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The Pandemic Effect: The Outlook of Lung Transplantation

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PERSPECTIVE

The Pandemic Effect: The Outlook of Lung Transplantation

Running title: Google Trends & Lung Transplant

Keywords: COVID-19, ARDS, lung transplant, patient therapeutic education, Google Trends

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ABSTRACT

Lung transplant (LT) is a life-saving treatment for patients with end-stage lung disease. In the setting of COVID-19-associated acute respiratory distress syndrome (ARDS), LT emerged as a therapeutic option for select cases. It is challenging to determine the extent of the knowledge and interest the United States (US) general population has on LT as salvage therapy during and following the COVID-19 pandemic. It is the authors' opinion that patient therapeutic education (PTE) can directly influence established practices by creating an open channel of communication based on needs and expectations for healthcare services. This perspective is a cursory reflection of the nuances between healthcare providers, their services, the interests and expectations of the general population, specifically on LT following COVID-19.

The main endpoint of this study is to analyze the US general population's interest in LT as COVID-19 salvage therapy via the Google Trends (GT) web-kit tool.

Introduction

To date, over 87 million cases of COVID-19 infection have been reported in the United States (US) of which 4.8 million have required medical care hospitalization, nearly 200 thousand have been fully vaccinated (representing 66.8% of the US population), and a death-toll that surpasses 1 million patients¹. It is well evidenced that COVID-19 infection can potentially progress to acute respiratory distress syndrome (ARDS) and refractory hypoxemia requiring prolonged mechanical ventilatory support². Due to its clinical severity, 6 to 10% of infected patients will progress to a clinical severity, and consequently, 20 to 40% of these patients will inevitably result in the need of intensive care support³. Lung transplant (LT) is a life-saving treatment for multiple end-stage lung diseases. Owing to the number of patients requiring prolonged mechanical ventilation, extracorporeal support, and the high mortality risk when COVID-19-associated ARDS ensues, LT supervenes as a salvage therapy when medical therapy fails⁴. The COVID-19 pandemic

represented one of the most challenging health emergencies of our time. Thus, in the era of internet connectivity, the general population sought out healthcare alternatives in lieu of the inadequacy for treating the severity of COVID-19.

The ability of the general population for gathering information related to healthcare creates a significant gap between patients and healthcare providers. Due to the lack of access to trustworthy, peer-reviewed, professionally monitored, societal standardized sources of information, patient therapeutic education (PTE) impedes a knowledgeable understanding and adequate decision-making process when seeking healthcare⁵. While internet-based search engines have been long considered sources of healthcare information, a significant portion of this information can be biased, misleading, unclear, insufficient, and incomplete, further expanding the gap of proper PTE⁶. Google Trends is a web-kit tool providing access to a largely unfiltered sample of actual search requests made through the Google search engine. The data provided is anonymized, categorized, and aggregated, consequently allowing for a display of interest in a particular subject at a global or city-level geography⁷. Since the nature of this web-kit tool is to solely provide feedback on specific queries, the authors endeavored to determine how PTE has a bidirectional influence on contemporary healthcare and its therapies via the US population's general interest on LT following the COVID-19 pandemic.

Framework

Google Trends was used to access data searched for the term '*lung transplant*'. The gathered information included data from January 2016 through October 2021 within US territories. Search frequency, time intervals, sub-regions, frequent topics of interest, and related terms searches were analyzed. Data was reported as search frequency on means, and a value of 100 represented overall peak popularity. Upon assessment of the queried term, the number of Google searches related to *lung transplant* has sustained a steady increase in interest over time and surged in

congruence with the appearance of COVID-19 in the US. From January 2016, interest staggered at 29% and doubled to 58% interest at the end of 2021 (overall average of 40%).

