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REVIEW ARTICLE

Gastrointestinal Complications in the Postoperative Period of Lung Transplantation: An Integrative Review

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ABSTRACT

Objectives: To investigate the spectrum of gastrointestinal complications (GICs) in patients after lung transplantation (LT), by synthesizing the evidence on prevalence, risk factors, clinical outcomes, and management strategies. **Methods:** An integrative literature review was conducted by searching the PubMed and Embase databases. Selection criteria included observational studies published in the last 20 years that assessed GICs in adult post-LT patients. Following a structured screening process, 19 articles were selected for the final synthesis. **Results:** GICs are highly prevalent, with esophageal dysmotility, gastroesophageal reflux, and gastroparesis being the most reported functional conditions. Esophageal dysmotility emerged as an independent risk factor for acute rejection, while gastroparesis was associated with the development of chronic lung allograft dysfunction. Acute surgical complications, such as perforated diverticulitis and intestinal ischemia, had high mortality rates, especially when managed emergently. **Conclusion:** GICs are frequent events that negatively impact the survival and quality of life of patients undergoing LT. The clinical application of these findings indicates an urgent need for the standardization of screening and early management protocols, with an emphasis on the functional assessment of the esophagus and stomach, to optimize outcomes in this population.

Descriptors: Lung Transplantation; Postoperative Complications; Gastrointestinal Complications; Gastroparesis; Gastroesophageal Reflux.

Complicações Gastrointestinais no Pós-Operatório de Transplante de Pulmão: Uma Revisão Integrativa

Objetivos: Investigar o espectro de complicações gastrointestinais (CGIs) em pacientes no pós-operatório de transplante de pulmão (TP), sintetizando as evidências sobre prevalência, fatores de risco, desfechos clínicos e estratégias de manejo. **Métodos:** Realizou-se uma revisão integrativa da literatura com busca nas bases de dados PubMed e Embase. Os critérios de seleção abrangeram estudos observacionais publicados nos últimos 20 anos que avaliaram CGIs em pacientes adultos pós-TP. Após um processo de triagem estruturado, 19 artigos foram selecionados para a síntese final. **Resultados:** As CGIs são altamente prevalentes, com a dismotilidade esofágica, o refluxo gastroesofágico e a gastroparesia sendo as condições funcionais mais relatadas. A dismotilidade esofágica emergiu como um fator de risco independente para a rejeição aguda, enquanto a gastroparesia associou-se ao desenvolvimento de disfunção crônica do enxerto (DCE). Complicações cirúrgicas agudas, como diverticulite perfurada e isquemia intestinal, especialmente quando manejadas em caráter de emergência, apresentaram elevada mortalidade. **Conclusão:** As CGIs são eventos frequentes que impactam negativamente a sobrevida e a qualidade de vida dos pacientes submetidos ao TP. A aplicação clínica desses achados indica a necessidade urgente da padronização de protocolos de triagem e manejo precoce, com ênfase na avaliação funcional do esôfago e estômago, para otimizar os desfechos nessa população.

Descritores: Transplante de Pulmão; Complicações Pós-Operatórias; Complicações Gastrointestinais; Gastroparesia; Refluxo Gastroesofágico.

INTRODUCTION

Lung transplantation (LT) is the definitive therapy for advanced lung disease, but long-term survival is primarily limited by chronic allograft dysfunction (CLAD). Gastrointestinal complications (GICs) are recognized as essential triggers in this process, with the association between gastroesophageal reflux (GER) and CLAD being a concern that has been consolidated in the literature for almost two decades[21].

Despite this recognition, knowledge about the full spectrum of GICs remains fragmented. The role of esophageal dysmotility and gastroparesis as direct risk factors for graft injury, the emergence of new endoscopic therapies, and notable heterogeneity in clinical practice are examples of developments that warrant an updated integrative synthesis.

Given the above, the objective of this review was to synthesize the scientific evidence of the last 20 years, addressing the spectrum of GICs after labor, their risk factors, the impact on clinical outcomes, and the evolution of management strategies, to provide a cohesive overview for clinical practice.

METHODS

The study was developed based on the research question: "What are the main GICs, their associated risk factors, and clinical outcomes in patients undergoing LT, according to the literature published in the last 20 years?" For study selection, precise eligibility criteria were established so that primary observational studies with a quantitative approach were included, such as cohorts (prospective and retrospective) and cross-sectional studies, whose population consisted of adult patients undergoing LT, regardless of the type (unilateral, bilateral, or retransplant).

