**Article:**
Curry, PDK, Chinoy, H, Jani, M et al. (8 more authors) (2023) The impact of COVID-19 on medication adherence in a rheumatoid (BRAGGSS) and psoriatic arthritis (OUTPASS) UK cohort. The Journal of Rheumatology, 50 (7). jrheum.2022-1277. ISSN 0315-162X

https://doi.org/10.3899/jrheum.2022-1277

**Short running head:**

**COVID-19 impact on non-adherence**

**Full title of manuscript:**

# The impact of COVID-19 on medication adherence in a rheumatoid (BRAGGSS) and psoriatic arthritis (OUTPASS) UK cohort

**Authors complete given names:**

Philippa Curry, Hector Chinoy, Meghna Jani, Darren Plant, Kimmie Hyrich, Ann Morgan, Gerry Wilson, John Isaacs, Andrew Morris, Anne Barton, James Bluett.

**Funding statement (Sources):**

This work was supported by Versus Arthritis (Grant references:21754 and 21755) and the National Institute of Health Research (NIHR) Manchester Biomedical Research Centre. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR National Institute of Health Research or the Department of Health and Social Care.

**Authors initials and affiliations:**

**P.D.K. Curry[1], Prof. H. Chinoy[1,2,3], Dr M. Jani[2,4], Dr D. Plant[1,2], Prof. K.L. Hyrich[2,4], Prof. A. Morgan[5], Prof. A.G. Wilson[6], Prof. J.D. Isaacs[7], Prof. A.P. Morris[1,2], Prof. A. Barton[1,2], Dr. J. Bluett[1,2]**

1. Centre for Musculoskeletal Research, Faculty of Biology, Medicine and Health, The University of Manchester, Manchester, United Kingdom.
2. National Institute for Health Research Manchester Biomedical Research Centre, Manchester University NHS Foundation Trust, The University of Manchester, Manchester, United Kingdom.
3. Department of Rheumatology, Salford Royal Hospital, Northern Care Alliance NHS Foundation Trust, Manchester Academic Health Science Centre, Salford, United Kingdom.

4. Centre of Epidemiology Versus Arthritis, Faculty of Biology, Medicine and Health, The University of Manchester, Manchester, United Kingdom.
5. School of Medicine, University of Leeds and NIHR Leeds Biomedical Research Centre, Leeds Teaching Hospitals NHS Trust, Leeds, United Kingdom.
6. School of Medicine & Medical Science, Conway Institute, University College Dublin, Dublin, Ireland.
7. Translational and Clinical Research Institute, Newcastle University, and Musculoskeletal Unit, The Newcastle upon Tyne Hospitals NHS Foundation Trust, Newcastle upon Tyne, United Kingdom.

A list of OUTPASS and BRAGGSS collaborating sites and authors is available in the appendix.

**Conflicts of interest:**

HC has received grant support from Eli Lilly and UCB; consulting fees from Eli Lilly, Orphazyme, Astra Zeneca and is supported by the National Institution for Health Research Manchester Biomedical Research Centre Funding Scheme. MJ is funded by a NIHR Advanced Fellowship [NIHR301413]. DP has grant support from Bristol Myers Squibb. KLH has grant support from Pfizer and BMS and has received honoraria from AbbVie. AM has previously held grant support from Roche, Kiniksa Pharmaceuticals and previously undertook consultancy for GSK, Roche, Chugai, AstraZeneka, Regeneron, Sanofi, Vifor on behalf of the University of Leeds. JDI has grant support from GSK, Janssen, Pfizer and a paid speaker/consultant for Abbvie, Gilead and Roche. AB has grant/speaker fees from Pfizer, Galapagos, Scipher Medicine, Chugai, Roche and Bristol Myers Squibb. JB has received grant support from Pfizer and travel/conferences fees from UCB, Pfizer and Eli Lilly.

**Corresponding author:**

Dr James Bluett[1,2], james.bluett@manchester.ac.uk, ORCID ID: 0000-0001-5062-5779.

