

ISTITUTO NAZIONALE DI RICERCA METROLOGICA  
Repository Istituzionale

Outcome of infection with omicron SARS-CoV-2 variant in patients with hematological malignancies: An EPICOVIDEHA survey report

*Original*

Outcome of infection with omicron SARS-CoV-2 variant in patients with hematological malignancies: An EPICOVIDEHA survey report / Blennow, Ola; Salmanton-García, Jon; Nowak, Piotr; Itri, Federico; Van Doesum, Jaap; López-García, Alberto; Farina, Francesca; Jaksic, Ozren; Pinczés, László Imre; Bilgin, Yavuz M; Falces-Romero, Iker; Jiménez, Moraima; Ormazabal-Vélez, Irati; Weinbergerová, Barbora; Duléry, Rémy; Stojanoski, Zlate; Lahmer, Tobias; Fernández, Noemí; Hernández-Rivas, José-Ángel; Petzer, Verena; De Jorio, Nick; Glenthøj, Andreas; De Ramón, Cristina; Biernat, Monika M; Fracchiolla, Nicola; Aujayeb, Avisar; Mani, Pavel; Jaksic, Ozren; Schöberl, Martin; Méndez-Carniado, Adolfo; Zattaneo, Chiara; Guidetti, Anna; Sciumè, Mariarita; Ammatuna, Emanuele; Cordoba, Raul; García-Poutón, Nicole; Gräfe, Stefanie; Cabirta, Alba; Wolf, Dominik; Nordlander, Anna; García-Sanz, Ramón; Delia, Mario; Berg Venemyr, Caroline; Brones, Clara; Di Blasi, Roberta; De Kort, Elizabeth; Meers, Stef; Lamure, Sylvain; Serrano, Laura; Merelli, Maria; Coppola, Nicola; Bergantim, Rui; Besson, Caroline; Kohn, Milena; Petit, Jessica; Garcia-Vidal, Carolina; Dargenio, Michelina; Danion, François; Machado, Marina; Bailén-Almorox, Rebeca; Hoenigl, Martin; Dragonetti, Giulia; Chai, Louis Yi Ann; Kho, Chi Shan; Bonanni, Matteo; Liévin, Raphaël; Marchesi, Enrico; Zojana, Oliver A; Pagano, Livio. - In: AMERICAN JOURNAL OF HEMATOLOGY. - ISSN 0361-8609. - 97:8(2022), pp. 312-317. [10.1002/ajh.26626]

*Terms of use:*

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

*Publisher copyright*

(Article begins on next page)



## CORRESPONDENCE

# Outcome of infection with omicron SARS-CoV-2 variant in patients with hematological malignancies: An EPICOVIDEHA survey report

To the Editor:

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection has caused high mortality in patients with hematological malignancies (HM).<sup>1</sup> The newly emerged omicron variants of SARS-CoV-2 harbor multiple novel spike protein mutations that raise concerns about vaccine efficiency and antiviral efficacy of the available therapeutic monoclonal antibodies.<sup>2</sup> The first published clinical data in immunocompetent patients have found that infection with omicron variants is associated with reduced vaccine efficiency compared to the delta variants, but decreased hospital admission and mortality.<sup>3,4</sup> Preliminary, prepublished, data from a large case-control study have shown that the vaccine effect against omicron in immunocompromised patients, including HM patients, is even more reduced, but data regarding clinical outcomes are lacking.<sup>5</sup> The aim of this study was to describe risk factors, antiviral treatment and outcomes of SARS-CoV-2 omicron variant infection in 593 HM patients included in the EPICOVIDEHA registry.

EPICOVIDEHA is an international open web-based registry for patients with HM infected with SARS-CoV-2.<sup>1,6</sup> Both hospitalized and nonhospitalized patients are eligible for inclusion. The questionnaire includes data on the HM, SARS-CoV-2 vaccination status, risk factors for severe COVID-19 infection, SARS-CoV-2 virus variant, antiviral treatment, and outcomes including mortality (eFigure 1 and eTable 4). Classification of attributable, contributable, or nonattributable death is made by the reporting physician. All included cases are validated by experts with previous experience in research studies of hematological malignancies and infectious diseases at the University Hospital Cologne, Cologne, Germany.