Following the COVID-19 surge, average US population interest shifted upwards to 49%, with an all-time increase in November 2019, February 2020, and June 2020, of 82, 63, and 100%, respectively. Over the study time frame, the lead frequency of searches in sub-region, metro area, and cities, were Pennsylvania, Gainesville FL, and Philadelphia PA, respectively. Top related topic and top related query in search frequency over the queried time frame were *electronic cigarette* and *lung transplant covid*. **Figure 1** summarizes the US populations' interest over time and the percentages of said interest by sub-region⁸.

<<FIGURE 1 HERE>>

The query was subsequently extended towards the present date alongside comparative trendlines from the CDC's COVID-19 data tracker.

Discussion

With the emergence of LT as surgical therapy for COVID-19, to date, 3607 transplants have been performed in the US since 2021⁹. In spite of the scarcity of clinical practice reports describing the implications of LT in the COVID-19 patient regardless of the present status of this disease, it has been determined that patients with severe COVID-19 develop fibrotic lung disease for which LT is their only option for survival^{4,10}. Bearing this in mind, the application of LT for severe COVID-19 patients became available in parallel to other exploratory therapeutic alternatives in highly specialized centers. The time frame for the pandemic had an incongruent shift with the available therapies for a novel disease. This created an unequivocal gap between patients and healthcare providers. Given that COVID-19 infection spread was exponential and faster than its understanding and management, a myriad of unreliable information emerged. Following the

quarantine periods across the US, the general population sought out information for prevention and management of the COVID-19 infection. The associated queries were substantially focused on therapies in face of the severity and in rapport of the number of cases, hospitalizations, and deaths¹¹.

In performance of the present perspective analysis, an evident increase was observed alongside the death toll caused by COVID-19. **Figure 2** visually depicts how the highest death rate peak in May 2020 was followed by an unprecedented rate of interest of 100% by the US population on LT in June 2020^{1,8}. With the nation-wide availability of the COVID-19 vaccine in late August 2021, the overall deaths underwent a subsequent relevant increase on January 2022 and since then sustained a pre-pandemic average interest in LT. The unfiltered data provided by Google Trends is certainly a limitation for accuracy. Nevertheless, when comparing the trends provided by this web-kit tool to factual data recorded by the CDC, it becomes noticeable that queries from the general population are influenced by contemporary healthcare needs.

To further support this premise, the COVID-19 pandemic certainly disrupted science in 2020 and transformed scientific publications. It is estimated that 100,000 scientific articles about the coronavirus pandemic were published in 2020, representing 4% of the world's research output¹². The almost-immediate response on scientific data is encouraging for the healthcare provider as it conveys evidence-based support for adequate clinical practice. Albeit, proper healthcare is bidirectional and it requires a collaboration of both provider and patient. Science has become more difficult for non-specialists to understand. This is not a new input, rather an ongoing observation over the years. In a brief commentary on knowledge disparity, an exponential rise in lexical difficulty in *Nature*, *Science*, and *Scientific America* between 1930 and 1990, was observed¹³. Given that more than 10 million caregivers were directly impacted and employed during the COVID-19, the yielded efforts from clinical practice and research output certainly redirected the course of national healthcare regardless of the general population's understanding.

<<FIGURE 2 HERE>>

It is evident that there is a gap between access to information for healthcare providers and the general population. More so, many communicators of scientific information believe that it is difficult for people to process uncertainty in publications, thus resulting in the routinely simplification of science for public consumption¹⁴. In consequence, the PTE the general population receives is directly influenced by the lexicon complexity, difficulty of access, and adequate interpretation. Being that this brief perspective only reflects trends for surgical therapy, there is an implicit demand for scientific information monitoring in all branches of healthcare. The purpose in addressing this observation is the improvement of healthcare delivery and promoting preventive medicine rather than curative medicine alone.

The nature of this study is to highlight the clear temporal link between the course of the COVID-19 pandemic and the frequency of LT interest in a single nation. The correlation, observational in nature, remains speculative and its merely suggestive of the role healthcare providers, epidemic/pandemic factors, and the general population involvement have in a specific timeframe. The consequences of COVID-19 were devastating and, in a lower-degree of severity, still present. It is the authors' best interest to convey this study as a call to attention for the improvement in PTE in accordance to clinical practice.