The search included articles published from January 2005 to December 2024, without any language or country restrictions. However, the following exclusion criteria were defined: literature reviews (systematic, integrative, or narrative), case reports with only one patient, editorials, letters to the editor, preclinical or animal studies, and articles whose full text could not be retrieved for analysis.

Data collection was conducted in two databases: the National Library of Medicine (NLM) – MEDLINE and Embase. MEDLINE was accessed through the PubMed platform. The search strategy was developed based on the Medical Subject Headings (MeSH 2024) terms provided by the NLM. Initially, two core terms were identified ("Lung Transplantation" and "Gastrointestinal Complications") and their synonyms. The strategy was then structured, incorporating the MeSH terms: "Lung Transplantation/adverse effects" OR "Lung Transplantation" AND ("Gastrointestinal Diseases" OR "Digestive System Diseases" OR "Gastrointestinal Hemorrhage" OR "Peptic Ulcer") AND "Postoperative Complications".

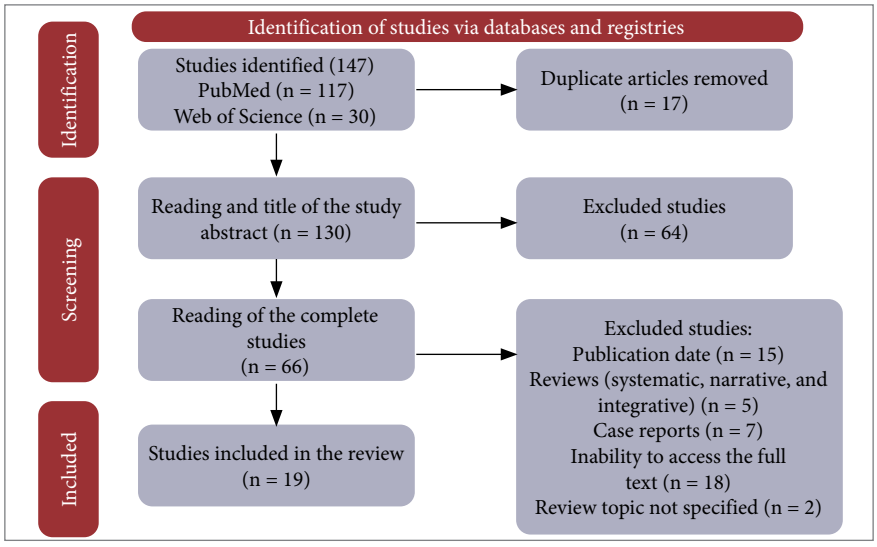
The strategy, composed of MeSH terms and Boolean operators, was applied to all platforms, except for Embase, as it uses Emtree terms, which present some differences from MeSH terms.

Article selection was conducted in two stages by two independent researchers, using the online platform Rayyan to manage the process. Initially, titles and abstracts were screened. The pre-selected articles were then read in full for a final eligibility assessment. Any disagreements between the reviewers were resolved by consensus. The detailed search and selection process was illustrated in a flowchart, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[1] model, which presents the number of articles identified, those excluded in each phase, and those included in the review.

Data extraction from the selected studies was performed independently by two researchers, and the information was compiled into a spreadsheet (Microsoft Excel®). The following variables were extracted: study identification (authors, year of publication, country), methodological design, sample size, population characteristics, type of gastrointestinal complication, associated risk factors, and clinical outcomes such as mortality and graft dysfunction. The main findings of each article were then summarized descriptively. Finally, the same pair of researchers conducted the methodological quality assessment using specific tools. For most studies, the Newcastle-Ottawa Scale (NOS)[23] was used, with the assignment of quality level and star rating. For the other designs, the Joanna Briggs Institute (JBI)[22] checklist was used.

RESULTS

The search resulted in the inclusion of 19 studies that met the eligibility criteria. The article selection process is detailed in the PRISMA flowchart (Fig. 1). Most studies consisted of retrospective cohorts, with patient populations ranging from dozens to over 600 individuals. The overall incidence of post-LT GICs varied widely across cohorts, with reported rates ranging from 36.3% to 62%[13-15]. The characteristics and main findings of each study are summarized in Table 1.



Source: Elaborated by the authors.

Figure 1. Flowchart of identification, selection and inclusion of studies in the integrative review.

Table 1. Characteristics of the studies included in the integrative review on GIC in the postoperative period of organ transplantation (OT).

