Residual Lung Abnormalities Following COVID-19 Hospitalization

Stewart, I, Jacob, J, George, PM, Molyneaux, PL, Porter, JC, Allen, RJ, Aslani, S, Baillie, JK, Barratt, SL, Beirne, P, Bianchi, SM, Blaikley, JF, Chalmers, JD, Chambers, RC, Chaudhuri, N, Coleman, C, Collier, G, Denneny, EK, Docherty, A, Elneima, O, Evans, RA, Fabbri, L, Gibbons, MA, Gleeson, FV, Gooptu, B, Greening, NJ, Guillen Guio, B, Hall, IP, Hanley, NA, Harris, V, Harrison, EM, Heightman, M, Hillman, TE, Horsley, A, Houchen-Wolloff, L, Jarrold, I, Johnson, SR, Jones, MG, Khan, F, Lawson, R, Leavy, O, Lone, N, Marks, M, McAuley, H, Mehta, P, Parekh, D, Piper Hanley, K, Platé, M, Pearl, J, Poinasamy, K, Quint, JK, Raman, B, Richardson, M, Rivera-Ortega, P, Saunders, L, Saunders, R, Semple, MG, Sereno, M, Shikotra, A, Simpson, AJ, Singapuri, A, Smith, DJ, Spears, M, Spencer, LG, Stanel, S, Thickett, D, Thompson, AAR, Thorpe, M, Walsh, SL, Walker, S, Weatherley, ND, Weeks, M, Wild, JM, Wootton, DG, Brightling, CE, Ho, L-P, Wain, LV & Jenkins, RG 2022, 'Residual Lung Abnormalities Following COVID-19 Hospitalization: Interim Analysis of the UKILD Post-COVID Study', *American Journal of Respiratory and Critical Care Medicine*. https://doi.org/10.1164/rccm.202203-0564OC

Digital Object Identifier (DOI):
10.1164/rccm.202203-0564OC

Published In:
American Journal of Respiratory and Critical Care Medicine

Residual lung abnormalities following COVID-19 hospitalization: interim analysis of the UKILD Post-COVID study

(Running head) Lung damage burden after COVID-19 hospitalization

Iain Stewart[1], Joseph Jacob[2], Peter M George[3], Philip L Molyneaux[1], Joanna C Porter[4], Richard J Allen[5,6], Shahab Aslani[2], J Kenneth Baillie[7], Shaney L Barratt[8], Paul Beirne[9], Stephen M Bianchi[10], John F Blaikley[11], James D Chalmers[12], Rachel C Chambers[13], Nazia Chadhuri[11], Christopher Coleman[14], Guilhem Collier[15], Emma K Denneny[4], Annemarie Docherty[7], Omer Elneima[6], Rachel A Evans[6], Laura Fabbri[1], Michael A Gibbons[16], Fergus V Gleeson[17], Bibek Gooptu[5], Neil J Greening[6], Beatriz Guillen Guio[5], Ian P Hall[14], Neil A Hanley[11], Victoria Harris[6], Ewen M Harrison[7], Melissa Heightman[18], Toby E Hillman[18], Alex Horsley[11], Linzy Houchen-Wolloff[6], Ian Jarrold[19], Simon R Johnson[14], Mark G Jones[20], Fasihul Khan[14], Rod Lawson[10], Olivia Leavy[5], Nazir Lone[21], Michael Marks[18], Hamish McAuley[6], Puja Mehta[18], Dhruv Parekh[22], Karen Piper Hanley[11,23], Manuela Platé[18], John Pearl[5], Krisnah Poinasamy[24], Jennifer K Quint[1], Betty Raman[25], Matthew Richardson[6], Pilar Rivera-Ortega[11], Laura Saunders[15], Ruth Saunders[6], Malcolm G Semple[26], Marco Sereno[6], Aarti Shikotra[6], A John Simpson[27], Amisha Singapuri[6], David JF Smith[3], Mark Spears[28], Lisa G Spencer[29], Stefan Stanel[11], David Thickett[22], A A Roger Thompson[15], Mathew Thorpe[7], Simon LF Walsh[1], Samantha Walker[30], Nicholas David Weatherley[30], Mark Weeks[1], Jim M Wild[30], Dan G Wootton[26], Chris E Brightling[6], Ling-Pei Ho[25], Louise V Wain[5,6], R Gisli Jenkins[1]

On behalf of the PHOSP-COVID Study Collaborative Group

[1]National Heart & Lung Institute, Imperial College London, [2]Centre for Medical Imaging Computing, University College London, [3]Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation Trust, [4]University College London, [5]Department of Health Sciences, University of Leicester, [6]Leicester NIHR Biomedical Research Centre, [7]University of Edinburgh, [8]North Bristol NHS Trust, [9]Leeds Teaching Hospitals & University of Leeds, [10]Sheffield Teaching Hospitals NHS Foundation Trust, [11]University of Manchester, [12]Ninewells Hospital and Medical School, [13]Respiratory Medicine, University College London, [14]University of Nottingham, [15]University of Sheffield, [16]Royal Devon and Exeter NHS Foundation Trust, [17]Oxford University Hospitals NHS Foundation Trust, [18]University College London Hospital, [19]Asthma UK British Lung Foundation, [20]Faculty of Medicine, University of Southampton, [21]Usher Institute, University of Edinburgh, [22]University of Birmingham, [23]Manchester University NHS Foundation Trust, [24]British Lung Foundation, [25]University of Oxford, [26]University of Liverpool, [27]Newcastle University, [28]Perth Royal Infirmary, NHS Tayside, [29]Liverpool University Hospitals NHS Foundation Trust, [30]Sheffield Teaching NHS Foundation Trust

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Corresponding author:
Dr Iain Stewart, National Heart & Lung Institute
iain.stewart@imperial.ac.uk

Author Contributions

Conceptualisation: IS, JJ, JMW, JCP, PLM, PMG, RJA, JKB, SLB, PB, SMB, JFB, NC, GC, EKD, AD, LF, MAG, FVG, BG, IPH, NAH, MH, TEH, SRJ, MGJ, FK, RL, PM, MP, KP, JKQ, PRO, MS, AJS, DJFS, MS, LGS, SS, DRT, AART, SLFW, NDW, MEW, DGW, CEB, RCC, LPH, KPH, LVW, RGJ. Data curation: SA, EMH, MS, OL, HM, IS, JJ, NL, AB, JKQ, SLFW. Formal analysis: IS, JJ, JKQ. Funding acquisition: CEB, LVW, RAE, JC, LPH, AH, MM, KP, BR, OL, MR, OE, HM, ASh, MS, RS, VH, LH, NG, RGJ. Project administration: ASh, MW, AS. Writing - original draft: IS, JJ, PMG, LVW, RGJ. Writing - review & editing: IS, JJ, PMG, PLM, JCP, RJA, JKB, SLB, PB, SMB, JFB, JC, RCC, NC, CC, GC, EKD, AD, OE, RAE, LF, MAG, FVG, BG, NJG, BGG, IPH, NAH, VH, EMH, MH, TEH, AH, LHW, IJ, SRJ, MGJ, FK, RL, OL, NL, MM, HM, PM, EO, DP, KPH, MP, JP, KP, JKQ, BR, MR, PRO, LS, RS, MGS, MS, ASh, AJS, AS, DJFS, MS, LGS, SS, DT, AART, MT, SLFW, SW, NDW, JMW, DGW, CEB, LPH, LVW, RGJ.

Funding

Jointly funded by UK Research and Innovation and National Institute of Health Research (grant references: MR/V027859/1 and COV0319). Ethics Approval Ethics Ref: 20/YH/0225. JB acknowledges MRC Transition Fellowship (MR/T032529/1) and Manchester BRC funding. BG acknowledges UKRI-MRC Programme Grant and Confidence in Concept Grant, British Lung Foundation and the NIHR Leicester BRC funding. BGG acknowledges funding from Wellcome Trust grant 221680/Z/20/Z. NG is funded by an NIHR fellowship. IPH is in receipt of a NIHR Senior Investigator award. PLM and RJA are funded by the Action for Pulmonary Fibrosis Mike Bray Fellowships. DGW is funded by an NIHR Advanced Fellowship. RCC and MP acknowledge funds from the British Lung Foundation and the University College London Hospitals Biomedical Research Centre (UCLH BRC). JP is supported by UKRI PC-ILD grant, Breathing Matters Charity, and UCLH/UCL funding from the Department of Health's NIHR Biomedical Research Centres funding scheme. AART is

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

funded by an Intermediate Clinical Fellowship from the British Heart Foundation (FS/18/13/33281). LVW is supported by GSK / Asthma + Lung UK Chair in Respiratory Research (C17-1). GJ acknowledges funding from a NIHR Research Professorship. IS fellowship is funded by the Rayne Foundation.

9.23 Interstitial Lung Disease

Word count: 3498

At a Glance Commentary

Current scientific knowledge on the subject: Current studies highlight persistent breathlessness and radiological patterns suggestive of lung fibrosis, as well as shared genetic architecture with idiopathic pulmonary fibrosis, in people who are discharged following severe COVID-19 hospitalisation. Survivors of COVID-19 may develop parenchymal abnormalities consistent with lung fibrosis.

What this study adds to the field: This study assesses the risk factors for residual lung abnormalities, provides evidence of persistent abnormalities within a year of discharge from over 200 CT scans, and estimates the prevalence of lung abnormalities after discharge to be up to 11% in a broad range of COVID-19 severity. The findings emphasise the importance for health services to undertake active radiological and physiological monitoring to assess progression or resolution over time.

Some of the results of these studies have been previously reported in the form of a preprint (medRxiv, 16 March 2022 https://www.medrxiv.org/content/10.1101/2022.03.10.22272081v2).

This article has an online data supplement, which is accessible from this issue's table of content online at www.atsjournals.org.

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Abstract

Rationale. Shared symptoms and genetic architecture between COVID-19 and lung fibrosis suggests SARS-CoV-2 infection may lead to progressive lung damage.

Objectives. The UKILD Post-COVID study interim analysis was planned to estimate the prevalence of residual lung abnormalities in people hospitalized with COVID-19 based on risk strata.

Methods. The Post-HOSPitalisation COVID Study (PHOSP-COVID) was used for capture of routine and research follow-up within 240 days from discharge. Thoracic CTs linked by PHOSP-COVID identifiers were scored for percentage of residual lung abnormalities (ground glass opacities and reticulations). Risk factors in linked CT were estimated with Bayesian binomial regression and risk strata were generated. Numbers within strata were used to estimate post-hospitalization prevalence using Bayesian binomial distributions. Sensitivity analysis was restricted to participants with protocol driven research follow-up.

Measurements and Main Results. The interim cohort comprised 3700 people. Of 209 subjects with linked CTs (median 119 days, interquartile range 83-155), 166 people (79.4%) had >10% involvement of residual lung abnormalities. Risk factors included abnormal chest X-ray (RR 1·21 95%CrI 1·05; 1·40), percent predicted DLco<80% (RR 1·25 95%CrI 1·00; 1·56) and severe admission requiring ventilation support (RR 1·27 95%CrI 1·07; 1·55). In the remaining 3491 people, moderate to very-high risk of residual lung abnormalities was classified in 7·8%, post-hospitalization prevalence was estimated at 8.5% (95%CrI 7.6%; 9.5%) rising to 11.7% (95%CrI 10.3%; 13.1%) in sensitivity analysis.

Conclusions. Residual lung abnormalities were estimated in up to 11% of people discharged following COVID-19 related hospitalization. Health services should monitor at-risk individuals to elucidate long-term functional implications.

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

1.0 Introduction

Long term symptoms of COVID-19 have been widely reported and can have a severe impact on quality of life, frequently characterized by chronic breathlessness.[1-3] Post-mortem studies on COVID-19 patients have highlighted diffuse parenchymal alterations, including alveolar damage, exudation, and development of pulmonary fibrosis, which may explain chronic respiratory symptoms in survivors.[4-6]

A number of studies have identified similarities between severe COVID-19 and idiopathic pulmonary fibrosis (IPF), an archetypal interstitial lung disease (ILD). These include shared genetic etiology, [7, 8] circulating biomarkers, [9, 10] similarities in pulmonary function and radiological features.[11] Viral injury may promote lung fibrosis, and chronic viral infection has been shown to be associated with developing IPF.[12] Consequently, survivors of COVID-19 may develop parenchymal abnormalities consistent with ILD, including radiological patterns of ground glass opacities and reticulations.

To understand the potential risk of COVID-19 leading to the development of longer term ILD and fibrosis, the UKILD-Post COVID study aims to investigate the risk factors and nature of long term lung damage from COVID-19 in a longitudinal observational study. To support clinical and research management, this planned interim analysis of the UKILD-Post COVID study addresses the extent of residual lung abnormalities post hospitalization following completion of an early follow-up visit of the prospective Post-HOSPitalisation COVID-19 Study (PHOSP-COVID). [13]

2.0 Methods

2.1 Participants

This interim analysis was restricted to participants of the PHOSP-COVID study, a prospective longitudinal cohort study of adults discharged from National Health Service hospitals across the United Kingdom following admission for confirmed or clinical-diagnosed COVID-19, previously described in detail.[14]

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Individuals withdrawing consent from PHOSP-COVID were excluded. Individuals being managed for an *a priori* diagnosed interstitial lung disease or pulmonary fibrosis as recorded by site teams using hospital notes were identified by hand searches of comorbidities and subsequently excluded.

2.2 Interim Study Design

Interim participants were discharged by end of March 2021 representing wave 1 of the pandemic, interim data were collected up to October 2021 and were restricted to within 240 days of discharge. Analyses were performed with data recorded through routine follow-up (PHOSP-COVID Tier 1) and those with completed early research follow-up visits (PHOSP-COVID Tier 2). Clinically indicated thoracic CT scans were identified through the PHOSP-COVID study via linkage to a radiological database, linked CT scans were requested at clinical discretion. The presence of residual lung abnormalities on volumetric CTs was scored on a lobar basis; percentage involvement of ground glass opacities, reticulations, or the sum of involvement were averaged across lobes to quantify residual abnormality. [15] The primary outcome was visually scored residual abnormalities >10% lung involvement on CT.[15]

Risk factors implicated in worse outcomes following COVID-19 hospitalization of individuals with ILD were described.[16] These included sex, age, ethnicity, Body Mass Index (BMI), and Index of Multiple Deprivation (IMD). A modified WHO clinical progression scale was used to define the severity of admission (i. no supplemental oxygen ii. supplemental oxygen only; iii. continuous positive airway pressure (CPAP); iv. invasive mechanical ventilation (IMV), extra-corporeal membrane oxygenation (ECMO)). Abnormal chest X-ray reports were classified at follow-up, defined as "suggestive of lung fibrosis", "extensive persistent changes greater than 1/3 lung involvement" and "indeterminate", compared with "other" or "normal". Breathless and cough symptoms were recorded at follow-up with the Patient Symptom Questionnaire developed for the PHOSP-COVID Study.[14] Percent predicted values for Forced Vital Capacity (ppFVC) and Diffusion capacity across the Lung

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

for carbon monoxide (ppDLco) were obtained at follow-up visits and calculated using GLI reference equations.

2.3 Statistical analysis

Risk factor data were presented descriptively overall, according PHOSP-COVID Tier, and within the sample of linked and scored CTs. Chi-square tests were performed on non-missing categories. Residual abnormalities on paired CT scans were tested with paired t-test; changes in scored residual lung abnormalities over time were estimated using linear mixed effect models, with random effects of timing at the level of the individual, adjusted for sex and IMD. A random sample of 70 CT scans were tested for inter-rater agreement by Cohen's kappa (κ) with a second radiologist blinded to scores.

Univariate relative risk ratios of threshold >10% residual abnormalities, and difference in involvement on CT, were modelled with dichotomized exposure variables. Bayesian binomial and linear associations were estimated using 12,500 Markov Chain Monte Carlo iterations including a burn-in of 2,500 and 10,000 subsequent simulations using random-walk Metropolis Hastings sampling. Non-informative, flat priors were selected and estimates were reported with 95% credible interval (95%CrI). Linear associations were additionally adjusted for demographics of sex and IMD.

Clinical risk factors with consistent significant effects were selected to develop risk strata of suspected residual lung abnormalities Post-COVID hospitalization. For the indexing of risk strata, missing data on clinical indicators were imputed to the reference (lowest risk) category. The percentage of participants within moderate to very-high risk strata and no CT scored were defined as at-risk. Hospital admissions were compared between at-risk groups using chi-square, 15 index admission variables were selected from 61 by least absolute shrinkage and selection operator.

Bayesian inference with binomial distribution of at-risk cases and non-cases,[17] was used to estimate the prevalence of suspected residual lung abnormalities Post-COVID hospitalization within 240 days of discharge, reported with the 95%CrI. MCMC simulations

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

were run as described above. Non-informative, uniform, beta priors were used and compared in sensitivity analyses with uniform Jeffrey's priors, as well as skeptical and power priors informed by published population studies of ILD.[18, 19] Sensitivity analyses were performed in PHOSP-COVID Tier 2 research follow-up participants where data completeness was greater. Analyses were performed in Stata SE16.0 within the Scottish National Safe Haven Trusted Research Environment.

3.0 Results

3.1 Cohort demographics and patterns of lung damage

A total of 3700 PHOSP-COVID participants reached criteria for inclusion in the interim UKILD cohort. This included 1304 patients with data available through routine clinical care (Tier 1) and 2396 who had completed an early follow-up research visit within 240 days of discharge (Tier 2; Figure 1). We observed that 255/3700 people of the interim cohort (6.9%) had a linkable thoracic CT scan performed, 220 were performed in Tier 2 participants (9.2% of 2396) and 35 were performed in Tier 1 participants (2.7% of 1304, $p<0.001$). Of 255 participants with linked CT scans within 240 days of discharge (median 113 days; IQR 69 to 166, Supplementary Figure 1), a total of 209 (82.0%) were visually scored with inter-rater agreement on 70% of scans (Cohen's κ 0.33). Participants with a CT scored were majority male (68.4%), white (68.9%), had a median age of 58 (52 to 67) and had a median time to early follow-up visit of 140 days (IQR 106 to 170) (Table 1).

