Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

post–COVID-19[3]), although seropositivity rates appear to be lower in patients receiving MHD.[4] Although anti–S1 IgG titer is reported to correlate with *in vitro* virus neutralization,[4] postvaccine immunity longevity (including cellular immunity not studied in this work) and protection from symptomatic infection remain to be studied in patients receiving MHD.

Overall, this study suggests that most patients receiving MHD given both doses of the BNT162b2 mRNA vaccine are expected to develop an anti–S1 IgG response that may be protective.

ACKNOWLEDGEMENTS
We thank all the patients involved in this study.

SUPPLEMENTARY MATERIAL
Supplementary File (PDF)
Supplementary Methods.
Table S1. Characteristics of patients according to late serologic status.
Table S2. Characteristics of patients according to early serologic status.
Table S3. Characteristics of patients according to previous COVID-19 history.
Table S4. Characteristics of infection-naïve patients according to early serologic status.
Table S5. Characteristics of infection-naïve patients according to late serologic status.

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Philippe Attias[1,5], Hamza Sakhi[2,3,5], Philippe Rieu[1], Arvish Soorkia[4], David Assayag[4], Sabrina Bouhroum[1], Patrice Nizard[4] and Khalil El Karoui[2,3]

[1]*Department of Nephrology and Dialysis, Hôpital Privé Nord Parisien, Sarcelles, France;* [2]*Assistance Publique Hôpitaux de Paris, Hôpitaux Universitaires Henri Mondor, Service de Néphrologie et Transplantation, Centre de Référence Maladie Rare « Syndrome Néphrotique Idiopathique », Fédération Hospitalo-Universitaire « Innovative Therapy for Immune Disorders », Créteil, France;* [3]*University Paris Est Créteil, Institut National de la Santé et de la Recherche Médicale U955, Institut Mondor de Recherche Biomédicale, Equipe 21, Créteil, France; and* [4]*Laboratoire de Biologie Médicale ANA-L, Sarcelles, France*

Correspondence: *Khalil El Karoui, Assistance Publique des Hôpitaux de Paris, Hôpitaux Universitaires Henri Mondor, Service de Néphrologie et Transplantation, Centre de Référence Maladie Rare « Syndrome Néphrotique Idiopathique », Fédération Hospitalo-Universitaire « Innovative Therapy for Immune Disorders », Créteil, France. E-mail: khalil.el-karoui@aphp.fr*

[5]PA and HS contributed equally.

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Seroprevalence of antibody to S1 spike protein following vaccination against COVID-19 in patients receiving hemodialysis: a call to arms

see commentary on page 1275

To the editor: Adult patients with end-stage kidney disease on hemodialysis are at increased risk of coronavirus disease 2019 (COVID-19) infection and death.[1] This group is often multiracial, experiences from many comorbidities, and can be socioeconomically deprived, all factors strongly associated with COVID-19 mortality.[1] Vaccination is a priority for this at-risk group who are relatively immunosuppressed, and the effectiveness of vaccines has not been explicitly tested in patients with chronic kidney disease and on dialysis, meaning vaccine efficacy or immunogenicity is not well-understood.[2] To achieve maximum population coverage, in the United Kingdom, the second vaccine dose was delayed to 12 weeks. Retrospective review of the Oxford-AstraZeneca vaccine (AZD1222) trial data suggests that a single dose is efficacious and the delay may result in overall improved efficacy,[3] but prospective data and data on other vaccines are lacking. In health care workers, a single dose of the Pfizer-BioNTech vaccine (BNT162b2) elicited much stronger humoral and cellular responses in those with a previous natural infection.[4] Understanding the immune responses of patients receiving hemodialysis is vital to guide current and future vaccine dosing strategies in this vulnerable group.

Herein, we describe the antibody response against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) spike protein 28 days after the first dose of either the BNT162b2 or AZD1222 vaccine in 94 patients receiving maintenance hemodialysis (full methods in Supplementary Appendix S1).

Mean time between vaccination and antibody testing was 27.8 ± 4.2 days. Clinical characteristics of the study population

Table 1 | Baseline characteristics of hemodialysis patients

Clinical characteristics	Hemodialysis cohort (n = 94)
Age, mean ± SD, yr	62.1 ± 12.2
Female sex, n (%)	38 (40.4)
Race, n (%)	
Asian	47 (50)
White	35 (37.2)
Black	10 (10.6)
Mixed	1 (1.1)
Other	1 (1.1)
Diabetic, n (%)	43 (45.7)
Previous immunosuppression, n (%)	10 (10.6)
Previous COVID-19 infection, n (%)	20 (22.3)
Pfizer vaccine, n (%)	77 (82)
AstraZeneca vaccine, n (%)	17 (18)

COVID-19, coronavirus disease 2019.

