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ICNARC report on COVID-19 in critical care
15 May 2020

This report presents analyses of data on patients critically ill with confirmed COVID-19 reported to ICNARC up to 4pm on 14 May 2020 from critical care units participating in the Case Mix Programme (the national clinical audit covering all NHS adult, general intensive care and combined intensive care/high dependency units in England, Wales and Northern Ireland, plus some additional specialist and non-NHS critical care units). Please note that adult critical care units in Scotland, paediatric intensive care units and neonatal intensive care units do not participate in the Case Mix Programme.

Reporting process

Critical care units participating in the Case Mix Programme are asked to:

- notify ICNARC as soon as they have an admission with confirmed COVID-19;
- submit early data for admissions with confirmed COVID-19, including demographics and first 24-hour physiology, as soon as possible after the end of the first 24 hours in critical care;
- resubmit data for the whole critical care stay, including critical care outcome and organ support, when the patient leaves critical care; and
- submit final data when the patient leaves acute hospital.

The same data are reported for an historic cohort of patients critically ill with viral pneumonia (non-COVID-19) admitted between 1 January 2017 and 31 December 2019.

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Participation and population coverage

Critical care unit participation

Total number of units: <u>289</u>
    Units with at least one patient notified: 252
    Units with zero patients: 33
    Units with uncertain participation: 4

Admissions to critical care

To date, ICNARC have been notified of 11,292 admissions for critical care with confirmed COVID-19, either at or after the start of critical care, in England, Wales and Northern Ireland. Of these, early data covering the first 24 hours of critical care have been submitted to ICNARC for 10,472 admissions for 8699 patients (Figure 1, Figure 2 and Figure 3). Of the 8699 patients, 6860 have outcomes reported and 1839 patients were last reported as still receiving critical care (Figure 4). The largest numbers of patients (2591) are being managed by the three London Operational Delivery Networks (Figure 5). Please note that Figure 2, Figure 3 and Figure 4 are affected by a variable lag time for submission of data of about 1-3 days (shaded grey).

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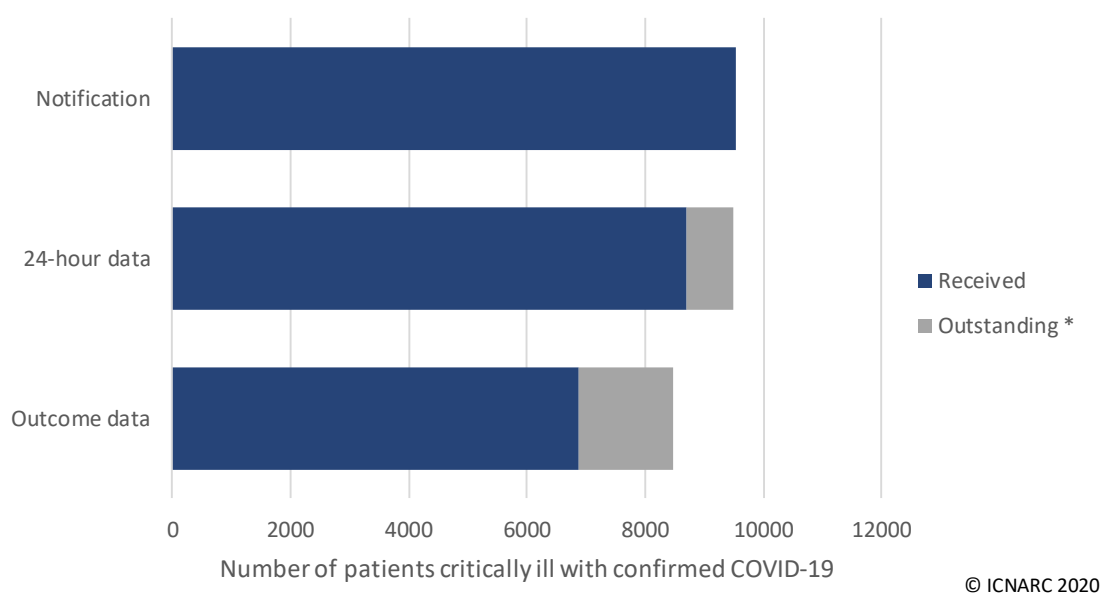
Figure 1   Numbers of patients with data included in this report and outstanding *

* Please note that 24-hour data are considered outstanding where ICNARC was notified of the admission at least 48 hours previously and outcome data are considered outstanding when at least 10 days have elapsed since the start of critical care.

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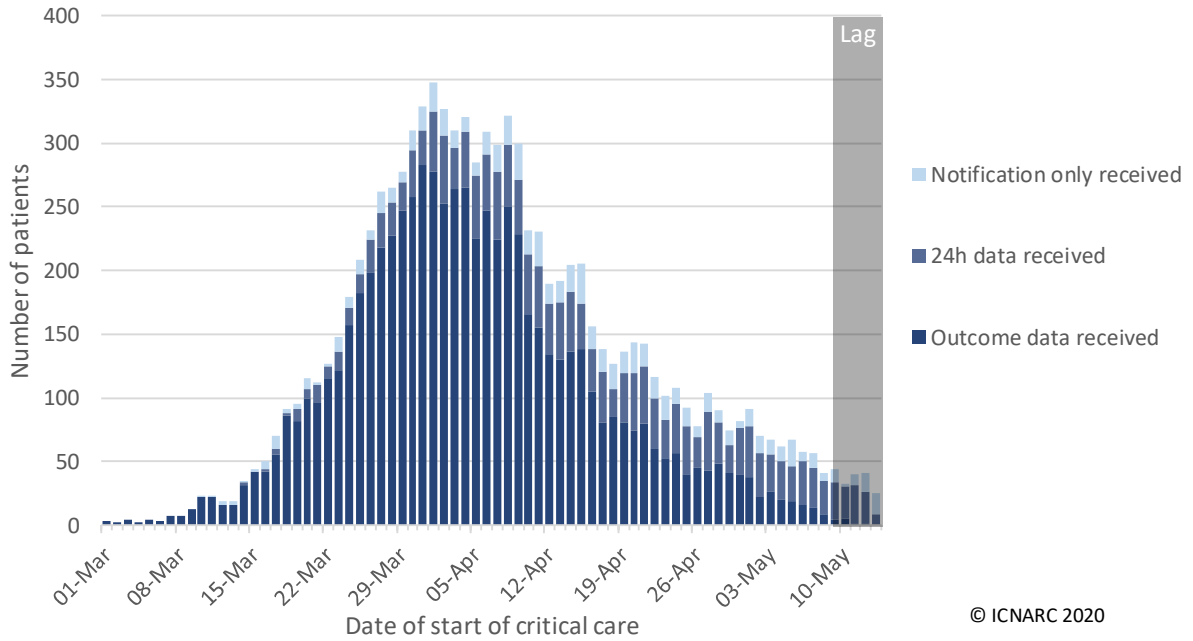
Figure 2   Number of new patients critically ill with confirmed COVID-19 by date of start of critical care

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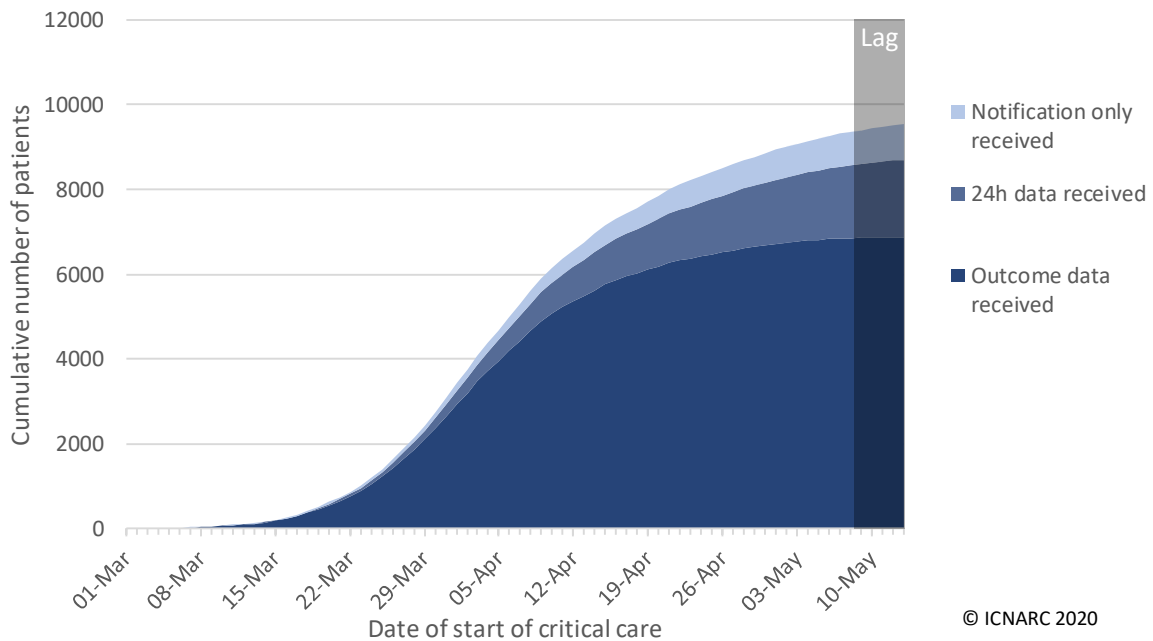
Figure 3   Cumulative number of patients critically ill with confirmed COVID-19 by date of start of critical care
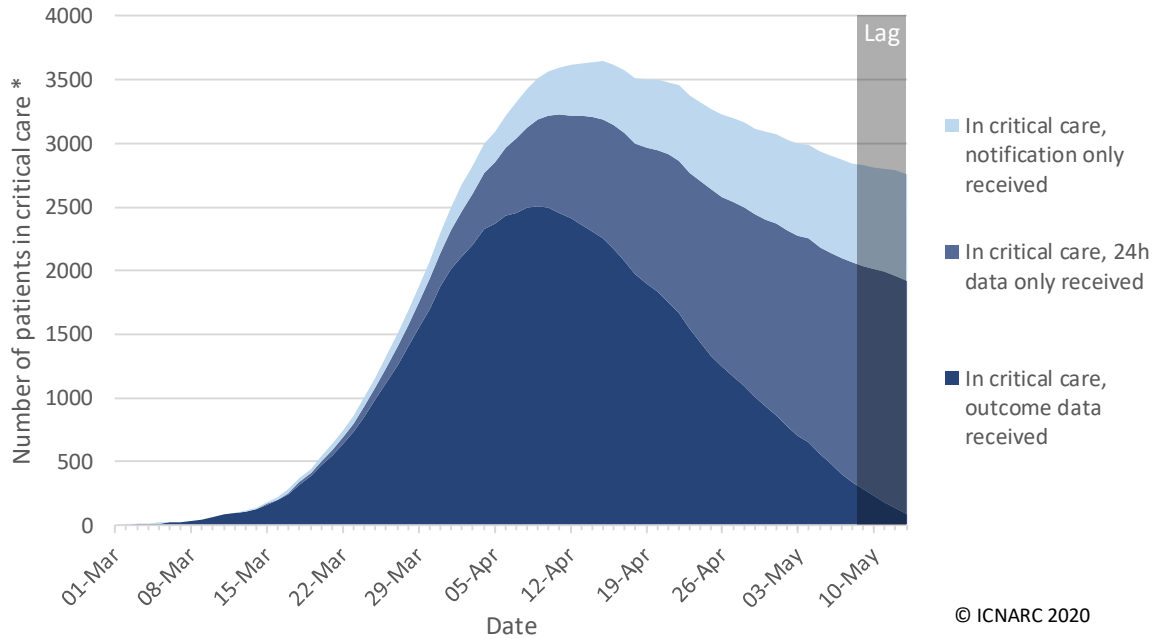
Figure 4 Total number of patients critically ill with confirmed COVID-19 by date *

