NOCA National Office of Clinical Audit

ICU Bed Information System (ICU BIS)

NOCA REPORT ON ICU ACTIVITY DURING COVID-19 PANDEMIC

Title	**NOCA Report on ICU Activity during COVID-19 pandemic**
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Terms of disclosure and usage Recipients should acknowledge the relevant data sources:

National Office of Clinical Audit (NOCA) ICU Audit,
National Office of Clinical Audit (NOCA) ICU Bed Information System
Health Protection Surveillance Centre (HPSC)
Intensive Care National Audit and Research Centre (ICNARC)
Mobile Intensive Care Ambulance Service (MICAS)
Mater Extra Corporeal Membrane Oxygenation treatment (ECMO) team

Technical Notes: Data may change in future reports as further review and validation are carried out.

Erratum

An error was discovered in chapter 5 of this report. This chapter has been removed entirely from the report and will be re-inserted once a full review of the data has been undertaken and all amendments made. 16/03/2022

Acknowledgements

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- National ICU-BIS and ICU Audit Managers
- Mater ECMO Team
- Acute Operations Sponsors – Liam Woods and Ciaran Browne
- ICU Clinical Lead
- ICU Clinical Governance Committee
- NOCA Information Management and Data Analytics Teams.

Contents

Glossary

Explanation of acronyms, abbreviations and other key terms used in this report.

ABG	Arterial Blood Gas
APACHE 2	Acute Physiology and Chronic Health Evaluation; a measure of illness severity for adult patients admitted to Intensive Care Units.
BIS	Bed Information System
BMI	Body Mass Index
CCRS	Critical Care Retrieval Service
CMSWG	COVID-19 Major Surge Working Group
CNM	Clinical Nurse Manager
CPAP	Continuous Positive Airway Pressure
CRRT	Continuous Renal Replacement Therapy
ECMO	Extra Corporeal Membrane Oxygenation
ETT	Endotracheal tube
FiO_2	The concentration of inspired oxygen (FiO_2) expressed as a fraction of 1.0 (1.0 = 100% oxygen).
HD	Haemodialysis
HDU	High Dependency Unit
HFNO	High Flow Nasal Oxygen
HPSC	Health Protection Surveillance Centre
ICU	Intensive Care Unit
ICU-BIS	Intensive Care Unit – Bed Information System
ICNARC	Intensive Care National Audit and Research Centre
IHD	Intermittent Haemodialysis
INICUA	Irish National Intensive Care Unit Audit

IPPV	Intermittent positive-pressure ventilation; mechanical ventilation of a patient's lungs
Level of Care	Specifies the level of monitoring or organ support provided to a patient. Levels of care 0-3 are as defined by the Intensive Care Society of Ireland and Joint Faculty of Intensive Care Medicine of Ireland document on Standards for Intensive Care in Ireland.
Level 3	Monitoring and support for patients with 2 or more organ systems failure (excluding GI system failure). Includes any patients receiving ventilatory support via an endotracheal tube or a tracheostomy.
Level 2	Monitoring and support for patients with primarily one organ system failure (excluding GI system failure). May include patients receiving non-invasive ventilatory support.
LOS	Length of stay; the number of days that a patient spends in ICU and /or hospital. In this document both the day of admission to ICU and the day of discharge from ICU are included in the calculation of length of stay.
MICAS	Mobile Intensive Care Ambulance Service
NAS	National Ambulance Service
NAS-CCRS	National Ambulance Service-Critical Care Retrieval Services
NIV	Non-invasive Ventilation
NOCA	National Office of Clinical Audit
P/F ratio	The arterial PO_2 ("P") in kPa from the ABG divided by the FiO_2 ("F") – the inspired oxygen concentration as a decimal fraction of 1.0. (e.g., 40% inspired oxygen is an FiO_2 of 0.4).
PO_2	The partial pressure of oxygen in the blood.
UK	United Kingdom
V-V ECMO	Veno-Venous Extra Corporeal Membrane Oxygenation

Executive summary

The ICU Bed Information System (BIS) was set up at the start of the COVID-19 pandemic in March 2020 and has provided real-time data for managing ICU capacity and information on trends for decision makers in the HSE and Department of Health to guide policy. Some of the key findings from this report are summarised below:

- Admissions of patients with COVID-19 followed a pattern of four waves. The highest peak in numbers of COVID-19 patients in ICU was 215 patients in January 2021[1].
- Surges in numbers of COVID-19 patients in ICU were accommodated by expansion in the numbers of ICU beds open (from a baseline of 256 beds in March 2020 to a peak of 348 ICU beds open) and by decreases in non-COVID patients in ICU. The largest number of patients in ICU at any one time was 330 on 26thJanuary 2021.
- Expansion in numbers of ICU beds was achieved by opening of ICU beds in areas not normally designated as ICUs, redeployment of non-clinical and non-ICU staff to ICU and up-skilling and clinical support of staff in these roles.
- Every adult HSE-funded hospital in the country cared for significant numbers of COVID-19 patients. The larger hospitals cared for greater numbers of COVID-19 patients and continued to care for significant numbers of non-COVID-19 patients. Smaller hospitals tended to have a proportionately greater increase in ICU activity compared to their baseline levels, particularly during local surges in cases.
- Numbers of COVID-19 patients in paediatric and private hospital ICUs were small. Activity levels remained high in private hospital ICUs, with large numbers of non-COVID-19 patients cared for; many of these are likely to have been patients transferred from public hospitals who required time-critical surgery.
- COVID-19 patients accounted for 22% of all patient days in ICU from March 2020 to October 2021. This increased to 55% of all patient days in ICU during the peak surge period of January-February 2021.
- COVID-19 patients had a high requirement for invasive ventilation (65% of all COVID-19 patient days in ICU). 30 patients required ECMO in the Mater Hospital with a survival rate to hospital discharge of 50% to date.
- Fifty-three patients who were pregnant or recently pregnant have been admitted to ICU with COVID-19 up to October 31st. Fifty-eight per cent of these admissions were in the last 3 months (August –October 2021). Only one patient was fully vaccinated. All have survived to date.
- An unvaccinated person was much more likely to be admitted to ICU with COVID-19 than a vaccinated person. Unvaccinated patients continue to make up the majority of patients admitted to ICU with COVID-19 each month, but this has declined from a high of 75% in June 2021 to 51% in October 2021 as more of the population has been vaccinated.
- Fully vaccinated patients who required ICU admission because of COVID-19 were older and had pre-existing medical conditions; these factors are likely to have contributed to their need for ICU admission. As would be predicted from their older age and higher rate of pre-existing conditions, ICU mortality was higher in this group.

[1]The peak number of COVID-19 patients of 215 in adult HSE hospitals. If a patient in a private hospital is included, the peak nationally for COVID-19 patients was 216, see Figure 2.4

- A crucial support for ICUs treating COVID-19 patients was the specialist ICU transfer service 'MICAS' staffed by the National Ambulance Service and the large hospitals. One hundred and fifty-eight critically ill patients were transferred by MICAS in Quarter 1 2021, 129% more than in the same quarter in 2019 (pre-pandemic). Transfers of critically ill patients between hospitals contributed significantly to management of the caseload of the pandemic.
- HSE Acute Operations ran a Surge Management Committee during the peak surge in COVID-19 cases which identified situations where hospitals required support and facilitated solutions e.g. help with staffing issues or transfer of critically ill patients to a hospital with available capacity.
- Overall mortality for patients in ICU with COVID-19 since March 2020 was 28.3%. This is comparable to ICU mortality rates in other developed countries.
- ICU mortality (unadjusted for risk factors such as severity of illness, existing co-morbidities) in patients admitted with COVID-19 increased during winter 2020-2021, decreased in summer 2021 and has shown an upward trend in recent months. The reasons for this variability are not yet known and will require further analysis, which will be provided by future reports from the NOCA Irish National ICU Audit.
- The NOCA ICU Audit reports which are available to date for the overall ICU patient population (COVID-19 plus non-COVID-19) in individual ICUs over this period have shown risk-adjusted mortality rates within the expected range.
- Benchmarking outcomes of COVID-19 patients between Ireland and the UK showed lower mortality in Ireland during Wave 1. Mortality increased to similar levels as the UK during Wave 3. The reasons for increased mortality in Wave 3 are unclear and require more detailed data from formal ICU Audit.
- The patterns of admissions, interventions and outcomes in Northern Ireland closely paralleled those in the Republic of Ireland rather than the UK.
- The data indicate that the caseload from COVID-19 approached the peak capacity of the ICU network in Ireland but did not exceed it and the system was not overwhelmed.
- Based on the NOCA reports on activity in ICU, daily contact with each hospital to collect data on ICU numbers and daily NOCA participation in the HSE Acute Surge Management Committee, ICU beds were made available for patients who required one and who were clinically assessed as likely to benefit.

Introduction

In December 2019, a novel strain of coronavirus disease named as COVID-19 was identified in the city of Wuhan in China and may have spread from a market for live animals. Whilst this raised concerns internationally, the wider potential impact was poorly understood until the outbreak hit Italy in February 2020 with rapid and devastating effects. It quickly became apparent that many of those diagnosed with COVID-19 required mechanical ventilation in an Intensive Care Unit (ICU) and that COVID-19 was likely to reach Ireland shortly. The timeline of COVID-19 in Ireland focusing on key dates for ICU has been described in Figure 1.1.

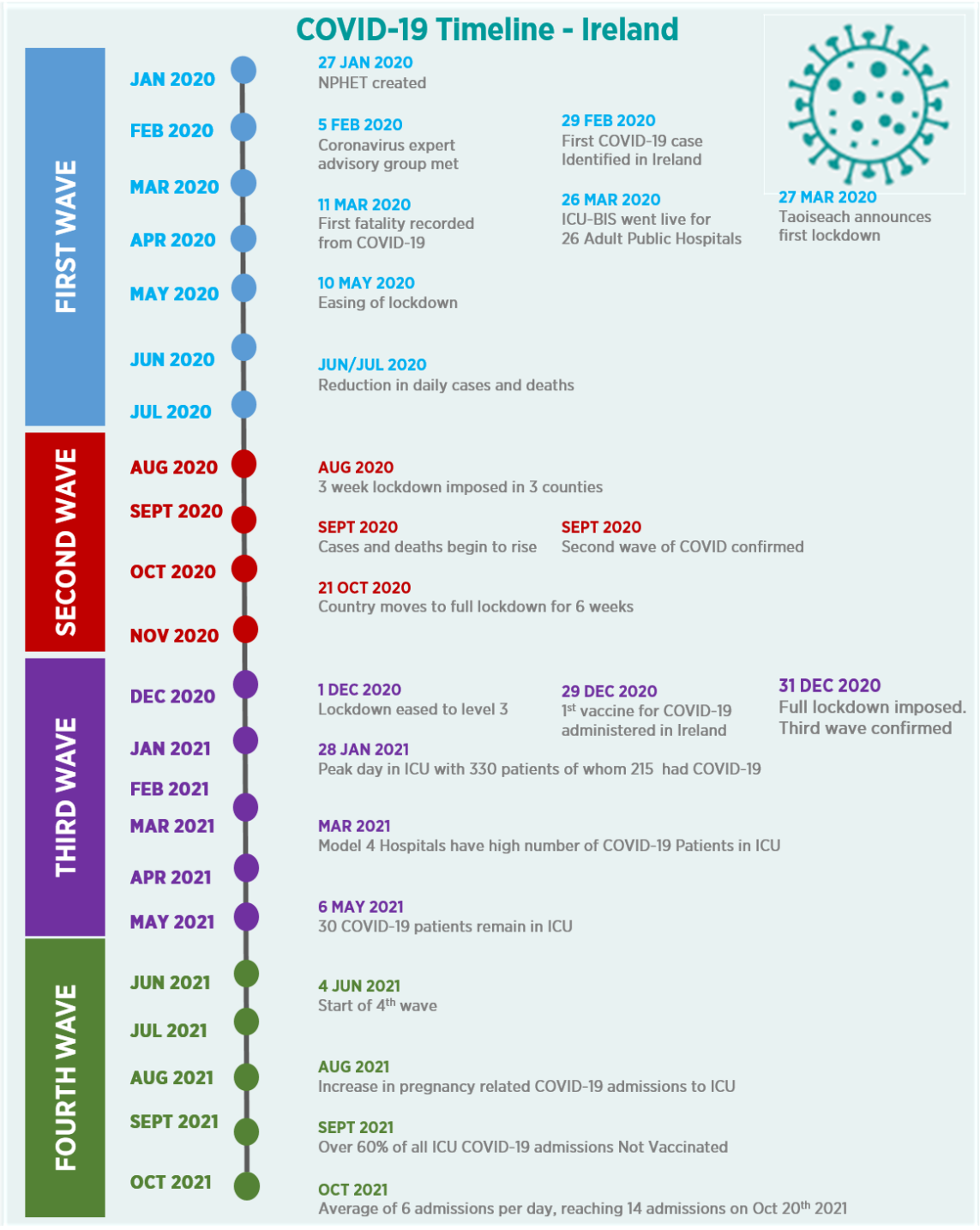

FIGURE 1.1 TIMELINE OF COVID-19 PANDEMIC

It is important to note that there is a time lag between the onset of symptoms and hospital admission and ICU admission. This led to a lag of three weeks typically after the imposition of COVID-19 lockdown restrictions before there was an impact on reduced COVID-19 admissions to ICU.

In February 2020, Ireland was not well equipped to deal with a major increase in numbers of patients requiring ICU care. Ireland had 5.2 ICU beds per 100,000 population at the start of the pandemic - well below the European average (Figure 1.2). ICU bed occupancy rates averaged 90% with occupancy rates approaching 100% in some larger Units much greater than the recommended occupancy levels of 75% (NOCA Irish National ICU Interim Annual Report 2019).

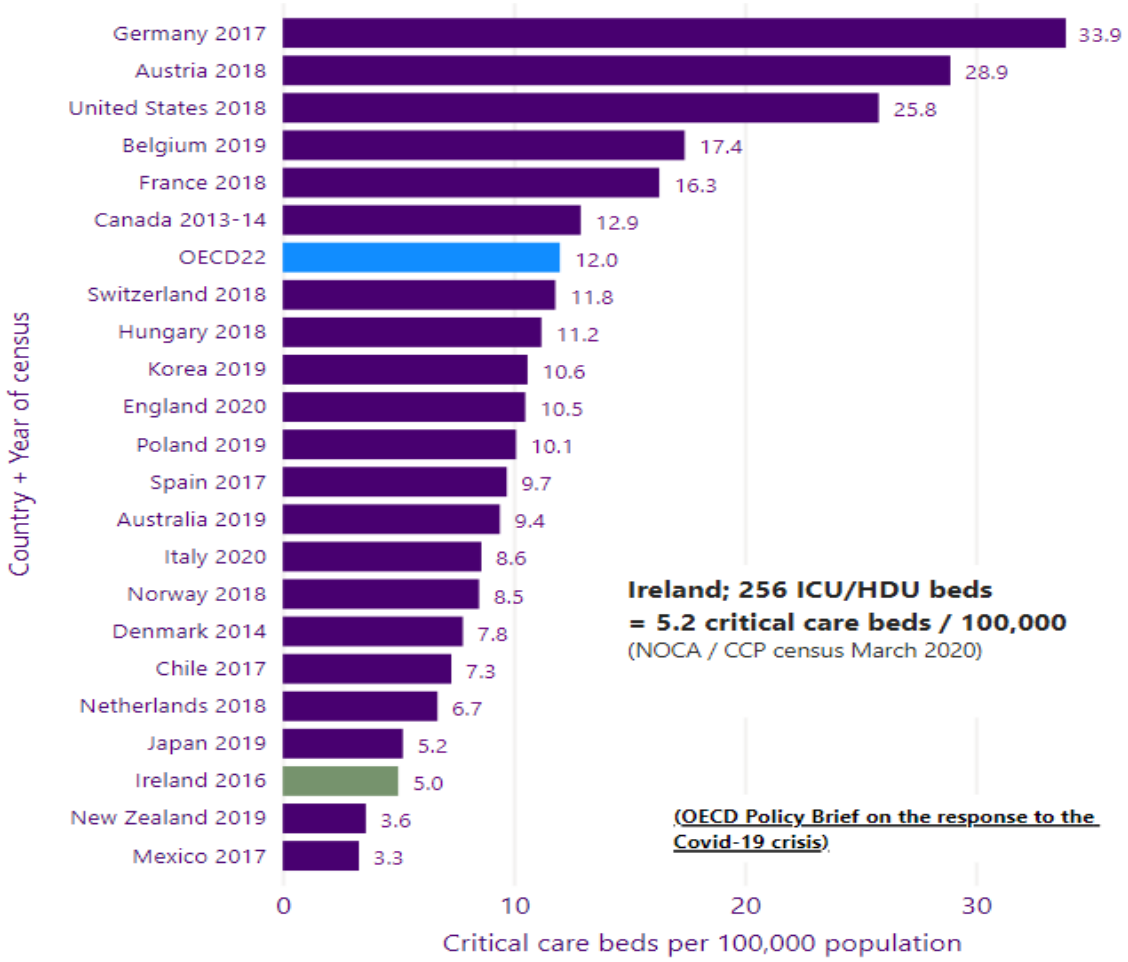

FIGURE 1.2. CRITICAL CARE BEDS (ICU/HDU) PER 100,000 POPULATION IN OECD COUNTRIES
Data source: https://www.oecd.org/coronavirus/en/data-insights/intensive-care-beds-capacity

It was essential to make optimal use of ICU bed capacity in Irish hospitals and this required real-time monitoring of ICU bed capacity and occupancy. The National Office of Clinical Audit (NOCA) was already progressing a project to provide this information. With support from the HSE and by prioritising this project within NOCA and DMF Systems (NOCA's Information Technology (IT) provider for ICU Audit), the ICU Bed Information System (BIS) was developed speedily and went live on 26th March 2020

ICU BIS provides data on the numbers of ICU beds open, ICU beds occupied and ICU beds available. It also provides data on the impact of COVID-19 on ICU, i.e. numbers of new admissions of COVID-19 cases to ICU, numbers of COVID-19 patients in ICU and numbers of discharges and of deaths in ICU of COVID-19 patients. Data are also collected on the numbers of patients' invasively ventilated and undergoing renal replacement therapy (RRT).

