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Lessons learned from model-based economic evaluations of COVID-19 treatments under pandemic circumstances: results from a systematic review

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Objective

To analyse key methodological characteristics of model-based economic evaluations of COVID-19 treatments, especially focused on model choices which pertain to disease dynamics, model structure, and long-term sequelae.

Methods

A narrative synthesis using a systematic literature review including A) full economic evaluations of B) pharmaceutical treatments against COVID-19 C) using a decision-analytic model. Not included: studies focusing on vaccines, diagnostic techniques, non-pharmaceutical interventions, and hospital-level treatment strategies; trial-based and "partial" economic evaluations. The search was last rerun on July 22, 2023.

Topic	Value	No. studies (%)
Continent	North America	12 (44.4)
	Asia	8 (29.6)
	Europe	6 (22.2)
	Africa	1 (3.7)
Type of economic evaluation	Cost-effectiveness analysis	10 (37.0)
	Cost-utility analysis	17 (63.0)
Model structure	Markov model	6 (22.2)
	Decision tree	8 (29.6)
	Decision tree + Markov model	6 (22.2)
	Epidemiological model	2 (7.4)
	Epidemiological model + Markov model	4 (14.8)
	Partitioned survival	1 (3.7)

	Most influential parameters on the results	No. studies
1	Treatment effect of the intervention	18
2	Costs of intervention and hospitalization	10
3	Risk of disease progression	6
4	Probability of infection / COVID-19 incidence	5

	Frequently reported limitations*	No. studies
1	Lack of (significant) evidence of treatment effectiveness	11
2	Imprecise cost estimates for resources and drug treatment	10
3	Impact of pandemic evolution and policy choices on outcomes of analysis	9
4	(Partial) omission of adverse events or contra-indications of the intervention	9

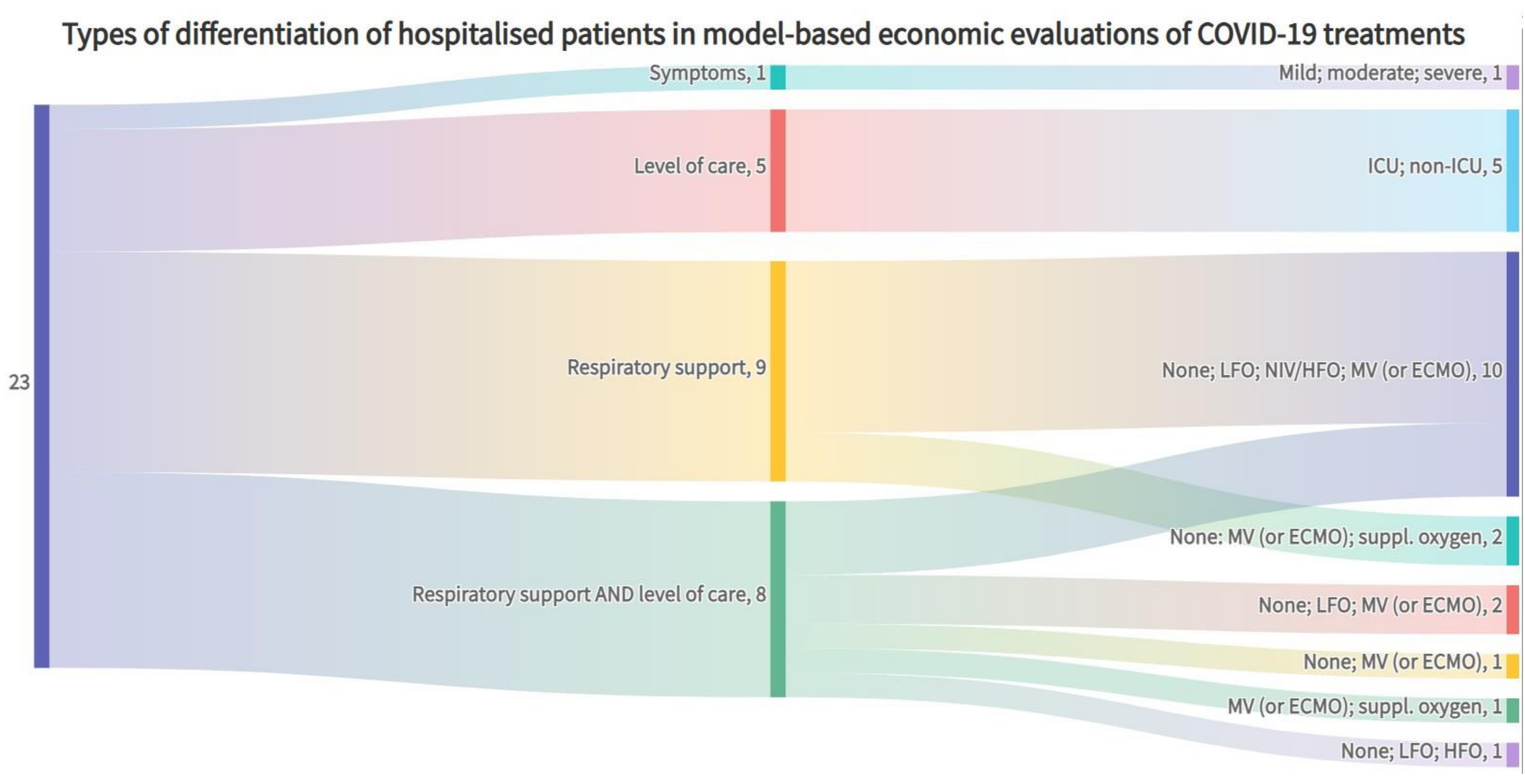
*: limitations specifically related to the context of the analysis and model structure were mentioned in one-third of the studies.

