Anaesth Crit Care Pain Med 41 (2022) 101056

Contents lists available at ScienceDirect

Anaesthesia Critical Care & Pain Medicine

journal homepage: www.elsevier.com

Editorial

From descriptive epidemiology to interventional epidemiology: The central role of epidemiologists in COVID-19 crisis management

ARTICLE INFO

Keywords:
Epidemiology
Public health
COVID-19
Health crisis management

The topic of epidemiological modelling in the context of the COVID-19 pandemic has not only been central to many scientific developments but also, and perhaps most importantly, has had very strong direct implications for crisis management. The search in the PubMed database with the keyword "epidemiological model COVID" retrieved 1669 scientific publications published between September 2020 and February 2022!

In the April issue of *Anaesthesia Critical Care & Pain Medicine* is published a series of updates describing the extent to which clinical epidemiology has been an indispensable tool in the management of the health crisis in France, in Europe and more generally, around the world.

1. Toward an interventional epidemiology?

The COVID-19 pandemic has certainly been exceptional, but it is not the first global health crisis in our modern history. Indeed, the H1N1 pandemic in 2009 [1] and the Ebola epidemic in West Africa in 2013–2016 [2] were recent opportunities to increase the interest in epidemiological modelling, as mentioned by Crépey et al. in their contribution to this issue [3].

The compelling need to develop epidemiological models was first identified in a report by scientists at Imperial College at the end of February 2020 [4], as discussed by Sofonea et al. in this issue [5].

During the COVID-19 pandemic, epidemiological models have become the cornerstone of crisis management, as they made it possible to better understand the spread of SARS-CoV-2, to predict future risk and to assess control strategies. These models have allowed us to stay one step ahead and thus to better adapt our capabilities for the management of COVID-19 patients. From then on, epidemiological tools have been used not only to describe the pandemic but also to support crisis management decisions. Table 1 summarises the main fields of interventions for epidemiological modelling in the context of the management of the COVID-19 pandemic.

Numerous epidemiological studies have focused on determining the exposures associated with COVID-19 infections [6], with the idea of obtaining decision support tools for enhanced and targeted control of these exposures to limit the spread of the virus. As pointed out by Colosi et al., school closures have been a widely used measure in the first year of the pandemic for this purpose [7]. However, the impact of these school closures has not been negligible for children's well-being and mental health, and modelling work specifically studying school closures has helped determine a balance between controlling the spread of the virus and maintaining a satisfactory educational offer.

COVID-19 pandemic's impact on hospitals was threefold: an influx of patients with COVID-19, a significant risk of nosocomial infections, and an impact on health care professionals, causing absenteeism. Particular efforts regarding modelling nosocomial transmission have been made, allowing for a better understanding as discussed by Opatowski et al. in their contribution to this issue [8]. Other epidemiological studies have rapidly alerted researchers to the risk of nosocomial infections, particularly in patients admitted for surgery, where the acquisition of a COVID-19 infection in the hospital is associated with an increase in morbidity and mortality [9]. These results led to recommendations for a preoperative screening strategy [10].

Finally, mathematical modelling was also used to unravel some key aspects of host-pathogen interactions [11]. Within-host models of SARS-CoV-2 have been used to model viral kinetics and its impact on virus spread and the theoretical effects of new treatments.

However, it should be noted that epidemiological models have limitations. The main limitation is that they are all based on assumptions. Even if these assumptions are based on previous knowledge, data and observations, they may be partially incorrect, requiring an update of the model. Thus, the main assumptions considered were the contagiousness and severity of the virus strain, the effects of mitigation measures, the effect of natural immunity, the effect of immunity induced by vaccination and the effectiveness of medical management. It has been clearly demonstrated that all these variables have evolved over time, requiring constant adaptations of the models.

2. Open access to (good) data: the key to success!

Building an epidemiological model requires access to robust epidemiological data. To be useful, the data that is made available must be of good quality, *i.e.*, unbiased, understandable and

https://doi.org/10.1016/j.accpm.2022.101056

Table 1
Main areas of epidemiological modelling interventions in the management of the COVID-19 pandemic.

Forecast impact on health care
Adaptation of COVID-19 health care offerings
Maintenance of a minimum capacity for non-COVID-19 health care
Decision support for mitigation measures
Effects of social distancing measures (including school closures)
Determination of exposures associated with COVID-19 infections
Limiting admission to public facilities
Hospital admission rules to limit nosocomial infections
Modelling of a strategic medical evacuation plan
Definition of a threshold for triggering the plan
Definition of the number of people to be evacuated
Decision support for COVID-19 vaccination policies
Determining priority audiences
Development of a booster dose administration strategy
To predict the effects of pharmacological interventions using within-host models of SARS-CoV-2

frequently updated. Very quickly, many countries gave access to the data produced by their information systems. France has been particularly active in this area, making hospitalisation data (SIVIC database), test data (SI-DEP database) and vaccination data (COVID-19 vaccine database) available via the https://www.data.gouv.fr website.

Thus, many teams in France and teams around the world have contributed to the epidemiological modelling of COVID-19. Far from being an unproductive competition, a worldwide collaboration has been created, even including the creation of a space for sharing different modelling approaches (for example, the European COVID-19 Forecast Hub, https://covid19forecasthub.eu).

Beyond epidemiological modelling, open science has also led to the sharing of technological solutions facilitating crisis management, particularly through decision-making tools for health care structures, as discussed by Garaix et al. [12].

3. The management of COVID-19 is also the management of non-COVID-19

After the initial shock of the first waves successively affecting different continents, epidemiological modelling was used to model the maintenance of the non-COVID-19 health care offerings. Indeed, the management of the first waves of COVID-19 patients was largely to the detriment of the management of non-COVID-19-related pathologies. The impact on the prognosis of non-COVID-19 patients has been modelled; the example of the delay in diagnosis of breast cancer is particularly noteworthy. Using the theoretical frameworks of three established cancer intervention and surveillance modelling network breast cancer models, Alagoz et al. predicted that the initial pandemic-related disruptions in breast cancer care will have a small but significant long-term cumulative impact on breast cancer mortality [13].

Here, again, epidemiological modelling has contributed to the reflection on the adaptation of care offerings with the goal of maintaining non-COVID-19 care offerings in parallel with the adaptation of the care system for the management of patients infected by SARS-CoV-2.

4. Conclusion and perspectives

Epidemiological modelling provides reliable and objective information for decision-makers to consider the different options. However, as pointed out by Crepey et al. [3], "making the choice remains a political decision". In fact, the decision-making process not only considers the need to face the pandemic and to take the best possible care of our patients but must also consider other realities: social and psychological consequences, consequences on the management of non-COVID-19 diseases, etc. To put it another way, epidemiological modelling was one of the tools that allowed decision-makers to manage the constant uncertainty during this crisis.

More than two years after the beginning of the pandemic, our health system response has improved thanks to progress in treatments, testing strategies, prevention (through social distancing and especially through vaccination) and the improvement of our capacity to model the pandemic. It is in this respect that epidemiologists, such as physicians, nurses and health system managers, have made major contributions to the fight against COVID-19.

Disclosure of interest

The authors declare that they have no competing interest.

Acknowledgments

None.

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