* Please note that patients whose outcome data have not been received are assumed to remain in critical care as of 14 May 2020.
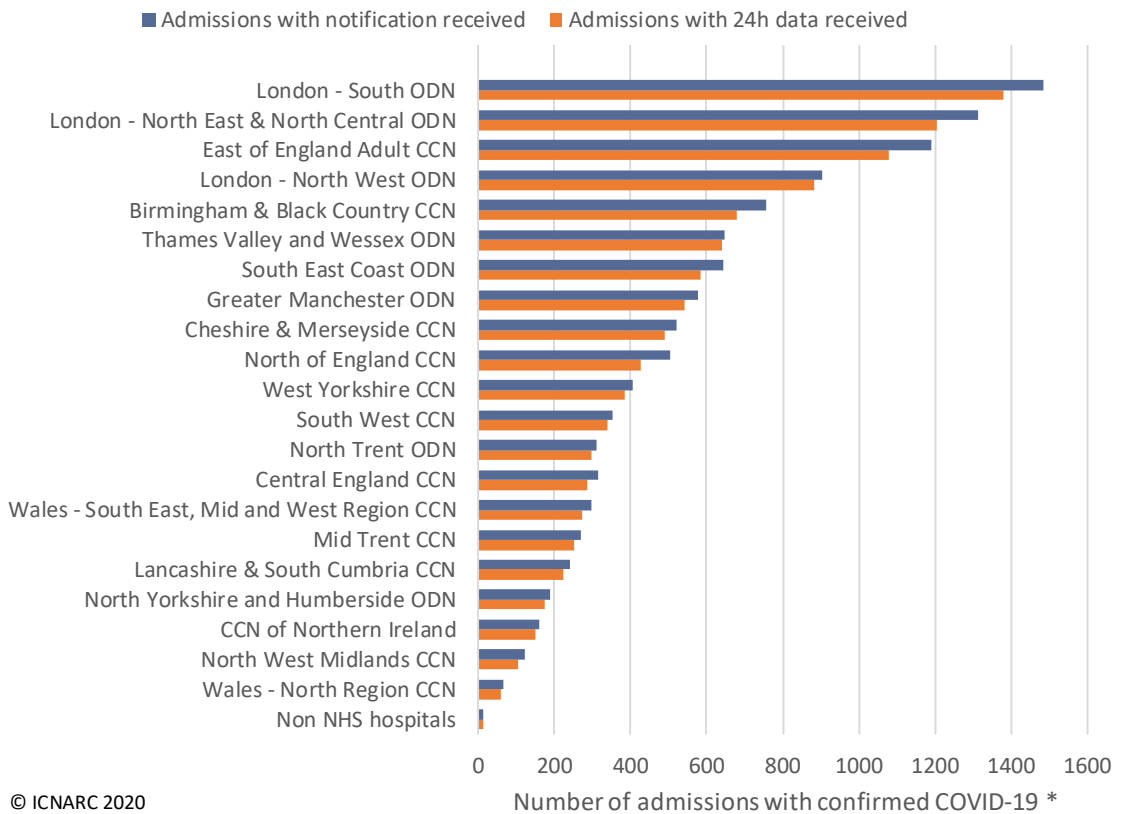
Figure 5 Number of admissions critically ill with confirmed COVID-19 by Critical Care Network *

ODN: Organisational Delivery Network; CCN: Critical Care Network. * Please note that this figure represents the number of admissions (i.e. includes transfers between units and readmissions) and NOT the number of patients.

Patient characteristics

Characteristics of patients critically ill with confirmed COVID-19 are summarised in Table 1 and Table 2 and compared with an historic cohort of patients critically ill with viral pneumonia (non-COVID-19) admitted between 1 January 2017 and 31 December 2019.

Table 1   Patient characteristics: demographics

Demographics	Patients with confirmed COVID-19 and 24h data (N=8699)	Patients with viral pneumonia (non-COVID-19), 2017-19 (N=5782)
Age at admission (years) [N=8692]		
Mean (SD)	58.6 (12.5)	58.0 (17.4)
Median (IQR)	60 (51, 67)	61 (48, 71)
Sex, n (%) [N=8694]		
Female	2513 (28.9)	2641 (45.7)
Male	6181 (71.1)	3141 (54.3)
Currently or recently pregnant, n (% of females aged 16-49) [N=598]		
Currently pregnant	23 (3.8)	56 (7.4)
Recently pregnant (within 6 weeks)	32 (5.4)	29 (3.8)
Not known to be pregnant	543 (90.8)	674 (88.8)
Ethnicity, n (%) [N=7852]		
White	5242 (66.8)	4951 (88.4)
Mixed	134 (1.7)	52 (0.9)
Asian	1191 (15.2)	325 (5.8)
Black	780 (9.9)	155 (2.8)
Other	505 (6.4)	117 (2.1)
Index of Multiple Deprivation (IMD) quintile *, n (%) [N=8530]		
1 (least deprived)	1267 (14.9)	873 (15.3)
2	1387 (16.3)	999 (17.5)
3	1671 (19.6)	1115 (19.5)
4	2077 (24.3)	1232 (21.6)
5 (most deprived)	2128 (24.9)	1489 (26.1)
Body mass index *, n (%) [N=8012]		
<18.5	53 (0.7)	310 (5.5)
18.5-<25	2044 (25.5)	1933 (34.2)
25-<30	2819 (35.2)	1691 (29.9)
30-<40	2484 (31.0)	1330 (23.5)
40+	612 (7.6)	394 (7.0)

* Please see Definitions on page 31.

Table 2   Patient characteristics: medical history and indicators of acute severity *

Medical history	Patients with confirmed COVID-19 and 24h data (N=8699)	Patients with viral pneumonia (non-COVID-19), 2017-19 (N=5782)
Dependency prior to admission to acute hospital, n (%) [N=8350]		
Able to live without assistance in daily activities	7626 (91.3)	4244 (73.6)
Some assistance with daily activities	700 (8.4)	1392 (24.1)
Total assistance with all daily activities	24 (0.3)	134 (2.3)
Very severe comorbidities *, n (%) [N=8426]		
Cardiovascular	37 (0.4)	78 (1.4)
Respiratory	71 (0.8)	295 (5.1)
Renal	136 (1.6)	120 (2.1)
Liver	27 (0.3)	54 (0.9)
Metastatic disease	34 (0.4)	68 (1.2)
Haematological malignancy	136 (1.6)	268 (4.6)
Immunocompromise	276 (3.3)	503 (8.7)
Prior hospital length of stay [N=8677]		
Mean (SD)	2.4 (6.7)	2.8 (14.9)
Median (IQR)	1 (0, 3)	1 (0, 2)
CPR within previous 24h, n (%) [N=8587]		
In the community	41 (0.5)	21 (0.4)
In hospital	50 (0.6)	85 (1.5)
Indicator of acute severity		
Mechanically ventilated within first 24h *, n (%) [N=8080]	5109 (63.2)	2482 (43.0)
APACHE II Score [N=8310]		
Mean (SD)	14.7 (5.3)	17.2 (6.3)
Median (IQR)	14 (11, 18)	17 (13, 21)
PaO2/FiO2 ratio † (kPa), median (IQR) [N=7783]	15.8 (11.3, 21.9)	18.0 (11.6, 26.4)
PaO2/FiO2 ratio †, n (%) [N=7783]		
< 13.3 kPa (< 100 mmHg)	2859 (36.7)	1819 (33.3)
13.3-26.6 kPa (100-200 mmHg)	3832 (49.2)	2318 (42.4)
≥ 26.7 kPa (≥ 200 mmHg)	1092 (14.0)	1328 (24.3)

* Please see Definitions on page 31. Indicators of acute severity are based on data from the first 24 hours of critical care. † Derived from the arterial blood gas with the lowest PaO_2 during the first 24 hours of critical care.

The distribution of age and sex is presented in Figure 6. The distribution of ethnicity, matched on 2011 census ward for location of patients critically ill with COVID-19, is presented in Figure 7.

Females critically ill with COVID-19   Males critically ill with COVID-19

Age at admission	Females	Males
16-30	0.9	1.2
30-39	1.9	3.9
40-49	4.2	9.6
50-59	8.3	19.7
60-69	8.4	21.4
70-79	4.5	13.4
80+	0.7	1.9

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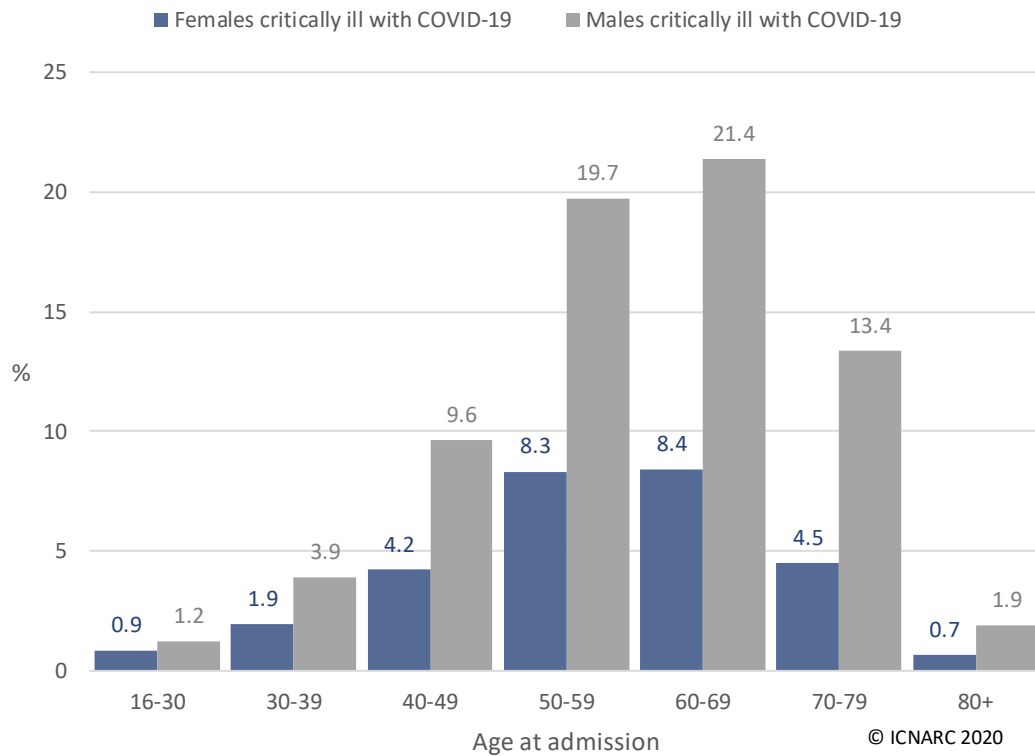
Figure 6   Age and sex distribution of patients critically ill with confirmed COVID-19

Patients critically ill with confirmed COVID-19

Local population (matched on 2011 census ward)