Title/quality	Periodic/year	Author/ place of origin	Type of study	Type of transplant	Risk factors	Complications	n	Outcome
Association between diverticular disease requiring surgical intervention and mortality in the postlung transplant population – A retrospective cohort study High quality – 9/9 stars	Transplant International 2019	Tague et al.[3] USA	Retrospective cohort study	Unilateral: 96 patients Bilateral: 48 patients Retransplantation: 14 patients	Alpha-1 antitrypsin deficiency (A1ATD) CF	Diverticulitis	158	Twenty-five developed post-transplant diverticulitis, of which 17 required surgery. Diagnoses of A1ATD and CF were more prevalent in the surgical group. Emergency surgery was performed in 10 of the 17 cases, with two deaths within 30 days. Diverticular surgery was associated with worse 1-year (aHR 2.93) and 2-year (aHR 4.17) survival, with a higher risk of emergency interventions (HR 5.12).
Changes in health-related quality of life during the first year in lung transplant recipients High quality – 7/9 stars	Transplantation Proceedings 2021	Zhu et al.[4] China	Cohort study	Unilateral: 42 patients Bilateral: 16 patients	Immunosuppression and the type of transplant may influence complications, but detailed individual risk factors are lacking.	Nausea, GERD, and diarrhea	58	GICs were identified in 43.3% of patients in the first year after OT, being associated with worse mental quality of life (β = −3.937; $p = 0.007$). Although the study does not specify the types, the literature cites GER (50-75% of cases), nausea, vomiting, diarrhea, gastroparesis, and cholecystitis as frequent, with a negative impact on physical function, sleep, and mental health.
Diverticulitis occurs early after lung transplantation High quality – 7/9 stars	The Journal of Surgical Research 2014	Larson et al.[5] USA	Retrospective cohort study	Unilateral: 175 patients Bilateral: 139 patients	Advanced age	Diverticulitis	314	Diverticulitis occurred in 4.5% of patients undergoing OT, with most cases (79%) arising in the first postoperative year (median of 86.5 days). The condition was more frequent among patients with unilateral OT (5.1%) than bilateral OT (3.6%), although without statistical significance. The mean age of patients with diverticulitis was significantly higher than that of other transplant recipients (63 vs. 58 years; $p = 0.023$). Of the 14 cases, 57% required surgical intervention, usually due to the more severe form of the disease, while 43% were successfully treated conservatively. The mortality rate among patients who underwent surgery was 12.5%.

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Table 1. Continuation...