ICU BIS is a valuable resource for clinicians trying to find an ICU bed when their own Unit is full. Data from ICU BIS are an essential component in how the Health Service Executive (HSE) manages the pandemic on a day-to-day basis. It also provides vital information to those modelling the future progress of the epidemic and guides Government decisions regarding public health measures to limit the spread of COVID-19.

A key role for the NOCA ICU BIS was to provide daily data on the capacity of the healthcare system to care for critically ill patients. This included data on ICU bed occupancy and bed availability and on the situation in individual hospitals, especially those approaching their peak ICU capacity.

Report Data

This report utilises data from ICU-BIS, National ICU Audit NOCA, the Health Protection Surveillance Centre (HPSC), the Intensive Care National Audit and Research Centre (ICNARC), the Mobile Intensive Care Ambulance Service (MICAS) and the Mater ECMO Team. References to data sources are outlined for each table and figure. Additional information on each of these data sources is provided in Appendix III – Data Sources.

Report Aims and Target Audiences

The aims of this report are to:

1. Document the provision of ICU resources for COVID-19 and non-COVID-19 patients during the COVID-19 pandemic, in the period 26th March 2020 – 31st July 2021.
2. Document the numbers and the outcomes of COVID-19 patients during this period.
3. Benchmark activity and outcomes against data from the UK and from Northern Ireland
4. Define and communicate the lessons learned regarding ICU services during the COVID-19 pandemic to inform future planning for pandemics or major disaster situations.

Target Audiences

- All staff who worked in ICU during the COVID-19 pandemic
- All staff working in the delivery of healthcare
- Management of the HSE and the Department of Health
- Researchers in healthcare or public policy fields
- Politicians and policy makers
- Media & General Public.

Chapter 1: Methodology

The National ICU Bed Information System (ICU-BIS) provided most of the data for this report. In addition, this report includes data published by the NOCA Irish National ICU Audit (INICUA), the Health Protection Surveillance Centre (HPSC), and the Intensive Care National Audit and Research Centre (ICNARC), (London, UK). The Report also includes unpublished data from the Mobile Intensive Care Ambulance Service (MICAS) of the National Ambulance Service-Critical Care Retrieval Services (NAS-CCRS). The methodology below focuses predominantly on ICU-BIS as most of this report is based on data from this system. The methodology pertaining to data from INICUA, HPSC, ICNARC and MICAS is available from their websites.

On 26th March 2020, the BIS went live for the 26 adult public hospitals who have an ICU. This coincided with marked increases in numbers of COVID-19 patients in ICU at this time. On 2nd April 2020, the five private hospitals with ICU capacity were included, and on 6th April 2020 the two paediatric hospitals were included on the system. Since then, the ICU-BIS has provided a full national picture of bed capacity and COVID-19 patient numbers in ICU.

Inclusions criteria for Units reported

Data are collected from all Intensive Care Units (ICUs), defined as Units with the ability to provide invasive ventilation on an ongoing basis.

Data are also collected from High Dependency Units (HDUs), which were defined as Units with the ability to provide organ support like vasopressors or renal replacement therapy (but short of invasive ventilation) and the ability to undertake invasive monitoring like direct arterial pressure monitoring. Other criteria were a nurse: patient ratio of 1:2 and clinical and administrative management of the Unit by the ICU medical team.

For clarity of expression, the term ICU is used throughout the document whenever both ICU and HDU data are reported.

Exclusion criteria

Coronary Care Units (CCU) were not included.
Detailed ICU Audit data on patient demographics, illness severity, interventions and outcomes are not included; this will be reported when available in National ICU Audit Reports for 2020 and 2021.

Data Entry and submission

The ICU-BIS data are updated at least once a day on the ICU BIS website, providing up-to-date information on ICU bed occupancy. A designated user in each of the participating hospitals enters the data. Regular users are trained using brief definitions for each data item and there is guide text on the data entry screens to help with consistency in data entry. The data items are limited, to provide key data without excessive burden on the busy clinical staff entering the data. The definitions and guide text are designed to provide clear and unambiguous support for users to ensure consistent and accurate data entry. Users include the

ICU Consultant, the senior nurse in charge in the Unit, the ICU Audit Nurse, ICU administrative staff or bed managers depending on local circumstances.

ICU-BIS is supported by NOCA seven-days a week, to ensure the completeness and accuracy of data. This support involves phoning Units who have not entered data or where the data entered differs from expected. If there are new admissions of COVID-19 patients, NOCA staff contact the Unit to obtain further details which are important for epidemiological purposes.

Data collected by ICU-BIS

Data collected by ICU-BIS falls into two categories; ICU occupancy data and COVID-19 specific patient data. Data collected and reported by BIS include:

1. Numbers of ICU beds open (with appropriate staffing), beds occupied, beds reserved for another patient, patients cleared for discharge from ICU and beds available.
2. Total number of patients invasively ventilated (COVID and non-COVID).
3. Total number of patients undergoing renal replacement therapy; intermittent and continuous.
4. Data on critically ill patients managed by the ICU team outside normal ICU locations.
5. Data on COVID-19 patients defined as those who have tested positive for COVID-19 during this hospital admission; (i) numbers of COVID-19 patients in each Unit, (ii) numbers invasively ventilated, (iii) new admissions, (iv) discharges and (v) deaths in the last 24 hours.
6. Patient level data on COVID-19 patients regarding age, sex, co-morbidities, vaccination status, whether currently or recently pregnant (If female), primary reason for admission to ICU, source of infection (if known) etc.

ICU-BIS Data Coverage

Patient coverage refers to the proportion of patients admitted to ICU or HDU in Ireland who were documented in the ICU-BIS. For the reporting period, NOCA estimates that patient coverage for the BIS data presented in this report was 99-100%.

Strengths of ICU BIS data

1. The ICU-BIS data provides the core data on bed occupancy and bed availability in ICU's. ICU bed occupancy is the key limiting factor in the ability of the health service to cope with the COVID-19 pandemic.
2. ICU-BIS data plays a central role in the allocation of resources by the HSE, in providing information to the public and in guiding Government decisions about lockdown and other public health measures.
3. ICU BIS provides data on the epidemiology of COVID-19 which is central to modelling the likely future pattern of hospital and ICU admissions
4. The data are accurate and comprehensive, with full coverage of all acute hospitals in the state throughout the reporting period
5. The data are provided in 'real-time', data are available by midday each day.

Limitations of ICU BIS data

- The ICU-BIS dataset is limited to a small number of items. This was deliberate to enable input of only essential data by busy clinical staff in ICU and did not set out to provide comprehensive ICU audit data
- Data were formally updated and validated just once a day meaning that data on ICU bed occupancy could change before the next update
- The ICU-BIS data was entered manually which may have increased the risk of minor data entry errors occurring
- Data were not available for the earliest COVID-19 patients admitted from 1st March 2020 to 25th March 2020, as the BIS system had not gone live at that point in time.

Reporting periods

This report uses data from five data sources and over different time periods based on the availability of data from each source at the time of writing this report:

- NOCA Core ICU-BIS data: data on ICU bed capacity, bed occupancy, complexity of care provided and admissions, discharges of COVID-19 patients between 26th March 2020 and 31st October 2021.
- Clinical subsets of ICU-BIS data:
    - Mortality data on COVID-19 Patients in ICU – 26th March 2020 to 31st October 2021.
    - Data on COVID-19 patients who were pregnant or recently pregnant on admission to ICU – 26th March 2020 to 31st August 2021. Data on LOS and outcome for these patients was updated on 30th September 2021. Overall pregnant admission numbers updated on 31st October 2021
    - Vaccination Data on COVID-19 Patients in ICU – 3rd June 2021 to 31st October 2021. Data on country of birth and vaccination status was updated on October 11th 2021.
- ICNARC and INICUA data
    - Chapter 5: data on patients in ICU with confirmed COVID-19 for the period 1st January 2020 to 30th June 2020
    - ICNARC analysis; data on patients in ICU with confirmed COVID-19 for the period 1st September 2020 to 6th July 2021.
- HPSC data: data on patients in ICU with confirmed COVID-19 for the period 16th February 2020 to 5th July 2021
- MICAS data: data refers to patient transfers during the time period March 2020 to April 2021.
- Mater ECMO data - March 2020 to September 2021.

Supplementary information relating to ICU-BIS dataset and reports

Appendix I – Dataset and definitions
Appendix II – ICU-BIS daily data dissemination and usage
Appendix III - Data Sources – Organisation Information
Appendix IV - HSE National Multi-Disciplinary COVID-19 Major Surge Working Group (CMSWG) Members

Chapter 2: ICU bed capacity, bed occupancy and numbers of COVID-19 and non-COVID-19 patients

The vast majority of COVID-19 patients were treated in HSE-funded (public) adult hospitals. Data on daily numbers of COVID-19 admissions were collected from 27th May 2020.

During the period 27th May 2020 to 31st October 2021:

- 1,641 COVID-confirmed patients were admitted to ICU across 26 public adult hospitals.
- 15 COVID-confirmed children were admitted to ICU across 2 paediatric hospitals.
- 27 COVID-confirmed patients were admitted to ICU across 5 private hospitals.

The data presented below refer to adult public hospitals unless stated otherwise. Data are also provided at the end of this chapter on patients in paediatric and private hospitals. Occupancy data in this chapter covers the period 26th March 2020 to 31st October 2021.

Admissions, discharges and deaths of COVID-19 patients in HSE-funded (public) hospitals

Numbers of COVID-19 admissions to ICU followed a pattern of three waves, the largest in January 2021 – February 2021 (Figure 2.1, FIgure 6.1). The peak daily number of COVID-19 admissions was 27 patients on 21st January 2021.

Deaths of COVID-19 patients followed the peaks in admissions as would be expected. The highest number of COVID-19 deaths in ICU in one day was 11 on 24th February 2021.

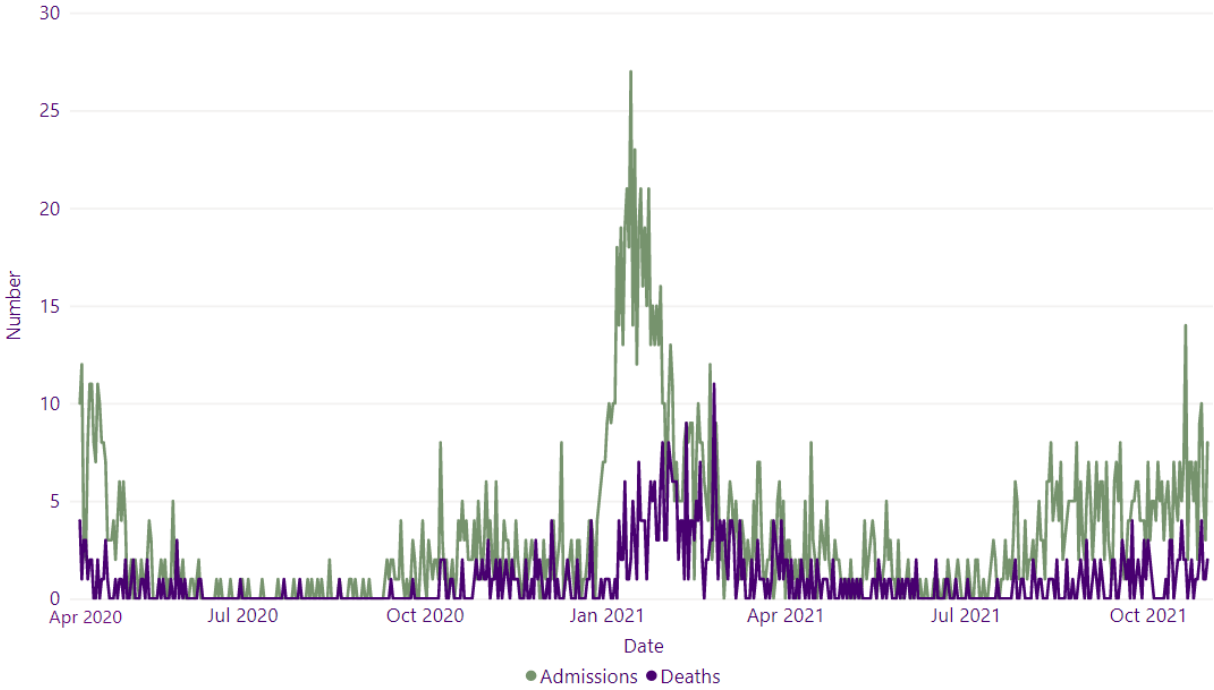

FIGURE 2.1: COVID-19 PATIENTS IN ICU; ADMISSIONS AND DEATHS (10TH APRIL 2020 –31ST OCTOBER 2021)
Data Source: NOCA ICU-BIS Core dataset

Bed occupancy

Numbers of COVID-19 patients in ICU increased during three surge periods; March 2020 - April 2020, October 2020 - November 2020 and January - March 2021 (during Waves 1, 2 and 3 respectively) (Figure 2.2). This led to increases in the total number of patients in ICU. However, numbers of non-COVID-19 patients in ICU decreased which mitigated the increase in the total numbers in ICU which would otherwise have occurred. Wave 4, commencing in July 2021 to the present is also depicted below in (Figure 2.2)

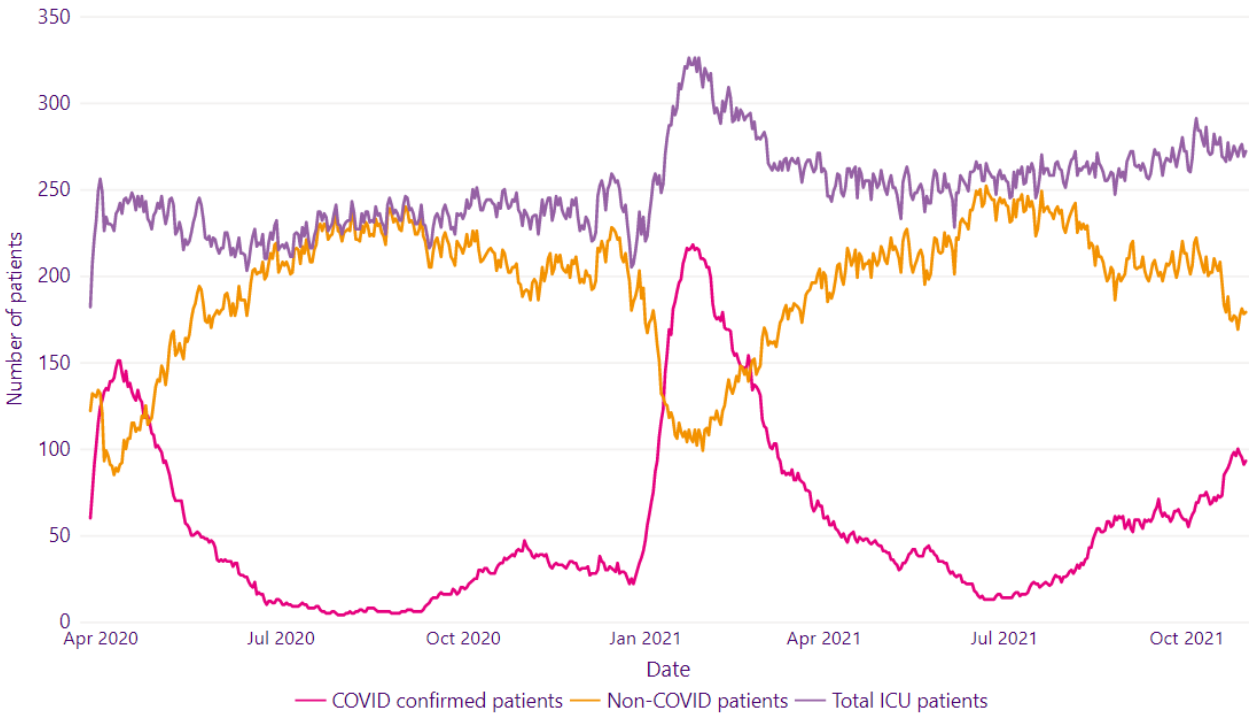

FIGURE 2.2: ICU BED OCCUPANCY 26TH MARCH 2020 – 31ST OCTOBER 2021
Data Source: NOCA ICU-BIS Core dataset

ICU capacity

Baseline ICU bed capacity in adult HSE-funded hospitals in March 2020 was 256 beds spread across 26 hospitals which had the capacity to provide invasive ventilation. In anticipation of the projected surge in COVID-19 cases requiring ICU care, all non-urgent care in these hospitals was suspended. This reduced the number of non-COVID-19 patients requiring ICU admission and allowed redeployment of staff to increase the number of ICU beds which could be provided.