Ethnicity	Patients	Local population
White	66.8	77.7
Mixed	1.7	2.9
Asian	15.2	11.7
Black	9.9	6.1
Other	6.4	1.7

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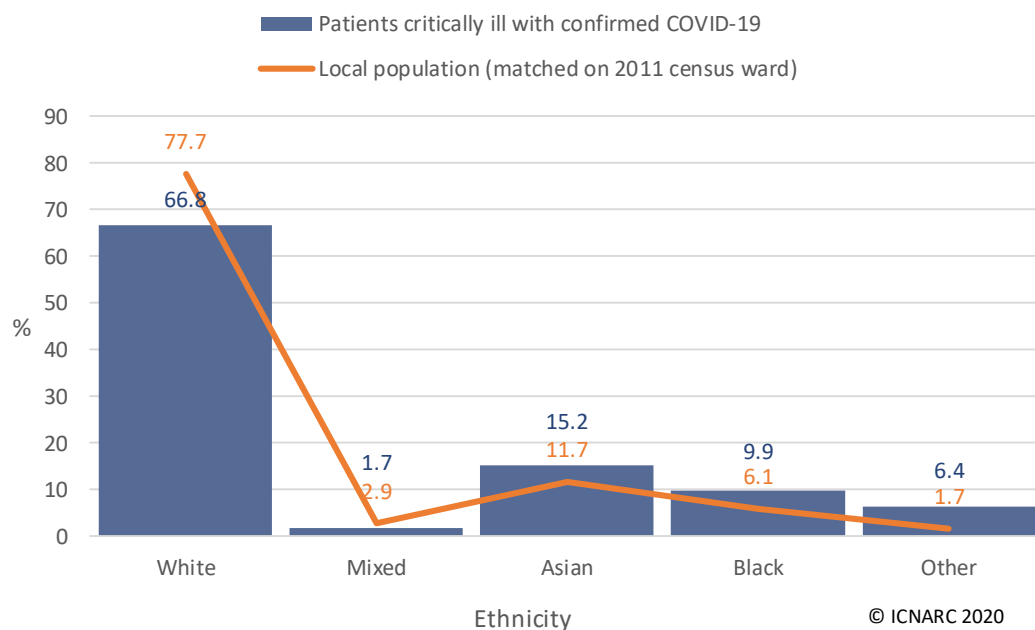
Figure 7   Ethnicity distribution of patients critically ill with confirmed COVID-19

The distribution of Index of Multiple Deprivation (IMD) is presented in Figure 8. The distribution of body mass index (BMI), compared with an age- and sex-matched population (from the Health Survey for England 2018), is presented in Figure 9.
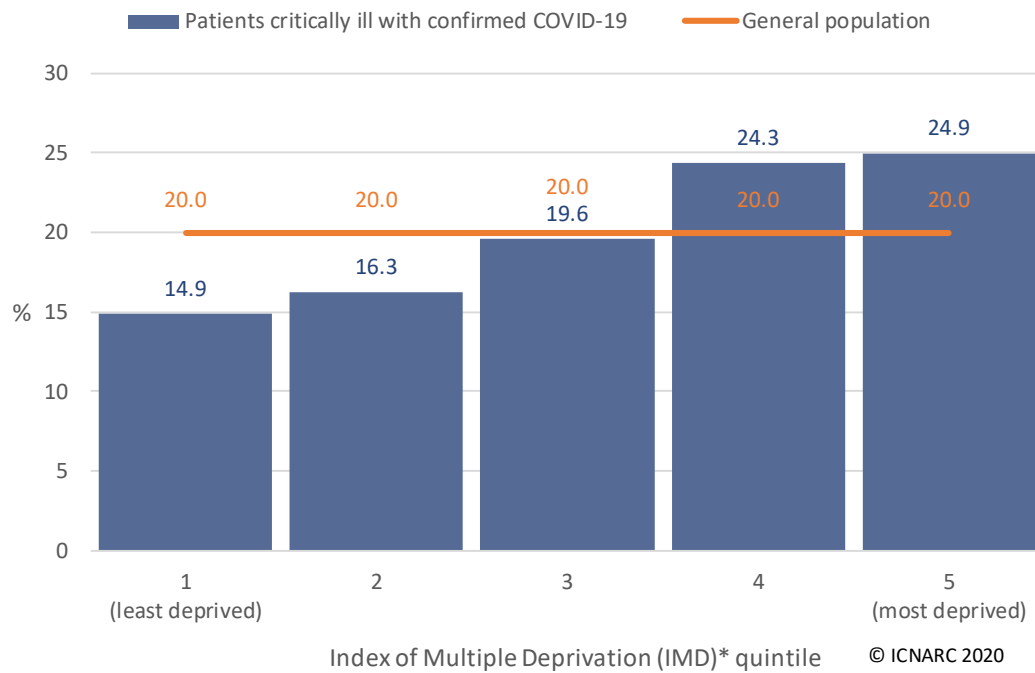
Figure 8   Index of Multiple Deprivation (IMD) * distribution of patients critically ill with confirmed COVID-19

* Please see Definitions on page 31.
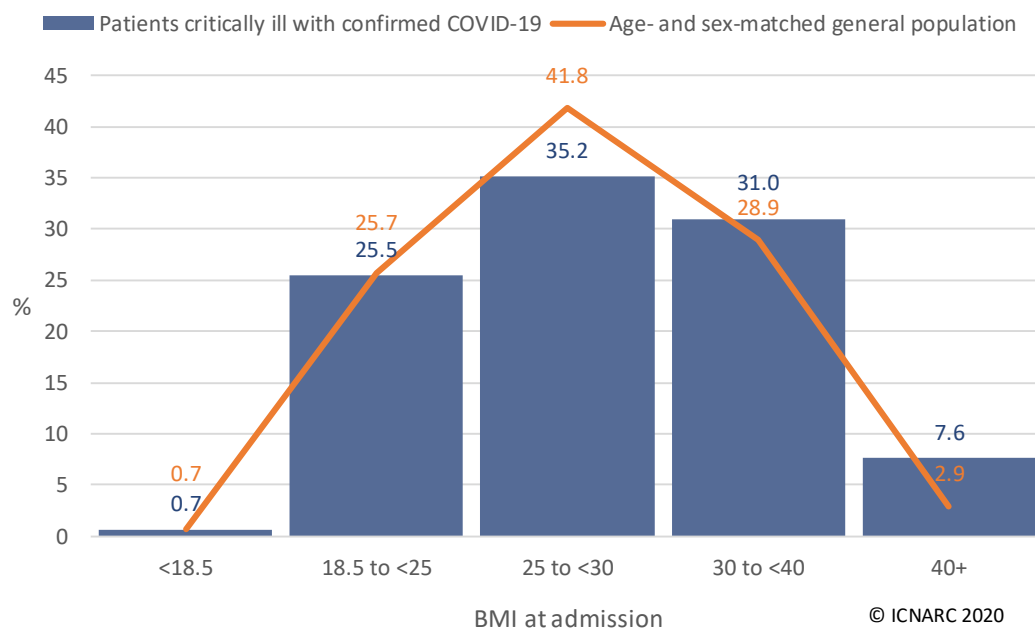
Figure 9   BMI distribution of patients critically ill with confirmed COVID-19

Patient characteristics by receipt of organ support

Characteristics of patients critically ill with confirmed COVID-19 who received advanced respiratory support at any point during critical care and those who received basic respiratory support only are summarised in Table 3 and Table 4. Characteristics of patients critically ill with confirmed COVID-19 who received renal support at any point during critical care and those who did not receive renal support are summarised in Table 5 and Table 6. Most patients who received renal support (95.5%) also received advanced respiratory support.

Table 3   Patient characteristics: demographics by receipt of respiratory support *

Demographics	Patients receiving advanced respiratory support (N=4855)	Patients receiving only basic respiratory support (N=1727)
Age at admission (years) [N=6579]		
Mean (SD)	59.3 (12.1)	58.6 (14.2)
Median (IQR)	60 (52, 68)	59 (49, 69)
Sex, n (%) [N=6580]		
Female	1327 (27.3)	571 (33.1)
Male	3526 (72.7)	1156 (66.9)
Currently or recently pregnant, n (% of females aged 16-49) [N=443]		
Currently pregnant	9 (3.1)	8 (5.4)
Recently pregnant (within 6 weeks)	16 (5.4)	6 (4.1)
Not known to be pregnant	270 (91.5)	134 (90.5)
Ethnicity, n (%) [N=6005]		
White	2886 (65.6)	1215 (75.6)
Mixed	67 (1.5)	24 (1.5)
Asian	682 (15.5)	191 (11.9)
Black	474 (10.8)	100 (6.2)
Other	289 (6.6)	77 (4.8)
Index of Multiple Deprivation (IMD) quintile *, n (%) [N=6475]		
1 (least deprived)	697 (14.6)	283 (16.7)
2	787 (16.5)	296 (17.5)
3	909 (19.0)	317 (18.7)
4	1215 (25.4)	354 (20.9)
5 (most deprived)	1172 (24.5)	445 (26.3)
Body mass index *, n (%) [N=6138]		
<18.5	22 (0.5)	15 (0.9)
18.5-<25	1087 (23.9)	406 (25.7)
25-<30	1660 (36.4)	548 (34.6)
30-<40	1442 (31.7)	462 (29.2)
40+	345 (7.6)	151 (9.5)

* Please see Definitions on page 31. Patients receiving no respiratory support excluded due to small numbers.

Table 4   Patient characteristics: medical history and indicators of acute severity by receipt of respiratory support *

Medical history	Patients receiving advanced respiratory support (N=4855)	Patients receiving only basic respiratory support (N=1727)
Dependency prior to admission to acute hospital, n (%) [N=6437]		
Able to live without assistance in daily activities	4401 (92.6)	1453 (86.3)
Some assistance with daily activities	346 (7.3)	219 (13.0)
Total assistance with all daily activities	7 (0.1)	11 (0.7)
Very severe comorbidities *, n (%) [N=6468]		
Cardiovascular	16 (0.3)	11 (0.7)
Respiratory	33 (0.7)	30 (1.8)
Renal	53 (1.1)	43 (2.5)
Liver	12 (0.3)	8 (0.5)
Metastatic disease	14 (0.3)	11 (0.7)
Haematological malignancy	57 (1.2)	45 (2.7)
Immunocompromise	135 (2.8)	82 (4.9)
Prior hospital length of stay [N=6579]		
Mean (SD)	2.1 (6.7)	2.8 (7.7)
Median (IQR)	1 (0, 3)	1 (0, 3)
CPR within previous 24h, n (%) [N=6564]		
In the community	30 (0.3)	5 (0.3)
In hospital	38 (0.4)	2 (0.1)
Indicator of acute severity		
Mechanically ventilated within first 24h *, n (%) [N=6317]	3848 (82.6)	---
APACHE II Score [N=6409]		
Mean (SD)	15.2 (5.1)	13.7 (5.2)
Median (IQR)	15 (12, 18)	13 (10, 17)
PaO2/FiO2 ratio † (kPa), median (IQR) [N=6082]	15.3 (10.9, 21.3)	17.7 (12.7, 23.8)
PaO2/FiO2 ratio †, n(%) [N=6082]		
< 13.3 kPa (< 100 mmHg)	1808 (39.2)	417 (28.4)
13.3-26.6 kPa (100-200 mmHg)	2227 (48.2)	797 (54.4)
≥ 26.7 kPa (≥ 200 mmHg)	581 (12.6)	252 (17.2)

* Please see Definitions on page 31. Patients receiving no respiratory support excluded due to small numbers. Indicators of acute severity are based on data from the first 24 hours of critical care. † Derived from the arterial blood gas with the lowest PaO_2 from the first 24 hours of critical care.

