Potential impact of the UK vaccination strategy on the numbers of patients becoming critically ill with COVID-19

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Abstract

Objectives

With the aim of shifting the emphasis from mortality to pressure on the NHS, we, first, mapped the nine priority groups outlined by the Joint Committee on Vaccination and Immunisation (JCVI) for Phase 1 of the vaccination strategy to available critical care data fields in the ICNARC COVID-19 study. Second, we examined the likely impact of vaccinating these priority groups on the numbers of patients becoming critically ill with COVID-19. Third, we described the characteristics of the critically ill patients with confirmed COVID-19 not covered by the Phase 1 priority groups for vaccination with a view to informing groupings for Phase 2 of the vaccination strategy.

Methods

Phase 1 priority groups for vaccination were those identified by the JCVI. Data fields on patient characteristics, available from the ICNARC COVID-19 study built on the Case Mix Programme - the national clinical audit for adult critical care, were mapped to each of the nine priority groups. General population estimates, by age and sex for England, Wales and Northern Ireland combined, were obtained from the Office for National Statistics. The number and percentage of patients covered by the Phase 1 priority groups were calculated, applying the mapped ICNARC COVID-19 study data fields, using data on patients critically ill with confirmed COVID-19 from 1 February 2020 to 31 January 2021. The characteristics of patients not covered by the Phase 1 priority groups were reported as numbers and percentages and, where possible, as rates per one million general population.

Results

Of the 12 groups/subgroups (derived from the nine Phase 1 priority groups), eight mapped precisely. Of the remaining four, two were unable to be mapped due to absence of occupation data fields in the ICNARC COVID-19 study and two were partially mapped. Between 1 February 2020 and 31

January 2021, there were a total of 31,489 patients critically ill with confirmed COVID-19. Applying the data on the characteristics of these patients to the mapped Phase 1 priority groups, 26,628 (84.6%) were covered. For priority groups 1-4, 8,811 (28%) were covered.

Of the 4,861 (15.4%) patients critically ill with confirmed COVID-19 not covered, older age groups and male sex dominated with two-thirds 40 years or older and two-thirds male. Per one million general population, the disparity between males and females increased with increasing age. Almost half were from non-White ethnic groups with one quarter of these categorised as Asian. Almost 60% resided in areas of greater deprivation with over 90% residing in urban environments.

Conclusion

Our mapping suggests that Phase 1 of the vaccination strategy has the potential to impact the numbers of patients becoming critically ill with COVID-19, substantially. Among those not covered by the nine Phase 1 priority groups, age remains a dominant factor, however, males and some ethnic groups appear disproportionally represented. Given the current and recent overwhelming burden of COVID-19 on critical care services in the NHS, our estimates for a substantial reduction in the numbers of patients becoming critically ill with COVID-19 will be welcome news.

Introduction

Coronavirus disease 2019 (COVID-19) is caused by a novel coronavirus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The majority of people infected with SARS-CoV-2 are either asymptomatic or have only mild disease.[1] A substantial proportion, however, develop a respiratory illness requiring hospital care, which can progress to critical illness with hypoxic respiratory failure requiring prolonged ventilatory support. As of 19 February 2021, 33,623 patients have been admitted to critical care with COVID-19 and in-hospital mortality at 28 days is 37%, rising to 46% in those receiving invasive mechanical ventilation.[2] In January 2021, the mean daily number of all patients in critical care (COVID-19 and non-COVID-19) had expanded to 1.8-fold greater than January figures for the previous five years through creating surge areas, staff re-deployment and working with lower staff/patient ratios.[2]

In the UK, vaccination has commenced on a national scale. The priority for vaccination was stated as: “to save as many lives as possible, as quickly as possible, while also reducing the hospitalisations that are creating such pressure on the NHS.” [3] Nine priority groups were identified, by the Joint Committee on Vaccination and Immunisation (JCVI), covering 32 million people and estimated to account for 99 per cent of COVID-19 fatalities.[3] By 15 February, and on target, a first vaccine dose was offered to everyone in the top four, of the nine, priority groups estimated to account for 88 per cent of COVID-19 fatalities.[4]

