Review Article

Impact of the COVID-19 pandemic on esophageal cancer resource allocation: a systematic review

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Background: The coronavirus disease 2019 (COVID-19) pandemic challenged global infrastructure. Healthcare systems were forced to reallocate resources toward the frontlines. In this systematic review, we analyze the impact of resource reallocation during the COVID-19 pandemic on the diagnosis, management, and outcomes of esophageal cancer (EC) patients.

Methods: PubMed and Embase were systematically searched for articles investigating the impact of the COVID-19 pandemic on EC patients. Of the 1,722 manuscripts initially screened, 23 met the inclusion criteria.

Results: Heterogeneity of data and outcomes reporting prohibited aggregate analysis. Reduced detection of EC and considerable variability in disease stage at presentation were noted during the COVID-19 pandemic. EC patients experienced delays in diagnostic and preoperative staging investigations but surgical resection was not associated with greater short-term morbidity or mortality. Modeling the impact of pandemic-related delays in EC care predicts significant reductions in survival with associated economic losses in the coming years.

Conclusions: Amidst resource scarcity during the COVID-19 pandemic, the multidisciplinary management of patients with EC was affected at multiple stages in the care pathway. Although the complete ramifications of reductions in EC diagnosis and delays in care remain unclear, EC surgery was able to safely continue as a result of collaboration between centers, strict adherence to COVID-19 protective measures, and reallocation of healthcare resources towards the same. Ultimately, when healthcare systems are pushed to the brink, the downstream consequences of resource reallocation require judicious analysis to optimize overall patient outcomes.

Keywords: Coronavirus disease 2019 (COVID-19); esophageal cancer (EC); resource allocation; pandemic

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Introduction

Background

Afflicting over 500,000 individuals globally and accounting for 3.2% of all cancer diagnoses, esophageal cancer (EC) is the eighth most common cancer type worldwide. With an average 5-year survival of 19.9%, EC has a very poor prognosis. Surgical resection in the form of esophagectomy is the mainstay of management for patients with resectable disease (1,2). Esophagectomy is a complex procedure with an overall morbidity rate greater than 50% (3). Due to the nature of this operation, significant risk of complications, and prolonged recovery time, EC and its treatments necessitate the utilization of significant healthcare resources to allow for surgical intervention and patient support for postoperative recovery. Estimated to account for approximately 3% of cancer diagnoses, the prevalence of EC is significant (2).

Rationale and knowledge gap

To date, the coronavirus disease 2019 (COVID-19) or severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has caused approximately 650 million infections and over 6 million deaths (4). As COVID-19 swept across the world, governments were tasked with ensuring the pandemic response had sufficient resources to allow frontline healthcare workers to tackle COVID-19. Unfortunately, the resources for the pandemic response were required to be redirected from other sectors of healthcare and allocated away from patients with stable conditions, such as those undergoing planned oncologic resections (5-7).

In cases of delayed access to care, the prolonged time to diagnosis, and delays in treatment of ECs may have resulted in disease progression prior to treatment initiation which confers worse long-term prognostication for some patients, while precluding others from surgical resection with curative intent (5,7). While it was necessary to allocate resources during the pandemic to the management of the COVID-19 outbreaks, large groups of non-COVID patients may have received suboptimal care as a result (1).

Highlight box

Key findings
- Reduced detection of esophageal cancer (EC) during the coronavirus disease 2019 (COVID-19) pandemic.
- Delays in EC diagnostic, staging, and preoperative investigations.
- Surgery for EC did not come at greater morbidity or mortality during the pandemic.

What is known and what is new?
- COVID-19 prompted unprecedented healthcare resource reallocation.
- Despite equivalent surgical outcomes for EC patients during the pandemic, significant reductions in EC are predicted in the coming years secondary to delays at multiple stages in the multidisciplinary care pathway.

What is the implication, and what should change now?
- Effective care triage, implantation and strict adherence to public health isolation guidelines and allocation of resources towards the same, as well as collaboration between centers permit the continuation of EC surgery when healthcare infrastructure is overwhelmed.
- The downstream consequences of resource reallocation require judicious analysis to optimize overall patient outcomes.

Objective

In this systematic review, we look to identify whether resource allocation during the pandemic influenced the outcomes of patients with EC in terms of diagnosis, management, and outcomes. We present this article in accordance with the PRISMA reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1232/rc).

Methods

Data sources

PubMed and Embase were systematically searched using the keywords "Esophageal Neoplasms, Esophageal Squamous Cell Carcinoma, Esophageal Diseases, Adenocarcinoma, Gastrointestinal Neoplasms, Thoracic Neoplasms, Neoplasms, Surgical Oncology, Radiation Oncology, Medical Oncology, Integrative Oncology, COVID-19, Pandemics, Early Detection of Cancer, Endoscopy, Time-To-Treatment, Health Resources" individually or in combination for articles published between January 1st, 2019 and February 4th, 2023. The reference lists of included articles were also screened to identify other relevant studies. The initial screening, full-text review, and data extraction from the included studies were performed by two authors based on prespecified outcomes. Conflicts over final text inclusion were resolved by the involvement of a third author and deliberation until a unanimous decision was reached.