Planning for the surge in ICU numbers had focused on (i) the provision of adequate infrastructure (bed spaces with piped gases, ventilators, syringe drivers, oxygen capacity etc.) and (ii) the redeployment of nurses and medical staff to ICU from other duties. However, prediction of maximum potential ICU capacity was somewhat speculative until hospitals had gained practical experience in expanding capacity in March 2020 to April 2020.

NOCA Census of ICU beds

NOCA undertook a census of ICU beds on 1st May 2020 when ICU Directors were able to define their maximum potential ICU capacity with much greater certainty with the experience gained in Surge 1. ICU Directors or Lead Clinicians for ICU were contacted individually by telephone by the NOCA ICU Clinical Lead. They were asked to estimate the potential maximum capacity of their hospital to provide care for critically ill (ICS Levels 2 and 3) patients at each of three defined levels of quality of care (Table 2.1).

Surge 1 conditions

Non-ICU nurses and doctors redeployed from normal responsibilities but supported adequately by ICU nurses and doctors. Clinical care is provided by nurses and doctors with appropriate skill mix and the quality of care provided to patients is maintained at normal levels. Hospitals may have to expand ICU capacity outside normal ICU locations. There is a significant impact on other activities within the hospital because of staff redeployment.

Surge 2 conditions

Expansion of ICU beds outside normal ICU locations; care is provided by non-ICU nurses and redeployed medical staff but supported in a variable ratio by ICU nurses (e.g., 1:2 to 1:4) and ICU medical staff.
Surge 2 conditions are expected to lead to the inability to sustain and deliver routine standards of ICU care, both medical and nursing, with a likely negative impact on patient outcomes and a major impact on all other activities in the hospital.

Surge 3 conditions

Expansion of ICU beds outside normal ICU areas (e.g., into Operating Theatre): care primarily provided by non-ICU nurses and medical staff redeployed from other areas. There will be limited resource for support from ICU nursing and medical staff. There must be adequate equipment in-house already and identifiable staffing.

Surge 3 conditions are expected to lead to the inability to deliver routine standards of ICU care, both medical and nursing. This will lead to significant diminution in quality of care for ICU patients, increased mortality both in COVID-19 and non-COVID-19 patients and an overwhelming impact on all other activities in the hospital.

TABLE 2.1. RISK MATRIX: GREEN NORMAL CARE. YELLOW, ORANGE, RED INCREASING RISK RESPECTIVELY:

Baseline Capacity	Quality of care sustained in ICU and HDU
Surge 1 escalation	Quality of care sustained in ICU/ HDU by redeployment of staff but a significant impact on other hospital Departments
Surge 2 escalation	Quality of care impacted in ICU / HDU and a major impact on other hospital Departments
Surge 3 escalation	Quality of care in ICU/ HDU seriously impacted and an overwhelming impact on other hospital Departments

ICU bed census

Experience of the prolonged increase in demand for ICU beds over March 2020 and April 2020 showed that the primary limiting factor in all hospitals was the availability of experienced ICU nurses. However, key requirements also included equipping and development of new isolation facilities and cohorts in the core and expanded ICU areas. Hospitals had maximized their ICU capacity by expansion into areas outside the normal Unit location, had cancelled non-urgent activity and had maximised redeployment of nursing and medical staff to ICU / HDU. Thus, clinicians had good insight into the maximal capacity available for each of the three Surge conditions listed above. They had particularly good insight into the maximum potential capacity achievable while maintaining normal quality of care (Surge 1 conditions above).

Maximum numbers of patients during March 2020 and April 2020 increased by less than had been feared due to the impact of lockdown in reducing viral transmission. No hospitals experienced levels of demand which exceeded the ability to maintain normal quality of care. Hospitals which came under stress from numbers greater than their maximum safe capacity were able to transfer patients to other hospitals which had spare capacity.

National overall total potential capacity for ICU and HDU (Level 2 and Level 3) patients are summarized in Table 2.2. Data for 26 HSE-funded hospitals and 5 private hospitals are provided, based on estimates from the ICU Director or Clinical Lead for ICU in each hospital.

TABLE 2.2. ADULT CRITICAL CARE BED CAPACITY; BASELINE, SURGE 1, 2 AND 3 CONDITIONS (MAY 2020)

	HSE hospitals	Private hospitals
Baseline ICU (Level 3) beds	204	35
Baseline HDU (Level 2) beds	51	10
Surge 1 ICU (Level 3) beds	308	35
Surge 1 HDU (Level 2) beds	46	10
Surge 2 ICU beds	446	51
Surge 2 HDU beds	38	3
Surge 3 ICU beds	577	68
Surge 3 HDU beds	34	11

Over the course of 2020 and 2021 considerable resources were committed to expanding ICU capacity by the HSE. This led to an increase in baseline ICU bed capacity over the course of 2020 up to 280 beds by 2nd November 2020. The NOCA estimate of maximum potential ICU bed capacity remained approximately 350 beds over the period described (up to 30th June 2021) (Figure 2.2).
The expansion of ICU bed capacity has continued during 2021 with funding provided for a further 66 ICU beds to a total of 322 beds nationally. However, it has not been possible to find staff for these beds in all hospitals (or in some cases a suitable location is not yet available) and the current baseline number of ICU beds available daily is around 300.

Bed occupancy in ICU / HDU

ICU bed capacity was overwhelmed in Italy and to a lesser extent London during the early days of the COVID-19 pandemic. Fears that this would happen in Ireland did not materialise; the numbers of patients in ICU /HDU remained less than the maximum potential bed capacity throughout the period described (Figure 2.3).

During Wave 1 and Wave 3, there was a marked decrease in numbers of non-COVID-19 patients in ICU. This contributed significantly to ensuring there were adequate ICU beds available for patients who needed them, both COVID-19 and non-COVID-19.

It will be important to document the impact on non-COVID-19 patients with acute illness or those awaiting elective surgery who would normally have been admitted to an ICU bed during these periods. Preliminary data from ICU audit indicates a major decrease in the numbers of patients admitted to ICU with diagnoses not related to respiratory disease. This data will be reported in the future when full audit data are available.

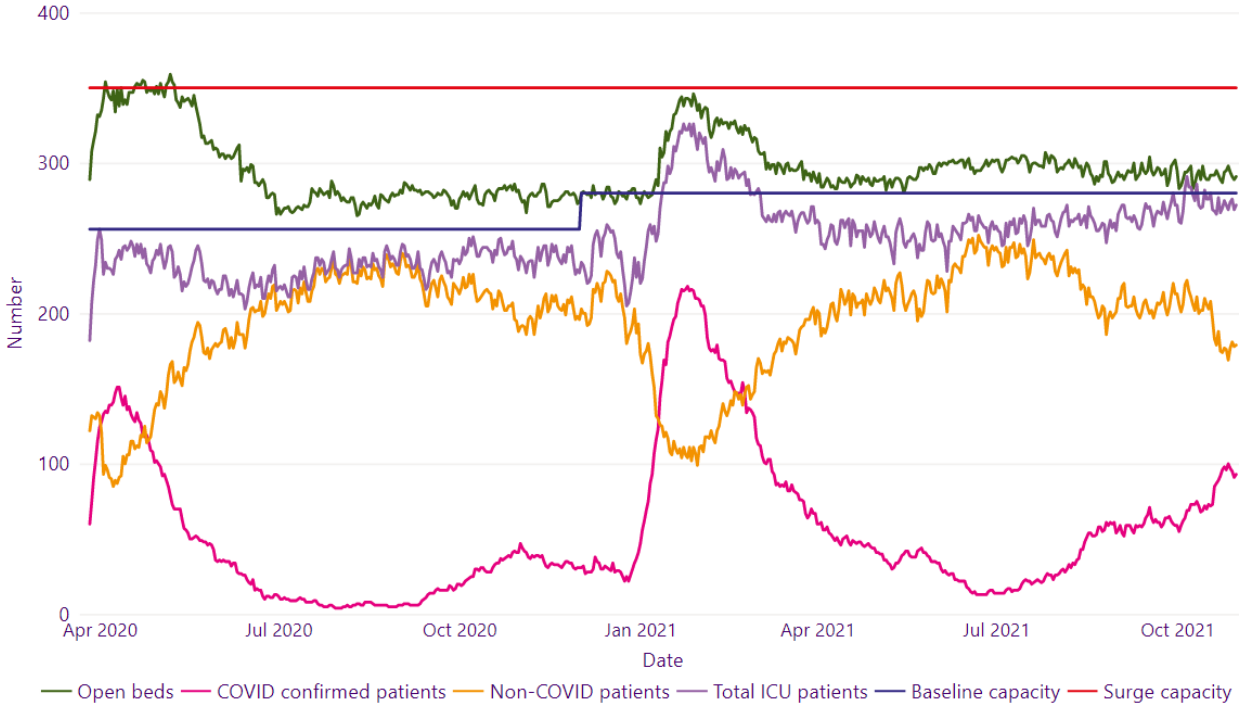

FIGURE 2.3: ICU BED CAPACITY AND BED OCCUPANCY 26TH MARCH 2020 – 31ST OCTOBER 2021
Data Source: NOCA ICU-BIS Core dataset

Peak ICU/HDU bed occupancy

The number of patients in ICU/HDU peaked on 28th January 2021 at 330 patients of whom 215[2] had COVID-19 (Figure 2.4). The number of ICU beds open on this date was 348, giving an overall ICU/HDU bed occupancy rate of 95% of critical care beds open nationally on that date.

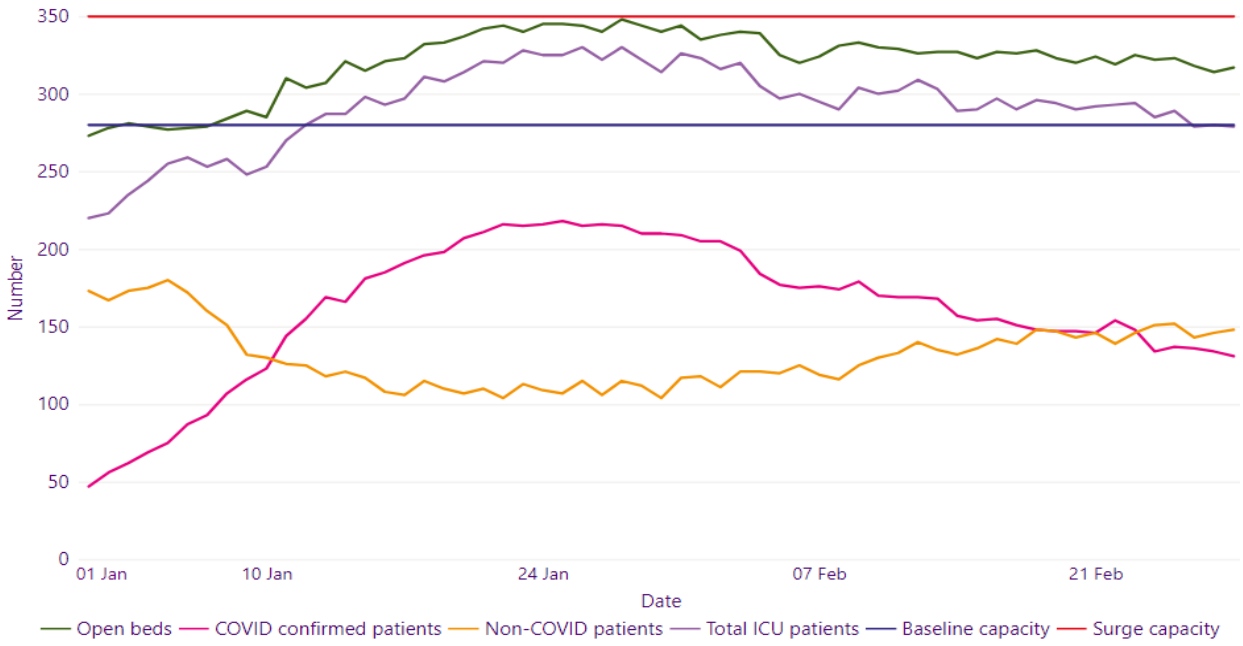

Figure 2.4: ICU BED CAPACITY AND BED OCCUPANCY 1ST JANUARY 2021 – 28TH FEBRUARY 2021
Data Source: NOCA ICU-BIS Core dataset

[2] This graph shows a peak number of COVID-19 patients of 215 in adult HSE hospitals. If a patient in a private hospital is included, the peak nationally for COVID-19 patients was 216.

Patients invasively ventilated

The ability to admit critically ill patients to ICU can be impacted by the availability of ICU beds so that admission to ICU in itself does not define the severity of illness of the patients admitted. Similarly the timing of discharge from ICU can be determined by operational issues rather than clinical criteria, particularly by the availability of a ward bed.

The criteria for the provision of invasive ventilation however are generally consistent across all hospitals, allowing comparisons of caseload complexity between hospitals (while recognising that it underestimates the requirements for Level 3 ICU care by 30-50%). Thus, data regarding the provision of invasive ventilation are a useful guide to the requirements for and provision of Level 3 ICU care and a useful metric to compare ICU activity between hospitals. The tertiary referral ICUs in Ireland generally have 50-70% of bed days occupied by patients undergoing invasive ventilation (NOCA, Irish National ICU Audit Interim Report, 2019).

Numbers of non-COVID-19 ventilated patients remained relatively constant over the reporting period (Figure 2.5). Numbers of COVID-19 patients ventilated followed the same trends over time as the total numbers of COVID-19 patients in ICU (Figure 2.5). The proportion of patients in ICU undergoing invasive ventilation was greater in January 2021 and February 2021 when the ICU facilities were required to sustain both COVID and non-COVID admissions as hospital activity was maintained compared to Wave 1 of March 2020.

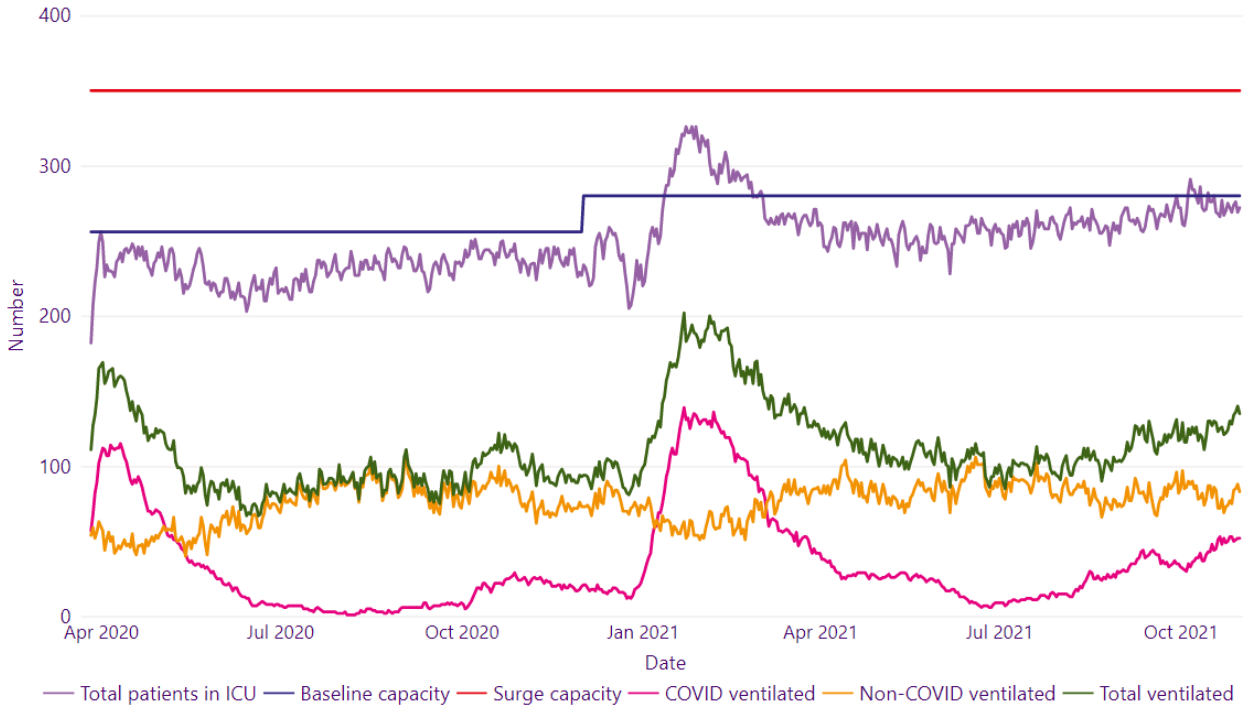

FIGURE 2.5: ICU BED CAPACITY AND PATIENTS INVASIVELY VENTILATED 26TH MARCH 2020 – 31ST OCTOBER 2021
Data Source: NOCA ICU-BIS Core dataset

ICU bed occupancy in individual hospitals

The total number of patients in ICU / HDU nationally peaked on 26th January 2021 at 330 of whom 195 were ventilated. The numbers of patients in individual hospitals (invasively ventilated and total numbers) on that date are shown in Figure 2.6. The greatest numbers of patients (COVID-19 and non-COVID-19) were admitted to the larger hospitals, as would be expected. It should be noted that this was not necessarily the date of maximum occupancy in individual hospitals.