1. Centre for Musculoskeletal Research, Faculty of Biology, Medicine and Health, The University of Manchester, Manchester, United Kingdom.

2. National Institute for Health Research Manchester Biomedical Research Centre, Manchester University NHS Foundation Trust, The University of Manchester, Manchester, United Kingdom.

**Key message:**

COVID-19 impacted adherence to immunosuppressive therapies in psoriatic and rheumatoid arthritis UK patients.

**Key indexing Terms (MeSH)**

(COVID-19)(Medication Adherence)(Arthritis, Psoriatic)(Arthritis, Rheumatoid)

**Ethics statement:**

This study complies with the Declaration of Helsinki, the locally appointed ethics committee has approved the research protocol and that written informed consent has been obtained from the subjects (or their legally authorized representative). BRAGGSS-MREC No: 04/Q1403/37. OUTPASS-REC ref: 13/NW/0068.

**Data availability statement:**

The data that support the findings of this study are available on request from the corresponding author, JB. The data are not publicly available due to privacy/ethical restrictions.

Dear Editor,

Suboptimal treatment adherence has been reported in patients with arthritic diseases, is associated with psychological factors, including anxiety, and correlates with future treatment response (1,2). During the COVID-19 pandemic, patients identified as 'clinically extremely vulnerable', including people prescribed ≥2 immunosuppressives, were advised to shield and continue treatment unless they developed COVID-19 symptoms. The aim of this multi-centre study was to investigate the impact of the COVID-19 pandemic on adherence to disease modifying anti-rhematic drugs (DMARDs) in patients with established rheumatoid arthritis (RA) and psoriatic arthritis (PsA) in the UK.

Between August 2020 and June 2021, RA and PsA patients from two multi-centre observational studies (BRAGGSS and OUTPASS) who were within 12 months of commencing biologic or targeted synthetic DMARDs, were sent a questionnaire on adherence and medication perceptions. Adherence during the COVID-19 pandemic was assessed using a 5-point Likert scale, as described previously (2,3), and the reason for non-adherence recorded. Pandemic adherence was compared to paired pre-pandemic data (prior to 2020), where available, using similar questionnaires. Summary statistics for pandemic and pre-pandemic data, and Pearson's chi-squared ($\chi^2$) tests were used to investigate variables associated with self-reported non-adherence. Linear and logistic regression were used to investigate association between returning questionnaires, Hospital Anxiety and Depression Scale (HADS) and drug response.

One hundred and fifty-nine questionnaires were returned (81.1% RA and 18.9% PsA). Seven patients reported COVID-19 symptoms with five testing positive and two being hospitalised. Methotrexate (53.5%) was the most frequently prescribed agent, followed by etanercept (25.2%), sulfasalazine (22.6%), adalimumab (22.0%) and hydroxychloroquine (21.4%), with 72.3% of patients being prescribed ≥2 immunosuppressives. In the PsA cohort there was no significant association between questionnaire responders/non-responders and 6-month drug response, demonstrating no evidence of responder bias. Information was not available in the RA cohort. Of patients with adherence

information, 43.2% reported missing or delaying a treatment dose. Of those that missed or delayed therapy, 59.7% reported non-medically advised non-adherence. Overall, this resulted in 25.8% of patients self-reporting non-adherence during COVID-19.

There was no significant difference in non-adherence rates between the different DMARDs. Furthermore, there was no association between disease type (RA vs. PsA) or perception of disease control (good vs. bad) and adherence. Of non-adherent patients, 22.5% reported increased anxiety and fear of a greater risk of infection due to the COVID-19 pandemic as an influencing factor; 25.0% listed non-COVID-19 intentional reasons such as fear of treatment, side-effects and aversion to injections, while 55.0% reported non-intentional reasons, with forgetting and lack of treatment availability listed most frequently, similar to previous literature (4,5). A higher HADS-T score was associated with increased self-reporting missing or delaying a dose of treatment [Odds Ratio=1.11 (95% Confidence Interval:1.01-1.14), p-value=0.01], however there was no significant association with non-medically advised non-adherence during COVID-19.

