PharmacoEconomics (2020) 38:1149–1151
https://doi.org/10.1007/s40273-020-00959-7

COMMENTARY

On Pandemic Preparedness: How Well is the Modeling Community Prepared for COVID-19?

Kamal Desai[1] · Eric Druyts[1] · Kevin Yan[1,2] · Chakrapani Balijepalli[1]

Published online: 14 September 2020

1 Background

Since the outbreak of SARS-CoV-2, the number of globally confirmed cases of COVID-19 has surpassed 20 million while reported deaths now exceed 750,000 [1]. In the absence of effective vaccines, authorities have implemented various forms of social distancing, including travel bans, restrictions on gatherings, school closures, and confinement, guided in part by epidemiological models [2–6]. The pandemic has economic and social impacts felt beyond the health sector alone. Consumer retail, tourism, and travel are sectors that have been hard hit. Furthermore, social inequalities, which result in differential exposure to the virus and its consequences, cause some groups to be more affected and interventions less effective [7, 8]. For instance, lower socioeconomic groups or residents of long-term care facilities may have increased frailty, not be able to practice social distancing, or are more vulnerable to economic downturns. Meanwhile, the proliferation of epidemiological models assessing the effectiveness of social distancing and confinement strategies on cases and deaths has generally overlooked the inter-relationship with economic outcomes and social inequalities [2–6, 9, 10]. To comprehensively understand the impact of COVID-19, it is important to assess the economic, social, and health consequences, particularly as public health responses influence social and economic consequences felt beyond the health sector. Such analyses are needed for situational awareness to inform policy decisions and to better communicate them to the public.

In this context, we ask whether the epidemiology and health economics modeling communities are prepared to address the myriad of questions pertaining to the cost effectiveness of therapies or the effectiveness of public health interventions in a manner that incorporates economic and social dimensions associated with COVID-19. Some question types may be readily addressed with current economic evaluation methods, such as what is the cost effectiveness of adopting antiviral agents for hospitalized patients relative to current practices, while others may not, such as what are the costs and consequences to society across all sectors of re-opening specific segments of society or the economy compared to maintaining the status quo?

However, several inter-related issues limit the conduct of an economic evaluation for a public health emergency of the type and magnitude of COVID-19. These issues relate to the multi-sector societal perspective needed for the analysis, the measurement of costs and effects, healthcare capacity constraints, and technical adaptations needed for epidemiological models. We suggest that pre-pandemic priorities along with methodological and practical issues limit the scope of what modeling communities have been able to assess. Collaborations amongst modelers from epidemiology, health economics, and potentially macroeconomics would help with current limitations.

2 Current Preparedness and Practices

Many governments and agencies have adopted pandemic influenza preparedness plans, whose primary goal has been to minimize illness, deaths, and societal disruption through integrated surveillance, modeling, and infection control [11–13]. However, these plans and models do not typically include a component to assess the economic or social impact of a pandemic under various public health strategies while explaining the distribution of these costs and benefits across sectors of the economy or socioeconomic classes [14, 15]. Previous outbreaks have demonstrated the need for a cross-sectoral societal perspective.

✉ Kamal Desai
kamal.desai@pharmalyticsgroup.com

[1] Pharmalytics Group, 422 Richards Street, Suite 170, Vancouver, BC V6B 2Z4, Canada

[2] Faculty of Medicine, University of British Columbia, Vancouver, BC, Canada

The 2013–2015 Ebola crisis in West Africa, the 2015 Zika outbreak in Latin America, the 2003 SARS outbreak, and the 2009 H1N1 outbreak had cross-sectoral impacts seen in national declines in gross domestic product [16]. The 2003 SARS outbreak affected sectors other than healthcare with the bulk of the estimated US$30 billion to US$100 billion cost falling on travel and tourism sectors [14]. H1N1 was reported to cost Mexico's tourism industry $2.1 billion [14].