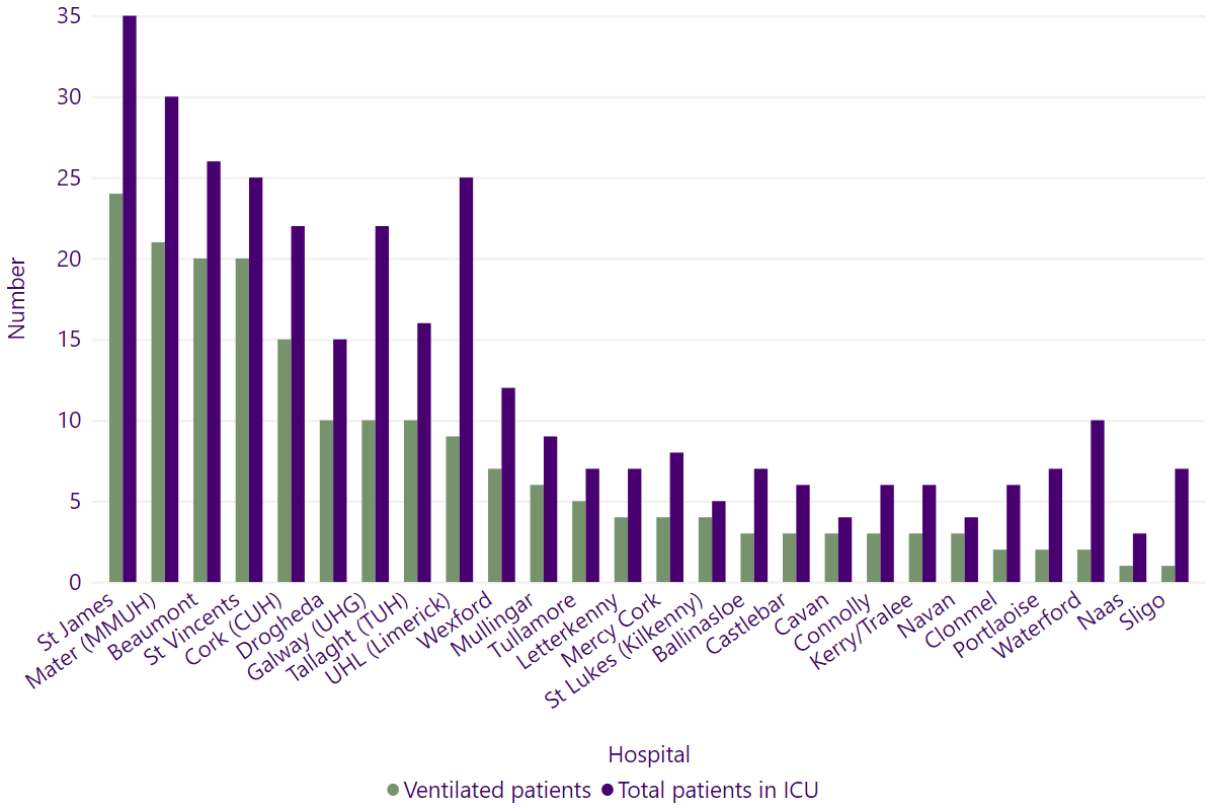

FIGURE 2.6: PATIENTS IN ICU (TOTAL NUMBER AND NUMBERS VENTILATED) ON DAY OF PEAK ACTIVITY NATIONALLY (26TH JANUARY 2021)
Data Source: NOCA ICU-BIS Core dataset

ICU bed occupancy; average over January 2021 to February 2021

Another measure of ICU occupancy in individual hospitals is the average number of patients during the period of peak activity (January 2021 to February 2021). Figure 2.7 shows the mean daily bed occupancy of both COVID-19 and non-COVID-19 patients for this period. The larger referral 'hub' hospitals continued to care for large numbers of non-COVID-19 patients.

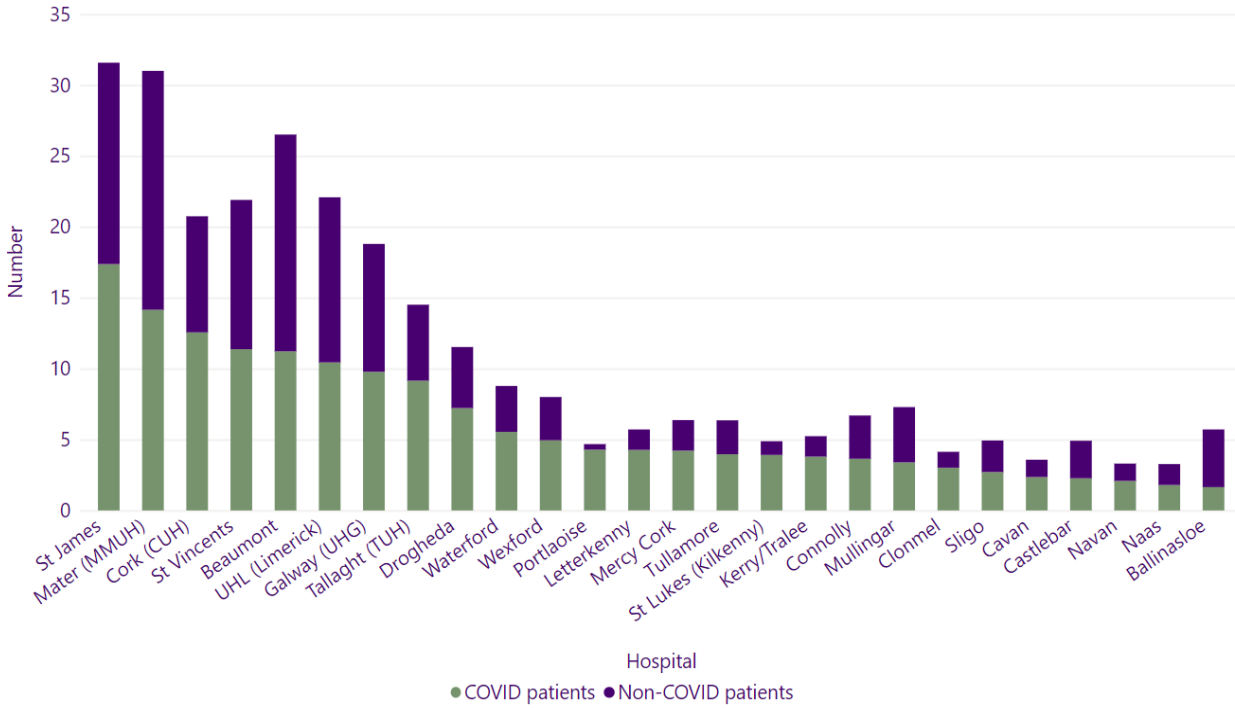

FIGURE 2.7: COVID-19 AND NON-COVID-19 PATIENTS IN ICU – MEAN DAILY NUMBERS JANUARY 2021 – FEBRUARY 2021
Data Source: NOCA ICU-BIS Core dataset

ICU bed occupancy relative to baseline bed capacity

Rates of COVID-19 infection and hospital admission varied regionally throughout the course of the pandemic. This led to greater proportional increases in ICU numbers in individual hospitals at certain times, putting severe pressure on their ICU capacity.

Numbers of patients in individual hospitals must be interpreted in the light of their underlying baseline bed capacity to understand the level of pressure on their resources. Figure 2.8 shows the mean daily bed occupancy as a percentage of the baseline bed capacity (March 2020) over the period January 2021-February 2021.

Some of the smaller hospitals were those with the largest increase in bed occupancy as a proportion of their baseline ICU bed capacity.

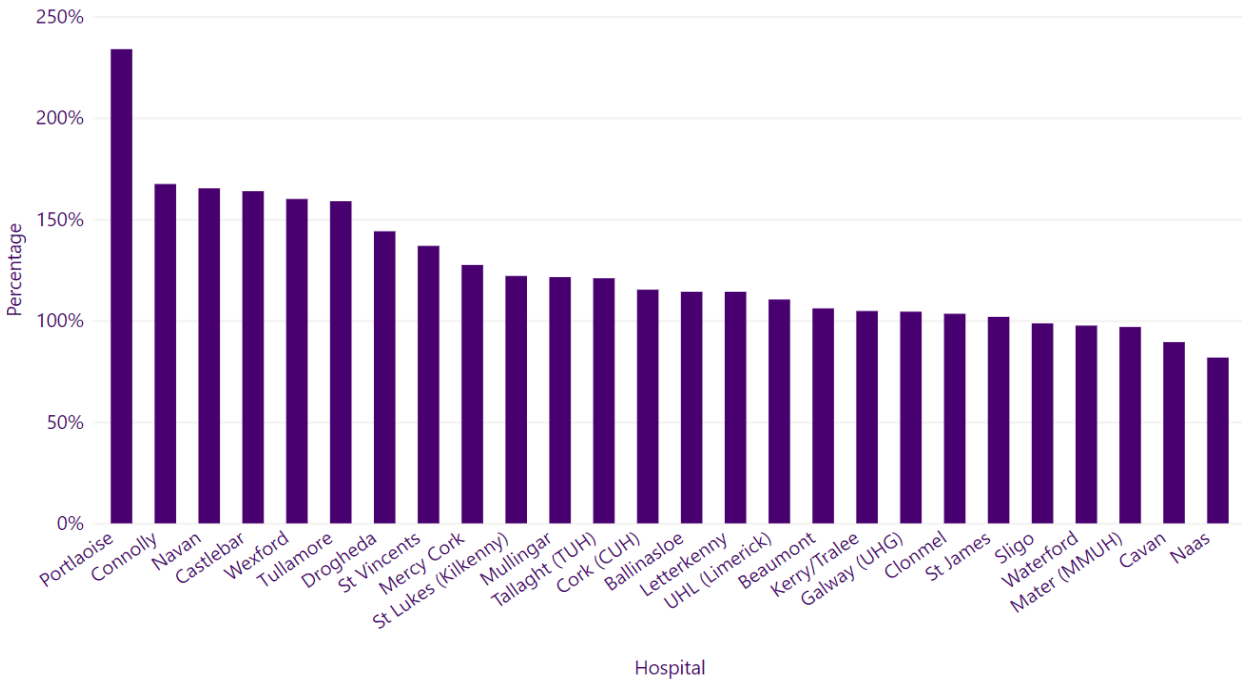

FIGURE 2.8: MEAN DAILY BED OCCUPANCY OVER THE PERIOD 1ST JANUARY 2021 – 28TH FEBRUARY 2021 AS A PERCENTAGE OF BASELINE BED CAPACITY ON 16TH MARCH 2020
Data Source: NOCA ICU-BIS Core dataset

ICU bed occupancy on day of peak numbers of invasively ventilated patients

Bed occupancy averaged over a period will not capture shorter periods of intense pressure on capacity due to a surge in cases. Figure 2.9 presents the number of ventilated patients in ICU on the day of peak activity/ occupancy in each hospital (defined by the number of invasively ventilated patients in ICU as a percentage of the baseline number of Level 3 ICU beds). Presenting the data in this format shows the smaller hospitals with the largest percentage increase in occupancy above baseline capacity because a small increase in real numbers is a large increase proportionally. This explains why the larger hospitals are towards the right-hand side of the graph below.

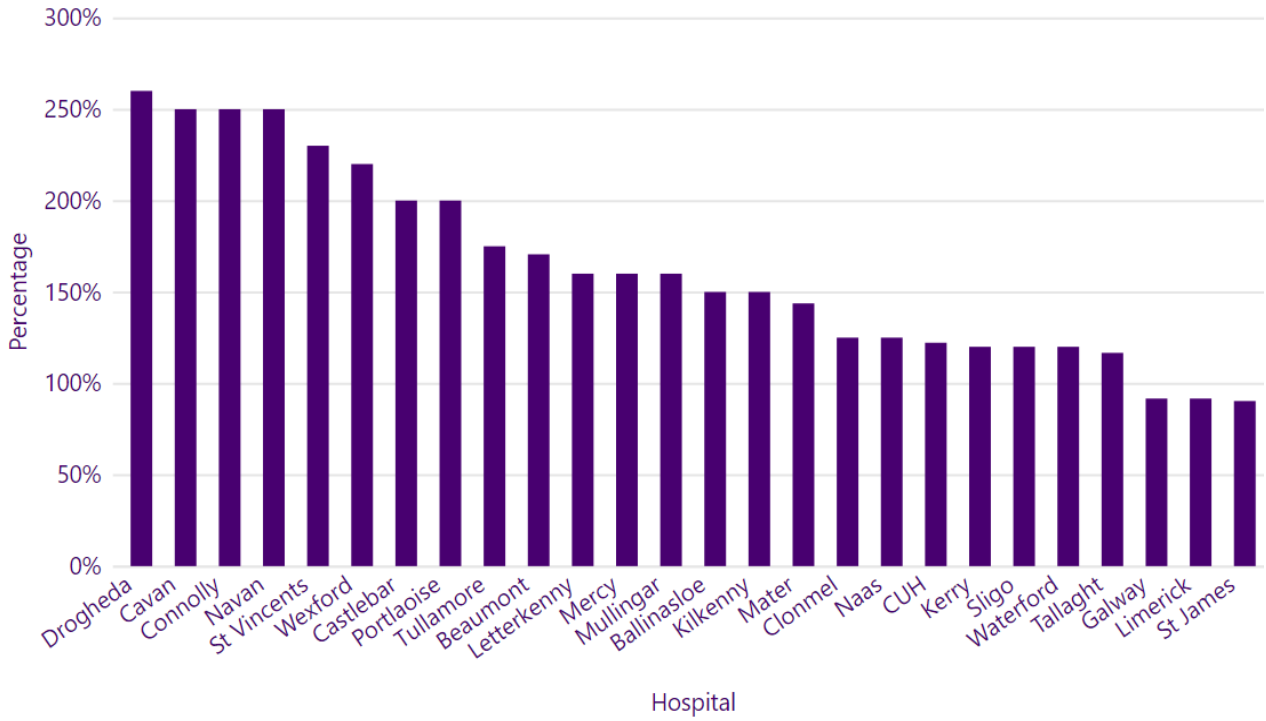

FIGURE 2.9. VENTILATED PATIENTS AS A PERCENTAGE OF THE BASELINE NUMBER OF LEVEL 3 ICU BEDS ON THE DAY OF PEAK NUMBERS OF VENTILATED PATIENTS IN EACH HOSPITAL BETWEEN 26TH MARCH 2020 AND 31ST OCTOBER 2021,
BASELINE NUMBERS = NUMBER OF LEVEL 3 ICU BEDS ON 16TH MARCH 2020
Data Source: NOCA ICU-BIS Core dataset

Beds occupied by invasively ventilated patients in each hospital

Numbers of invasively ventilated patients during the time period 26th March 2020 to 31st October 2021 tended to be relatively consistent in the larger hospitals with larger catchment areas and a pattern of receiving transfers, which made them less likely to have troughs in COVID-19 activity. Smaller hospitals with lower baseline numbers of beds and serving a smaller catchment area were very vulnerable to large percentage increases in numbers of invasively ventilated patients following localised outbreaks of COVID-19 e.g. Castlebar, Wexford (Figure 2.10). Smaller hospitals also showed troughs in activity with periods of fewer ventilated patients.

FIGURE 2.10. INVASIVELY VENTILATED PATIENTS AS % OF BASELINE LEVEL 3 BEDS IN EACH HOSPITAL DURING THE PERIOD 26TH MARCH 2020 – 31ST OCTOBER 2021. BASELINE NUMBERS = NUMBER OF LEVEL 3 ICU BEDS ON 16TH MARCH 2020.[3]
Data Source: NOCA ICU-BIS Core dataset

[3] Each hospital and hospital group will receive a separate PDF document of the key graphs from this report showing the individual hospital data.

Private and paediatric hospitals.

The ICU-BIS collected data on ICU bed availability, bed occupancy and numbers of COVID-19 patients in ICU in private (Figure 2.11) and paediatric hospitals (Figure 2.12).

The numbers of COVID-19 patients admitted to ICUs in private hospitals were very small (27 in total over the period May 2020 to October 2021). This allowed the private hospitals to accept transfers of patients (both COVID-19 and non-COVID-19) from HSE hospitals with no ICU beds available. The private hospitals also provided capacity for non-COVID-19 patients who required major surgery at a time when there was little ICU capacity in the public hospitals. This is reflected in increases in their levels of ICU activity at times of peak COVID-19 activity in the public hospitals.