Table 5   Patient characteristics: demographics by receipt of renal support *

Demographics	Patients receiving any renal support (N=1659)	Patients not receiving any renal support (N=5089)
Age at admission (years) [N=6746]		
Mean (SD)	59.9 (11.2)	58.8 (13.2)
Median (IQR)	61 (53, 68)	60 (51, 69)
Sex, n (%) [N=6746]		
Female	364 (22.0)	1600 (31.4)
Male	1294 (78.0)	3488 (68.6)
Currently or recently pregnant, n (% of females aged 16-49) [N=459]		
Currently pregnant	2 (2.6)	18 (4.7)
Recently pregnant (within 6 weeks)	1 (1.3)	24 (6.3)
Not known to be pregnant	75 (96.2)	339 (89.0)
Ethnicity, n (%) [N=6157]		
White	933 (61.9)	3275 (70.4)
Mixed	13 (0.9)	79 (1.7)
Asian	242 (16.0)	653 (14.0)
Black	228 (15.1)	361 (7.8)
Other	92 (6.1)	281 (6.0)
Index of Multiple Deprivation (IMD) quintile *, n (%) [N=6634]		
1 (least deprived)	218 (13.4)	782 (15.6)
2	253 (15.5)	856 (17.1)
3	312 (19.1)	938 (18.8)
4	435 (26.7)	1178 (23.6)
5 (most deprived)	414 (25.4)	1248 (25.0)
Body mass index *, n (%) [N=6284]		
<18.5	11 (0.7)	30 (0.6)
18.5-<25	340 (21.6)	1208 (25.7)
25-<30	558 (35.4)	1694 (36.0)
30-<40	542 (34.4)	1399 (29.7)
40+	126 (8.0)	376 (8.0)

* Please see Definitions on page 31. Includes 104 patients requiring chronic renal replacement therapy for end stage renal disease prior to critical care; outcomes for these patients are similar.

Table 6   Patient characteristics: medical history and indicators of acute severity by receipt of renal support *

Medical history	Patients receiving any renal support (N=1659)	Patients not receiving any renal support (N=5089)
Dependency prior to admission to acute hospital, n (%) [N=6597]		
Able to live without assistance in daily activities	1513 (92.4)	4473 (90.2)
Some assistance with daily activities	120 (7.3)	468 (9.4)
Total assistance with all daily activities	4 (0.2)	19 (0.4)
Very severe comorbidities *, n (%) [N=6628]		
Cardiovascular	7 (0.4)	23 (0.5)
Respiratory	13 (0.8)	51 (1.0)
Renal	77 (4.7)	27 (0.5)
Liver	1 (0.1)	19 (0.4)
Metastatic disease	8 (0.5)	22 (0.4)
Haematological malignancy	16 (1.0)	88 (1.8)
Immunocompromise	55 (3.3)	172 (3.5)
Prior hospital length of stay [N=6744]		
Mean (SD)	2.0 (4.4)	2.4 (7.8)
Median (IQR)	1 (0, 3)	1 (0, 3)
CPR within previous 24h, n (%) [N=6727]		
In the community	10 (0.2)	25 (0.5)
In hospital	6 (0.1)	36 (0.7)
Indicator of acute severity		
Mechanically ventilated within first 24h *, n (%) [N=6456]	1291 (80.7)	2697 (55.5)
APACHE II Score [N=6560]		
Mean (SD)	16.9 (5.4)	14.1 (5.0)
Median (IQR)	16 (13, 20)	14 (11, 17)
PaO2/FiO2 ratio † (kPa), median (IQR) [N=6188]	14.3 (10.5, 19.8)	16.7 (11.7, 23.1)
PaO2/FiO2 ratio †, n(%) [N=6188]		
< 13.3 kPa (< 100 mmHg)	698 (44.3)	1532 (33.2)
13.3-26.6 kPa (100-200 mmHg)	730 (46.3)	2314 (50.2)
≥ 26.7 kPa (≥ 200 mmHg)	149 (9.4)	765 (16.6)

* Please see Definitions on page 31. Includes 104 patients requiring chronic renal replacement therapy for end stage renal disease prior to critical care; outcomes for these patients are similar. Indicators of acute severity are based on data from the first 24 hours of critical care. † Derived from the arterial blood gas with the lowest PaO$_2$ from the first 24 hours of critical care.

Outcomes, length of stay and organ support

Critical care outcomes have been received for 6860 (of 8699) patients, of whom 3139 patients have died and 3721 have been discharged alive from critical care (Figure 10 and Figure 11). Length of stay in critical care and duration of organ support in critical care are summarised in Table 7 and compared with an historic cohort of patients critically ill with viral pneumonia (non-COVID-19) admitted between 1 January 2017 and 31 December 2019. Receipt and duration of organ support are summarised graphically in Figure 12 and in Figure 13, respectively.

Please note that Figure 11 is biased towards longer lengths of stay in critical care due to the time lag in notification of a patients' discharge or death, while Table 7, Figure 12 and Figure 13 are biased towards patients with shorter lengths of stay in critical care due to the emerging nature of the UK epidemic. Figure 10 and Figure 11 assume that patients are still in critical care unless ICNARC has been notified otherwise, and Table 7, Figure 12 and Figure 13 include only those patients who have either died or been discharged from critical care.

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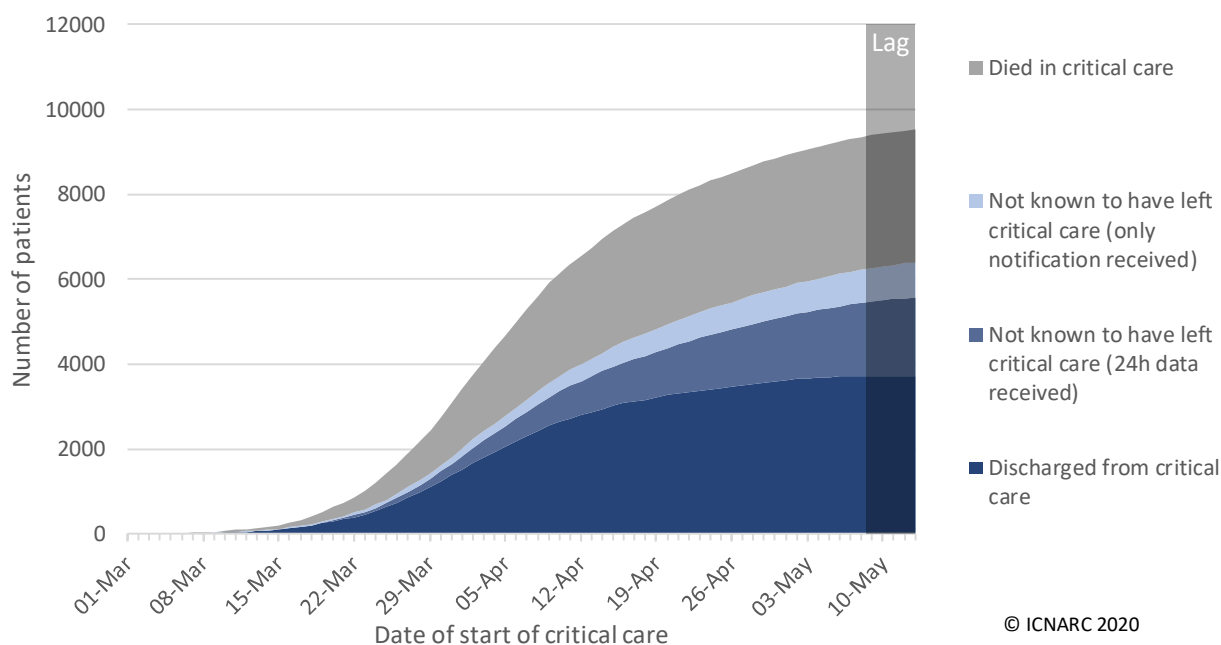
Figure 10 Cumulative outcomes by date of start of critical care *

* Please note that patients whose outcome data have not been received are assumed to remain in critical care as of 14 May 2020.
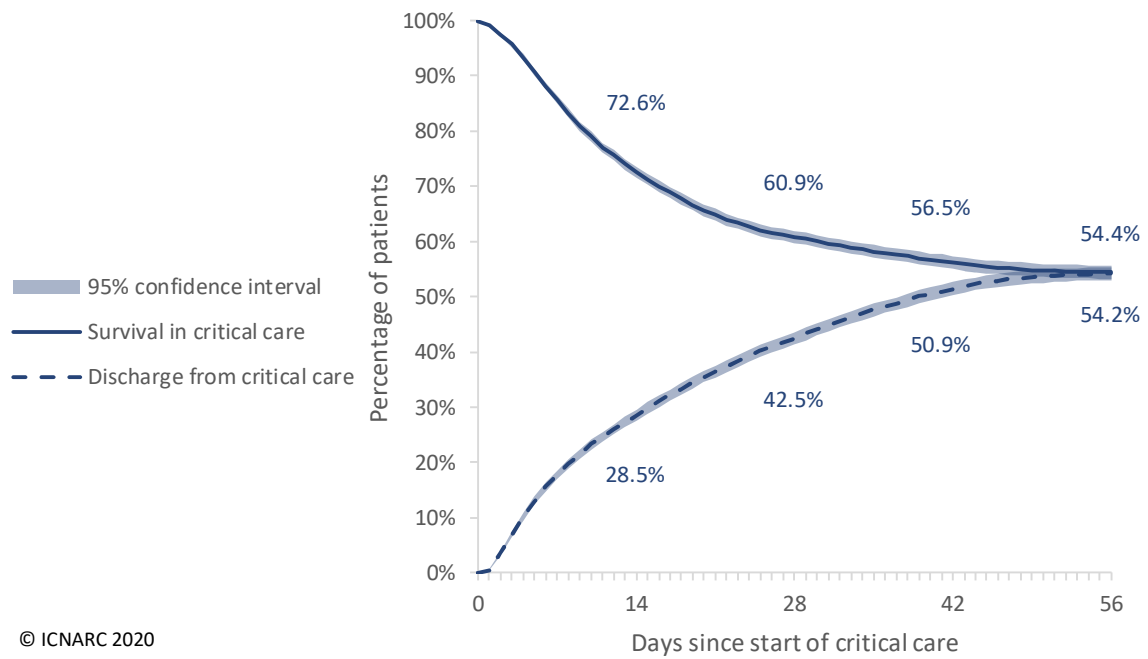
	0	14	28	42	56
Died while receiving critical care	0	2237	3005	3100	3107
Still receiving critical care	8633	3590	1412	336	12
Discharged from critical care	0	2323	3264	3636	3696
Censored	0	483	952	1561	1818

Figure 11 Survival and discharge among patients with at least 24h data received

Please note that due to the time lag in notification of patients' discharge or death, this figure is expected to be biased towards *longer* lengths of stay in critical care. Patients who are still in critical care are included only for the period in which they are known to have been in critical care, i.e. from their date of admission until 14 May 2020. Due to the emerging nature of the UK epidemic, the total number of patients available for reporting becomes smaller at longer lengths of follow-up. Compared with the survival statistics presented in Table 7, Table 10 and Table 11, this approach makes better use of all available data, including data about patients who are still in critical care.