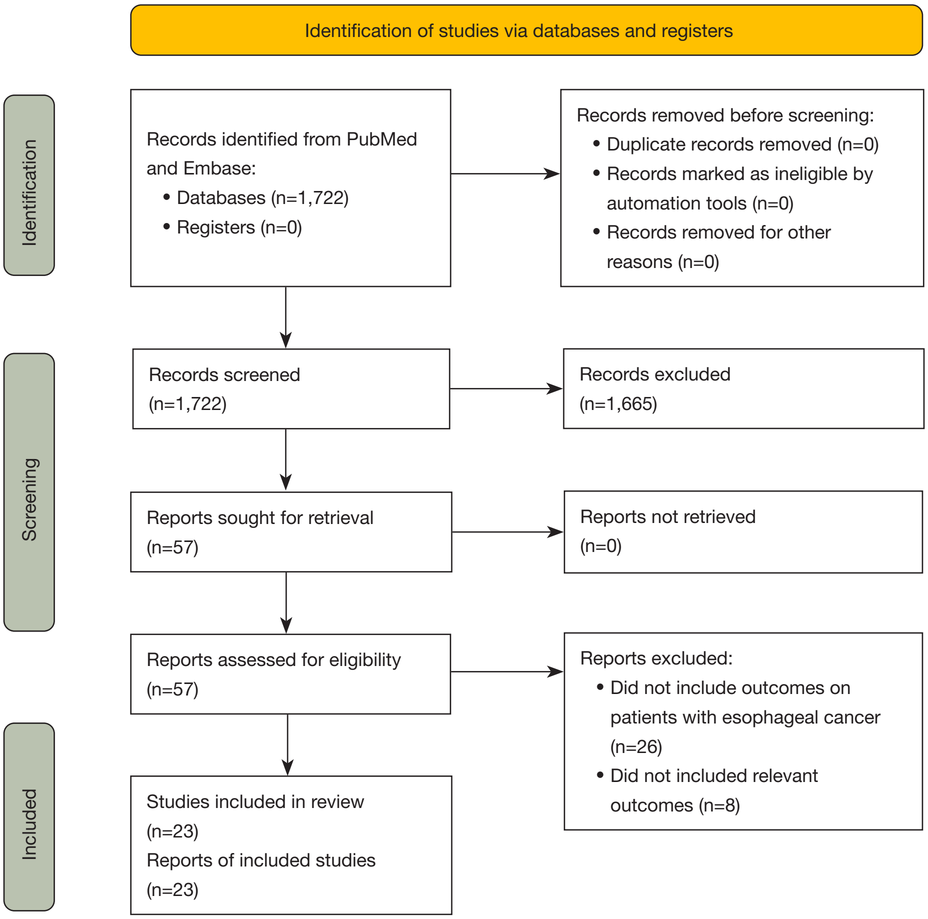

Figure 1 Study flow chart based on the PRISMA guidelines.

This systematic review was not registered prior to the commencement of data collection. A review protocol was not prepared.

Study selection

The initial screening, full-text review, and structure of the study were conducted in keeping with the PRISMA guidelines and a published explanation of the PRISMA guidelines (8,9). Literature investigating the impact of resource allocation during the COVID-19 pandemic and the outcomes of EC patients was identified in retrospective and prospective studies. The inclusion criteria consisted of studies published since 2019 that investigated the incidence, diagnosis, management, or outcomes of patients with EC with a focus on the period since the start of the COVID-19 pandemic. The exclusion criteria for this study included manuscripts that did not discuss the management or outcomes of patients with EC, were case reports or series, abstracts without an associated full text, or studies focusing on an era prior to the start of the COVID-19 pandemic. Initially, 1,722 manuscript titles and abstracts were screened, 57 full texts were reviewed, and 23 were included in this review (*Figure 1*, *Table 1*). All data included in this review are available within the text and its supplements.

Results

The characteristics of each study are available in *Table 1*. A summary of the systematic review and findings along with the level of evidence according to the Oxford Centre for Evidence-Based Medicine is provided in *Table 2*.