Residual lung abnormalities >10% were observed in 166/209 participants (79.4%). Visual scoring of involvement indicated ground glass opacities affected a mean 25.5% ±15.9 of the lung, reticulation a mean 15.1% ±11.0, with residual abnormalities involving in a mean a 40.6% ±20.8 of the lung (Figure 2A). 33 people had a repeat CT visually scored after a minimum of 90 days (median 161 days; IQR 109 to 187), 28/33 (84.8%) of whom were classified with residual abnormalities >10% on the initial scan, with 26/28 (92.9%) observed to have >10% involvement in subsequent scans. In paired analysis the overall

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

change in residual lung abnormalities was -3.62% (95%CI -6.10; -1.13, p=0.006; Figure 2B). The involvement of lung reticulations and ground glass opacities did not significantly change with a mean difference of -2.08% (95%CI -4.66; 0.51, p=0.112) and -1.54% (95%CCI -4.74; 1.39, p=0.293), respectively (Figure 2C-2D). Using all scored CT scans, the mean weekly change in lung involvement was estimated at -0.13% per week (95%CI -0.20; -0.05) for reticulations and -0.13% per week (95%CI -0.22; -0.04) for ground glass opacities (Figure 2E). The weekly change in residual lung abnormalities was -0.20% per week (95%CI -0.28; -0.11, Figure 2F). Representative CT images of residual lung abnormality demonstrated persistent involvement >100 days post discharge (Figure 3).

Overall, the median time to follow-up in the UKILD interim cohort (N=3700) was 127 days (IQR 91 to 173), the median age was 59 (IQR 50 to 68) and the cohort was majority male (60.7%). Tier 1 participants (n=1304) had a median time to follow-up of 101 days (IQR 82 to 138), a median age of 60 (IQR 51 to 70) and the majority were male (58.9%); demographics were similar in Tier 2 participants (n=2396) with a median time to research visit of 141 days (IQR 100 to 180), a median age of 59 (IQR 50 to 67) and a majority male (61.7%) (Table 1). There was minimal evidence of systematic bias in the characteristics between Tier 2 and Tier 1 participants in non-missing data (Table 1), although the representation of people aged below 60 was greater in Tier 2 participants (52.5% vs 48.8%; p=0.027), similarly there were small differences in representation of ethnicity (p<0.001), greater representation of the lowest deprivation quintile (19.1% vs 16.1%; p=0.031), as well as lower representation of normal CXR (32.5% vs 39.2%; p=0.004).

Tier 2 participants had a median ppFVC at research follow-up of 90.2% (IQR 78.6 to 101.6) with missing records at 55.5%, whilst median ppDLCO was 87.5% (IQR 74.0 to 101.3) with missing records at 78.8%; lung function was largely missing in routine follow-up of Tier 1 participants. We observed 34.6% of people reported worsening cough or dyspnea since discharge in Tier 2. ILD diagnostic criteria of lung function (ppFVC and ppDLCO), CXR and symptoms was frequently missing, particularly in Tier 1 of clinical follow-up

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

(Supplementary Figure 2). In Tier 1, 578/1304 (44.3%) were missing data on all four characteristics at interim analysis, whilst in Tier 2, 362/2396 people (15.1%) were missing data on all four characteristics. In contrast, a total of 202 Tier 2 participants had complete data on all (8.4%), no Tier 1 participants had complete lung function, CXR or symptom data. In the subsample of participants with scored CTs, data was missing at a rate similar to Tier 2 for lung function (ppDLco 70.3%; ppFVC 60.8%), CXR (47.4%), and Patient Symptom Questionnaire (43.1%) (Table 1).

3.2 Risk of residual lung abnormalities and persistence over time.

Univariate risk ratios were calculated to assess the risk of residual lung abnormalities >10% on CT. A greater risk was observed in males (RR 1.42 95%CrI 1.17; 1.77) and in those over 60 years of age (RR 1.22 95%CrI 1.06; 1.40). Clinical indicators, including severe illness on admission requiring CPAP, IMV or ECMO (RR 1.40 95%CrI 1.23; 1.63), abnormal CXR findings (RR 1.40 95%CrI 1.22; 1.61), and ppDLco <80% (RR 1.26 95%CrI 1.02; 1.58) were also associated with greater risk, with consistent effects for the relative mean difference of percent involvement after adjustment for sex and deprivation quintile (Table 2).

Three significant clinical indicators were selected to index the risk of residual lung abnormalities Post-COVID in the remaining cohort (n=3491) based on combined thresholds: ppDLco <80%; abnormal CXR; and severe illness on admission. Individuals were considered to be at very-high risk when reaching the defined thresholds in all three indicators (risk index 4), high risk when two thresholds were reached (risk index 3), or moderate risk if reaching ppDLco or CXR thresholds alone (risk index 2). Individuals reaching the threshold of severity of illness on admission alone were considered low-risk in the absence of other indicators (risk index 1). Those who did not reach any threshold were considered very low risk (risk index 0). A total 14/3419 participants (0.4%) were considered very-high risk, 143/3419 at high risk (4.1%), and 116/3419 at moderate risk (3.3%), 1256/3419 at low risk (36.0%) and 1962/3419 at very-low risk (56.2%) (Table 3). Combined, 273/3419 (7.8%) people in strata of moderate to very-high risk were

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

defined as at-risk, 8/46 (17.4%) people with an unscored clinically indicated CT were at-risk. In sensitivity analyses applying risk stratification to Tier 2 alone, 231/2219 (10.4%) people were at moderate to very-high risk including 20% of those with an unscored clinically indicated CT (Table 3).

No differences were observed between at-risk participants (n=273) and participants with >10% residual abnormalities on CT (n=166) according to representation of males, older age, ethnicity, deprivation, BMI, severity of admission, ppFVC <80% or Patient Symptom Questionnaire (Supplementary Table 1). There was lower representation of normal CXR in the at-risk group (14.7% vs 30.1%, p<0.001) and more representation of ppDLco <80% (55.3% vs 14.5%, p<0.001). The percentage of people who did not have a severe admission requiring CPAP, ECMO or IMV was similar in both groups (44.3% vs 45.2%), whilst CXR was missing in 26.0% of the at-risk group and 48.2% of people with residual abnormalities scored.

Comparing at-risk participants to low-risk participants, there were more records of immunosuppressant (18.3% vs 9.9%, p=0.001) and corticosteroid treatments (35.3% vs 26.5%, p=0.019) pre-admission, intensive care unit stays (50.0% vs 33.4%, p<0.001), and complications of acute respiratory distress syndrome (ARDS; 25.0% vs 13.7%, p<0.001) (Supplementary Table 2). Additionally, there were more recorded unscheduled emergency visits post discharge (34.8% vs 25.2%, p=0.001), with a greater representation of visits where patients presented with symptoms of shortness of breath (33.7% vs 24.3%, p=0.046). Findings were similar in comparisons of CT scored residual lung abnormalities >10% compared to those not reaching this threshold, although statistical significance was not always met (Supplementary Table 2).

Based on the distribution of at-risk cases, the prevalence of residual lung abnormalities post-COVID hospitalization was estimated at 8.51% (95%CrI 7.56; 9.51%) using non-informative priors, or 6.49% (95%CrI 5.75; 7.27) with skeptical priors based on ILD population prevalence estimated at 1 in 1,000 (Table 4, Supplementary Figure 3).[18, 19] In sensitivity analyses based on Tier 2 distribution, the prevalence of residual lung

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

abnormalities post-COVID hospitalization was estimated at 11.67% (95%CrI 10.28; 13.14) using non-informative priors, or 7.74% (95%CrI 6.79; 8.72) using skeptical priors.

4.0 Discussion

These data demonstrate that residual lung abnormalities were visually identifiable on clinically indicated thoracic follow-up CT imaging in a substantial proportion of patients within 8 months of discharge following COVID-19 hospitalization. The involvement of scored residual lung abnormalities minimally declined per week following discharge, whilst minimal resolution was observed in paired subsequent scans at least 90 days apart. Key clinical risk factors associated with residual abnormalities in the early follow-up period included abnormal CXR, ppDLco <80% and severe admissions requiring invasive support (IMV, CPAP, ECMO). In those without a scored CT, 0.4% were in very-high risk strata (all three indicators present), 4.1% in high risk strata (any two indicators present), and 3.3% in moderate risk strata (presence of either ppDLco<80% or abnormal CXR, alone). Combining these risk strata, 7.8% of the interim cohort had suspected residual lung abnormalities Post-COVID hospitalization, which increased to 10.4% in sensitivity analysis on those with planned research follow-up. Based on Bayesian modelling, we estimate the prevalence of suspected residual lung abnormalities with >10% lung involvement to be up to 11.7% in people hospitalized with acute COVID-19 infections before March 2021.

This UKILD Post-COVID interim analysis of residual abnormalities in patients hospitalized for COVID-19 offers the largest assessment of prevalence in hospitalized individuals to date, and is consistent with findings from a number of smaller studies that demonstrate persistent radiological patterns and impaired gas transfer during extended follow-up of patients with COVID-19.[20-23] At the time of this interim analysis it is not possible to determine whether the observed residual lung abnormalities represent early interstitial lung disease (ILD) with potential for progression, or whether they reflect residual pneumonitis that may be stable or resolve over time.[24] The 10% threshold used was determined to support distinction of interstitial lung damage from interstitial lung

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

abnormalities.[15] Longer term follow-up and mechanistic studies will be required to determine the clinical trajectory of these observations.

Where linked longitudinal scans were available most patients did not show evidence of substantial improvement, although such clinically requested CTs may be over-represented by those with slower recovery. However, approximately half the people with visually scored residual abnormalities above the 10% threshold did not require CPAP, IMV or ECMO during their admission and less than one quarter had ARDS recorded as a complication, suggesting medium and longer term disability consequent to severe COVID-19 infection, consistent with prior studies. [18]

The risk factors for residual abnormality as scored in the CT subsample (abnormal CXR, ppDLco <80% and severe admissions requiring invasive support) were applied to the remaining hospitalized cohort to generate clinically applicable risk strata. For participants in receipt of a clinically indicated but unscored CT, 17.4% of people were in moderate to very-high risk strata for residual lung abnormalities (sensitivity 20.0%). These rates were similar to meta-analysis estimates of the percentage of clinically indicated CT scans with radiological patterns suggestive of fibrosis (29%; 95%CI 22% to 37%) and people with impaired gas transfer (17%; 95%CI 13% to 23%), neither of which were associated with timing of follow-up within the first year post-COVID.[25] In paired CT scans greater than 90 days apart we demonstrate no significant difference in the mean change for percent involvement of reticulations and ground glass opacities, whilst the scored involvement of reticulations and ground glass opacities based on all CT scans declined by 0.13% per week of study from discharge, suggesting persistence over time in at-risk groups.

Differences between individuals at moderate to very high risk and those at lower risk suggested more immunosuppressant and corticosteroid treatment pre-admission, intensive care unit stays and ARDS complications, as well as further unscheduled emergency visits post discharge both overall and including presentation with breathlessness. Classification of at-risk participants using clinically applicable strata identified those who may have had a more severe viral injury and inflammatory response

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

during acute infection, as well as subsequent respiratory exacerbations post COVID. Recent analysis identified a hyper inflammatory phenotype of COVID-19 related ARDS was associated with worse outcomes, with better survival linked to corticosteroid treatment.[26] Surviving a hyper inflammatory response to COVID-19 may be consistent with residual lung abnormalities, including fibrosing non-specific interstitial pneumonia and alveolar damage.[27]

Residual lung abnormalities Post-COVID were not uncommon in this hospitalized population and may persist long-term, but indicators that could support diagnosis and clinical management of lung disease were frequently unavailable. Considering approximately 280,000 people were discharged following confirmed COVID-19 admission in the UK National Health Service by end of March 2021,[28] these results emphasize the importance for health services to undertake active radiological and physiological monitoring especially in people at moderate, or above, risk.[15]

4.1 Strengths and Limitations

The UKILD long-COVID cohort excluded participants with any evidence of ILD prior to hospitalization, and we used informative skeptical priors and power priors for more conservative estimates of prevalence, which continued to suggest a substantial burden of residual lung abnormalities Post-COVID hospitalization. The approach we report can be reasonably applied to other cohorts and time points, with current findings used as informative priors for updating Bayesian inference.

Whilst included CTs were assumed to be representative of clinically indicated radiology, this is limited by local management protocols, timing of services, and changes to healthcare service prioritization during the COVID-19 pandemic, which increases chances of selection and ascertainment bias. Furthermore, individuals with linked CT may have unrecorded pre-existing disease or present with radiological patterns other than reticulation and ground glass opacities. Fair inter-rater agreement (kappa 0.33) of CT scoring was observed, representing agreement in 70% of scans.

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

We recognize these interim findings may also be limited by misclassification. Descriptive analyses identified substantial missing data in clinical risk factors, limiting multiple imputation techniques. We used dichotomized thresholds with single data imputation at the reference category to support risk strata classification, maintain denominators, and provide conservative estimates. In contrast, lung involvement of reticulation and ground glass opacities was frequently scored on CTs which were clinically indicated, contributing to selection bias. It is similarly likely that repeat CT scans reflect a sample of individuals that did not experience clinical improvement over time. We report estimates from multilevel models to support interpretation of residual lung abnormalities over time.

Whist our findings are based on people hospitalized with mixed severity of COVID-19 infection, we recognize that they may not be generalizable to all populations especially those people not admitted to hospital. Severe admissions requiring CPAP or IMV were over-represented in the PHOSP-COVID dataset relative to hospitalized survivors of COVID-19.[14] Linked clinical admission data suggested 50% of at-risk individuals and those scored with residual abnormalities attended intensive care units during admission, and up to 25% had complications of anemia and ARDS. Furthermore, these data reflect people who were discharged before end of March 2021, and do not represent later SARS-CoV-2 variants in fully vaccinated populations that more frequently led to milder infections.

4.2 Conclusion

Thresholds of ppDLco, CXR and severity of admission can stratify risk of residual abnormalities on CT involving more than 10% of the lung, informing clinical management particularly of individuals meeting moderate to very-high risk strata. Longitudinal analysis of CT scans suggested persistence of abnormalities over study time, although the longer term functional consequence is unknown and may be limited by clinical indication. These findings highlight the importance of radiological and physiological monitoring of patients at both early and later follow-up, and suggest up to 11% of people discharged from an acute COVID-19 admission are at risk of residual lung abnormalities. Further study is

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

required to elucidate progressive development of radiological patterning, or resolution over time.

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Acknowledgements

The authors would like to acknowledge the support of the eDRIS Team (Public Health Scotland) for their involvement in obtaining approvals, provisioning and linking data and the use of the secure analytical platform within the National Safe Haven. This study would not be possible without all the participants who have given their time and support. We thank all the participants and their families. We thank the many research administrators, health-care and social-care professionals who contributed to setting up and delivering the study at all of the 65 NHS trusts/Health boards and 25 research institutions across the UK, as well as all the supporting staff at the NIHR Clinical Research Network, Health Research Authority, Research Ethics Committee, Department of Health and Social Care, Public Health Scotland, and UK Health Security Agency, and support from the ISARIC Coronavirus Clinical Characterisation Consortium (ISARIC4C). We thank Kate Holmes at the NIHR Office for Clinical Research Infrastructure (NOCRI) for her support in coordinating the charities group. The PHOSP-COVID industry framework was formed to provide advice and support in commercial discussions, and we thank the Association of the British Pharmaceutical Industry as well as Ivana Poparic and Peter Sargent at NOCRI for coordinating this. We are very grateful to all the charities that have provided insight to the study: Action Pulmonary Fibrosis, Alzheimer's Research UK, Asthma & Lung UK, British Heart Foundation, Diabetes UK, Cystic Fibrosis Trust, Kidney Research UK, MQ Mental Health, Muscular Dystrophy UK, Stroke Association Blood Cancer UK, McPin Foundations, and Versus Arthritis. We thank the NIHR Leicester Biomedical Research Centre patient and public involvement group and the Long Covid Support Group.

Competing Interests

JJ reports fees from Boehringer Ingelheim, F. Hoffmann-La Roche, GlaxoSmithKline, NHSX, Takeda and patent: UK patent application number 2113765.8 all unrelated to the submitted work. PMG reports honoraria from Boehringer Ingelheim, Roche, AstraZeneca, Cipla, Brainomix. JCP reports grants from LifeArc, NIHR, Breathing Matters, consulting fees from Carrick Therapeutics, AstraZeneca and honoraria from The Limbic. RAE reports

speaker fees from Boehringer Ingelheim and membership positions on European Respiratory Society and American Thoracic Society committees. PM reports consulting fees from EUSA pharma and SOBI, and honoraria from SOBI, UCB, Lilly, and Abbvie. MGS reports grants from NIHR, MRC, board positions on Pfizer External Data Monitoring Committee and Integrum Scientific LLC Infectious Disease Scientific Advisory Board, member positions of HMG UK SAGE and MHG UK NERVTAG, stocks in Integrum Scientific LLC and MedEx Solutions Ltd, gifts from Chiesi Farmaceutici S.p.A. AART reports grants and travel support from Janssen-Cilag Ltd. CEB reports consultancy fees paid to institution from GSK, AstraZeneca, Sanofi, Boehringer Ingelheim, Chiesi, Novartis, Roche, Genentech, Mologic, 4DPharma, TEVA. LVW reports recent and current research funding from GSK and Orion, and consultancy from Galapagos. RGJ reports honoraria from Chiesi, Roche, PatientMPower, AstraZeneca, GSK, Boehringer Ingelheim, and consulting fees from Bristol Myers Squibb, Daewoong, Veracyte, Resolution Therapeutics, RedX, Pliant, Chiesi. All remaining authors declare no competing interests.