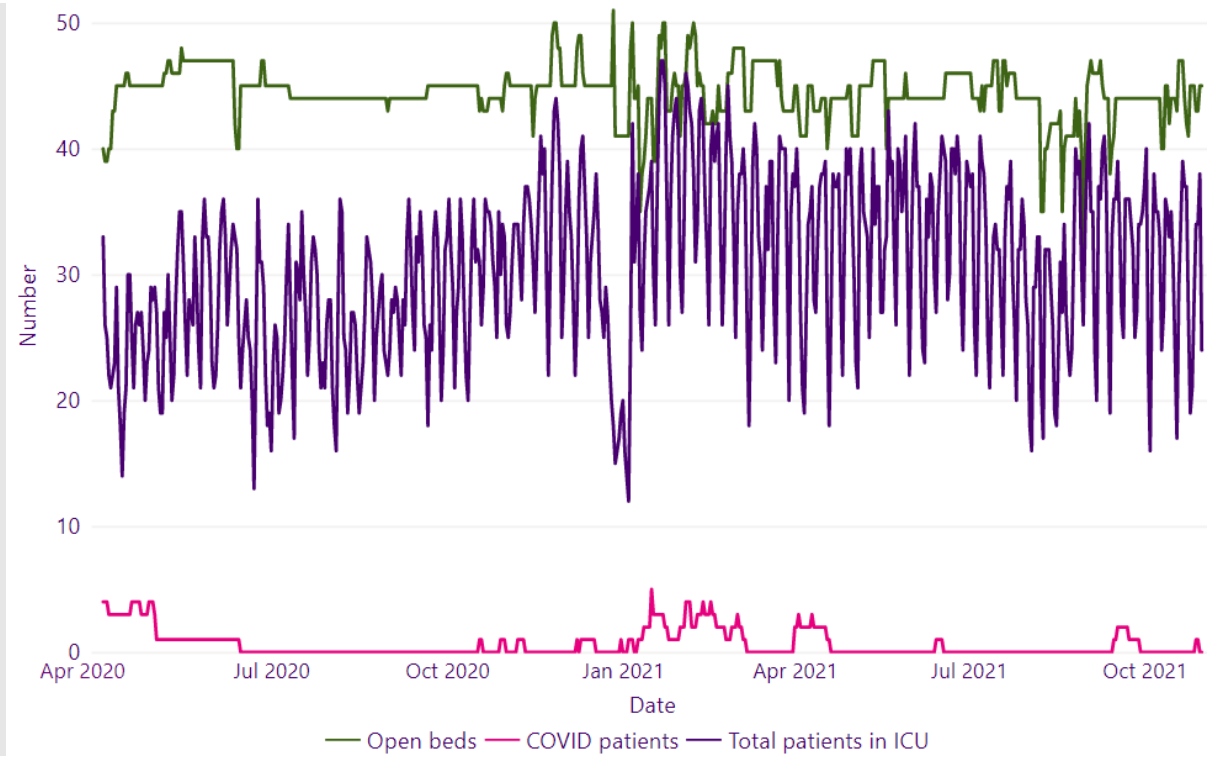

FIGURE 2.11: ICU BED CAPACITY, BED OCCUPANCY AND NUMBERS OF COVID PATIENTS IN PRIVATE HOSPITALS ICUS, (26TH MARCH 2020 – 31ST OCTOBER 2021)
Data Source: NOCA ICU-BIS Core dataset

The numbers of children requiring ICU care while testing positive for COVID-19 was very small; just 15 patients during the period 6th April 2020 to 31st October 2021. This allowed continuation of normal levels of activity in the paediatric hospitals during the pandemic. At the start of the pandemic, there had been suggestions that paediatric ICUs might take overflow patients from adult ICUs, but this turned out not to be practical and no admissions of patients over 18 occurred. Some paediatric Intensive care nurses were redeployed and provided care in adult ICUs during Wave 3.

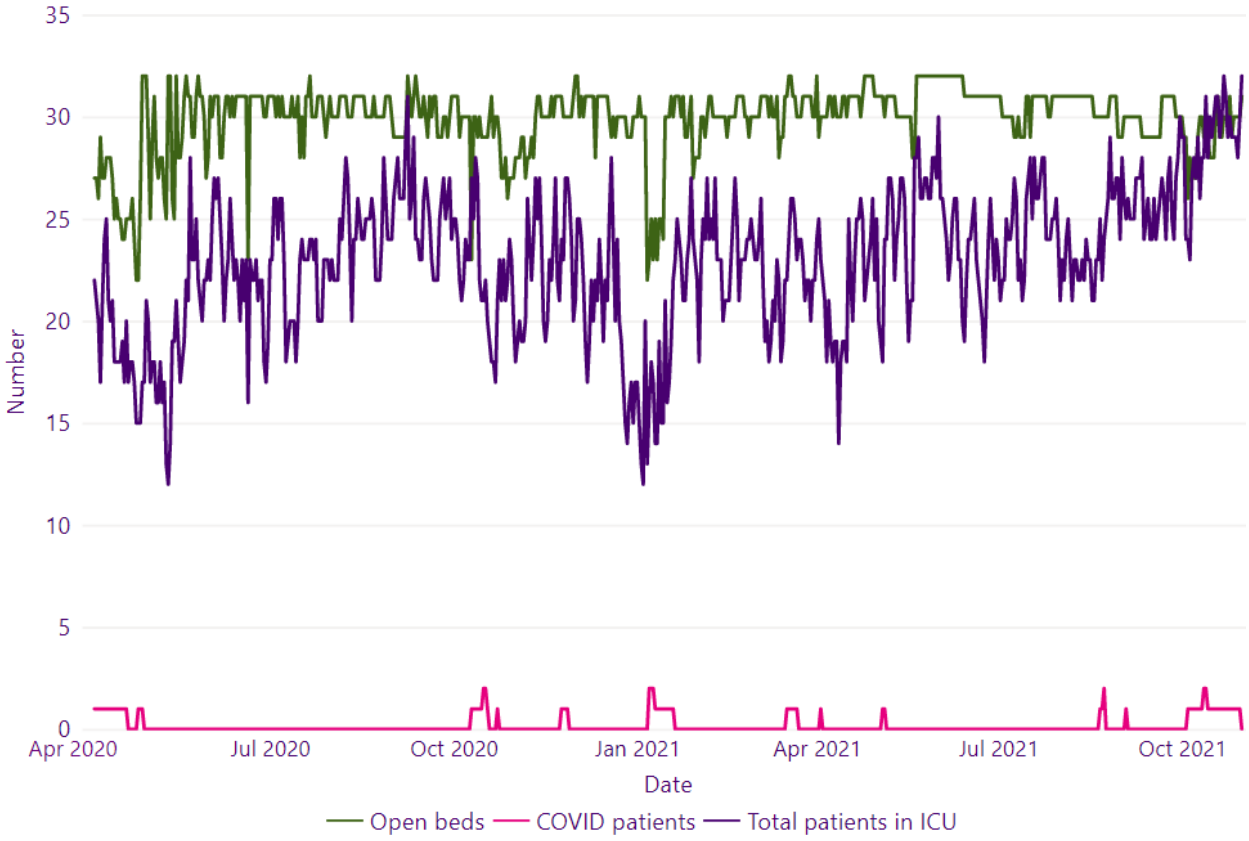

Figure 2.12: ICU bed capacity, bed occupancy and numbers of COVID patients in paediatric hospitals ICUs (26th March 2020 – 31st October 2021)
Data Source: NOCA ICU-BIS Core dataset

Summary

1. COVID-19 led to large numbers of ICU admissions but fewer than had been predicted based on experiences in other countries
2. Redeployment of staff and expansion of ICUs into new spaces allowed national ICU capacity to increase by 37% to 350 beds.
3. Bed occupancy reached 95% of the ICU beds open at the peak of Wave 3 in January 2021.
4. Numbers of non-COVID-19 patients invasively ventilated stayed relatively constant as these are a core group of patients who absolutely require care in ICU. The decrease in non-COVID-19 patient numbers was achieved by decreasing the numbers of non-COVID-19 non-ventilated patients accessing ICU.
5. The largest hospitals with more ICU beds cared for larger numbers of COVID-19 patients and also continued to care for large numbers of non-COVID-19 patients. Many of the smaller hospitals had to cope with a proportionally greater increase in patients as a percentage of their baseline numbers of ICU beds.
6. Numbers of COVID-19 patients were relatively constant in the larger hospitals but were more subject to peaks and troughs in activity in the smaller hospitals.
7. Numbers of COVID-19 patients in the private and paediatric hospitals were small but levels of non-COVID activity were maintained or even increased.

Chapter 3. COVID-19 patients in ICU; demographics, supports and outcomes

ICU admission data

The NOCA ICU Bed Information System (BIS) has collected demographic and other patient-level data on COVID-19 admissions to ICU since May 2020. This is an extension of the original role envisaged for ICU (BIS) (which was to provide data on ICU bed availability). This extension was in response to a request from the HSE for data to understand the epidemiological significance of a sudden increase in new COVID-19 admissions.

Over two thirds (67%) of new COVID cases before their first acceptance under the care of an ICU team came from a ward in the same hospital. (Figure 3.1). A small number of patients were transferred from hospitals without an ICU team (Model 2 hospitals, obstetric hospitals). Most inter-hospital transfers occurred from the ICU team in the referring hospital to the ICU team in the accepting hospital and were classified as an admission from a ward to ICU in the referring hospital (see Chapter 4).

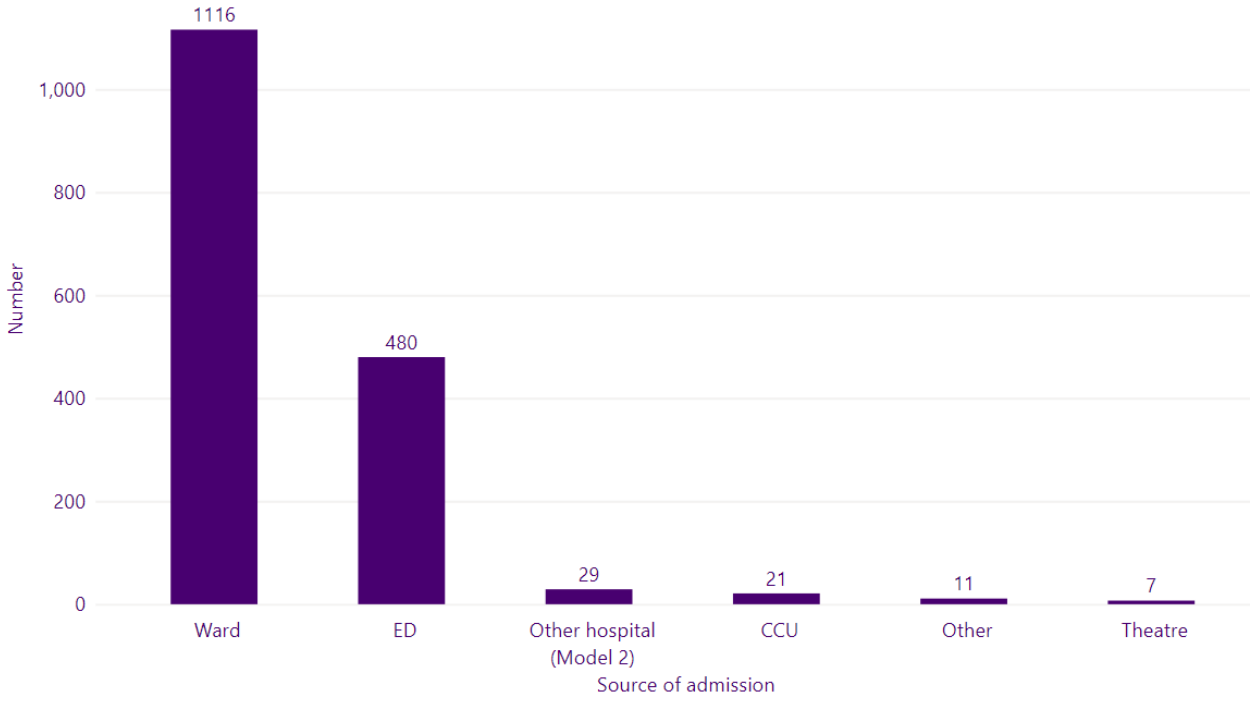

FIGURE 3.1: LOCATION OF NEW COVID-19 CASES BEFORE THEIR FIRST ACCEPTANCE UNDER THE CARE OF AN ICU TEAM (27TH MAY 2020 – 31ST OCTOBER 2021).
ED = EMERGENCY DEPARTMENT. CCU = CORONARY CARE UNIT. OTHER HOSPITAL = HOSPITAL WITHOUT AN ICU TEAM (MODEL 2 HOSPITALS, OBSTETRIC HOSPITALS).
Data source: NOCA ICU-BIS Supplemental dataset - Admissions

The majority of patients admitted to ICU with a diagnosis of COVID-19 were admitted to ICU primarily for treatment of their COVID-19 disease (Figure 3.2). In the non-COVID-19 admissions, COVID was often an incidental finding.

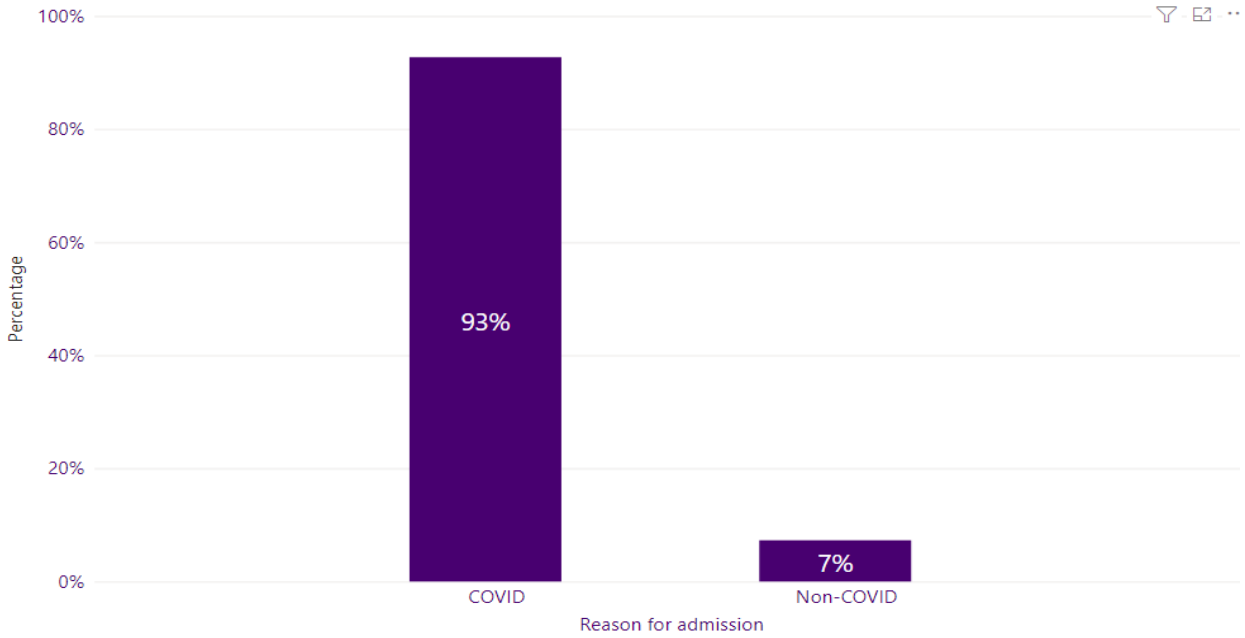

FIGURE 3.2: PRIMARY REASON FOR ADMISSION OF PATIENTS POSITIVE FOR COVID-19 TO ICU; ADMISSION RELATED TO COVID-19 OR TO NON-COVID DISEASE (27TH MAY 2020 – 31ST OCTOBER 2021)
Data Source: NOCA ICU-BIS Supplemental dataset - Admissions

48% of patients admitted to ICU with COVID-19 were aged between 60 and 79 years (Figure 3.3).

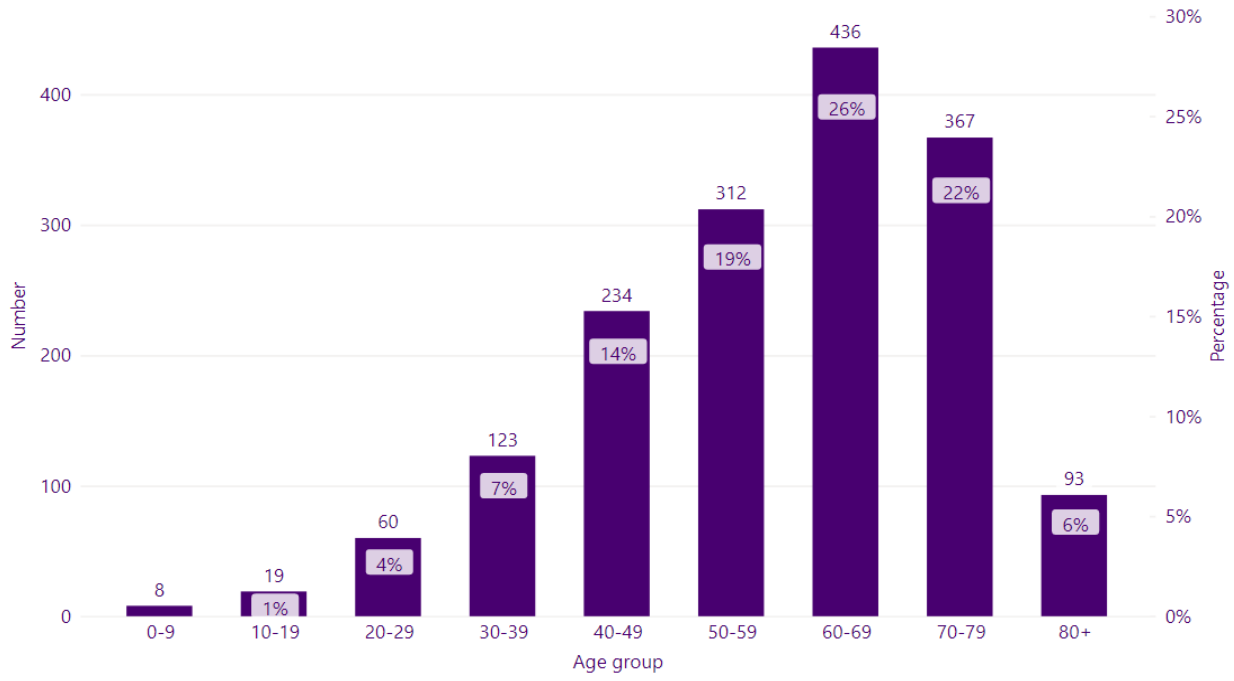

FIGURE 3.3: AGE RANGES OF PATIENTS WITH COVID-19 ADMITTED TO ADULT PUBLIC [18-90+], PAEDIATRIC [0-17] AND PRIVATE HOSPITALS [19-70+] OVER THE COURSE OF THE PANDEMIC, (27TH MAY 2021–31ST OCTOBER 2021).
Data Source: NOCA ICU-BIS Supplemental dataset - Admissions

The mean age of patients admitted to ICU decreased over the course of the pandemic, presumably in line with the higher vaccination rates in older people (Figure 3.4). However, the mean age of COVID-19 patients has increased again since July 2021.