Impact of COVID-19 on EC rates & presentation

Morais *et al.* conducted an epidemiological analysis of

Table 1 Characteristics of included studies

Study	Study type	Study organization	Years data collected	Study population	Sample size (No. of cases)	Outcomes
Retrospective						
Bolger *et al.* 2022 (Ireland) (10)	Retrospective, single center	Group 1: baseline (Apr 2019–Jun 2019), 45 patients Group 2: pandemic (Apr 2020–Jun 2020), 53 patients	2019–2020	Patients undergoing surgery for EC	98	EC surgical outcomes
Borgstein *et al.* 2021 (Netherlands, Germany, Sweden, Belgium) (11)	Retrospective, multi-center	Group 1: baseline (Oct 2019–Feb 2019), 168 patients Group 2: pandemic (Mar 2020–May 2020), 139 patients	2019–2020	Patients undergoing surgery for EC	307	Rate of respiratory failure requiring mechanical ventilation
Dolan *et al.* 2021 (United States) (12)	Retrospective, single center	Group 1: baseline (Mar 2019–Jun 2019), 96 patients Group 2: pandemic (Mar 2020–Jun 2020), 37 patients	2019–2020	Patients undergoing surgery for EC	133	EC surgical outcomes
Doyle *et al.* 2023 (United Kingdom) (13)	Retrospective, single center	231 patients	2020–2021	Patients with upper GI cancer undergoing surgical resection	231	Upper GI cancer surgical outcomes
Huang *et al.* 2021 (China) (14)	Retrospective, single center	Group 1: baseline (Feb 2019–May 2019), 5,903 cases Group 2: pandemic (Feb 2020–May 2020), 1,808 cases	2019–2020	Patients undergoing diagnostic/therapeutic endoscopy	7,711	Endoscopic case volume, GI cancer diagnosis
Kamarajah *et al.* 2020 (International; 49 countries) (15)	Retrospective, multi-center, survey-based	Online survey sent to 225 centers	2020	Patients with EG cancer	234 survey respondents	EC initial investigations, oncological and surgical therapy
Khan *et al.* 2022 (United Kingdom) (7)	Retrospective, single center	Group 1: pre-lockdown Group 2: pandemic lockdown	2019–2020	Patients with EG cancer	506	EC diagnosis, stage, treatment, and outcomes
Kirchberg *et al.* 2021 (Germany) (16)	Retrospective, single center	Group 1: baseline (Mar 2019–May 2019) Group 2: pandemic (Mar 2020–May 2020)	2014–2020	Patients with GI cancer	15,995	EC diagnosis

Table 1 (*continued*)

Table 1 (*continued*)

Study	Study type	Study organization	Years data collected	Study population	Sample size (No. of cases)	Outcomes
Kuzuu *et al.* 2021 (Japan) (17)	Retrospective, multi-center	Group 1: baseline (Jan 2017–Feb 2020), 4,218 patients Group 2: pandemic (Mar 2020–Dec 2020), 949 patients	2016–2020	Patients with GI cancer	5,167	EC diagnosis and stage
Milito *et al.* 2022 (Italy) (18)	Retrospective, multi-center	Group 1: baseline (2019), 41 patients Group 2: pandemic (Mar 2020–Mar 2021), 29 patients	2019–2021	Patients undergoing surgery for EC	70	EC surgical outcomes
Miyawaki *et al.* 2022 (Japan) (19)	Retrospective, single center	Group 1: baseline (Apr 2018–Mar 2020), 378 patients Group 2: pandemic (Apr 2020–Jun 2020), 178 patients	2018–2021	Patients with EC	546	EC diagnosis, stage, treatment, and outcomes
Morais *et al.* 2021 (Portugal) (20)	Retrospective, single center	Group 1: baseline (Mar–Jul 2019) Group 2: pandemic (Mar–Jul 2020)	2019–2020	Patients with malignancy	2,072	Cancer-related screening and diagnosis
Okuyama *et al.* 2022 (Japan) (6)	Retrospective, multi-center	Group 1: baseline (2016–2019) Group 2: pandemic (2020)	2016–2020	Patients with cancer	22,556	EC diagnosis and stage
Rebecchi *et al.* 2021 (Italy) (21)	Retrospective, multi-center, survey-based	Online questionnaire sent to 12 SISME institutions	2019–2020	Patients with EC	12 Italian Society for Study of Esophageal Diseases esophageal surgery units	EC initial investigations, oncological and surgical therapy
Seitlinger *et al.* 2021 (France, Germany, Italy, Canada) (22)	Retrospective, multi-center	731 total patients (17 esophagectomies)	2020	Patients undergoing thoracic oncologic surgery	731	Thoracic oncologic surgical outcomes
Soni *et al.* 2022 (India) (23)	Retrospective, single center	Group 1: baseline (Apr 2019–Apr 2020) Group 2: pandemic (May 2020–May 2021)	2019–2021	Patients undergoing oncologic surgery	1,576	Oncologic surgical outcomes
Trindade *et al.* 2022 (United States) (24)	Retrospective, multi-center	Group 1: baseline (Apr 2019–Mar 2020) Group 2: pandemic (Apr 2020–Mar 2021)	2018–2021	Patients with Barrett's esophagus or EC	–	EC and Barrett's esophagus diagnosis, treatment