With the aim of shifting the emphasis from mortality to pressure on the NHS, we, first, mapped the nine priority groups outlined by the JCVI for Phase 1 of the vaccination strategy to available critical care data fields in the ICNARC COVID-19 study. Second, we examined the likely impact of vaccinating these priority groups on the numbers of patients becoming critically ill with COVID-19. Third, we described the characteristics of the critically ill patients with confirmed COVID-19 not covered by the Phase 1 priority groups for vaccination with a view to informing groupings for Phase 2 of the vaccination strategy.

Methods

Data sources

Three data sources were accessed and used.

First, priority groups for vaccination were those identified by the JCVI in Phase 1 of the Department of Health and Social Care's UK COVID-19 Vaccines Delivery Plan.[3]

Second, data on characteristics of patients critically ill with confirmed COVID-19 were identified from the ICNARC COVID-19 study built on the Case Mix Programme - the national clinical audit for adult critical care - coordinated by ICNARC covering 100% of adult general intensive care units (ICUs; including both standalone and combined intensive/high dependency care units) across England, Wales and Northern Ireland. The data collection process and database for the ICNARC COVID-19 study has been described elsewhere.[5, 6] Briefly, in response to the emerging COVID-19 epidemic, Case Mix Programme data submission was accelerated, from monthly/quarterly to daily, for patients critically ill with confirmed COVID-19 admissions.

Data on characteristics of patients included: age; sex; pregnancy status (not known to be pregnant, currently pregnant or recently pregnant); body mass index (calculated from actual/estimated values for weight and height); NHS ethnic group (combined as Asian, Black, White, or Other); prior dependency (level of assistance in daily activities prior to critical illness); severe comorbidities; residence prior to admission to acute hospital; deprivation (derived using residential postcode from the 2019 English,[7] Welsh Index of Multiple Deprivation [8] or from the 2017 Northern Ireland Multiple Deprivation Measure [9]); and Office for National Statistics' rural/urban classification (derived using residential postcode).[10]

Third, general population estimates, by age and sex, for England, Wales and Northern Ireland combined were obtained from the Office for National Statistics.[11]

Priority groups for vaccination

Phase 1 priority groups for vaccination, as determined by JCVI, were: 1) residents and staff in care homes for older adults; 2) those aged 80 years or older and frontline health and social care workers; 3) those aged 75 years or older; 4) those aged 70 years or older clinically extremely vulnerable individuals (excluding pregnant women and those aged under 16 years); 5) those aged 65 years or older; 6) those aged 16 to 65 years in at-risk groups; 7) those aged 60 years or older; 8) those aged 55 years or older; and 9) those aged 50 years or older.

Mapping available data fields to Phase 1 priority groups

Data fields on patient characteristics available from the ICNARC COVID-19 study were mapped to each of the Phase 1 priority groups. Priority groups 1, 2 and 4 were each considered as two separate subgroups – residents (denoted 1a) and staff (denoted 1b) in care homes for older adults, those aged 80 years or older (denoted 2a) and frontline health and social care workers (denoted 2b) and those aged 70 years or older (denoted 4a) and clinically extremely vulnerable individuals (denoted 4b). Along with the data fields for age and for residence prior to admission to critical care, the clinically extremely vulnerable individuals and the at-risk groups, as listed by the UK Government,[12, 13] were mapped, specifically, using the severe comorbidities fields and, generically, using the prior dependency field.

Examining the impact of Phase 1 of the vaccination strategy on numbers critically ill

Applying the ICNARC COVID-19 study mapped data fields to data on patients critically ill with confirmed COVID-19 between 1 February 2020 and 31 January 2021, the number and percentage of patients covered by the Phase 1 priority groups were calculated and presented as descriptive

statistics. Additionally, the characteristics of those patients not covered by the priority groups were reported as numbers and percentages, and as rates per one million general population.