Conclusion

The results illustrate the differences in modelling COVID-19 treatments. Researchers, health technology assessment (HTA) agencies as well as pharmaceutical suppliers could benefit from the results and gain a better understanding of the challenges and needs for best modelling practices in the field of infectious diseases for the future.

Main findings

Of the 1,047 records identified, **27** were included. Frequencies of some study characteristics are displayed in the upper table on the left. ◆ 23 studies (85%) differentiated patients by disease severity in the hospitalisation phase. Patients were differentiated by type of respiratory support, level of care management, a combination of both, or symptoms (*see diagram below*). ◆ Six state-transition models included more than one hospitalisation state and allowed for transition between these states. The post-acute phase was differently composed across models, ranging from a two-state model ('alive-dead') to the inclusion of a 'rehospitalisation' or 'recovered with long-term sequelae' health state. ◆ Of ten studies with a lifetime horizon, seven adjusted general population estimates to account for long-term sequelae (i.e. mortality, quality of life, and costs), lasting for one year, five years or a patient's lifetime. Adjustments were applicable to all patients discharged, patients discharged after mechanical ventilation, or patients with moderate or severe health issues. Two other studies adjusted only quality of life parameters, whereas one study did not account for long-term sequelae. ◆ Not unexpectedly, treatment effectiveness was the most often reported parameter influencing the outcome of the analysis. ◆ Limitations frequently reported in the studies were mainly dependent on the study context, methods used, and the actual emergency of COVID-19 (*see table on the left*).



Abbreviations: ECMO = extracorporeal membrane oxygenation; HFO = high-flow oxygenation; ICU = intensive care unit; LFO = low-flow oxygenation; MV = mechanical ventilation.

Recommendations

- Although a general model structure for a specific disease (like COVID-19) applicable to multiple countries would be a solution to increase consistency across studies, healthcare systems and capacities as well as treatment pathways vary per jurisdiction. Therefore, health authorities should increase transparency of clinical pathways and clearly define the different compartments of healthcare systems that are frequently applied in decision-analytic models.
- To improve dynamic properties, time-dependent health economic models of COVID-19 treatments should incorporate several (respiratory support) health states for in the hospitalization phase and include the possibility to shift between these health states.

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