Title/quality	Periodic/year	Author/ place of origin	Type of study	Type of transplant	Risk factors	Complications	n	Outcome
Early and late abdominal surgeries after lung transplantation: incidence and outcome High quality – 7/9 stars	Interactive Cardiovascular and Thoracic Surgery 2018	Sulser et al.[6] Switzer-land	Retrospective cohort study	Unilateral: 1 patient Bilateral: 51 patients	CF Chronic Obstructive Pulmonary Disease (COPD)	Biliary Pathology Diarrheal Syndromes/ Colitis Small Bowel Obstruction Gastroparesis	52	GICs affect 36% to 62% of post-transplant patients. Motility disorders are the most common, especially EGR, which affects up to 57% of patients. Pre-transplant IEM is an independent risk factor for acute rejection (HR 2.20), and HR is a strong predictor of post-transplant EGR (adjusted odds ratio 3.26). Mortality directly attributed to GICs ranges from 1.25% to 5.3%. The need for early abdominal surgery (in the immediate postoperative period) is associated with a mortality rate of 35% to 38%. Early abdominal surgery reduces median survival from 40 to 31 months, while late surgery has a median survival of 90 months, comparable to that of non-operated patients.
Early severe digestive complications after lung transplantation High quality – 9/9 stars	European Journal of Cardio-Thoracic Surgery 2011	Lahon et al.[7] France	Retrospective cohort study	Unilateral: 17 patients Bilateral: 9 patients	Advanced age Bilateral LT	Acute cholecystitis Angiocholitis Gastroduodenal ulcers Digestive perforations Bowel occlusions Mesenteric ischemia Acute pancreatitis	26	Early severe GICs occurred in 7.4% of post-OT patients in the study. These GICs significantly prolonged intensive care unit stay (median 44 vs. 20 days, $p < 0.001$) and overall hospitalization (median 77 vs. 45 days, $p = 0.003$). The studied GICs were directly responsible for death in 19% (n = 5) of patients in the study group. Among patients with complications (n = 26), 17 (65.3%) underwent unilateral transplantation and nine (34.7%) bilateral transplantation. Advanced age and bilateral transplantation were identified as significant risk factors for early severe GICs.
Esophageal aperistalsis and lung transplant: Recovery of peristalsis after transplant is associated with improved long-term outcomes High quality – 9/9 stars	Journal of Thoracic and Cardiovascular Surgery 2020	Masuda et al.[8] USA	Retrospective cohort study	Unilateral: 1 patient Bilateral: 30 patients	Connective tissue disease (CTD) Advanced age	Esophageal aperistalsis	31	Patients with esophageal aperistalsis undergoing OT had lower survival at 1, 3, and 5 years (80.6%, 51.2%, and 34.9%) compared with controls with normal motility (90.3%, 73.4%, and 58.8%; $p = 0.038$). Approximately 65% of the patients recovered peristalsis after OT and had a survival rate similar to that of the control group. Persistent dysmotility was associated with CTD, present in 40% of nonresponders.
Esophageal function and reflux evaluations in lung transplantation: a nationwide survey of UNOS-accredited transplant centers in the United States Quality – High risk of bias: low	Clinical and Translational Gastroenterology 2023	Leung et al.[9] USA	Descriptive cross-sectional study	Not specified	The study did not investigate individual risk factors.	GER disease	39	In the postoperative period, esophageal disorders were routinely assessed by EFT in 26.3% of centers, performed between 3 and 6 months after transplantation. Another 23.7% of centers considered the use of EFT conditionally, depending on the presence of symptoms or clinical status, such as declining lung function or acute rejection. Among centers that performed EFT, the majority (63.2%) completed the test 3 to 6 months after transplantation, while others did not follow a fixed schedule. The requirement for EFT was more common in centers with a higher transplant volume in the last 5 years (253 vs. 159, $p = 0.04$).

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Table 1. Continuation...

Title/quality	Periodic/year	Author/ place of origin	Type of study	Type of transplant	Risk factors	Complications	n	Outcome
Esophageal motility disorders associated with death or allograft dysfunction after lung transplantation? Results of a retrospective monocentric study High quality – 7/9 stars	Clinical and Translational Gastroenterology 2020	Gouynou et al.[10] France	Retrospective cohort study	Unilateral: 27 patients Bilateral: 57 patients	CF Hypotensive lower esophageal sphincter (LES)	Esophageal motility disorders	93	Esophageal motility disorders varied according to the type of transplant: jackhammer esophagus was more common in single-lung transplants, while ineffective motility predominated in double-lung transplants. The use of opioids (18.3%) was associated, without statistical significance ($p = 0.115$), with a higher frequency of esophagogastric junction (EGJ) obstruction, jackhammer, and distal spasm. The prevalence of GER was 20.4%, associated with younger age (38.2 vs. 44.6 years; $p = 0.05$), FC (63.2% vs. 29.7%; $p = 0.01$), and hypotensive LES (47.4% vs. 22.9%; $p = 0.04$). There was no significant difference in motility disorders between patients with or without GER ($p = 0.45$), and the risk factors for Pathological GER remained consistent when including borderline cases
Evaluation of pneumatosis intestinalis as a complication of lung transplantation High quality – 7/9 stars	Radiología English Edition 2020	Ripollés et al.[11] Spain	Retrospective cohort study	Unilateral: 4 patients Bilateral: 11 patients	Immunosuppression	Pneumatosis intestinalis	17	The incidence of post-OT pneumatosis intestinalis at the study hospital was 3.1%, occurring between 9 and 1,270 days post-transplant. Patients were asymptomatic or had mild symptoms, with no significant laboratory abnormalities. The radiological appearance was cystic/expansive. Treatment was conservative in all asymptomatic cases.
Gastric per-oral endoscopic myotomy for severe post-lung transplant gastroparesis: A single-center experience 12 Quality – High risk of bias: low	The Journal of Heart and Lung Transplantation 2020	Podboy et al.[12] USA	Case series	Unilateral: 1 patient Bilateral: 8 patients	Not specified	Gastroparesis	11	Technical success was observed in all 11 patients who underwent Peroral Endoscopic Mucosotomy with Gastroscopy (POEMG). One patient (9.1%) had unintentional duodenal mucosotomy secondary to extensive fibrosis, which was closed with endoscopic clips. One patient developed pyloric canal stenosis approximately 2 weeks after the procedure, which was successfully treated with endoscopic balloon dilation. No episodes of immediate or delayed perforation, pyloric canal ulceration, or bleeding were observed.
Gastrointestinal complications after lung transplantation High quality – 7/9 stars	Journal Heart Lung Transplant 2009	Paul et al.[13] USA	Retrospective cohort study	Unilateral: 57 patients Bilateral: 33 patients	CF COPD	Biliary Pathology Diarrheal Syndromes/ Colitis Small Bowel Obstruction Gastroparesis	208	Of the 208 patients undergoing OT, 90 (43%) developed 113 GICs. Biliary complications were the most common (25 patients), followed by diarrheal syndromes/colitis (21 patients), small bowel obstruction (17 patients), and gastroparesis (12 patients). Eleven (16%) of the 113 complications resulted in directly related deaths. In patients who required laparotomy for indications other than cholelithiasis, nine (35%) died within 8 weeks.