Approvals

The Case Mix Programme has approval for the collection and use of patient-identifiable data without consent under Section 251 of the NHS Act 2006 (approval number PIAG 2–10(f)/2005) and a fully supported amendment (13 March 2020) for the ICNARC COVID-19 study. The UK Health Research Authority designates this as a service evaluation and approval from a Research Ethics Committee was not required.

Results

Mapping available data fields to Phase 1 priority groups

Of the 12 groups/subgroups (derived from the nine Phase 1 priority groups), eight were mapped precisely. Of the remaining four, two subgroups, 1b (staff in care homes for older adults) and 2b (frontline health and social care workers) were unable to be mapped due to absence of occupation data fields in the ICNARC COVID-19 study. One subgroup (clinically extremely vulnerable) and one group (at-risk) were partially mapped (Table 1).

Table 1 Mapping of available data fields to Phase 1 priority groups

Priority	Risk group	ICNARC COVID-19 study
1a	Residents in care homes for older adults	Age 65+ and residence prior to admission to acute hospital is “Nursing home or equivalent” – note age criterion included as nursing home definition includes care for the chronically ill
1b	Staff in care homes for older adults	<i>Unable to map</i>
2a	Those aged 80 years or older	Age 80+
2b	Frontline health and social care workers	<i>Unable to map</i>

3	Those aged 75 years or older	Age 75-79
4a	Those aged 70 years or older	Age 70-74
4b	Clinically extremely vulnerable individuals, who:	Age 16-69 and clinically extremely vulnerable
	have had an organ transplant	<i>Unable to map</i>
	are having chemotherapy or antibody treatment for cancer, including immunotherapy	Chemotherapy in the six months prior to admission
	are having an intense course of radiotherapy (radical radiotherapy) for lung cancer	Unable to map (any radiotherapy included in at-risk groups)
	are having targeted cancer treatments that can affect the immune system (such as protein kinase inhibitors or PARP inhibitors)	Included in definition of chemotherapy
	have blood or bone marrow cancer (such as leukaemia, lymphoma or myeloma)	Acute myelogenous/lymphocytic leukaemia or multiple myeloma; or Chronic myelogenous/lymphocytic leukaemia; or Lymphoma
	have had a bone marrow or stem cell transplant in the past 6 months, or are still taking immunosuppressant medicine	Included in definition of chemotherapy
	have been told by a doctor you have a severe lung condition (such as cystic fibrosis, severe asthma or severe COPD)	Severe respiratory disease (permanent shortness of breath with light activity due to pulmonary disease) or Home ventilation
	have a condition that means you have a very high risk of getting infections (such as SCID or sickle cell)	Congenital immunohumoral or cellular immune deficiency state
	are taking medicine that makes you much more likely to get infections (such as high doses of steroids or immunosuppressant medicine)	Daily high dose steroid treatment for the six months prior to admission (others included in chemotherapy)
	have a serious heart condition and are pregnant	N/A (pregnant excluded for purpose of vaccine priority groups)
	have a problem with your spleen or your spleen has been removed (splenectomy)	<i>Unable to map</i>
	are an adult with Down's syndrome	<i>Unable to map</i>
	are an adult who is having dialysis or has severe (stage 5) long-term kidney disease	Chronic renal replacement therapy for irreversible renal disease

have been classed as clinically extremely vulnerable, based on clinical judgement and an assessment of your needs