Considering pre-pandemic data, 26.7% of the OUTPASS cohort had adherence information available, with 100.0% self-reporting complete adherence within the first 3 months of treatment. In the BRAGGSS cohort 21.7% had pre-pandemic adherence information available. Of these patients 25.0% reported non-adherence within the first 3 months of treatment. Compared to pre-pandemic data, non-adherence was seen to increase during the pandemic for both RA and PsA patients. In international cohorts, non-adherence of patients on immunosuppressive therapy, was described at similar levels (**Table 1**) (4,6–8).

Throughout the pandemic, there was a vast amount of conflicting information, which may have contributed to increased anxiety and exacerbated symptoms in patients prescribed immunosuppressants (4,5). By contrast, patients with higher adherence had lower levels of relapse (7). In one cohort, only one patient that stopped therapy did not restart following reassurance, highlighting the benefits of good communication skills (7). This was supported by findings from the

current study, with one patient describing stopping treatment due to fear of COVID-19 before restarting after discussion with their Rheumatology team.

Strengths of the study include the multi-centre recruitment, inclusion of patients with both RA and PsA and the availability of pre-pandemic adherence data. Despite this, adherence information was only available for 3-months following treatment commencing, which could have led overestimated treatment adherence. Limitations include the inability to explore the influence of telemedicine which, may support higher levels of adherence due to a continuation of disease management (8).

In this multi-centre UK study of patients with RA and PsA commencing anti-rheumatic therapy 12 months prior, non-adherence during COVID-19 was captured at a national level and showed an increase in these patients compared to pre-pandemic available data. Increased anxiety and fear of infection were contributory factors to non-adherence. Lack of clear communication was cited as a reason for non-adherence both in the current UK study and in previous reports internationally. Clear, non-judgemental, and transparent communication and further education about infection risk in immunosuppression are pivotal for improving adherence behaviours and potential drug response in immunosuppressed patients in the context of infectious diseases.

**References**


1. Murage MJ, Tongbram V, Feldman SR, et al. Medication adherence and persistence in patients with rheumatoid arthritis, psoriasis, and psoriatic arthritis: a systematic literature review. Patient Prefer. Adherence. 2018;12:1483–503.

2. Bluett J, Morgan C, Thurston L , et al. Impact of inadequate adherence on response to subcutaneously administered anti-tumour necrosis factor drugs: Results from the Biologics in Rheumatoid Arthritis Genetics and Genomics Study Syndicate cohort. Rheumatology (Oxford). 2015;54(3):494–9.

3. Chan AHY, Horne R, Hankins M, Chisari C. The Medication Adherence Report Scale : A measurement tool for eliciting patients ' reports of nonadherence. Br. J. Clin. Pharmacol. 2020;86(7):1281–8.

4. Murray K, Quinn S, Turk M, et al. COVID-19 and rheumatic musculoskeletal disease patients: Infection rates, attitudes and medication adherence in an Irish population. Rheumatolgy (Oxford). 2021;60(2):902–6.

5. Lee YJ, Kim KO, Kim MC, Cho KB, Park KS, Jang BI. Perceptions and Behaviors of Patients with Inflammatory Bowel Disease during the COVID-19 Crisis. Gut Liver. 2022;16(1):81-91.

6. Kado S, Kamiya K, Kishimoto M, et al. Single-center survey of biologic use for inflammatory skin diseases during the coronavirus disease 2019 pandemic. J. Dermatol. 2021;48(12):1907–12.

7. Polat Ekinci A, Pehlivan G, Gökalp MO. Surveillance of psoriatic patients on biologic treatment during the COVID-19 pandemic: A single-center experience. Dermatol. Ther. 2021;34(1):e14700.

