



OPEN ACCESS

Characteristics and outcomes of neonates hospitalised with SARS-CoV-2 infection in the UK by variant: a prospective national cohort study

Chris Gale ,¹ Don Sharkey ,² Kathryn E Fitzpatrick,³ Helen Mactier ,⁴ Alessandra Morelli,⁵ Mariko Nakahara,⁵ Madeleine Hurd,⁵ Anna Placzek,⁵ Marian Knight ,⁵ Shamez N Ladhani ,⁶ Elizabeth S Draper ,⁷ Cora Doherty,⁸ Maria A Quigley,⁵ Jennifer J Kurinczuk,⁵ Neonatal complications of COVID-19 Collaborative Group

► Additional supplemental material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/archdischild-2023-326167>).

For numbered affiliations see end of article.

Correspondence to

Dr Chris Gale, School of Public Health, Faculty of Medicine, Imperial College of Science Technology and Medicine, London, SW10 9NH, UK; christopher.gale@imperial.ac.uk

CG and DS contributed equally.

CG and DS are joint first authors.

Received 2 August 2023
Accepted 25 October 2023
Published Online First
15 November 2023



© Author(s) (or their employer(s)) 2024. Re-use permitted under CC BY. Published by BMJ.

To cite: Gale C, Sharkey D, Fitzpatrick KE, et al. *Arch Dis Child Fetal Neonatal Ed* 2024;**109**:F279–F286.

ABSTRACT

Objective Neonatal infection with wildtype SARS-CoV-2 is rare and good outcomes predominate. We investigated neonatal outcomes using national population-level data to describe the impact of different SARS-CoV-2 variants.

Design Prospective population-based cohort study.

Setting Neonatal, paediatric and paediatric intensive care inpatient care settings in the UK.

Patients Neonates (first 28 days after birth) with confirmed SARS-CoV-2 infection who received inpatient care, March 2020 to April 2022. Neonates were identified through active national surveillance with linkage to national SARS-CoV-2 testing data, routinely recorded neonatal data, paediatric intensive care data and obstetric and perinatal mortality surveillance data.

Outcomes Presenting signs, clinical course, severe disease requiring respiratory support are presented by the dominant SARS-CoV-2 variant in circulation at the time.

Results 344 neonates with SARS-CoV-2 infection received inpatient care; breakdown by dominant variant: 146 wildtype, 123 alpha, 57 delta and 18 omicron. Overall, 44.7% (153/342) neonates required respiratory support; short-term outcomes were good with 93.6% (322/344) of neonates discharged home. Eleven neonates died: seven unrelated to SARS-CoV-2 infection, four were attributed to neonatal SARS-CoV-2 infection (case fatality 4/344, 1.2% 95% CI 0.3% to 3.0%) of which three were born preterm due to maternal COVID-19. More neonates were born very preterm (23/54) and required invasive ventilation (27/57) when delta variant was predominant, and all four SARS-CoV-2 related deaths occurred in this period.

Conclusions Inpatient care for neonates with SARS-CoV-2 was uncommon. Although rare, severe neonatal illness was more common during the delta variant period, potentially reflecting more severe maternal disease and associated preterm birth.

Trial registration number ISRCTN60033461.

INTRODUCTION

Children are less severely affected by SARS-CoV-2 than adults, and this pattern has been seen across viral variants.¹ In the neonatal period (first 28

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Neonatal infection with wildtype SARS-CoV-2 is rare and good outcomes predominate; the impact of later viral variants on neonates has been unclear.

WHAT THIS STUDY ADDS

⇒ During the UK COVID-19 pandemic, neonatal infection with SARS-CoV-2 was rare compared with older children and adults across all viral variants; when symptomatic it was associated with respiratory problems, especially during the delta variant period when it was linked to a small number of neonatal deaths.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Rapidly established and ongoing national surveillance was essential to understand the neonatal impact of the evolving SARS-CoV-2 pandemic, highlighting the key role of established systems in future pandemics.
⇒ The long-term effects of early life exposure to SARS-CoV-2 are unknown, and ongoing data collection, linkage and developmental follow-up remain crucial.

days), neonates can be infected by SARS-CoV-2 or indirectly affected because of maternal infection, for example, through spontaneous or iatrogenic preterm birth. We have previously reported that neonates were more likely than older children to require respiratory support following SARS-CoV-2 infection when the wildtype variant was dominant,² but it is not clear if this pattern persisted in later periods. The alpha and delta variants of SARS-CoV-2 resulted in more severe maternal SARS-CoV-2 infection,³ but there are few studies describing the impact of SARS-CoV-2 viral variants in neonates.⁴

Using population-level active surveillance data linked to maternal, neonatal and paediatric intensive care and perinatal mortality data, we aimed to describe the epidemiology, clinical course and short-term outcomes of neonates with confirmed SARS-CoV-2 infection cared for in hospitals in the

UK over the first 2 years of the pandemic, stratified by the dominant SARS-CoV-2 variant in circulation at the time of infection.

METHODS

This was a national prospective cohort study using the British Paediatric Surveillance Unit (BPSU).⁵ From 1 April 2020, senior paediatricians (~4000) in all 155 hospital trusts and health boards in the UK with their associated 190 neonatal units (NNUs) received a weekly (until March 2021) then monthly electronic BPSU reporting card asking them to report any baby who had laboratory-confirmed SARS-CoV-2 infection in the first 28 days after birth and received inpatient care on a postnatal ward, NNU, paediatric inpatient ward or paediatric intensive care unit (PICU). Well neonates born in the UK remained with their mother on postnatal wards until mother and baby were fit for discharge; neonates with asymptomatic SARS-CoV-2 on postnatal wards and asymptomatic cases detected through screening were not reported. Monthly reporting cards sought confirmation that all eligible neonates in the previous month had been reported, and that any reports of no infected neonates were accurate (active negative surveillance). To maximise case ascertainment, we linked to national testing data from Public Health England and Health Protection Scotland between 1 March 2020 and 31 March 2021, as well as the Paediatric Intensive Care Audit Network,⁶ United Kingdom Obstetric Surveillance System (UKOSS) data⁷ and MBRRACE-UK national perinatal mortality surveillance data.⁸ Additional details can be found in the online supplemental methods. Intensive care was defined using British Association of Perinatal Medicine categories of care⁹ for neonatal admissions, or any admission to a PICU. Severe disease was defined as having received respiratory support. Very preterm birth was defined as birth at <32 gestational weeks.

Neonatal deaths were verified with the MBRRACE-UK national surveillance of perinatal deaths.¹⁰ Neonatal deaths were attributed to SARS-CoV-2 if the treating paediatrician reported that SARS-CoV-2 infection contributed to the baby's death; we also recorded if the referring clinician reported that maternal SARS-CoV-2 infection led to spontaneous or iatrogenic preterm birth.

UK SARS-CoV-2 testing policy among pregnant women and neonates evolved during the study. Initially, only symptomatic women and neonates were tested. Routine screening of all obstetric admissions was recommended by the Royal College of Obstetricians and Gynaecologists on 29 May 2020 and neonatal testing recommended for symptomatic neonates of mothers with a SARS-CoV-2 infection; testing of asymptomatic neonates varied. Confirmation of neonatal SARS-CoV-2 infection required at least two positive samples, including one at least 72 hours after birth.¹¹ UK policy was that well neonates of SARS-CoV-2-infected mothers should be cared for alongside their mother in the postnatal ward and not routinely tested.

This analysis presents characteristics and outcomes for neonates reported as having confirmed SARS-CoV-2 infection in the first 28 days after birth, between 1 March 2020 and 1 April 2022, and for whom complete data had been received by 30 July 2022. To provide a complete description of the first two pandemic years, this report includes neonates with SARS-CoV-2 infection between 1 March 2020 and 30 April 2020 previously reported.²

As individual-level SARS-CoV-2 variant data were not recorded in medical records, the outcomes were compared across four proxy groups according to the period in which the

original wildtype, alpha variant, delta variant or omicron variant was the dominant circulating strain in the UK.

The original wildtype period included neonates diagnosed from 1 March to 30 November 2020, the alpha variant period from 1 December 2020 to 15 May 2021, the delta variant period from 16 May 2021 to 14 December 2021 and the omicron variant period from 15 December 2021 to 1 April 2022. We chose cut-off dates for the delta and omicron periods using data on variant sequencing from Public Health England to identify the week when these variants first contributed >50% of SARS-CoV-2 infections nationally.¹² Since genomic data on the variant were less widely available at the start of the pandemic, Public Health England modelled proxy data and reported that the alpha variant reflected the substantial majority of infections across all areas of England during December 2020; therefore, 1 December 2020 was used as an estimated cut-off date.¹³

Parent, patient and public involvement

Parents, patients and the public were consulted during the design of the study and presentation of the findings through the MBRRACE-UK third-sector stakeholder group and the NIHR Policy Research Unit in the Maternal and Neonatal Care Public and Patient Involvement group.

Statistical analysis

Descriptive statistics are presented as frequencies, proportions and medians with IQRs, as appropriate.

RESULTS

Monthly BPSU card returns were received between 91.3% (3748/4070, April 2020) and 71.9% (3110/4298, February 2022) of UK paediatricians over the surveillance period. In total, 1192 potentially eligible neonates were reported to the BPSU system over the study period and 116 non-duplicate neonates were identified from other sources (figure 1). Linkage with data held in the NNRD was achieved for 99% (132/134) of neonates reported through the BPSU system who received NNU care. Three hundred and forty-four neonates were diagnosed with SARS-CoV-2 infection in the first 28 days after birth and received inpatient care, predominantly in the wildtype-dominant

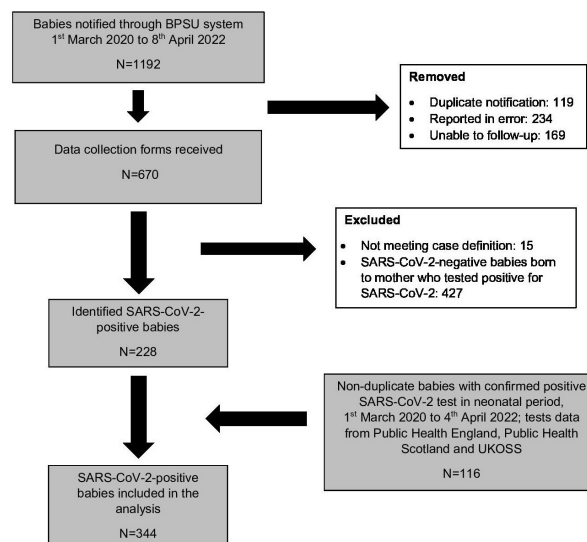


Figure 1 Flow chart of case selection for study period 1 March 2020 to 1 April 2022. BPSU, British Paediatric Surveillance Unit; UKOSS, United Kingdom Obstetric Surveillance System.

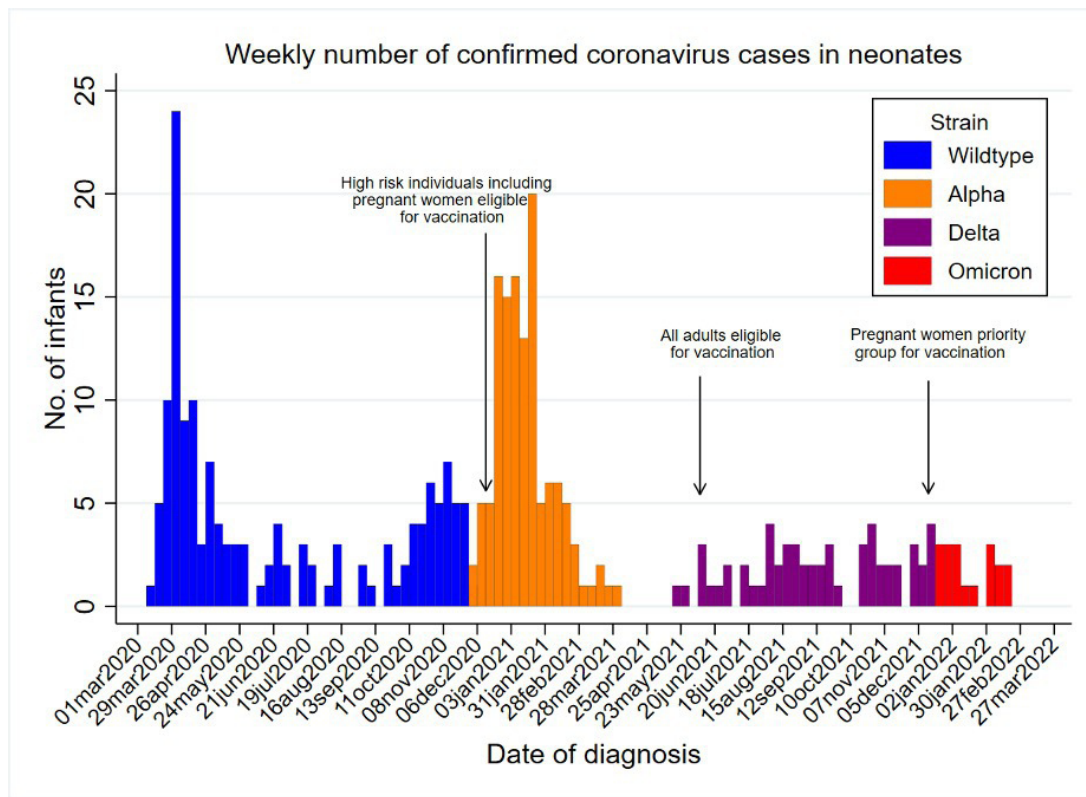


Figure 2 Weekly confirmed neonatal SARS-CoV-2 infections by dominant circulating variant in the UK.

and alpha-dominant periods, with numbers dropping in subsequent variant periods: 146 neonates were reported in the wildtype period, 123 in the alpha period, 57 in the delta and 18 in the omicron periods (figure 2). Three hundred and twenty cases were in England, 16 cases in Scotland, 6 in Wales or Northern Ireland; country data were missing for 2 cases.