Despite the obvious benefit of transplantation as therapeutic means for severe COVID-19 cases, LT withholds many concerns¹⁰. Nonetheless, the trends reflected by Google Trends show that the general population information-seeking behavior is driven by healthcare needs. Presently, the outcomes regarding solid organ transplantation and its direct consequences on recipients and transplantation programs during the COVID-19 pandemic has been comprehensively explored. Lung transplantation recipients were initially affected at a significant level. The current practice of LT has taken a turn and it is now suggested for the treatment of patients with severe SARS-

COVID-19 pneumonia¹⁵. Since the engagement of internet-users is based on their current reality and immediate needs, it is highly encouraged that the communication of therapies throughout the internet be focused on both user and healthcare providers alike. This assumption is yet to be reflected in clinical practice yet it poses the initiative of all providers to engage in the proper divulgence of information and directly improve PTE.

Conclusions

Google Trends complements the understanding of interest in lung transplantation, especially in consideration of the COVID-19 pandemic's perspective. When properly interpreted, the use of these trends can potentially improve on patient therapeutic education and therapy awareness via specific medical relevant websites.

Disclosure Statement

The authors have no financial conflicts of interest to disclose.

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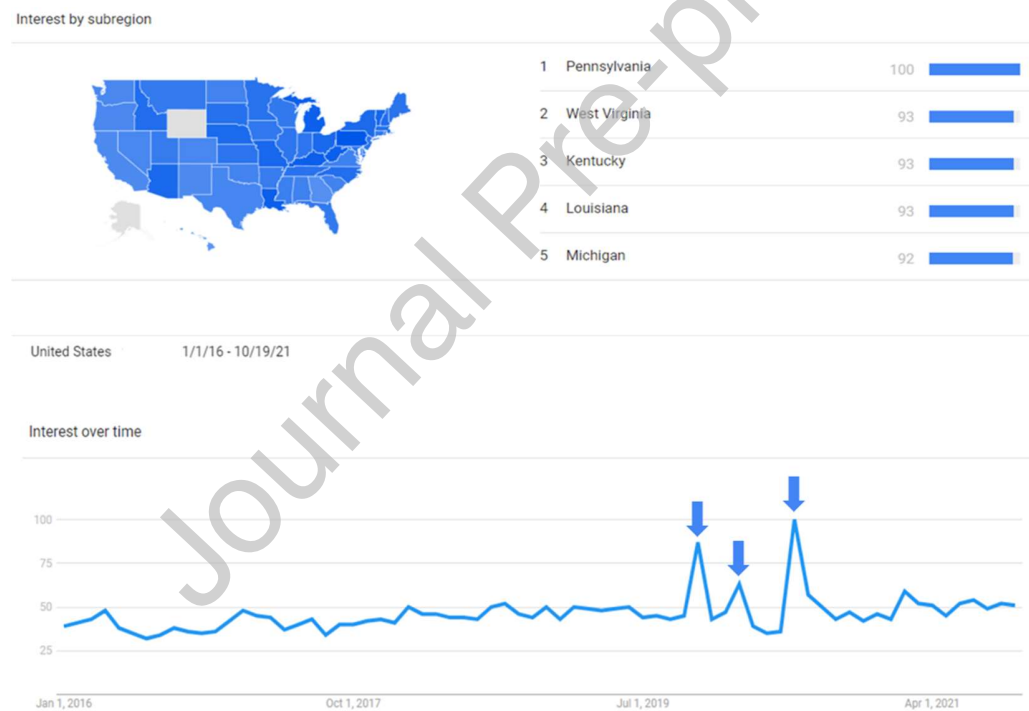
Figure 1

Top: Interest by subregion of COVID-19 and lung transplant in the US.
Bottom: Interest over time for the queried timeframe.