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Table 1. Continuation...

Title/quality	Periodic/year	Author/ place of origin	Type of study	Type of transplant	Risk factors	Complications	n	Outcome
Gastrointestinal complications after lung transplantation in Japanese patients High quality – 7/9 stars	Surgery Today 2018	Kayawake et al.[14] Japan	Retrospective study	Unilateral: 59 patients Bilateral: 101 patients	Superior mesenteric artery syndrome (SMAS) History of hematopoietic stem cell transplant	Gastroparesis GERD *Clostridium difficile* colitis	160	The study revealed that 36.3% of LT recipients developed GICs, but these did not significantly impact the clinical outcome. There was no statistical difference in overall survival (3 years: 74.1% with complication vs. 78.6% without; 5 years: 70.6% vs. 70.5%) or PFS (pulmonary disease-free survival) (3 years: 58.5% vs. 59.2%; 5 years: 39.0% vs. 47.0%). Most of the complications (97%) were managed medically, with only two fatal deaths directly attributed.
Incidence and risk factors of abdominal complications after lung transplantation High quality – 9/9 stars	World Journal of Surgery 2015	Grass et al.[15] Switzerland	Retrospective cohort study	Not specified in the sample	COPD Bilateral transplant	GERD Colitis (inflammatory or infectious) Gastroparesis Peptic ulcer disease	127	Of the 205 patients analyzed in the study, 62% (n = 127) had GICs. Significant complications occurred in 40.5% (n = 83) and were fatal in 2% (n = 4). Twenty-one percent (n = 43) required surgery, with a 30-day mortality rate of 2.3%. The main complications were GERD (22.9%), colitis (20.5%), and gastroparesis (10.7%). Risk factors for major complications included bilateral transplantation ($p = 0.012$) and the early transplantation period (1993–1998) ($p = 0.008$). For surgical complications, the Charlson comorbidity index 3 was a risk factor ($p = 0.015$). The most recent transplantation period (2004–2010) was associated with a higher rate of overall GICs ($p = 0.03$).
Ineffective esophageal motility is associated with acute rejection after lung transplantation independent of gastroesophageal reflux High quality – 7/9 stars	World Journal of Gastroenterology 2023	Lo et al.[16] USA	Retrospective cohort study	Unilateral: 43 patients Bilateral: 138 patients	Not specified	IEM (Ineffective Esophageal Motility)	181	Association between pre-transplant IEM (Esophageal Motility Ineffective) and acute rejection (HR: 2.20; $p = 0.01$). Prevalence of dysmotility: 29.3% (17% of the cohort with IEM). Persistence of dysmotility is linked to worse outcomes—overall mortality: 16.6%.
Lung transplantation delays gastric motility in patients without prior gastrointestinal surgery – A single-center experience of 412 consecutive patients High quality – 9/9 stars	Clinical Transplantation 2017	Hirji et al.[17] USA	Retrospective cohort study	Unilateral: 309 patients Bilateral: 103 patients	CF	GERD	412	The prevalence of GERD was 57%, with CF/bronchiectasis as the only significant risk factor (aOR: 3.26). The demographic profile of those affected was mainly men (60%), Caucasian (>90%), and bilateral transplant recipients (70%). There was no statistical difference in survival, although the 1-year mortality (unadjusted) was clinically higher in the GERD group

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Table 1. Continuation...

