The Egyptian Journal of Bronchology

REVIEW

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The indirect oncological burden of the COVID-19 pandemic: global disruptions in lung cancer diagnosis, surgical management, and healthcare system resilience — a narrative review

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Abstract

Background The coronavirus disease 2019 (COVID-19) pandemic imposed substantial challenges on healthcare systems worldwide, significantly influencing the diagnosis, treatment processes, and clinical outcomes of patients with lung cancer. This article aims to evaluate the indirect oncological consequences of the pandemic, with particular emphasis on delays in diagnosis, staging, and surgical treatment from a thoracic surgery perspective.

Methods During the pandemic, extensive structural and administrative transformations were implemented in hospitals, including reorganization of clinical services, allocation of dedicated COVID-19 units, postponement of elective procedures, and redistribution of healthcare resources. While these measures were essential for infection control, they significantly limited access to routine oncological care. This study was designed as a narrative review. Literature was searched in PubMed databases for studies published between January 2020 and February 2026 using combinations of the terms "COVID-19", "lung cancer", "thoracic surgery", "delay diagnosis". English-language articles evaluating the impact of the pandemic on lung cancer diagnosis, staging, treatment, and outcomes were included. Relevant studies were selected based on clinical relevance and methodological quality. Case reports were excluded from the study as exclusion criteria.

Results Evidence from multiple international studies demonstrates substantial reductions in lung cancer diagnoses, decreased surgical volumes, prolonged referral and treatment intervals, and a shift toward more advanced disease stages at presentation. Screening interruptions, patient reluctance to seek medical attention, and restricted diagnostic procedures contributed to a global "diagnostic deficit." Although surgical outcomes remained generally safe when appropriate protective protocols were applied, treatment delays and altered therapeutic strategies, including increased use of radiotherapy and systemic therapies, raised concerns regarding long-term oncological outcomes. Overall, the pandemic highlighted the vulnerability of cancer care systems during global health crises while also

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demonstrating that continuity of thoracic oncology services can be maintained through structured protocols and dedicated pathways.

Conclusion These findings underscore the necessity of developing resilient healthcare systems capable of preserving timely cancer diagnosis and treatment during future pandemics to minimize indirect mortality and loss of life-years among lung cancer patients.

Keywords COVID-19, Lung cancer, Thoracic Surgery, Health system

Introduction

The world, which began 2020 with news of an infection originating in China, experienced a period that was both highly dynamic and equally challenging as it sought the most accurate, fastest, and most effective solution for the treatment and eradication of the novel coronavirus. The world confronted the full meaning and reality of the term "pandemic," and the truth that the fight against the pandemic could only be achieved through social cohesion became the sole, unchanging truth of this process. The term "COVID-19" has subjected both hospital administration and all healthcare workers involved in the pandemic response to a new set of experiences, thoughts, and emotions they had never encountered before [1]. The purpose of this article is to highlight the devastation caused by the COVID-19 pandemic in the healthcare system, to address the challenges faced by lung cancer patients in particular, and to contribute to the literature and provide guidance to ensure better management of the process in the event of another pandemic.

Main text

The COVID-19 pandemic represented an unprecedented challenge for healthcare systems worldwide and created a highly dynamic environment characterized by uncertainty, rapidly evolving scientific recommendations, and considerable pressure on healthcare professionals and hospital administrations. Hospitals were compelled to adapt quickly to extraordinary circumstances while simultaneously maintaining essential medical services. During this period, healthcare workers faced substantial physical and psychological burdens, and healthcare systems underwent profound organizational changes in response to the demands imposed by the pandemic [1].

To control viral transmission and optimize the use of limited resources, extensive structural and administrative modifications were implemented in many institutions. Dedicated COVID-19 units and triage areas were established, hospital workflows were reorganized, elective procedures were postponed, and healthcare personnel and resources were redistributed according to urgent priorities. Strict infection-control measures and the widespread use of personal protective equipment became integral components of daily clinical practice. Although these measures were necessary to protect patients and healthcare workers, they significantly altered routine hospital operations and reduced the capacity available for non-COVID conditions [1].

As healthcare systems focused primarily on managing the pandemic, disruptions inevitably occurred in the diagnosis and treatment of chronic diseases, particularly cancer. Screening programs were interrupted, access to imaging and bronchoscopy became restricted, elective surgical procedures were postponed, and many patients delayed seeking medical attention because of fear of infection. Consequently, concerns emerged regarding delayed diagnosis, stage migration, and deterioration of long-term oncological outcomes. Lung cancer, which relies heavily on timely diagnosis and surgical treatment, was especially vulnerable to these disruptions. Understanding the indirect consequences of the COVID-19 pandemic on lung cancer care is therefore essential to improve healthcare system resilience and to develop strategies capable of preserving oncological services during future global health crises.

