

ECONOMIC EVALUATION OF EXTRACORPOREAL MEMBRANE OXYGENATION (ECMO) V/S INVASIVE VENTILATION FOR COVID-19 PATIENTS WITH SEVERE ACUTE RESPIRATORY DISTRESS SYNDROME (ARDS)

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ABSTRACT

Objectives: Most of the clinicians use invasive mechanical ventilation in COVID- 19 patients with moderate or severe Acute Respiratory Distress Syndrome and in those who have substantial gas exchange anomalies in the setting of possibly reversible acute respiratory failure may benefit from Extracorporeal Membrane Oxygenation (ECMO) as a salvage therapy. This research aims to assess the cost- effectiveness of use of VV- ECMO when compared to that of invasive mechanical ventilation, in COVID- 19 patients with ARDS.

Methods: In individuals infected with Covid-19, a cost-effectiveness analysis was performed comparing Venovenous Extracorporeal Membrane Oxygenation (VV- ECMO) to that of invasive mechanical ventilation. A decision tree was constructed using data from previously published studies and other government websites comparing the use of VV- ECMO to that of invasive mechanical ventilation in COVID- 19 patients with severe ARDS.

Results: VV- ECMO when used in COVID-19 ARDS patients gains 1.89 QALY, in the time horizon of one month whereas invasive mechanical ventilation mode gains only 0.48 QALY with an ICER value of ₹ 3,35,311.78 per QALY gained. When the WTP is greater than ₹ 4,00,000, VV- ECMO is almost 85% cost effective. One- way sensitivity analysis reveals that the uncertainty in the probability of patients alive after receiving VV- ECMO, probability of patients having no adverse reaction after receiving VV- ECMO and cost of VV- ECMO, have the greatest impact on the ICER.

Conclusion: Although managing COVID- 19 patients with ARDS with VV- ECMO is comparatively costlier than that of managing with invasive mechanical ventilation in monetary terms, the QALY gained is fairly higher in case of VV- ECMO and is cost effective. It was also observed from the studies that there is reduced length of stay in patients under VV- ECMO compared to the alternative.

BACKGROUND

Acute respiratory distress syndrome or ARDS and lung failure are the major lung diseases observed in patients diagnosed with COVID-19 disease. It is characterized by life- threatening impairment of pulmonary gas exchange, which results in hypoxemia, hypercapnia, and respiratory acidosis. Mechanical ventilation and other supportive therapies are the major treatments in such cases. Ventilator settings, positioning therapy and other supportive measures are essential to improve the survival of an individual with severe ARDS. Most of the clinicians use invasive mechanical ventilation in patients with moderate or severe ARDS. Patients with ARDS who have substantial gas exchange anomalies in the setting of possibly reversible acute respiratory failure may benefit from ECMO as a salvage therapy and is thus termed as respiratory ECMO. Extracorporeal membrane oxygenation or otherwise known as ECMO is an artificial life support machine used across the globe. There are two types of ECMO. Venoarterial (VA) ECMO can be used for heart and lung support, while venovenous (VV) ECMO is used for lung support only. The mode is chosen based on the patient's illness.

OBJECTIVE OF THE STUDY

The goal of this economic evaluation is to assess the cost-effectiveness of use of Extracorporeal Membrane Oxygenation (ECMO) when compared to that of Non- invasive Ventilation (NIV), in patients with Acute Respiratory Failure (ARF).

PICO

Patients: COVID- 19 patients with acute respiratory distress syndrome (ARDS)
Intervention: Venovenous (VV) Extracorporeal Membrane Oxygenation (ECMO)
Comparator: Invasive Mechanical Ventilation
Outcomes:
·Incremental cost-effectiveness ratio
·Net Health Benefit
·QALYs Gained
Time Horizon: One month
Study Perspective: Patient
Currency: INR (₹)

CONTACT

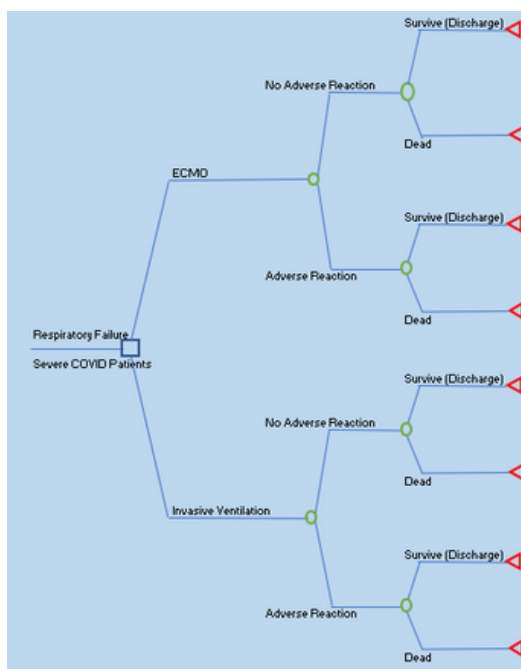
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METHODS

Cost-effectiveness analysis lays the path for prioritization and earmarking of healthcare interventions. In individuals infected with Covid-19, a cost-effectiveness analysis was performed to compare the cost-effectiveness of Venovenous Extracorporeal Membrane Oxygenation (VV- ECMO) vs invasive mechanical ventilation.