Median age at diagnosis was 9 days (IQR 3–17 days); 44.5% (153/344) of the neonates were diagnosed in the first 7 days after birth; of these, 66.7% (102/153) were born to a mother with confirmed SARS-CoV-2 infection within 7 days before or after giving birth. The age distribution at diagnosis was similar across different dominant circulating variant periods (online supplemental figure 1). Respiratory signs were common along with poor feeding or vomiting and fever (online supplemental figure 2); 15% of neonates were asymptomatic.

Neonates in hospital with neonatal SARS-CoV-2 infection were more commonly preterm and male when compared with all live births in England and Wales and this was consistent across all variant epochs, although sex differences were less marked in the alpha period (table 1). The highest proportions of very preterm births were seen in the delta-predominant period. An over-representation of non-white ethnic groups among neonatal SARS-CoV-2 infections in the wildtype period was not seen with later variants (table 1).

Most neonates in hospital with neonatal SARS-CoV-2 infection did not require high-level care; however, 44.7% required some form of respiratory support and 21.8% received intensive care (table 2). Higher numbers and proportions of neonates in hospital with neonatal SARS-CoV-2 in the delta period required intensive care or invasive respiratory support, compared with other variant periods (figure 3). Infection following suspected nosocomial transmission, excluding vertical transmission, affected 7.8% of neonates overall. Outcomes following neonatal

SARS-CoV-2 infection were generally good; however, 11 deaths occurred in neonates who tested positive for SARS-CoV-2, 4 of which were attributed either directly or indirectly to neonatal SARS-CoV-2 infection (case fatality 4/344, 1.2% 95% CI 0.3% to 3.0%). Three of these four neonates had been born preterm due to maternal COVID-19. All four SARS-CoV-2-related neonatal deaths were in the delta period.

As expected in any neonatal population, degree of prematurity was strongly linked with receipt of respiratory support with all extremely preterm neonates infected with SARS-CoV-2 requiring ventilation; this highlights the challenges separating severe manifestations of SARS-CoV-2 infection from conditions related to preterm birth (online supplemental table 1).

DISCUSSION

Using population-level active surveillance data from March 2020 to April 2022 and spanning wildtype, alpha, delta and omicron variant-predominant periods during which there were approximately 1.4 million births recorded in the UK,^{14–16} we confirm that the need for inpatient care for neonates with SARS-CoV-2 infection was rare and outcomes were generally good. Neonatal SARS-CoV-2 infection led to severe disease in a minority of neonates, with death related to neonatal SARS-CoV-2 infection occurring in 1.2% of hospitalised neonates. During the delta variant-predominant period, higher numbers of neonates had severe disease associated with SARS-CoV-2 infection, defined as requiring respiratory support, compared with other variant epochs. We believe this is the first study to present descriptive data from a national cohort on neonatal deaths reported as related to SARS-CoV-2 infection, all of which occurred in the delta-predominant period in the UK.

Table 1 Background characteristics of neonates in hospital with SARS-CoV-2 infection by dominant circulating variant; distribution of background characteristics in all UK live births in 2021¹⁴

	Distribution in live births in England and Wales 2021 (%)	All variants N (%)*	Wildtype N (%)*	Alpha N (%)*	Delta N (%)*	Omicron N (%)*
Total cases		344	146	123	57	18
Gestation at birth						
<28 ⁺⁰	0.5	11 (3.3)	5 (3.6)	2 (1.6)	3 (5.6)	1 (5.6)
28 ⁺⁰ –31 ⁺⁶	0.8	41 (12.3)	8 (5.7)	12 (9.8)	20 (37.0)	1 (5.6)
32 ⁺⁰ –36 ⁺⁶	6.3	79 (23.7)	27 (19.3)	34 (27.9)	12 (22.2)	6 (33.3)
≥37	92.1	203 (60.8)	100 (71.4)	74 (60.7)	19 (35.2)	10 (55.6)
Missing	–	10	6	1	3	0
Sex						
Male	51.2	188 (55.0)	84 (57.9)	63 (51.2)	31 (55.4)	10 (55.6)
Female	48.8	154 (45.0)	61 (42.1)	60 (48.8)	25 (44.6)	8 (44.4)
Missing	–	2	1	0	1	0
Ethnicity						
White	70.5	230 (70.3)	89 (61.8)	80 (71.4)	46 (86.8)	15 (83.3)
Asian/Asian British	12.2	60 (18.3)	34 (23.6)	19 (17.0)	5 (9.4)	2 (11.1)
Black/African/Caribbean/Black British	4.8	19 (5.8)	11 (7.6)	6 (5.4)	1 (1.9)	1 (5.6)
Mixed/Other	9.1	18 (5.5)	10 (7.0)	7 (6.3)	1 (1.9)	0 (0)
Missing	–	17	2	11	4	0

*Percentage of those with complete data; duration of variant-predominant periods were not equal.

The pattern of more serious neonatal disease in the delta period described here may be explained by the higher number and proportion of neonates born very preterm with neonatal SARS-CoV-2 infection during this period. More severe maternal infection and higher rates of preterm birth have been described in the delta-predominant wave in the UK³ and internationally¹⁷; it is unclear whether this pattern of more severe maternal disease was related to changing characteristics of the viral variant or changes in behaviour and low vaccination rates among pregnant women in the UK during this period. Similarly, it is not possible to determine from these data presented whether the delta variant was more pathogenic in neonates, or whether adverse neonatal outcomes were a result of more severe maternal SARS-CoV-2

disease leading to more preterm births, a well-described risk factor for neonatal infection.¹⁸

There have been very few population-based studies of neonates infected with SARS-CoV-2 infection, and data describing neonatal SARS-CoV-2 infection by variant are even more sparse. Population-level data from Germany describing paediatric SARS-CoV-2 infection show higher rates of COVID-19-related hospitalisation and intensive care unit admission for children under 5 years in the delta-predominant period compared with alpha-predominant, wildtype-predominant and omicron-predominant periods,¹⁹ although data from the UK did not report a higher rate of intensive care admissions for children under 5 with delta compared with earlier viral variants.²⁰ Data covering

Table 2 Clinical care received and outcomes following neonatal SARS-CoV-2 infection during the dominant circulating variant periods

	All variants N (%)*	Wildtype N (%)*	Alpha N (%)*	Delta N (%)*	Omicron N (%)*
Total cases	344	146	123	57	18
Transmission					
Maternal SARS-CoV-2 infection at birth	133 (38.7)	45 (30.8)	54 (43.9)	25 (43.9)	9 (50.0)
Suspected nosocomial transmission	27 (7.8)	18 (12.3)	3 (2.4)	4 (7.0)	2 (11.1)
Highest level of care					
Intensive care	75 (21.8)	23 (15.8)	18 (14.6)	28 (49.1)	6 (33.3)
Non-intensive care	269 (78.2)	123 (84.2)	105 (85.4)	29 (50.9)	12 (66.7)
Required respiratory support					
Yes	153 (44.7)	55 (37.9)	46 (37.7)	42 (73.7)	10 (55.6)
No	189 (55.3)	90 (62.1)	76 (62.3)	15 (26.3)	8 (44.4)
Missing	2	1	1	0	0
Neonatal outcome					
Discharged home	322 (93.6)	137 (93.8)	119 (96.8)	50 (87.7)	16 (88.9)
Transferred to another site/still admitted	11 (3.2)	7 (4.8)	3 (2.4)	1 (1.8)	0 (0)
Died	11 (3.2)	2 (1.4)	1 (0.8)	6 (10.5)	2 (11.1)
Death related to SARS-CoV-2	4	0	0	4	0

*Percentage of those with complete data.

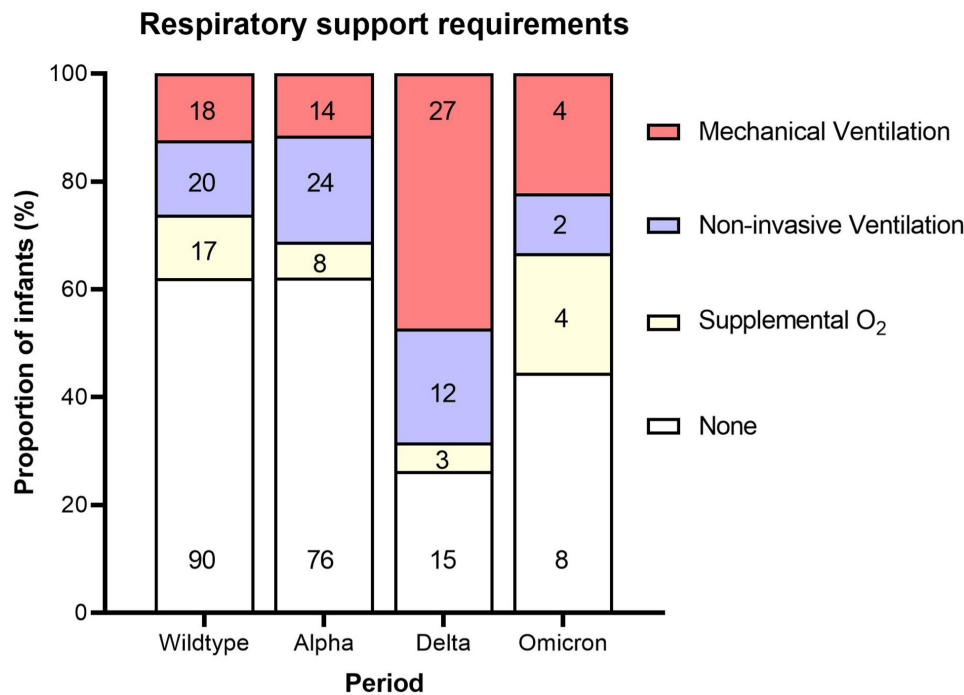


Figure 3 Maximum respiratory support requirements of hospitalised neonates with SARS-CoV-2 infection during the dominant circulating variant period (wildtype n=145, alpha n=122, delta n=57 and omicron n=18).

approximately 10% of the US population found similar rates of intensive care admissions of infants <6 months of age with the delta and omicron variants.²¹ A further study examining administrative data representing approximately 20% of US hospital admissions found that COVID-19 among newborns is rare but is associated with newborn critical care outcomes like invasive ventilation, and that risks for invasive compared with non-invasive ventilatory support were higher in delta compared with pre-delta periods,²² consistent with the UK data we present here. Single-centre case-series have also reported more severe SARS-CoV-2 infection in infants and neonates in delta-predominant compared with other variant-predominant periods,⁴ supporting a link between infection with the delta variant and more severe neonatal disease.

Although there have been multiple registries describing neonatal SARS-CoV-2 infection,^{23 24} there have been very few representative population-level studies and those that have published have been limited by low case numbers.²⁵ The population-level data we present here include and build on previously published neonatal surveillance data from the UK from the first weeks of the SARS-CoV-2 pandemic when the wildtype variant predominated.² These updated data describe the presentation and clinical course of neonatal SARS-CoV-2 infection in the largest number of neonates reported to date. Consistent with early data,² we confirm that while respiratory signs were widespread, symptomatic neonatal SARS-CoV-2 most commonly presented with poor feeding or other gastrointestinal signs. Fever and respiratory signs were also common but did not predominate as in other paediatric groups.²⁶ Data from Switzerland in one of the few other population-level surveillance studies found fever and respiratory signs most common at presentation in the 73 neonates reported,²⁵ possibly reflecting the non-specific nature of these neonatal signs. The large number of neonatal cases we report compared with other neonatal studies provide confidence in our key findings that while receipt of respiratory support is relatively common among neonates hospitalised with

neonatal SARS-CoV-2, this is generally seen in the context of preterm birth. Almost half of hospitalised neonates with SARS-CoV-2 infection received some form of respiratory support. We also report reassuring short-term outcomes following neonatal SARS-CoV-2 infection consistent with Swiss national data²⁵ and international registry data.^{27 28}

The high rate of presumed nosocomial transmission reported throughout the study (7.8%) is of concern. This likely reflects the challenges of limiting viral exposure in NNUs with few isolation facilities, in the context of a pandemic with high rates of staff and parent infection.

Strengths and limitations

A key strength of this national prospective cohort study was the use of an established active surveillance system with high reporting rates by UK paediatricians throughout the study period. The long-standing monthly BPSU reporting cards were augmented by additional weekly reporting and supplemented by national virology testing during the first year. Data were also linked to national obstetric surveillance data, paediatric intensive care national audit data, routinely recorded neonatal data and national perinatal mortality surveillance throughout the study period to ensure comprehensive case ascertainment and nationally representative disease severity and outcome data. Use of such established national reporting systems minimises selection bias. By limiting the study to neonates in hospital with SARS-CoV-2 infection, we focused on the more severe spectrum of disease, which is of most interest to health services and clinicians. The main limitation of this approach is that neonates with less severe SARS-CoV-2 in the community were not included and hence true population incidence and asymptomatic infection rates are not possible to quantify. Linked population-level data from Scotland which included community testing data found that two in three neonates with SARS-CoV-2 infection received hospital care,²⁹ suggesting that the true incidence of

neonatal infection in the whole UK including community testing was around 500–550 neonates—still rare compared with older children and adults. Other limitations of this study include the challenges of separating out the effects of SARS-CoV-2 infection *per se* from other common causes of neonatal illness, primarily preterm birth which commonly requires respiratory support, and the lack of an agreed severity definition for neonatal infection. We did not have access to viral variant sequencing data for individual neonates and hence we used proxy time periods to ascribe variants. In addition, national guidance for neonatal testing changed over the study period, particularly in the early stages of the pandemic. This may have led to underestimation of the actual numbers of SARS-CoV-2 infection during the wildtype-dominant period. The lower number of BPSU reporting card returns in the omicron-dominant period may reflect reporting fatigue by this point in the pandemic, and may thus also underestimate the number of mildly affected neonates admitted during this period.