8. Vakirlis E, Bakirtzi K, Papadimitriou I, et al. Treatment adherence in psoriatic patients during COVID-19 pandemic: Real-world data from a tertiary hospital in Greece. J. Eur. Acad.

Dermatol. Venereol. 2020;34(11):e673–5.

**Appendix:**

**Members of the Biologics in Rheumatoid Arthritis Genetics and Genomics Study Syndicate (BRAGGSS)**

Steering Committee members: Professor Anne Barton, Professor John Isaacs, Professor Ann Morgan, Professor Gerry Wilson

Chief Investigator: Professor Anne Barton

The Newcastle upon Tyne Hospitals NHS Foundation Trust (Prof. J D Isaacs (PI), Prof. H Foster, Dr B Griffiths, Dr I Griffiths, Dr L Kay, Dr W-F Ng, Dr P N Platt, Dr D J Walker, Dr P Peterson, Dr A Lorenzi, Dr M Friswell, Dr B Thompson, Dr M Lee, Dr. A Pratt)

St Helens and Knowsley Hospitals NHS Trust (D Graham (PI), Dr R Abernethy (former PI), Dr A R Clewes, Dr J K Dawson)

Gateshead Health NHS Foundation Trust (S Pugmire (PI), Dr C A Kelly, Dr J Hamilton, Dr C R Heycock, Dr V Saravanan)

West Suffolk NHS Foundation Trust (Dr S Bhagat (PI), Dr D T O'Reilly (former PI), Dr V Rajagopal)

Sheffield Teaching Hospitals NHS Foundation Trust (Dr M Akil (PI), Prof. G Wilson (former PI), Dr S Till, Dr L Dunkley, Dr R Tattersall, Dr R Kilding, Dr T Tait, Dr J Maxwell, Dr K-P Kue)

Leeds Teaching Hospitals NHS Trust (Prof. P Emery (PI), Prof. M Buch, Dr S Bingham, Prof. A Morgan, Prof. H A Bird, Prof P G Conaghan, Dr C T Pease, Dr R J Wakefield, Dr S Dass)

Portsmouth Hospitals University NHS Trust (Dr J Ledingham (PI), Dr R G Hull, Dr F McCrae, Dr A Cooper, Dr S A Young Min, Dr Wong, Dr Shaban)

Manchester Royal Infirmary (Manchester University NHS Foundation Trust) (Prof. A Barton (PI), Prof. I Bruce (former PI), Dr R Gorodkin, Dr P Ho, Dr K Hyrich)

Royal Lancaster Infirmary (University Hospitals of Morecambe Bay NHS Foundation Trust) (Dr M Bukhari (PI), Dr L Ottewell, Dr Palkonyai)

Hampshire Hospitals NHS Foundation Trust (Dr E Williams (PI), Dr P Prouse (former PI), Dr R K Moitra, Dr D J Shawe)

The Dudley Group NHS Foundation Trust (Prof. G Kitas (PI), Dr K Douglas (former PI), Dr C Koutsianas, Dr N Erb, Dr R Klocke, Dr A J Whallett, Dr A Pace, Dr R Sandhu, Dr H John)

University Hospitals Birmingham NHS Foundation Trust (Dr A Filer (PI), Dr Bowman, Dr P Jobanputra, Dr E C Rankin)

South Tees Hospitals NHS Foundation Trust (Dr M Plant (PI), Dr F Clarke, Dr J N Fordham, Dr S Tuck, Dr S K Pathare, Dr A Paul)

Royal Derby Hospital (University Hospitals of Derby and Burton NHS Foundation Trust) (Dr S O'Reilly (PI), Dr T Ding, Dr L J Badcock, Dr C M Deighton, Dr N Raj, Dr M R Regan, Dr G D Summers, Dr R A Williams)

Northumbria Healthcare NHS Foundation Trust (Dr F Birrell (PI), Dr P R Crook)