5.0 References

1. Arnold, D.T., et al., *Patient outcomes after hospitalisation with COVID-19 and implications for follow-up: results from a prospective UK cohort.* Thorax, 2021. **76**(4): p. 399-401.
2. Carfi, A., et al., *Persistent Symptoms in Patients After Acute COVID-19.* JAMA, 2020. **324**(6): p. 603-605.
3. Mandal, S., et al., *'Long-COVID': a cross-sectional study of persisting symptoms, biomarker and imaging abnormalities following hospitalisation for COVID-19.* Thorax, 2021. **76**(4): p. 396-398.
4. Carsana, L., et al., *Pulmonary post-mortem findings in a series of COVID-19 cases from northern Italy: a two-centre descriptive study.* The Lancet Infectious Diseases, 2020. **20**(10): p. 1135-1140.
5. Ducloyer, M., et al., *Complete post-mortem data in a fatal case of COVID-19: clinical, radiological and pathological correlations.* Int J Legal Med, 2020. **134**(6): p. 2209-2214.
6. Zhao, L., et al., *Correlation of autopsy pathological findings and imaging features from 9 fatal cases of COVID-19 pneumonia.* Medicine (Baltimore), 2021. **100**(12): p. e25232.
7. Fadista, J., et al., *Shared genetic etiology between idiopathic pulmonary fibrosis and COVID-19 severity.* EBioMedicine, 2021. **65**: p. 103277.
8. Allen, R.J., et al., *Genetic overlap between idiopathic pulmonary fibrosis and COVID-19.* Eur Respir J, 2022. **60**(1).

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

9. Nasr El-Din, A., et al., *Impact of High Serum Levels of MMP-7, MMP-9, TGF-beta and PDGF Macrophage Activation Markers on Severity of COVID-19 in Obese-Diabetic Patients.* Infect Drug Resist, 2021. **14**: p. 4015-4025.
10. Moin, A.S.M., et al., *Identification of macrophage activation-related biomarkers in obese type 2 diabetes that may be indicative of enhanced respiratory risk in COVID-19.* Sci Rep, 2021. **11**(1): p. 6428.
11. Guler, S.A., et al., *Pulmonary function and radiological features 4 months after COVID-19: first results from the national prospective observational Swiss COVID-19 lung study.* Eur Respir J, 2021. **57**(4).
12. Sheng, G., et al., *Viral Infection Increases the Risk of Idiopathic Pulmonary Fibrosis: A Meta-Analysis.* Chest, 2020. **157**(5): p. 1175-1187.
13. Wild, J.M., et al., *Understanding the burden of interstitial lung disease post-COVID-19: the UK Interstitial Lung Disease-Long COVID Study (UKILD-Long COVID).* BMJ Open Respir Res, 2021. **8**(1).
14. Evans, R., et al., *Physical, cognitive, and mental health impacts of COVID-19 after hospitalisation (PHOSP-COVID): a UK multicentre, prospective cohort study.* The Lancet Respiratory Medicine, 2021. **9**(11).
15. Hatabu, H., et al., *Interstitial lung abnormalities detected incidentally on CT: a Position Paper from the Fleischner Society.* The Lancet Respiratory Medicine, 2020. **8**(7): p. 726-737.
16. Drake, T.M., et al., *Outcome of Hospitalization for COVID-19 in Patients with Interstitial Lung Disease. An International Multicenter Study.* Am J Respir Crit Care Med, 2020. **202**(12): p. 1656-1665.
17. Hoff, P., *A First Course in Bayesian Statistical Methods*. Springer Texts Statistics. 2009: Springer, New York, NY.
18. Duchemann, B., et al., *Prevalence and incidence of interstitial lung diseases in a multi-ethnic county of Greater Paris.* Eur Respir J, 2017. **50**(2).
19. Maher, T.M., et al., *Global incidence and prevalence of idiopathic pulmonary fibrosis.* Respir Res, 2021. **22**(1): p. 197.
20. Wu, X., et al., *3-month, 6-month, 9-month, and 12-month respiratory outcomes in patients following COVID-19-related hospitalisation: a prospective study.* The Lancet Respiratory Medicine, 2021. **9**(7): p. 747.
21. Han, X., et al., *Six-month Follow-up Chest CT Findings after Severe COVID-19 Pneumonia.* Radiology, 2021. **299**(1): p. E177-E186.
22. Han, X., et al., *Fibrotic Interstitial Lung Abnormalities at 1-year Follow-up CT after Severe COVID-19.* Radiology, 2021. **301**(3): p. E438-E440.
23. Zou, J.N., et al., *The characteristics and evolution of pulmonary fibrosis in COVID-19 patients as assessed by AI-assisted chest HRCT.* PLoS One, 2021. **16**(3): p. e0248957.
24. Gupta, V.K., et al., *Ventilator associated lung injury in severe COVID-19 pneumonia patients - Case Reports: Ventilator associated lung injury in COVID-19.* Eur J Radiol Open, 2021. **8**: p. 100310.
25. Fabbri, L., et al., *Post-viral parenchymal lung disease following COVID-19 and viral pneumonitis hospitalisation: A systematic review and meta-analysis.* MedRxiv, 2021.
26. Sinha, P., et al., *Latent Class Analysis Reveals COVID-19-related Acute Respiratory Distress Syndrome Subgroups with Differential Responses to Corticosteroids.* Am J Respir Crit Care Med, 2021. **204**(11): p. 1274-1285.
27. Ravaglia, C., et al., *Clinical, radiological, and pathological findings in patients with persistent lung disease following SARS-CoV-2 infection.* Eur Respir J, 2022.
28. NHSEngland. *https://www.england.nhs.uk/statistics/statistical-work-areas/covid-19-hospital-activity/*. NHS Coronavirus (COVID-19) Hospital Activity 2021 Last accessed 22 August 2022].

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Figure Legends

Figure 1. CONSORT Flow diagram of UKILD interim cohort definition

White boxes derived from PHOSP-COVID database. Blue boxes represent CT sample linked with PHOSP-COVID identifiers a radiological database.

Figure 2. Extent of residual lung abnormalities on linked CT

A) Mean percentage lung involvement of reticulations, ground glass opacities, and residual abnormalities within 240 days of discharge with visually scored involvement >10%, presented with standard deviation (n=166). Percentage lung involvement of B) residual abnormalities, C) reticulations and D) ground glass opacities at initial and repeat CT scans with >90days between (n=33), with p-values from paired t-test. E) Estimated percent lung involvement of ground glass opacities (top, blue) and reticulations (bottom, red) from linear mixed effects by weeks post discharge (n=209, scans=242), F) estimated percent lung involvement of residual abnormalities from linear mixed effects by weeks post discharge, presented with mean weekly effect and 95% confidence intervals (n=209, scans=242).

Figure 3. Representative CT images of residual lung abnormalities

Representative A) coronal and B) axial non-contrast CT imaging from the same individual performed at 137 days post discharge following a COVID-19 admission, scored with 52.5% total lung involvement of residual lung abnormality of which 18.3% reticulation and 34.2% ground glass opacity. Peripheral reticulation (arrows) is evident surrounded by faint areas of ground glass density. Representative coronal CT images from the same individual at C) 114 days post discharge scored with 56.8% lung involvement (28.5% reticulation; 28.3% ground glass opacity) and D) 239 days post discharge scored with 49.2% total lung involvement (20.0% reticulation; 29.2% ground glass opacity). Peripheral areas of reticulation (black arrow) and ground glass density (white arrow) in the right lung.

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Table 1: UKILD interim cohort demographics

	Interim		CT score		Tier 1		Tier 2		χ^2 pval
	N=3700	percent	n=209	percent	n=1304	percent	n=2396	percent	
Sex									0.091
Male	2247	60.7%	143	68.4%	768	58.9%	1479	61.7%	
Female	1450	39.2%	66	31.6%	535	41.0%	915	38.2%	
Age									0.027
60+	1801	48.7%	99	47.4%	667	51.2%	1134	47.3%	
<60	1895	51.2%	110	52.6%	636	48.8%	1259	52.5%	
Ethnicity									<0.001
White	2804	75.8%	144	68.9%	1015	77.8%	1789	74.7%	
Asian	467	12.6%	40	19.1%	144	11.0%	323	13.5%	
Black	223	6.0%	15	7.2%	56	4.3%	167	7.0%	
Other	131	3.5%	6	2.9%	31	2.4%	100	4.2%	
Missing	75	2.0%			58	4.4%	17	0.7%	
IMD									0.031
1 Most	867	23.4%	38	18.2%	326	25.0%	541	22.6%	
2	817	22.1%	40	19.1%	268	20.6%	549	22.9%	
3	666	18.0%	41	19.6%	251	19.2%	415	17.3%	
4	659	17.8%	38	18.2%	241	18.5%	418	17.4%	
5 Least	667	18.0%	50	23.9%	210	16.1%	457	19.1%	
Missing	24	0.6%			8	0.6%	16	0.7%	
BMI									0.491
<25	262	7.1%	22	10.5%	45	3.5%	217	9.1%	
25 - <30	612	16.5%	59	28.2%	84	6.4%	528	22.0%	
30 - <40	880	23.8%	67	32.1%	121	9.3%	759	31.7%	
>=40	230	6.2%	12	5.7%	30	2.3%	200	8.3%	
Missing	1716	46.4%	49	23.4%	1024	78.5%	692	28.9%	
WHO severity									0.826
No O2 (i)	624	16.9%	35	16.7%	223	17.1%	401	16.7%	
Non-invasive O2 (ii)	1567	42.4%	77	36.8%	557	42.7%	1010	42.2%	
CPAP (iii)	860	23.2%	34	16.3%	306	23.5%	554	23.1%	
IMV (iv)	645	17.4%	63	30.1%	217	16.6%	428	17.9%	
CXR at follow-up									<0.004
Normal	1289	34.8%	70	33.5%	511	39.2%	778	32.5%	

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Other	325	8.8%	19	9.1%	140	10.7%	185	7.7%	
Abnormal	162	4.4%	21	10.0%	45	3.5%	117	4.9%	
Missing	2139	57.8%	36	41.4%	677	52.2%	1462	60.8%	
CT at follow-up									
Linked records	255	6.9%	209	100.0%	35	2.7%	220	9.2%	<0.001
Scored	209	5.6%	209	100.0%	29	2.2%	180	7.5%	<0.001
Symptoms at follow-up									0.636
Present - worsen	850	23.0%	74	35.4%	21	1.6%	829	34.6%	
Present - no change	319	8.6%	21	10.0%	11	0.8%	308	12.9%	
Not present/improved	359	9.7%	24	11.5%	9	0.7%	350	14.6%	
Missing	2172	58.7%	90	43.1%	1263	96.9%	909	37.9%	
ppFVC at follow-up									-
80%+	786	21.2%	53	25.4%			773	32.3%	
<80%	297	8.0%	29	13.9%			294	12.3%	
Missing	2617	70.7%	127	60.8%	1288	98.8%	1329	55.5%	
ppDLco at follow-up									-
80%+	333	9.0%	37	17.7%			333	13.9%	
<80%	177	4.8%	25	12.0%			175	7.3%	
Missing	3190	86.2%	147	70.3%	1302	99.8%	1888	78.8%	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	
Age	59	50, 68	58	52, 67	60	51, 70	59	50, 67	
ppFVC	90.3	78.6, 101.7	87.0	75.0, 98.8	-	-	90.2	78.6, 101.6	-
ppDLco	87.6	74.2, 101.3	84.7	69.9, 96.2	-	-	87.5	74.0, 101.3	-
Time to follow-up	127	91, 173	140	106, 170	101	82, 138	141	100, 180	

Small numbers <5 have been suppressed. Chi-squared (χ^2) performed between Tier 1 and Tier 2 on non-missing categories. IMD: index of multiple deprivation in quintiles, BMI: body mass index, WHO: modified World Health Organisation severity score, CXR: chest X-ray, CT: computed tomography – chest, Symptoms: Patient Symptom Questionnaire breathless or cough, ppFVC: percent predicted forced vital capacity, ppDLco: percent predicted diffusion capacity across the lung for carbon monoxide.

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Table 2: Risk factors of residual lung abnormalities on CT

Characteristic	Risk factor present (%)	Risk factor absent (%)	Univariate risk ratio	95% Credible Interval	Estimated mean difference (%)	95% Credible Interval	Adjusted mean difference (%)	95% Credible Interval
Male	87.4%	62.1%	1.42	(1.17; 1.77)	12.46	(5.76; 19.59)	11.26	(4.24; 18.04)
Age 60+	87.9%	71.8%	1.22	(1.06; 1.40)	8.29	(2.11; 14.44)	8.57	(3.61; 16.16)
Non-white	78.5%	79.9%	0.97	(0.84; 1.12)	3.48	(-3.78; 10.88)	3.84	(-4.95; 9.37)
IMD (Q1/2)	87.2%	74.4%	1.17	(1.02; 1.34)	6.91	(0.38; 13.33)	6.28	(-0.31; 12.91)
BMI >30	87.3%	71.6%	1.22	(1.04; 1.45)	3.93	(-3.70; 11.52)	4.54	(-2.40; 11.65)
CPAP/IMV	93.8%	67.0%	1.40	(1.23; 1.63)	20.56	(14.80; 26.36)	20.14	(14.34; 25.69)
aCXR	100.0%	73.0%	1.40	(1.22; 1.61)	14.96	(3.89; 25.78)	11.54	(0.53; 21.59)
ppFVC <80	86.2%	79.3%	1.07	(0.85; 1.31)	10.40	(-0.90; 22.00)	11.99	(-0.14; 23.52)
ppDLco <80	96.0%	75.7%	1.26	(1.02; 1.58)	19.04	(7.65; 30.71)	15.31	(2.84; 28.06)
PSQ worse	78.4%	80.0%	0.99	(0.81; 1.21)	4.49	(-4.58; 13.54)	4.71	(-4.31; 13.87)

Percentage of non-missing case observations reaching >10% threshold of residual lung abnormalities according to risk factor being present or absent. Univariate risk ratio (RR) of >10% threshold of residual lung abnormalities and 95% credible interval derived from binomial regression, mean effect difference in % lung involvement where risk factor present relative to risk factor absent estimated from univariate linear regression and adjusted for sex and index of multiple deprivation**.** Index of multiple deprivation (IMD); Body mass index (BMI); continuous positive airway pressure or invasive mechanical ventilation (CPAP/IMV); abnormal chest x-ray (aCXR); percent predicted forced vital capacity (ppFVC); percent predicted diffusion capacity across the lung for carbon monoxide (ppDLco); Patient Symptom Questionnaire (PSQ).

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Table 3: Risk stratification of residual lung abnormalities in unscored UKILD interim cohort

Interim cohort				
Strata	Unscored (N=3491)	Percent	Sensitivity (n=2219)	Percent
Very high	14	0.4%	14	0.6%
High	143	4.1%	123	5.5%
Moderate	116	3.3%	94	4.2%
Low	1256	36.0%	767	34.6%
Very low	1962	56.2%	1221	55.0%
Linked CT: unscored				
	Interim (n=46)	Percent	Sensitivity (n=40)	Percent
At-risk	8	17.4%	8	20.0%
Low risk	38	82.6%	32	80.0%

Risk strata: very high – all three risk factors present (abnormal CXR, ppDLco <80%, severe admission requiring CPAP or IMV). High – at least two risk factors present. Moderate – either abnormal CXR or ppDLco<80% present. Low – severe admission present only. Very low – risk factors not present. Missing data were imputed at the reference category. Percent denominator is interim cohort without linked, scored CT (n=3491) and sensitivity analysis within Tier 2 research visit participants (n=2219). Moderate to very-high risk combined to at-risk; low to very-low risk combined to low risk, quantified in people with unscored linked CT.

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Table 4: Prevalence estimate of residual lung abnormalities >10% following COVID-19 hospitalisation

Model	Prevalence (%)	95% CrI	Prior	a	b	DIC
1	8.51	(7.56; 9.51)	Uniform	1	1	9.38
1-i	8.48	(7.52;9.49)	Jeffreys	0.5	0.5	9.45
1-ii	6.49	(5.75; 7.27)	Skeptical	1	1000	28.67
1-iii	7.37	(6.53; 8.24)	Power	1	1000	14.99
2	11.67	(10.28; 13.14)	Uniform	1	1	9.20
2-i	11.61	(10.19; 13.04)	Jeffreys	0.5	0.5	9.27
2-ii	7.74	(6.79; 8.72)	Skeptical	1	1000	45.97
2-iii	9.32	(8.17; 10.54)	Power	1	1000	20.91

Estimated prevalence of >10% residual lung abnormalities on CT following hospitalization for COVID-19, derived from posterior mean and 95% credibility interval using binomial distributions of at-risk vs low-risk numbers in interim UKILD cohort. Model 1, overall; Model 2, Tier 2 research visit participants. Uniform priors and in sensitivity analysis with Jeffreys non-informative (i), skeptical informative priors (ii) and skeptical informative priors with power weighting (iii). Beta prior distributions defined using cases (a) and non-cases (b). Deviance information criterion (DIC) presented to interpret model.