Table 1 (*continued*)

Table 1 (*continued*)

Study	Study type	Study organization	Years data collected	Study population	Sample size (No. of cases)	Outcomes
Turkington *et al.* 2021 (Northern Ireland) (25)	Retrospective, multi-center	Group 1: baseline (Mar 2017–Sep 2019) Group 2: pandemic (Mar 2020–Sep 2020)	2017–2020	Patients with Barrett's esophagus or EC; NICR database	–	EC and Barrett's esophagus diagnosis
Prospective						
Chan *et al.* 2021 (United Kingdom) (26)	Prospective, single center	20 patients	2020	Patients undergoing ILO for EC	20	EC surgical outcomes
Population-based modeling studies						
Gheorghe *et al.* 2021 (United Kingdom) (27)	Population-based modeling study	Model of cancer survival and economic impact after COVID-19-induced delays in care	–	Patients with EC; NHS database	–	Health losses (QALYs), lost economic productivity (HC)
Maringe *et al.* 2020 (United Kingdom) (28)	Population-based modeling study	Model of cancer survival after COVID-19-induced delays in care	–	Patients with EC; NHS database	–	Estimated additional deaths, YLLs
Shipe *et al.* 2021 (United States) (29)	Population-based modeling study	Model of immediate *vs.* delayed surgical resection in a T1b esophageal adenocarcinoma	–	Patients with T1b esophageal adenocarcinoma	–	5-year overall survival
Sud *et al.* 2020 (United Kingdom) (30)	Population-based modeling study	Model of cancer progression during COVID-19-induced delays in care	2013–2017	Patients with malignancy	–	Hazard ratios of cancer progression, 5-year reduction in survival

EC, esophageal cancer; GI, gastrointestinal; EG, esophagogastric; SISME, Society for Study of Esophageal Diseases; COVID-19, coronavirus disease 2019; NICR, Northern Ireland Cancer Registry; ILO, Ivor-Lewis esophagectomy; QALYs, quality-adjusted life years; HC, human capital; NHS, National Health Service; YLLs, years of life lost.

patients with malignancy in Portugal between 2019–2020. A 30.8% decrease in newly diagnosed EC cases was noted, along with a 40% absolute reduction of new cancer cases overall and an increased diagnosis of cancer at an advanced stage (20). Similarly, a German study of patients with GI cancers between 2019–2020 indicated a 3.2% decrease in newly diagnosed gastrointestinal (GI) cancers during the pandemic along with a 25.5% decrease in newly diagnosed EC during the first lockdown (16). Also, an analysis of patients with esophagogastric cancer between 2019–2020 in the United Kingdom (UK) indicated a significant increase in acute hospital admissions and a decline in urgent clinic referrals after the first government-issued lockdown during the pandemic. After the lockdown, increased metastatic disease at presentation was noted (7).

A single-center analysis of 133 patients between 2019–2020 in the United States (US) reported no significant difference in preoperative pathologic tumor stage between pandemic and pre-pandemic patient populations (12). An analogous study of 70 patients undergoing surgical intervention for EC across multiple centers in Italy reported equivalent results, with no significant difference in pathological stage at presentation between pre-pandemic and pandemic groups (18).

In their retrospective study consisting of 556 patients at a single center in Japan from 2018–2021, Miyawaki *et al.* reported a significant decrease in the number of newly diagnosed EC cases during the first wave of the

Table 2 Studies evaluating the impact of resource allocation during the COVID-19 pandemic on esophageal cancer: summary of systematic review and findings