University Hospitals Coventry and Warwickshire NHS Trust (Dr S Dubey (PI), Dr M Allen (former PI), Dr K Chaudhuri, Dr A Price-Forbes, Dr J Ravindran)

North Manchester General Hospital (Manchester University NHS Foundation Trust) (Dr L Das (PI), Dr M Ahmad (former PI), Dr M Pattrick, Dr H N Snowden, Dr A P Bowden, Dr E E Smith, Dr P Klimiuk, Dr D J Speden)

Nottingham University Hospitals NHS Trust (Dr J McHale (PI), Dr I Pande, Dr I C Gaywood, Dr C Godsave, Dr M Rutter, Dr A C Jones, Dr P Lanyon, Prof. M Doherty, Dr A Gupta, Dr P A Courtney, Dr A Srikanth, Dr A Abhishek)

Salford Royal (Northern Care Alliance NHS Foundation Trust) (Prof. H Chinoy (PI), Prof. T O'Neil, Prof. A Herrick, Prof. A Jones, Dr R Cooper, Dr W Dixon, Dr B Harrison)

South Warwickshire University NHS Foundation Trust (Dr C Marguerie (PI), Dr S P Rigby, Dr N Dunn)

Northern Lincolnshire and Goole Hospitals NHS Foundation Trust (Dr B Szebenyi (PI), Dr D Bates, Dr D James, Dr T Gillott, Dr A Alvi, C Grey, J Browning)

York Hospital (York and Scarborough Teaching Hospitals NHS Foundation Trust) (Dr M Green (PI), Dr M Quinn, Dr A Isdale, Dr A Brown, Dr B Saleem)

University Hospitals of Leicester NHS Trust (Dr A Moorthy (PI), Dr A Memon, Dr P Sheldon, Dr W Hassan, Dr J Francis, Dr A Kinder, Dr R Neame)

New Cross Hospital (The Royal Wolverhampton NHS Trust) (Dr S Raizada (PI), Dr W Al Allaf (former PI), Dr N Barkham)

Harrogate and District NHS Foundation Trust (Dr M Green (PI), Dr A Gough, Dr C Lawson)

Chesterfield Royal Hospital NHS Foundation Trust (Dr K Fairburn (PI), Dr M Piper (former PI))

Royal United Hospitals Bath NHS Foundation Trust (Dr J Pauling (PI), Dr E Korendowych, Dr T Jenkinson, Dr R Sengupta, Dr A Bhalla, Prof. N McHugh, Dr W Tillett, Dr T Ahmed)

Liverpool University Hospitals NHS Foundation Trust (Dr D Mewar (PI), Dr E J Tunn, Dr K Nelson, Dr T D Kennedy, Dr C Dubois)

Countess Of Chester Hospital NHS Foundation Trust (Dr J Nixon (PI), Dr T Barnes, Dr M Hui)

Royal Cornwall Hospitals NHS Trust (Dr D Hutchinson (PI), Prof. A D Woolf (former PI), Dr M Davis, Dr A Endean)

County Durham and Darlington NHS Foundation Trust (N Rusby (PI), Dr R Reece (former PI), Dr M Bridges (former PI), Dr D Armstrong, Dr A J Chuck, Dr S Hailwood, Dr N Kumar, Dr D Ashok)

South Tyneside and Sunderland NHS Foundation Trust (Dr D Coady (PI), Dr C Morley, Dr E Kidd, Dr D Wright, Dr G Raftery, Dr C Bracewell)

Stockport NHS Foundation Trust (Dr L Mercer (PI), Dr A Ismail (former PI), Dr C Filer)

Trafford General Hospital (Manchester University NHS Foundation Trust) (Dr P McCabe (PI), Dr F McKenna (former PI))

Kettering General Hospital NHS Foundation Trust (Dr A Kuttikat (PI), Dr G Kallarackal (former PI), Dr D Das (former PI), Dr D Parthajit, Dr E Borbas, Dr T Wazir)