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

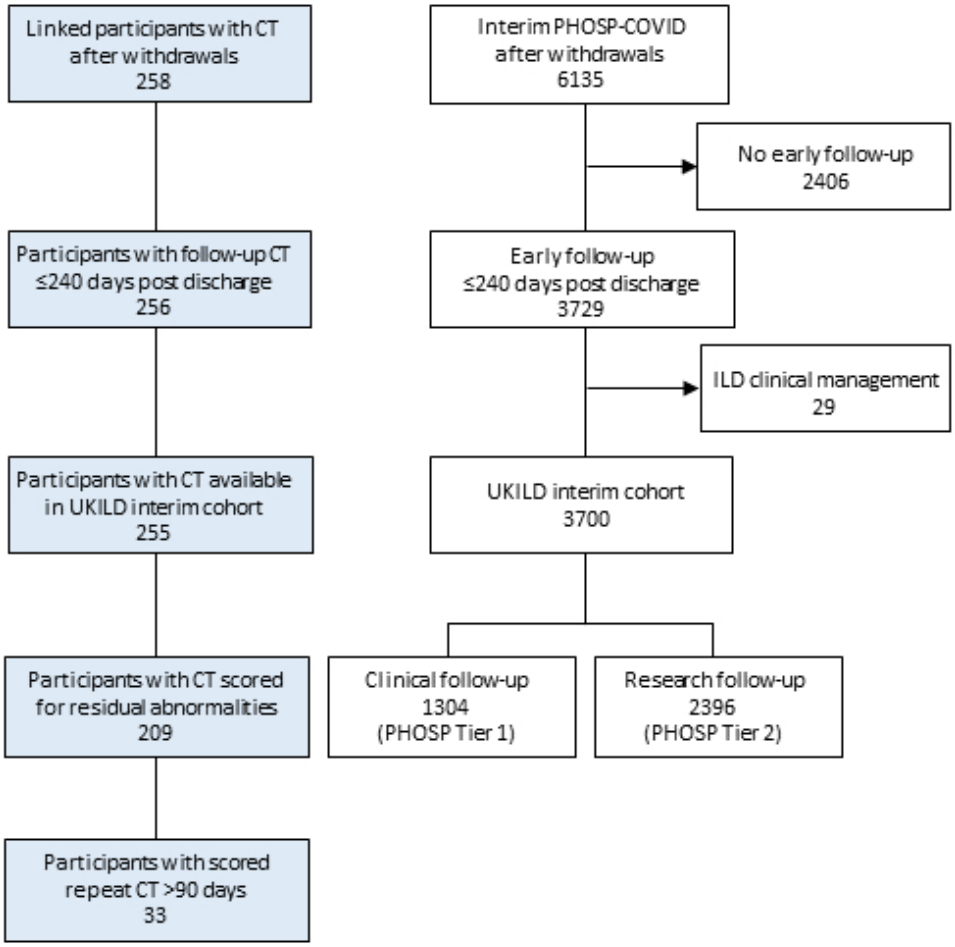


Figure 1. CONSORT Flow diagram of UKILD interim cohort definition.
White boxes derived from PHOSP-COVID database. Blue boxes represent CT sample linked with PHOSP-COVID identifiers a radiological database.

109x119mm (118 x 118 DPI)

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

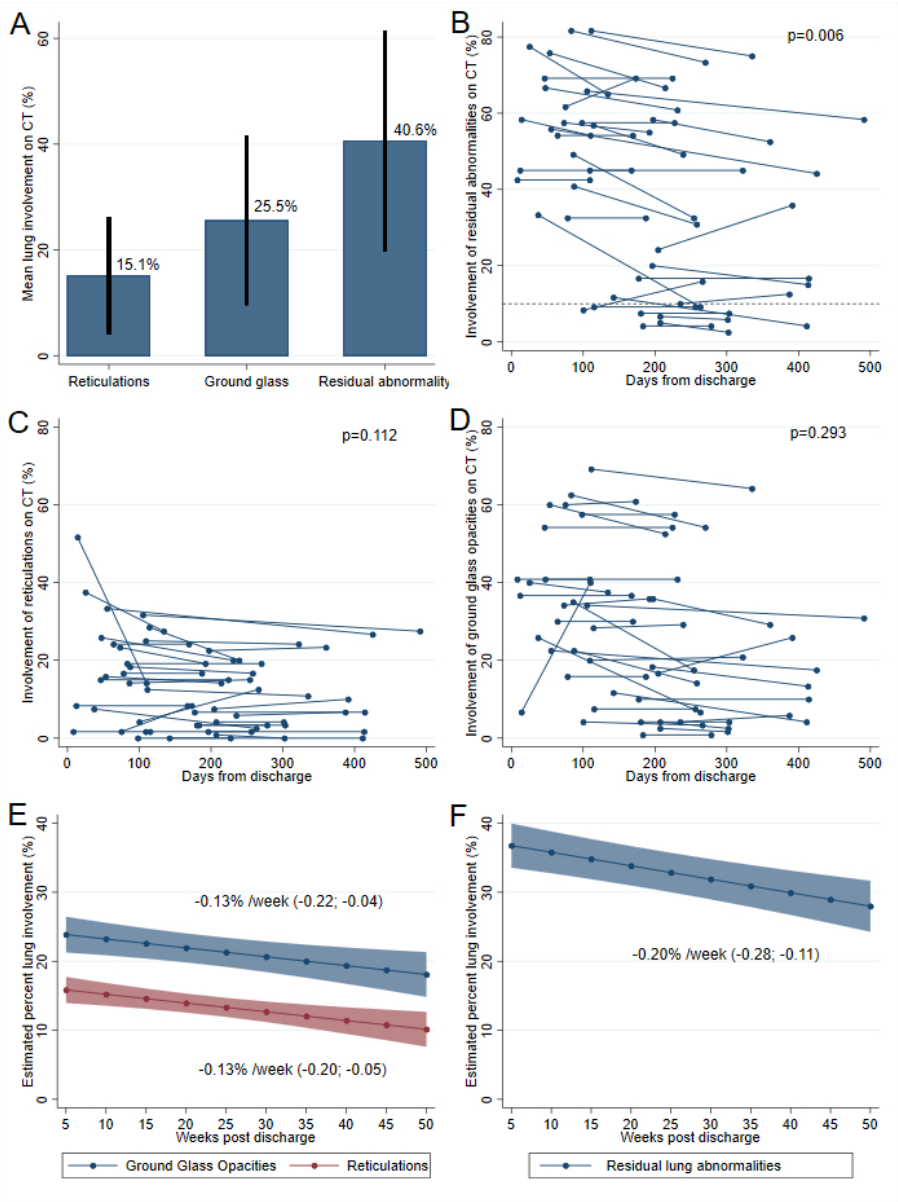


Figure 2. Extent of residual lung abnormalities on linked CT.
A) Mean percentage lung involvement of reticulations, ground glass opacities, and residual abnormalities within 240 days of discharge with visually scored involvement >10%, presented with standard deviation (n=166). Percentage lung involvement of B) residual abnormalities, C) reticulations and D) ground glass opacities at initial and repeat CT scans with >90days between (n=33), with p-values from paired t-test. E) Estimated percent lung involvement of ground glass opacities (top, blue) and reticulations (bottom, red) from linear mixed effects by weeks post discharge (n=209, scans=242), F) estimated percent lung involvement of residual abnormalities from linear mixed effects by weeks post discharge, presented with mean weekly effect and 95% confidence intervals (n=209, scans=242).

149x199mm (118 x 118 DPI)

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

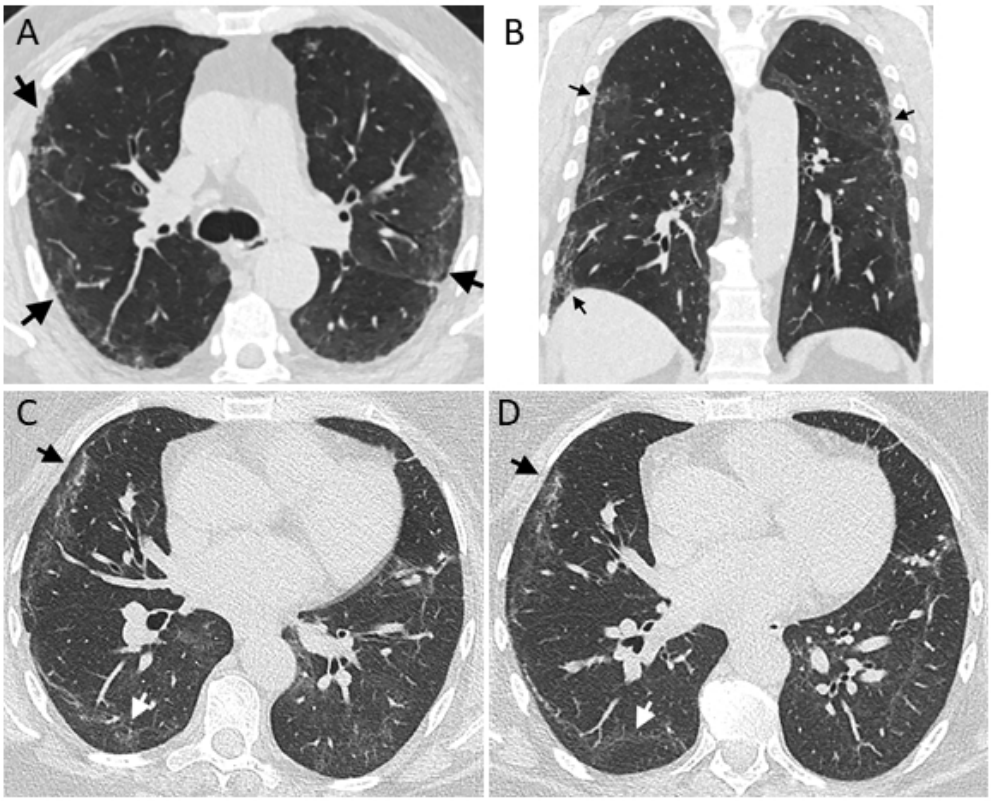


Figure 3. Representative CT images of residual lung abnormalities.Representative A) coronal and B) axial non-contrast CT imaging from the same individual performed at 137 days post discharge following a COVID-19 admission, scored with 52.5% total lung involvement of residual lung abnormality of which 18.3% reticulation and 34.2% ground glass opacity. Peripheral reticulation (arrows) is evident surrounded by faint areas of ground glass density. Representative coronal CT images from the same individual at C) 114 days post discharge scored with 56.8% lung involvement (28.5% reticulation; 28.3% ground glass opacity) and D) 239 days post discharge scored with 49.2% total lung involvement (20.0% reticulation; 29.2% ground glass opacity). Peripheral areas of reticulation (black arrow) and ground glass density (white arrow) in the right lung.

49x39mm (300 x 300 DPI)

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Residual lung abnormalities following COVID-19 hospitalization: interim analysis of the UKILD Post-COVID study

(Running head) Lung damage burden after COVID-19 hospitalization

Iain Stewart, Joseph Jacob, Peter M George, Philip L Molyneaux, Joanna C Porter, Richard J Allen, Shahab Aslani, J Kenneth Baillie, Shaney L Barratt, Paul Beirne, Stephen M Bianchi, John F Blaikley, James D Chalmers, Rachel C Chambers, Nazia Chadhuri, Christopher Coleman, Guilhem Collier, Emma K Denneny, Annemarie Docherty, Omer Elneima, Rachel A Evans, Laura Fabbri, Michael A Gibbons, Fergus V Gleeson, Bibek Gooptu, Neil J Greening, Beatriz Guillen Guio, Ian P Hall, Neil A Hanley, Victoria Harris, Ewen M Harrison, Melissa Heightman, Toby E Hillman, Alex Horsley, Linzy Houchen-Wolloff, Ian Jarrold, Simon R Johnson, Mark G Jones, Fasihul Khan, Rod Lawson, Olivia Leavy, Nazir Lone, Michael Marks, Hamish McAuley, Puja Mehta, Dhruv Parekh, Karen Piper Hanley, Manuela Platé, John Pearl, Krisnah Poinasamy, Jennifer K Quint, Betty Raman, Matthew Richardson, Pilar Rivera-Ortega, Laura Saunders, Ruth Saunders, Malcolm G Semple, Marco Sereno, Aarti Shikotra, A John Simpson, Amisha Singapuri, David JF Smith, Mark Spears, Lisa G Spencer, Stefan Stanel, David Thickett, A A Roger Thompson, Mathew Thorpe, Simon LF Walsh, Samantha Walker, Nicholas David Weatherley, Mark Weeks, Jim M Wild, Dan G Wootton, Chris E Brightling, Ling-Pei Ho, Louise V Wain, R Gisli Jenkins

ONLINE DATA SUPPLEMENT

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Supplementary Table 1: Comparison of demographics between visually scored >10% residual abnormalities and at-risk group

	Interim		At-risk		>10% involvement		χ^2 pval
	N=3700	percent	N=273	percent	N=166	percent	
Sex							0.295
Male	2247	60.7%	193	70.7%	125	75.3%	
Female	1450	39.2%	80	29.3%	41	24.7%	
Age							0.155
60+	1801	48.7%	162	59.3%	87	52.4%	
<60	1895	51.2%	111	40.7%	79	47.6%	
Ethnicity							0.567
White	2804	75.8%	199	72.9%	115	69.3%	
Asian	467	12.6%	41	15.0%	31	18.7%	
Black	223	6.0%	15	5.5%	11	6.6%	
Other	131	3.5%	sn	sn	sn	sn	
Missing	75	2.0%	sn	sn	sn	sn	
IMD							0.076
1 Most	867	23.4%	72	26.4%	32	19.3%	
2	817	22.1%	63	23.1%	36	21.7%	
3	666	18.0%	48	17.6%	31	18.7%	
4	659	17.8%	54	19.8%	28	16.9%	
5 Least	667	18.0%	35	12.8%	37	22.3%	
BMI							0.416
<25	262	7.1%	29	10.6%	15	9.0%	
25 - <30	612	16.5%	90	33.0%	43	25.9%	
30 - <40	880	23.8%	81	29.7%	58	34.9%	
>=40	230	6.2%	20	7.3%	11	6.6%	
Missing	1716	46.4%	52	19.0%	39	23.5%	
WHO severity							0.123
No O2 (i)	624	16.9%	21	7.7%	16	9.6%	
Non-invasive O2 (ii)	1567	42.4%	100	36.6%	59	35.5%	
CPAP (iii)	860	23.2%	73	26.7%	30	18.1%	
IMV (iv)	645	17.4%	79	28.9%	61	36.7%	
CXR							<0.001
Normal	1289	34.8%	40	14.7%	50	30.1%	
Other	325	8.8%	21	7.7%	15	9.0%	
Abnormal	162	4.4%	141	51.6%	21	12.7%	
Missing	1924	52.0%	71	26.0%	80	48.2%	
CT							<0.001
Performed	255	6.9%	8	2.9%	166	100.0%	
PSQ: cough/breathless							0.277
Present - worsen	850	23.0%	116	42.5%	58	34.9%	
Present - no change	319	8.6%	22	8.1%	19	11.4%	
Not present/improved	359	9.7%	34	12.5%	17	10.2%	
Missing	2172	58.7%	101	37.0%	72	43.4%	
ppFVC							0.920
80%+	786	21.2%	97	35.5%	42	25.3%	
<80%	297	8.0%	56	20.5%	25	15.1%	
Missing	2617	70.7%	120	44.0%	99	59.6%	
ppDLco							<0.001
80%+	333	9.0%	13	4.8%	28	16.9%	
<80%	177	4.8%	151	55.3%	24	14.5%	
Missing	3190	86.2%	109	39.9%	114	68.7%	

Small numbers ≤5 have been suppressed. Chi-squared (χ^2) performed on non-missing categories. IMD: index of multiple deprivation in quintiles, BMI: body mass index, WHO: modified World Health Organisation severity score, CXR: chest X-ray, CT: computed tomography – chest, PSQ:

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Patient Symptom Questionnaire, ppFVC: percent predicted forced vital capacity, ppDLco: percent predicted diffusion capacity across the lung for carbon monoxide.