Critical infection was defined as admittance to an intermediate and/or intensive care unit. Independent predictors for mortality were assessed via a Cox proportional hazard model. Risk factors for critical SARS-CoV-2 infection were determined with a logistic regression. Variables with a  $p$ -value  $\leq .1$  in the univariable models were considered for multivariable analysis. Multivariable regression models (both Cox and logistic) were calculated with the Wald backward method, and only those variables that were statistically significant displayed. Log-rank test was used to compare the survival probability of the patients included in the different models. A priori sample size

calculation was not applied in this exploratory study. SPSSv25.0 was employed for statistical analyses (SPSS, IBM Corp.).

In total 593 HM patients infected with omicron were included, whereof 309 patients were admitted to hospital and 284 patients stayed home (eTable 1). Hospitalized patients were older than nonhospitalized patients, had more comorbidities, and had a higher proportion of patients with neutropenia, lymphocytopenia, active hematological malignancy, and treatment with anti-CD20 antibodies (eTable 1). At least one dose of vaccine had been administered to 83.1% of all patients, with a nonsignificant difference between nonhospitalized and hospitalized patients, 86.3% compared to 80.3% ( $p = .157$ ) (eTable 1, eTable 2).

Overall mortality among hospitalized patients was 16.5% (51/309), of which 61% was classified as attributable to omicron, 35.3% contributable, and 3.9% unrelated. Factors associated with attributable and contributable mortality in hospitalized patients were older age (analyzed as continuous variable, hazard ratio (HR) 1.05 [95% confidence interval (CI) 1.02–1.07,  $p < .001$ ]) and active malignancy (HR 2.5 [95% CI 1.3–4.8,  $p = .007$ ]) (Table 1). Having received at least one dose of SARS-CoV-2 vaccine was protective in univariable analysis (HR 0.53 [95% CI 0.29–0.96,  $p = .036$ ]), but did not reach statistical significance in multivariable analysis (HR 0.58 [95% CI 0.32–1.05,  $p = .074$ ]) (eFigure 2a, Table 1).

Progression to critical infection occurred in 53 (17.0%) of hospitalized patients. Risk factor for progression to critical COVID-19 was pre-existent chronic pulmonary disease (odds ratio (OR) 3.2 [95% CI 1.4–7.3,  $p = .005$ ]) (eTable 3). Baseline lymphocytes of  $\geq 500$  cells/mm<sup>3</sup> were protective (OR 0.4 [95% CI 0.18–0.90,  $p = .027$ ]) while a lymphocyte count between 200 and 499 cells/mm<sup>3</sup> was protective in univariable but not multivariable analysis (OR 0.44 [95% CI 0.16–1.20,  $p = .108$ ]). Three doses of vaccine were protective (OR 0.29 [95% CI 0.13–0.64,  $p = .003$ ]), but not two doses (OR 0.73 [95% CI 0.33–1.66,  $p = .457$ ]) (eTable 3). Mortality among patients with critical infection was 39.2% (20/53). Administration of antibody-based antiviral treatment with sotrovimab or tixagevimab/cilgavimab was associated with a lower risk for mortality in critical infection (HR 0.13, [95% CI 0.02–0.61,  $p = .010$ ]) (eFigure 2b, Table 1), while administration of other SARS-CoV-2 directed monoclonal antibodies was not (data not shown).

This is an open access article under the terms of the [Creative Commons Attribution](https://creativecommons.org/licenses/by/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2022 The Authors. *American Journal of Hematology* published by Wiley Periodicals LLC.

TABLE 1 Risk factor analysis for omicron-related mortality in hospitalized patients