Although recommendations exist for a societal perspective that requires relevant costs and benefits including those incurred outside the health sector to be considered, there is no consensus on consistent methods to extend an analysis that would permit costs and outcomes from different sectors to be combined [17]. As an example, there would need to be consensus on whether the incremental cost-effectiveness ratio (cost per quality-adjusted life-year), which is a central summary outcome used in health economics, would be suitable to capture impacts outside the health sector, or whether it could reflect socioeconomic impacts adequately (e.g., as for employment precarity in a pandemic setting). Relevant guiding examples for cross-sector impact analysis from the literature are sparse; one approach used a macroeconomic model to assess the impact of an influenza epidemic in Europe to quantify costs of deaths, absenteeism, as well as consumption shocks by sector [14, 18]. However, most health economic models, especially those developed for health technology assessments, for non-communicable conditions, have not required a societal perspective, measuring only direct healthcare costs (e.g., drugs, hospital stays, and healthcare workers' time) and benefits to those directly receiving treatment. Many economic models also tend to overlook individual heterogeneities, whether clinical, epidemiological, socioeconomic, or otherwise. Epidemiologic models for communicable diseases more generally adopt a societal view and may incorporate individual heterogeneities, but they also limit their analysis to health outcomes only or to the health sector [19].

A further issue relates to healthcare capacity. Typical economic evaluations assume that the new intervention introduced into a health system finds the capacity and elasticity to accommodate it without a noticeable need to change the healthcare infrastructure. Furthermore, there is no consideration on whether the new technology crowds out other health services. These assumptions are unjustified in the COVID-19 pandemic, where elective surgeries are postponed under a pandemic response whose primary goal of flattening the curve is to ensure sufficient acute care capacity. An economic framework for COVID-19 needs to consider capacity and service displacement. Not doing so would underestimate cost where new healthcare infrastructure may be created or would overestimate health gains where there may be declines in other health services [20, 21].

3 Adapting Models for a Way Forward

Traditionally, interests of modelers from health economics, epidemiology, and macroeconomics have not much overlapped, but collaborations could improve upon current limitations and practices. Infectious disease modeling has a long history during which time sophisticated methods have been developed to simulate a variety of population heterogeneities, contact patterns, behaviors, and the dynamics of disease spreading within it. This know-how can be leveraged to facilitate the addition of an economic component, which has not been a priority to date within the epidemiology community. This could be achieved with existing model types that normally stratify populations on epidemiologically relevant criteria to further stratify on sector-specific or socioeconomic criteria, permitting a finer examination of strategies directed at economic sectors as well as epidemiological or socioeconomic subgroups (e.g., differential social distancing by risk group or economic sector) and the estimation of outcomes specific to those affected groups. Understandably, this will increase the complexity of the model's description of contact patterns but not necessarily the underlying mathematical methods. Additional data would also be needed, for example, on population distribution across economic sectors, owing to the finer stratification.

Further thought could be given on how a model's structure could be extended to a macroeconomic framework. For instance, agreement is needed on whether economic impact based on illness, death, and productivity losses is sufficient or whether it should be extended to include, for example, changes in consumption or personal assets. Ideally, an appropriately constructed framework that takes a fully societal perspective would quantify health and economic outcomes for different epidemiological and socioeconomic strata and by economic sectors under different public health scenarios.

4 Conclusion

While it is difficult to predict how the COVID-19 pandemic will change and when the threat will subside, a wide variety of potential pharmacotherapies are under study. At least one antiviral agent, remdesivir, has been approved in several countries for emergency use for hospitalized patients [22, 23]. It is likely that combinations of pharmacotherapies, social distancing, and an eventual vaccine will be the basis of an evolving public health strategy. Against this changing background, a variety of questions related to optimal control strategies will continue to be asked,

and increasingly, the economic and social costs should be part of the decision making. In this respect, there should be an important role for modelers that combines expertise across disciplines.

Author Contributions Kamal Desai performed the conceptualization and drafted and edited the article. Eric Druyts, Kevin Yan, and Chakrapani Balijepalli provided supervision, performed the conceptualization, and reviewed and edited the article. All authors reviewed, added value, and approved the final version of this manuscript.

Funding No funding was provided for this work.

Compliance with Ethical Standards

Conflict of Interest Kamal Desai, Eric Druyts, Kevin Yan, and Chakrapani Balijepalli have no conflicts of interest that are directly relevant to the content of this article.

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent for publication Not applicable.

Availability of data and materials Not applicable.

Code availability Not applicable.