DECISION TREE:

A decision tree was constructed using data from previously published studies and other government websites comparing the use of VV- ECMO to that of invasive mechanical ventilation in COVID- 19 patients with severe ARDS.



Microsoft Excel was used to develop the model and calculate the results. Data from published literature was used to compile the data for the cost-effectiveness analysis. When there was a dearth of data, an expert's opinion was considered.

This model included several probabilities of developing adverse events in both the scenarios, probabilities of death attributed to adverse events and without adverse events, and probabilities of surviving post adverse events and without adverse events. Utility weights on the other hand, were calculated using beta, gamma and normal distributions.

QALYs (Quality Adjusted Life Years) are the result of a cost-effectiveness analysis, and they indicate both the quality and quantity of life associated with various health conditions. The length of life and quality of life, or utility ratings, for each health condition are used to calculate QALYs. The utilities are rated on a scale of 0 to 1, with 0 denoting death and 1 denoting optimum health.

The cost-effectiveness threshold was considered in the terms of GDP per capita. Various degrees of willingness to pay were put into the model to anticipate the probability of ECMO being a cost-effective mode of treatment in COVID- 19 patients with severe ARDS.

SENSITIVITY ANALYSIS:

A Monte Carlo Stimulation with 1,000 repetitions was also performed to account for the heterogeneity. The PSA results were used to create a cost-effectiveness plane. A main output of a PSA is the proportion of outcomes that fall favorably (i.e., are considered cost-effective) in comparison to a particular cost-effectiveness threshold. To demonstrate this, a cost-effectiveness acceptability curve could be employed. The threshold for India was calculated to be Rs 1,46,000.

RESULTS

BASE CASE RESULTS:

	ECMO	IV
EXPECTED BENEFIT	1.89	0.48
EXPECTED COST	₹ 8,51,210.57	₹ 3,78,840.09
Per Life years Gained	₹ 4,49,959.33	₹ 7,84,348.01
ICER	₹ 3,35,311.78	

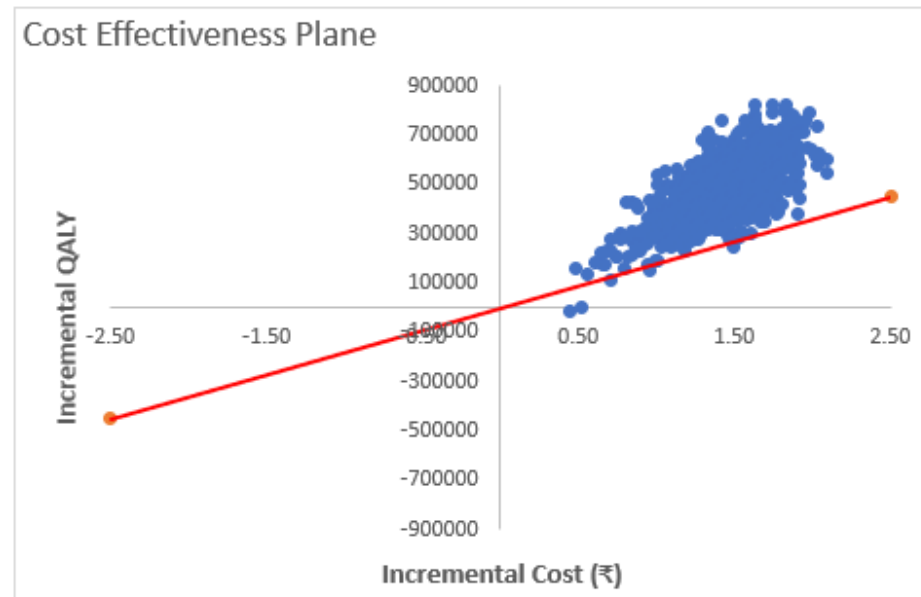
Base-case results of model analyses, which revealed that VV- ECMO when used in COVID-19 ARDS patients gains 1.89 QALY, in the time horizon of one month whereas invasive mechanical ventilation mode gains only 0.48 QALY. The ICER for ECMO compared to that of invasive mechanical ventilation was calculated ₹ 3,35,311.78.