Title/quality	Periodic/year	Author/ place of origin	Type of study	Type of transplant	Risk factors	Complications	n	Outcome
Lung transplant outcomes in systemic sclerosis with significant esophageal dysfunction. A comprehensive single-center experience High quality – 9/9 stars	Annals of the American Thoracic Society 2016	Miele et al.[18] USA	Retrospective cohort study	Unilateral: 3 patients Bilateral: 32 patients	Systemic sclerosis (SSc)	Severe esophageal dysfunction	35	Thirty-five patients with SSc (91% with bilateral OT) had post-LT survival comparable to that of the control groups (1 year: 94%; 3 years: 77%; 5 years: 70%). SSc was not associated with overall survival, although ~60% had severe esophageal dysfunction. Esophageal dysfunction rarely precluded transplantation. Other outcomes, such as grade 3 primary graft dysfunction (8.6% in the SSc group), acute rejection, and bronchiolitis obliterans syndrome-free survival, were also similar.
Morbidity and mortality of serious gastrointestinal complications after lung transplantation High quality – 9/9 stars	Journal of Cardiothoracic Surgery 2019	Zevallos-Villegas et al.[2] Spain	Retrospective cohort study	Unilateral: 49 patients Bilateral: 87 patients	Not specified	Biliary breakthrough Pneumatosis colonica Bowel perforation Upper and lower bowel bleeding Acute and obstructive pancreatitis	136	Surgery was required in 70.6% of cases, and mortality in the severe GIC group was 52.9%. Survival was significantly lower in this group (median 14 vs. 28 months; $p = 0.0099$). The timing of the complication (early vs. late) had no statistical impact on survival ($p = 0.2448$), while low cardiac output ($p = 0.0194$) and arrhythmias ($p = 0.0240$) were significant risk factors.
Prevalence and management of gastrointestinal complications in lung transplant patients: MITOS Study Group Quality – Moderate risk of bias: moderate	Transplantation Proceedings 2007	Bravo et al.[19] USA	Cross-sectional and multicenter study	Not specified	Female Post-transplant time	Nausea Abdominal pain Diarrhea GERD	58	Of the 58 lung transplant patients, 58.6% developed GICs. The most frequent were nausea (61.8%) and abdominal pain (38.2%). These complications impacted the daily activities of more than 50% of patients. Associated factors were female gender (46.9% in the group with complications vs. 17.5% without, $p < 0.05$) and longer post-transplant time (2.4 years with complications vs. 1.6 years without, $p < 0.05$). Gastric protectors were the primary treatment (70.5%).
Risk factors and outcomes for gastroparesis after lung transplantation High quality – 9/9 stars	Digestive Diseases and Sciences 2023	Blackett et al.[20] USA	Retrospective cohort study	Unilateral: 50 patients Bilateral: 57 patients	Black ethnicity	Gastroparesia	107	The 3-year prevalence of post-transplant gastroparesis was 17.4%. Black ethnicity was the only significant demographic risk factor (28.2% prevalence vs. 15.5% in whites), while traditional factors such as age, sex, and diabetes were not predictive. Gastroparesis was significantly associated with the development of ECD, but not with mortality.

Source: Elaborated by the authors.

Esophageal motility disorders represent one of the most relevant and studied complications. The prevalence of pre-transplant dysmotility, such as aperistalsis or ineffective esophageal motility (IEM), has been identified in 17% to 30% of patients across different cohorts[10,16]. Although one study showed improved motility in 65% of patients after transplantation[8], persistence of these disorders has been associated with worse outcomes, including shorter overall survival and shorter CLAD-free survival8. Additionally, IEM was independently associated with a higher risk of acute rejection [hazard ratio (HR) 2.20][16].

GER, often linked to dysmotility, has been reported as the most common complication in some series, with a prevalence of up to 22.9%[15]. Analysis of specific cohorts demonstrated that non-acid reflux, in particular, was associated with an increased risk of acute rejection, regardless of the underlying motility[16]. Despite the clinical relevance, a survey of US transplant centers revealed wide variability in screening protocols, with less than 40% of centers requiring routine esophageal function testing (EFT)[9].

Furthermore, gastroparesis has been consistently reported as a frequent complication, with prevalence ranging from 6% to 57%, depending on the diagnostic method and time of post-transplant evaluation[13,17,20]. The condition tends to manifest early, with most cases occurring within the first month post-surgery[14]. Risk factors identified for the development of gastroparesis included an underlying disease such as cystic fibrosis (CF)[17], the need for extracorporeal circulation (ECC) during transplantation[14] and black ethnicity[20]. Gastroparesis demonstrated a significant association with the subsequent development of CLAD, but not with overall mortality[20]. For the management of severe cases, peroral endoscopic gastric myotomy (POEMG) has been presented as a promising therapeutic option, with high clinical success rates and objective improvement in gastric emptying[12].