Table 7   Outcome, length of stay and organ support *

| Critical care outcomes among patients who have been discharged or died	Patients with COVID-19 and outcome reported (N=6860)	Patients with viral pneumonia (non-COVID-19), 2017-19 (N=5367)
Outcome at end of critical care, n (%)		
Discharged	3721 (54.2)	4184 (78.0)
Died	3139 (45.8)	1183 (22.0)
Length of stay		
Length of stay in critical care (days), median (IQR)		
Survivors	9 (4, 19)	6 (3, 14)
Non-survivors	8 (5, 14)	6 (2, 13.5)
Organ support (Critical Care Minimum Dataset) *		
Receipt of organ support, at any point, n (%)		
Advanced respiratory support	4855 (71.8)	2610 (48.6)
Basic respiratory support	4199 (62.1)	4413 (82.2)
Advanced cardiovascular support	1907 (28.2)	1223 (22.8)
Basic cardiovascular support	6285 (92.9)	4993 (93.0)
Renal support	1659 (24.6)	959 (17.9)
Liver support	42 (0.6)	48 (0.9)
Neurological support	450 (6.7)	316 (5.9)
Combinations of advanced respiratory, advanced cardiovascular and renal support, n (%):		
Advanced respiratory support only	2224 (32.4)	1174 (21.9)
Advanced cardiovascular support only	21 (0.3)	79 (1.5)
Renal support only	66 (1.0)	117 (2.2)
Advanced respiratory and advanced cardiovascular support only	1035 (15.1)	609 (11.3)
Advanced respiratory and renal support only	753 (11.0)	307 (5.7)
Advanced cardiovascular and renal support only	8 (0.1)	15 (0.3)
Advanced respiratory, advanced cardiovascular and renal support	843 (12.3)	520 (9.7)
Duration of organ support (calendar days), median (IQR)		
Advanced respiratory support	11 (6, 18)	9 (4, 17)
Total (advanced + basic) respiratory support	9 (5, 17)	6 (3, 13)
Advanced cardiovascular support	3 (2, 6)	3 (2, 5)
Total (advanced + basic) cardiovascular support	9 (5, 17)	6 (4, 13)
Renal support	6 (3, 12)	6 (3, 12)

Please note that owing to the emerging nature of the epidemic, the sample of patients with confirmed COVID-19 represented in this table is biased towards patients with *shorter* lengths of stay in critical care prior to discharge or death, i.e. those who died or recovered quickly. This does not apply to the comparison patients with viral pneumonia (non-COVID-19), 2017-19. * Please see Definitions on page 31.
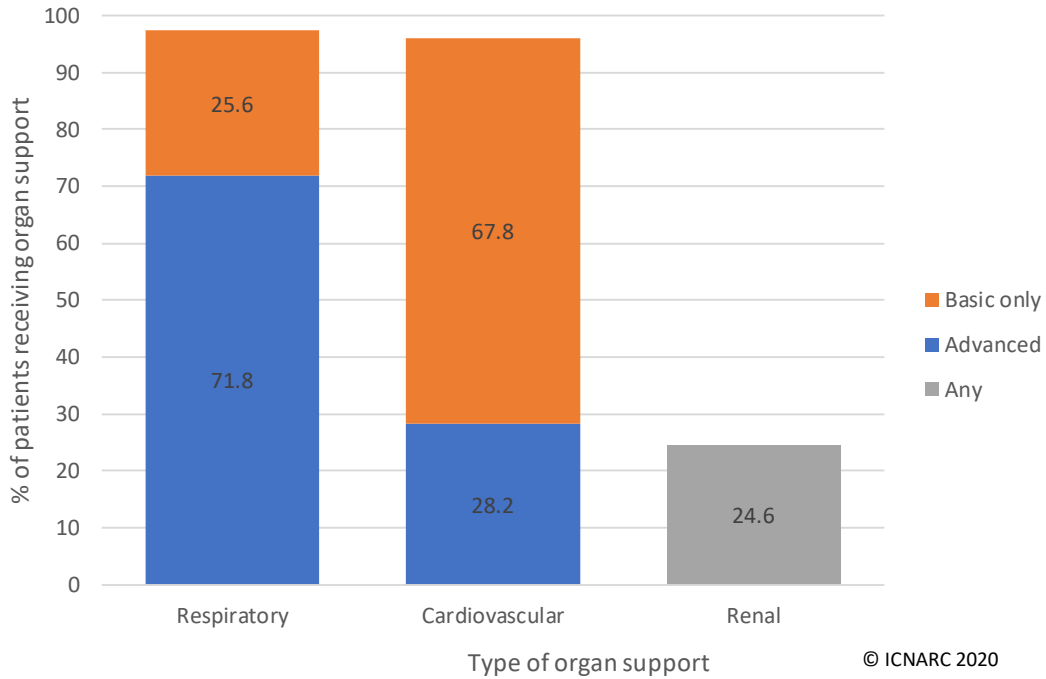
Figure 12   Percentage of patients receiving organ support *

Please note that owing to the emerging nature of the epidemic, the sample of patients with confirmed COVID-19 represented in this table is biased towards patients with *shorter* lengths of stay in critical care prior to discharge or death, i.e. patients who died or recovered quickly. * Please see Definitions on page 31.
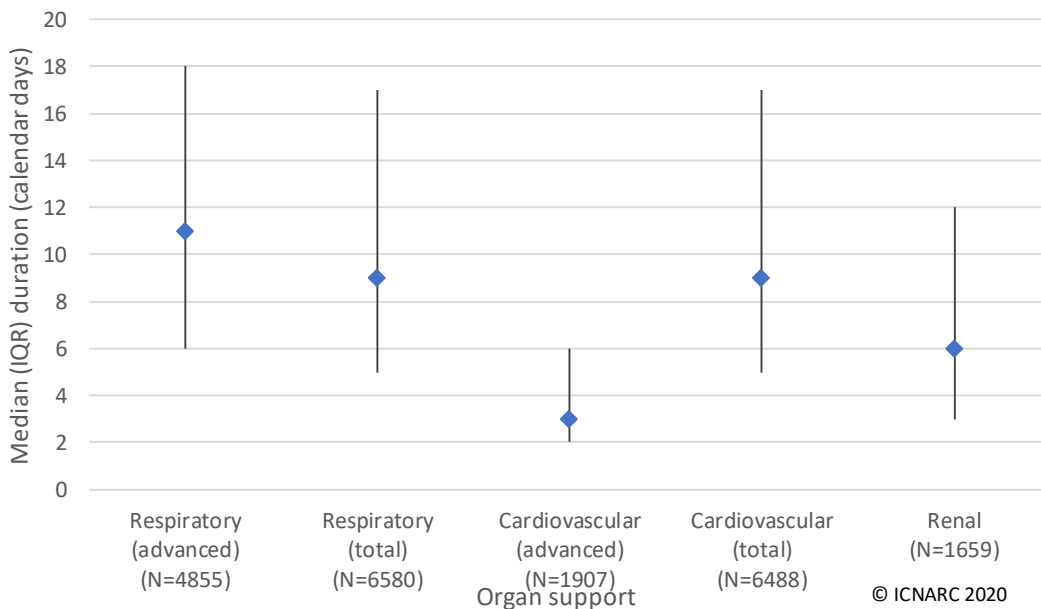
Figure 13   Duration of organ support received *

This Figure presents median and interquartile range, in calendar days. Please note that owing to the emerging nature of the epidemic, the sample of patients with confirmed COVID-19 represented in this table is biased towards patients with *shorter* lengths of stay in critical care prior to discharge or death, i.e. patients who died or recovered quickly. * Please see Definitions on page 31.

Outcomes by patient characteristics

Critical care outcomes for patients critically ill with confirmed COVID-19 across major patient subgroups are summarised in Table 8 and compared with an historic cohort of patients critically ill with viral pneumonia (non-COVID-19) admitted between 1 January 2017 and 31 December 2019.

Table 8   Outcome by patient characteristics

Patient characteristic	Patients with COVID-19 and outcome reported (N=6860)		Patients with viral pneumonia (non-COVID-19), 2017-19 (N=5782)
	Discharged alive from critical care	Died in critical care	Died in critical care
	n (%)	n (%)	(%)
Age at admission (years)			
16-39	451 (81.9)	100 (18.1)	(8.5)
40-49	677 (75.3)	222 (24.7)	(12.6)
50-59	1132 (60.7)	734 (39.3)	(19.1)
60-69	931 (46.1)	1087 (53.9)	(25.7)
70-79	450 (34.2)	865 (65.8)	(30.7)
80+	78 (37.5)	130 (62.5)	(29.7)
Sex			
Female	1194 (59.8)	803 (40.2)	(19)
Male	2527 (52.0)	2334 (48.0)	(24)
Ethnicity			
White	2386 (55.9)	1884 (44.1)	(22.1)
Mixed	45 (48.4)	48 (51.6)	(11.9)
Asian	432 (47.5)	477 (52.5)	(18.9)
Black	292 (49.1)	303 (50.9)	(13.6)
Other	223 (58.7)	157 (41.3)	(20.2)
Index of Multiple Deprivation (IMD) quintile *			
1 (least deprived)	575 (56.2)	449 (43.8)	(21.7)
2	625 (55.5)	501 (44.5)	(22.2)
3	698 (54.6)	580 (45.4)	(21.9)
4	845 (51.9)	784 (48.1)	(21.9)
5 (most deprived)	901 (53.4)	785 (46.6)	(21.1)
Body mass index			
<25	881 (54.2)	744 (45.8)	(22.9)
25-<30	1181 (51.7)	1102 (48.3)	(22.9)
30-<40	1124 (57.2)	841 (42.8)	(19.7)
40+	295 (58.0)	214 (42.0)	(15)
Assistance required with daily activities			
No	3345 (55.1)	2728 (44.9)	(19.7)
Yes	282 (45.8)	334 (54.2)	(27.4)
Any very severe comorbidities *			
No	3429 (55.0)	2806 (45.0)	(19)
Yes	221 (44.9)	271 (55.1)	(33.5)

Please note that owing to the emerging nature of the epidemic, the sample of patients with COVID-19 represented in this table is biased towards patients with *shorter* lengths of stay in critical care prior to discharge or death (i.e. those who died or recovered quickly). This does not apply to the comparison patients with viral pneumonia (non-COVID-19), 2017-19. * Please see Definitions on page 31.

Outcomes by receipt of organ support

Figure 14 presents 30-day survival for patients critically ill with confirmed COVID-19 who received mechanical ventilation during the first 24 hours of critical care compared with patients who did not.

Critical care outcomes for patients critically ill with confirmed COVID-19 who received advanced respiratory support at any point during critical care and who received basic respiratory support only are summarised in Table 10. Critical care outcomes for patients critically ill with confirmed COVID-19 who received renal support at any point during critical care and who did not receive renal support are summarised in Table 11.

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	(2702)	(2658)	(2586)	(2524)	(2472)	(2411)	(2351)
	(4844)	(4820)	(4759)	(4668)	(4519)	(4338)	(4120)

Figure 14 30-day survival by mechanical ventilation during the first 24 hours *

* Please see Definitions on page 31. Patients who are still in critical care are included only for the period in which they are known to have been in critical care, i.e. from their date of start of critical care until 14 May 2020. The numbers of patients available for reporting (in brackets) are the number of patients who are known to have either died or been discharged on or before that time point plus the number of patients known to have been still in critical care beyond that time point. Due to the emerging nature of the UK epidemic, the total number of patients available for reporting becomes smaller at longer lengths of follow-up. Compared with the survival statistics presented in Table 7 and Table 10, this approach makes better use of all available data, including data about patients who are still in critical care.