CONCLUSIONS

Inpatient care for neonates infected with SARS-CoV-2 was uncommon throughout the first 2 years of the pandemic and short-term outcomes were generally good. Severe disease was more common, although still rare, during the delta variant period; this may have been influenced by more severe maternal disease resulting in more very preterm neonates. Rapidly established and ongoing national surveillance was essential to understand the neonatal impact of the evolving SARS-CoV-2 pandemic, highlighting the key role of established systems such as the BPSU, UKOSS and MBRRACE-UK perinatal mortality surveillance. The long-term effects of early life exposure to SARS-CoV-2 are unknown, and ongoing data collection, linkage and developmental follow-up remain crucial.

Author affiliations

¹School of Public Health, Faculty of Medicine, Imperial College of Science Technology and Medicine, London, UK

²Academic Child Health, School of Medicine, University of Nottingham, Nottingham, UK

³Nuffield Department of Population Health, University of Oxford, Oxford, UK

⁴Neonatology, University of Glasgow, Glasgow, UK

⁵National Perinatal Epidemiology Unit, Oxford University, Oxford, UK

⁶UK Health Security Agency, London, UK

⁷Health Sciences, University of Leicester, Leicester, UK

⁸Neonatology, University Hospital of Wales, Cardiff, UK

X Chris Gale @DrCGale, Don Sharkey @DrDonSharkey, Helen Mactier @HMactier, Alessandra Morelli @AleMor_90, Marian Knight @Marianfknight and Shamez N Ladhani @shamezladhani

Acknowledgements We acknowledge the assistance of Jacob Avis, Richard Lynn and Farhana Ahmed at the BPSU, the BPSU reporting clinicians, the NIHR Clinical Research Networks and other people without whose support this research would not have been possible in such a timely manner.

Collaborators Neonatal complications of COVID-19 Collaborative Group Good Hope Hospital: Dr Babi Rani Pal; Aberdeen Maternity Hospital: Dr Lambrini Psouri; Aberdeen Royal Infirmary: Dr Saulius Satas, Dr Catriona Middleton; Addenbrooke's Hospital: Dr Sajeev Job; Adelaide House: Dr Melanie Douglas; Airedale General Hospital: Emma Dooks, Dr Philippa Rawling; Alder Hey Children's Hospital: Dr Andrew Riordan, Dr Narayani Vayyeti, Dr Clare Pain, Dr David Porter, Dr Stephen McWilliam, Dr Charlotte Durand; Alexandra Hospital: Dr Tom Charles Dawson; Altnagelvin Area Hospital: Dr Damian Armstrong, Dr Mary Ledwidge; Antrim Area Hospital: Dr Lynne McFetridge; Arrowe Park Hospital: Dr Anand Kamlanathan, Dr Sarah Thompson, Dr David Lacy; Barking Hospital: Ms Helen Smith; Barnet Hospital: Dr Shanthi Shanmugalingam, Dr Esther Freeman; Basildon University Hospital: Dr Donna Southam, Dr Sanjay Rawal; Bedford Hospital: Dr Jennifer Valentine; Birmingham Children's Hospital: Dr Divya Gurudutt, Dr Harsha Gowda, Dr Sarah Denniston, Dr Victoria Fradd, Dr Vidya Garikapati, Dr Amy Walker, Dr Pinki Surana; Birmingham Women's Hospital: Dr Manobi Borooah, Dr Gergely Toldi, Dr Matthew Nash; Bradford Royal Infirmary: Dr Liz Ingram, Dr Sam Wallis, Dr Sam Oddie, Dr

Chris Day, Dr Rebecca Newbegin, Dr Firth; Bradford Teaching Hospitals: Dr Ellen Mosley, Dr Chakrapani Vasudevan; Brightmet Health Centre: Dr Gabrielle Lipshen; Bristol Royal Hospital for Children: Dr Stefania Vergnano, Dr Jeyesh Patel, Dr Marion Ruth Roderick, Dr Frances Hutchings, Dr Hannah Langford-Wood, Dr Malini Ketty, Dr Hester Taekema; Bronglais General Hospital: Dr Alzbeta Kolenova; Broomfield Hospital: Dr Dean Richard Lethaby, Dr Rachel Thomas; Burnley General Hospital: Dr Amitava Sur; Calderdale Royal Hospital: Dr Matthew Taylor, Dr David Bromley, David Bromley; Cavan General Hospital: Dr Alan Finan; Central Middlesex Hospital: Dr Ashiya Ali; Chelsea Chesterfield Royal Hospital: Dr Penelope Young; Children's University Hospital—Dublin: Dr Michael Riordan; City Hospital Colchester General Hospital: Dr Joakim Anderson; Conquest Hospital: Dr Manivannan Kandasamy; Countess of Chester Hospital: Dr Ravi Jayaram, Dr Stephen Paul Brearey, Dr Helen Dallow, Dr Joanne Marie Dangerfield, Dr Alison Timmis, Dr Victoria Guratsky, Dr S Murthy Saladi; Craigavon Area Hospital: Dr Veena Vasi, Dr Lesley-Ann Funston, Dr David George Grier, Dr Philip Quinn, Dr David Graham; Croydon University Hospital: Dr Grant Marais, Dr John Chang, Dr Arun Kumar; Darent Valley Hospital: Dr Abdul Hasib; Darlington Memorial Hospital: Dr John Furness; Derbyshire Children's Hospital: Dr Jennifer Evennett, Dr Richard Bowker, Dr Velur Palaniswamy Balasubramaniam, Dr Claire Weights; Dr Gisela Robinson, Dr Anneli Wyn-Davies; Derriford Hospital: Dr Oladipo Aworinde, Dr Georgina Selby; Diana Princess of Wales Hospital: Dr Bemigho Etuwee; Dorset County Hospital: Dr Dominic Sheehy; Dumfries Ealing Hospital: Dr Ewa Lichtarowicz-Krynska; East Surrey Hospital: Dr Bindu Nair Radha, Dr Lola Adenuga; Epsom General Hospital: Dr Saifa Rashid; Evelina Children's Hospital: Dr Emma Parish, Dr Claire Lemer, Dr Ella Aidoo, Dr Chloe Macaulay; Forth Valley Royal Hospital: Dr Kristyna Bohmova, Dr Dominic O'Reilly; Dr Sabine Grosser; Frimley Park Hospital: Dr Sanjay Jaiswal; Furness General Hospital: Dr Ashutosh Kale; Glan Clwyd Hospital: Dr Sandra Bakker, Dr Oliver Rackham, Dr Amanda McKenna, Dr Lee Wisby; Gloucester Royal Hospital: Dr Miles Wagstaff, Dr Miles Wagstaff; Good Hope Hospital: Daniel Dogar; Grange University Hospital: Dr Gillian Smith; Great North Children's Hospital: Dr Andrew Ian Villis, Dr Jason Gane; Great Ormond Street Hospital: Dr Alasdair Bamford, Dr Mark Peters, Dr Doris Abomeli, Dr Wesley Hayes, Dr Cho Ng; Great Western Hospital: Dr Sarah Bates, Dr Claire Broomfield; Hereford County Hospital: Dr Simon Meyrick, Dr Cathryn Seagrave; Hillingdon Hospital: Dr Tristan Bate, Dr Elizabeth Lek; Dr Alex Chan, Dr Jide Menakaya, Dr Devangi Thakkar, Dr Jaikumar Ganapathi; Hinchingsbrooke Hospital: Dr Hilary Dixon, Dr Philip Gauci; Homerton Hospital: Dr Marianna Varsami, Dr Julia Thomson, Dr Ravi Prakash, Dr Claire Howarth, Dr Sujith Pereira; Huddersfield Royal Infirmary: Dr Karin Schwarz, Dr Salamiah Burgess; Hull Royal Infirmary: Dr Hilary Klonin, Dr Hani Khdir, Dr Aparna Manou, Dr Verghese Mathew; Imperial College School of Medicine: Dr Simon Nadel, Dr Aubrey Cunningham; Ipswich Hospital: Dr Matthew James; James Cook University Hospital: Dr Shalabh Garg; James Paget University Hospital: Dr Priyadarshan Ambadkar, Dr John Chapman; Jersey General Hospital: Dr David Lawrenson; Jessop Wing Hospital: Dr Elizabeth Pilling, Dr Porus Bustani; John Radcliffe Hospital: Dr Eleri Adams, Dr Dominic Kelly, Dr Charles Roehr; Joyce Green Hospital: Dr Selwyn D'Costa; Kettering Children's Hospital: Dr Pratibha Rao, Dr Keshavamurthy Kallambella Sushilendra; King George Hospital: Dr Morgan Keane; Kings College Hospital: Dr Theodoros Dassios, Dr Sreena Das, Dr Lucy Pickard, Dr Zainab Kassim; King's Mill Hospital: Dr Rebecca Sands, Dr Simon Rhodes; Kingston Hospital: Dr Matthew Lee, Dr Edit Molnar, Dr Unice Tawiah Naakai Nartey, Dr Jon Filkin, Dr Nader Abd El Twab Elgharably; Leeds General Infirmary: Dr Sian Cooper, Dr Ramesh Kumar, Dr Kerry Jeavons, Dr Elizabeth Evans, Dr Christopher Forster, Dr Amelia Shaw, Dr Elizabeth McKechnie, Dr Anne-Marie Childs, Dr Elizabeth Day, Dr Rachel Toone, Dr Joanna Wright, Dr Sharon English, Dr Nicola Mullins; Leicester General Hospital: Dr Gareth Lewis; Leicester Royal Infirmary: Dr Premkumar Sundaram; Dr Habab Mekki, Dr Andrew Currie, Dr Jonathan Cusack, Dr Vikas Saxena, Dr Joe Fawke, Dr Jane Gill, Dr Kamini Yadav, Dr Mohammad Zoha, Dr Joanna Behrsin, Dr Vinayak Rai, Dr Robin Miralles, Marie Hubbard, Dr Nicola Owen, Dr Usha Niranjani; Liverpool Women's Hospital: Dr Richard Hutchinson; Luton Maidstone Hospital: Dr Siaw Chieng, Dr Laura J Louise Halpin; Manor Hospital: Dr Rayasandra Gireesh, Dr Raghu Krishnamurthy, Dr Ashok Karupaiah, Dr Pooja Shivananda Siddhi; Medway Maritime Hospital: Dr Ghada Ramadan, Dr Santosh Pattnayak; Milton Keynes General Hospital: Dr Zuzanna Gawlowski, Dr D Gonapoladeniya, Dr Indrani Misra, Dr Mya Aye; Musgrove Park Hospital: Dr Alexandra Powell, Dr Nicola Johnson; Nevill Hall Hospital: Dr Ravi Manikonda, Dr Yvette Cloete, Dr Nakul Gupta, Dr Marcus Pierrepont; New Cross Hospital: Dr Robert Negrine, Dr Melanie Sutcliffe, Dr Buvenekaba Kumararatne, Dr Julie Brent, Dr Chrisantha Halahakoon, Dr Richard Heaver, Dr Chrisantha Halahakoo, Dr Richard Heaver, Dr Surinder Judge; Newham Hospital: Dr Nicolene Plaatjies, Dr Susan Liebeschuetz, Dr Esmira Jafarova, Dr Nicolene Plaatjies, Dr Imdad Ali, Dr Ivone Lancoma-Malcom, Dr Rakesh Ravi; Ninewells Hospital and Medical School: Dr Jennifer Scotland, Noah's Ark Children's Hospital for Wales: Dr Ruth Elizabeth Hanks; Norfolk Dr Catherine Thomas; Dr Priyadarisini Muthukumar; Dr Mark Dyke, Dr Florence Walston; North Devon District Hospital: Dr Michael Selter; North Hampshire Hospital: Dr Lucinda Winckworth; North Manchester General Hospital: Dr Hatem Sager; North Middlesex Hospital: Dr Cheentan Singh, Dr Piyusha Kapila, Dr Cassandra Gyamtso; Dr Linda Walker, Dr Fionnghuala Fuller, Dr Lesley Alford, Dr Rosalind Mensah, Dr Janani Pallawela, Dr Olu Wilkey, Dr Bijan Shahrad, Dr Aparna Nambisan, Dr Dhruv Rastogi; North