Supplementary Table 2: Comparison of hospital admissions

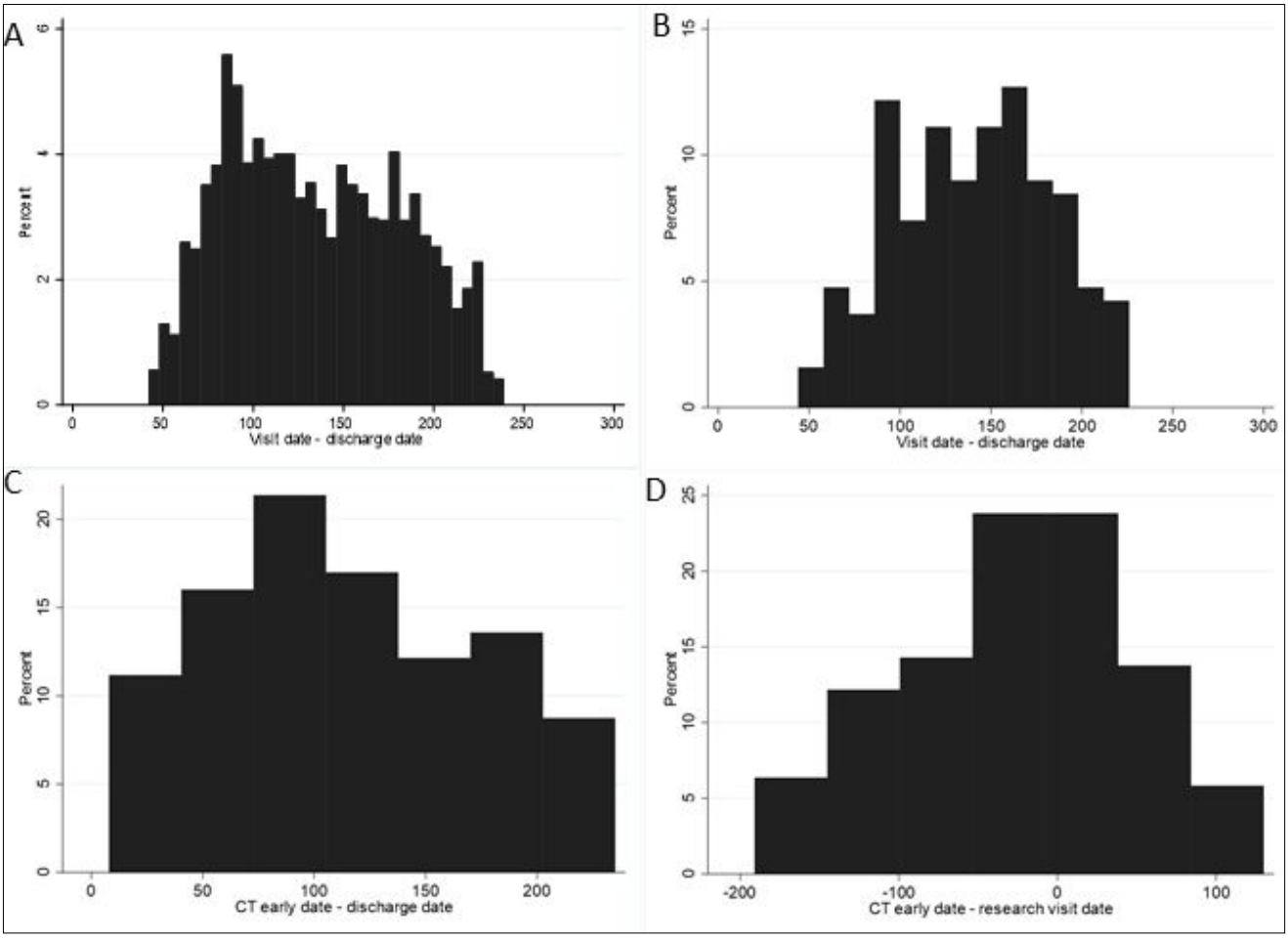
	No CT scored (n=3491)			Abnormalities scored (n=209)		
	At-risk	Low-risk	χ^2 pval	>10%	<10%	χ^2 pval
Pre admission						
Treatment for infection	23.4%	14.7%	0.004	19.6%	11.5%	0.342
Immunosuppressant	18.3%	9.9%	0.001	10.3%	3.9%	0.305
Corticosteroid treatment	35.3%	26.5%	0.019	33.3%	23.1%	0.318
Renal replacement therapy	9.0%	3.8%	0.002	9.7%	0.0%	0.099
Ionotrope treatment	25.2%	12.7%	<0.001	24.7%	7.7%	0.059
Admission						
Muscle aches	27.9%	24.7%	0.374	26.3%	50.0%	0.020
Headache	13.0%	16.9%	0.212	11.1%	19.2%	0.270
Sore throat	9.1%	8.8%	0.888	11.1%	0.0%	0.075
Intensive care unit	50.0%	33.4%	<0.001	50.0%	15.4%	0.002
Invasive therapy	35.5%	20.1%	<0.001	41.9%	7.7%	0.001
Oxygen	89.7%	79.4%	0.002	85.0%	61.5%	0.009
Complications						
Anaemia	15.1%	11.1%	0.138	23.9%	3.9%	0.023
Acute Respiratory Distress Syndrome	25.0%	13.7%	<0.001	17.4%	11.5%	0.473
Liver dysfunction	7.9%	5.2%	0.157	12.0%	7.7%	0.540
Discharged home	*44.7%*	*44.9%*	*0.937*	*48.2%*	*60.5%*	*0.151*
Post discharge						
≥1 unscheduled emergency visit	34.8%	25.2%	0.001	15.7%	11.6%	0.507
≥1 unscheduled emergency visit*	24.5%	16.2%	<0.001	13.3%	sn	0.258
Symptoms of emergency visit			n=906			n=31
Shortness of breath	33.7%	24.3%	0.046	34.6%	sn	0.818
Cough	14.7%	9.7%	0.129	sn	sn	0.656

Percentages based on small numbers have been suppressed (sn). Index admission variables from linked ISARIC4C dataset were selected from a list of 61 using least absolute shrinkage and selection operator, using last lamda for at-risk associations (8 non zero coefficients) and >10% involvement associations (6 non-zero coefficients). Post discharge recorded in PHOSP-COVID Study. *indicates participants with a minimum of 12 months research follow-up completed.

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

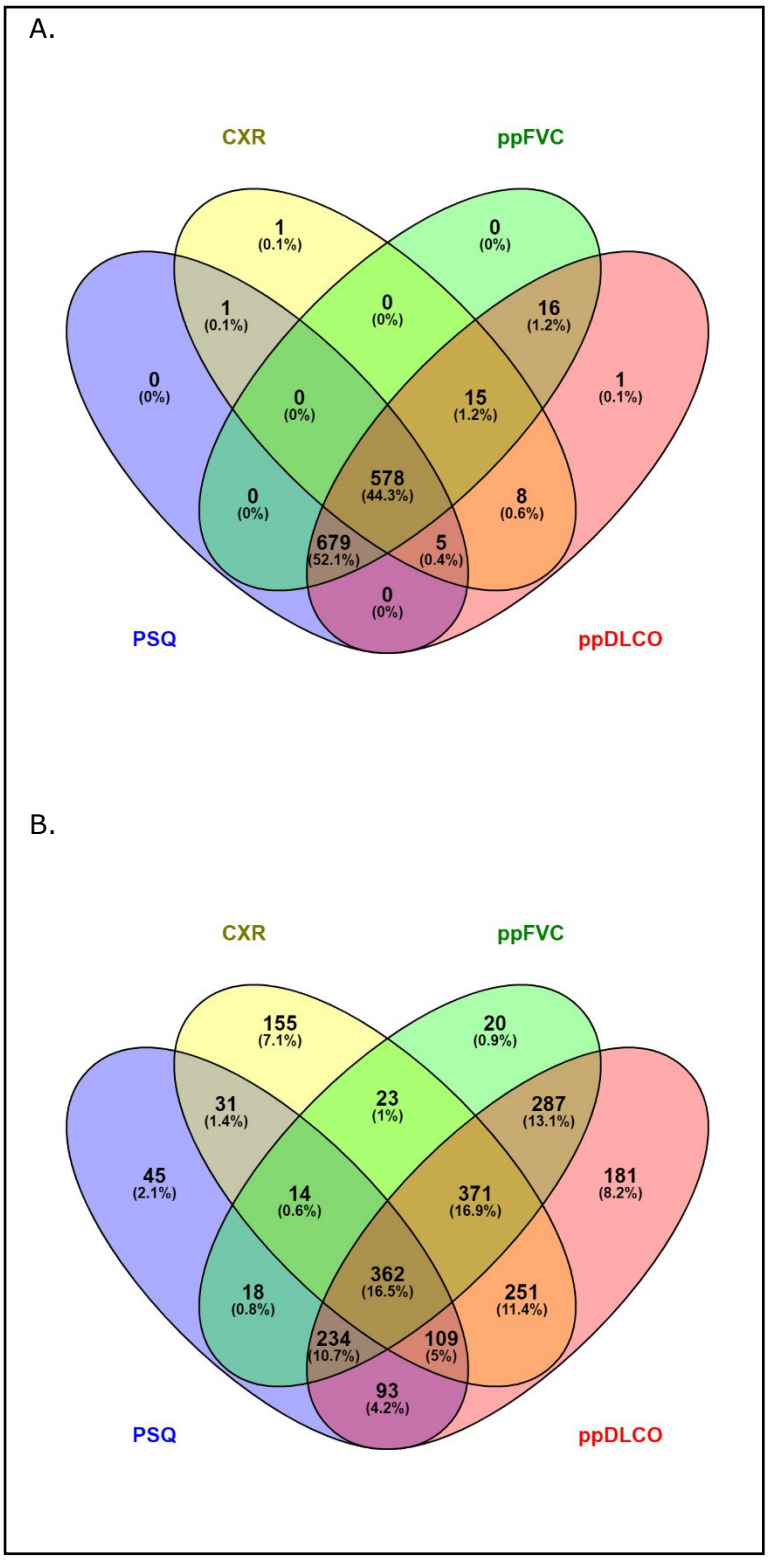
Supplementary Figure 1. Histograms of follow-up time.

Where CTs were performed and linked. The time from discharge to follow-up visit in the interim cohort (A) and in those with CT scored (B) are plotted. Time between CT date and discharge date (C), and CT date to follow-up visit (D) are plotted.



AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Supplementary Figure 2. Missing records in ILD diagnostic indicators

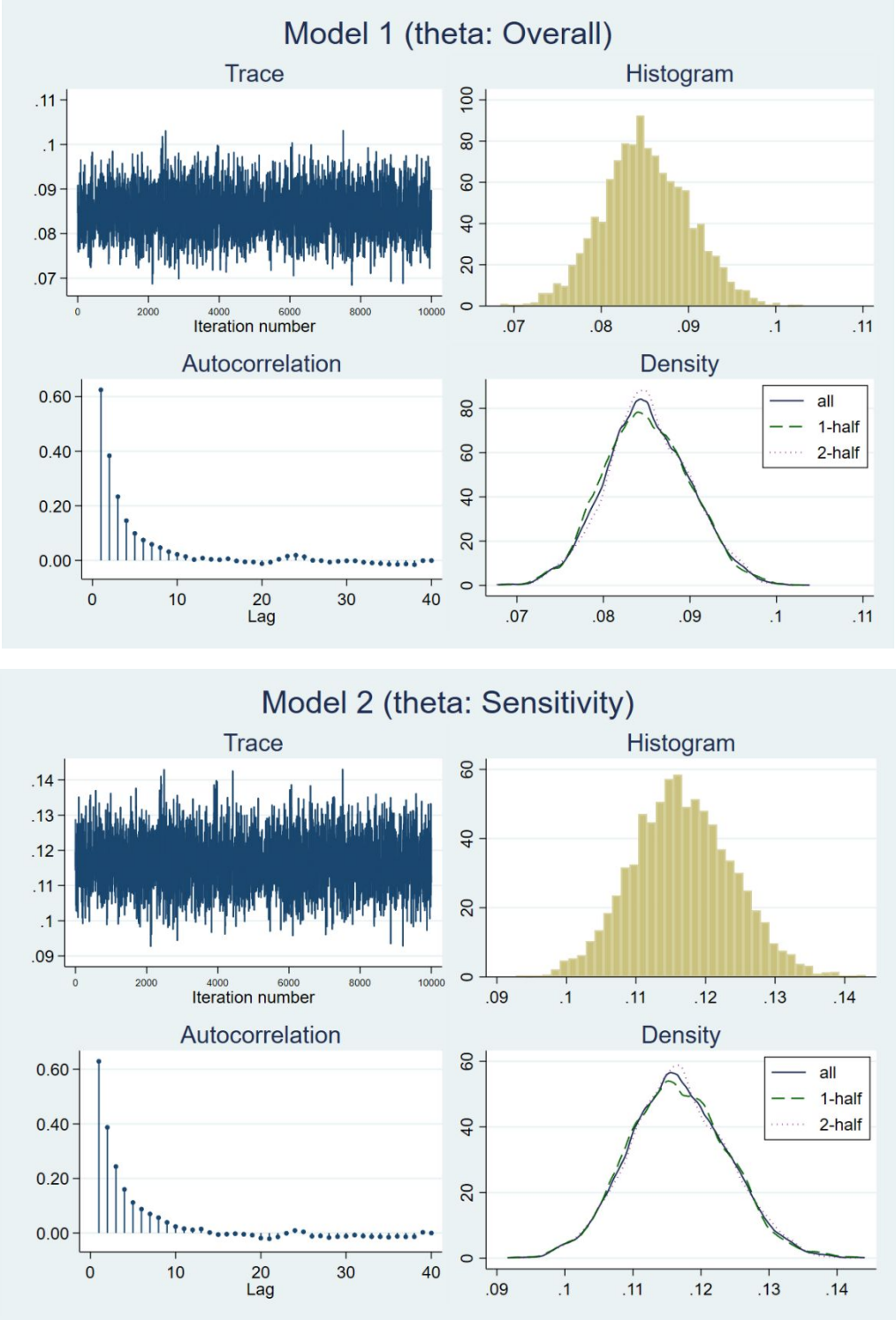


Missing data and representative percentage of missing data are reported for A) Tier 1 (n=1304) and B) Tier 2 (n=2396, of which 2194 had a missing value in one of the records) according to ppFVC (percent predicted forced vital capacity), ppDLco (percent predicted DLco gas transfer), PSQ (patient symptom questionnaire, cough and/or breathlessness), CXR (chest X-ray). *Venny (2007-2015) https://bioinfogp.cnb.csic.es/tools/venny/index.html*

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Supplementary Figure 3. Convergence traces

Bayes convergence diagnostics provided for prevalence of suspected Post-COVID ILDam in hospitalised participants <240 days with non-informative flat priors (Model 1), and sensitivity based on cases in Tier 2 alone (Model 2).



AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Supplementary Document PHOSP members and affiliations

Surname	Initial	Primary Affiliated Organisation
Abel	K	University of Manchester
Adamali	H	North Bristol NHS Trust & University of Bristol
Adeloye	D	University of Edinburgh
Adeyemi	O	King's College Hospital NHS Foundation Trust
Adrego	R	King's College Hospital NHS Foundation Trust
Aguilar Jimenez	L A	Guy's and St Thomas' NHS Foundation Trust
Ahmad	S	Royal Free London NHS Foundation Trust
Ahmad Haider	N	University Hospital Birmingham NHS Foundation Trust
Ahmed	R	Stroke Association
Ahwireng	N	University College London Hospital
Ainsworth	M	Oxford University Hospitals NHS Foundation Trust
Al-Sheklly	B	Manchester University NHS Foundation Trust
Alamoudi	A	Oxford University Hospitals NHS Foundation Trust
Ali	M	St George's University Hospitals NHS Foundation Trust
Aljaroof	M	University Hospitals of Leicester NHS Trust
All	AM	Liverpool University Hospitals NHS Foundation Trust
Allan	L	University of Exeter
Allen	R J	University of Leicester
Allerton	L	Liverpool University Hospitals NHS Foundation Trust
Allsop	L	Sherwood Forest Hospitals NHS Foundation Trust
Almeida	P	Nottingham University Hospitals NHS Trust
Altmann	D	Imperial College London
Alvarez Corral	M	Hampshire Hospitals NHS Foundation Trust
Anderson	D	NHS Greater Glasgow and Clyde Health Board
Antoniades	C	University of Oxford
Arbane	G	Guy's and St Thomas' NHS Foundation Trust
Arias	A	Hampshire Hospitals NHS Foundation Trust
Armour	C	Belfast Health & Social Care Trust
Armstrong	L	Airedale NHS Foundation Trust
Armstrong	N	University Hospitals of Leicester NHS Trust
Arnold	D	North Bristol NHS Trust
Arnold	H	University Hospitals of Leicester NHS Trust
Ashish	A	Wrightington Wigan and Leigh NHS trust
Ashworth	A	Leeds Teaching Hospitals
Ashworth	M	University of Liverpool
Aslani	S	University College London
Assefa-Kebede	H	King's College Hospital NHS Foundation Trust
Atkin	C	University Hospital Birmingham NHS Foundation Trust
Atkin	P	Hull University Teaching Hospitals NHS Trust
Aul	R	St George's University Hospitals NHS Foundation Trust
Aung	H	University Hospitals of Leicester NHS Trust
Austin	L	East Kent Hospitals University NHS Foundation Trust
Avram	C	Manchester University NHS Foundation Trust
Ayoub	A	Newcastle upon Tyne Hospitals NHS Foundation Trust
Babores	M	East Cheshire NHS Trust
Baggott	R	University Hospital Birmingham NHS Foundation Trust
Bagshaw	J	Sheffield Teaching NHS Foundation Trust
Baguley	D	University of Nottingham
Bailey	L	Wirral University Teaching Hospital
Baillie	J K	Roslin Institute, University of Edinburgh, Edinburgh
Bain	S	University of Swansea
Bakali	M	University Hospitals of Leicester NHS Trust
Bakau	M	University Hospitals of Leicester NHS Trust
Baldry	E	University Hospitals of Leicester NHS Trust
Baldwin	D	University of Southampton
Ballard	C	University of Exeter
Bang	B	University College London Hospital
Barker	R E	Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation trust.
Barman	L	York & Scarborough NHS Foundation Trust
Barratt	S	North Bristol NHS Trust
Barrett	F	NHS Highland
Basire	D	University College London Hospital
Basu	N	NHS Greater Glasgow and Clyde Health Board
Bates	M	University Hospital Birmingham NHS Foundation Trust