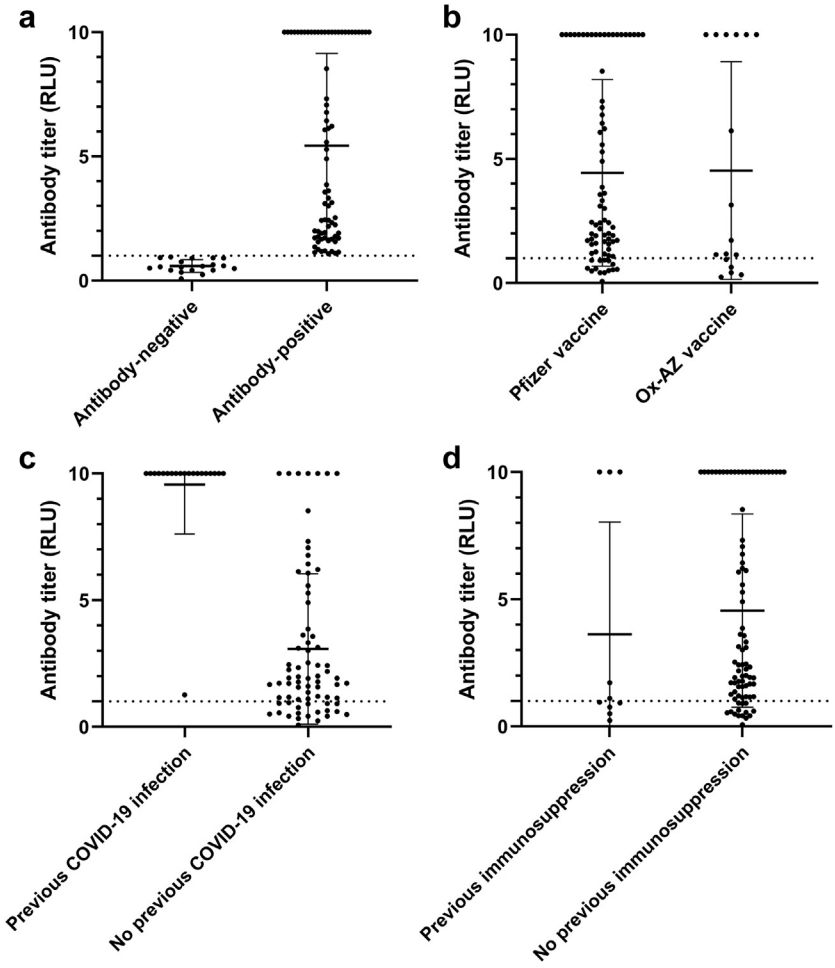

Figure 1 | Differences in antibody titers between groups. (**a**) Antibody-negative and antibody-positive patients. (**b**) Patients who received the Pfizer vaccine and those who received the Oxford-AstraZeneca (Ox-AZ) vaccine. (**c**) Patients with a previous history of coronavirus disease 2019 (COVID-19) infection and those without. (**d**) Patients with a previous history of immunosuppression and those without. RLU, relative light unit.

are shown in Table 1. Overall SARS-CoV-2 neutralizing antibodies against the receptor binding domain of the S1 spike protein were detectable in 75 patients (79.8%) and were not detectable in 19 patients (20.2%). Median antibody level was 2.4 [interquartile range, 8.8] relative light units. Patients with detectable antibodies were younger than patients without detectable antibodies (60.2 ± 11.6 years vs. 69.8 ± 11.8 years; $P = 0.002$). Patients who were immunosuppressed were less likely to have detectable antibodies than patients who were not immunosuppressed (50% vs. 83.3%; χ^2 [1, N = 94] = 6.2; $P = 0.013$). Patients previously infected with COVID-19 were more likely to have detectable antibodies than those with no history of COVID-19 infection (100% vs. 74.3%; χ^2 [1, N = 94] = 6.436; $P = 0.011$). There were no differences in detection of antibodies within the cohort between females and males (84.2% vs. 76,8%; χ^2 [1, N = 94] = 0.77; $P = 0.4$); the presence or absence of diabetes (86% vs. 74.5%; χ^2 [1, N = 94] = 1.9; $P = 0.17$); or race (Asian, 85.1%; White, 68.6%; Black, 90%; mixed, 100%; other, 100%; χ^2 [1, N = 94] = 4.7; $P = 0.32$). There were no differences between patients who received the Pfizer-BioNTech vaccine or the Oxford-AstraZeneca vaccine (81.8% vs. 70.6%; χ^2 [1, N = 94] = 1.089; $P = 0.3$) (Figure 1).