Tyneside General Hospital: Dr Ivonne Haar, Dr Sangeeta Tiwary; Northampton General Hospital: Dr Cathryn Chadwick, Dr Sathyaseelan Jayaseelan, Dr Nick Barnes, Dr Fiona Thompson, Dr Janet Collinson, Richard Breene; Northumberland Child Health Centre: Dr Sangeeta Tiwary; Northwick Park Hospital: Dr Richard Nicholl, Ms Anam Fayadh, Dr Krzysztof Zieba, Dr Edit Fukari-Irvine; Nottingham City Hospital: Dr Dushyant Batra, Dr Stylianie Tsilika, Dr Anushma Sharma; Our Lady's Hospital for Sick Children: Dr Fiona Ringholz, Dr Sinead Harty; Peterborough City Hospital: Dr Katharine McDevitt, Dr Mona Aslam, Dr Ramya Ramaswamy, Coralie Huson, Dr David John Hopkins, Dr Tim Jones; Dr Katharine McDevitt; Pinderfields General Hospital: Dr Natasha De Vere, Dr Kallinath Shyamanur, David Gibson; Poole Hospital: Dr Mark Tighe, Dr Peter McEwan; Portsmouth Community: Dr Kathy Padoa; Princess Alexandra Hospital: Dr Chinnappa Reddy; Princess Anne Hospital: Dr Victoria Puddy, Dr Rupjani Banerjee, Dr Kelly Brown, Dr Kevin Goss, Dr Helen Fielder; Princess Elizabeth Hospital: Dr Clare Betteridge; Princess of Wales Hospital: Dr Torsten Hildebrandt; Princess Royal Maternity Hospital: Dr Tomasz Dygas; Princess Royal University Hospital: Dr Stella Nzekwue; Queen Alexandra Hospital: Dr Huw Jones, Dr Tim Scorer, Dr Amanda Freeman, Dr Karen Deem, Dr Borbone, Dr Roy Sievers, Dr Jennie Pridgeon; Queen Charlotte's Dr Emma Porter, Queen Elizabeth Hospital—Birmingham: Dr Manobi Borooah; Queen Elizabeth Hospital—East Anglia: Dr Abigail Reeve; Queen Elizabeth Hospital—Lewisham and Greenwich: Dr Julie Lord, Dr Olutoyin Banjoko, Emma Gardiner; Queen Elizabeth University Hospital, Glasgow: Dr Ruth Bland; Queen Mary's Hospital for Children: Dr Daniel Langer, Dr Ralf Hartung, Dr Arunava Kundu; Queen's Hospital—Romford: Dr Ambalika Das, Dr Helen Smith, Dr Donna Nicholls, Dr Ranjith Joseph; Queen's Medical Centre—Nottingham: Dr Leona Lee, Dr Anjum Deorukkar, Dr Jodi Wood; Rosie Maternity Hospital: Dr Stergios Papakostas; Rotheram General Hospital: Dr Soma Sengupta; Royal Albert Edward Infirmary: Dr Hough; Royal Alexandra Hospital: Dr Hilary Conetta; Royal Belfast Hospital: Dr Rachel Beckett, Dr Elizabeth Dalzell; Royal Belfast Hospital: Dr Paul Moriarty; Royal Berkshire Royal Berkshire Hospital: Dr Syed Akmal Hussain; Royal Blackburn Hospital: Dr Andrew Cox; Royal Bolton Hospital: Dr Fiona Watson, Dr Shanmuga Sundaram, Dr Archana Mishra, Dr Jo Morgan, Dr Ian Freeman; Royal Brompton Hospital: Dr Piers Daubeney; Royal Cornwall Hospital: Dr Thomas Fontaine; Royal Devon Royal Free Hospital: Dr James Rosenberg, Dr Marice Theron, Dr Eleanor M Bond; Royal Glamorgan Hospital: Dr Takin Omolokun; Royal Gwent Hospital: Dr Tanoj Gopalan Kollamparambil, Dr Sarmistha Maity, Dr Murali Natti, Dr Sarika Goel; Royal Hampshire County Hospital: Dr Lucinda Winckworth; Royal Hospital for Children: Dr Neil Patel, Dr Dominic Cochran, Dr Helen McDevitt, Dr Andrew Brunton, Dr Jonathan Coutts, Dr Louise Leven, Dr Jennifer Mitchell, Dr Owen Forbes, Dr Rosie Hague, Dr Morag Nina Joyce Wilson; Royal Hospital for Sick Children, Edinburgh: Dr Mairi Stark; Royal Infirmary of Edinburgh: Dr Ewen Johnston; Royal Jubilee Maternity Hospital: Dr Stan Craig; Royal Lancaster Infirmary: Dr Clare Peckham, Dr Joanne Fedee; Royal Oldham Hospital: Dr Fazal Rehman, Dr Sarah McCullough, Dr Anita Vayalakkad, Zainab Sarwar, Dr Lydia Bowden; Royal Preston Hospital: Dr Raju Narasimhan, Dr Hyacinth Akaolisa Egebeama, Katrina Rigby, Dr Aubrey Makhallira; Royal Stoke University Hospital: Dr Laura Roe, Dr Olayinka Kowobari, Dr Lee Abbott, Dr Julia Uffindell; Royal Surrey County Hospital: Dr Ozan Hanci, Dr Dilara Greene, Dr Soad Habeeb, Dr Sameh El-Sayed Zaki Abdulsamea, Dr Catherine Garland, Dr Nikolay Drenchev, Royal United Hospital: Dr Tobias Hunt, Dr Steve Jones, Dr Dan Jolley, Royal Victoria Infirmary: Dr Robert Tinnion, Dr Julie Groombridge; Dr Stefan Zalewski, Dr Jenna Gillone, Dr R Hearn, Dr Julie Groombridge; Russells Hall Hospital: Dr Evans Chingwenje, Dr Samantha Wilegoda; Salisbury District Hospital: Dr Philippa Ridley; Scunthorpe General Hospital: Dr Rasheed Oba; Sheffield Children's Hospital: Dr Alison Smith, Dr Lucy Hinds, Dr Rachel Riddell, Dr Mairi Gillespie, Dr Soma Sengupta; Singleton Hospital: Dr Jamie Evans, Dr Geraint Morris; South West Acute Hospital: Dr Gerry Mackin; Southampton General Hospital: Dr Mark Johnson, Dr Anne-Marie Goss, Dr Helen Rutkowska, Dr Jason Michael Barling; Southend General Hospital: Dr Raj Gupta, Dr Jennifer Foster; Southend University Hospital: Jennifer Foster, Dr Vineet Gupta, Dr Ravi Chetan, Dr Veena Rao, Dr Ravi Chetan; Southern General Hospital, Glasgow: Dr Joyce O'Shea; Southmead General Hospital: Dr Claire Michelle Rose, Dr Richard Wach, Dr Faith Emery; Dr Madhavi Parvathareddy, Dr Paul Mannix; St George's University Hospital: Dr Sijo Francis, Dr Danielle Hake, Dr Sophie Robinson, Dr Daniel Langer; St James University Hospital, Leeds: Dr Kathryn Johnson, Dr Liz McKechnie; St Mary's Hospital—London: Dr Jayanta Banerjee, Dr Caroline Louise Scott-Lang, Dr Jenny Ziprin, Dr Geraldine Ng; St Mary's Hospital—Manchester: Dr Sajit Nedungadi; Dr Ruth Gottstein; Dr Kalwa Munthali; St Peter's Hospital: Dr Alison Groves, Dr Mayu Otsuka, Dr Vennila Ponnusamy, St Peter's Hospital: Dr Jennifer McGrath, Dr Maria Samantha Edwards, Dr Clare Hill, Dr Peter Martin; Dr Luciana Elisabeta Ene; St Richard's Hospital: Dr Ann-Marie Buckley; St Thomas' Hospital: Dr Timothy Watts; Stepping Hill Hospital, Stockport: Dr Carrie Heal; Stoke Mandeville Hospital: Dr Caroline Lowdon, Dr Ralph Robertson, Dr Gopa Sarkar; Sunderland Royal Hospital: Dr Chike Onwuneme; Tameside General Hospital: Dr Helen Purves, Dr David Levy, Dr Trupti Dhorajiwala, Dr Robert Block; Tayside Children's Hospital: Dr Birgit Wefers; The James Cook University Hospital: Dr Ginny Birrell, Dr Thomas Skeath, Dr Maeve O'Sullivan, Dr Helen Chitty; The Princess Royal Hospital: Dr Wendy Tyler; The Princess Royal Hospital: Dr Sanjeev Deshpande; The Royal London Hospital: Dr Hemmay Raychaudhuri, Dr Catherine Warrick, Dr Nicolene Plaatjies, Dr Caroline Francia, Dr Caroline May, Dr Ajay Sinha, Dr Anup

Kage, Dr Anne Opute, Dr Rainer Ebel, Dr Gemma Sedgwick; The Ulster Hospital: Dr Julia Courtney, Dr Carl Harris, Dr Damhnait Cassidy, Dr Michael McGowan; The York Hospital: Dr Luke Kevin McLaughlin, Dr Rebecca Proudfoot, Dr Dominic Smith, Dr Liz Baker; Torbay Hospital: Dr Richard Tozer, Dr Jonathan Graham, Dr Esther J Morris, Dr Alison Janzen; Tunbridge Wells Hospital: Louise Swaminathan; University College Hospital London: Dr Sarah Eisen, Dr Christina Kortsalioudaki, Dr Andrea Leigh, Dr Leigh Dyet; University Hospital Coventry: Dr Karen McLachlan; University Hospital Crosshouse: Dr Nuno Cordeiro, Dr Althaf Ansary; University Hospital Lewisham: Dr Ozioma Obi, Dr Neha Sharma, Dr Kumudini Gomez, Dr Emma Gardiner; University Hospital of North Tees: Alex Ramshaw; University Hospital of Wales: Dr Nitin Goel, Dr Amarkumar Asokkumar, Dr Marcia Scheller, Dr Elisa Smit, Dr Cora Doherty; University Hospital Wishaw: Dr Augusta Anenih, Dr Hatice Isikli, Dr Padma Rajagopal, Dr Caroline Delahunty, Dr Adrienne Sullivan; University Hospitals Dorset NHS Foundation Trust: Dr Amy Roff; University Hospitals of Leicester NHS Trust: Dr Deepa Panjwani; Victoria Hospital—Blackpool: Dr Mohammed Idris Ahmed, Dr Christopher John Rawlins, Professor Morris Gordon; Warrington Hospital: Dr Delyth Webb, Dr Colin Wong, Dr Rachael Sutton, Dr Elinor Thomason, Dr Delyth Webb; Warwick Hospital: Dr Sumedha Chamalie Bird, Dr Kate Blake; Watford General Hospital: Dr CS Narayanan, Dr Nirmala Costa-Fernandes, Dr Nazakat Merchant, Dr Renton L'Heureux, Dr Avinash Jinadatha, Dr Meera Mallya; West Cumberland Hospital: Dr Clive Graham, Dr Hannah Holt-Davis; West Middlesex University Hospital: Dr Tsitsi Dadirai Chawatama, Dr Eleanor Hulse; West Suffolk Hospital: Dr Ian Evans; Wexham Park Hospital: Dr Kanaga Raj Sinnathuray, Dr Sujata Narayan Edate; Whipps Cross Hospital: Dr Nicolene Plaatjies, Dr John Ho; Whittington Hospital: Dr Juliet Penrice, Dr Andrew Robins, Dr Alka Desai, Dr Gopa Sen, Dr Caroline Fertleman, Dr Nischal Rao; William Harvey Hospital: Dr Amit Gupta, Dr Vimal Vasu; Worcester Royal Hospital: Dr Subramania Kalambettu, Dr Jessie Brain, Dr Viviana Anne Sophie Weckemann; Worthing Hospital: Dr Gillian Hobden, Dr Stuart Nicholls, Dr Jonathan Rabbs; Wycombe General Hospital: Dr Boon Tang; Wythenshawe Hospital: Dr Asim Ahmed, Dr Ahmed Elazabi, Dr Abhijeet Godhangaonkar; Ysbyty Gwynedd District General Hospital, Bangor: Dr Shakir Saeed; British Paediatric Surveillance Unit, Royal College of Paediatrics and Child Health: Richard Lynn, Jacob Avis, Farhana Ahmed. Public, parent and patient involvement: Charlotte Bevan and Rachel Plachcinski, PPPI Leads Policy Research Unit in Maternal and Neonatal Health and Care.

Contributors CG wrote the first draft of the article with help from DS, KEF, MAQ, CG, JJK, AM and AP carried out the analyses. All authors edited and approved the final version of the article. CG, MK, SK, ESD, DS, CD, HM and JJK contributed to the development and conduct of the study. CG as guarantor accepts full responsibility for the conduct of the study, had access to the data and controlled the decision to publish. CG, MAQ and JJK have accessed and verified the data underlying the study.

Funding The BPSU COVID-19 study is funded by the National Institute for Health Research (NIHR) Policy Research Programme, conducted through the NIHR Policy Research Unit in Maternal and Neonatal Health and Care, PR-PRU-1217-21202. The UKOSS study was funded by the National Institute for Health Research HS&DR Programme (project number 11/46/12). MK is an NIHR Senior Investigator. The Maternal, Newborn and Infant Clinical Outcome Review Programme, delivered by MBRRACE-UK, is commissioned by the Healthcare Quality Improvement Partnership (HQIP) as part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP). The Maternal, Newborn and Infant Clinical Outcome Review Programme is funded by NHS England, NHS Wales, the Health and Social Care division of the Scottish government, The Northern Ireland Department of Health and the States of Jersey, Guernsey and the Isle of Man.

Disclaimer The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health and Social Care.

Competing interests MK, MAQ, CG and JJK received grants from the UK NIHR Policy Research Programme in relation to the submitted work. KEF, AM, MH, AP, SNL, ESD, DS, CD and HM declare no competing interests.

Patient consent for publication Not applicable.

Ethics approval The study was approved by the North East—Newcastle & North Tyneside 2 Research Ethics Committee (IRAS ID 282127; REC 20/NE/0107). Data were collected in England and Wales without parental consent following Section 251 advice from the Confidentiality Advisory Group of the Health Research Authority (20/CAG/0058) and under the COVID-19 notice issued by the Secretary of State for Health and Social Care under Regulation 3(4) of the Health Service Control of Patient Information Regulations 2002. Data were collected in Scotland without parental consent following COVID-19 rapid review and advice from the Public Benefit and Privacy Panel for Health and Social Care (PBPP) (1920-0288), and with maternal consent following advice from the Privacy Commissioner in Northern Ireland. All NNUs agreed to the inclusion of their NNRD data in the study. Data were collected in England and Wales without parental consent following Section 251 advice from the Confidentiality Advisory Group of the Health Research Authority (20/CAG/0058) and under the COVID-19 notice issued by the Secretary of State for Health and Social Care under Regulation 3(4) of the Health Service Control of Patient Information Regulations 2002. Data were collected in Scotland without parental

consent following COVID-19 rapid review and advice from the Public Benefit and Privacy Panel for Health and Social Care (PBPP) (1920-0288), and with maternal consent following advice from the Privacy Commissioner in Northern Ireland. All NNUs agreed to the inclusion of their NNRD data in the study.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. The datasets generated during and analysed during the current study are available from the corresponding author on reasonable request.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution 4.0 Unported (CC BY 4.0) license, which permits others to copy, redistribute, remix, transform and build upon this work for any purpose, provided the original work is properly cited, a link to the licence is given, and indication of whether changes were made. See: <https://creativecommons.org/licenses/by/4.0/>.