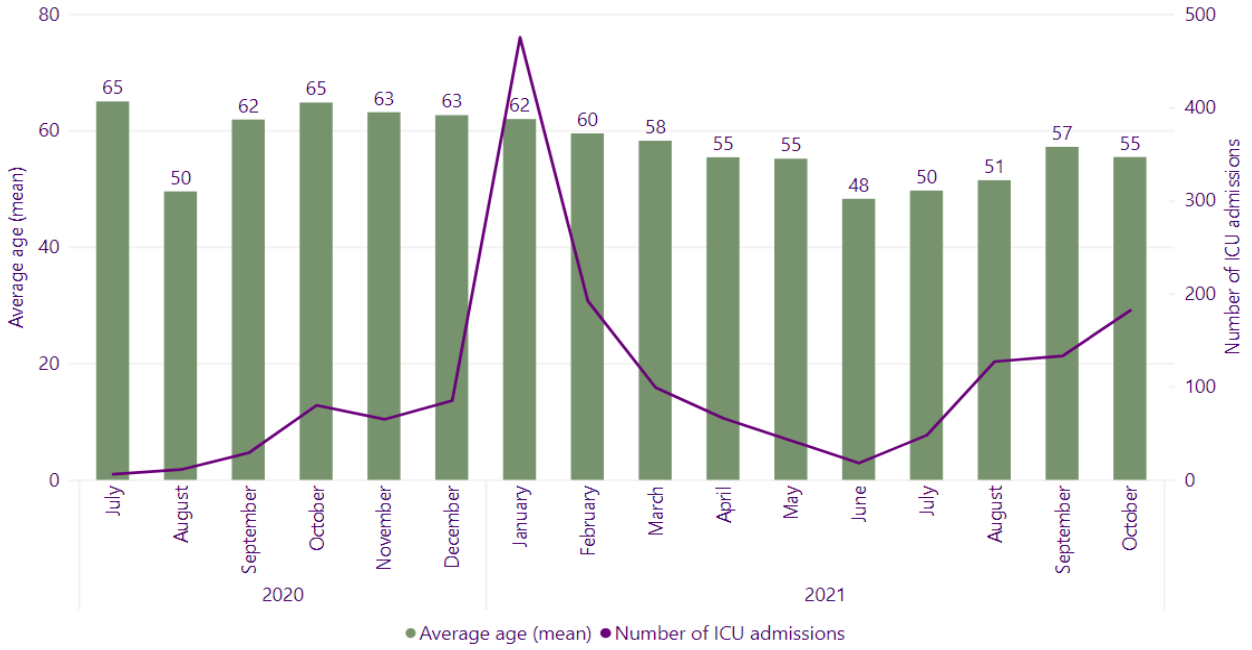

Figure 3.4. Mean age of patients with COVID-19 admitted to ICU each month from July 2020 to October 2021, with a line graph showing monthly numbers of COVID-19 ICU admissions.[4]
Data Source: NOCA ICU-BIS Supplemental dataset - Admissions

The majority of patients admitted to ICU were male (Figure 3.5).

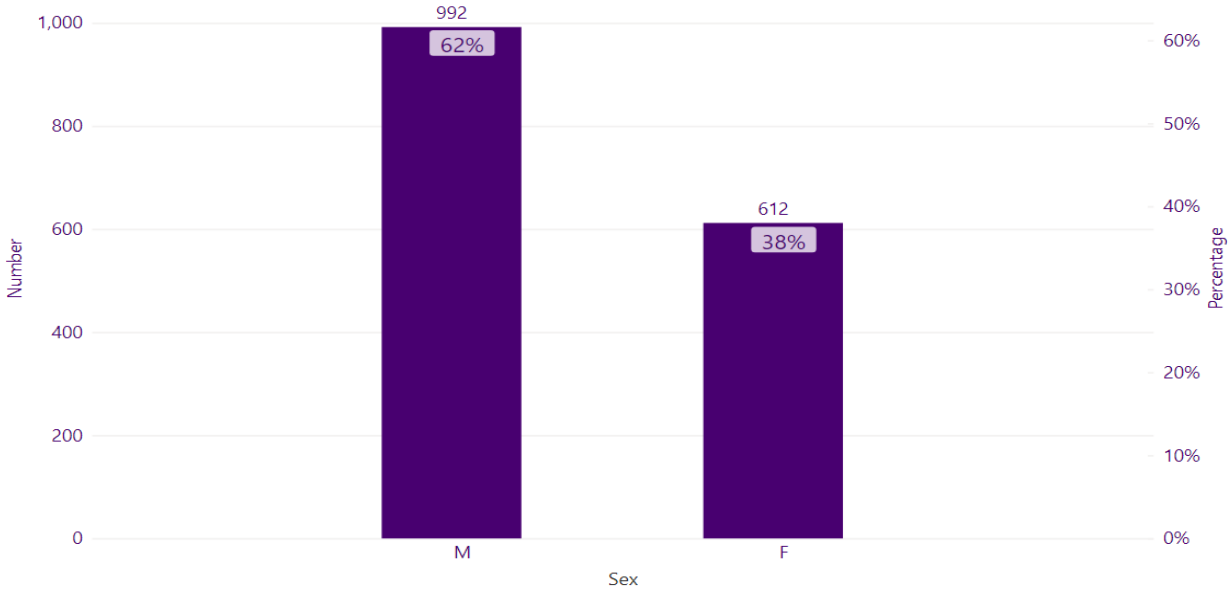

FIGURE 3.5: SEX OF ICU PATIENTS IN ADULT PUBLIC HOSPITALS (27TH MAY 2020 – 31ST OCTOBER 2021)
Data Source: NOCA ICU-BIS Supplemental dataset - Admissions

[4] NOCA ICU-BIS commenced reporting age of COVID-19 patients in July 2020. This was in response to an increase in admissions to ICU and a requirement to understand the demographics of the patients.

Organ support: Ventilation days

Patient days undergoing invasive ventilation made up 45% of all patient days during the period from March 2020 to October 2021. This increased to 57% of patient days during the period of peak activity in January – February 2021 (Tables 3.1 - 3.2).

COVID-19 patients spent a greater proportion of their time in ICU undergoing ventilation than did non-COVID-19 patients (Tables 3.1 - 3.2). COVID-19 patients accounted for 32% of all invasive ventilation bed-days, but only 22% of total patient days over the period March 2020 – October 2021. COVID-19 patient days increased to 55% of all patient days during the period of peak COVID activity (January – February 2021) and 62% of all invasive ventilation days.

COVID-19 patients dominated activity in ICU during the peaks of Wave 1 and Wave 3 in March – April 2020 and January – February 2021 but non-COVID admissions rebounded quickly afterwards as normal hospital activity resumed (Figure 2.5).

Patients in ICU are usually a very heterogenous population with a wide variety of diagnoses. The fact that a single disease accounted for 22% of patient bed days over a 16-month period indicates the impact COVID-19 has had.

TABLE 3.1: TOTAL ICU DAYS AND DAYS UNDERGOING INVASIVE VENTILATION FOR ALL PATIENTS AND FOR COVID-19 PATIENTS, MARCH 2020 TO OCTOBER 2021
Data Source: NOCA ICU-BIS Supplemental dataset – Admissions

	26th March 2020 to 31st October 2021	1st January 2021 to 28th February 2021
Patient days in ICU (all patients - COVID-19 + non-COVID-19)	146220	17257
Ventilation days in ICU (all patients)	65325	9860
COVID-19 patients; days in ICU	32491	9508
COVID-19 patients; ventilation days in ICU	20708	6151

TABLE 3.2: TOTAL ICU DAYS AND DAYS UNDERGOING INVASIVE VENTILATION FOR ALL PATIENTS AND FOR COVID-19 PATIENTS AS A PERCENTAGE OF TOTALS
Data Source: NOCA ICU-BIS Supplemental dataset – Admissions

	26th March 2020 to 31st October 2021	1st January 2021 to 28th February 2021
Total ventilation days as % of total patient days	45%	57%
COVID ventilation days as % of total COVID patient days	64%	65%
COVID patient days as % of total patient days	22%	55%
COVID ventilation days as % of total ventilation days	32%	62%

Organ support: Renal replacement therapy

Renal failure is a common complication of severe COVID-19 disease. This led to increased numbers of patients requiring renal replacement therapy and fears about shortages of dialysis machines and disposable supplies for continuous renal replacement therapy (CRRT).

The numbers of patients requiring RRT increased in association with increases in the numbers of patients in ICU with COVID-19, particularly in January-February 2021 (Figure 3.6).

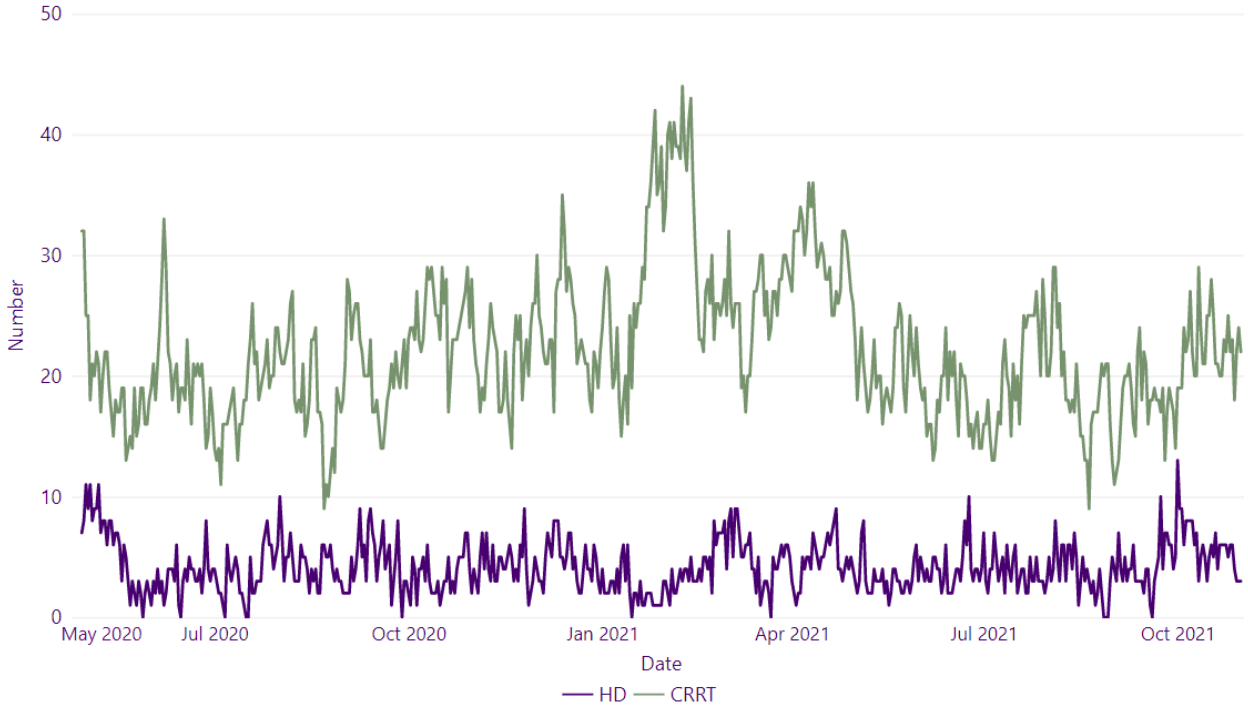

FIGURE 3.6: NUMBERS OF PATIENTS (COVID-19 + NON-COVID-19) UNDERGOING HAEMODIALYSIS (HD) AND CONTINUOUS RENAL REPLACEMENT THERAPY (CRRT) IN ICU, APRIL 2020 – OCTOBER 2021[5]
Data Source: NOCA ICU-BIS Core dataset

Incidentally, NOCA noted considerable variability between hospitals in the numbers of patients undergoing CRRT which was not explained by the numbers of patients in ICU. A way to describe this was to express the total number of patient days undergoing CRRT as a percentage of the total number of patient days undergoing invasive ventilation (Figure 3.7). Note this is data for all patients, COVID-19 and non-COVID-19.

The explanation for this variability is not clear from the ICU-BIS data but may be explained when more detailed data becomes available from the ICNARC National ICU Audit Report. Any conclusions must keep in mind that the data presented here on CRRT relates to all patients in ICU, not just COVID-19 patients.

[5] Collection of this data was commenced in April 2020 in response to a request from HSE in order to predict the demand for supplies for dialysis.

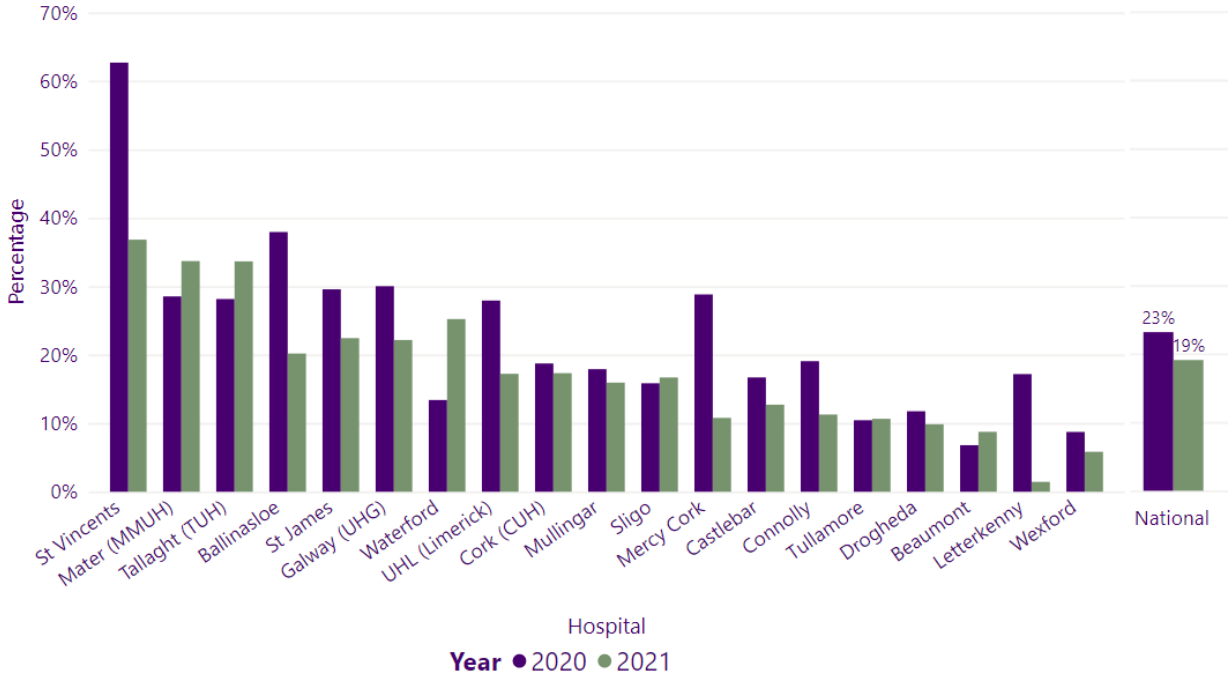

FIGURE 3.7: PATIENT DAYS UNDERGOING CRRT IN EACH HOSPITAL AS A PERCENTAGE OF PATIENT DAYS UNDERGOING INVASIVE VENTILATION; 29TH APRIL 2020 -31ST OCTOBER 2021[6]
Data Source: NOCA ICU-BIS Core dataset

[6] Cavan and Tralee are omitted from this analysis as these hospitals did not undertake CRRT for the entire period being presented.

Organ support: ECMO

ECMO for Covid-19 pneumonitis (2020 and January – September 2021)
Data Source: Mater ECMO team

The impact of Covid-19 on the Mater ECMO Service has been significant. The Covid-19 pandemic has led to a three-fold increase in the demand for V-V ECMO. The Mater ECMO Service has supported 30 patients with V-V ECMO for Covid-19 pneumonitis since the pandemic began.