Study	Level of evidence	Findings
EC rates & presentation		
Dolan *et al.* 2021 (12)	3	No significant difference in preoperative pathologic tumor stage between pandemic and control group
Khan *et al.* 2022 (7)	3	Increase in acute hospital admissions after the lockdown (28.0% *vs.* 12.5%, P=0.001)
		Decline in urgent clinic referrals after the lockdown (5.7% *vs.* 12.5%, P=0.042)
		Increased metastatic disease at presentation after the lockdown (47.8% *vs.* 33.3%, P=0.008)
Kirchberg *et al.* 2021 (16)	3	3.2% decrease in total number or newly diagnosed GI cancers during the pandemic
		25.5% decrease in new EC diagnoses during the first shutdown
Kuzuu *et al.* 2021 (17)	3	No significant difference in the number of patients with newly diagnosed EC during the pandemic
Morais *et al.* 2021 (20)	3	30.8% decrease in new EC diagnoses
		40% absolute reduction of new cancer cases overall
		Increased diagnosis of advanced stage cancer
Miyawaki *et al.* 2022 (19)	3	Decrease in number of newly diagnosed EC during the first wave of the pandemic
		Increased proportion of patients diagnosed with distant metastases during the pandemic
Okuyama *et al.* 2022 (6)	3	1.9% overall decrease in new cancer diagnoses during the pandemic
		3.1% decrease in new diagnoses of EC during the pandemic
		8.6%, 7.1%, and 10% decrease in new diagnoses of stage I, II, III EC during the pandemic, respectively
Delays in EC diagnosis/care		
Bolger *et al.* 2022 (10)	3	No difference in median time to surgery from neoadjuvant therapy (8 weeks in both groups)
Dolan *et al.* 2021 (12)	3	No significant difference in surgical wait times
Huang *et al.* 2021 (14)	3	69% decrease in endoscopic case volume during the pandemic
Kamarajah *et al.* 2020 (15)	4	26.5% and 62.8% availability of endoscopic ultrasound and spiral CT for staging as compared to pre-pandemic baseline
Khan *et al.* 2022 (7)	3	Increased referral wait time during the pandemic (28 *vs.* 15 days, P=0.021)
Milito *et al.* 2022 (18)	3	No significant difference in surgical wait time during the pandemic
Rebecchi *et al.* 2021 (21)	4	Significant restrictions in esophageal cancer surgery at 50% of centers
		Surgical delays reported at 50% of centers
Trindade *et al.* 2022 (24)	3	Significant decrease in newly diagnosed BE, BE endoscopic ablation procedures, and newly diagnosed esophageal cancer during the pandemic
		No difference in esophagectomy rates during the pandemic
Turkington *et al.* 2021 (25)	4	59.3% decrease in newly diagnosed BE during the first 6 months of the pandemic
		26.6% decrease in newly diagnosed EG cancer during the first 6 months of the pandemic

Table 2 (*continued*)

Table 2 (*continued*)

Study	Level of evidence	Findings
EC surgical outcomes		
Bolger *et al.* 2022 (10)	3	No differences in patient demographics, co-morbidities, or use of neoadjuvant therapy
		No significant differences in operative interventions or in-hospital mortality
		0% rate of postoperative COVID-19 infection
Borgstein *et al.* 2021 (11)	3	No difference in the rate of respiratory failure requiring mechanical ventilation or number of pulmonary complications
		No difference in all measures of postoperative morbidity
		No difference in 30-day mortality
		0% rate of postoperative COVID-19 infection
Dolan *et al.* 2021 (12)	3	Reduced rate of overall postoperative complications during the pandemic
		0% rate of perioperative mortality
		0% rate of postoperative COVID-19 infection
Doyle *et al.* 2023 (13)	3	3.5% 90-day mortality rate
		0.4% rate of postoperative COVID-19 infection
		2-year disease-free and overall survival for EC resection 70.8% and 72.9%, respectively
Milito *et al.* 2022 (18)	3	64% decrease in esophagectomy volume during the pandemic
		No significant difference in 30-day mortality or hospital LOS
		0% rate of postoperative COVID-19 infection
Rebecchi *et al.* 2021 (21)	4	No significant difference in the overall number of EC resections during the pandemic
		Increased rate of open EC resections during the pandemic
		1.5% rate of postoperative pneumonia
Seitlinger *et al.* 2021 (22)	3	1.2% rate of COVID-19 infection
		0.5% rate of readmission for oxygen requirements with 0.3% of these patients requiring ICU admission and mechanical ventilatory support
		3% overall mortality
Soni *et al.* 2022 (23)	3	35% reduction in oncological surgical activity during the pandemic
		11% reduction in thoracic oncological surgical activity
		No difference in postoperative mortality for thoracic surgery
		0% rate of postoperative COVID-19 infection for thoracic surgery
EC overall outcomes		
Khan *et al.* 2022 (7)	3	6-month decrease in overall median survival for all new patients with EC after the first lockdown
		3-month decrease in median survival after the first lockdown in patients not treated with surgical resection

Table 2 (*continued*)

Table 2 (*continued*)

Study	Level of evidence	Findings
Statistical modelling		
Gheorghe *et al.* 2021 (27)	3	Overall, an estimated loss of 32,700 QALYs and £103.8 million GBP in the next 5 years in England alone
		An estimated 2,700 QALYs lost and productivity losses of £6.6 million GBP in the next 5 years specific to esophageal cancer
Maringe *et al.* 2020 (28)	3	Estimated 330–342 additional deaths due to EC with a 5.8-6.0% increase up to 5 years after diagnosis
		Overall, an estimated 3,291–3,621 additional deaths due to all malignancy within 5 years and total YLLs 59,204–63,229 years
Shipe *et al.* 2021 (29)	3	Slight improvement in 5-year overall survival with immediate esophagectomy
		Delayed esophagectomy (>3 months) preferred when the probability of perioperative COVID-19 infection >7%
Sud *et al.* 2020 (30)	3	24.7–35.9% reduction in 5-year net survival as a consequence of 6-month delay to surgery depending on tumor stage and age at diagnosis