|   | Hospital    |               |             |             |               |             |       |              |
|---|-------------|---------------|-------------|-------------|---------------|-------------|-------|--------------|
|   | Overall     |               |             | Critical    |               |             |       |              |
|   | Univariable | Multivariable |             | Univariable | Multivariable |             |       |              |
| p value   | HR          | 95% CI        | p value     | HR          | 95% CI        | p value     | HR    | 95% CI       |
|   | Lower       | Upper         |             | Lower       | Upper         |             | Lower | Upper        |
| <b>Sex</b>  |             |               |             |             |               |             |       |              |
| Female  | —           | —             | —           | —           | —             | —           | —     | —            |
| Male  | .609        | 0.866         | 0.500 1.501 | .800        | 0.894         | 0.377 2.124 |       |              |
| <b>Age</b>  | <.001       | 1.047         | 1.022 1.072 | <.0001      | 1.044         | 1.020 1.068 | 1.029 | 0.991 1.069  |
| <b>Status of malignancy at COVID-19 onset<sup>a</sup></b> |             |               |             |             |               |             |       |              |
| Controlled malignancy                                     | —           | —             | —           | —           | —             | —           | —     | —            |
| Stable malignancy   | 0.348       | 1.526         | 0.632 3.684 | 0.668       | 1.215         | 0.499 2.957 | 4.780 | 1.370 16.676 |
| Active malignancy   | 0.003       | 2.726         | 1.421 5.229 | 0.007       | 2.473         | 1.284 4.762 | 2.511 | 0.871 7.240  |
| <b>Baseline malignancy</b>                                |             |               |             |             |               |             |       |              |
| Lymphoproliferative malignancies                          | —           | —             | —           | —           | —             | —           | —     | —            |
| Myeloproliferative malignancies                           | 0.508       | 0.798         | 0.409 1.556 | 0.758       | 1.153         | 0.465 2.862 |       |              |
| Aplastic anemia   | 0.974       | 0.000         | 0.000       |             |               |             |       |              |
| <b>Previous SARS-CoV-2 vaccination</b>                    | 0.036       | 0.530         | 0.293 0.959 | 0.074       | 0.581         | 0.320 1.054 | 0.780 | 0.314 1.934  |
| <b>COVID-19 treatment<sup>b</sup></b>                     |             |               |             |             |               |             |       |              |
| No treatment  | —           | —             | —           | —           | —             | —           | —     | —            |
| Any remdesivir, minus sotrovimab                          | 0.857       | 0.941         | 0.487 1.817 | 0.953       | 0.967         | 0.314 2.975 | 0.200 | 0.452 1.521  |
| Any sotrovimab + any tixagevimab/cilgavimab               | 0.134       | 0.531         | 0.232 1.216 | 0.021       | 0.172         | 0.039 0.766 | 0.010 | 0.134 0.614  |
| Plasma only + molnupiravir only                           | 0.639       | 1.330         | 0.404 4.377 | 0.776       | 1.242         | 0.280 5.513 | 0.604 | 1.491 6.738  |
| <b>Previous administration of antiCD20</b>                | 0.760       | 1.090         | 0.626 1.898 | 0.187       | 0.528         | 0.205 1.363 |       |              |

Abbreviations: 95% CI, 95% confidence interval; COVID-19, coronavirus disease 2019, HR, hazard ratio; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

<sup>a</sup>Controlled malignancy: Complete remission or partial remission; active malignancy: onset or refractory/resistant.

<sup>b</sup>No treatment: Includes treatment with acyclovir, favipiravir, casivimab/imdevimab, bamlanivimab/etesivimab and regdanvimab; Any remdesivir, minus sotrovimab; Includes all antiviral treatment which included remdesivir except for sotrovimab and tixagevimab/cilgavimab; Any sotrovimab + any tixagevimab/cilgavimab: Includes all antiviral treatment which included sotrovimab or tixagevimab/cilgavimab; Plasma only + molnupiravir only: Includes single therapy with convalescent plasma or molnupiravir.

This observational study from the EPICOVIDEHA registry is the first report on clinical data in a large cohort of omicron-infected HM patients. The main finding is that infection with omicron is associated with considerable attributable mortality in HM patients. Additionally, we found factors associated with a potential antibody response, that is, not having severe lymphocytopenia and having received at least three doses of SARS-CoV-2 vaccine, and treatment with monoclonal antibodies with in vitro effect against omicron, to be protective against progression to critical infection and death.

The mortality among hospitalized HM patients was 16.5% which is lower than during the COVID-19 waves of 2020 and 2021, but considerable higher than previously reported mortality rates in immunocompetent patients with omicron infection.<sup>1,3,4</sup> Data regarding outcomes in HM patients with omicron are scarce, but our finding is in agreement with a small recent preliminary report on omicron in chronic lymphoid leukemia patients, where 23% 30-day mortality was reported.<sup>7</sup> Thus, as opposed to immunocompetent patients, infection with omicron in HM patients is still associated with a considerable mortality in hospitalized patients.