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Bates	A	University of Oxford
Batterham	R	University College London
Baxendale	H	Royal Papworth Hospital NHS Foundation Trust
Bayes	H	NHS Greater Glasgow and Clyde Health Board
Beadsworth	M	Liverpool University Hospitals NHS Foundation Trust
Beckett	P	University Hospitals of Derby and Burton
Beggs	M	University of Oxford
Begum	M	Sheffield Teaching NHS Foundation Trust
Beirne	P	Leeds Teaching Hospitals
Bell	D	NHS Lanarkshire
Bell	R	University College London
Bennett	K	Sherwood Forest Hospitals NHS Foundation Trust
Beranova	E	East Kent Hospitals University NHS Foundation Trust
Bermperi	A	Cambridge University Hospitals NHS Foundation Trust
Berridge	A	Liverpool University Hospitals NHS Foundation Trust
Berry	C	NHS Greater Glasgow and Clyde Health Board
Betts	S	Guy's and St Thomas' NHS Foundation Trust
Bevan	E	Hampshire Hospitals NHS Foundation Trust
Bhui	K	University of Oxford
Bingham	M	University of Leicester
Birchall	K	Sheffield Teaching NHS Foundation Trust
Bishop	L	Loughborough University
Bisnauthsing	K	Guy's and St Thomas' NHS Foundation Trust
Blaikely	J	Manchester University NHS Foundation Trust
Bloss	A	Oxford University Hospitals NHS Foundation Trust
Bolger	A	Betsi Cadwallader University Health Board
Bolton	C E	Nottingham University Hospitals NHS Trust
Bonnington	J	Nottingham University Hospitals NHS Trust
Botkai	A	University Hospital Birmingham NHS Foundation Trust
Bourne	C	University Hospitals of Leicester NHS Trust
Bourne	M	University Hospitals of Leicester NHS Trust
Bramham	K	King's College London
Brear	L	Bradford Teaching Hospitals NHS Foundation Trust
Breen	G	South London and Maudsley NHS Foundation Trust
Breeze	J	King's College Hospital NHS Foundation Trust
Briggs	A	London School of Hygiene & Tropical Medicine
Bright	E	Whittington Health NHS Trust
Brightling	C E	University Hospitals of Leicester NHS Trust
Brill	S	Royal Free London NHS Foundation Trust
Brindle	K	Hull University Teaching Hospitals NHS Trust
Broad	L	Cardiff and Vale University Healthy Board
Broadley	A	Yeovil District Hospital NHS Foundation Trust
Brookes	C	York & Scarborough NHS Foundation Trust
Broome	M	University of Birmingham
Brown	A	NHS Greater Glasgow and Clyde Health Board
Brown	J	Liverpool University Hospitals NHS Foundation Trust
Brown	J S	University College London Hospital
Brown	M	King's College London
Brown	V	Belfast Health & Social Care Trust
Brugha	T	University of Leicester
Brunskill	N	University Hospitals of Leicester NHS Trust
Buch	M	Manchester University NHS Foundation Trust
Buckley	P	Sherwood Forest Hospitals NHS Foundation Trust
Bularga	A	BHF Centre for Cardiovascular Science
Bullmore	E	University of Cambridge
Burden	L	Imperial College Healthcare NHS Trust
Burdett	T	Harrogate and District NHD Foundation Trust
Burn	D	Newcastle University
Burns	G	Newcastle upon Tyne Hospitals NHS Foundation Trust
Burns	A	Oxford University Hospitals NHS Foundation Trust
Busby	J	Queen's University Belfast
Butcher	R	Sheffield Teaching NHS Foundation Trust
Butt	A	Tameside and Glossop Integrated Care NHS Foundation Trust
Byrne	S	King's College Hospital NHS Foundation Trust
Cairns	P	University Hospitals of Leicester NHS Trust
Calder	P C	University of Southampton
Calvelo	E	Imperial College Healthcare NHS Trust

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Carborn	H	Sheffield Teaching NHS Foundation Trust
Card	B	Imperial College Healthcare NHS Trust
Carr	C	Imperial College Healthcare NHS Trust
Carr	L	University Hospitals of Leicester NHS Trust
Carson	G	University of Oxford, Nuffield Department of Medicine
Carter	P	Oxford University Hospitals NHS Foundation Trust
Casey	A	University Hospital Birmingham NHS Foundation Trust
Cassar	M	Oxford University Hospitals NHS Foundation Trust
Cavanagh	J	University of Glasgow
Chablani	M	United Lincolnshire Hospitals NHS Trust
Chalder	T	Department of Psychological Medicine, King's College London
Chalmers	J D	NHS Tayside & University of Dundee
Chambers	R C	University College London Hospital
Chan	F	Sheffield Teaching NHS Foundation Trust
Channon	K M	University of Oxford
Chapman	K	Sheffield Teaching NHS Foundation Trust
Charalambou	A	University Hospitals of Leicester NHS Trust
Chaudhuri	N	University Hospital of South Manchester NHS Foundation Trust
Checkley	A	University College London Hospital
Chen	J	Oxford University Hospitals NHS Foundation Trust
Cheng	Y	Sheffield Teaching NHS Foundation Trust
Chetham	L	Sheffield Teaching NHS Foundation Trust
Childs	C	University Hospital Southampton NHS Foundation Trust
Chilvers	E R	Imperial College Healthcare NHS Trust
Chinoy	H	University of Manchester
Chiribiri	A	Kings College Hospital, Guys and St Thomas NHS FT
Chong-James	K	Barts Health NHS Trust
Choudhury	G	NHS Lothian & University of Edinburgh
Choudhury	N	Manchester University NHS Foundation Trust
Chowienczyk	P	School of Cardiovascular Medicine & Sciences. King’s College London
Christie	C	University Hospitals of Leicester NHS Trust
Chrystal	M	Nottingham University Hospitals NHS Trust
Clark	D	University of Oxford
Clark	C	Sheffield Teaching NHS Foundation Trust
Clarke	J	Leeds Teaching Hospitals
Clohisey	S	NHS Lothian
Coakley	G	Lewisham & Greenwich NHS Trust
Coburn	Z	Sheffield Teaching NHS Foundation Trust
Coetzee	S	Hywel Dda University Health Board
Cole	J	Sheffield Teaching NHS Foundation Trust
Coleman	C	University of Nottingham
Conneh	F	Oxford University Hospitals NHS Foundation Trust
Connell	D	NHS Tayside
Connolly	B	Queen's University Belfast
Connor	L	Swansea Bay University Health Board
Cook	A	Swansea Bay University Health Board
Cooper	B	University Hospital Birmingham NHS Foundation Trust
Cooper	J	Wrightington Wigan and Leigh NHS trust
Cooper	S	Liverpool University Hospitals NHS Foundation Trust
Copeland	D	Imperial College Healthcare NHS Trust
Cosier	T	East Kent Hospitals University NHS Foundation Trust
Coulding	M	Tameside and Glossop Integrated Care NHS Foundation Trust
Coupland	C	Leeds Teaching Hospitals
Cox	E	University of Nottingham
Craig	T	Belfast Health & Social Care Trust
Crisp	P	Whittington Health NHS Trust
Cristiano	D	Royal Brompton and Harefield Clinical Group, Guy’s and St Thomas’ NHS Foundation trust.
Crooks	M G	Hull University Teaching Hospitals NHS Trust
Cross	A	Liverpool University Hospitals NHS Foundation Trust
Cruz	I	Cambridge University Hospitals NHS Foundation Trust
Cullinan	P	Imperial College Healthcare NHS Trust
Cuthbertson	D	University of Liverpool
Daines	L	Usher Institute, University of Edinburgh, Edinburgh, United Kingdom
Dalton	M	Leeds Teaching Hospitals
Daly	P	Imperial College Healthcare NHS Trust
Daniels	A	The Rotherham NHS Foundation Trust
Dark	P	Salford Royal NHS Foundation Trust

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Dasgin	J	University Hospital Birmingham NHS Foundation Trust
David	A	University College London
David	C	Barts Health NHS Trust
Davies	E	Cwm Taf Morgannwg University Health Board
Davies	F	Betsi Cadwallader University Health Board
Davies	G	Newcastle upon Tyne Hospitals NHS Foundation Trust
Davies	G A	Swansea Bay University Health Board
Davies	K	Hywel Dda University Health Board
Davies	M	University Hospitals of Leicester NHS Trust
Dawson	J	Borders General Hospital, NHS Borders
Daynes	E	University Hospitals of Leicester NHS Trust
De Soyza	A	Newcastle upon Tyne Hospitals NHS Foundation Trust
Deakin	B	University of Manchester
Deans	A	NHS Lothian & University of Edinburgh
Deas	C	NHS Tayside & University of Dundee
Deery	J	East Kent Hospitals University NHS Foundation Trust
Defres	S	Liverpool University Hospitals NHS Foundation Trust
Dell	A	Aneurin Bevan University Health Board
Dempsey	K	Cambridge University Hospitals NHS Foundation Trust
Denneny	E	University College London
Dennis	J	University of Exeter Medical School
Dewar	A	Guy's and St Thomas' NHS Foundation Trust
Dharmagunawardena	R	Whittington Health NHS Trust
Diar-Bakerly	N	Salford Royal NHS Foundation Trust
Dickens	C	University Hospitals of Derby and Burton
Dipper	A	North Bristol NHS Trust & University of Bristol
Diver	S	University Hospitals of Leicester NHS Trust
Diwanji	S N	London North West University Healthcare NHS Trust
Dixon	M	Sheffield Teaching NHS Foundation Trust
Djukanovic	R	University Hospital Southampton NHS Foundation Trust
Dobson	H	Alzheimer's Research UK
Dobson	S L	Liverpool University Hospitals NHS Foundation Trust
Docherty	A B	NHS Lothian
Donaldson	A	NHS Highland
Dong	T	Oxford University Hospitals NHS Foundation Trust
Dormand	N	Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation trust.
Dougherty	A	NHS Greater Glasgow and Clyde Health Board
Dowling	R	University Hospitals of Leicester NHS Trust
Drain	S	Belfast Health & Social Care Trust
Draxlbauer	K	University Hospital Birmingham NHS Foundation Trust
Drury	K	Hull University Teaching Hospitals NHS Trust
Dulawan	P	King's College Hospital NHS Foundation Trust
Dunleavy	A	St George's University Hospitals NHS Foundation Trust
Dunn	S	North Bristol NHS Trust & University of Bristol
Earley	J	Liverpool University Hospitals NHS Foundation Trust
Easom	N	Hull University Teaching Hospitals NHS Trust
Echevarria	C	Newcastle upon Tyne Hospitals NHS Foundation Trust
Edwards	S	University Hospitals of Leicester NHS Trust
Edwardson	C	University Hospitals of Leicester NHS Trust
El-Taweel	H	Borders General Hospital, NHS Borders
Elliott	A	NHS Tayside & University of Dundee
Elliott	K	York & Scarborough NHS Foundation Trust
Ellis	Y	Health & Care Research Wales
Elmer	A	Cambridge University Hospitals NHS Foundation Trust
Elneima	O	University Hospitals of Leicester NHS Trust
Evans	D	Salford Royal NHS Foundation Trust
Evans	H	University Hospitals of Leicester NHS Trust
Evans	J	University of Bristol
Evans	R	University College London Hospital
Evans	R A	University Hospitals of Leicester NHS Trust
Evans	R I	Oxford University Hospitals NHS Foundation Trust
Evans	T	Cardiff and Vale University Healthy Board
Evenden	C	Cwm Taf Morgannwg University Health Board
Evison	L	Imperial College Healthcare NHS Trust
Fabbri	L	University of Nottingham
Fairbairn	S	Aneurin Bevan University Health Board
Fairman	A	Sheffield Teaching NHS Foundation Trust

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Fallon	K	NHS Greater Glasgow and Clyde Health Board
Faluyi	D	Manchester University NHS Foundation Trust
Favager	C	Leeds Teaching Hospitals
Fayzan	T	Imperial College Healthcare NHS Trust
Featherstone	J	Harrogate and District NHD Foundation Trust
Felton	T	Manchester University NHS Foundation Trust
Finch	J	University Hospitals of Leicester NHS Trust
Finney	S	University of Leicester
Finnigan	J	Sheffield Teaching NHS Foundation Trust
Finnigan	L	University of Sheffield
Fisher	H	Newcastle upon Tyne Hospitals NHS Foundation Trust
Fletcher	S	University Hospital Southampton NHS Foundation Trust
Flockton	R	Hull University Teaching Hospitals NHS Trust
Flynn	M	Sherwood Forest Hospitals NHS Foundation Trust
Foot	H	Sheffield Teaching NHS Foundation Trust
Foote	D	Sheffield Teaching NHS Foundation Trust
Ford	A	Sheffield Teaching NHS Foundation Trust
Forton	D	St George's University Hospitals NHS Foundation Trust
Fraile	E	The Great Western Hospital Foundation Trust
Francis	C	Newcastle upon Tyne Hospitals NHS Foundation Trust
Francis	R	Stroke Association
Francis	S	Nottingham University
Frankel	A	Imperial College London
Fraser	E	Oxford University Hospitals NHS Foundation Trust
Free	R	University of Leicester
French	N	Liverpool University Hospitals NHS Foundation Trust
Fu	X	University of Oxford
Fuld	J	Cambridge University Hospitals NHS Foundation Trust
Furniss	J	NHS Lothian & University of Edinburgh
Garner	L	Royal Papworth Hospital NHS Foundation Trust
Gautam	N	University Hospital Birmingham NHS Foundation Trust
Geddes	J R	Oxford University Hospitals NHS Foundation Trust
George	J	NHS Tayside & University of Dundee
George	P	Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation trust.
Gibbons	M	Royal Devon and Exeter NHS Trust
Gill	M	Sherwood Forest Hospitals NHS Foundation Trust
Gilmour	L	NHS Greater Glasgow and Clyde Health Board
Gleeson	F	Oxford University Hospitals NHS Foundation Trust
Glossop	J	Leeds Teaching Hospitals
Glover	S	University Hospitals of Leicester NHS Trust
Goodman	N	University Hospitals of Leicester NHS Trust
Goodwin	C	Sherwood Forest Hospitals NHS Foundation Trust
Gooptu	B	University Hospitals of Leicester NHS Trust
Gordon	H	Imperial College Healthcare NHS Trust
Gorsuch	T	Manchester University NHS Foundation Trust
Greatorex	M	Sherwood Forest Hospitals NHS Foundation Trust
Greenhaff	P L	Nottingham University Hospitals NHS Trust
Greenhalf	W	Liverpool University Hospitals NHS Foundation Trust
Greenhalgh	A	Newcastle upon Tyne Hospitals NHS Foundation Trust
Greening	N J	University Hospitals of Leicester NHS Trust
Greenwood	J	Leeds Teaching Hospitals
Gregory	H	Sherwood Forest Hospitals NHS Foundation Trust
Gregory	R	Sheffield Teaching NHS Foundation Trust
Grieve	D	NHS Greater Glasgow and Clyde Health Board
Griffin	D	Hampshire Hospitals NHS Foundation Trust
Griffiths	L	York & Scarborough NHS Foundation Trust
Guerdette	A-M	Kettering General Hospital NHS Trust
Guillen Guio	B	University of Leicester
Gummadi	M	Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation trust.
Gupta	A	Nottingham University Hospitals NHS Trust
Gurram	S	London North West University Healthcare NHS Trust
Guthrie	E	University of Leeds
Guy	Z	York & Scarborough NHS Foundation Trust
H Henson	H	Airedale NHS Foundation Trust
Hadley	K	University Hospitals of Leicester NHS Trust
Haggar	A	Betsi Cadwallader University Health Board
Hainey	K	Liverpool University Hospitals NHS Foundation Trust

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Hairsine	B	Airedale NHS Foundation Trust
Haldar	P	University Hospitals of Leicester NHS Trust
Hall	I	University of Nottingham
Hall	L	Leeds Teaching Hospitals
Halling-Brown	M	Royal Surrey NHS Foundation Trust
Hamil	R	NHS Lanarkshire
Hancock	A	Cwm Taf Morgannwg University Health Board
Hancock	K	Cwm Taf Morgannwg University Health Board
Hanley	N A	Manchester University NHS Foundation Trust
Haq	S	Imperial College Healthcare NHS Trust
Hardwick	H E	Liverpool University Hospitals NHS Foundation Trust
Hardy	E	Salford Royal NHS Foundation Trust
Hardy	T	Leeds Teaching Hospitals
Hargadon	B	University Hospitals of Leicester NHS Trust
Harrington	K	Sheffield Teaching NHS Foundation Trust
Harris	E	Chesterfield Royal Hospital NHS Trust
Harris	V C	University Hospitals of Leicester NHS Trust
Harrison	E M	NHS Lothian
Harrison	P	Oxford University Hospitals NHS Foundation Trust
Hart	N	Guy's and St Thomas' NHS Foundation Trust
Harvey	A	Salford Royal NHS Foundation Trust
Harvey	M	University Hospital Southampton NHS Foundation Trust
Harvie	M	University of Manchester
Haslam	L	Sheffield Teaching NHS Foundation Trust
Havinden-Williams	M	Oxford University Hospitals NHS Foundation Trust
Hawkes	J	Liverpool University Hospitals NHS Foundation Trust
Hawkings	N	Aneurin Bevan University Health Board
Haworth	J	Aneurin Bevan University Health Board
Hayday	A	Kings College Hospital NHS Foundation Trust
Haynes	M	Cardiff and Vale University Healthy Board
Hazeldine	J	University Hospital Birmingham NHS Foundation Trust
Hazelton	T	East Kent Hospitals University NHS Foundation Trust
Heaney	L G	Belfast Health & Social Care Trust
Heeley	C	Sherwood Forest Hospitals NHS Foundation Trust
Heeney	J L	University of Cambridge
Heightman	M	University College London Hospital
Henderson	M	University of Leeds
Hesselden	L	Sheffield Teaching NHS Foundation Trust
Hewitt	M	Kettering General Hospital NHS Trust
Highett	V	Liverpool University Hospitals NHS Foundation Trust
Hillman	T	University College London Hospital
Hingorani	A	University College London
Hiwot	T	University Hospital Birmingham NHS Foundation Trust
Ho	L P	Oxford University Hospitals NHS Foundation Trust
Hoare	A	King's College Hospital NHS Foundation Trust
Hoare	M	Aneurin Bevan University Health Board
Hockridge	J	Sheffield Teaching NHS Foundation Trust
Hogarth	P	Newcastle upon Tyne Hospitals NHS Foundation Trust
Holbourn	A	Sheffield Teaching NHS Foundation Trust
Holden	S	University Hospital Birmingham NHS Foundation Trust
Holdsworth	L	Hull University Teaching Hospitals NHS Trust
Holgate	D	Salford Royal NHS Foundation Trust
Holland	M	East Cheshire NHS Trust
Holloway	L	Sherwood Forest Hospitals NHS Foundation Trust
Holmes	K	NIHR Office for Clinical Research Infrastructure
Holmes	M	Sherwood Forest Hospitals NHS Foundation Trust
Holroyd-Hind	B	Sheffield Teaching NHS Foundation Trust
Holt	L	Sheffield Teaching NHS Foundation Trust
Hormis	A	The Rotherham NHS Foundation Trust
Horsley	A	Manchester University NHS Foundation Trust
Hosseini	A	Nottingham University Hospitals NHS Trust
Hotopf	M	South London and Maudsley NHS Foundation Trust
Houchen	L	University Hospitals of Leicester NHS Trust
Howard	K	York & Scarborough NHS Foundation Trust
Howard	L	Imperial College London
Howell	A	Sheffield Teaching NHS Foundation Trust
Hufton	E	University of Nottingham