Quality Rating Scheme for Studies and Other Evidence based on the Oxford Centre of Evidence-Based Medicine. COVID-19, coronavirus disease 2019; EC, esophageal cancer; GI, gastrointestinal; CT, computed tomography; BE, Barrett's esophagus; EG, esophagogastric; ICU, intensive care unit; QALYs, quality-adjusted life years; YLLs, years of life lost.

pandemic. Additionally, they noted an increased proportion of patients diagnosed with distant metastases (19). Another Japanese study reported 1.9% and 3.1% decreases in overall new cancer diagnoses and new EC diagnoses during the pandemic as compared to the average rates from 2016–2019. Of note, greater reductions in early-stage EC were observed (6). However, a separate multicenter study consisting of 5,167 patients in Japan did not report any significant difference in the number of patients with newly diagnosed EC during the pandemic as compared to the pre-pandemic baseline (17).

Delays in EC diagnosis and care during the COVID-19 pandemic

In a survey sent to 225 centers across 49 countries, Kamarajah *et al.* reported limited or delayed availability of diagnostic endoscopy, therapeutic endoscopy, spiral computed tomography (CT) scans, endoscopic ultrasound, positron-emission tomography (PET) scans, and staging laparoscopy in up to 60.7%, 57.3%, 35.0%, 52.2%, 36.8%, and 41.0% of responses, respectively. The same staging modalities were unavailable during the pandemic in up to 9.4%, 10.9%, 2.1%, 23.1%, 13.7%, and 23.7% of cases, respectively (15). Referral delays for diagnostic gastroscopy were also noted in a UK analysis of patients with esophagogastric cancer between 2019–2020 (7). Additionally, Huang *et al.* noted a 69% decrease in overall endoscopic case volume during the pandemic in China (14).

Consistent with this delayed access to endoscopy, a large multicenter analysis in the US, Trindade *et al.* reported significant decreases in newly diagnosed Barrett's esophagus (BE) in addition to reductions in newly diagnosed EC cases (24). Analogous results were published in a study utilizing the Northern Ireland Cancer Registry from 2017–2020 (25).

In a survey of 12 Society for Study of Esophageal Diseases (SISME) institutions in Italy between 2019–2020, surgical delays were reported at 50% of centers (21). A single-center analysis of 133 patients between 2019–2020 in the US noted no significant difference in surgical wait time between pandemic and pre-pandemic patient populations (12). Similarly, an Italian multicenter analysis of 70 patients reported no significant difference in surgical wait times between pre-pandemic and pandemic groups (18). Furthermore, in a retrospective, single-center study of 98 patients with EC undergoing surgical intervention in Ireland, Bolger *et al.* reported no difference in median time to surgery from neoadjuvant therapy during the pandemic as compared to the pre-pandemic baseline (10).

Surgical intervention for EC during the COVID-19 pandemic

Rebecchi *et al.* surveyed 12 SISME institutions in Italy between 2019–2020, 50% of centers experienced significant restrictions in EC surgery. Of these centers, 25% reported general reductions in EC resections, 16.7% limited resections to patients without severe comorbidities, and 8.3% completely ceased all surgical activity. However, there was no significant difference in the overall number of EC resections during the pandemic (21). A separate Italian analysis of 70 patients across multiple centers noted a 64% decrease in esophagectomy volume during the pandemic, with no significant difference in 30-day mortality or hospital LOS between pre-pandemic and pandemic groups, as well as a 0% rate of postoperative COVID-19 infection (18).

Retrospective studies conducted in India (23), Ireland (10), and the US (12), reported equivalent perioperative mortality between pre-pandemic and pandemic groups undergoing EC surgery, along with a 0% rate of postoperative COVID-19 infection. Similarly, a multicenter study of 307 patients in Holland, Germany, Sweden, and Belgium reported no differences in 30-day mortality or postoperative morbidity, as well as a 0% rate of postoperative COVID-19 infection (11). In a prospective analysis of 731 patients undergoing thoracic oncologic surgery in France, Germany, Italy, and Canada, Seitlinger *et al.* also reported low perioperative mortality (3%) and COVID-19 infection (1.2%) (22).

Regarding postoperative morbidity, a prospective, analysis of 20 patients undergoing Ivor Lewis esophagectomy (ILO) in the US reported a 35% rate of postoperative pneumonia, a 5% rate of postoperative anastomotic leak, and the median length of hospital stay was 9 days (26). The aforementioned multicenter analysis of 731 patients across Europe and North America noted a 0.5% rate of hospital readmission during the follow-up period (22). In terms of late surgical outcomes, Doyle *et al.* reported a 2-year disease-free and overall survival for EC resection of 70.8% and 72.9%, respectively (13).