Due to serological data not being registered consistently by all participating centers, the protective effect of vaccination was analyzed according to number of doses administered. For the whole cohort, the vaccination rate was numerically higher in non-hospitalized patients than hospitalized patients, 86.3% compared to 80.3%, respectively. Administration of at least one dose of vaccine was protective against death in all hospitalized patients in univariable analysis but not in multivariable analysis ( $p = .074$ ). Three doses of vaccine were protective against progression to critical infection in hospitalized patients, while two doses were not, a finding that is well in line with the additional booster effect against omicron in immunocompetent patients.<sup>3,8</sup> Interestingly, lymphocytopenia, which has been associated with a poor vaccine response, was also associated with progression to critical infection.<sup>9</sup> Finally, among patients that progressed to critical infection, vaccination was not associated with a protective effect against death, contrary to treatment with monoclonal antibodies with in vitro effect against omicron.<sup>2</sup> These findings raise the hypothesis that while vaccination appears to be protective against severe infection and death, lack of response, as manifested by progression to critical infection despite vaccination, may be at least in part compensated by passive immunization using SARS-CoV-2-antagonizing monoclonal antibodies. This hypothesis is in line with the findings from a large, randomized treatment study, reporting significantly decreased mortality with administration of monoclonal antibodies in hospitalized seronegative immunocompetent patients.<sup>10</sup>

Important limitations of our study include the retrospective observational design and the accompanying risk for selection bias at participating sites, lack of serological data, and lack of sequencing data which would enable distinction between the different omicron variants. Due to these limitations, caution must be taken in interpretation and generalization of the results.

In conclusion, infection with omicron in patients with HM was associated with considerable morbidity and mortality, vaccination with

at least three doses was protective against progression to critical infection, and treatment with monoclonal antibodies was associated with reduced mortality in patients that had progressed to critical infection.

## FUNDING INFORMATION

EPICOVIDEHA has received funds from Optics COMMIT (COVID-19 Unmet Medical Needs and Associated Research Extension) COVID-19 RFP program by GILEAD Science, United States (Project 2020-8223).

## CONFLICT OF INTEREST

The authors declare that they have no competing interests for this work.

## DATA AVAILABILITY STATEMENT

The datasets used and/or analyzed during the current study are not publicly available due to individual privacy reason, but are available from the corresponding author on reasonable request.

## FUNDING INFORMATION

Optics COMMIT (COVID-19 Unmet Medical Needs and Associated Research Extension) COVID-19 RFP program by GILEAD Science, United States, Grant/Award Number: Project 2020-8223

Ola Blennow<sup>1</sup> , Jon Salmanton-García<sup>2,3</sup> , Piotr Nowak<sup>1</sup> ,  
 Federico Itri<sup>4</sup> , Jaap Van Doesum<sup>5</sup> , Alberto López-García<sup>6</sup> ,  
 Francesca Farina<sup>7</sup> , Ozren Jaksic<sup>8</sup> , László Imre Pinczés<sup>9</sup> ,  
 Yavuz M. Bilgin<sup>10</sup> , Iker Falces-Romero<sup>11,12</sup> ,  
 Moraima Jiménez<sup>13,14</sup> , Irati Ormazabal-Vélez<sup>15</sup> ,  
 Barbora Weinbergerová<sup>16</sup> , Rémy Duléry<sup>17</sup> ,  
 Zlate Stojanoski<sup>18</sup> , Tobias Lahmer<sup>19</sup> , Noemí Fernández<sup>20</sup>, José-  
 Ángel Hernández-Rivas<sup>21</sup>, Verena Petzer<sup>22</sup> , Nick De Jonge<sup>23</sup> ,  
 Andreas Glenthøj<sup>24</sup> , Cristina De Ramón<sup>25,26</sup> ,  
 Monika M. Biernat<sup>27</sup> , Nicola Fracchiolla<sup>28</sup> , Avinash Aujayeb<sup>29</sup> ,  
 , Jens Van Praet<sup>30</sup> , Martin Schönlein<sup>31</sup> ,  
 Gustavo-Adolfo Méndez<sup>32</sup> , Chiara Cattaneo<sup>33</sup> , Anna Guidetti<sup>34</sup>,  
 Mariarita Sciumè<sup>28</sup> , Emanuele Ammatuna<sup>5</sup> , Raul Cordoba<sup>6</sup> ,  
 Nicole García-Poutón<sup>35</sup> , Stefanie Gräfe<sup>2,3,36</sup> ,  
 Alba Cabrita<sup>13,14</sup> , Dominik Wolf<sup>22</sup> , Anna Nordlander<sup>1</sup>,  
 Ramón García-Sanz<sup>25,26</sup> , Mario Delia<sup>37</sup> , Caroline Berg  
 Venemyr<sup>24</sup> , Clara Brones<sup>38</sup> , Roberta Di Blasi<sup>39</sup> , Elizabeth De  
 Kort<sup>40</sup> , Stef Meers<sup>41</sup> , Sylvain Lamure<sup>42</sup> , Laura Serrano<sup>43</sup> ,  
 Maria Merelli<sup>44</sup> , Nicola Coppola<sup>45</sup> , Rui Bergantim<sup>46</sup> ,  
 Caroline Besson<sup>38</sup> , Milena Kohn<sup>38</sup> , Jessica Petiti<sup>47</sup> ,  
 Carolina Garcia-Vidal<sup>35</sup> , Michelina Dargenio<sup>48</sup> ,  
 François Danion<sup>49</sup> ,  
 Marina Machado<sup>50</sup> , Rebeca Bailén-Almorox<sup>51</sup> ,  
 Martin Hoenig<sup>52,53,54</sup> , Giulia Dragonetti<sup>55</sup> , Louis Yi Ann Chai<sup>56</sup>,  
 Chi Shan Kho<sup>57</sup>, Matteo Bonanni<sup>55,58</sup>, Raphaël Liévin<sup>39</sup> ,  
 Francesco Marchesi<sup>59</sup> , Oliver A. Cornely<sup>2,3,60,61,62</sup> ,  
 Livio Pagano<sup>55,58</sup> 