All countries, their leaders, institutional leaders, and healthcare providers have demonstrated an extraordinary effort in the fight against this major pandemic, adapted to the situation, developed treatment and prevention strategies, and drawn unforgettable lessons from pandemic.

When we review the literature evaluating the effects of the COVID-19 pandemic on lung cancer patients, we observe that some articles contain the approaches, data, and projections from the very first weeks of the pandemic, while others present data on patients from the time the pandemic had become well-established, and still others present data obtained after the pandemic had ended. We observe that researchers acted with great speed, documenting every stage of the process and recording notes in the history of the pandemic.

It is clear that the structural and administrative measures mentioned above led to significant disruptions in the delivery of healthcare services in 2020, as the COVID-19 pandemic overwhelmed healthcare systems worldwide. During this period, when many patients with chronic and serious illnesses avoided seeking hospital care out of fear of infection, significant disruptions were also experienced in cancer treatment. Screening programs were suspended, and treatment strategies were reviewed [2].

The postponement of non-urgent elective surgeries and the acceleration of discharge procedures in hospitals as part of efforts to prepare hospitals for the pandemic have caused significant disruptions to routine hospital services worldwide. The decision to postpone elective surgeries led to numerous positive outcomes related to the pandemic, such as reducing patient contamination, ensuring that staff and facilities could provide more effective care to COVID-19 patients, and improving the proper use and supply of personal protective equipment. However, deviating from routine hospital operations was likely to have numerous and potentially fatal consequences.

The COVID-19 pandemic introduced substantial uncertainty into surgical decision-making; however, maintaining sound clinical judgment remained essential. As emphasized by previous authors, careful patient selection, effective use of personal protective equipment, strict infection-control measures, and protection of healthcare personnel constitute key principles for sustaining safe surgical practice during periods of crisis [3].

During pandemics, performing surgery carries a significant risk of perioperative infection; Surgical cancellations create cumulative backlogs that exceed existing healthcare capacity, and clearing these delays requires substantial increases in surgical volume with considerable economic costs [4]. A global predictive modeling study by COVIDSurg Collaborative on surgical cancellations and recovery plans caused by the COVID-19 pandemic predicted that 28,404,603 surgeries would be canceled or postponed during the 12-week period of peak disruption due to COVID-19, with 37.7% of cancer surgeries expected to be canceled or postponed. It also indicated that a 20% increase in normal surgical volume would be necessary to return to normal operations, and that clearing the surgical backlog would take an average of 45 weeks [4].

In a study by Dolan et al. conducted in the United States, lung cancer surgeries performed in 2019 were compared with those carried out between March and May 2020, based on the hypothesis that the COVID-19 pandemic would lead to prolonged surgical waiting times, more advanced tumor stages, and increased postoperative complications among patients with lung cancer. It was emphasized that, in general, there was no difference when subdivided into Stage I-II and Stage III-IV. The number of cases was found to be at its lowest level in April 2020, and this was stated to be statistically significant. It was also emphasized that the tumor size was clinically larger in the COVID-19 group. In conclusion, it was emphasized that the significant decrease in surgical cases is concerning in terms of appropriate treatment planning for lung cancer patients [5].

In the retrospective study by Kato et al., the effects of the COVID-19 pandemic on lung cancer surgery practices in Japan were assessed by analyzing patients with primary lung cancer who underwent thoracic surgery between 2018 and 2021. The authors reported that patients operated on during the pandemic exhibited significantly greater tumor dimensions and invasive tumor size in stage I disease compared with those treated before the pandemic. These findings suggested that delays and disruptions associated with the pandemic may have contributed to pathological progression even among patients with early-stage lung cancer [6].

In a study conducted by Cozma et al. in Romania, the study period was divided into three groups: February 2018–2020 (pre-pandemic), February 2020–2022 (pandemic), and February 2022–2024 (post-pandemic). The study found a significant decrease in the number of surgical procedures during the pandemic, and that a significant increase in the T stage of cancer was observed compared to both the pre-pandemic and post-pandemic periods [7].