Figure 2

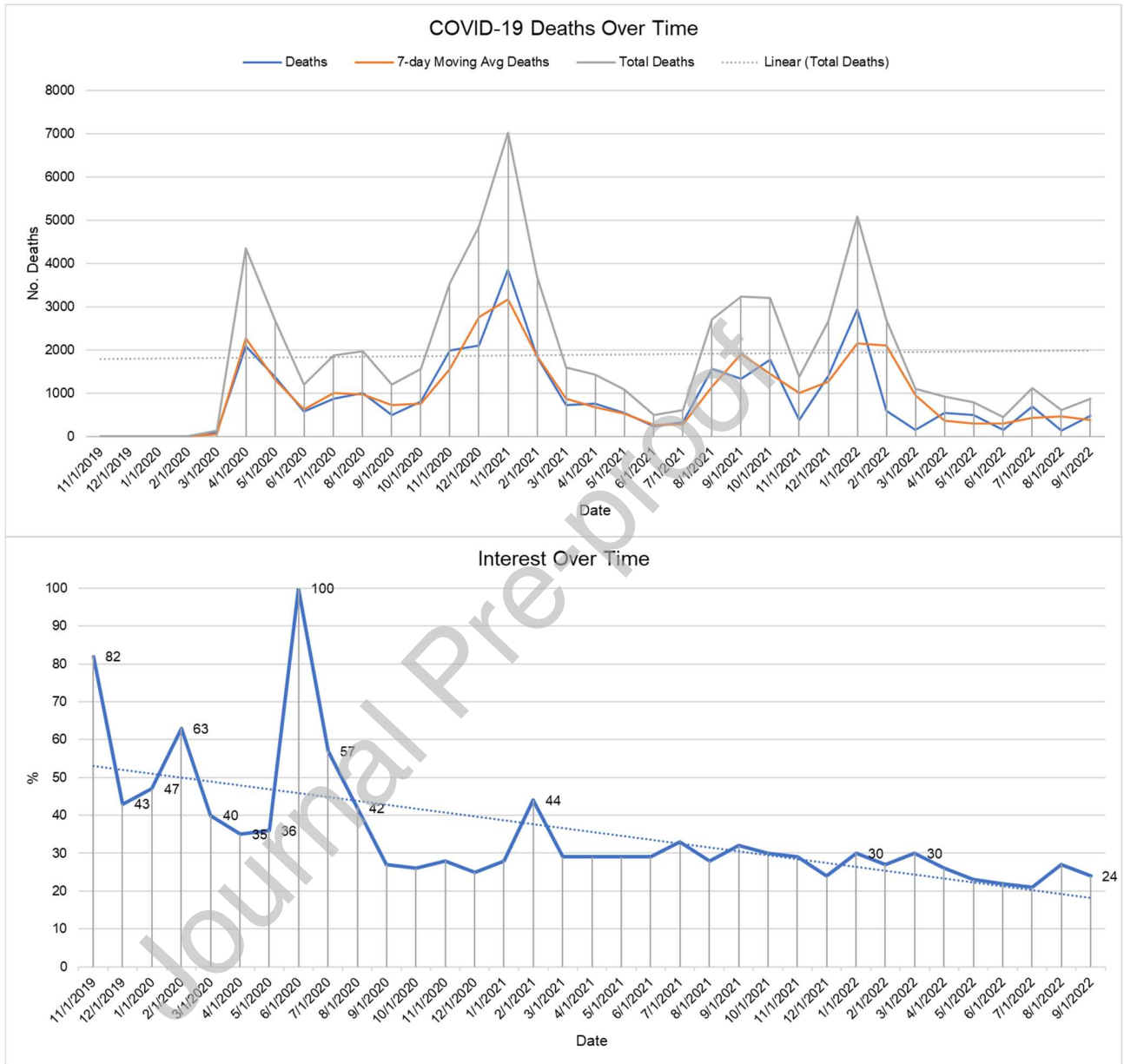
Top: Number of COVID-19 deaths over time in the US since first reported case.
Bottom: Lung transplant interest over time for the same time frame of COVID-19 presence in the US.

Figure 1



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