- <sup>1</sup>Department of Infectious Diseases, Karolinska University Hospital, Stockholm, Sweden
- <sup>2</sup>Faculty of Medicine and University Hospital Cologne, Department I of Internal Medicine, Excellence Center for Medical Mycology (ECMM), University of Cologne, Cologne, Germany
- <sup>3</sup>Faculty of Medicine and University Hospital Cologne, Cologne Excellence Cluster on Cellular Stress Responses in Aging-Associated Diseases (CECAD), University of Cologne, Cologne, Germany
- <sup>4</sup>Department of Clinical and Biological Sciences, San Luigi Gonzaga Hospital - Orbassano, Orbassano, Italy
- <sup>5</sup>Department of Hematology, University Medical Center Groningen, Groningen, The Netherlands
- <sup>6</sup>Health Research Institute IIS-FJD, Fundacion Jimenez Diaz University Hospital, Madrid, Spain
- <sup>7</sup>U.O. Ematologia e Trapianto Midollo, Dipartimento di Oncologia Istituto Scientifico San Raffaele, Milan, Italy
- <sup>8</sup>Department of Hematology, University Hospital Dubrava, Zagreb, Croatia
- <sup>9</sup>Division of Hematology, Department of Internal Medicine, Faculty of Medicine, University of Debrecen, Debrecen, Hungary
- <sup>10</sup>Department of Internal Medicine/Hematology, ADRZ, Goes, Netherlands
- <sup>11</sup>Microbiology and Parasitology Department, University Hospital La Paz, Madrid, Spain
- <sup>12</sup>CIBERINFEC, Instituto de Salud Carlos III, Madrid, Spain
- <sup>13</sup>Department of Hematology, Vall d'Hebron Hospital Universitari, Experimental Hematology, Vall d'Hebron Institute of Oncology (VHIO), Vall d'Hebron Barcelona Hospital Campus, Barcelona, Spain
- <sup>14</sup>Departament de Medicina, Universitat Autònoma de Barcelona, Bellaterra, Spain
- <sup>15</sup>Department of Haematology, Complejo Hospitalario de Navarra, Pamplona, Spain
- <sup>16</sup>Department of Internal Medicine, Hematology and Oncology, Masaryk University and University Hospital Brno, Brno, Czech Republic
- <sup>17</sup>INSERM UMRs 938, Service d'Hématologie Clinique et de Thérapie Cellulaire, Hôpital Saint Antoine, AP-HP, Sorbonne Université, Paris, France
- <sup>18</sup>University Clinic for Hematology, Medical Faculty, Ss Cyril and Methodius University of Skopje, Skopje, North Macedonia
- <sup>19</sup>Medizinische Klinik II, Klinikum rechts der Isar, TU München, Munich, Germany
- <sup>20</sup>Department of Hematology, Hospital Universitario Marqués de Valdecilla, Santander, Spain
- <sup>21</sup>Department of Hematology, Hospital Universitario Infanta Leonor, Madrid, Spain
- <sup>22</sup>Department of Hematology and Oncology, Medical University of Innsbruck, Innsbruck, Austria
- <sup>23</sup>Department of Hematology, Cancer Center Amsterdam, Amsterdam UMC, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands
- <sup>24</sup>Department of Hematology, Copenhagen University Hospital Rigshospitalet, Copenhagen, Denmark
- <sup>25</sup>Hematology Department, Hospital Universitario de Salamanca, Salamanca, Spain
- <sup>26</sup>Centro de Investigación del Cáncer-IBMCC (USAL-CSIC), IBSAL, Salamanca, Spain
- <sup>27</sup>Department of Haematology, Blood Neoplasms, and Bone Marrow Transplantation, Wroclaw Medical University, Wroclaw, Poland
- <sup>28</sup>Hematology Unit, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy
- <sup>29</sup>Respiratory Department, Northumbria Healthcare, Newcastle, UK
- <sup>30</sup>Department of Nephrology and Infectious diseases, AZ Sint-Jan Brugge-Oostende AV, Brugge, Belgium
- <sup>31</sup>Department of Oncology, Hematology and Bone Marrow Transplantation with Section of Pneumology, University Medical Center Hamburg-Eppendorf, Hamburg, Germany
- <sup>32</sup>Servicio de Infectología y Control de Infecciones, Hospital Escuela de Agudos Dr. Ramón Madariaga, Posadas, Misiones, Argentina
- <sup>33</sup>Hematology Unit, ASST-Spedali Civili, Brescia, Italy
- <sup>34</sup>Division of Hematology and Bone Marrow Transplantation, Fondazione IRCCS Istituto Nazionale dei Tumori, Milan, Italy
- <sup>35</sup>Department of Infectious Diseases, Hospital Clinic de Barcelona, University of Barcelona, IDIBAPS, Barcelona, Spain
- <sup>36</sup>Department of Oncology, Hematology, and Bone Marrow Transplantation with Section of Pneumology, Universitätsklinikum Hamburg Eppendorf, Hamburg, Germany
- <sup>37</sup>Hematology and Stem Cell Transplantation Unit, AOUC Policlinico, Bari, Italy
- <sup>38</sup>Service d'Hématologie, Centre Hospitalier de Versailles, Le Chesnay, France
- <sup>39</sup>Hemato-Oncology Department, Hopital Saint Louis, Paris, France
- <sup>40</sup>Department of Hematology, Radboud University Medical Center, Nijmegen, The Netherlands
- <sup>41</sup>Department Oncology, AZ KLINA, Brasschaat, Belgium
- <sup>42</sup>Department of Clinical Hematology, Montpellier University Hospital, IGMM UMR5535 CNRS, University of Montpellier, Montpellier, France
- <sup>43</sup>Department of Hematology, Hospital Universitario de Cabueñes, Gijón, Spain
- <sup>44</sup>Infectious Diseases Clinic, ASU FC Udine Hospital, Udine, Italy
- <sup>45</sup>Department of Mental Health and Public Medicine, University of Campania, Naples, Italy
- <sup>46</sup>Department of Hematology, Centro Hospitalar e Universitário de São João, Porto, Portugal
- <sup>47</sup>Department of Clinical and Biological Sciences, University of Turin, Turin, Italy
- <sup>48</sup>Hematology and Stem Cell Transplant Unit, "Vito Fazzi" Hospital, Lecce, Italy
- <sup>49</sup>Department of Infectious Diseases, CHU de Strasbourg, Strasbourg, France
- <sup>50</sup>Clinical Microbiology and Infectious Diseases Department, Hospital General Universitario Gregorio Marañón, Madrid, Spain
- <sup>51</sup>Department of Hematology and Hemotherapy, Hospital General Universitario Gregorio Marañón, Madrid, Spain
- <sup>52</sup>Division of Infectious Diseases and Global Public Health, Department of Medicine, University of California San Diego, San Diego, California, USA