In a study from Canada conducted by Kasymjanova et al., patient data were categorized into three periods: the pre-pandemic era (2019), the first year of the COVID-19 pandemic (2020), and the second pandemic year (2021). The study demonstrated a 35% reduction in newly diagnosed lung cancer cases and a 64% decline in lung cancer surgeries during the first year of the pandemic. In contrast, the number of newly diagnosed cases increased by 75% in the second pandemic year, with more than half of these patients presenting with advanced or metastatic disease. Furthermore, a significant rise in cases with multiple extrathoracic metastases was observed during the pandemic period. The authors also reported that radiosurgical treatment was utilized significantly more frequently in the first pandemic year compared with the pre-pandemic period [8].

In their study, Poucineau et al. in France used the French National Hospital Database to compare lung cancer cases observed during the pandemic years of 2020 and 2021 with estimates based on the pre-pandemic period of 2013–2019. They found that during the first wave of the pandemic specifically the March–June 2020 period there were 12% fewer new lung cancer cases than expected. They noted that this could be a significant effect of the pandemic, suggesting that some patients may have died before receiving a lung cancer diagnosis [9].

Jones et al., in their study evaluating trends and changes in thoracic surgery practices in Canada during the COVID-19 pandemic, noted that the pandemic significantly impacted perioperative care practices and delayed both benign and malignant thoracic surgery procedures [10].

Yang observed in his research on thoracic surgery practices during the COVID-19 pandemic that guidelines had been published in the US and Europe, and that the

majority of these guidelines were created for medical professionals and hospitals that were still able to treat cancer patients and had not yet been completely overtaken by the virus's effects. During the COVID-19 pandemic, these guidelines advised delaying all thoracic surgical procedures for lung adenocarcinomas resembling ground glass opacity with a diameter of less than 30 mm. They also recommended that patients with resectable stage IIIA-N2 disease undergo induction therapy prior to surgery [11]. We can also draw the following conclusion from this study: Identifying hospitals that have been less affected by the pandemic particularly to ensure the continued treatment of patients with life-threatening conditions such as cancer will prevent disruptions in the diagnosis and treatment of these patients and minimize the impact of the pandemic on their care.

These new arrangement within the hospital can help unsure the continuity of car efor thoracic oncology patients. At the start of the COVID-19 pandemic, a high-volume thoracic surgery center in Italy implemented a rapid restructuring process to both manage the outbreak and maintain the continuity of oncological surgery services. Some hospital departments were converted into Covid wards, while thoracic oncology surgery remained active with safe patient routes and strict infection control protocols. Thanks to these measures, only a limited decrease in surgical volume occurred during the pandemic, and no COVID-19 -related complications or infections developed during follow-up. This study demonstrates that thoracic oncology surgery can be safely continued even under pandemic conditions with clear protocols and disciplined practices [12].

All approaches to pandemic control were an important form of healthcare delivery, but some consequences were inevitable. One of these consequences was the unavoidable delay in diagnosis, detection of the disease in more advanced stages a decrease in surgical intervention rates, and the more widespread use of immuno-chemotherapy and stereotactic treatments [13].

The COVID-19 crisis led to an unprecedented disruption of cancer care systems across the globe, with numerous population-based registries reporting a substantial decrease in newly diagnosed malignancies between 2020 and 2022. Lung cancer, the foremost cause of cancer-related mortality worldwide, was particularly affected by this decline. Data from various national and regional cancer databases demonstrated a notable reduction in newly identified lung cancer cases compared with pre-pandemic levels in 2019. These reductions occurred in parallel with major healthcare restructuring, postponement of non-urgent imaging procedures, limitations on aerosol-generating diagnostic interventions such as bronchoscopy, and a marked hesitation among patients to seek medical attention. Rather than indicating a genuine decrease in tumor development, this pattern has been largely attributed to a pandemic-related "diagnostic deficit," reflected by a shift toward more advanced-stage disease at presentation due to delayed detection of early lesions. In fact, the convergence of data from several continents including the, United States, Romania, Scandinavian nations, Italy, Japan, and the United Kingdom provides strong evidence that the pandemic caused a global diagnostic deficit, which paradoxically worsened prognosis while drastically lowering observed Lung Cancer incidence in 2020 [14].

In the study conducted by Werner et al. from Switzerland severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and a severe course of the disease are more likely to occur in patients with non small cell lung cancer (NSCLC). Anatomical lung resections can be carried out safely during the pandemic, according to available data and our institution's experience, as the postoperative incidence of COVID-19 among patients receiving surgical resection for NSCLC is still comparatively low. Despite these encouraging results, worries about treatment delays and the possible increase in advanced-stage presentations still exist. Thus, throughout the COVID-19 pandemic, promoting lung cancer awareness and guaranteeing the continuation of oncological surgery remain crucial [15].