ORCID iDs

Chris Gale <http://orcid.org/0000-0003-0707-876X>

Don Sharkey <http://orcid.org/0000-0002-4989-8697>

Helen Mactier <http://orcid.org/0000-0001-6154-5758>

Marian Knight <http://orcid.org/0000-0002-1984-4575>

Shamez N Ladhani <http://orcid.org/0000-0002-0856-2476>

Elizabeth S Draper <http://orcid.org/0000-0001-9340-8176>

REFERENCES

- Kartsonaki C, Baillie JK, Barrio NG, *et al*. Characteristics and outcomes of an international cohort of 600 000 hospitalized patients with COVID-19. *Int J Epidemiol* 2023;52:355–76.
- Gale C, Quigley MA, Placzek A, *et al*. Characteristics and outcomes of neonatal SARS-CoV-2 infection in the UK: a prospective national cohort study using active surveillance. *Lancet Child Adolesc Health* 2021;5:113–21.
- Vousden N, Ramakrishnan R, Bunch K, *et al*. Impact of SARS-CoV-2 variant on the severity of maternal infection and perinatal outcomes: data from the UK obstetric surveillance system national cohort. *Obstetrics and Gynecology* [Preprint] 2021.
- Borgi A, Louati A, Miraoui A, *et al*. Critically ill infants with SARS-CoV-2 Delta variant infection. *Pediatr Neonatal* 2023;64:335–40.
- Verity C, Preece M. Surveillance for rare disorders by the BPSU. The British Paediatric surveillance unit. *Arch Dis Child* 2002;87:269–71.
- PICANet. Paediatric intensive care audit network annual report 2019. Summary report January 2016 – December 2018; 2019.
- Knight M, Bunch K, Vousden N, *et al*. Characteristics and outcomes of pregnant women admitted to hospital with confirmed SARS-CoV-2 infection in UK: national population based cohort study. *BMJ* 2020;369:m2107.
- Draper ES, Gallimore ID, Smith LK, *et al*. *MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2020*. Leicester: University of Leicester, 2022.
- BAPM. *Categories of Care (2011) A BAPM Framework for Practice*. London: British Association of Perinatal Medicine, 2011.
- Draper ES, Gallimore ID, Kurinczuk JJ, *et al*. MBRRACE-UK perinatal mortality surveillance report, UK perinatal deaths for births from January to December 2017: summary report. Leicester; 2018.
- BAPM. *Covid19 Pandemic Frequently Asked Questions within Neonatal Services*. British Association of Perinatal Medicine (BAPM), 2022.
- Public Health England. *SARS-CoV-2 variants of concern and variants under investigation in England: technical Briefing 13*. Public Health England, 2021.
- Public Health England. *Investigation of novel SARS-CoV-2 variant: variant of concern 202012/01: technical Briefing 2*. Public Health England, 2020.
- Office for National Statistics (ONS). *Birth characteristics in England and Wales: 2021*. Office for National Statistics (ONS), 2023.
- National Records of Scotland. *Births in Scotland by month of registration and NHS Board area, 1990 to 2023*. National Records of Scotland website, 2023.
- NISARA. *The number of live births to Northern Ireland residents, registered each month and occurring each month, 2006 to 2023*. Northern Ireland Statistics and Research Agency (NISRA) website, 2023.
- Favre G, Maisonneuve E, Pomar L, *et al*. Maternal and perinatal outcomes following pre-Delta, Delta, and Omicron SARS-CoV-2 variants infection among Unvaccinated pregnant women in France and Switzerland: a prospective cohort study using the COVI-PREG registry. *Lancet Reg Health Eur* 2023;26:100569.
- Allotey J, Chatterjee S, Kew T, *et al*. SARS-CoV-2 positivity in offspring and timing of mother-to-child transmission: living systematic review and meta-analysis. *BMJ* 2022;376:e067696.
- Jank M, Oechsle A-L, Armann J, *et al*. Comparing SARS-CoV-2 variants among children and adolescents in Germany: relative risk of COVID-19-related hospitalization, ICU admission and mortality. *Infection* 2023;51:1357–67.
- Ward JL, Harwood R, Kenny S, *et al*. Pediatric hospitalizations and ICU admissions due to COVID-19 and pediatric inflammatory multisystem syndrome temporally associated with SARS-CoV-2 in England. *JAMA Pediatr* 2023;177:947–55.
- Hamid S, Woodworth K, Pham H, *et al*. COVID-19-associated hospitalizations among U.S. infants aged <6 months — COVID-NET, 13 States, June 2021–August 2022. *MMWR Morb Mortal Wkly Rep* 2022;71:1442–8.
- Wallace B, Chang D, O'Malley Olsen E, *et al*. Critical care among newborns with and without a COVID-19 diagnosis. *J Perinatol* 2023;43:766–74.
- Hudak ML, Flannery DD, Barnette K, *et al*. Maternal and newborn hospital outcomes of perinatal SARS-CoV-2 infection: a national registry. *Pediatrics* 2023;151:e2022059595.
- Mullins E, Perry A, Banerjee J, *et al*. Pregnancy and neonatal outcomes of COVID-19: the PAN-COVID study. *Eur J Obstet Gynecol Reprod Biol* 2022;276:161–7.
- Zimmermann P, Uka A, Buettcher M, *et al*. Neonates with SARS-CoV-2 infection: spectrum of disease from a prospective nationwide observational cohort study. *Swiss Med Wkly* 2022;152:w30185.
- Swann OV, Holden KA, Turtle L, *et al*. Clinical characteristics of children and young people admitted to hospital with COVID-19 in United Kingdom: prospective multicentre observational cohort study. *BMJ* 2020;370:m3249.
- Mullins E, Hudak ML, Banerjee J, *et al*. Pregnancy and neonatal outcomes of COVID-19: coreporting of common outcomes from PAN-COVID and AAP-SONPM registries. *Ultrasound Obstet Gynecol* 2021;57:573–81.
- Giuliani F, Oros D, Gunier RB, *et al*. Effects of prenatal exposure to maternal COVID-19 and perinatal care on neonatal outcome: results from the INTERCOVID multinational cohort study. *Am J Obstet Gynecol* 2022;227:488.
- Goulding A, McQuaid F, Lindsay L, *et al*. Confirmed SARS-CoV-2 infection in Scottish neonates 2020-2022: a national, population-based cohort study. *Arch Dis Child Fetal Neonatal Ed* 2023;108:367–72.

Supplemental data: Characteristics and outcomes of neonates hospitalised with SARS-CoV-2 infection in the United Kingdom by variant: a prospective national cohort study

Contents

	page
Details of the Neonatal complications of COVID-19 Collaborative Group	2
Acknowledgements	7
Supplemental Figure 1: Age at diagnosis of neonatal SARS-CoV-2 by dominant circulating strain in the United Kingdom	8
Supplemental Figure 2: Signs at presentation with neonatal SARS-CoV-2 infection.	9
Supplemental Table 1: Respiratory support received by babies with SARS-CoV-2 infection in hospital in the United Kingdom, presented by gestation at birth.	10
Data collection form	11

Details of the Neonatal complications of COVID-19 Collaborative Group

Writing committee

Chris Gale, PhD, Professor of Neonatal Medicine, Imperial College London, School of Public Health, Faculty of Medicine, Chelsea and Westminster campus, 4th Floor, Lift Bank D, 369 Fulham Road, SW10 9NH, UK

Kathryn E Fitzpatrick, DPhil, Senior Researcher in Statistical Epidemiology, NIHR Policy Research Unit in Maternal and Neonatal Health and Care, National Perinatal Epidemiology Unit, Nuffield Department of Population Health, University of Oxford, UK

Helen Mactier, MD, Neonatal Consultant and Honorary Clinical Associate Professor, Princess Royal Maternity and the University of Glasgow, Glasgow, UK

Alessandra Morelli, MSc, Research Midwife, NIHR Policy Research Unit in Maternal and Neonatal Health and Care, National Perinatal Epidemiology Unit, Nuffield Department of Population Health, University of Oxford, UK

Mariko Nakahara,

Madeleine Hurd, BSc, Data Manager, NIHR Policy Research Unit in Maternal and Neonatal Health and Care, National Perinatal Epidemiology Unit, Nuffield Department of Population Health, University of Oxford, UK

Anna Placzek, MA, Project Manager, NIHR Policy Research Unit in Maternal and Neonatal Health and Care, National Perinatal Epidemiology Unit, Nuffield Department of Population Health, University of Oxford, UK

Marian Knight, DPhil, Professor of Maternal and Child Population Health, NIHR Policy Research Unit in Maternal and Neonatal Health and Care, National Perinatal Epidemiology Unit, Nuffield Department of Population Health, University of Oxford, UK

Shamez N Ladhani, PhD, Consultant Epidemiologist, Public Health England, Colindale, UK; Professor of Paediatric Infectious Diseases and Vaccinology, St. George's University of London, UK

Elizabeth S Draper, PhD, Professor of Perinatal & Paediatric Epidemiology, Department of Health Sciences, University of Leicester, Centre for Medicine, University Road, Leicester, UK

Don Sharkey, PhD, Professor of Neonatal Medicine and Technologies, Centre for Perinatal Research, School of Medicine, University of Nottingham, UK

Cora Doherty, MD, Consultant Neonatologist, University Hospital of Wales, Cardiff, UK

Maria A Quigley, MSc, Professor of Statistical Epidemiology, NIHR Policy Research Unit in Maternal and Neonatal Health and Care, National Perinatal Epidemiology Unit, Nuffield Department of Population Health, University of Oxford, UK

Jennifer J Kurinczuk, MD, Professor of Perinatal Epidemiology, NIHR Policy Research Unit in Maternal and Neonatal Health and Care, National Perinatal Epidemiology Unit, Nuffield Department of Population Health, University of Oxford, UK

Reporting clinicians

Good Hope Hospital: Dr Babi Rani Pal; **Aberdeen Maternity Hospital:** Dr Lambrini Psiouri; **Aberdeen Royal Infirmary:** Dr Saulius Satas, Dr Catriona Middleton; **Addenbrooke's Hospital:** Dr

Sajeev Job; Adelaide House: Dr Melanie Douglas; **Airedale General Hospital:** Emma Dooks, Dr Philippa Rawling ; **Alder Hey Children's Hospital:** Dr Andrew Riordan, Dr Narayani Vayyeti, Dr Clare Pain, Dr David Porter, Dr Stephen McWilliam, Dr Charlotte Durand; **Alexandra Hospital:** Dr Tom Charles Dawson; **Altnagelvin Area Hospital:** Dr Damian Armstrong, Dr Mary Ledwidge; **Antrim Area Hospital:** Dr Lynne McFetridge; **Arrowe Park Hospital:** Dr Anand Kamlanathan, Dr Sarah Thompson, Dr David Lacy; **Barking Hospital:** Ms Helen Smith; **Barnet Hospital:** Dr Shanthi Shanmugalingam, Dr Esther Freeman; **Basildon University Hospital:** Dr Donna Southam, Dr Sanjay Rawal; **Bedford Hospital:** Dr Jennifer Valentine; **Birmingham Children's Hospital:** Dr Divya Gurudutt, Dr Harsha Gowda, Dr Sarah Denniston, Dr Victoria Fradd, Dr Vidya Garikapati, Dr Amy Walker, Dr Pinki Surana; **Birmingham Women's Hospital:** Dr Manobi Borooah, Dr Gergely Toldi, Dr Matthew Nash; **Bradford Royal Infirmary:** Dr Liz Ingram, Dr Sam Wallis, Dr Sam Oddie, Dr Chris Day, Dr Rebecca Newbegin, Dr Firth; **Bradford Teaching Hospitals:** Dr Ellen Mosley, Dr Chakrapani Vasudevan; **Brightmet Health Centre:** Dr Gabrielle Lipshen; **Bristol Royal Hospital for Children:** Dr Stefania Vergnano, Dr Jeyesh Patel, Dr Marion Ruth Roderick, Dr Frances Hutchings, Dr Hannah Langford-Wood, Dr Malini Ketty, Dr Hester Taekema; **Bronglais General Hospital:** Dr Alzbeta Kolenova; **Broomfield Hospital:** Dr Dean Richard Lethaby, Dr Rachel Thomas; **Burnley General Hospital:** Dr Amitava Sur; **Calderdale Royal Hospital:** Dr Matthew Taylor, Dr David Bromley, David Bromley; **Cavan General Hospital:** Dr Alan Finan; **Central Middlesex Hospital:** Dr Ashiya Ali; **Chelsea & Westminster Hospital:** Dr Hester Yorke, Dr Catherine O'Sullivan, Dr Deena-Shefali Patel, Dr Nora Tusor, Dr Walton D'Costa, Dr Sabita Uthaya, Dr Cheryl Battersby, Dr Mark Thomas; **Chesterfield Royal Hospital:** Dr Penelope Young; **Children's University Hospital - Dublin:** Dr Michael Riordan; **City Hospital & Birmingham Treatment Centre:** Dr Penelope Broggio, Dr Lindsay Halpern, Dr Sheilah Kamupira; **Colchester General Hospital:** Dr Joakim Anderson; **Conquest Hospital:** Dr Manivannan Kandasamy; **Countess of Chester Hospital:** Dr Ravi Jayaram, Dr Stephen Paul Brearey, Dr Helen Dallow, Dr Joanne Marie Dangerfield, Dr Alison Timmis, Dr Victoria Guratsky, Dr S Murthy Saladi; **Craigavon Area Hospital:** Dr Veena Vasi, Dr Lesley-Ann Funston, Dr David George Grier, Dr Philip Quinn, Dr David Graham; **Croydon University Hospital:** Dr Grant Marais, Dr John Chang, Dr Arun Kumar; **Darent Valley Hospital:** Dr Abdul Hasib; **Darlington Memorial Hospital:** Dr John Furness; **Derbyshire Children's Hospital:** Dr Jennifer Evennett, Dr Richard Bowker, Dr Velur Palaniswamy Balasubramaniam, Dr Claire Weights; Dr Gisela Robinson, Dr Anneli Wyn-Davies; **Derriford Hospital:** Dr Oladipo Aworinde, Dr Georgina Selby; **Diana Princess of Wales Hospital:** Dr Bemigho Etuwewe; **Dorset County Hospital:** Dr Dominic Sheehy; **Dumfries & Galloway Royal Infirmary:** Dr Andrew Eccleston; **Ealing Hospital:** Dr Ewa Lichtarowicz-Krynska; **East Surrey Hospital:** Dr Bindu Nair Radha, Dr Lola Adenuga; **Epsom General Hospital:** Dr Saifa Rashid; **Evelina Children's Hospital:** Dr Emma Parish, Dr Claire Lemer, Dr Ella Aidoo, Dr Chloe Macaulay; **Forth Valley Royal Hospital:** Dr Kristyna Bohmova, Dr Dominic O'Reilly; Dr Sabine Grosser; **Frimley Park Hospital:** Dr Sanjay Jaiswal; **Furness General Hospital:** Dr Ashutosh Kale; **Glan Clwyd Hospital:** Dr Sandra Bakker, Dr Oliver Rackham, Dr Amanda McKenna, Dr Lee Wisby; **Gloucester Royal Hospital:** Dr Miles Wagstaff, Dr Miles Wagstaff; **Good Hope Hospital:** Daniel Dogar; **Grange University Hospital:** Dr Gillian Smith; **Great North Children's Hospital:** Dr Andrew Ian Villis, Dr Jason Gane; **Great Ormond Street Hospital:** Dr Alasdair Bamford, Dr Mark Peters, Dr Doris Abomeli, Dr Wesley Hayes, Dr Cho Ng; **Great Western Hospital:** Dr Sarah Bates, Dr Claire Broomfield; **Hereford County Hospital:** Dr Simon Meyrick, Dr Cathryn Seagrave; **Hillingdon Hospital:** Dr Tristan Bate, Dr Elizabeth Lek; Dr Alex CHAN, Dr Jide Menakaya, Dr Devangi Thakkar, Dr Jaikumar Ganapathi; **Hinchingbrooke Hospital:** Dr Hilary Dixon, Dr Philip Gauci; **Homerton Hospital:** Dr Marianna Varsami, Dr Julia Thomson, Dr Ravi Prakash, Dr Claire Howarth, Dr Sujith Pereira;