EC outcomes during the COVID-19 pandemic

Khan *et al.* conducted a retrospective analysis of 349 patients being treated for esophagogastric cancer between 2019–2020 in the UK and found a 6-month decrease in overall median survival for patients presenting with EC after the first UK national lockdown (7 *vs.* 13 months, P=0.001). There was a 3-month decrease in survival in patients not treated with surgical resection (5 *vs.* 8 months, P=0.004). In addition to the aforementioned increased rates of acute hospital admissions (28.0% *vs.* 12.5%, P=0.001) and metastatic disease at presentation (47.8% *vs.* 33.3%, P=0.008), significantly higher rates of palliative treatment were noted after the lockdown in this patient population (71.3% *vs.* 55.7%, P=0.003) (7).

Modeling of the impact of pandemic-related delays in EC care

In their model of cancer survival and economic impact after pandemic-induced delays in cancer care, Gheorghe *et al.* estimated overall losses of 32,700 quality-adjusted life years (QALYs) and £103.8 million over the next five years. Regarding EC, they estimated 2,700 QALYs lost and productivity losses of £6.6 million over the next five years (27). A population-based modeling study addressing the estimated impacts of immediate *vs.* delayed surgical resection in a T1b esophageal adenocarcinoma was performed by Shipe *et al.* Immediate esophagectomy resulted in an insignificant improvement in 5-year overall survival compared to delaying surgery by 3 months. However, in a sensitivity analysis, delayed esophagectomy (>3 months) resulted in a superior 5-year overall survival when the probability of COVID-19 infection was >7% (29). Sud *et al.* modeled cancer progression during the pandemic as a result of pandemic-induced delays solely in surgical care. They estimated a 24.7–35.9% reduction in 5-year net survival for EC as a consequence of a 6-month delay to surgery depending on tumor stage and age at diagnosis (30).

Discussion

Key findings

In this systematic review investigating the impact of resource allocation during the COVID-19 pandemic on patients with EC, several points were noteworthy. For one, reductions in rates of new EC diagnoses were essentially ubiquitous, with up to a 26% reduction noted in some studies (6,7,19,20,24,25,28). Decreased EC diagnosis was accompanied by inconsistent results regarding the disease severity at presentation. Multiple studies identified a greater disease burden with increased cancer stage or metastatic disease (7,19,20). Others described no difference in tumor stage at presentation during the pandemic (12,18). However, one of these studies solely analyzed patients undergoing surgery for EC, raising the possibility of selection bias as highly advanced or metastatic disease decreases surgical candidacy (12). Interestingly, documented delays in care for EC patients appeared to be limited to preoperative staging investigations (15). Despite restrictions on thoracic oncologic surgery and reported reductions in case volume (18,23), surgical delays were not consistent across the literature, with select studies noting increased wait times (7,21), but others reporting no delays (10,12,18). Moreover, excellent outcomes following EC surgery were evident, with low rates of short-term mortality and morbidity, including postoperative COVID-19 infection (10-13,18,23,26). Across the literature, EC surgery did not come at any greater mortality or morbidity in comparison to pre-pandemic baselines (10-12,18,23). Despite these results, up to a 6-month reduction in survival was noted in patients diagnosed with EC after the first lockdown (7). Delayed access to endoscopy and subsequent greater disease severity at presentation have been suggested to be driving factors. Finally, various statistical analyses attempting to quantify the future health-related and economic costs of disruptions in EC care predicted significant decreases in survival and associated increased financial costs in the coming years (29,30).

Strengths and limitations

This review provides a comprehensive summary of resource allocation during the pandemic and its effect on the diagnosis, management, and outcomes of EC; however, it does have limitations. The retrospective nature of the majority of the included studies compounded by relatively small sample sizes inherently limits the conclusions that may be drawn from the literature. Moreover, there was significant heterogeneity in time periods included across studies, with some analyses focusing on outbreak or lockdown periods and others on relatively stable or ramp-up periods during the pandemic. Additionally, with a relative paucity of data on specific tumor grade and stage at presentation, it is challenging to objectively analyze discrepancies in disease severity. A selection bias secondary to patient death prior to presentation secondary to delayed diagnosis or treatment initiation is likely present as well. Additionally, although the surgical treatment of EC was the primary focus of this review, medical and radiologic therapies also represent critical aspects of EC multidisciplinary management and consequently should be highlighted in future studies. As to be expected due to differential disease burden, there was considerable variation in outcomes across the continents. In addition to considerable variety in outcomes reporting, the majority of the current literature on this patient population is limited to short-term follow-up. In comparison to the literature analyzing EC surgery during the COVID-19 pandemic, there is insufficient data on alterations in non-operative EC cancer care and subsequent outcomes. Given changing recommendations for surgical intervention, radiotherapy, and systemic treatment for EC during the pandemic, this is an important area that requires greater attention and should be the subject of additional investigation as centers continue to ramp up to pre-pandemic case volumes.

