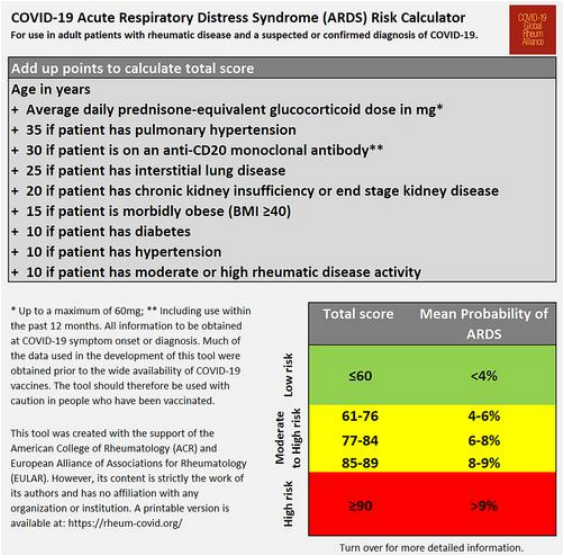
Model to Predict the Risk of COVID-19 Acute Respiratory Distress Syndrome in Patients With Rheumatic Diseases

Acute respiratory distress syndrome (ARDS) affects about 5% of all patients with COVID-19, and a third of hospitalized patients. It carries a high mortality risk and often leads to lifelong consequences, such as cognitive impairment or physical weakness. In this study, we developed 1) a tool (prediction model) to determine a patient's probability of developing ARDS and 2) a simple risk score calculator to help physicians decide on the course of treatment.

Because ARDS is a rare event, machine learning provided an approach with the potential to improve predictions. Using 83 variables collected at the time of COVID-19 diagnosis, machine learning determined 10 predictors as the key risk factors for developing ARDS. In order of importance, age, average daily prednisone-equivalent glucocorticoid dose, and pulmonary hypertension were the most influential predictors for developing ARDS. The model was tested on data from the COVID-19 Global Rheumatology Alliance Registry resulting in a 71% probability of correctly identifying the development of ARDS. The results were confirmed with data from four other independent registries resulting in sensitivity ranging from 61% to 80%.



COVID-19 Acute Respiratory Distress Syndrome (ARDS) Risk Calculator

For use in adult patients with rheumatic disease and a suspected or confirmed diagnosis of COVID-19.

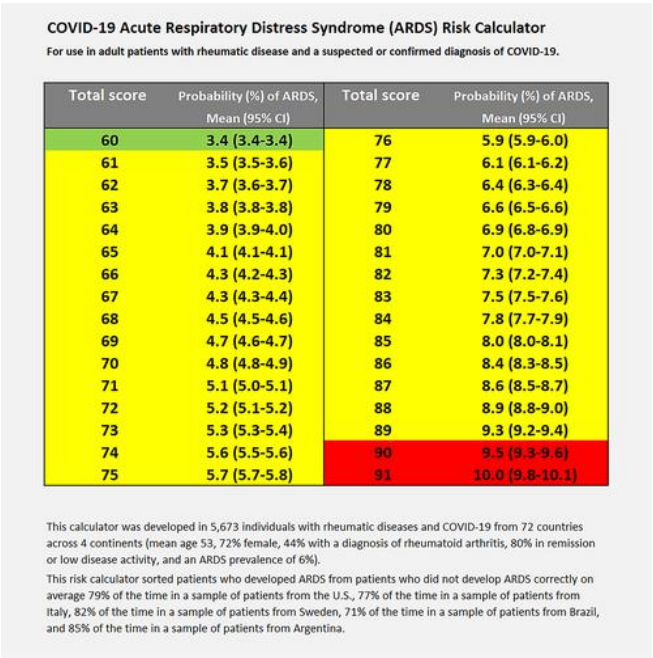
Add up points to calculate total score
Age in years
+ Average daily prednisone-equivalent glucocorticoid dose in mg*
+ 35 if patient has pulmonary hypertension
+ 30 if patient is on an anti-CD20 monoclonal antibody**
+ 25 if patient has interstitial lung disease
+ 20 if patient has chronic kidney insufficiency or end stage kidney disease
+ 15 if patient is morbidly obese (BMI ≥40)
+ 10 if patient has diabetes
+ 10 if patient has hypertension
+ 10 if patient has moderate or high rheumatic disease activity

* Up to a maximum of 60mg; ** Including use within the past 12 months. All information to be obtained at COVID-19 symptom onset or diagnosis. Much of the data used in the development of this tool were obtained prior to the wide availability of COVID-19 vaccines. The tool should therefore be used with caution in people who have been vaccinated.

