail patient may have a substantially different capacity to tolerate emergency surgery and recover from its physiological consequences compared with a physiologically robust patient of the same age. The prognostic information provided by frailty therefore adds an important dimension to conventional operative risk assessment, particularly when considering the balance between the potential benefits of surgery and its postoperative burden [1,2,3].

This distinction is particularly important when considering potentially futile surgery. A procedure may be technically successful and initially life-saving while still resulting in an outcome that does not represent meaningful recovery for the individual patient. Frailty-associated risks of prolonged hospitalisation, critical care requirements, functional decline, institutionalisation and loss of independence therefore need to be considered alongside operative mortality when determining the potential value of surgery [1–4]. The concept of futility should consequently move beyond a binary consideration of survival or death and towards a broader assessment of whether surgery is likely to achieve an outcome that the patient would consider worthwhile.

Frailty assessment should support this process rather than determine treatment in isolation. The CFS and other validated measures can provide additional information regarding physiological reserve, expected postoperative risk and potential recovery, while established models such as NELA and P-POSSUM contribute information regarding physiological derangement and operative severity [8,10]. Used together, these measures can provide a more comprehensive picture of risk and help clinicians communicate the potential benefits and burdens of surgery more realistically. Importantly, a high frailty score should not automatically be interpreted as a contraindication to surgery. Instead, it should be the cause of greater consideration of likely post operative complications and whether the expected outcomes are in line with the patient's own.

This becomes particularly relevant when discussing goals of care with patients and their families. In patients living with severe frailty, discussions should extend beyond the probability of surviving surgery to include the likelihood of returning home, maintaining independence, recovering functional capacity and achieving an acceptable quality of life [1,2]. Individual patients may place different values on these outcomes, with some prioritising maximal survival while others may place greater importance on independence, comfort, dignity or avoiding prolonged institutional care [2]. Frailty assessment can therefore provide an evidence-based foundation for these discussions while allowing treatment decisions to remain individualised and aligned with patient preferences.

Potentially futile surgery also presents important ethical challenges. Decisions in emergency laparotomy are made within a narrow time frame. Thus there is a tendency to cause friction between the obligation to preserve life and the requirement to avoid interventions that are not beneficial all the while maintaining respect for the patients autonomy [2,3]. The use of frailty assessment can help make this balance more transparent, but clinical judgement and multidisciplinary assessment remain essential. The importance of identifying frailty early on is to ensure that the consequences of treatment are considered alongside its benefits rather than to deny treatment based on a score.

Current limitations and Future directions

Despite the strong association between frailty and adverse postoperative outcomes, current evidence does not allow frailty to be used as a definitive measure of surgical futility. The major limitation is that frailty predicts risk considerably better than it defines benefit. Existing studies demonstrate that frail patients are more likely to die, develop complications and lose independence, but they do not provide a validated threshold at which emergency laparotomy can reliably be considered unlikely to provide meaningful benefit [1,2,11]. Such a demarcation is important as the prediction of a poor outcome and the prediction that an intervention is futile are two separate entities

The lack of standardisation in frailty assessment is also a limitation. Different studies utilise various instruments and thresholds such as, CFS-9, CFS-7, fTRST, modified frailty indices, and Rockwood- and Fried-based approaches [2,11]. Such variation affects the identification and classification of frailty and limits direct comparison between studies. Although CFS demonstrates strong prognostic performance while becoming the most widely used tool for frailty assessment, variations in cut-off values and the difficulty of obtaining qualitative variables with regards to acutely unwell patients remain relevant limitations [1,2]. In emergency surgery, it is of paramount importance as the assessment needs to be rapid and feasible to avoid delays in treatment.

Due to the predominance of retrospective and single center studies over prospective multicentre studies available for external validation, the current evidence is limited [2,11]. Differences in patient age, emergency pathology, healthcare systems and frailty assessment methodology further limit the generalisability of individual findings. Emergency surgery-specific frailty indices can be utilised to effectively identify high-risk patients but across broader populations, require validation to suit including younger demographics with substantial comorbidity [11]. Similarly, conventional risk

prediction tools such as P-POSSUM, ASA and ACS-NSQIP have limitations in capturing long-term mortality, functional recovery, independence and discharge destination, leaving an important gap between prediction of operative risk and assessment of meaningful patient outcomes [11].

The most important limitation therefore remains the absence of a validated model for identifying potentially futile emergency laparotomy. Current evidence supports frailty as a predictor of mortality, morbidity and functional decline and as an important component of patient-centred decision-making, but it does not establish when the probability of meaningful benefit becomes sufficiently low to consider an operation potentially non-beneficial [1,2,11]. The available literature also does not consistently incorporate patient-reported outcomes, independence, institutionalisation, quality of life and functional recovery as core endpoints. As a result, the concept of futility is insufficiently operationalised albeit being clinically relevant.