Comparison with similar researches

Discrepancies in the diagnosis and management of upper GI pathology during the pandemic were not limited to EC. Multiple studies reported concomitant reductions in BE diagnoses over the same period (24,25). The indolent nature of GI metaplasia and dysplasia results in delayed ramifications of alterations in care, and thus it is likely too early to see the downstream consequences given the relatively short follow-up durations in the current literature. Population-based statistical models attempting to quantify the future impact of pandemic-related delays in EC care are critical in this respect. Conversely, the retrospective cohort analyses that comprise the majority of the literature are better equipped to analyze epidemiological information and outcomes of surgical activity during the pandemic.

Explanations of findings

Surgical resection is a critical aspect of the management algorithm for patients with EC. Delays in EC surgery can have a significant impact on patient outcomes (31). Therefore, proper management of EC patients requiring surgery amidst resource scarcity was paramount during the pandemic. At the height of the pandemic, there was considerable variation in EC surgical practice globally, likely secondary to differential COVID-19 case burden, continuation of oncology care recommendations, and existing pathways of care (32-36). Despite heterogeneous practice, outcomes of EC surgery were excellent, with delays rarely reported (10,12,18) and equivalent rates of morbidity and mortality surgery to pre-pandemic baselines (10-12,18,23). There were several factors critical to the global success of EC surgery during the pandemic.

Implementation of Hub-and-Spoke models, characterized by care triage at "Spoke" centers followed by redirection of patients free of infection requiring surgical management to designated "Hub" centers, was essential and highlighted the importance of collaboration between centers (37,38). The establishment and strict adherence to COVID-19 protective measures, including preoperative and postoperative self-isolation, questionnaires, testing, imaging, as well as thorough multidisciplinary review and utilization of personal protective equipment by hospital staff were also central to the success of institutional modifications in EC care provision. Additional aspects of EC surgery that were not as highly emphasized in the current literature include minimally invasive techniques and enhanced recovery after surgery protocols (1). Given the effectiveness of these interventions both independently and combined, moving forward they should be utilized to hasten patient recovery and optimize healthcare resource utilization.

Implications and actions needed

In addition to adjustments in the surgical management of EC, there has been a concomitant paradigm shift towards virtual health for oncology patients during the pandemic. Telehealth has been integrated into healthcare systems to facilitate care continuity for a broader patient population. The proposed benefits of telehealth are considerable—convenience, cost-effectiveness, and increased accessibility for patients in rural areas as well as those with mobility or transportation barriers. However, limitations in physical examination, financial and technological barriers, as well as cyber security are all drawbacks to this method of care delivery. Consequently, this has been an area of interest not only for EC patients but the larger oncologic patient population. A recent systematic review of telehealth in patients undergoing surgery for malignancy established the safety, efficiency, and effectiveness of virtual care provision in the postoperative setting. Objective measures of care including rates of readmission, recurrence, and morbidity or mortality were equivalent to traditional care (39). Ultimately, telehealth has an important role to play in the management of patients with EC and should be integrated into existing pathways of care.

All in all, the COVID-19 pandemic necessitated considerable resource reallocation with subsequent modifications in evidence-based care provision for oncologic patients. Given the progressive and indolent nature of malignancy, the ramifications of such alterations in care have not yet been fully realized. Imperatively, future resource allocation should strive to balance immediate triage with the impact of delays in care for patients with malignancy. Diagnostic and therapeutic algorithms should undergo continual revision with the ever-changing scenery of the healthcare landscape to ensure resources are being optimally allocated and patients are receiving care of the highest quality.

Conclusions

Pushing healthcare systems well beyond their capacity, the COVID-19 pandemic necessitated resource reallocation away from non-COVID patients to meet the escalating disease burden. Amidst resource scarcity, the multidisciplinary management of patients with EC was affected at multiple stages in the care pathway. The was an overall reduction in the detection of EC and significant variability in the presenting disease stage. EC patients experienced delays in diagnostic and preoperative staging investigations. However, EC surgery was able to safely continue and patients experienced excellent short-term outcomes secondary to revised guideline recommendations, effective care triage, institutional modifications, and collaboration between centers. Ultimately, the complete ramifications of reductions in EC diagnosis and delays in care remain unclear. When healthcare systems are pushed to the brink, the downstream consequences of resource allocation away from patients with chronic disease require judicious analysis to optimize overall patient outcomes.

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Footnote

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