This tool was created with the support of the American College of Rheumatology (ACR) and European Alliance of Associations for Rheumatology (EULAR). However, its content is strictly the work of its authors and has no affiliation with any organization or institution. A printable version is available at: https://rheum-covid.org/

	Total score	Mean Probability of ARDS
Low risk	≤60	<4%
Moderate to High risk	61-76	4-6%
	77-84	6-8%
	85-89	8-9%
High risk	≥90	>9%

Turn over for more detailed information.



COVID-19 Acute Respiratory Distress Syndrome (ARDS) Risk Calculator

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Total score	Probability (%) of ARDS, Mean (95% CI)	Total score	Probability (%) of ARDS, Mean (95% CI)
60	3.4 (3.4-3.4)	76	5.9 (5.9-6.0)
61	3.5 (3.5-3.6)	77	6.1 (6.1-6.2)
62	3.7 (3.6-3.7)	78	6.4 (6.3-6.4)
63	3.8 (3.8-3.8)	79	6.6 (6.5-6.6)
64	3.9 (3.9-4.0)	80	6.9 (6.8-6.9)
65	4.1 (4.1-4.1)	81	7.0 (7.0-7.1)
66	4.3 (4.2-4.3)	82	7.3 (7.2-7.4)
67	4.3 (4.3-4.4)	83	7.5 (7.5-7.6)
68	4.5 (4.5-4.6)	84	7.8 (7.7-7.9)
69	4.7 (4.6-4.7)	85	8.0 (8.0-8.1)
70	4.8 (4.8-4.9)	86	8.4 (8.3-8.5)
71	5.1 (5.0-5.1)	87	8.6 (8.5-8.7)
72	5.2 (5.1-5.2)	88	8.9 (8.8-9.0)
73	5.3 (5.3-5.4)	89	9.3 (9.2-9.4)
74	5.6 (5.5-5.6)	90	9.5 (9.3-9.6)
75	5.7 (5.7-5.8)	91	10.0 (9.8-10.1)

This calculator was developed in 5,673 individuals with rheumatic diseases and COVID-19 from 72 countries across 4 continents (mean age 53, 72% female, 44% with a diagnosis of rheumatoid arthritis, 80% in remission or low disease activity, and an ARDS prevalence of 6%).

This risk calculator sorted patients who developed ARDS from patients who did not develop ARDS correctly on average 79% of the time in a sample of patients from the U.S., 77% of the time in a sample of patients from Italy, 82% of the time in a sample of patients from Sweden, 71% of the time in a sample of patients from Brazil, and 85% of the time in a sample of patients from Argentina.

We gathered data from March 24, 2020, to May 12, 2021. The study included 8633 patients from 74 countries, of whom 523 (6%) had ARDS. It is the first study predicting COVID-19 ARDS among individuals with rheumatic diseases. The prediction model was trained and verified on data from all over the world leading to generalizable patient characteristics associated with ARDS. Among limitations is the fact that the model relies on reporting from providers which might create bias. Also, we were unable to account for other important medical, sociodemographic, or environmental factors.

Further studies are needed that include vaccinated individuals and COVID-19 variants, such as Omicron, to evaluate the utility of this risk score calculator in classifying patients as low, moderate, or high risk for ARDS. The model can also serve to inform preventative measures against and treatment for COVID-19 in high-risk patients with rheumatic diseases.

We want to thank all healthcare providers who participated in the registry, and as such contributed to a better understanding of the interplay between COVID-19 and rheumatologic diseases.

Study Title

Development of a Prediction Model for COVID-19 Acute Respiratory Distress Syndrome in Patients With Rheumatic Diseases: Results From the Global Rheumatology Alliance Registry

Link to original paper

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