Table 9   Outcome by combinations of organ support *

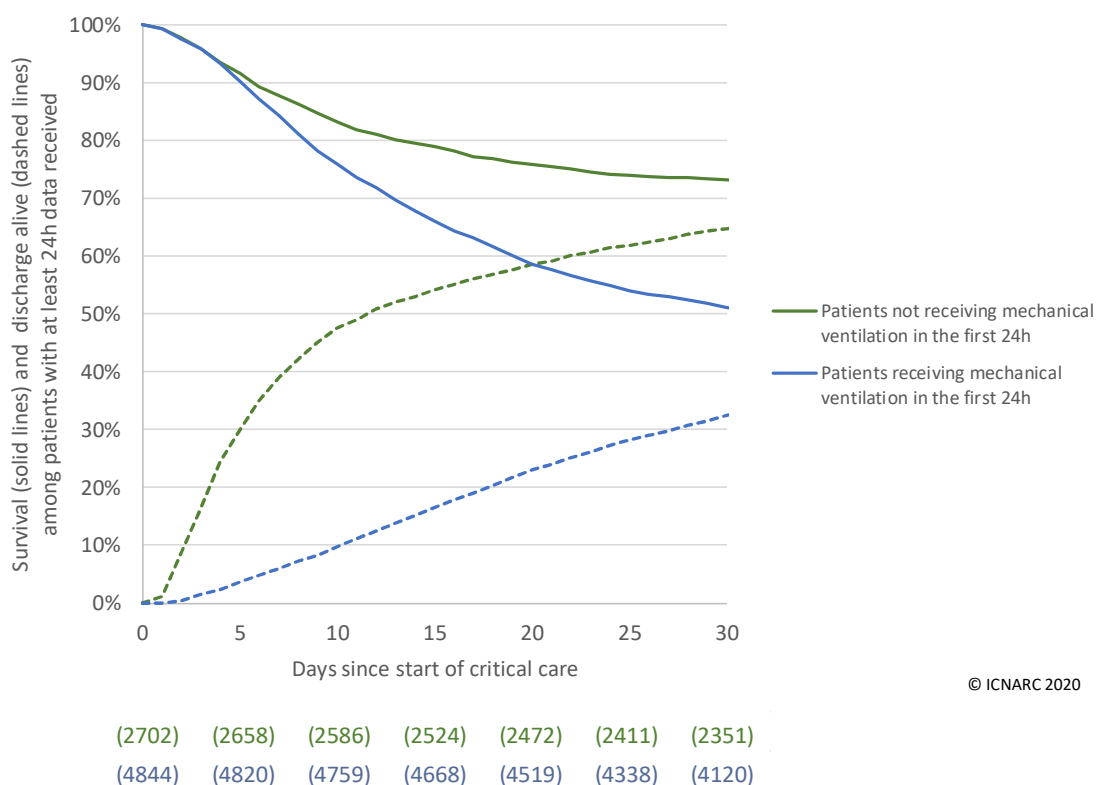| Organ support received *	Patients with COVID-19 and outcome reported (N=6860)		Patients with viral pneumonia (non-COVID-19), 2017-19 (N=5782)
	Discharged alive from critical care	Died in critical care	Died in critical care
	n (%)	n (%)	(%)
Any respiratory support			
Basic only	1409 (81.6)	318 (18.4)	(11.2)
Advanced	2098 (43.2)	2757 (56.8)	(34.5)
Any renal support	519 (31.1)	1151 (68.9)	(47.9)
Combinations of advanced respiratory, advanced cardiovascular and renal support:			
Advanced respiratory support only	1287 (57.9)	937 (42.1)	(19.4)
Advanced respiratory and advanced cardiovascular support only	350 (33.8)	685 (66.2)	(41.1)
Advanced respiratory and renal support only	283 (37.6)	470 (62.4)	(39.2)
Advanced respiratory, advanced cardiovascular and renal support	178 (21.1)	665 (78.9)	(60.1)

Please note that owing to the emerging nature of the epidemic, the sample of patients with COVID-19 represented in this table is biased towards patients with *shorter* lengths of stay in critical care prior to discharge or death, i.e. those who died or recovered quickly. * Please see Definitions on page 31.

Table 10   Outcome, length of stay and organ support by receipt of respiratory support *

Critical care outcomes among patients who have been discharged or died	Patients receiving advanced respiratory support * (N=4287)	Patients receiving only basic respiratory support * (N=1584)
Outcome at end of critical care, n (%)		
Discharged	1768 (41.2)	1302 (82.2)
Died	2519 (58.8)	282 (17.8)
Length of stay		
Length of stay in critical care (days), median (IQR)		
Survivors	15 (9, 23)	4 (2, 6)
Non-survivors	9 (5, 15)	3 (2, 5.5)
Organ support (Critical Care Minimum Dataset) *		
Receipt of organ support, at any point, n (%)		
Basic respiratory support	2076 (48.4)	1584 (100.0)
Advanced cardiovascular support	1644 (38.4)	17 (1.1)
Basic cardiovascular support	4069 (94.9)	1393 (87.9)
Renal support	1374 (32.1)	54 (3.4)
Liver support	37 (0.9)	1 (0.1)
Neurological support	364 (8.5)	12 (0.8)
Duration of organ support (calendar days), median (IQR)		
Total (advanced + basic) respiratory support	12 (7, 18)	4 (2, 6)
Advanced cardiovascular support	3 (2, 5)	2 (1, 3)
Total (advanced + basic) cardiovascular support	12 (7, 18)	4 (3, 6)
Renal support	6 (3, 11)	3 (2, 4)

Please note that owing to the emerging nature of the epidemic, the sample of patients with COVID-19 represented in this table is biased towards patients with *shorter* lengths of stay in critical care prior to discharge or death, i.e. those who died or recovered quickly. * Please see Definitions on page 31. Patients receiving no respiratory support excluded due to small numbers.

Table 11   Outcome, length of stay and organ support by receipt of renal support *

Critical care outcomes among patients who have been discharged or died	Patients receiving any renal support * (N=1659)	Patients not receiving any renal support * (N=5089)
Outcome at end of critical care, n (%)		
Discharged	510 (30.7)	3138 (61.7)
Died	1149 (69.3)	1951 (38.3)
Length of stay		
Length of stay in critical care (days), median (IQR)		
Survivors	22 (15, 30)	8 (3, 16)
Non-survivors	12 (7, 18)	7 (4, 12)
Organ support (Critical Care Minimum Dataset) *		
Receipt of organ support, at any point, n (%)		
Advanced respiratory support	1585 (95.5)	3259 (64.0)
Basic respiratory support	727 (43.8)	3455 (67.9)
Advanced cardiovascular support	848 (51.1)	1055 (20.7)
Basic cardiovascular support	1586 (95.6)	4679 (91.9)
Liver support	29 (1.8)	13 (0.3)
Neurological support	171 (10.4)	279 (5.5)
Duration of organ support (calendar days), median (IQR)		
Advanced respiratory support	14 (9, 20)	10 (5, 16)
Total (advanced + basic) respiratory support	15 (9, 21)	8 (4, 14)
Advanced cardiovascular support	3 (2, 6)	3 (1, 5)
Total (advanced + basic) cardiovascular support	15 (9, 22)	8 (4, 15)

Please note that owing to the emerging nature of the epidemic, the sample of patients with COVID-19 represented in this table is biased towards patients with *shorter* lengths of stay in critical care prior to discharge or death, i.e. those who died or recovered quickly. * Please see Definitions on page 31. Includes 104 patients requiring chronic renal replacement therapy for end stage renal disease prior to critical care; outcomes for these patients are similar.

Critical care outcomes for patients critically ill with confirmed COVID-19 who received advanced respiratory support at any point during critical care and who received basic respiratory support only across major patient subgroups are summarised in Table 12. Critical care outcomes for patients critically ill with confirmed COVID-19 who received renal support at any point during critical care and who did not receive renal support across major patient subgroups are summarised in Table 13.

Table 12   Outcome by receipt of respiratory support * and patient characteristics

Patient characteristic	Patients receiving advanced respiratory support * (N=4855)		Patients receiving only basic respiratory support * (N=1727)	
	Discharged alive from critical care	Died in critical care	Discharged alive from critical care	Died in critical care
	n (%)	n (%)	n (%)	n (%)
Age at admission (years)				
16-39	242 (72.5)	92 (27.5)	176 (97.2)	5 (2.8)
40-49	403 (66.7)	201 (33.3)	235 (92.9)	18 (7.1)
50-59	678 (49.9)	681 (50.1)	405 (91.2)	39 (8.8)
60-69	542 (35.7)	978 (64.3)	339 (80.5)	82 (19.5)
70-79	216 (22.9)	726 (77.1)	200 (61.7)	124 (38.3)
80+	16 (17.0)	78 (83.0)	53 (51.5)	50 (48.5)
Sex				
Female	641 (48.3)	686 (51.7)	471 (82.5)	100 (17.5)
Male	1457 (41.3)	2069 (58.7)	938 (81.1)	218 (18.9)
Ethnicity				
White	1272 (44.1)	1614 (55.9)	979 (80.6)	236 (19.4)
Mixed	23 (34.3)	44 (65.7)	21 (87.5)	3 (12.5)
Asian	260 (38.1)	422 (61.9)	148 (77.5)	43 (22.5)
Black	196 (41.4)	278 (58.6)	84 (84.0)	16 (16.0)
Other	142 (49.1)	147 (50.9)	70 (90.9)	7 (9.1)
Index of Multiple Deprivation (IMD) quintile				
1 (least deprived)	309 (44.3)	388 (55.7)	230 (81.3)	53 (18.7)
2	350 (44.5)	437 (55.5)	245 (82.8)	51 (17.2)
3	401 (44.1)	508 (55.9)	262 (82.6)	55 (17.4)
4	499 (41.1)	716 (58.9)	296 (83.6)	58 (16.4)
5 (most deprived)	501 (42.7)	671 (57.3)	346 (77.8)	99 (22.2)
Body mass index				
<25	477 (43.0)	632 (57.0)	338 (80.3)	83 (19.7)
25-<30	669 (40.3)	991 (59.7)	452 (82.5)	96 (17.5)
30-<40	690 (47.9)	752 (52.1)	386 (83.5)	76 (16.5)
40+	158 (45.8)	187 (54.2)	124 (82.1)	27 (17.9)
Assistance required with daily activities				
No	1927 (43.8)	2474 (56.2)	1247 (85.8)	206 (14.2)
Yes	123 (34.8)	230 (65.2)	131 (57.0)	99 (43.0)
Any very severe comorbidities *				
No	1986 (44.1)	2515 (55.9)	1265 (84.2)	237 (15.8)
Yes	80 (28.7)	199 (71.3)	117 (62.9)	69 (37.1)

Please note that owing to the emerging nature of the epidemic, the sample of patients with COVID-19 represented in this table is biased towards patients with *shorter* lengths of stay in critical care prior to discharge or death, i.e. those who died or recovered quickly. * Please see Definitions on page 31. Patients receiving no respiratory support excluded due to small numbers.