The need for surgical interventions to treat severe GICs was a common finding, occurring in 10% to 21% of patients in different series[3,15]. Diverticular disease was a significant cause of morbidity, affecting 4.5% to 10.7% of patients[5], with more than half of these requiring surgery, often on an emergency basis[3]. Mortality associated with diverticular surgery was high, with an adjusted risk of death at 2 years up to 4.17 times higher compared to non-operated patients[3].

Early abdominal surgeries (<30 days post-transplant), mainly caused by intestinal ischemia or perforation, presented a particularly high mortality rate, reaching 38%[6]. Similarly, serious complications such as perforation, biliary pathology or pancreatitis, when they required surgery, were associated with an overall mortality of up to 52.9% in the affected group, with GIC itself being the direct cause of death in 17.6% of these cases[2].

Pneumatosis intestinalis was identified with an incidence of 3.1% in a large cohort[11], being in most cases (94%) an incidental finding, asymptomatic or with mild symptoms. The clinical course was predominantly benign, with spontaneous resolution in most patients under conservative management, with no reported mortality associated with this condition[3]. Biliary pathology, mainly cholecystitis, was also a frequent complication, being the most common cause of early severe digestive complications (38%) in one study[7] and leading to a significant number of post-transplant cholecystectomies[13,15].

In addition to clinical outcomes, GICs have been shown to have a direct and measurable impact on patients' quality of life. A prospective study found a statistically significant association between the presence of GICs and worse scores on the mental component of quality of life[4]. Another study showed that gastrointestinal symptoms, especially nausea, affected daily activities in more than 50% of affected patients[19].

DISCUSSION

This integrative review aimed to synthesize the evidence from the last 20 years on GICs after LT, their risk factors, and clinical outcomes. Our findings, based on 19 studies, confirm that GICs are highly prevalent and negatively impact graft outcomes, survival, and patient quality of life. Innovatively, the comparative analysis of the data identified esophageal dysmotility as an independent risk factor for graft rejection, highlighted developments in the management of conditions such as gastroparesis, and quantified the prognostic impact of the timing of surgical interventions.

One of the most significant findings of this review is the role of esophageal dysmotility as an independent predictor of adverse outcomes, transcending its classic association with GER. Multiple studies have demonstrated a high prevalence of motility disorders, such as aperistalsis and IEM, in transplant candidates[8,10]. The importance of this finding is underscored by the evidence that persistent postoperative aperistalsis is associated with significantly lower 5-year overall survival (34.9% vs. 58.8%) and worse CLAD-free survival[8].

Deepening this analysis, the work of Lo et al.[16] revealed that IEM alone more than doubles the risk of acute rejection. This effect persisted even after statistically controlling for the presence of acid and non-acid reflux. The presented information is crucial, as it shifts the paradigm that graft injury is caused solely by aspiration of gastric contents. The most likely interpretation is that failure of the esophageal clearance mechanism—dysmotility itself—leads to stasis of oral, biliary, and gastric material in the esophagus, resulting in chronic microaspiration of a variety of inflammatory contents, not just acid. The above would explain why non-acid reflux was also associated with a higher risk of rejection[16]. Despite this robust evidence, current clinical practice does not appear to reflect the importance of motor assessment. A national survey showed that less than 40% of transplant centers in the United States require esophageal manometry as part of routine evaluation, and nearly a third do not perform any esophageal functional testing[8]. Clinically, these data imply an urgent need to standardize pre-transplant evaluation. Incorporating esophageal manometry as a standard prognostic tool could allow the identification of high-risk patients, guiding closer monitoring and proactive therapies post-transplant.

Similar to esophageal dysmotility, gastroparesis and delayed gastric emptying (DGE) represent a significant source of post-transplant morbidity. The prevalence of this condition is remarkably high, although variable across studies (from 6% to 57%), a range that likely reflects differences in diagnostic methodologies and evaluation periods[13,17,20]. An essential finding of this review is that the risk factors for gastroparesis in this specific population differ from those in the general population. While traditional factors such as diabetes were not shown to be consistent predictors, underlying lung disease, such as CF, and perioperative factors, such as the need for CPB, were associated with an increased risk[14,17].