Wrightington, Wigan and Leigh Teaching Hospitals NHS Foundation Trust (Dr E G Chelliah (PI), Dr C Chattopadhyay)

Queen's Hospital Burton (University Hospitals of Derby and Burton NHS Foundation Trust) (Dr Laxminarayan (PI), Dr M Nisar (former PI))

East Suffolk and North Essex NHS Foundation Trust (Dr S Lane (PI), Dr L Shand (former PI))

Fairfield General Hospital (Northern Care Alliance NHS Foundation Trust) (Dr S Naz (PI), Dr L Das

Cannock Chase Hospital (The Royal Wolverhampton NHS Trust) (Dr D Mulherin (PI), Dr S V Chalam, Dr T Price, Dr T Sheeran, Dr S Venkatachalam, Dr S Baskar)

Midlands Partnership NHS Foundation Trust (Dr S Hider (PI), Dr A Menon, Dr C Dowson, Dr S Dutta, Dr S Kamath, Dr J Packham, Dr S Price, Dr E Roddy, Dr Z Paskins, Prof. A Hassell)

Scarborough Hospital (York and Scarborough Teaching Hospitals NHS Foundation Trust) Dr Z Al-Saffar (PI), Dr J Foo (former PI), Dr G Koduri)

Furness General Hospital (University Hospitals of Morecambe Bay NHS Foundation Trust) (Dr M Bukhari (PI), Dr F Wood)

Barts Health NHS Trust (Prof. C Pitzalis (PI))

Bolton NHS Foundation Trust (Dr S Ling (PI), Dr S Wig (former PI))

Tameside and Glossop Integrated Care NHS Foundation Trust (Dr D Roy (PI))

Lancashire and South Cumbria NHS Foundation Trust (Dr S Horton (PI), Dr A Madon)

Northampton General Hospital NHS Trust (Dr J Taylor (PI))

University College London Hospitals NHS Foundation Trust (Dr M Castelino (PI))

Wythenshawe Hospital (Manchester University NHS Foundation Trust) (Dr S Haque (PI), Prof. I Bruce (former PI))

Pennine MSK (Dr J Bluett (PI))

Warrington and Halton Teaching Hospitals NHS Foundation Trust (H Whittle (PI))

Homerton Healthcare NHS Foundation Trust (Dr C Gorman (PI))

**Members of the Outcome of treatment response in Psoriatic Arthritis Studies Syndicate (OUTPASS)**

Chief investigator: Dr James Bluett

Wrightington, Wigan and Leigh Hospitals NHS Foundation Trust (Dr E G Chelliah (PI), Dr C Chattopadhyay (former PI))

Manchester Royal Infirmary (Manchester University NHS Foundation Trust) (Dr P Ho (PI), Prof. A Barton (former PI), Dr M Castelino, Prof. I Bruce, Dr R Gorodkin, Dr K Hyrich, Dr B Parker)

Salford Royal (Northern Care Alliance NHS Foundation Trust) (Dr H Chinoy (PI), Prof. T O'Neil, Prof. A Herrick, Prof. A Jones, Dr R Cooper, Prof. W Dixon, Dr B Harrison)

Royal United Hospitals Bath NHS Foundation Trust (Dr E Korendowych (PI), Prof. N McHugh, Dr W Tillett)

Aintree University Hospital (Liverpool University Hospitals NHS Foundation Trust) (Dr N Goodson (PI))

East Suffolk and North Essex NHS Foundation Trust (Dr S Lane (PI), Dr L Shand)

Nottingham University Hospitals NHS Trust (Dr I Pande (PI), Dr I Gaywood (former PI), Dr F Rees, Dr M Rutter, Dr S Hayat, Dr J F McHale, Dr A C Jones, Dr P Lanyon, Dr A Gupta, Dr P A Courtney, Dr A Srikanth, Dr A Abhishek)

Royal Devon University Healthcare NHS Foundation Trust (Dr S Kyle (PI), Dr R Manhas)