Huddersfield Royal Infirmary: Dr Karin Schwarz, Dr Salamiah Burgess; **Hull Royal Infirmary:** Dr Hilary Klonin, Dr Hani Khdir, Dr Aparna Manou, Dr Verghese Mathew; **Imperial College School**

of Medicine: Dr Simon Nadel, Dr Aubrey Cunnington; **Ipswich Hospital:** Dr Matthew James; **James Cook University Hospital:** Dr Shalabh Garg; **James Paget University Hospital:** Dr Priyadarshan Ambadkar, Dr John Chapman; **Jersey General Hospital:** Dr David Lawrenson; **Jessop Wing Hospital:** Dr Elizabeth Pilling, Dr Porus Bustani; **John Radcliffe Hospital:** Dr Eleri Adams, Dr Dominic Kelly, Dr Charles Roehr; **Joyce Green Hospital:** Dr Selwyn D'Costa; **Kettering Children's Hospital:** Dr Pratibha Rao, Dr Keshavamurthy Kallambella Sushilendra; **King George Hospital:** Dr Morgan Keane; **Kings College Hospital:** Dr Theodoros Dassios, Dr Sreena Das, Dr Lucy Pickard, Dr Zainab Kassim; **King's Mill Hospital:** Dr Rebecca Sands, Dr Simon Rhodes; **Kingston Hospital:** Dr Matthew Lee, Dr Edit Molnar, Dr Unice Tawiah Naakai Nartey, Dr Jon Filkin, Dr Nader Abd El Twab Elgharably; **Leeds General Infirmary:** Dr Sian Cooper, Dr Ramesh Kumar, Dr Kerry Jeavons, Dr Elizabeth Evans, Dr Christopher Forster, Dr Amelia Shaw, Dr Elizabeth McKechnie, Dr Anne-Marie Childs, Dr Elizabeth Day, Dr Rachel Toone, Dr Joanna Wright, Dr Sharon English, Dr Nicola Mullins; **Leicester General Hospital:** Dr Gareth Lewis; **Leicester Royal Infirmary:** Dr Premkumar Sundaram; Dr Habab Mekki, Dr Andrew Currie, Dr Jonathan Cusack, Dr Vikas Saxena, Dr Joe Fawke, Dr Jane Gill, Dr Kamini Yadav, Dr Mohammad Zoha, Dr Joanna Behrsin, Dr Vinayak Rai, Dr Robin Miralles, Marie Hubbard, Dr Nicola Owen, Dr Usha Niranjani; **Liverpool Women's Hospital:** Dr Richard Hutchinson; **Luton & Dunstable Hospital:** Dr Amy Carmichael, Dr Doris Iyamabo, Dr Jennifer Birch; **Maidstone Hospital:** Dr Siaw Chieng, Dr Laura J Louise Halpin; **Manor Hospital:** Dr Rayasandra Gireesh, Dr Raghu Krishnamurthy, Dr Ashok Karupaiah, Dr Pooja Shivananda Siddhi; **Medway Maritime Hospital:** Dr Ghada Ramadan, Dr Santosh Pattnayak ; **Milton Keynes General Hospital:** Dr Zuzanna Gawlowski, Dr D Gonapoladeniya, Dr Indranil Misra, Dr Mya Aye; **Musgrove Park Hospital:** Dr Alexandra Powell, Dr Nicola Johnson; **Nevill Hall Hospital:** Dr Ravi Manikonda, Dr Yvette Cloete, Dr Nakul Gupta, Dr Marcus Pierrepont; **New Cross Hospital:** Dr Robert Negrine, Dr Melanie Sutcliffe, Dr Buvenekaba Kumararatne, Dr Julie Brent, Dr Chrisantha Halahakoon, Dr Richard Heaver, Dr Chrisantha Halahakoo, Dr Richard Heaver, Dr Surinder Judge; **Newham Hospital:** Dr Nicolene Plaatjies, Dr Susan Liebeschuetz, Dr Esmira Jafarova, Dr Nicolene Plaatjies, Dr Imdad Ali, Dr Ivone Lancoma-Malcom, Dr Rakesh Ravi; **Ninewells Hospital and Medical School:** Dr Jennifer Scotland; **Noah's Ark Children's Hospital for Wales:** Dr Ruth Elizabeth Hanks; **Norfolk & Norwich Univ Hospital:** Dr Paul Clarke; Dr Catherine Thomas; Dr Priyadarsini Muthukumar; Dr Mark Dyke, Dr Florence Walston; **North Devon District Hospital:** Dr Michael Selter; **North Hampshire Hospital:** Dr Lucinda Winckworth; **North Manchester General Hospital:** Dr Hatem Sager; **North Middlesex Hospital:** Dr Cheentan Singh, Dr Piyusha Kapila, Dr Cassandra Gyamtso; Dr Linda Walker, Dr Fionnghuala Fuller, Dr Lesley Alsford, Dr Rosalind Mensah, Dr Janani Pallawela, Dr Olu Wilkey, Dr Bijan Shahradsad, Dr Aparna Nambisan, Dr Dhruv Rastogi; **North Tyneside General Hospital:** Dr Ivonne Haar, Dr Sangeeta Tiwary; **Northampton General Hospital:** Dr Cathryn Chadwick, Dr Sathyaseelan Jayaseelan, Dr Nick Barnes, Dr Fiona Thompson, Dr Janet Collinson, Richard Breene; **Northumberland Child Health Centre:** Dr Sangeeta Tiwary; **Northwick Park Hospital:** Dr Richard Nicholl, Ms Anam Fayadh, Dr Krzysztof Zieba, Dr Edit Fukari-Irvine; **Nottingham City Hospital:** Dr Dushyant Batra, Dr Stylianie Tsilika, Dr Anushma Sharma; **Our Lady's Hospital for Sick Children:** Dr Fiona Ringholz, Dr Sinead Harty; **Peterborough City Hospital:** Dr Katharine McDevitt, Dr Mona Aslam, Dr Ramya Ramaswamy, Coralie Huson, Dr David John Hopkins, Dr Tim Jones; Dr Katharine McDevitt; **Pinderfields General Hospital:** Dr Natasha De Vere, Dr Kallinath Shyamanur, David Gibson; **Poole Hospital:** Dr Mark Tighe, Dr Peter McEwan; **Portsmouth Community:** Dr Kathy Padoa; **Princess Alexandra Hospital:** Dr Chinnappa Reddy; **Princess Anne Hospital:** Dr Victoria Puddy, Dr Rupjani Banerjee, Dr Kelly Brown, Dr Kevin Goss, Dr Helen Fielder; **Princess Elizabeth Hospital:** Dr Clare Betteridge; **Princess of Wales Hospital:** Dr Torsten Hildebrandt; **Princess Royal Maternity Hospital:** Dr Tomasz Dygas; **Princess Royal University Hospital:** Dr Stella Nzekwue; **Queen Alexandra Hospital:** Dr Huw Jones, Dr Tim Scorrer, Dr Amanda Freeman, Dr Karen Deem, Dr Borbone, Dr Roy Sievers, Dr Jennie Pridgeon; **Queen Charlotte's & Chelsea Hospital:** Dr Aniko Deierl, Dr Jayanta Banerjee; Dr Emma Porter, **Queen Elizabeth Hospital - Birmingham:** Dr Manobi

Borooh; **Queen Elizabeth Hospital - East Anglia:** Dr Abigail Reeve; **Queen Elizabeth Hospital - Lewisham and Greenwich:** Dr Julie Lord, Dr Olutoyin Banjoko, Emma Gardiner; **Queen Elizabeth University Hospital, Glasgow:** Dr Ruth Bland; **Queen Mary's Hospital for Children:** Dr Daniel Langer, Dr Ralf Hartung, Dr Arunava Kundu; **Queen's Hospital - Romford:** Dr Ambalika Das, Dr Helen Smith, Dr Donna Nicholls, Dr Ranjith Joseph; **Queen's Medical Centre - Nottingham:** Dr Lleona Lee, Dr Anjum Deorukhkar, Dr Jodi Wood; **Rosie Maternity Hospital:** Dr Stergios Papakostas; **Rotheram General Hospital:** Dr Soma Sengupta; **Royal Albert Edward Infirmary:** Dr Hough; **Royal Alexandra Hospital:** Dr Hilary Conetta; **Royal Belfast Hospital:** Dr Rachel Beckett, Dr Elizabeth Dalzell; **Royal Belfast Hospital:** Dr Paul Moriarty; **Royal Berkshire & Battle Hospitals:** Dr Ahmed Aldouri, Dr Chandan Yaliwal, Dr Ravi Kumar, Dr Ann Gordon, Dr Nicola Pritchard, Dr Kementri Naidoo; **Royal Berkshire Hospital:** Dr Syed Akmal Hussain; **Royal Blackburn Hospital:** Dr Andrew Cox; **Royal Bolton Hospital:** Dr Fiona Watson, Dr Shanmuga Sundaram, Dr Archana Mishra, Dr Jo Morgan, Dr Ian Freeman; **Royal Brompton Hospital:** Dr Piers Daubeney; **Royal Cornwall Hospital:** Dr Thomas Fontaine; **Royal Devon & Exeter Hospital:** Dr Sian Ludman, Dr Simon Parke, Dr David Mabin, Dr Nagendra Venkata, Dr Pasupulety Venkata; **Royal Free Hospital:** Dr James Rosenberg, Dr Marice Theron, Dr Eleanor M Bond; **Royal Glamorgan Hospital:** Dr Takin Omolokun; **Royal Gwent Hospital:** Dr Tanoj Gopalan Kollamparambil, Dr Sarmistha Maity, Dr Murali Natti, Dr Sarika Goel; **Royal Hampshire County Hospital:** Dr Lucinda Winckworth; **Royal Hospital for Children:** Dr Neil Patel, Dr Dominic Cochran, Dr Helen McDevitt, Dr Andrew Brunton, Dr Jonathan Coutts, Dr Louise Leven, Dr Jennifer Mitchell, Dr Owen Forbes, Dr Rosie Hague, Dr Morag Nina Joyce Wilson; **Royal Hospital for Sick Children, Edinburgh:** Dr Mairi Stark; **Royal Infirmary of Edinburgh:** Dr Ewen Johnston; **Royal Jubilee Maternity Hospital:** Dr Stan Craig; **Royal Lancaster Infirmary:** Dr Clare Peckham, Dr Joanne Fedee; **Royal Oldham Hospital:** Dr Fazal Rehman, Dr Sarah McCullough, Dr Anita Vayalakkad, Zainab Sarwar, Dr Lydia Bowden; **Royal Preston Hospital:** Dr Raju Narasimhan, Dr Hyacienth Akaolisa Egbeama, Katrina Rigby, Dr Aubrey Makhallira; **Royal Stoke University Hospital:** Dr Laura Roe, Dr Olayinka Kowobari, Dr Lee Abbott, Dr Julia Uffindell; **Royal Surrey County Hospital:** Dr Ozan Hanci, Dr Diarra Greene, Dr Soad Habeeb, Dr Sameh El-Sayed Zaki Abdulsamea, Dr Catherine Garland, Dr Nikolay Drenchev; **Royal United Hospital:** Dr Tobias Hunt, Dr Steve Jones, Dr Dan Jolley; **Royal Victoria Infirmary:** Dr Robert Tinnion, Dr Julie Groombridge; Dr Stefan Zalewski, Dr Jenna Gillone, Dr R Hearn, Dr Julie Groombridge; **Russells Hall Hospital:** Dr Evans Chingwenje, Dr Samantha Wilegoda; **Salisbury District Hospital:** Dr Philippa Ridley; **Scunthorpe General Hospital:** Dr Rasheed Oba; **Sheffield Children's Hospital:** Dr Alison Smith, Dr Lucy Hinds, Dr Rachel Riddell, Dr Mairi Gillespie, Dr Soma Sengupta; **Singleton Hospital:** Dr Jamie Evans, Dr Geraint Morris; **South West Acute Hospital:** Dr Gerry Mackin; **Southampton General Hospital:** Dr Mark Johnson, Dr Anne-Marie Goss, Dr Helen Rutkowska, Dr Jason Michael Barling; **Southend General Hospital:** Dr Raj Gupta, Dr Jennifer Foster; **Southend University Hospital:** Dr Jennifer Foster, Dr Vineet Gupta, Dr Ravi Chetan, Dr Veena Rao, Dr Ravi Chetan; **Southern General Hospital, Glasgow:** Dr Joyce O' Shea; **Southmead General Hospital:** Dr Claire Michelle Rose, Dr Richard Wach, Dr Faith Emery; Dr Madhavi Parvathareddy, Dr Paul Mannix; **St George's University Hospital:** Dr Sijo Francis, Dr Danielle Hake, Dr Sophie Robinson, Dr Daniel Langer; **St James University Hospital, Leeds:** Dr Kathryn Johnson, Dr Liz McKechnie; **St Mary's Hospital - London:** Dr Jayanta Banerjee, Dr Caroline Louise Scott-Lang, Dr Jenny Ziprin, Dr Geraldine Ng; **St Mary's Hospital - Manchester:** Dr Sajit Nedungadi; Dr Ruth Gottstein; Dr Kalwa Munthali; **St Peter's Hospital:** Dr Alison Groves, Dr Mayu Otsuka, Dr Vennila Ponnusamy; **St Peter's Hospital:** Dr Jennifer McGrath, Dr Maria Samantha Edwards, Dr Clare Hill, Dr Peter Martin; Dr Luciana Elisabeta Ene; **St Richard's Hospital:** Dr Ann-Marie Buckley; **St Thomas' Hospital:** Dr Timothy Watts; **Stepping Hill Hospital, Stockport:** Dr Carrie Heal; **Stoke Mandeville Hospital:** Dr Caroline Lowdon, Dr Ralph Robertson, Dr Gopa Sarkar; **Sunderland Royal Hospital:** Dr Chike Onwuneme; **Tameside General Hospital:** Dr Helen Purves, Dr David Levy, Dr Trupti Dhorajiwala, Dr Robert Block; **Tayside Children's Hospital:** Dr Birgit Wefers; **The James Cook University**