<sup>53</sup>Clinical and Translational Fungal-Working Group, University of California San Diego, La Jolla, California, USA

<sup>54</sup>Division of Infectious Diseases, Department of Internal Medicine, Medical University of Graz, Graz, Austria

<sup>55</sup>Hematology Unit, Fondazione Policlinico Universitario Agostino Gemelli – IRCCS, Rome, Italy

<sup>56</sup>National University Health System, University Medicine Center, Division of Infectious Diseases, Singapore

<sup>57</sup>Pamela Youde Nethersole Eastern Hospital, Hong Kong, Hong Kong SAR

<sup>58</sup>Hematology Unit, Università Cattolica del Sacro Cuore, Rome, Italy

<sup>59</sup>Hematology and Stem Cell Transplant Unit, IRCCS Regina Elena National Cancer Institute, Rome, Italy

<sup>60</sup>Faculty of Medicine and University Hospital Cologne, Clinical Trials Centre Cologne (ZKS Köln), University of Cologne, Cologne, Germany

<sup>61</sup>Faculty of Medicine and University Hospital Cologne, Center for Molecular Medicine Cologne (CMC), University of Cologne, Cologne, Germany

<sup>62</sup>German Centre for Infection Research (DZIF), Partner Site Bonn-Cologne, Cologne, Germany

#### Correspondence

Jon Salmanton-García, Faculty of Medicine and University Hospital Cologne, Department I of Internal Medicine, Excellence Center for Medical Mycology (ECMM), University of Cologne, Cologne, Germany,

Email: [jon.salmanton-garcia@uk-koeln.de](mailto:jon.salmanton-garcia@uk-koeln.de)

Ola Blennow and Jon Salmanton-García contributed equally to this study.