Mid and South Essex NHS Foundation Trust

Dr A Nandagudi (PI), Dr S Selvan (former PI), Dr A Bharadwaj, Dr N Gendi, Dr R Alshakh

Fairfield Hospital (Northern Care Alliance NHS Foundation Trust) (Dr S Naz (PI), Dr M Ahmad (former PI))

North Manchester General Hospital (Manchester University NHS Foundation Trust) (Dr L Das, Dr M Pattrick, Dr A P Bowden, Dr E E Smith, Dr P Klimiuk, Dr D J Speden)

University Hospitals of Morecambe Bay NHS Foundation Trust (Dr M Bukhari (PI), Dr S Kavaklieva, Dr L Ottewell, Dr M Massarotti)

Midlands Partnership NHS Foundation Trust (Dr J Packham (PI))

Wythenshawe Hospital (Manchester University NHS Foundation Trust) (Dr P Watson (PI), Dr P Sanders (former PI), Dr S Haque, Dr B Pal, Dr E Bruce)

The Mid Yorkshire Hospitals NHS Trust (Dr Z Karim (PI))

Torbay and South Devon NHS Foundation Trust (Dr K Mackay (PI), Dr H Shiels)

Northampton General Hospital NHS Trust (Dr J Taylor (PI), Dr R Jeffery, Dr P Nandi)

Stockport NHS Foundation Trust (Dr C Filer (PI), Dr A Ismail, Dr L Mercer)

North Cumbria Integrated Care NHS Foundation Trust (Dr A Hassan (PI), Dr A Russell)

University Hospitals of Leicester NHS Trust (Dr M Durrani (PI), Dr W Hassan (former PI), Dr A Samanta, Dr P Sheldon, Dr J Francis, Dr A Kinder, Dr R Neame, Dr A Moorthy)

Barts Health NHS Trust (Prof. M Bombardieri (PI), Dr S Kelly (former PI))

Sheffield Teaching Hospitals NHS Foundation Trust (Dr J Maxwell (PI), Dr M Akil, Dr S Till, Dr L Dunkley, Dr R Tattersall, Dr R Kilding, Dr T Tait, Dr K-P Kuet, Dr B Grant, Dr M Kazmi)

St Helens and Knowsley Teaching Hospitals NHS Trust (D Graham (PI), Dr V E Abernethy, Dr A R Clewes, Dr J K Dawson)

NHS Greater Glasgow and Clyde (Dr S Siebert (PI), Dr G Fragoulis)

Royal Liverpool and Broadgreen (Liverpool University Hospitals NHS Foundation Trust) (Dr D Mewar (PI), Dr E J Tunn, Dr K Nelson, Dr T D Kennedy, Dr C Dubois)

The Dudley Group NHS Foundation Trust (Dr K Douglas (PI), Dr E Ladoyanni, Dr C Koutsianas, Dr N Erb, Dr R Klocke, Dr A J Whallett, Dr A Pace, Dr R Sandhu, Dr H John)

Portsmouth Hospitals University NHS Trust (Dr S A Young Min (PI), Dr A Cooper, Dr J M Ledingham, Dr R G Hull, Dr F McCrae, Dr Wong, Dr Shaban)

Mid Cheshire Hospitals NHS Foundation Trust (Dr K Putchakayala (PI))

The Rotherham NHS Foundation Trust (Dr R Kumari (PI), Dr G Smith (former PI))

South Warwickshire NHS Foundation Trust (Dr C Marguerie (PI))

Homerton Healthcare NHS Foundation Trust (Dr P Reynolds (PI), Dr C Thornton (former PI), Dr C Gorman, Dr C Murphy)

Tameside and Glossop Integrated Care NHS Foundation Trust (Dr D Roy (PI))

Lancashire and South Cumbria NHS Foundation Trust (Dr S Horton (PI))

University College London Hospitals NHS Foundation Trust (Dr M Castelino (PI))