On the other hand, ın another study conducted despite delays in lung cancer screening during the COVID-19 pandemic, a single-centre study with carefully rescheduled radiological workflows reported an increase in Lung Imaging Reporting and Data System classification in many patients; however, the long-term adverse clinical outcomes associated with these delays were more limited than previously anticipated [16].

The effects of delays in primary healthcare on lung cancer detection were assessed in a study by Helsper et al. from the Netherlands. The results showed that the time for lung cancer diagnosis rose from 15 days to 41 days ($p < 0.01$). This showed that lung cancer patients' referral times to primary care had significantly increased. To maintain the accuracy and timeliness of cancer diagnosis during future pandemics or similar large-scale healthcare disruptions, general practitioners should adopt targeted approaches for the early identification and prompt referral of patient populations at increased risk of experiencing delays in access to primary healthcare services [17].

In the study by Villena Vargas et al. There were no differences in surgical complications prior to or during the COVID-19 pandemic, according to univariate analysis. Compared with the pre-pandemic period, during which no postoperative deaths were observed, lung cancer surgeries performed during the pandemic were associated with a 90-day mortality rate of 5%, with all fatalities attributed to COVID-19 infection. The authors

emphasized that COVID-19 infection developing within 90 days after surgery was strongly associated with mortality, highlighting the importance of close postoperative surveillance in this patient population [18]. A study conducted by Kirk et al. in Queensland, Australia, evaluated the impact of the COVID-19 pandemic on the delivery of lung cancer surgery services. The study demonstrated that the implementation of COVID-19-related restrictions resulted in significant delays between diagnosis and surgery, reduced surgical capacity, and impaired timely access to operative treatment, ultimately contributing to an increase in pathological tumor staging across the region [19]. The study by Berzenji et al. states that risk factors for SARS-CoV-2 infections are better understood and that patient subgroups with a higher probability of experiencing serious outcomes can be identified thanks to data from comprehensive, global registries. Patients requiring surgery for lung cancer constitute a specific patient subgroup with a much higher probability of contracting SARS-CoV-2 infection and higher morbidity and mortality rates. However, it has been noted that delaying cancer treatment is also associated with a higher mortality rate. This situation has led to challenging circumstances where medical professionals have to balance the benefits of surgery with the risk of contracting SARS-CoV-2 [20].

Throughout the pandemic, the indications for surgical treatment of NSCLC did not alter; nonetheless, because of the scarcity of healthcare resources, elective surgeries were often postponed. COVID-19 elective case triage guidelines based on hospital capacity and pandemic phase were released by the American College of Surgeons. Surgery was advised in a semi-urgent setting for individuals whose lives would probably be jeopardized if the procedure was delayed more than three months. Patients with solid or mostly solid (>50%) nodules, assumed lung cancer larger than 2 cm, N1-positive illness, and those who had finished induction therapy were included in this category specifically for lung cancer. Surgical intervention was only used in emergency scenarios for patients whose survival was predicted to be negatively impacted if surgery was not carried out within a few days [21].

The effect of the COVID-19 pandemic on treatment approaches for stage I NSCLC was examined in a study carried out in the Netherlands by van Vuren et al. It was reported that the COVID-19 pandemic had a major impact on lung cancer treatment, resulting in modifications to therapeutic approaches. Stereotactic radiation was mentioned as a surgical substitute. While the proportion of patients getting surgery fell during the epidemic, the number of patients with stage I NSCLC who got radiation therapy rose dramatically from 57% to 65% [22].

Early detection and surgical treatment are critical in the management of NSCLC, according to a Hungarian study by Ghimessy et al., with survival outcomes linked to early interventions and treatment delays linked to poor prognosis and disease progression. According to the study, the COVID-19 pandemic significantly impacted healthcare systems across the globe by interfering with diagnostic processes, limiting access to staging, and postponing elective surgical procedures. Consequently, the longer wait to surgery became a significant issue that can affect long-term oncological results. Therefore, assessing how pandemic-related disruptions affect surgery scheduling and survival is essential to comprehending the indirect oncological effects of global health crises and enhancing the future resilience of cancer care systems [23].

A preoperative history of COVID-19 did not raise the risk of postoperative complications in patients undergoing surgery for early-stage lung cancer, according to a study done in China by Niu et al. The results of prospective cohort studies conducted during a time when the Omicron variant was dominant and the majority of the population was fully vaccinated. They found that there was no significant correlation between the period from COVID-19 infection and surgery and the rates of postoperative complications, in contrast to the previously advised strategy of postponing surgery by 7–8 weeks. These results imply that surgical delays might not be required for all patients in the post-pandemic period and that current guidelines for surgical time should be reevaluated, especially in early-stage lung cancer patients who have had mild COVID-19 and are vaccinated [24].