Table 13　Outcome by receipt of renal support * and patient characteristics

Patient characteristic	Patients receiving any renal support * (N=1659)		Patients not receiving any renal support * (N=5089)	
	Discharged alive from critical care	Died in critical care	Discharged alive from critical care	Died in critical care
	n (%)	n (%)	n (%)	n (%)
Age at admission (years)				
16-39	39 (50.6)	38 (49.4)	403 (87.0)	60 (13.0)
40-49	119 (57.8)	87 (42.2)	540 (80.6)	130 (19.4)
50-59	159 (33.8)	311 (66.2)	954 (69.8)	413 (30.2)
60-69	132 (23.7)	426 (76.3)	780 (54.7)	646 (45.3)
70-79	57 (17.5)	269 (82.5)	386 (39.5)	591 (60.5)
80+	4 (18.2)	18 (81.8)	74 (40.2)	110 (59.8)
Sex				
Female	129 (35.4)	235 (64.6)	1042 (65.1)	558 (34.9)
Male	381 (29.4)	913 (70.6)	2096 (60.1)	1392 (39.9)
Ethnicity				
White	305 (32.7)	628 (67.3)	2038 (62.2)	1237 (37.8)
Mixed	5 (38.5)	8 (61.5)	40 (50.6)	39 (49.4)
Asian	64 (26.4)	178 (73.6)	362 (55.4)	291 (44.6)
Black	74 (32.5)	154 (67.5)	217 (60.1)	144 (39.9)
Other	22 (23.9)	70 (76.1)	197 (70.1)	84 (29.9)
Index of Multiple Deprivation (IMD) quintile				
1 (least deprived)	82 (37.6)	136 (62.4)	475 (60.7)	307 (39.3)
2	79 (31.2)	174 (68.8)	534 (62.4)	322 (37.6)
3	110 (35.3)	202 (64.7)	570 (60.8)	368 (39.2)
4	111 (25.5)	324 (74.5)	726 (61.6)	452 (38.4)
5 (most deprived)	118 (28.5)	296 (71.5)	769 (61.6)	479 (38.4)
Body mass index				
<25	100 (28.5)	251 (71.5)	765 (61.8)	473 (38.2)
25-<30	142 (25.4)	416 (74.6)	1017 (60.0)	677 (40.0)
30-<40	204 (37.6)	338 (62.4)	905 (64.7)	494 (35.3)
40+	43 (34.1)	83 (65.9)	245 (65.2)	131 (34.8)
Assistance required with daily activities				
No	461 (30.5)	1052 (69.5)	2828 (63.2)	1645 (36.8)
Yes	39 (31.5)	85 (68.5)	240 (49.3)	247 (50.7)
Any very severe comorbidities *				
No	449 (30.2)	1039 (69.8)	2919 (62.7)	1734 (37.3)
Yes	55 (35.0)	102 (65.0)	164 (49.7)	166 (50.3)

Please note that owing to the emerging nature of the epidemic, the sample of patients with COVID-19 represented in this table is biased towards patients with *shorter* lengths of stay in critical care prior to discharge or death, i.e. those who died or recovered quickly. * Please see Definitions on page 31. Includes 104 patients requiring chronic renal replacement therapy for end stage renal disease prior to critical care; outcomes for these patients are similar.

Multivariable analyses

Patient population:
- A multivariable Cox proportional hazards regression model was developed based solely on available data from patients critically ill with confirmed COVID-19 with a start of critical care between 1 March and 21 April 2020.
- All patients were followed up for a minimum of 7 days, and outcomes were censored at 30 days following the start of critical care. Patients discharged alive from hospital within 30 days, and those ending critical care within 30 days with missing hospital outcome were assumed to survive to 30 days.
- Patients either with a duration of critical care of less than 24 hours or with no data recorded for any core physiology (temperature, systolic blood pressure, heart rate or respiratory rate) were excluded.

Prognostic factors:
- Prognostic factors were selected, a priori, based on established relationships with outcome for critically ill patients and on emerging information from the COVID-19 pandemic.
- Continuous prognostic factors were assessed for non-linearity using restricted cubic splines with up to five knots.
- Missing data were imputed using fully conditional specification (with models fitted in ten multiply imputed datasets and results combined).

Results:
- Of 6989 patients, 58 had a duration of critical care of less than 24 hours and 595 had no data recorded for any core physiology; a cohort of 6336 patients were included in the model.
- The results of the multivariable modelling are presented in Figure 15, Figure 16 and Figure 17.

Explanation:
- The figures present the hazard ratio (solid lines or points) for values of each prognostic factor compared with a reference value (as indicated).
- A hazard ratio is a measure of how much more or less likely the event (death) is to occur.

For example, a patient aged 70 has a hazard ratio of approximately 2 compared with a patient aged 60; this means that they are twice as likely to die within 30 days of the start of critical care. In contrast, a patient aged 40 has a hazard ratio of approximately 0.5 compared with a patient aged 60; this means that they are half as likely to die within 30 days of the start of critical care. A hazard ratio of 1 means that the risk of death is the same.

- The hazard ratios indicate the association between each prognostic factor and the outcome adjusted for the effect of all the other variables in the model.

For example, the hazard ratio for dependency is adjusted for patients with dependency being older on average than those without dependency.

- The estimated hazard ratios are shown with 95% confidence intervals (as dashed lines or vertical spikes) indicating a range of possible values for the hazard ratio that will include the true value 19 times out of 20.

A manuscript reporting the full details of the modelling is being prepared for publication.
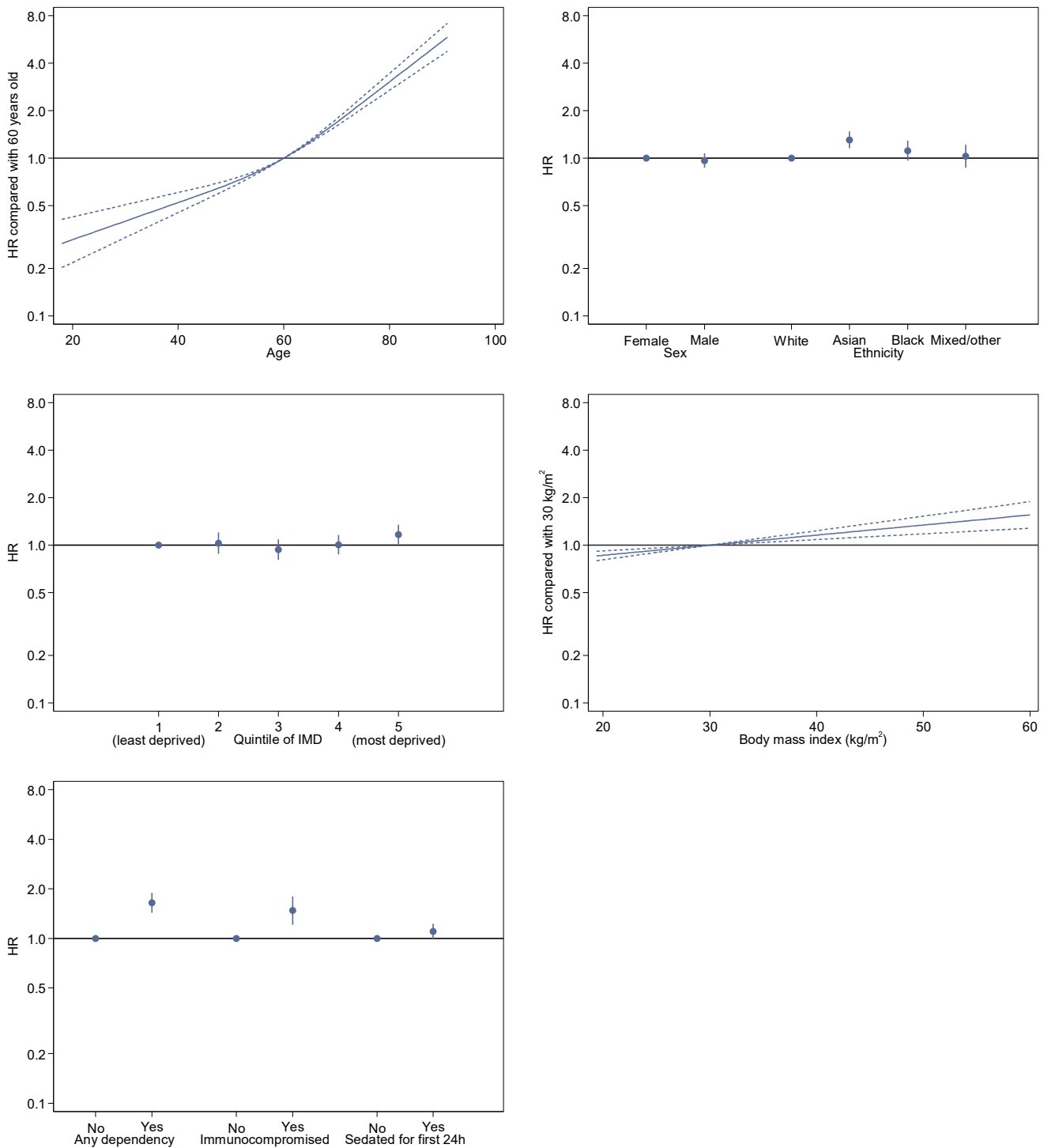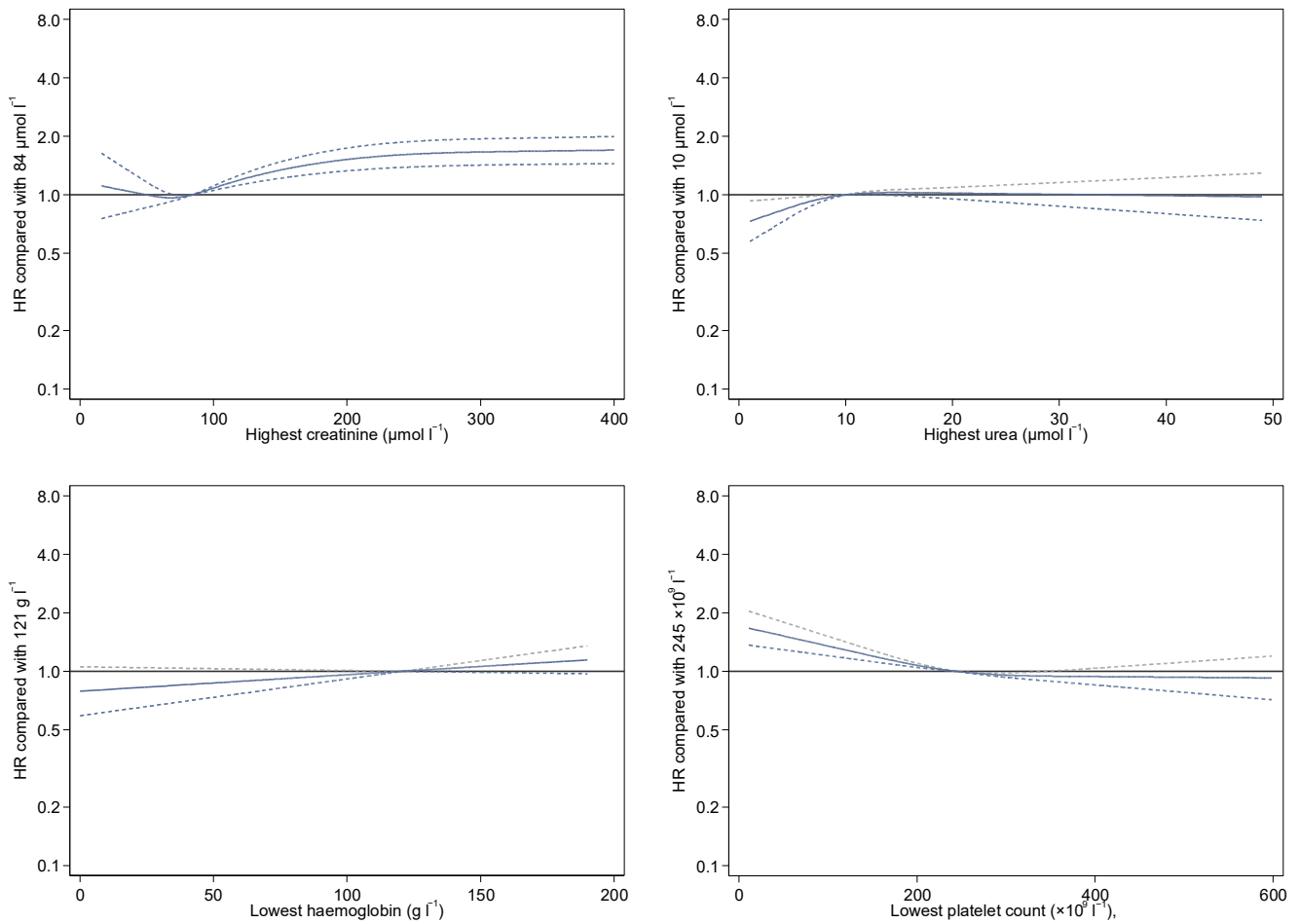
Figure 15 Hazard ratios and 95% confidence intervals from Cox proportional hazards regression model for death within 30 days following start of critical care: demographics and medical history