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Hughes	A D	University College London
Hughes	J	Newcastle upon Tyne Hospitals NHS Foundation Trust
Hughes	R	Hywel Dda University Health Board
Humphries	A	Leeds Teaching Hospitals & University of Leeds
Huneke	N	University of Southampton
Hurditch	E	Sheffield Teaching NHS Foundation Trust
Hurst	J	Royal Free London NHS Foundation Trust
Husain	M	University of Oxford
Hussell	T	Manchester University NHS Foundation Trust
Hutchinson	J	Sherwood Forest Hospitals NHS Foundation Trust
Ibrahim	W	University Hospitals of Leicester NHS Trust
Ilyas	F	Sheffield Teaching NHS Foundation Trust
Ingham	J	The Rotherham NHS Foundation Trust
Ingram	L	University Hospitals of Leicester NHS Trust
Ionita	D	York & Scarborough NHS Foundation Trust
Isaacs	K	University Hospital Birmingham NHS Foundation Trust
Ismail	K	King's College London
Jackson	T	University Hospital Birmingham NHS Foundation Trust
Jacob	J	University College London Hospital
James	W Y	Barts Health NHS Trust
Jarman	C	Sheffield Teaching NHS Foundation Trust
Jarrold	I	Asthma UK BLF
Jarvis	H	Royal Free London NHS Foundation Trust
Jastrub	R	University College London Hospital
Jayaraman	B	North Middlesex University Hospital NHS Trust
Jenkins	R G	Imperial College London
Jezzard	P	Oxford University Hospitals NHS Foundation Trust
Jiwa	K	Newcastle upon Tyne Hospitals NHS Foundation Trust
Johnson	C	Royal Papworth Hospital NHS Foundation Trust
Johnson	S	University of Nottingham
Johnston	D	Imperial College London
Jolley	C J	King’s College Hospital NHS Foundation Trust
Jones	D	University of Leicester
Jones	G	Newcastle upon Tyne Hospitals NHS Foundation Trust
Jones	H	Cambridge University Hospitals NHS Foundation Trust
Jones	I	Cardiff Univeristy, National Centre for Mental Health
Jones	L	Cardiff and Vale University Healthy Board
Jones	M	University Hospital Southampton NHS Foundation Trust
Jones	S	Action for Pulmonary Fibrosis
Jose	S	Cambridge University Hospitals NHS Foundation Trust
Kabir	T	McPin Foundation
Kaltsakas	G	Guy’s and St Thomas’ NHS Foundation Trust
Kamwa	V	University Hospital Birmingham NHS Foundation Trust
Kanellakis	N	Oxford University Hospitals NHS Foundation Trust
Kaprowska	s	Liverpool University Hospitals NHS Foundation Trust
Kausar	Z	Manchester University NHS Foundation Trust
Keenan	N	East Cheshire NHS Trust
Kelly	S	NHS Lothian
Kemp	G	University of Liverpool
Kerr	S	Roslin Institute, The University of Edinburgh
Kerslake	H	Guy’s and St Thomas’ NHS Foundation Trust
Key	A L	Liverpool University Hospitals NHS Foundation Trust
Khan	F	University of Nottingham
Khunti	K	University Hospitals of Leicester NHS Trust
Kilroy	S	Tameside and Glossop Integrated Care NHS Foundation Trust
King	B	Belfast Health & Social Care Trust
King	C	Imperial College Healthcare NHS Trust
Kirk	J	Sherwood Forest Hospitals NHS Foundation Trust
Kitterick	P	University of Nottingham
Klenerman	P	University of Oxford
Knibbs	L	Cardiff and Vale University Healthy Board
Knight	S	Salford Royal NHS Foundation Trust
Knighton	A	King’s College Hospital NHS Foundation Trust
Kon	O	Imperial College Healthcare NHS Trust
Kon	S	Royal Brompton and Harefield Clinical Group, Guy’s and St Thomas’ NHS Foundation trust.
Kon	S S	The Hillingdon Hospitals NHS Foundation Trust
Koprowska	S	Liverpool University Hospitals NHS Foundation Trust

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Korszun	A	Queen Mary University of London
Kotanidis	C	University of Oxford, Division of Cardiovascular Medicine
Koychev	I	Oxford University Hospitals NHS Foundation Trust
Kurasz	C	Airedale NHS Foundation Trust
Kurupati	P	Oxford University Hospitals NHS Foundation Trust
Laing	C	Royal Free London NHS Foundation Trust
Lamlum	H	University of Oxford
Landers	G	The Hillingdon Hospitals NHS Foundation Trust
Langenberg	C	University of Cambridge
Lasserson	D	University of Warwick
Lavelle-Langham	L	Liverpool University Hospitals NHS Foundation Trust
Lawrie	A	Sheffield Teaching NHS Foundation Trust
Lawson	C	University of Leicester
Layton	A	Harrogate and District NHD Foundation Trust
Lea	A	University Hospitals of Leicester NHS Trust
Leavy	O C	University of Leicester
Lee	D	University Hospitals of Leicester NHS Trust
Lee	J-H	Sheffield Teaching NHS Foundation Trust
Lee	E	Sheffield Teaching NHS Foundation Trust
Leitch	K	NHS Lanarkshire
Lenagh	R	Sheffield Teaching NHS Foundation Trust
Lewis	D	University Hospital Birmingham NHS Foundation Trust
Lewis	J	Betsi Cadwallader University Health Board
Lewis	K	Swansea University
Lewis	K E	Hywel Dda University Health Board
Lewis	V	Aneurin Bevan University Health Board
Lewis-Burke	N	Liverpool University Hospitals NHS Foundation Trust
Li	X	University of Oxford
Light	T	North Middlesex University Hospital NHS Trust
Lightstone	L	Imperial College London
Lilaonitkul	W	University College London
Lim	L	Royal Free London NHS Foundation Trust
Linford	S	Nottingham University Hospitals NHS Trust
Lingford-Hughes	A	Imperial College London
Lipman	M	University College London Hospital
Liyanage	K	Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation trust.
Lloyd	A	Betsi Cadwallader University Health Board
Logan	S	University College London Hospital
Lomas	D	University College London Hospital
Lone	N I	Usher Institute, University of Edinburgh
Loosley	R	Hywel Dda University Health Board
Lord	J M	University Hospital Birmingham NHS Foundation Trust
Lota	H	The Hillingdon Hospitals NHS Foundation Trust
Lovegrove	W	Sherwood Forest Hospitals NHS Foundation Trust
Lucey	A	Aneurin Bevan University Health Board
Lukaschuk	E	University of Oxford
Lye	A	Sheffield Teaching NHS Foundation Trust
Lynch	C	Cwm Taf Morgannwg University Health Board
MacDonald	S	University of Glasgow
MacGowan	G	Newcastle upon Tyne Hospitals NHS Foundation Trust
Macharia	I	Sheffield Teaching NHS Foundation Trust
Mackie	J	Royal Papworth Hospital NHS Foundation Trust
Macliver	L	NHS Lanarkshire
Madathil	S	University Hospital Birmingham NHS Foundation Trust
Madzamba	G	Liverpool University Hospitals NHS Foundation Trust
Magee	N	Belfast Health & Social Care Trust & Queen's University Belfast
Magtoto	M M	Guy's and St Thomas' NHS Foundation Trust
Mairs	N	Salford Royal NHS Foundation Trust
Majeed	N	Salford Royal NHS Foundation Trust
Major	E	Belfast Health & Social Care Trust
Malein	F	Liverpool University Hospitals NHS Foundation Trust
Malim	M	King's College Hospital NHS Foundation Trust
Mallison	G	Aneurin Bevan University Health Board
Man	W	Imperial College London
Mandal	S	Royal Free London NHS Foundation Trust
Mangion	K	NHS Greater Glasgow and Clyde Health Board
Manisty	C	Barts Heart Centre

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Manley	R	Betsi Cadwallader University Health Board
March	K	Imperial College Healthcare NHS Trust
Marciniak	S	Cambridge University Hospitals NHS Foundation Trust
Marino	P	Guy's and St Thomas' NHS Foundation Trust
Mariveles	M	Imperial College Healthcare NHS Trust
Marks	M	London School of Hygiene & Tropical Medicine
Marouzet	E	University Hospital Southampton NHS Foundation Trust
Marsh	S	Liverpool University Hospitals NHS Foundation Trust
Marshall	B	University Hospital Southampton NHS Foundation Trust
Marshall	M	Sheffield Teaching NHS Foundation Trust
Martin	J	Hampshire Hospitals NHS Foundation Trust
Martineau	A	Barts Health NHS Trust
Martinez	L M	Guy's and St Thomas' NHS Foundation Trust
Maskell	N	North Bristol NHS Trust & University of Bristol
Matila	D	Royal Free London NHS Foundation Trust
Matimba-Mupaya	W	Salisbury NHS Foundation Trust
Matthews	L	Nottingham University Hospitals NHS Trust
Mbuyisa	A	Sheffield Teaching NHS Foundation Trust
McAdoo	S	Imperial College London
Weir McCall	J	University of Cambridge
McAllister-Williams	H	Newcastle University
McArdle	A	University of Liverpool
McArdle	P	University of Birmingham
McAulay	D	Belfast Health & Social Care Trust
McCann	G P	University Hospitals of Leicester NHS Trust
McCauley	H J C	University Hospitals of Leicester NHS Trust
McCormick	J	Tameside and Glossop Integrated Care NHS Foundation Trust
McCormick	W	Gateshead NHS Trust
McCourt	P	University Hospitals of Leicester NHS Trust
McGarvey	L	Belfast Health & Social Care Trust
McGee	C	University Hospital Birmingham NHS Foundation Trust
Mcgee	K	University Hospital Birmingham NHS Foundation Trust
McGinness	J	Belfast Health & Social Care Trust
McGlynn	K	University of Oxford
McGovern	A	University of Exeter
McGuinness	H	Hywel Dda University Health Board
McInnes	I B	NHS Greater Glasgow and Clyde Health Board
McIntosh	J	Tameside and Glossop Integrated Care NHS Foundation Trust
McIvor	E	Betsi Cadwallader University Health Board
McIvor	K	Manchester Centre for Clinical Neurosciences, Salford Royal NHS Foundation Trust
McLeavey	L	Imperial College Healthcare NHS Trust
McMahon	A	Kidney Research UK
McMahon	M J	NHS Dumfries and Galloway
McMorrow	L	Salford Royal NHS Foundation Trust
Mcnally	T	University Hospitals of Leicester NHS Trust
McNarry	M	Swansea University
McNeill	J	Sheffield Teaching NHS Foundation Trust
McQueen	A	Cardiff and Vale University Healthy Board
McShane	H	Oxford University Hospitals NHS Foundation Trust
Mears	C	Liverpool University Hospitals NHS Foundation Trust
Megson	C	Oxford University Hospitals NHS Foundation Trust
Megson	S	Sheffield Teaching NHS Foundation Trust
Mehta	P	University College London
Meiring	J	Sheffield Teaching NHS Foundation Trust
Melling	L	Liverpool University Hospitals NHS Foundation Trust
Mencias	M	St George's University Hospitals NHS Foundation Trust
Menzies	D	Betsi Cadwallader University Health Board
Merida Morillas	M	University College London Hospital
Michael	A	Royal Papworth Hospital NHS Foundation Trust
Milligan	L	MQ Mental Health Research,
Miller	C	University of Manchester
Mills	C	Harrogate and District NHD Foundation Trust
Mills	N L	BHF Centre for Cardiovascular Science, University of Edinburgh
Milner	L	Sheffield Teaching NHS Foundation Trust
Misra	S	Sheffield Teaching NHS Foundation Trust
Mitchell	J	Imperial College London
Mohamed	A	Hywel Dda University Health Board

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Mohamed	N	Imperial College Healthcare NHS Trust
Mohammed	S	NHS Tayside
Molyneaux	P L	Imperial College London
Monteiro	W	University Hospitals of Leicester NHS Trust
Moriera	S	Imperial College Healthcare NHS Trust
Morley	A	North Bristol NHS Trust & University of Bristol
Morrison	L	North Bristol NHS Trust & University of Bristol
Morriss	R	University of Nottingham
Morrow	A	NHS Greater Glasgow and Clyde Health Board
Moss	A J	University of Leicester
Moss	P	University of Birmingham
Motohashi	K	University of Oxford
Msimanga	N	St George's University Hospitals NHS Foundation Trust
Mukaetova-Ladinska	E	University of Leicester
Munawar	U	Imperial College Healthcare NHS Trust
Murira	J	Leeds Teaching Hospitals
Nanda	U	University Hospitals of Derby and Burton
Nassa	H	Aneurin Bevan University Health Board
Nasseri	M	The Hillingdon Hospitals NHS Foundation Trust
Neal	A	University Hospital Birmingham NHS Foundation Trust
Needham	R	Nottingham University Hospitals NHS Trust
Neill	P	NHS Dumfries and Galloway
Neubauer	S	Oxford University Hospitals NHS Foundation Trust
Newby	D E	University of Edinburgh
Newell	H	Sheffield Teaching NHS Foundation Trust
Newman	T	Sheffield Teaching NHS Foundation Trust
Newton-Cox	A	University Hospital Birmingham NHS Foundation Trust
Nicholson	T	King's College London
Nicoll	D	Oxford University Hospitals NHS Foundation Trust
Nolan	C M	Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation trust.
Noonan	M J	Liverpool University Hospitals NHS Foundation Trust
Norman	C	Sheffield Teaching NHS Foundation Trust
Novotny	P	University of Leicester
Nunag	J	Imperial College Healthcare NHS Trust
Nwafor	L	Sheffield Teaching NHS Foundation Trust
Nwanguma	U	Imperial College Healthcare NHS Trust
Nyaboko	J	University Hospital Birmingham NHS Foundation Trust
O'Donnell	K	University of Glasgow
O'Brien	C	Kings College Hospital, Guys and St Thomas NHS FT
O'Brien	L	Hywel Dda University Health Board
O'Regan	D	Imperial College London
Odell	N	Manchester University NHS Foundation Trust
Ogg	G	Oxford University Hospitals NHS Foundation Trust
Olaosebikan	O	Royal Free London NHS Foundation Trust
Oliver	C	Cardiff and Vale University Healthy Board
Omar	Z	Hywel Dda University Health Board
Openshaw	P J M	National Heart and Lung Institute, Imperial College London, London, United Kingdom
Orriss-Dib	L	Imperial College Healthcare NHS Trust
Osborne	L	United Lincolnshire Hospitals NHS Trust
Osbourne	R	Manchester University NHS Foundation Trust
Ostermann	M	Guy's and St Thomas' NHS Foundation Trust
Overton	C	University of Leicester
Owen	J	Hampshire Hospitals NHS Foundation Trust
Oxton	J	Salford Royal NHS Foundation Trust
Pack	J	Royal Papworth Hospital NHS Foundation Trust
Pacpaco	E	Oxford University Hospitals NHS Foundation Trust
Paddick	S	Newcastle University
Painter	S	Shropshire Community Health NHS Trust
Pakzad	A	University College London
Palmer	S	Somerset NHS Foundation Trust
Papineni	P	London North West University Healthcare NHS Trust
Paques	K	Royal Papworth Hospital NHS Foundation Trust
Paradowski	K	Cardiff and Vale University Healthy Board
Pareek	M	University Hospitals of Leicester NHS Trust
Parekh	D	University Hospital Birmingham NHS Foundation Trust
Parfrey	H	Royal Papworth Hospital NHS Foundation Trust
Pariante	C	King's College London