1) **Number of V-V ECMO patients:** From 2009 to 2019, a median of 7 patients each year were supported with V-V ECMO for respiratory failure. From the start of the pandemic in 2020 to the present, 34 patients were supported with V-V ECMO for respiratory failure, 30 of whom had Covid-19 pneumonitis. From Jan-Oct 2021 alone, 25 patients were supported with V-V ECMO for respiratory failure of whom 23 patients had Covid-19.

Between 2009 to 2019, 34 of 82 (42%) V-V ECMO patients were retrieved on ECMO from a referral hospital. During the pandemic, 20 of the 30 (67%) V-V ECMO patients with Covid-19 were retrieved on ECMO from a referral hospital.

2) **Duration of V-V ECMO:** Between 2009 to 2019, the median duration of V-V ECMO for respiratory failure was 11 days. In 2020 and 2021, the duration of V-V ECMO for patients with Covid-19 was 30 days and 17 days respectively.

3) **Number of V-V ECMO days per year:** From 2009 to 2019, the median number of V-V ECMO days per year was 115 days. In 2020 and 2021, the number of V-V ECMO days was 225 days and 396 days respectively for patients with Covid-19 (excl. 3 patients still in ICU on V-V ECMO to date).

Survival to hospital discharge

To date, 15 (50%) patients have survived to hospital discharge while three remain supported on V-V ECMO in the Mater Intensive Care Unit. Survival after ECMO for Covid-19 in the Mater Hospital compares favourably to international data published by ELSO (Broman, L. *et al.* (2021) (50% vs 44%) in June 2021. Prior to the pandemic, the survival after ECMO for acute severe respiratory failure in the Mater Hospital was 60%.

COVID-19 in pregnancy; 26 March 2020 to 31st August 2021

Up to December 2020, there were no admissions of pregnant patients to ICU due to COVID-19. In the period 1st December 2020 to 31st August 2021, 23 women who were pregnant were admitted to ICU with COVID-19 (Table 3.3).

In addition, 11 women were admitted to ICU with COVID-19 on the day of delivery of their baby and another woman was admitted seven days after delivery because of COVID-19. These women were seriously ill; 57% required invasive ventilation and 3 required ECMO. Thankfully all have survived to date (Table 3.3).

TABLE 3.3. PREGNANT AND RECENTLY PREGNANT PATIENTS IN ICU WITH COVID 19, MARCH 2020 TO AUGUST 2021. DEMOGRAPHICS, PREGNANCY-RELATED DATA, INTERVENTIONS AND OUTCOMES
Data Source: NOCA ICU-BIS Supplemental dataset - Pregnancy

Data on length of stay (LOS) and outcome updated 30th September 2021

	Pregnant at ICU admission	Recently pregnant
Pregnant patients with COVID March 2020 to 31st August 2021	23	12
Pregnant patients with COVID-19 1st August to 31st August 2021	7	3
Gestation (weeks, mean)	30	33 weeks at delivery
ICU LOS (days, mean)	15.4 (median = 7, range 1-75)	10.6 (median = 3, range 1 - 49)
Age (mean)	31.9 yrs.	30.4 yrs.
BMI	31	35
Invasively ventilated	61%	50%
Days of IPPV (mean)	13.3	
Proned	48%	38%
Vasopressors	57%	50%
Dialysis	0	0
Delivery while in ICU	10/23 (All C/S)	0
Mortality	0	0
Fetal outcome	All alive	1 adverse fetal outcome
Days from delivery to ICU admit		11 admitted on day of delivery, one admitted 7 days post-partum
Vaccination status; fully vaccinated?	0	0
Primary reason for ICU admission was COVID-19	87%	82%

Admissions of pregnant women increased during 2021 and 58% of admissions (31/53) have been during the last 3 months; August - October 2021 (Table 3.4). This was presumably related to the low rate of vaccination in this group as vaccination had not been recommended up to recently.[7]

None of this cohort have died to date (October 31st 2021).

TABLE 3.4 PREGNANT AND RECENTLY PREGNANT PATIENTS IN ICU WITH COVID-19 (N AND % OF TOTAL COVID ADMISSIONS TO ICU) OVER DIFFERENT PHASES OF THE PANDEMIC
Data Source: NOCA ICU-BIS Supplemental dataset - Pregnancy

	April – December 2020	January – May 2021	June – August 2021	September – October 2021
Total COVID admissions	465	854	191	315
Pregnant COVID admissions (% total)	2 (0.4%)	12 (1.4%)	9 (4.7%)	7 (2.2%)
Recently pregnant COVID admissions (% total)	2 (0.4%)	4 (0.5%)	5 (2.6%)	12 (3.8%)
COVID admissions currently or recently pregnant (% of total COVID admissions)	4 (0.9%)	16 (1.9%)	14 (7.3%)	19(6.0%)

[7] 26th April 2021; NIAC recommended that pregnant women should be offered mRNA COVID-19 vaccination between 14-36 weeks' gestation following an individual risk/benefit discussion with their obstetric care provider.
3rd Sept 2021; vaccination was recommended for all stages of pregnancy

Vaccination data

Data are available on 510 patients admitted to ICU between 3rd June 2021 and 31st October 2021.
The majority of patients admitted to ICU with COVID-19 over this period were not vaccinated (Figure 3.8). Unvaccinated patients made up less than 20% or the population during this period, meaning they were considerably over-represented in ICU. The proportion of patients in ICU who were vaccinated increased over time, as they made up an increasing proportion of the population (now approximately 90%). Vaccinated patients as a proportion of COVID-19 patients in ICU remained much less than in the population as a whole and an unvaccinated person was much more likely to be admitted to ICU with COVID-19 than a vaccinated person.

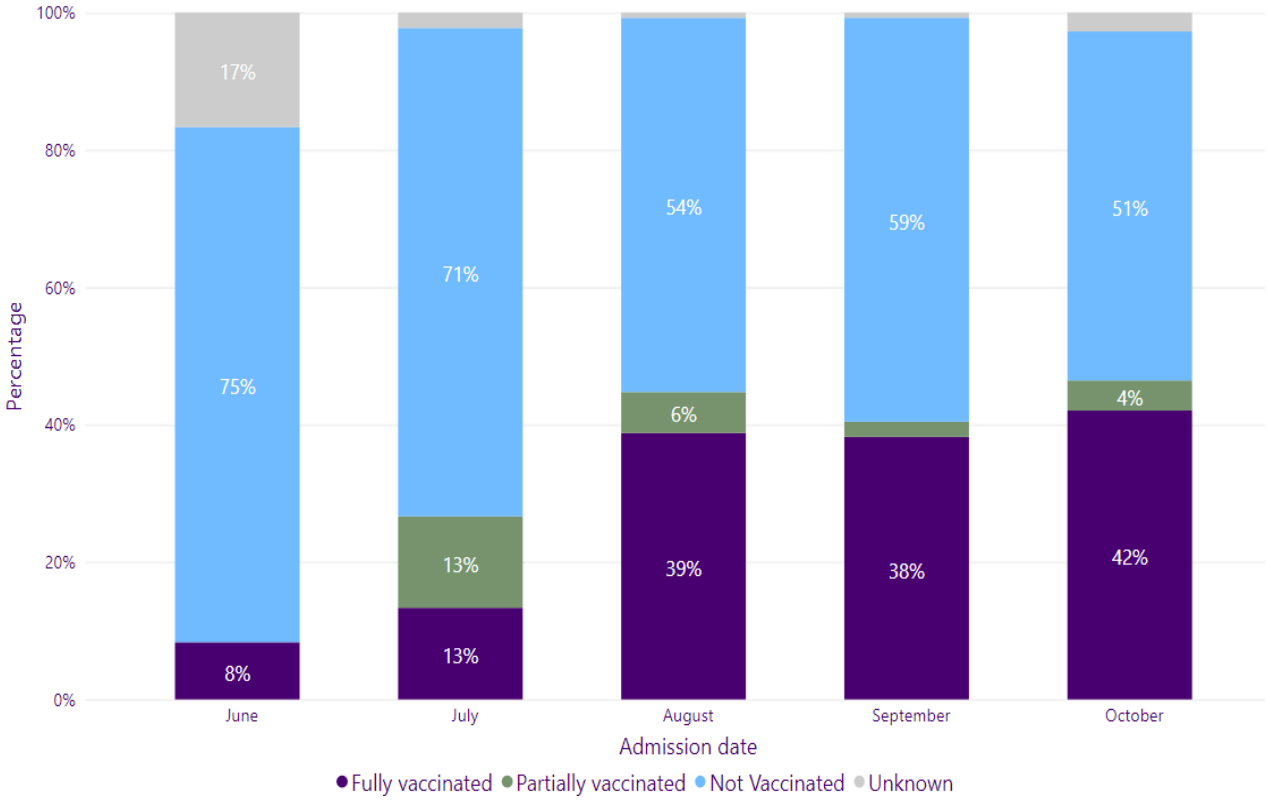

FIGURE 3.8; PATIENTS FULLY VACCINATED, PARTIALLY VACCINATED AND UNVACCINATED AS A PERCENTAGE OF ALL COVID-19 PATIENTS ADMITTED TO ICU BETWEEN 3RD JUNE 2021 AND 31ST OCTOBER 2021
Data Source: NOCA ICU-BIS Supplemental dataset – Vaccinations

During this period (June-October 2021), the total number of patients admitted to ICU with COVID-19 increased. There were major increases in numbers of both vaccinated and unvaccinated patients (Table 3.5).

TABLE 3.5. NUMBERS AND VACCINATION STATUS OF PATIENTS ADMITTED TO ICU WITH COVID-19 FROM JUNE TO OCTOBER 2021
Data Source: NOCA ICU-BIS Supplemental dataset – Vaccinations

Month	Fully vaccinated	Partially vaccinated	Unvaccinated	Unknown	Total
June	1	0	9	2	12
July	6	6	32	1	45
August	52	8	73	1	134
September	52	3	80	1	136
October	77	8	93	5	183
Total	188	25	287	10	510

Vaccination rates for patients in ICU were higher in older patients (Table 3.6). Possible explanations could be that (i) vaccination rates are higher in the elderly than the general population or (ii) vaccinated patients don't require ICU admission unless there are predisposing factors like increased age.

TABLE 3.6. RATES OF VACCINATION IN DIFFERENT AGE GROUPS OF PATIENTS ADMITTED TO ICU WITH COVID-19 BETWEEN 3RD JUNE 2021 AND 31ST OCTOBER 2021
Data Source: NOCA ICU-BIS Supplemental dataset - Vaccinations

Age range	0-18	19-29	30-49	50-69	70+
n	10	30	152	208	110
Fully vaccinated (%)	0%	3%	13%	44%	69%
Not vaccinated (%)	100%	93%	78%	50%	24%

Over the period 3rd June 2021 to 31st October 2021, 37% of patients admitted to ICU with COVID-19 were fully vaccinated. Over four-fifths (82%) of the vaccinated patients had significant predisposing factors (Table 3.7). In addition vaccinated patients were older with a median age of 66 years compared to 46 years for unvaccinated patients. Pre-existing conditions included significant respiratory, cardiac, or renal disease, malignancy, previous organ transplant, immunosuppressive therapy, obesity and pregnancy. These factors indicate that vaccinated patients needed to have more risk factors to require ICU admission.

TABLE 3.7. VACCINATION STATUS ON ADMISSION AND OUTCOMES FOR COVID-19 PATIENTS ADMITTED TO ICU FROM 3RD JUNE 2021 TO 31ST OCTOBER 2021
Data Source: NOCA ICU-BIS Supplemental dataset - Vaccinations

COVID-19 patients admitted to ICU, 3rd June 2021- 31st Oct 2021 N=510	n (% of ICU admissions)	Pre-existing conditions	Age; mean (median)
Vaccination; fully vaccinated	188 (37%)	155/188 (82%)	65 (66)
Partially vaccinated	25 (5%)	12/25 (48%)	52 (54)
No vaccination	287 (56%)	145/287 (51%)	48 (48)
Unknown	10 (2%)	4/10 (40%)	64 (70)

There was a higher mortality rate in vaccinated patients admitted to ICU with COVID-19 (Figure 3.9). This can be explained by the older age and greater prevalence of pre-existing conditions in the vaccinated group (Table 3.7). The factors that make COVID-19 patients more likely to need ICU even if vaccinated also make it more likely that they will not survive.

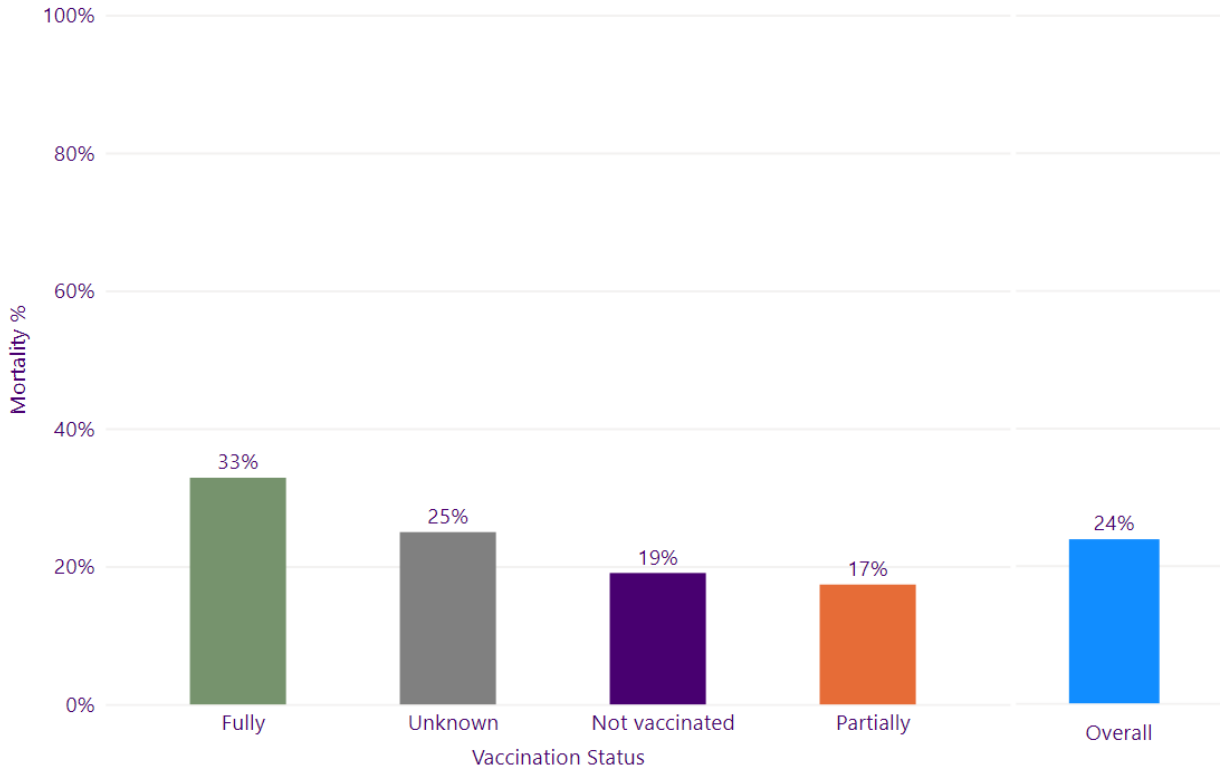

FIGURE 3.9. MORTALITY RATES AND VACCINATION STATUS IN COVID-19 PATIENTS ADMITTED TO ICU BETWEEN 3RD JUNE 2021 AND 31ST OCTOBER 2021, AND WHO HAD LEFT ICU BY 31ST OCTOBER 2021
Data Source: NOCA ICU-BIS Supplemental dataset – Vaccinations

Anecdotal evidence suggested that certain nationalities were more heavily represented among COVID-19 patients in ICU, particularly among the unvaccinated group. A survey of the country of birth of COVID-19 patients in ICU in mid-October 2021 confirmed this (Figure 3.10). A significant number of the patients born in Ireland had been fully vaccinated whereas none of the patients from a range of countries in Eastern Europe, Asia or Africa had been. This has important implications for the communication of public health information and tailoring of campaigns to increase the level of vaccination to protect these groups.

Interestingly there were no patients born in India, Pakistan the Philippines or the UK in ICU with COVID-19 at the time of the survey, despite the large numbers from these countries working in healthcare as well as other areas in Ireland.