Hospital: Dr Ginny Birrell, Dr Thomas Skeath, Dr Maeve O’Sullivan, Dr Helen Chitty; **The Princess Royal Hospital:** Dr Wendy Tyler; **The Princess Royal Hospital:** Dr Sanjeev Deshpande; **The Royal London Hospital:** Dr Hemmay Raychaudhuri, Dr Catherine Warrick, Dr Nicolene Plaatjies, Dr Caroline Francia, Dr Caroline May, Dr Ajay Sinha, Dr Anup Kage, Dr Anne Opute, Dr Rainer Ebel, Dr Gemma Sedgwick; **The Ulster Hospital:** Dr Julia Courtney, Dr Carl Harris, Dr Damhnait Cassidy, Dr Michael McGowan; **The York Hospital:** Dr Luke Kevin McLaughlin, Dr Rebecca Proudfoot, Dr Dominic Smith, Dr Liz Baker; **Torbay Hospital:** Dr Richard Tozer, Dr Jonathan Graham, Dr Esther J Morris, Dr Alison Janzen; **Tunbridge Wells Hospital:** Louise Swaminathan; **University College Hospital London:** Dr Sarah Eisen, Dr Christina Kortsalioudaki, Dr Andrea Leigh, Dr Leigh Dyet; **University Hospital Coventry:** Dr Karen McLachlan; **University Hospital Crosshouse:** Dr Nuno Cordeiro, Dr Althaf Ansary; **University Hospital Lewisham:** Dr Ozioma Obi, Dr Neha Sharma, Dr Kumudini Gomez, Dr Emma Gardiner; **University Hospital of North Tees:** Alex Ramshaw; **University Hospital of Wales:** Dr Nitin Goel, Dr Amarkumar Asokkumar, Dr Marcia Scheller, Dr Elisa Smit, Dr Cora Doherty; **University Hospital Wishaw:** Dr Augusta Anenih, Dr Hatice Isikli, Dr Padma Rajagopal, Dr Caroline Delahunty, Dr Adrienne Sullivan; **University Hospitals Dorset NHS Foundation Trust:** Dr Amy Roff; **University Hospitals of Leicester NHS Trust:** Dr Deepa Panjwani; **Victoria Hospital - Blackpool:** Dr Mohammed Idris Ahmed, Dr Christopher John Rawlins, Prof Morris Gordon; **Warrington Hospital:** Dr Delyth Webb, Dr Colin Wong, Dr Rachael Sutton, Dr Elinor Thomason, Dr Delyth Webb; **Warwick Hospital:** Dr Sumedha Chamalie Bird, Dr Kate Blake; **Watford General Hospital:** Dr CS Narayanan, Dr Nirmla Costa-Fernandes, Dr Nazakat Merchant, Dr Renton L'Heureux, Dr Avinash Jinadatha, Dr Meera Mallya; **West Cumberland Hospital:** Dr Clive Graham, Dr Hannah Holt-Davis; **West Middlesex University Hospital:** Dr Tsitsi Dadirai Chawatama, Dr Eleanor Hulse; **West Suffolk Hospital:** Dr Ian Evans; **Wexham Park Hospital:** Dr Kanaga Raj Sinnathuray, Dr Sujata Narayan Edate; **Whipps Cross Hospital:** Dr Nicolene Plaatjies, Dr John Ho; **Whittington Hospital:** Dr Juliet Penrice, Dr Andrew Robins, Dr Alka Desai, Dr Gopa Sen, Dr Caroline Fertleman, Dr Nischal Rao; **William Harvey Hospital:** Dr Amit Gupta, Dr Vimal Vasu; **Worcestershire Royal Hospital,** Dr Subramania Kalambettu, Dr Jessie Brain, Dr Viviana Anne Sophie Weckemann; **Worthing Hospital:** Dr Gillian Hobden, Dr Stuart Nicholls, Dr Jonathan Rabbs; **Wycombe General Hospital:** Dr Boon Tang; **Wythenshawe Hospital:** Dr Asim Ahmed, Dr Ahmed Elazabi, Dr Abhijeet Godhamgaonkar; **Ysbyty Gwynedd District General Hospital, Bangor:** Dr Shakir Saeed

British Paediatric Surveillance Unit, Royal College of Paediatrics and Child Health: Richard Lynn, Jacob Avis, Farhana Ahmed

Public, parent and patient involvement: Charlotte Bevan and Rachel Plachcinski, **PPPI Leads Policy Research Unit in Maternal and Neonatal Health and Care**, who commented on the design, protocol and the public facing materials.

Acknowledgements

We would also like to acknowledge the following groups who worked in extraordinary circumstances to expedite the process of getting this study set up within three weeks. Without their support and dedication, often working out of hour generally working from home, this would not have been possible to achieve.

British Paediatric Surveillance Unit Scientific Committee

Confidentiality Advisory Group, Health Research Authority

Public Health Scotland

Health Research Authority

Information Governance team, Nuffield Department of Population Health, University of Oxford

Public Health Scotland

Members of the MBRRACE-UK third sector stakeholder group

Multicentre Research Ethics Committee

Northern Ireland Maternal and Child Health, Public Health Agency

NIHR Policy Research Programme, Department of Health and Social Care, England

Public Benefit and Privacy Panel for Health and Social Care, Scotland

Public Health England

Sponsors, Clinical Trials and Research Governance, Research Support, University of Oxford

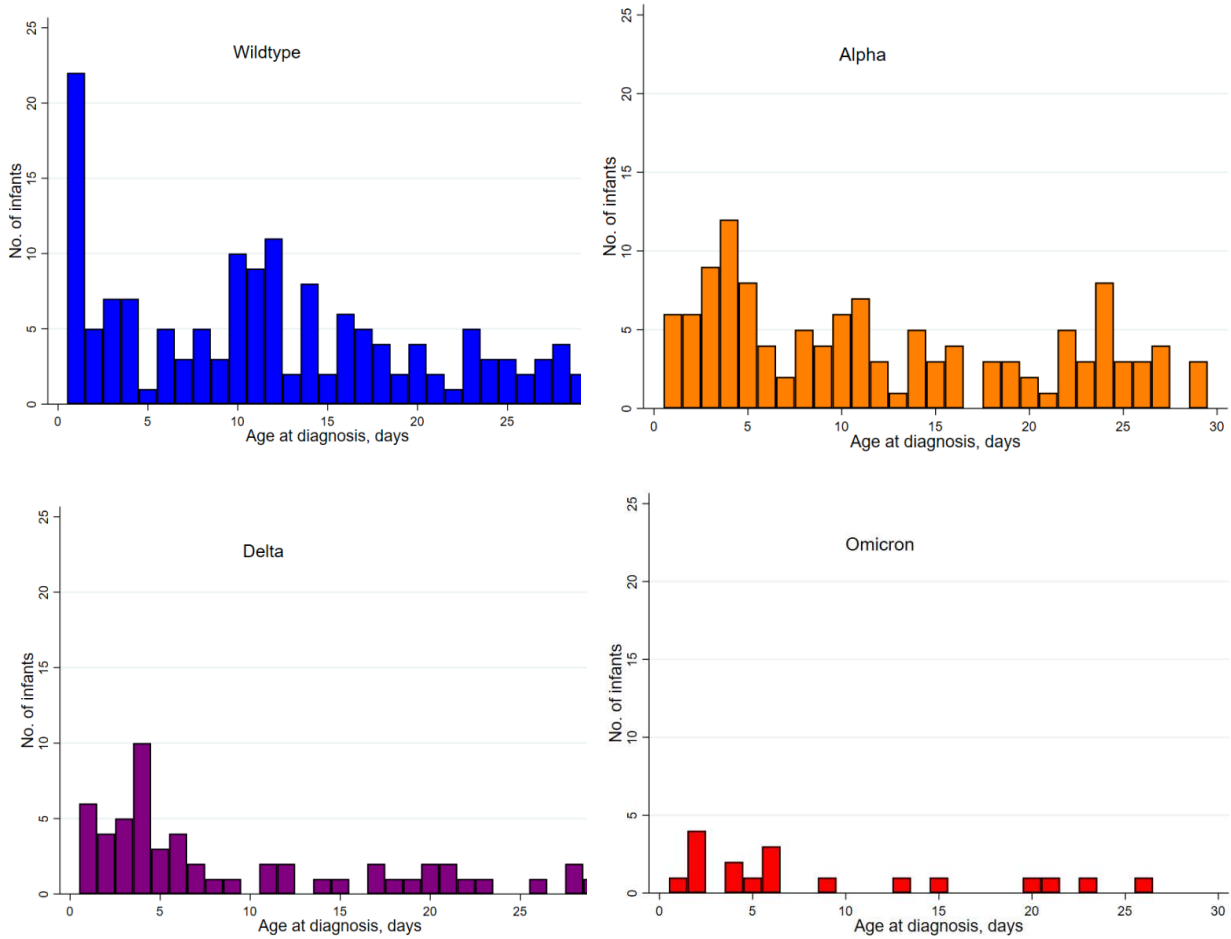
Supplemental methods

National testing data from public health organisations, PICANet, UKOSS and MBRRACE-UK data were used to identify any baby with a positive SARS-CoV-2 test taken in the first 28 days not reported through the BPSU. Following linkage, newly identified cases from these sources were followed up through local BPSU reporters and research nurses. Where cases identified through national testing data were unable to be matched to hospital records at the site of the test, they were categorised as not admitted for inpatient care and therefore excluded from the study.

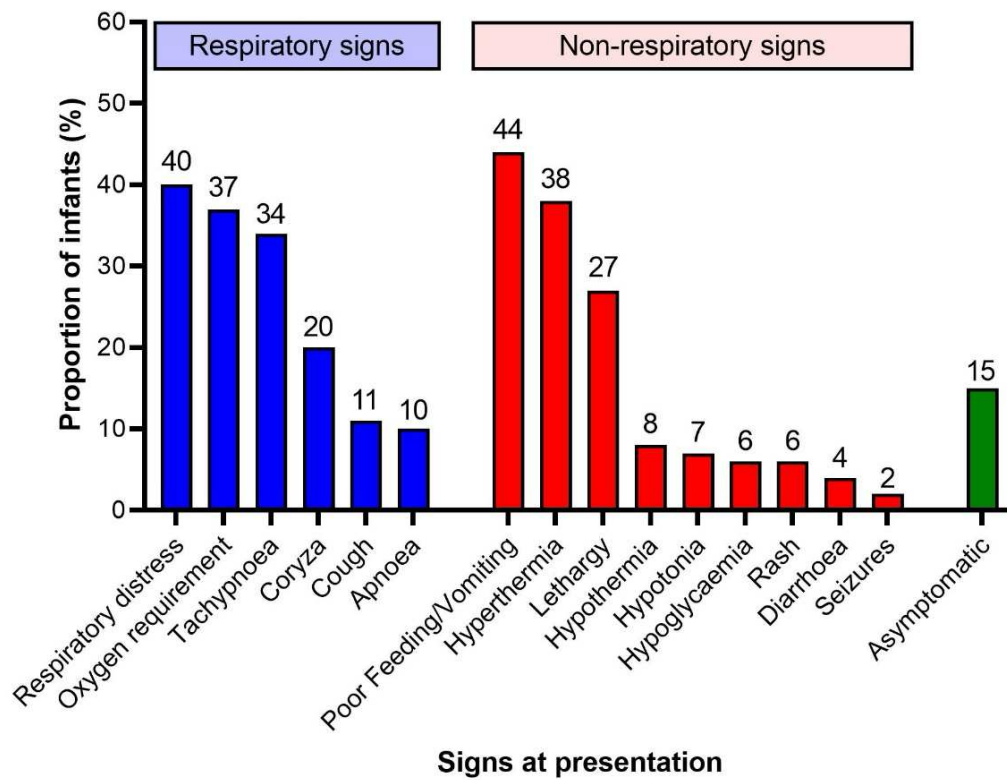
Linkage to routinely recorded data held in the National Neonatal Research Database (NNRD) was undertaken to confirm clinical care and outcomes for babies cared for on NNUs. Where there was a discrepancy between data reported via BPSU cards and NNRD data regarding the highest level of care or highest respiratory support a baby received we took the highest level recorded in either data source. We used NNRD data to define outcomes for babies who were reported as still admitted to neonatal units in BPSU reported data.