References

1. World Health Organization. Coronavirus disease 2019 (COVID-19) situation report—209. 2020. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200816-covid-19-sitrep-209.pdf. Accessed 2 Sept 2020.
2. Giordano G, Blanchini F, Bruno R, Colaneri P, Di Filippo A, Di Matteo A, et al. Modelling the COVID-19 epidemic and implementation of population-wide interventions in Italy. Nat Med. 2020;26(6):855–60.
3. Imperial College London. COVID-19. 2020. https://www.imperial.ac.uk/mrc-global-infectious-disease-analysis/covid-19/. Accessed 2 Sep 2020.
4. Aleta A, Martín-Corral D, Pastore Y Piontti A, Ajelli M, Litvinova M, Chinazzi M, et al. Modelling the impact of testing, contact tracing and household quarantine on second waves of COVID-19. Nat Hum Behav. 2020. https://doi.org/10.1038/s41562-020-0931-9.
5. Hellewell J, Abbott S, Gimma A, Bosse NI, Jarvis CI, Russell TW, et al. Feasibility of controlling COVID-19 outbreaks by isolation of cases and contacts. Lancet Glob Health. 2020;8(4):e488–e496496.
6. Kissler SM, Tedijanto C, Goldstein E, Grad YH, Lipsitch M. Projecting the transmission dynamics of SARS-CoV-2 through the postpandemic period. Science. 2020;368(6493):860–8.
7. Abrams EM, Szefler SJ. COVID-19 and the impact of social determinants of health. Lancet Respir Med. 2020;8(7):659–61.
8. Burström B, Tao W. Social determinants of health and inequalities in COVID-19. Eur J Public Health. 2020;30(4):617–8.
9. medRxiv. COVID-19 SARS-CoV-2 preprints from medRxiv and bioRxiv. 2020. https://connect.medrxiv.org/relate/content/181. Accessed 2 Sep 2020.
10. Goldsztejn U, Schwartzman D, Nehorai A. Public policy and economic dynamics of COVID-19 spread: a mathematical modeling study. medRxiv; 2020.
11. Government of Canada. Canadian pandemic influenza preparedness: planning guidance for the health sector. 2018. https://www.canada.ca/en/public-health/services/flu-influenza/canadian-pandemic-influenza-preparedness-planning-guidance-health-sector.html. Accessed 2 Sept 2020.
12. World Health Organization. A checklist for pandemic influenza risk and impact management. 2018. https://www.who.int/influenza/preparedness/pandemic/influenza_risk_management_checklist_2018/en/. Accessed 2 Sept 2020.
13. Public Health England. Pandemic influenza response plan 2014. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/344695/PI_Response_Plan_13_Aug.pdf. Accessed 2 Sept 2020.
14. Keogh-Brown MR, Smith RD, Edmunds JW, Beutels P. The macroeconomic impact of pandemic influenza: estimates from models of the United Kingdom, France, Belgium and The Netherlands. Eur J Health Econ. 2010;11(6):543–54.
15. Pasquini-Descomps H, Brender N, Maradan D. Value for money in H1N1 influenza: a systematic review of the cost-effectiveness of pandemic interventions. Value Health. 2017;20(6):819–27.
16. Smith KM, Machalaba CC, Seifman R, Feferholtz Y, Karesh WB. Infectious disease and economics: the case for considering multisectoral impacts. One Health. 2019;7:100080.
17. Sanders GD, Neumann PJ, Basu A, Brock DW, Feeny D, Krahn M, et al. Recommendations for conduct, methodological practices, and reporting of cost-effectiveness analyses: second panel on cost-effectiveness in Health and Medicine. JAMA. 2016;316(10):1093–103.
18. Keogh-Brown MR, Wren-Lewis S, Edmunds WJ, Beutels P, Smith RD. The possible macroeconomic impact on the UK of an influenza pandemic. Health Econ. 2010;19(11):1345–60.
19. Jit M, Brisson M. Modelling the epidemiology of infectious diseases for decision analysis. Pharmacoeconomics. 2011;29(5):371–86.
20. Vassall A, Mangham-Jefferies L, Gomez GB, Pitt C, Foster N. Incorporating demand and supply constraints into economic evaluations in low-income and middle-income countries. Health Econ. 2016;25(Suppl. 1):95–115.
21. Hauck K, Morton A, Chalkidou K, Chi YL, Culyer A, Levin C, et al. How can we evaluate the cost-effectiveness of health system strengthening? A typology and illustrations. Soc Sci Med. 2019;220:141–9.
22. U.S. Food and Drug Administration. Coronavirus (COVID-19) update: FDA issues emergency use authorization for potential COVID-19 treatment. 2020. https://www.fda.gov/media/137564/download. Accessed 2 Sept 2020.
23. Thorlund K, Dron L, Park J, Hsu G, Forrest JI, Mills EJ. A real-time dashboard of clinical trials for COVID-19. Lancet Digit Health. 2020;2(6):e286–e287287. https://doi.org/10.1016/S2589-7500(20)30086-8.