Unable to map

5	Those 65 years or older	Age 65-69
6	Those aged 16 to 65 years in at-risk groups, who have:	Age 16-64 and at-risk group
	a blood cancer (such as leukaemia, lymphoma or myeloma)	Included in clinically extremely vulnerable
	diabetes	<i>Unable to map</i>
	dementia	<i>Unable to map</i>
	a heart problem	Very severe cardiovascular disease (symptoms at rest)
	a chest complaint or breathing difficulties, including bronchitis, emphysema or severe asthma	Unable to map (other than severe – included in clinically extremely vulnerable)
	a kidney disease	Unable to map (other than dialysis-dependent – included in clinically extremely vulnerable)
	a liver disease	Biopsy-proven cirrhosis; Portal hypertension; or Hepatic encephalopathy
	lowered immunity due to disease or treatment (such as HIV infection, steroid medication, chemotherapy or radiotherapy)	HIV/AIDS; Radiotherapy during six months prior to admission (chemotherapy, daily high dose steroids and congenital conditions included in clinically extremely vulnerable)
	rheumatoid arthritis, lupus or psoriasis (who may require long term immunosuppressive treatments)	Unable to map (unless included by treatment in clinically extremely vulnerable)
	have had an organ transplant	Unable to map (but would be included in clinically extremely vulnerable)
	had a stroke or a transient ischaemic attack (TIA)	<i>Unable to map</i>
	a neurological or muscle wasting condition	<i>Unable to map</i>
	a severe or profound learning disability	<i>Unable to map</i>
	a problem with your spleen, example sickle cell disease, or you have had your spleen removed	<i>Unable to map</i>
	a BMI of 40 and above	BMI 40+ (calculated from measured or estimated weight and height)
	severe mental illness	<i>Unable to map</i>

		Requires assistance (minor, major or total) with daily activities; or residence prior to admission to acute hospital is “Nursing home or equivalent”, “Health-related institution” or “Hospice” – included on the basis that people aged 16-64 meeting these criteria are highly likely to be in an at-risk group although we cannot identify which group
7	Those aged 60 years or older	Age 60-64
8	Those aged 55 years or older	Age 55-59
9	Those aged 50 years or older	Age 50-54

Examining the impact of Phase 1 of the vaccination strategy on numbers critically ill

Between 1 February 2020 and 31 January 2021, there were a total of 31,489 patients critically ill with confirmed COVID-19. Applying the data on the characteristics of patients to the ICNARC COVID-19 study mapped data fields for the nine Phase 1 priority groups indicated that 26,628 (84.6%) patients critically ill with confirmed COVID-19 were covered by these groups. Focussing on priority groups 1-4, for which the UK Government announced on 15 February 2021 that they had achieved their target of offering a first dose of vaccine [4], 8,811 (28.0%) patients were covered. Coverage for each priority group is presented in Table 2.

Table 2 Impact of Phase 1 of the vaccination strategy on numbers of critically ill patients

Priority groups for Phase 1 of the vaccination strategy *	All patients critically ill with confirmed COVID-19 [N=31,489]		
	N	Percent	Cumulative
1a. Residents in care home for older adults	70	0.2	0.2
2a. Those aged 80 years or older	1,032	3.3	3.5
3. Those aged 75 years or older	2,258	7.2	10.7
4a. Those aged 70 years or older	3,458	11.0	21.7
4b. Clinically extremely vulnerable individuals	1,993	6.3	28.0
5. Those aged 65 years or older	4,065	12.9	40.9
6. Those aged 16 to 65 years in at-risk groups	3,752	11.9	52.8
7. Those aged 60 years or older	3,894	12.4	65.2
8. Those aged 55 years or older	3,539	11.2	76.4
9. Those aged 50 years or older	2,567	8.2	84.6

* 1b and 2b unable to be mapped due to absence of occupation data fields in the ICNARC COVID-19 study dataset

Characteristics of critically ill patients not covered by Phase 1 priority groups

The characteristics of the 4,861 (15.4%) patients critically ill with confirmed COVID-19 not covered by the nine priority groups are presented in Table 3.

Table 3 Characteristics of critically ill patients not covered by Phase 1 priority groups

Patient characteristics	Critically ill patients with confirmed COVID-19 not covered by Phase 1 priority groups [N=4,861]
Age group (years)	
16-19	60 (1.2)
20-24	148 (3.1)
25-29	277 (5.7)
30-34	515 (10.6)
35-39	790 (16.3)
40-44	1,165 (24.1)
45-49	1,888 (39.0)
Sex	
Male	3,216 (66.2)
Female	1,639 (33.8)
Pregnancy status (% of females)	
Not known to be pregnant	1,352 (83.9)
Currently pregnant	123 (7.6)
Recently pregnant	137 (8.5)
Body mass index (kg m ⁻²)	
<18.5	41 (0.9)
18.5 to <25	917 (20.8)
25 to <30	1,445 (32.8)
30 to <40	2,000 (45.4)
Ethnic group (combined NHS)	
White	2,424 (53.5)
Mixed	114 (2.5)
Asian	1,200 (26.5)
Black	388 (8.6)
Other	409 (9.0)
Quintile of deprivation	
1 (least deprived)	482 (10.1)
2	586 (12.3)