Following receipt of a report, notifying clinicians were asked to complete a data collection form (Supplemental Data) with details of the pregnancy, baby characteristics, neonatal management and outcomes. Reporters who had not returned the form were contacted by email at one, two and four weeks after notification.

Supplemental data



Supplemental Figure 1: Age at diagnosis of neonatal SARS-CoV-2 by dominant circulating strain in the United Kingdom



Supplemental Figure 2: Signs at presentation with neonatal SARS-CoV-2 infection. Babies could have more than one sign. For more detail on signs see data collection form.

Gestation at birth in weeks^{+days}	<28⁺⁰ N (%)*	28+0-31+6 N (%)*	32+0-36+6 N (%)*	≥37 N (%)*
n	11	41	79	203
Highest level of care received				
Intensive care	11 (100.0)	36 (87.8)	18 (22.8)	10 (4.9)
Non-intensive care	0 (0)	5 (12.2)	61 (77.2)	193 (95.1)
Highest respiratory support				
Mechanical ventilation	11 (100.0)	30 (73.2)	15 (19.0)	7 (3.5)
Non-invasive ventilation	0 (0)	11 (26.8)	30 (38.0)	16 (8.0)
Supplemental oxygen	0 (0)	0 (0)	7 (8.9)	24 (11.9)
None	0 (0)	0 (0)	27 (34.2)	154 (76.6)
Missing	0	0	0	2

Supplemental Table 1: Respiratory support received by babies with SARS-CoV-2 infection in hospital in the United Kingdom, presented by gestation at birth. *Percentage of those with complete data

Study ID number:

BPSU ID number:



Neonatal complications of coronavirus disease (COVID-19)

Data Collection Form - Strictly Confidential

Please report all eligible babies admitted on or after **1st March 2020** and before **1st April 2021**

Case Definition:

(Please tick relevant box. If unable to do so, your case may not fulfil the case definition.)

Any baby or infant

1. That has a diagnosis of COVID-19 made on a sample taken before 29 days of age and receives inpatient care for COVID-19 (this includes postnatal ward, neonatal unit, paediatric inpatient wards, PICU)

OR

2. Where the mother had confirmed COVID-19 at the time of birth or suspected COVID-19 at the time of birth that has subsequently been confirmed, and the baby was admitted for neonatal care (admitted for care on a neonatal unit regardless of the reason for admission and clinical course)

Please **do not** include any cases where the COVID-19 diagnosis in baby or mother **has not** been confirmed by laboratory testing.

A follow-up questionnaire may be sent within the first year after notification.
Please keep a copy of this form as a record.

Version 2.2 (08/10/20)

England, Wales and Scotland



Section 1: Reporter details

- 1.1 Date of completion of questionnaire: / /
- 1.2 Consultant responsible for case: _____
- 1.3 a) Hospital name: _____
- b) Country: England Wales Scotland
- 1.4 Telephone number: _____
- Email: _____
- 1.5 Has the patient been transferred to/from another centre? Yes No
- If Yes:
- 1) Name of referring centre _____
- 2) Referring consultant name _____
- 1.6 Name of person completing form (if not 1.2) _____

Section 2: Infant case details (If multiple babies complete additional form)

- 2.1 NHS number: (or equivalent Scottish CHI)
- 2.2 Postcode: (ONLY include **first half of the postcode** e.g. NG7)
- 2.3 Sex: Male Female
- Date of birth: / /
- Time of Birth: : : 24hr
- 2.4 Gestation at birth: (e.g. 37+1) +
- 2.5 Birthweight: g
- Ethnicity*: Specify if any 'Other' background: _____
- *Please choose the correct ethnicity code from Appendix A*

Section 3: Maternal case details

Maternal details are essential to allow linkage with the maternal (UKOSS) surveillance

3.1 NHS number: (or equivalent Scottish CHI or Northern Irish Health & Social Care number)

3.2 Hospital name where this baby was delivered _____

3.3 Was this mother tested for COVID-19 in the 7 days before or 7 days after birth?

Yes No (Go to Qu. 4.1) Unsure

If Yes, did this confirm the diagnosis? Yes No

Sample source: _____

Date first positive sample taken / /

If there were further positive samples please give date(s) taken and sample source

1: / / Sample Source _____

2: / / Sample Source _____

If Yes, was the baby separated from the mother following birth? Yes No

How was this done? _____

Section 4: Pregnancy/birth details

4.1 Antenatal steroids given: None Partial Full

4.2 MgSO₄ given: Yes No

4.3 Delivery mode: (Please tick one) Vaginal – spontaneous Vaginal – forceps/ventouse
Elective C-section Emergency C-section Not known

4.4 Multiple pregnancy: (Is there >1 fetus during pregnancy?)

No Not known Yes If Yes, birth order of

4.5 Nulliparous: (Is this the first pregnancy?) Yes No Not known

4.6 Apgar score: at 5 mins at 10 mins Not known

4.7 Lowest cord pH: (either arterial or venous) . Not known

Arterial Venous Not known

4.8 Did mother have any of the following in the 7 days before birth? (Please tick Yes/No/Not Known)

	Yes	No	Not known
Prolonged rupture of membranes (>24hrs)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Meconium stained liquor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fever (>37.8°C)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4.9 Did the baby require any of the following at birth? (Please tick Yes/No/Not Known)

	Yes	No	Not known
Inflation/ventilation breaths	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Intubation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chest compressions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Resuscitation drugs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Section 5: Infant presentation/clinical features**5.1 Where did the baby receive medical care?**Neonatal unit PICU Paediatric ward Postnatal ward **5.2 Was this baby tested for COVID-19?**Yes No (Go to Qu. 5.6) Unsure

If Yes, did this confirm the diagnosis?

Yes No

For each test performed for COVID-19, please state the source, date and result

Sample source (e.g. cord blood, NPA, stool)	Positive	Negative	Time taken	Date taken
1.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text" value="h h : m m"/> <small>24hr</small>	<input type="text" value="D D / M M / Y Y"/>
2.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text" value="h h : m m"/> <small>24hr</small>	<input type="text" value="D D / M M / Y Y"/>
3.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text" value="h h : m m"/> <small>24hr</small>	<input type="text" value="D D / M M / Y Y"/>
4.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text" value="h h : m m"/> <small>24hr</small>	<input type="text" value="D D / M M / Y Y"/>
5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text" value="h h : m m"/> <small>24hr</small>	<input type="text" value="D D / M M / Y Y"/>

5.3 If COVID-19 positive, did the baby have any signs?Yes No

If Yes, date of onset of signs of COVID-19

5.4 If COVID-19 positive, did the baby have immediate family or close contacts with sign/symptoms of COVID-19 when diagnosed?Yes No Unsure

If Yes, who? _____

5.5 If COVID-19 positive, do you think the baby acquired this in hospital (nosocomial)?Yes No **5.6 Reason for admission** _____

5.7 Did the baby have any of the following signs? (Please tick Yes/No/Not Known)

	Yes	No	Not known
Hyperthermia (>37.5°C)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hypothermia (<36.5°C)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Apnoea	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cough	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Coryza	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tachypnoea	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Respiratory distress/recession	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Oxygen requirement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lethargy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hypotonia	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Seizures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Poor feeding/vomiting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Diarrhoea	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hypoglycaemia	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rash	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Asymptomatic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

If Other, please specify: _____

5.8 Other key investigations (use first result from point of suspicion/diagnosis of COVID-19 or following admission related to COVID-19)

Chest X-Ray performed? Yes No Date

Findings: Normal Pneumonia Ground glass

If Other, please state: _____

Blood tests performed:

	Positive	Date taken
Haemoglobin _____ (g/L)	<input type="checkbox"/>	<input type="text" value="DD"/> <input type="text" value="MM"/> <input type="text" value="YY"/>
WBC _____ (10 ⁹ /L)	<input type="checkbox"/>	<input type="text" value="DD"/> <input type="text" value="MM"/> <input type="text" value="YY"/>
Neutrophils _____ (10 ⁹ /L)	<input type="checkbox"/>	<input type="text" value="DD"/> <input type="text" value="MM"/> <input type="text" value="YY"/>
Lymphocytes _____ (10 ⁹ /L)	<input type="checkbox"/>	<input type="text" value="DD"/> <input type="text" value="MM"/> <input type="text" value="YY"/>
Platelets _____ (10 ⁹ /L)	<input type="checkbox"/>	<input type="text" value="DD"/> <input type="text" value="MM"/> <input type="text" value="YY"/>
ALT _____ (U/L)	<input type="checkbox"/>	<input type="text" value="DD"/> <input type="text" value="MM"/> <input type="text" value="YY"/>
CRP _____ (mg/L)	<input type="checkbox"/>	<input type="text" value="DD"/> <input type="text" value="MM"/> <input type="text" value="YY"/>
Lactate _____ (mmol/L)	<input type="checkbox"/>	<input type="text" value="DD"/> <input type="text" value="MM"/> <input type="text" value="YY"/>

If Other, please specify: _____

Section 6: Other diagnoses and investigations

6.1 Did the baby have any major congenital abnormalities? Yes No Not known

If Yes, please provide details: _____

6.2 Was neuroimaging performed? Yes No (Go to Qu. 6.3) Not known

If Yes, were any of the following identified? If Yes, please state modality and date first identified:

Finding	Modality	Date first identified
Normal	Cr USS <input type="checkbox"/> MRI <input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY
Grade I/II IVH	Cr USS <input type="checkbox"/> MRI <input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY
Grade III/IV IVH	Cr USS <input type="checkbox"/> MRI <input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY
Cystic periventricular leukomalacia (PVL)	Cr USS <input type="checkbox"/> MRI <input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY
Hypoxic-ischaemic injury	Cr USS <input type="checkbox"/> MRI <input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY
Congenital structural anomaly	Cr USS <input type="checkbox"/> MRI <input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY

6.3 Please indicate if any of the following tests were performed:

	Yes	No	Date	Result
EEG or CFAM:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY	Normal <input type="checkbox"/> Seizures <input type="checkbox"/> Other: _____
Echocardiogram:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY	_____

Section 7: Treatment/management of infant **Only for infants who are COVID-19 positive**

7.1 Please indicate if any of the following treatments were given for the treatment of COVID-19 (Please tick Yes/No/Not Known)

	Yes	No	Not known	Start date	End date
Oxygen	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY
Non-invasive ventilation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY
Invasive ventilation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY
HFOV	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY
Nitric oxide	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY
Therapeutic hypothermia	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY
ECMO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY	<input type="text"/> DD / <input type="text"/> MM / <input type="text"/> YY

7.2 Please indicate if any of the following treatments were given at the time of COVID-19 infection: (Please tick Yes/No)

	Yes	No	Start date	Name of medication(s)
Antibiotics	<input type="checkbox"/>	<input type="checkbox"/>	DD / MM / YY	_____
Antivirals	<input type="checkbox"/>	<input type="checkbox"/>	DD / MM / YY	_____
Postnatal steroids	<input type="checkbox"/>	<input type="checkbox"/>	DD / MM / YY	_____
Anti-arrhythmic treatment	<input type="checkbox"/>	<input type="checkbox"/>	DD / MM / YY	_____
Immunoglobulin	<input type="checkbox"/>	<input type="checkbox"/>	DD / MM / YY	Not applicable
Other experimental therapy	<input type="checkbox"/>	<input type="checkbox"/>	DD / MM / YY	_____

7.3 Do you think COVID 19 was predominantly responsible or significantly contributed to this neonates illness?

Yes No

Section 8: Outcome of infant

8.1 What was the final outcome? (Please tick all that apply)

	Date of event	
Discharged home:	<input type="checkbox"/> DD / MM / YY	
Transferred (e.g. another hospital):	<input type="checkbox"/> DD / MM / YY	
Still admitted:	<input type="checkbox"/> DD / MM / YY	Questionnaire completed
Died:	<input type="checkbox"/> DD / MM / YY	
Not known:	<input type="checkbox"/> Not applicable	Questionnaire completed

8.2 If discharged home, please indicate if any of the following are continued on discharge.

	Yes	No	Not known
Home oxygen:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Home pressure ventilatory support (CPAP or IPPV):	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
For palliation:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Community nursing:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
If discharged home, please indicate if any of the following follow up are organised.			
Follow up in clinic:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

8.3 If transferred, location transferred to: _____

8.4 If baby died, was a post-mortem (PM) performed? Yes No

If Yes, was evidence of COVID-19 infection found on PM? Yes No

Please give brief details: _____

Thank you for taking the time to complete the Questionnaire

Please return the completed form via NHS.net email to:

orh-tr.mbrance@nhs.net

Telephone: 01865 289733

Appendix A: Coding for Ethnic Group (ONS 2011 for UK wide data collection)

	Ethnicity Code	
A White	1	English / Welsh / Scottish / Northern Irish / British
	2	Irish
	3	Gypsy or Irish Traveller
	4	Any other White background, please write <i>in Section B/C</i>
B Mixed/ Multiple Ethnic Groups	5	White and Black Caribbean
	6	White and Black African
	7	White and Asian
	8	Any other Mixed / Multiple ethnic background, please write <i>in Section B/C</i>
C Asian / Asian British	9	Indian
	10	Pakistani
	11	Bangladeshi
	12	Chinese
	13	Any other Asian background, please write <i>in Section B/C</i>
D Black / African / Caribbean / Black British	14	African
	15	Caribbean
	16	Any other Black / African / Caribbean background, please write <i>in Section B/C</i>
E Other ethnic group	17	Arab