In order to assess the impact of the COVID-19 pandemic on the care procedures and results of lung cancer patients, Peirelinck et al. from Belgium conducted a large-scale analysis based on data from the nationwide Belgian Cancer Registry. Patients diagnosed during the pandemic were found to have higher incidence of distant metastases and lower functional status. Additionally, early-stage illness was found to have a minor decline in surgical treatment rates and an increase in radiotherapy use. Even though unadjusted studies showed an increase in 90-day postoperative mortality, this difference became insignificant when the case mix was taken into account. However, the relative survival rates after one and three years did not significantly change. According to the study's findings, ongoing observation of long-term results is necessary [25].

In a retrospective investigation at a French lung cancer rapid diagnostic center, Wang et al. showed that the COVID-19 pandemic caused major delays in lung cancer care pathways. Pre-hospital and in-hospital intervals to diagnosis and treatment were considerably longer, even though the center continued to operate during the pandemic. Patients scheduled for surgical treatment had a

Table 1 Summary of included studies on the impact of the COVID-19 pandemic on lung cancer care

Author/Year	Country	Study Design	Key Findings
Dolan et al. (2022) [5]	USA	Retrospective	Decreased surgical volume; larger tumor size
Kato et al. (2023) [6]	Japan	Retrospective	Larger tumors in stage I disease
Cozma et al. (2024) [7]	Romania	Retrospective	Increased T stage
Kasymjanova et al. (2022) [8]	Canada	Cohort	35% reduction in new diagnoses
Poucineau et al. (2024) [9]	France	Nationwide database	12% fewer cases than expected
Helsper et al. (2023) [17]	Netherlands	Cohort	Diagnosis time increased from 15 to 41 days
Kirk et al. (2023) [19]	Australia	Retrospective	Pathological staging progression

particularly noticeable increase in the overall care timeline. These delays were believed to be related to reduced access to diagnostic and treatment facilities, postponed elective procedures, and restricted access to healthcare services during lockdown periods. Patients with localized lung cancer, who have the best chance of receiving a cure, were particularly affected. The results highlight the significance of ongoing monitoring of care delays during health emergencies and show that disruptions in care pathways may happen even when healthcare systems continue to operate during a pandemic [26].

Throughout the pandemic, the global crisis it created and the health system problems it caused were addressed in the literature through studies from many countries (Table 1). Each country's pandemic intensity, health system infrastructure, the health system's adaptation to the pandemic, its response capacity, societal adaptation, and level of access to vaccines were highly influential in combating both the pandemic itself and the other health crises it caused.

Multidisciplinary team meetings also underwent substantial changes during the pandemic. Many institutions adopted virtual multidisciplinary team platforms to maintain continuity of decision-making. Although these adaptations allowed ongoing discussions among thoracic surgeons, pulmonologists, oncologists, radiologists, and pathologists, reduced face-to-face interactions and logistical challenges occasionally delayed treatment planning and altered management strategies [27].

Conclusion

Overall, the accumulated global evidence demonstrates that although healthcare systems rapidly adapted to the COVID-19 pandemic, disruptions in diagnostic pathways, surgical capacity, and treatment accessibility led to delayed lung cancer care, more advanced disease at presentation, and significant challenges in maintaining oncological continuity. These findings underscore the critical need for resilient, pandemic-prepared cancer care systems that can sustain timely diagnosis and treatment during future global health crises. To minimize the impact of similar disruptions, healthcare systems should implement protected diagnostic pathways, ensure uninterrupted access to bronchoscopy and thoracic imaging for patients with suspected malignancy, establish prioritization protocols for operable lung cancer cases, and maintain dedicated COVID-free surgical and perioperative care pathways. Furthermore, comprehensive backlog recovery strategies and flexible resource-allocation models should be incorporated into emergency preparedness plans to preserve oncological outcomes and reduce avoidable cancer-related morbidity and mortality during future healthcare emergencies.

Abbreviations

COVID-19	Coronavirus disease 2019
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
NSCLC	Non small cell lung cancer

Acknowledgements

Not applicable.

Authors' contributions

All authors conceived and designed the research. RY supervised, directed, and managed the study. All authors wrote the manuscript and read and approved the final version to be published.

Funding

The authors declared that this study received no financial support.

Data availability

No datasets were generated or analysed during the current study.

Declarations

Competing interests

The authors declare no competing interests.

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Received: 11 May 2026 / Accepted: 9 July 2026
Published online: 16 July 2026

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