#### ORCID

Ola Blennow <https://orcid.org/0000-0002-7167-7882>

Jon Salmanton-García <https://orcid.org/0000-0002-6766-8297>

Piotr Nowak <https://orcid.org/0000-0003-2747-0734>

Federico Itri <https://orcid.org/0000-0002-3532-5281>

Jaap Van Doesum <https://orcid.org/0000-0003-0214-3219>

Alberto López-García <https://orcid.org/0000-0002-5354-5261>

Francesca Farina <https://orcid.org/0000-0002-5124-6970>

Ozren Jaksic <https://orcid.org/0000-0003-4026-285X>

László Imre Pinczés <https://orcid.org/0000-0003-0453-1709>

Yavuz M. Bilgin <https://orcid.org/0000-0003-4854-5424>

Iker Falces-Romero <https://orcid.org/0000-0001-5888-7706>

Moraima Jiménez <https://orcid.org/0000-0003-1444-8562>

Iratí Ormazabal-Vélez <https://orcid.org/0000-0003-1141-5546>

Barbora Weinbergerová <https://orcid.org/0000-0001-6460-2471>

Rémy Duléry <https://orcid.org/0000-0002-5024-1713>

Zlate Stojanoski <https://orcid.org/0000-0001-7502-8356>

Tobias Lahmer <https://orcid.org/0000-0003-1008-5311>

Verena Petzer <https://orcid.org/0000-0002-9205-1440>

Nick De Jonge <https://orcid.org/0000-0002-9901-0887>

Andreas Glenthøj <https://orcid.org/0000-0003-2082-0738>

Cristina De Ramón <https://orcid.org/0000-0002-8167-6410>

Monika M. Biernat <https://orcid.org/0000-0002-5812-8520>

Nicola Fracchiolla <https://orcid.org/0000-0002-8982-8079>

Avinash Aujayeb <https://orcid.org/0000-0002-0859-5550>

Jens Van Praet <https://orcid.org/0000-0002-7125-7001>

Martin Schönlein <https://orcid.org/0000-0002-1010-0975>

Gustavo-Adolfo Méndez <https://orcid.org/0000-0003-0514-7004>

Chiara Cattaneo <https://orcid.org/0000-0003-0031-3237>

Mariarita Sciumè <https://orcid.org/0000-0001-7958-4966>

Emanuele Ammatuna <https://orcid.org/0000-0001-8247-4901>

Raul Cordoba <https://orcid.org/0000-0002-7654-8836>

Nicole García-Poutón <https://orcid.org/0000-0002-0675-2241>

Stefanie Gräfe <https://orcid.org/0000-0001-7678-0179>

Alba Cabirta <https://orcid.org/0000-0001-7198-8894>

Dominik Wolf <https://orcid.org/0000-0002-4761-075X>

Ramón García-Sanz <https://orcid.org/0000-0003-4120-2787>

Mario Delia <https://orcid.org/0000-0002-6486-8912>

Caroline Berg Venemyr <https://orcid.org/0000-0003-2461-5395>

Clara Brones <https://orcid.org/0000-0002-0971-5075>

Roberta Di Blasi <https://orcid.org/0000-0001-9001-573X>

Elizabeth De Kort <https://orcid.org/0000-0003-0125-9543>

Stef Meers <https://orcid.org/0000-0003-1754-2175>

Sylvain Lamure <https://orcid.org/0000-0001-5980-305X>

Laura Serrano <https://orcid.org/0000-0002-0931-1791>

Maria Merelli <https://orcid.org/0000-0003-3907-5264>

Nicola Coppola <https://orcid.org/0000-0001-5897-4949>

Rui Bergantim <https://orcid.org/0000-0002-7811-9509>

Caroline Besson <https://orcid.org/0000-0003-4364-7173>

Milena Kohn <https://orcid.org/0000-0003-1438-3391>

Jessica Petiti <https://orcid.org/0000-0001-8640-2462>