Please note that hazard ratios (HR) are reported relative to the median value for age (60 years) and the threshold for defining obesity for body mass index (30 kg/m²). Immunocompromised includes the conditions as defined on page 31 and also metastatic disease and haematological malignancy.
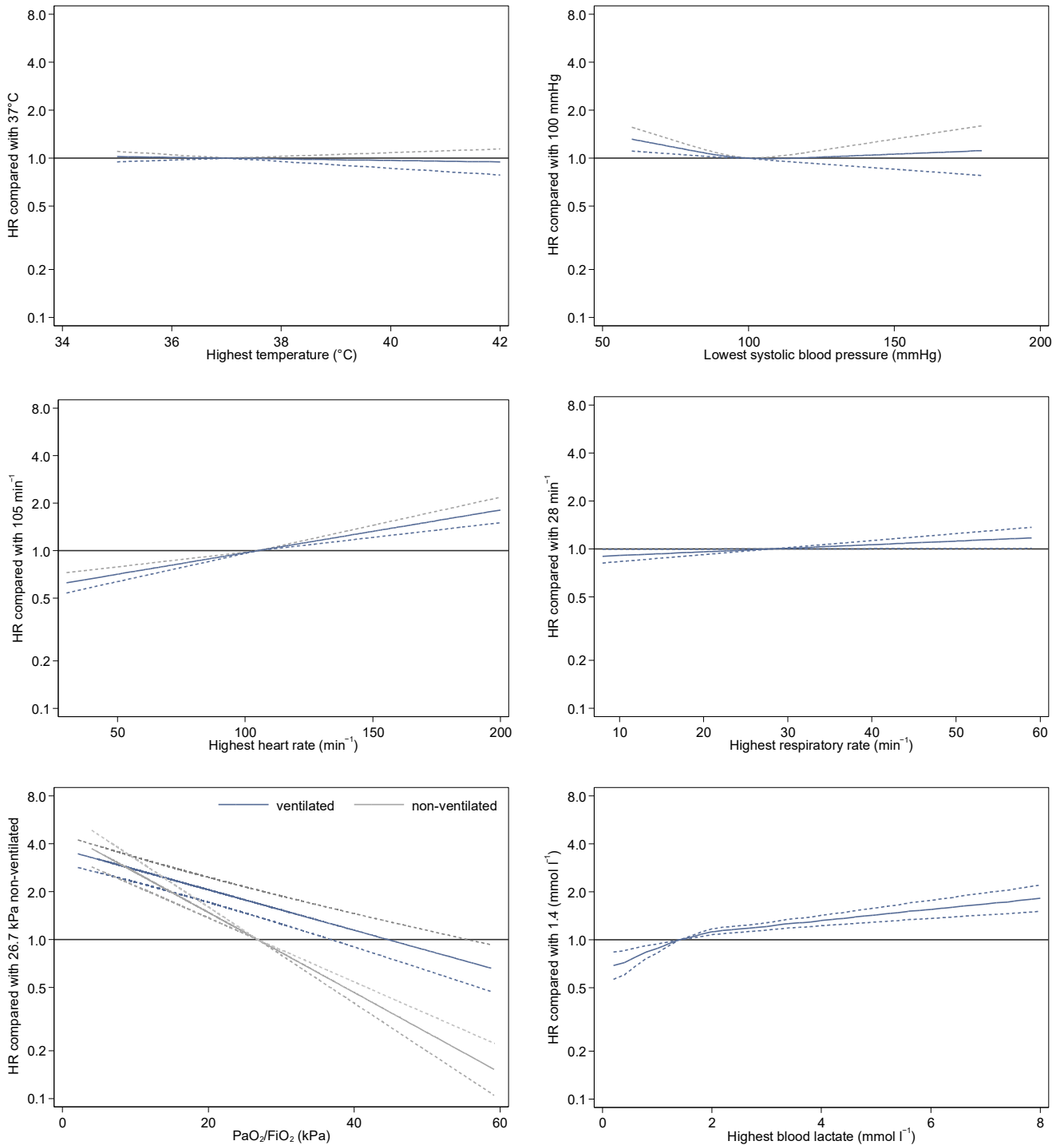
Figure 16   Hazard ratios and 95% confidence intervals from Cox proportional hazards regression model for death within 30 days following start of critical care: physiology (1)

Please note that hazard ratios (HR) are reported relative to the median value for each physiological parameter (as indicated on the y-axis) except for PaO_2/FiO_2 which is reported relative to the threshold for defining ARDS (26.7 kPa).

Figure 17 Hazard ratios and 95% confidence intervals from Cox proportional hazards regression model for death within 30 days following start of critical care: physiology (2)

Please note that hazard ratios (HR) are reported relative to the median value for each physiological parameter (as indicated on the y-axis).

Data completeness

Completeness of key variables is summarised in Table 14.

Table 14   **Data completeness of key variables**

Variable	N missing %
24h variables (N=8699)	
NHS number (used to combine transfers and readmissions)	223 (2.6)
Age	7 (0.1)
Sex	5 (0.1)
Currently or recently pregnant	11 (1.8) †
Ethnicity	847 (9.7)
Index of Multiple Deprivation	169 (1.9)
BMI	687 (7.9)
Prior dependency *	349 (4.0)
Very severe comorbidities	273 (3.1)
Prior hospital length of stay	22 (0.3)
CPR within previous 24h	112 (1.3)
Mechanical ventilation during the first 24h *	619 (7.1)
APACHE II Score	384 (4.4)
PaO2/FiO2 ratio	916 (10.5)
Outcome variables (N=6860)	
Length of stay in critical care	53 (0.8)
Advanced respiratory support *	101 (1.5)
Basic respiratory support *	95 (1.4)
Advanced cardiovascular support *	105 (1.5)
Basic cardiovascular support *	92 (1.3)
Renal support *	112 (1.6)
Liver support *	121 (1.8)
Neurological support *	121 (1.8)

* Please see Definitions on page 31; † % of female patients aged 16-49 years

Definitions

Patients are classified as either:

- Notification only received: ICNARC has received a notification of the patient's admission to critical care but has not received any patient data from the first 24 hours or beyond
- 24h data only received: ICNARC has received patient data relating to the first 24 hours in critical care but has not yet been notified of the patient's critical care outcome
- Outcome data received: ICNARC has received submission of data relating to the patient's underlined critical care outcome (e.g. survival, length of stay, duration of organ support) (Please note: to ensure that data are as complete and up-to-date as possible, we have begun transitioning to allow units to submit a reduced set of minimum outcome data, less than is ordinarily included in the full Case Mix Programme)
- Hospital outcome data received: Data have been updated with outcomes at ultimate discharge from hospital (Please note: this data is currently limited for patients with COVID-19 and not included in this report)

Index of Multiple Deprivation (IMD) is based on the patient's usual residential postcode (assigned at the level of Lower Layer Super Output Area) according to:

- English Index of Multiple Deprivation 2019 for postcodes in England
- Welsh Index of Multiple Deprivation 2019 for postcodes in Wales
- Northern Ireland Multiple Deprivation Measure 2017 for postcodes in Northern Ireland

Body mass index is calculated as the weight in kilograms divided by the height in metres squared. Weight and height values may have been measured or estimated.

Very severe comorbidities must have been evident within the six months prior to critical care and documented at or prior to critical care:

- Cardiovascular: symptoms at rest
- Respiratory: shortness of breath with light activity or home ventilation
- Renal: renal replacement therapy for end-stage renal disease
- Liver: biopsy-proven cirrhosis, portal hypertension or hepatic encephalopathy
- Metastatic disease: distant metastases
- Haematological malignancy: acute or chronic leukaemia, multiple myeloma or lymphoma
- Immunocompromise: chemotherapy, radiotherapy or daily high dose steroid treatment in previous six months, HIV/AIDS or congenital immune deficiency

Mechanical ventilation during the first 24 hours was identified by the recording of a ventilated respiratory rate, indicating that all or some of the breaths or a portion of the breaths (pressure support) were delivered by a mechanical device. This usually indicates invasive ventilation; BPAP (bilevel positive airway pressure) would meet this definition but CPAP (continuous positive airway pressure) does not.

Organ support is recorded as the number of calendar days (00:00-23:59) on which the support was received at any time, defined as:

- Advanced respiratory: invasive ventilation, BPAP via trans-laryngeal tube or tracheostomy, CPAP via trans-laryngeal tube, extracorporeal respiratory support
- Basic respiratory: >50% oxygen by face mask, close observation due to potential for acute deterioration, physiotherapy/suction to clear secretions at least two-hourly, recently extubated after a period of mechanical ventilation, mask/hood CPAP/BPAP, non-invasive ventilation, CPAP via a tracheostomy, intubated to protect airway
- Advanced cardiovascular: multiple IV/rhythm controlling drugs (at least one vasoactive), continuous observation of cardiac output, intra-aortic balloon pump, temporary cardiac pacemaker
- Basic cardiovascular: central venous catheter, arterial line, single IV vasoactive/ rhythm controlling drug
- Renal: acute renal replacement therapy, renal replacement therapy for chronic renal failure where other organ support is received
- Liver: management of coagulopathy and/or portal hypertension for acute on chronic hepatocellular failure or primary acute hepatocellular failure
- Neurological: central nervous system depression sufficient to prejudice airway, invasive neurological monitoring, continuous IV medication to control seizures, therapeutic hypothermia

Acknowledgement

Please acknowledge the source of these data in all future presentations (oral and/or written), as follows:

"These data derive from the ICNARC Case Mix Programme Database. The Case Mix Programme is the national clinical audit of patient outcomes from adult critical care coordinated by the Intensive Care National Audit & Research Centre (ICNARC). For more information on the representativeness and quality of these data, please contact ICNARC."