3	873 (18.4)
4	1,248 (26.2)
5 (most deprived)	1,566 (32.9)
Rural/urban classification	
Rural	340 (7.2)
City and town	1,861 (39.2)
Minor conurbation	177 (3.7)
Major conurbation	2,371 (49.9)

Older age groups and male sex dominated with two-thirds aged 40 years or older and two-thirds male. Of the one-third female, 16% were pregnant or recently pregnant. Over three quarters of patients were overweight or obese (body mass index of 25 or greater). Almost half were from non-White ethnic groups with one-quarter categorised as Asian (defined using the NHS ethnic groups as Asian or Asian British – Indian; Asian or Asian British – Pakistani; Asian or Asian British – Bangladeshi; Asian or Asian British – any other). Almost 60% resided in areas of greater deprivation (highest two quartiles) with over 90% residing in urban environments.

When looking at rates, by age and sex, per one million general population, the disparity between males and females increased with increasing age (Figure 1). The peak rate, among males aged 45-49 years, was 672 admissions per one million population. This pattern was consistent across all ethnic groups.

Figure 1 Number of critically ill patients not covered by Phase 1 priority groups per one million population

Discussion

Our mapping suggests that Phase 1 of the vaccination strategy has the potential to impact the numbers of patients becoming critically ill with COVID-19, substantially. Among those not covered by the nine priority groups, age remains a dominant factor, however, males and some ethnic groups appear disproportionately represented. Our figures for coverage of the critically ill with confirmed COVID-19 are in line with those reported by Cook and Roberts (81% coverage) despite a different approach to mapping, modelling and data. [14]

The strengths of our study relate to the inclusion of all adult critical care units in England, Wales and Northern Ireland ensuring representativeness, the comprehensive approach to mapping each of the priority groups, and the use of raw data (rather than published estimates) for patient characteristics to quantify the impact. The weaknesses of our study relate to absence of data for Scotland and being unable to map all the priority groups comprehensively, specifically the absence of occupation data

fields in the ICNARC COVID-19 study dataset. With healthcare workers having been identified as having an increased risk of becoming critically ill with COVID-19, [15] the ability to include these would have increased our estimates for the overall potential impact of the Phase 1 vaccination strategy.

Translation of our figure, 84.6%, as the overall potential impact of Phase 1 of the vaccination strategy on number of patients becoming critically ill with COVID-19, into an anticipated reduction in critical care demand needs to consider both effectiveness and uptake of the vaccines. The evidence suggests that the vaccines are not 100% effective and that effectiveness may be decreased by the new variants (B.1.1.7, P.1 and 501Y.V2).[16] In addition to this, there is some early indication that there may be lower uptake of vaccination among some ethnic groups and for people living in areas of greater deprivation.[17]

Given the current and recent overwhelming burden of COVID-19 on critical care services in the NHS, our estimates for a substantial reduction in the numbers of patients becoming critically ill with COVID-19 will be welcome news. As part of the ICNARC COVID-19 study, we will monitor the impact over time.

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Footnotes

Contributors: Conceptualisation and design: DAH, DWG, KMR. Analysis: DAH. Writing original draft: DAH, DWG, KMR. Reviewing and editing: DAH, DWG, KMR. Supervision: KMR, DAH. KMR is guarantor and corresponding author for this work, and attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Data sharing: Requests for accessing data from the Case Mix Programme are subject to approval by an independent Data Access Advisory Group (see <https://www.icnarc.org/Our-Audit/Cmp/Reports/Access-Our-Data> for more details). Requests should be submitted to the corresponding author in the first instance.

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