Future research should go beyond establishing whether frailty predicts poor outcomes and rather, focus on how the information obtained can be utilised into clinically useful decision-making. Large, prospective, multicentre studies should first establish greater consistency in frailty measurement and externally validate the CFS and other relevant instruments across different emergency surgical populations. Frailty should then be integrated with established predictors such as NELA, P-POSSUM, operative severity and physiological derangement to develop robust prognostic models that estimate not only mortality but also the likelihood of meaningful functional recovery. Importantly, future models should incorporate outcomes that matter directly to patients, including survival beyond 30 days, return to usual residence, independence in activities of daily living, functional and cognitive recovery, readmission, institutionalisation and quality of life. Rather than establishing a single frailty threshold at which surgery should be withheld, research should aim to develop transparent estimates of the probability of different postoperative outcomes, allowing these estimates to be interpreted alongside patient preferences and multidisciplinary clinical judgement. Further work should also evaluate whether frailty-triggered interventions, including early comprehensive geriatric assessment, nutritional support, rehabilitation, enhanced discharge planning and appropriate postoperative critical care, can modify the poor outcomes associated with frailty. Consequently, frailty assessment could transition from a prognostic instrument to an actionable competent component of emergency laparotomy pathways seeing as it identifies patients at increased risk, triggering targeted multidisciplinary care, and supporting clearer discussions regarding whether surgery is likely to deliver meaningful benefit.

Overall, frailty provides an important framework for identifying patients at increased risk of poor outcomes following emergency laparotomy and contributes substantially to discussions surrounding potentially futile surgery. Its greatest current value lies not in determining whether surgery should or should not be performed, but in bringing together prognostic information, functional outcomes, multidisciplinary clinical judgement and patient preferences. Establishing validated methods to translate this information into estimates of meaningful surgical benefit remains an important unmet research need [1,2,11].

Conclusion:

Frailty is consistently associated with poorer outcomes following emergency laparotomy, including short- and long-term mortality, postoperative morbidity, prolonged hospitalisation, functional decline, loss of independence, readmission and discharge to higher levels of care [1,2,3]. Unlike chronological age, frailty provides an assessment of physiological reserve and biological vulnerability and therefore identifies aspects of surgical risk that may not be adequately captured by age, comorbidity or physiological derangement alone. The evidence presented in this review supports the routine incorporation of frailty assessment into perioperative risk stratification for older patients undergoing emergency laparotomy.

The clinical value of frailty assessment extends beyond mortality prediction. When combined with established risk models such as NELA and P-POSSUM, it provides additional information regarding a patient's ability to tolerate emergency surgery and recover following an intervention. This can support multidisciplinary planning, appropriate allocation of critical care and rehabilitation resources, and more realistic discussions regarding expected outcomes. Importantly, frailty should not be interpreted as a contraindication to surgery or used as the sole determinant of treatment. Instead, it should inform shared decision-making by considering the probability of survival alongside functional recovery, independence, discharge destination and patient-defined quality of life [1,2,3,9].

The concept of potentially futile emergency laparotomy highlights an important limitation in the current evidence. Although frailty consistently predicts mortality, complications, functional decline and increasing care requirements, there is currently no validated frailty threshold that can reliably determine when surgery is unlikely to provide meaningful benefit [1,2,11]. Variation between frailty assessment tools, differences in diagnostic thresholds, limited prospective multicentre validation, and the incomplete incorporation of patient-centred outcomes into existing risk models remain important barriers. The available evidence therefore supports frailty as a means of informing decisions rather than as a definitive model of futility.

Future research should focus on standardising frailty assessment, integrating frailty with established mortality prediction models, and developing prognostic approaches that incorporate outcomes extending beyond perioperative survival. Independence, functional recovery, discharge destination, institutionalisation, readmission and quality of life should be considered important endpoints rather than secondary findings. Further research should also determine whether frailty-triggered multidisciplinary interventions can modify outcomes and translate risk identification into improved care. Such approaches could provide a more consistent and transparent framework for assessing the potential benefits and limitations of emergency laparotomy while ensuring that decisions remain individualised and aligned with patient preferences.

Ultimately, the role of frailty in emergency laparotomy should extend beyond predicting who is most likely to die. Its greater clinical value may lie in helping determine what survival is likely to look like, whether meaningful recovery is achievable, and whether the expected outcome is consistent with what matters to the patient. Frailty assessment therefore has the potential to bridge the gap between

conventional operative risk prediction and genuinely patient-centred decision-making. NELA's recommendation that frail patients be considered high-risk even when their calculated mortality risk is below conventional thresholds further demonstrates why physiological reserve should be considered alongside predicted mortality [8,10]. The development and validation of a framework capable of translating these risks into meaningful estimates of surgical benefit, while incorporating patient preferences and multidisciplinary judgement, represents the most important remaining research need in this area.

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