Carolina Garcia-Vidal <https://orcid.org/0000-0002-8915-0683>

Micheline Dargenio <https://orcid.org/0000-0003-0924-4629>

François Danion <https://orcid.org/0000-0003-3907-0658>

Marina Machado <https://orcid.org/0000-0002-8370-2248>

Rebeca Bailén-Almorox <https://orcid.org/0000-0003-2838-1776>

Martin Hoenigl <https://orcid.org/0000-0002-1653-2824>

Giulia Dragonetti <https://orcid.org/0000-0003-1775-6333>

Raphaël Liévin <https://orcid.org/0000-0002-5097-591X>

Francesco Marchesi <https://orcid.org/0000-0001-6353-2272>

Oliver A. Cornely <https://orcid.org/0000-0001-9599-3137>

Livio Pagano <https://orcid.org/0000-0001-8287-928X>

#### REFERENCES

- Pagano L, Salmanton-García J, Marchesi F, et al. COVID-19 infection in adult patients with hematological malignancies: a European Hematology Association survey (EPICOVIDEHA). *J Hematol Oncol*. 2021; 14(1):168.
- Bruel T, Hadjadj J, Maes P, et al. Serum neutralization of SARS-CoV-2 omicron sublineages BA.1 and BA.2 in patients receiving monoclonal antibodies. *Nat Med*. 2022;28(6):1297-1302.
- Nyberg T, Ferguson NM, Nash SG, et al. Comparative analysis of the risks of hospitalisation and death associated with SARS-CoV-2 omicron (B.1.1.529) and delta (B.1.617.2) variants in England: a cohort study. *Lancet*. 2022;399(10332):1303-1312.

4. Christensen PA, Olsen RJ, Long SW, et al. Signals of significantly increased vaccine breakthrough, decreased hospitalization rates, and less severe disease in patients with coronavirus disease 2019 caused by the omicron variant of severe acute respiratory syndrome coronavirus 2 in Houston, Texas. *Am J Pathol*. 2022;192(4):642-652.
5. Tseng HF, Ackerson BK, Luo Y, et al. Effectiveness of mRNA-1273 against SARS-CoV-2 omicron and Delta variants. *Nat Med*. 2022;28(5):1063-1071.
6. Salmanton-Garcia J, Busca A, Cornely OA, et al. EPICOVIDEHA: a ready to use platform for epidemiological studies in hematological patients with COVID-19. *Hema*. 2021;5(7):e612.
7. Niemann CU, da Cunha-Bang C, Helleberg M, Ostrowski SR, Brieghel C. Patients with CLL have lower risk of death from COVID-19 in the omicron era. *Blood*. Published online May 19, 2022. doi:10.1182/blood.2022016147
8. Lauring AS, Tenforde MW, Chappell JD, et al. Clinical severity of, and effectiveness of mRNA vaccines against, covid-19 from omicron, delta, and alpha SARS-CoV-2 variants in the United States: prospective observational study. *BMJ*. 2022;376:e069761.
9. Ollila TA, Lu S, Masel R, et al. Antibody response to COVID-19 vaccination in adults with hematologic malignant disease. *JAMA Oncol*. 2021;7(11):1714-1716.
10. Group RC. Casirivimab and imdevimab in patients admitted to hospital with COVID-19 (RECOVERY): a randomised, controlled, open-label, platform trial. *Lancet*. 2022;399(10325):665-676.

#### SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.