The clinical relevance of gastroparesis was solidified by the strong evidence of its association with adverse graft outcomes. The study by Blackett et al.[20] demonstrated conclusively that a diagnosis of gastroparesis was an independent predictor of the future development of CLAD, the leading cause of long-term mortality. This causal link, likely mediated by chronic aspiration of gastric contents, elevates gastroparesis from a mere symptomatic complication to a direct risk factor for graft failure. Given this association, effective management of gastroparesis becomes a cornerstone for preserving lung function.

Historically, treatment for severe and refractory gastroparesis was limited to medications with variable efficacy or invasive surgical drainage procedures[13]. However, this review captured a significant evolution in the therapeutic paradigm. The study by Podboy et al.[12] demonstrated the high efficacy of POEMG in a cohort of patients with severe post-transplant gastroparesis. The procedure not only resulted in substantial clinical improvement and a reduction in hospitalizations, but also in an objective and statistically significant improvement in gastric emptying. The availability of a minimally invasive and highly effective intervention like POEMG fundamentally changes the clinical approach. What justifies more aggressive screening for gastroparesis in symptomatic patients, as an accurate diagnosis can now lead to therapy that not only alleviates symptoms but also has the potential to mitigate the risk of developing ECD.

In contrast to the acute complications and high mortality, this review also helped demystify the clinical significance of other findings, such as pneumatosis intestinalis. Traditionally, the presence of gas in the intestinal wall is a worrisome radiological sign, often associated with ischemia and necrosis in other patient populations. However, in LT recipients, recent evidence suggests a significantly different prognosis and approach.

The study by Belloch Ripollés et al.[11], which analyzed the largest cohort on the topic, revealed that pneumatosis intestinalis, although with a notable incidence of 3.1%, presented in the overwhelming majority of cases (94%) as an incidental finding on routine imaging or associated with mild symptoms. Crucially, the clinical course was predominantly benign, with complete resolution in a median of 389 days under conservative management, with no mortality directly associated with the condition. This benign presentation was also observed in other smaller studies included in the review[14].

The most likely interpretation for this benign phenomenon in the context of LT is that pneumatosis is not primarily ischemic in origin. Instead, it may be related to multiple factors, such as increased intestinal mucosal permeability due to infections (such as *Clostridium difficile*, reported in one case) or immunosuppressive therapy, especially with corticosteroids, which can lead to intestinal wall thinning and subsequent intraluminal gas leakage[11]. The clinical implications of these findings are of great importance. When pneumatosis intestinalis is diagnosed in a lung transplant patient who is clinically stable and asymptomatic, the initial approach should be surveillance and conservative treatment, avoiding unnecessary exploratory laparotomies. Surgery should be reserved for the rare cases in which there are clear clinical signs of peritonitis or intestinal distress.

It is essential to acknowledge the inherent limitations of this review. The predominance of retrospective studies, the heterogeneity in definitions and methodologies across cohorts, and the potential for publication bias require caution in generalizing some findings and prevent a quantitative meta-analysis. Despite these caveats, the consolidated data unequivocally point to the urgent need to standardize screening and management protocols. Assessment of esophageal motor function with manometry and active screening for gastroparesis emerges as an essential strategy for risk stratification. Consequently, prospective, multicenter studies are imperative to overcome these limitations, validate the risk factors identified here, and compare the efficacy of different interventions, such as prophylactic fundoplication. Optimizing gastrointestinal management, therefore, represents a promising frontier for improving long-term outcomes in this complex patient population.

CONCLUSION

GICs are common after labor and negatively impact patients' survival and quality of life. Conditions such as esophageal dysmotility and gastroparesis are significant risk factors for CLAD, while acute surgical complications are associated with high mortality. The adoption of standardized screening and early management protocols, combined with multidisciplinary monitoring, is essential to optimize clinical outcomes in this population.

CONFLICT OF INTEREST

Nothing to declare.

AUTHOR'S CONTRIBUTION

Substantive scientific and intellectual contributions to the study: Fonseca Neto OCl; **Conception and design:** Fonseca Neto OCL; **Data analysis and interpretation:** Azevedo JLR; **Article writing:** Azevedo JLR; **Critical revision:** Fonseca Neto OCL; **Final approval:** Azevedo JLR, Fonseca Neto OCL.

DATA AVAILABILITY STATEMENT

All datasets were generated or analyzed in the current study.

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