These findings are consistent with the findings in other populations,[5] but due to the small numbers in this study should be viewed as hypothesis-generating. Indeed, we

Table 2 | Recommended reporting of clinical variables for future studies

Essential clinical characteristics
Age
Sex
Race
Previous COVID-19 infection (PCR-positive, or clear clinical features early in the pandemic when antigen testing was not widely available)
Previous immunosuppression
Diabetic status
Type of vaccine
Time *after* vaccination (recommended 28 days after vaccine doses)
Desired clinical characteristics
Primary cause of kidney disease
Prevaccination antibody status
Medical comorbidities

COVID-19, coronavirus disease 2019; PCR, polymerase chain reaction.

publish these preliminary findings to highlight the urgent, international need for professional organizations, clinicians, charities, and stakeholder partners to work collaboratively to investigate the factors that influence the immune response following vaccination against COVID-19 in this patient group. There are a myriad of factors that may affect the ability of a patient receiving dialysis to successfully seroconvert following vaccination, and only through a joined-up, standardized approach will we be able to understand and mitigate these factors for dialysis populations around the world. For patients receiving hemodialysis, the United Kingdom has coordinated a multicenter study that will phenotype antibody responses to vaccinations 28 days after the first and second doses of the vaccine with storage and centralized analysis at the Francis-Crick Institute (SP/VACCINE/2021). Centralized analysis using the same antibody assays is an essential component in the design of such studies, and we encourage international communities to conduct similar studies to allow contemporary study of seroconversion rates in response to the spectra of available vaccines, and differing vaccine deployment strategies in populations with different and unique characteristics. We encourage the standardized collection and reporting of clinical variables such that future data syntheses and meta-analyses are possible. Our recommendations for required and desired reporting of clinical measures are shown in Table 2.

The presence or absence of antibodies 28 days after the first vaccine dose in the data we present is not synonymous with protection or absence of protection from COVID-19. Rather, these data should be viewed as a call to arms to all who care for these patients to coordinate collection and standardized analysis of seroconversion following vaccination internationally to understand the immune response and how this relates to subsequent infection rates and outcomes for these patients. These data are essential to inform current and future vaccination programs to protect patients receiving hemodialysis who have had to endure the worst of the pandemic.

SUPPLEMENTARY MATERIAL

Supplementary File (Word)

Supplementary Appendix S1. Methods.

1. Williamson EJ, Walker AJ, Bhaskaran K, et al. Factors associated with COVID-19-related death using OpenSAFELY. *Nature*. 2020;584:430–436.
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Roseanne E. Billany[1,2], Haresh Selvaskandan[1,2], Sherna F. Adenwalla[1,2], Katherine L. Hull[1,2], Daniel S. March[1], James O. Burton[1,2,3,4], Nicolette C. Bishop[4], Edward J. Carr[5], Rupert Beale[5], Julian W. Tang[6], Paul W. Bird[6], Chris W. Holmes[5], Richard Baines[2], Nigel J. Brunskill[1,2,3] and Matthew P.M. Graham-Brown[1,2,3]

[1]Department of Cardiovascular Sciences, University of Leicester and National Institute for Health Research Leicester Cardiovascular Biomedical Research Centre, Glenfield Hospital Leicester, Leicester, UK, [2]John Walls Renal Unit, University Hospitals Leicester National Health Service Trust, Leicester, UK, [3]National Institute for Health Research Leicester Biomedical Research Centre, University Hospitals of Leicester National Health Service Trust, Leicester, UK, [4]National Centre for Sport and Exercise Medicine, School of Sport, Exercise and Health Sciences, Loughborough University, Loughborough, UK, [5]Cell Biology of Infection Laboratory, The Francis Crick Institute, London, UK; and [6]Department of Clinical Virology, Leicester Royal Infirmary, Leicester, UK

Correspondence: *Matthew P.M. Graham-Brown, Department of Cardiovascular Sciences, University of Leicester, Leicester, LE1 9HN, UK. E-mail: mgb23@le.ac.uk*

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Neutralizing SARS-CoV-2 antibody response in dialysis patients after the first dose of the BNT162b2 mRNA COVID-19 vaccine: the war is far from being won

see commentary on page 1275

To the editor: On December 21, 2020, the European Commission granted conditional marketing approval to the BNT162b2 coronavirus disease 2019 (COVID-19) mRNA vaccine developed by BioNTech.[1,2] In the general population, the first dose of BNT162b2 was reported to produce a rapid antibody response with 52% efficacy in preventing severe infection, similar to the protection induced by the natural disease.[2,3] There was great hope that vaccination would protect fragile individuals, and societies of nephrology asked that patients with end-stage kidney disease should be given priority in being vaccinated.[4]

The situation of in-center hemodialysis patients is a double challenge: their fragility and their proximity to others have made this population particularly vulnerable. In France, for instance, the cumulative incidence of COVID-19 is now >10% in dialysis patients, with a mortality rate of about 15% in those who tested positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).