PSA RESULTS:

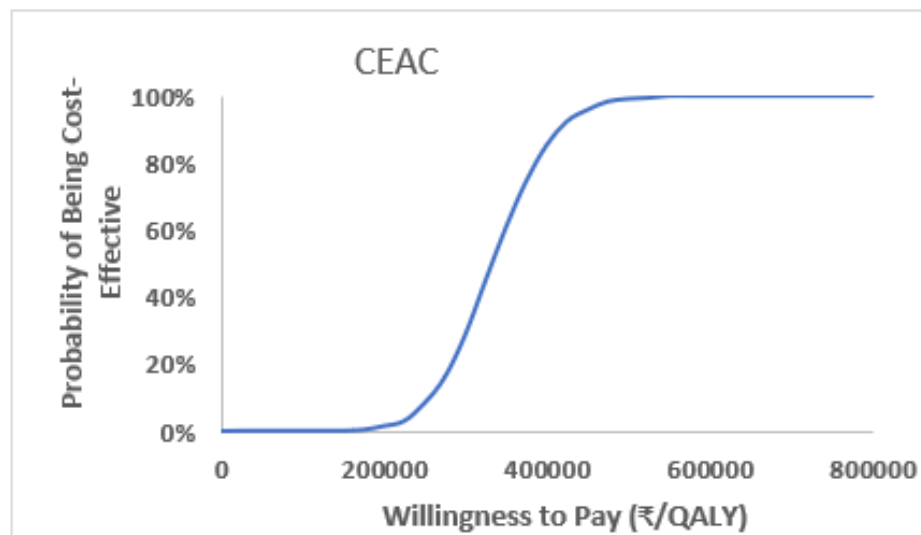
A Monte Carlo simulation of 1000 iteration was performed to deal with the uncertainty of the variables that affect the outcomes. The ICER values obtained from PSA are all somewhere close to the base-case lifetime horizon ICER value.

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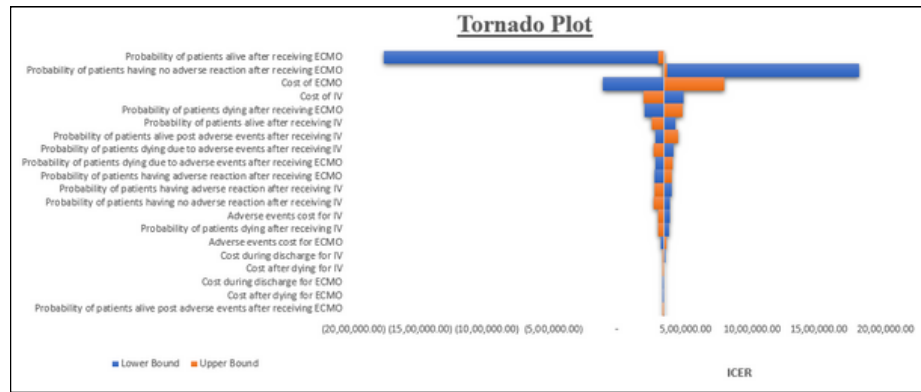
Probability of managing COVID- 19 ARD patients with VV- ECMO being cost effective with respect to willingness to pay. Up to the willingness to pay of ₹ 4,00,000, Invasive mechanical ventilation is cost-effective. When the willingness to pay is high, patients opt for better interventions that give better outcomes.



Here, in our study, when the WTP is greater than ₹ 4,00,000, VV- ECMO is almost 85% cost effective. When the WTP gets higher the probability of ECMO being cost effective also increases. The net monetary benefit for managing COVID- 19 ARD patients with VV- ECMO is higher compared to that invasive mechanical ventilation.

OWSA RESULTS:

Our one- way sensitivity analysis reveals that the uncertainty in the probability of patients alive after receiving VV- ECMO, probability of patients having no adverse reaction after receiving VV- ECMO and cost of VV- ECMO, have the greatest impact on the ICER.



CONCLUSION & DISCUSSION

The major finding of the study was that managing COVID- 19 ARDS patients with VV- ECMO was more cost effective than managing with invasive mechanical ventilation. Although managing the patients with VV- ECMO set up is comparatively costlier than that of managing with invasive mechanical ventilation in monetary terms, the QALY gained is fairly higher in case of VV- ECMO. It is also observed from the studies that there is reduced length of stay in patients under VV- ECMO compared to the alternative. Time is a factor to be considered when a patient is put on VV- ECMO as the longer the patient is on, higher would be the adverse events. Hence it can be used for short term.