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Parker	S	University Hospitals of Leicester NHS Trust
Parkes	M	Cambridge University Hospitals NHS Foundation Trust
Parmar	J	Royal Papworth Hospital NHS Foundation Trust
Patale	S	King's College Hospital NHS Foundation Trust
Patel	B	Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation trust.
Patel	M	NHS Lanarkshire
Patel	S	Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation trust.
Pattenadk	D	Sheffield Teaching NHS Foundation Trust
Pavlides	M	Oxford University Hospitals NHS Foundation Trust
Payne	S	Hampshire Hospitals NHS Foundation Trust
Pearce	L	Gateshead NHS Trust
Pearl	J E	University of Leicester
Peckham	D	Leeds Teaching Hospitals
Pendlebury	J	Salford Royal NHS Foundation Trust
Peng	Y	Oxford University Hospitals NHS Foundation Trust
Pennington	C	Aneurin Bevan University Health Board
Peralta	I	King's College Hospital NHS Foundation Trust
Perkins	E	Hywel Dda University Health Board
Peterkin	Z	University Hospital Birmingham NHS Foundation Trust
Peto	T	Queen's University Belfast
Petousi	N	Oxford University Hospitals NHS Foundation Trust
Petrie	J	University of Glasgow
Pfeffer	P	Barts Health NHS Trust
Phipps	J	Hywel Dda University Health Board
Pimm	J	Oxford University Hospitals NHS Foundation Trust
Piper Hanley	K	Manchester University NHS Foundation Trust
Pius	R	University of Edinburgh
Plant	H	University College London Hospital
Plein	S	Leeds Teaching Hospitals
Plekhanova	T	University of Leicester
Plowright	M	Sheffield Teaching NHS Foundation Trust
Poinasamy	K	Asthma UK and British Lung Foundation Partnership
Polgar	O	Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation trust.
Poll	L	Liverpool University Hospitals NHS Foundation Trust
Porter	J C	University College London Hospital
Porter	J	Sheffield Teaching NHS Foundation Trust
Portukhay	S	The Hillingdon Hospitals NHS Foundation Trust
Powell	N	King's College Hospital NHS Foundation Trust
Prabhu	A	Hampshire Hospitals NHS Foundation Trust
Pratt	J	Liverpool University Hospitals NHS Foundation Trust
Price	A	Aneurin Bevan University Health Board
Price	C	East Kent Hospitals University NHS Foundation Trust
Price	D	Newcastle upon Tyne Hospitals NHS Foundation Trust
Price	L	Royal Brompton Hospital
Prickett	A	University Hospitals of Leicester NHS Trust
Propescu	J	University of Oxford
Pugmire	S	Gateshead NHS Trust
Quaid	S	London North West University Healthcare NHS Trust
Quigley	J	NHS Lanarkshire
Quint	J	Imperial College London
Qureshi	H	University Hospital Birmingham NHS Foundation Trust
Qureshi	I N	University Hospitals of Leicester NHS Trust
Radhakrishnan	K	Manchester University NHS Foundation Trust
Rahman	N M	Oxford University Hospitals NHS Foundation Trust
Ralser	M	Francis Crick Institute
Raman	B	Oxford University Hospitals NHS Foundation Trust
Ramos	A	King's College Hospital NHS Foundation Trust
Ramos	H	East Kent Hospitals University NHS Foundation Trust
Rangeley	J	Leeds Teaching Hospitals
Rangelov	B	University College London
Ratcliffe	L	University Hospital Birmingham NHS Foundation Trust
Ravencroft	P	Sheffield Teaching NHS Foundation Trust
Reddington	A	Wirral University Teaching Hospital
Reddy	R	Kettering General Hospital NHS Trust
Redfearn	H	York & Scarborough NHS Foundation Trust
Redwood	D	Somerset NHS Foundation Trust
Reed	A	Hampshire Hospitals NHS Foundation Trust

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Rees	M	Cwm Taf Morgannwg University Health Board
Rees	T	Swansea Bay University Health Board
Regan	K	Bradford Teaching Hospitals NHS Foundation Trust
Reynolds	W	University of Liverpool
Ribeiro	C	Cambridge University Hospitals NHS Foundation Trust
Richards	A	Hull University Teaching Hospitals NHS Trust
Richardson	E	Liverpool University Hospitals NHS Foundation Trust
Richardson	M	University of Leicester
Rivera-Ortega	P	Manchester University NHS Foundation Trust
Roberts	K	Betsi Cadwallader University Health Board
Robertson	E	Diabetes UK, University of Glasgow
Robinson	E	Wrightington Wigan and Leigh NHS trust
Robinson	L	Borders General Hospital, NHS Borders
Roche	L	Cwm Taf Morgannwg University Health Board
Roddis	C	Sheffield Teaching NHS Foundation Trust
Rodger	J	Sheffield Teaching NHS Foundation Trust
Ross	A	Imperial College Healthcare NHS Trust
Ross	G	Hywel Dda University Health Board
Rossdale	J	Guy's and St Thomas' NHS Foundation Trust
Rostron	A	University of Newcastle
Rowe	A	Liverpool University Hospitals NHS Foundation Trust
Rowland	A	University Hospitals of Leicester NHS Trust
Rowland	J	NHS Tayside & University of Dundee
Rowland	M J	Oxford University Hospitals NHS Foundation Trust
Rowland-Jones	S L	Sheffield Teaching NHS Foundation Trust
Roy	K	University College London Hospital
Roy	M	Imperial College Healthcare NHS Trust
Rudan	I	University of Edinburgh
Russell	R	University Hospitals of Leicester NHS Trust
Russell	E	Imperial College Healthcare NHS Trust
Saalmink	G	Leeds Teaching Hospitals
Sabit	R	Cardiff and Vale University Healthy Board
Sage	E K	NHS Highland
Samakomva	T	St George's University Hospitals NHS Foundation Trust
Samani	N	University of Leicester
Sampson	C	Chesterfield Royal Hospital NHS Trust
Samuel	K	Imperial College Healthcare NHS Trust
Samuel	R	University Hospital Southampton NHS Foundation Trust
Sanderson	A	Barnsley Hospital NHS Foundation Trust
Sapey	E	University Hospital Birmingham NHS Foundation Trust
Saralaya	D	Bradford Teaching Hospitals NHS Foundation Trust
Saratzis	A	University of Leicester
Sargant	J	University of Leicester
Sarginson	C	York & Scarborough NHS Foundation Trust
Sass	T	University Hospital Southampton NHS Foundation Trust
Sattar	N	University of Glasgow
Saunders	K	Oxford University Hospitals NHS Foundation Trust
Saunders	R	University of Leicester
Saunders	P	Sheffield Teaching NHS Foundation Trust
Saunders	L C	University of Sheffield
Savill	H	Tameside and Glossop Integrated Care NHS Foundation Trust
Saxon	W	Betsi Cadwallader University Health Board
Sayer	A	Newcastle upon Tyne Hospitals NHS Foundation Trust
Schronce	J	Imperial College Healthcare NHS Trust
Schwaeble	W	University of Cambridge
Scott	J T	MRC - University of Glasgow Centre for Virus Research
Scott	K	NHS Greater Glasgow and Clyde Health Board
Selby	N	Nottingham University
Semple	M G	Liverpool University Hospitals NHS Foundation Trust
Sereno	M	University Hospitals of Leicester NHS Trust
Sewell	T A	Sherwood Forest Hospitals NHS Foundation Trust
Shah	A M	King's College Hospital NHS Foundation Trust
Shah	K	Diabetes UK
Shah	P	Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation trust.
Shankar-Hari	M	University of Edinburgh
Sharma	M	University of Leicester
Sharpe	C	King's College London

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Sharpe	M	Oxford University Hospitals NHS Foundation Trust
Shashaa	S	East Cheshire NHS Trust
Shaw	A	Airedale NHS Foundation Trust
Shaw	K	Nottingham University Hospitals NHS Trust
Shaw	V	Liverpool University Hospitals NHS Foundation Trust
Sheikh	A	NHS Lothian & University of Edinburgh
Shelton	S	Sherwood Forest Hospitals NHS Foundation Trust
Shenton	L	Airedale NHS Foundation Trust
Shevket	K	King's College Hospital NHS Foundation Trust
Shikotra	A	University Hospitals of Leicester NHS Trust
Short	J	University Hospital Birmingham NHS Foundation Trust
Siddique	S	St George's University Hospitals NHS Foundation Trust
Siddiqui	S	University Hospitals of Leicester NHS Trust
Sidebottom	J	Sheffield Teaching NHS Foundation Trust
Sigfrid	L	University of Oxford
Simons	G	University of Southampton
Simpson	J	Newcastle upon Tyne Hospitals NHS Foundation Trust
Simpson	N	Imperial College Healthcare NHS Trust
Singapuri	A	University Hospitals of Leicester NHS Trust
Singh	C	Royal Free London NHS Foundation Trust
Singh	S	Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation trust.
Singh	S J	University Hospitals of Leicester NHS Trust
Sissons	D	Sherwood Forest Hospitals NHS Foundation Trust
Skeemer	J	University Hospitals of Leicester NHS Trust
Slack	K	Sherwood Forest Hospitals NHS Foundation Trust
Smith	A	NHS Lanarkshire
Smith	D	Imperial College London
Smith	S	Sherwood Forest Hospitals NHS Foundation Trust
Smith	J	Sheffield Teaching NHS Foundation Trust
Smith	L	Sheffield Teaching NHS Foundation Trust
Soares	M	University Hospitals of Leicester NHS Trust
Solano	T S	Guy's and St Thomas' NHS Foundation Trust
Solly	R	East Kent Hospitals University NHS Foundation Trust
Solstice	AR	NHS Tayside
Soulsby	T	University Hospital Birmingham NHS Foundation Trust
Southern	D	Betsi Cadwallader University Health Board
Sowter	D	Sherwood Forest Hospitals NHS Foundation Trust
Spears	M	University of Glasgow
Spencer	L G	University of Liverpool
Speranza	F	King's College Hospital NHS Foundation Trust
Stadon	L	North Bristol NHS Trust
Stanel	S	University of Manchester
Steele	N	Sheffield Teaching NHS Foundation Trust
Steiner	M	University of Leicester
Stensel	D	Loughborough University
Stephens	G	Sheffield Teaching NHS Foundation Trust
Stephenson	L	Harrogate and District NHD Foundation Trust
Stern	M	Whittington Health NHS Trust
Stewart	I	Imperial College London
Stimpson	R	Sheffield Teaching NHS Foundation Trust
Stockdale	S	Manchester University NHS Foundation Trust
Stockley	J	University Hospital Birmingham NHS Foundation Trust
Stoker	W	Gateshead NHS Trust
Stone	R	Belfast Health & Social Care Trust & Queen's University Belfast
Storrar	W	Hampshire Hospitals NHS Foundation Trust
Storrie	A	Aneurin Bevan University Health Board
Storton	K	Bradford Teaching Hospitals NHS Foundation Trust
Stringer	E	University Hospitals of Leicester NHS Trust
Strong-Sheldrake	S	Salisbury NHS Foundation Trust
Stroud	N	Cwm Taf Morgannwg University Health Board
Subbe	C	Betsi Cadwallader University Health Board
Sudlow	C L	University of Edinburgh
Suleiman	Z	University Hospital Birmingham NHS Foundation Trust
Summers	C	University of Cambridge
Summersgill	C	Salford Royal NHS Foundation Trust
Sutherland	D	NHS Tayside
Sykes	D L	Hull University Teaching Hospitals NHS Trust

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Sykes	R	NHS Greater Glasgow and Clyde Health Board
Talbot	N	Oxford University Hospitals NHS Foundation Trust
Tan	A L	Leeds Teaching Hospitals
Tarusan	L	Imperial College Healthcare NHS Trust
Tavoukjian	V	St George's University Hospitals NHS Foundation Trust
Taylor	A	Hywel Dda University Health Board
Taylor	C	University of Leicester
Taylor	J	Cambridge University Hospitals NHS Foundation Trust
Te	A	King's College Hospital NHS Foundation Trust
Tedd	H	Newcastle upon Tyne Hospitals NHS Foundation Trust
Tee	CJ	NHS Tayside
Teixeira	J	St George's University Hospitals NHS Foundation Trust
Tench	H	Hywel Dda University Health Board
Terry	S	University of Leicester
Thackray-Nocera	S	Hull University Teaching Hospitals NHS Trust
Thaivalappil	F	Swansea Bay University Health Board
Thamu	B	Sheffield Teaching NHS Foundation Trust
Thickett	D	University of Birmingham
Thomas	C	Swansea Bay University Health Board
Thomas	D C	Imperial College Healthcare NHS Trust
Thomas	S	Newcastle upon Tyne Hospitals NHS Foundation Trust
Thomas	A K	Nottingham University Hospitals NHS Trust
Thomas-Woods	T	Cwm Taf Morgannwg University Health Board
Thompson	T	University Hospital Birmingham NHS Foundation Trust
Thompson	A A R	Sheffield Teaching NHS Foundation Trust
Thornton	T	University Hospitals of Leicester NHS Trust
Thorpe	M	University of Edinburgh
Thwaites	R S	Imperial College London
Tilley	J	Somerset NHS Foundation Trust
Tinker	N	Sheffield Teaching NHS Foundation Trust
Tiongson	G F	London North West University Healthcare NHS Trust
Tobin	M	University Hospitals of Leicester NHS Trust
Tomlinson	J	Shropshire Community Health NHS Trust
Tong	C	University of Leicester
Toshner	M	Cambridge University Hospitals NHS Foundation Trust
Touyz	R	Institute of Cardiovascular & Medical Sciences, University of Glasgow
Tripp	K A	Liverpool University Hospitals NHS Foundation Trust
Tunnicliffe	E	Oxford University Hospitals NHS Foundation Trust
Turnbull	A	York & Scarborough NHS Foundation Trust
Turner	E	University of Leicester
Turner	S	Sherwood Forest Hospitals NHS Foundation Trust
Turner	V	Tameside and Glossop Integrated Care NHS Foundation Trust
Turner	K	Sheffield Teaching NHS Foundation Trust
Turney	S	East Kent Hospitals University NHS Foundation Trust
Turtle	L	Liverpool University Hospitals NHS Foundation Trust
Turton	H	Sheffield Teaching NHS Foundation Trust
Ugoji	J	The Great Western Hospital Foundation Trust
Ugwuoke	R	Salford Royal NHS Foundation Trust
Upthegrove	R	University of Birmingham
Valabhji	J	Imperial College London
Ventura	M	University Hospital Birmingham NHS Foundation Trust
Vere	J	Tameside and Glossop Integrated Care NHS Foundation Trust
Vickers	C	Somerset NHS Foundation Trust
Vinson	B	University of Liverpool
Wade	E	Leeds Teaching Hospitals
Wade	P	Sheffield Teaching NHS Foundation Trust
Wain	L V	University Hospitals of Leicester NHS Trust
Wainwright	T	Somerset NHS Foundation Trust
Wajero	L O	Liverpool University Hospitals NHS Foundation Trust
Walder	S	University Hospital Birmingham NHS Foundation Trust
Walker	S	Sheffield Teaching NHS Foundation Trust
Wall	E	University College London Hospital
Wallis	T	University Hospital Southampton NHS Foundation Trust
Walmsley	S	University of Edinburgh
Walsh	J A	Royal Brompton and Harefield Clinical Group, Guy's and St Thomas' NHS Foundation trust.
Walsh	S	Imperial College London
Warburton	L	Shropshire Community Health NHS Trust

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC

Ward	T J C	University Hospitals of Leicester NHS Trust
Warwick	K	Kettering General Hospital NHS Trust
Wassall	H	East Cheshire NHS Trust
Waterson	S	North Bristol NHS Trust
Watson	E	London North West University Healthcare NHS Trust
Watson	L	Cambridge University Hospitals NHS Foundation Trust
Watson	J	Sheffield Teaching NHS Foundation Trust
Welch	C	University Hospital Birmingham NHS Foundation Trust
Welch	H	North Bristol NHS Trust
Welsh	B	NHS Lanarkshire
Wessely	S	King's College London
West	S	Newcastle upon Tyne Hospitals NHS Foundation Trust
Weston	H	East Kent Hospitals University NHS Foundation Trust
Wheeler	H	University Hospital Southampton NHS Foundation Trust
White	S	Kettering General Hospital NHS Trust
Whitehead	V	Betsi Cadwallader University Health Board
Whitney	J	King's College London
Whittaker	S	Salford Royal NHS Foundation Trust
Whittam	B	Leeds Teaching Hospitals
Whitworth	V	Sherwood Forest Hospitals NHS Foundation Trust
Wight	A	Wirral University Teaching Hospital
Wild	J	University of Sheffield
Wilkins	M	Imperial College London
Wilkinson	D	University of Birmingham
Williams	B	University College London
Williams	N	Hampshire Hospitals NHS Foundation Trust
Williams	J	Cardiff and Vale University Healthy Board
Williams-Howard	S A	Liverpool University Hospitals NHS Foundation Trust
Willicombe	M	Imperial College London
Willis	G	Aneurin Bevan University Health Board
Willoughby	J	University College London
Wilson	A	Gateshead NHS Trust
Wilson	D	University Hospital Birmingham NHS Foundation Trust
Wilson	I	Sheffield Teaching NHS Foundation Trust
Window	N	Leeds Teaching Hospitals
Witham	M	Newcastle upon Tyne Hospitals NHS Foundation Trust
Wolf-Roberts	R	Hywel Dda University Health Board
Wood	C	Imperial College Healthcare NHS Trust
Woodhead	F	University Hospitals of Leicester NHS Trust
Woods	J	Leeds Teaching Hospitals
Wootton	D G	Liverpool University Hospitals NHS Foundation Trust
Wormleighton	J	University of Leicester
Worsley	J	Cambridge University Hospitals NHS Foundation Trust
Wraith	D	University of Birmingham
Wrey Brown	C	Hampshire Hospitals NHS Foundation Trust
Wright	C	Hull University Teaching Hospitals NHS Trust
Wright	L	University of Nottingham
Wright	S	Newcastle upon Tyne Hospitals NHS Foundation Trust
Wyles	J	Liverpool University Hospitals NHS Foundation Trust
Wynter	I	Sherwood Forest Hospitals NHS Foundation Trust
Xie	C	University of Oxford, Division of Cardiovascular Medicine
Xu	M	University College London
Yasmin	N	Imperial College Healthcare NHS Trust
Yasmin	S	University Hospital Birmingham NHS Foundation Trust
Yates	T	University Hospitals of Leicester NHS Trust
Yip	K P	University Hospital Birmingham NHS Foundation Trust
Young	B	DUK | NHS Digital, Salford Royal Foundation Trust
Young	S	Aneurin Bevan University Health Board
Young	A	Newcastle upon Tyne Hospitals NHS Foundation Trust
Yousuf	A J	University Hospitals of Leicester NHS Trust
Zawia	A	Sheffield Teaching NHS Foundation Trust
Zeidan	L	The Rotherham NHS Foundation Trust
Zhao	B	University of Leicester
Zongo	O	Barts Health NHS Trust
Zheng	B	University of Edinburgh

AJRCCM Articles in Press. Published December 01, 2022 as 10.1164/rccm.202203-0564OC