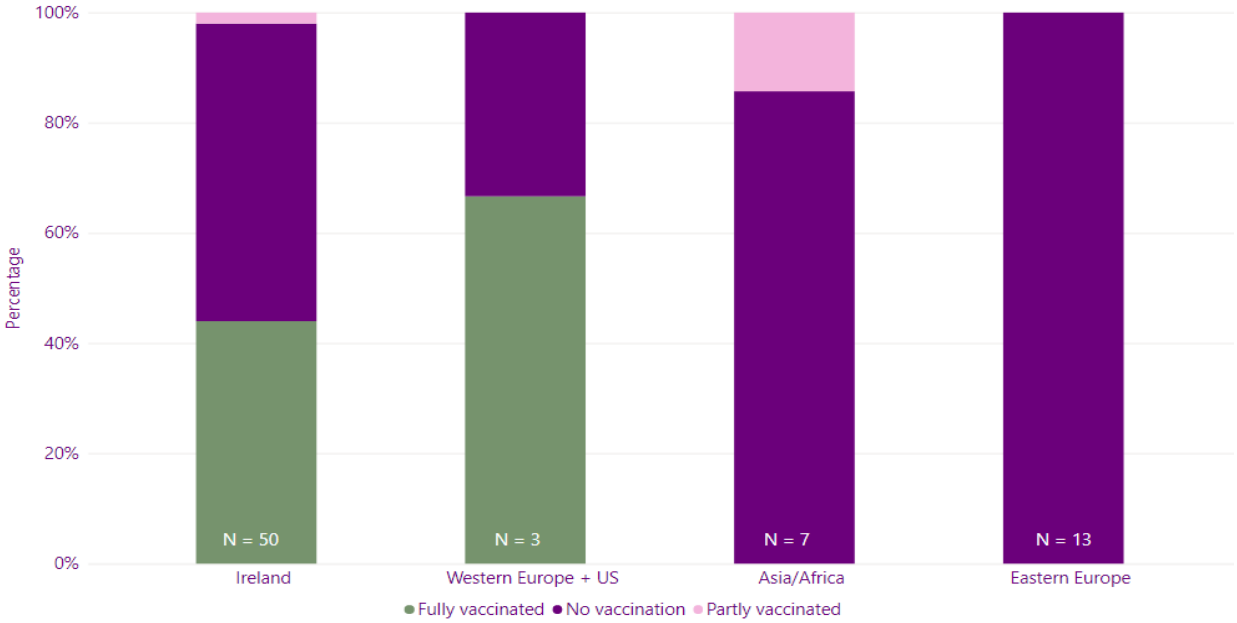

FIGURE 3.10. COUNTRY OF BIRTH (BY REGION) AND VACCINATION STATUS OF PATIENTS WITH COVID-19 IN ICU
Data Source: NOCA ICU-BIS Supplemental dataset – Vaccinations

Sex and age

Almost 60% (59%) of COVID-19 patients admitted to ICU from 3rd June to 31st October 2021 were male, and 41% were female. Mortality in those who had left ICU by 31st October 2021 was 27% in males and 20% in females.

The majority of patients who required ICU admission were in the older age groups and mortality rates were higher in older patients (Figure 3.11).

AgeGroup	Patients who left ICU
0-17	9
18-29	28
30-39	61
40-49	84
50-59	75
60-69	100
70-79	80
80+	16
Total	**453**

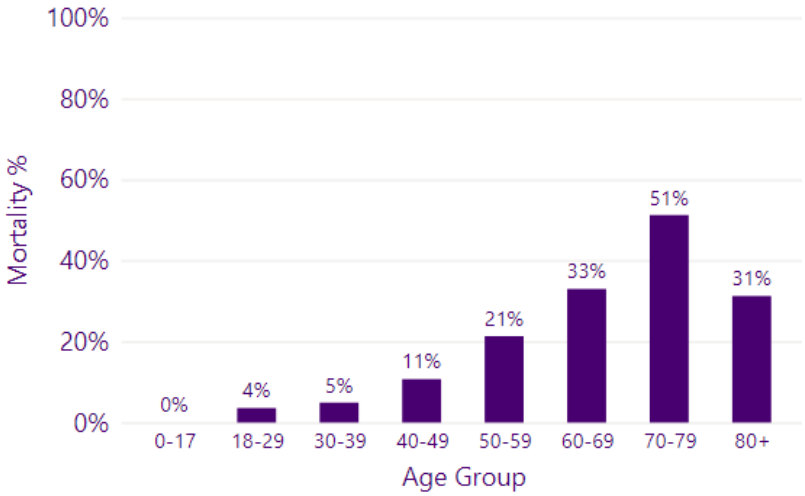

FIGURE 3.11 AGE PROFILE AND MORTALITY (%) IN PATIENTS ADMITTED TO ICU WITH COVID-19; BETWEEN 3RD JUNE 2021 AND 31ST OCTOBER 2021, AND WHO HAD LEFT ICU BY 31ST OCTOBER 2021
Data Source: NOCA ICU-BIS Supplemental dataset – Vaccinations

Mortality of COVID-19 patients in ICU

A striking feature of the data on crude mortality (i.e. unadjusted for risk) in COVID-19 patients in ICU has been variability during different phases of the pandemic (Figure 3.12, Table 3.8). Increases in crude mortality appeared to be associated with increased numbers of COVID-19 patients in ICU. Data from ICU-BIS Is not comprehensive enough to explain the reasons for these differences which will require more detailed data from NOCA ICU Audit and from the HPSC reports on COVID-19 patients in ICU. Caution is required in drawing conclusions from data on mortality which has not been adjusted for risk factors.

Other data have indicated that enhanced levels of care were provided to COVID-19 patients in hospital wards during periods of surge in COVID-19 patient numbers (Figure 4.6), suggesting ICU beds were reserved for more critically ill patients. Further reports from the ICU audit process will provide data on risk-adjusted mortality rates in COVID-19 patients – these are available for Quarter 1-2 2020 (see Chapter 5) but not yet for subsequent periods.

The NOCA ICU Audit reports which are available to date for the overall ICU patient population (COVID-19 plus non-COVID-19) in individual ICUs have shown no increase in risk-adjusted mortality rates.

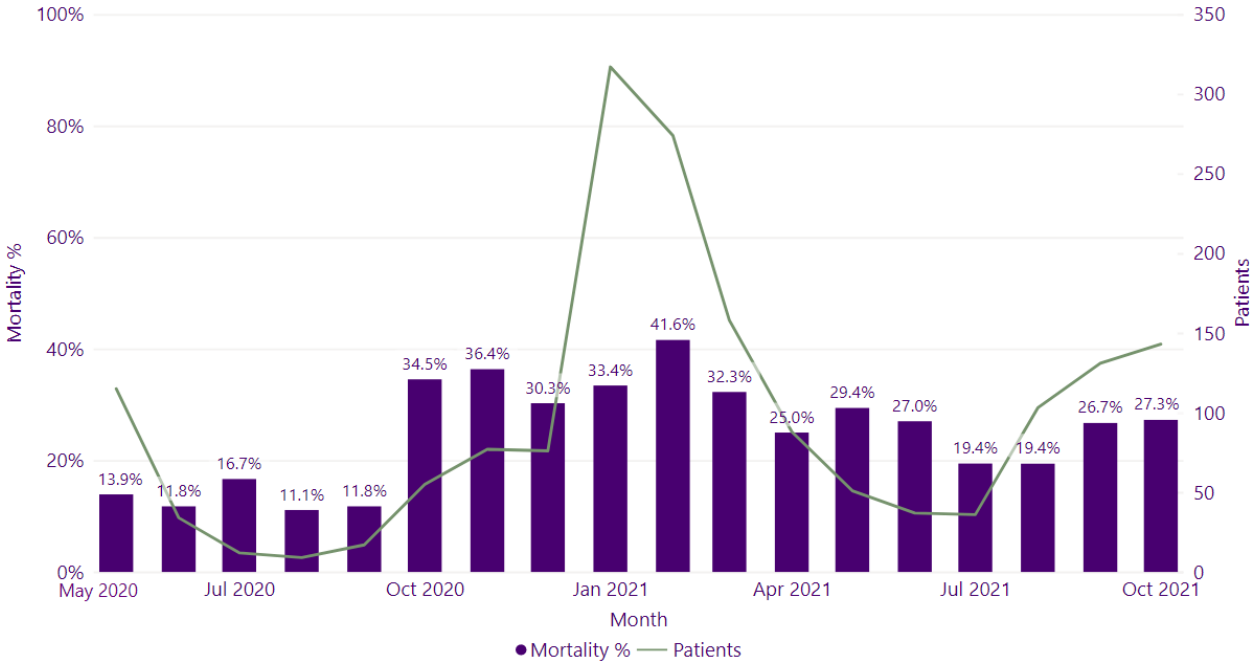

FIGURE 3.12. MONTHLY MORTALITY RATE FOR COVID-19 PATIENTS IN ICU DURING THE PERIOD MAY 2020 - OCTOBER 2021
The line graph shows numbers of monthly admissions to ICU of COVID-19 patients
Data Source: NOCA ICU-BIS Supplemental dataset – Admissions

TABLE 3.8 MORTALITY IN COVID-19 PATIENTS ADMITTED TO ICU OVER DIFFERENT PHASES OF COVID-19 PANDEMIC
Data Source: NOCA ICU-BIS Supplemental dataset - Admissions

	10th April 2020 – 31st Oct 2021	10th April 2020 – 31st Dec 2020	1st January 2021 – 31st May 2021	1st June 2021 – 31st October 2021
COVID-19 admissions	1813	465	854	507
COVID-19 patients already in ICU on first day of time period	151	151	47	34
COVID-19 patients remaining in ICU on last day of time period	93	47	34	91
Numbers for consideration	1871	569	867	450
COVID-19 deaths	530	118	303	111
Mortality (%)	28.3%	20.7%	34.9%	24.7%
Median age of admissions	57	58	54	57

Summary

1. Most patients in ICU with a diagnosis of COVID-19 were admitted after deteriorating in the ward. In 93% COVID-19 was the reason for admission to ICU, rather than being incidental.
2. Age was a significant factor in requirement for admission to ICU; 56% of ICU admissions were aged 60 years or over. The mean age decreased over the course of the pandemic, as more of the older population were vaccinated. Males were more likely to be admitted to ICU than females.
3. COVID-19 patients spent a higher proportion of their time in ICU undergoing invasive ventilation than non-COVID-19 patients. At the peak of COVID-19 (January to February 2021), a very high proportion of patients were undergoing invasive ventilation, putting major pressure on ICU staff and resources. At this time also, there was an increase in the number of patients undergoing CRRT.
4. Thirty COVID-19 patients required transfer to the National Centre for extra-corporeal life support (ECLS or ECMO) in the Mater.
5. There was an unanticipated surge from August 2021 in ICU admissions of patients who were pregnant or recently pregnant. Many of these required invasive ventilation, some for prolonged periods and 3 required ECMO. All have survived to date.
6. Unvaccinated patients have made up more than 50% of admissions to ICU each month, although approximately 90% of the adult population were vaccinated. Vaccinated patients in ICU had a much higher rate of pre-existing conditions which predisposed them to requiring admission to ICU.
7. There were significant differences in the vaccination status of ICU patients from different regions of birth; none of the COVID-19 patients in ICU from Eastern Europe had been vaccinated.
8. Mortality rates in vaccinated patients in ICU were higher than in unvaccinated reflecting the older age and frequent co-morbidities in the vaccinated ICU population.
9. Mortality rates have fluctuated over the course of the pandemic. The reasons for this are unclear but may be clarified when full data are available from the national ICU Audit process.
10. An interesting variability was noted between different hospitals in the proportion of patient days on CRRT to patient days on invasive ventilation.

Chapter 4: Supports for the national ICU network during the pandemic

Inter-hospital transfers of critically ill patients

There was significant variability between regions and hospitals in numbers of COVID-19 patients requiring Intensive Care at any one time. Transfers of patients were required to prevent busy hospitals from being overwhelmed. In addition, some COVID-19 patients required transfer for specialist care e.g., dialysis, ICU care in a Model 4 hospital, Extra Corporeal Membrane Oxygenation (ECMO), etc.

The specialist transfer service for critically ill adult patients is called the Mobile Intensive Care Ambulance Service (MICAS), part of the National Ambulance Service Critical Care and Retrieval Services (NASCCRS). MICAS operates from three regional hubs in Dublin, Galway and Cork (MICAS East, West and South respectively). These patients require skilled medical and nursing care to replicate the level of care they have been receiving in the ICU of the referring hospital. Their care may include mechanical ventilation, vasopressor support, an intra-aortic balloon pump or extra corporeal life support (ECLS). The MICAS service provides a trained team of an ICU nurse, an ICU doctor, an Emergency Medical Technician and an ambulance specially equipped for transfer of the critically ill. More recently, Critical Care Paramedics have provided additional support for the service.

Hospitals in the Irish healthcare system which cared for COVID-19 patients can be categorised as follows

(i) Model 2 (Regional hospitals without an ICU)
(ii) Model 3 (Regional hospitals with an ICU)
(iii) Model 4 (Hospitals with multiple specialist services)
(iv) private hospitals with an ICU.

Critically ill patients are transferred between hospitals for a variety of reasons

- Specialist care (e.g., dialysis, ICU in a Model 4 hospital)
- Capacity: no ICU bed available in the referring hospital
- Repatriation: return of previously transferred patients to the referring hospital.
- Mandatory transfer from a hospital without an ICU (Model 2 hospital)
- Requirement for ECMO

The MICAS was a key part of the response to COVID-19 by transferring critically ill patients from hospitals with no available ICU bed to another hospital with spare capacity. While MICAS did not undertake all transfers of critically ill COVID-19 patients, they undertook a large proportion and data on their activity over this period provides useful insights.[8]

Transfers of COVID-19 patients accounted for a large proportion of all transfers by the Mobile Intensive Care Ambulance Service (MICAS) over the period of the pandemic (Figure 4.1). This was particularly the case at times of peak COVID-19 activity. Ninety out of 152 MICAS transfers during Quarter 1 2021 were for COVID-19 patients (59%).

[8] Data have been provided by the coordinator of the MICAS adult retrieval service, National Ambulance Service Critical Care and Retrieval Services (NASCCRS)

MICAS East undertook the majority of transfers, but the other two services undertook an increasing proportion over time as their services developed (Figure 4.1). There was a significant increase in the number of transfers by MICAS of the Critical Care Retrieval Service (CCRS) compared to data for previous years and especially during periods with more COVID-19 cases (Figure 4.1). MICAS delivered the increased workload by providing additional transfer teams above the normal complement during Wave 3 of the pandemic in Quarter 1 2021. This was supported by increased redeployment of critical care paramedics to augment the workforce.

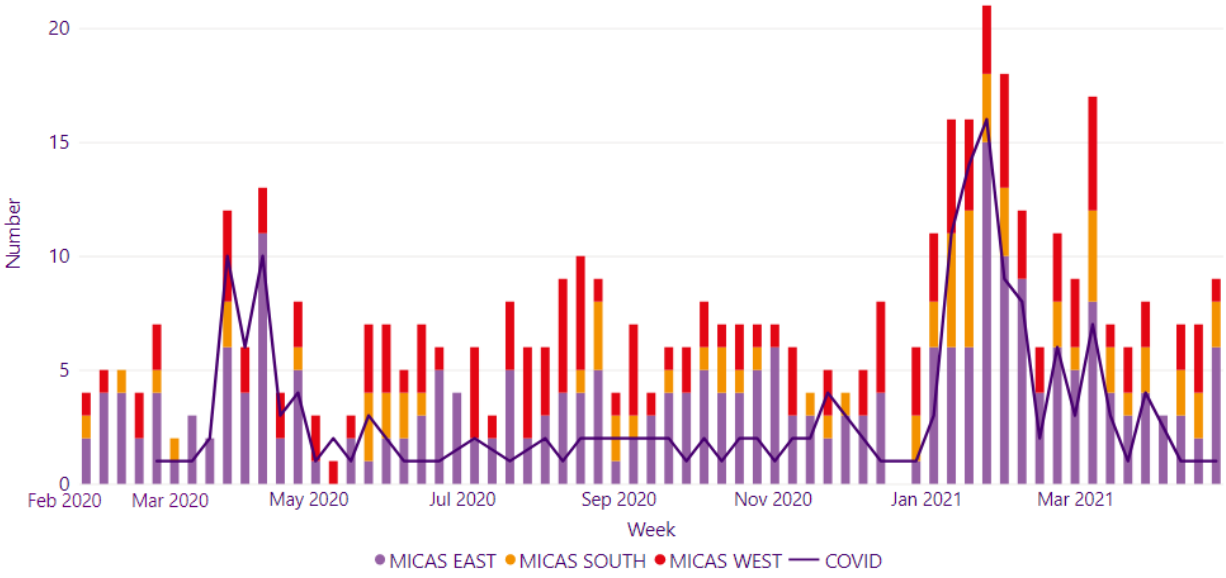

FIGURE 4.1; WEEKLY NUMBERS OF TRANSFERS OF CRITICALLY ILL PATIENTS (COVID-19 AND NON-COVID-19) BY EACH OF THE MICAS SERVICES (MICAS EAST, WEST AND SOUTH), MARCH 2020 TO APRIL 2021
Line graph indicates weekly numbers of COVID-19 patients transferred.
Data Source: MICAS Data

Activity levels were higher in 2021. Numbers of transfers were 129% higher in Quarter 1 2021 comparted to Quarter 1 2019, the most recent year before the pandemic started (Table 4.1).

TABLE 4.1. TRANSFERS OF CRITICALLY ILL PATIENT BY THE MOBILE INTENSIVE CARE AMBULANCE SERVICE (MICAS) DURING QUARTER 1 (Q1) AND % CHANGE FROM Q1 2019
Data Source: MICAS Data

Year	Transfers Q1	% change from 2019
2019	69	
2020	54	-28%
2021 (year to Oct)	158	+ 129%

The numbers of patients (COVID-19 and non-COVID-19) transferred from each hospital by MICAS during 2020 and 2021 are listed in Figure 4.2. It should be noted that many additional transfers were undertaken by the referring hospitals themselves if MICAS was unavailable; these are not included in this graph.

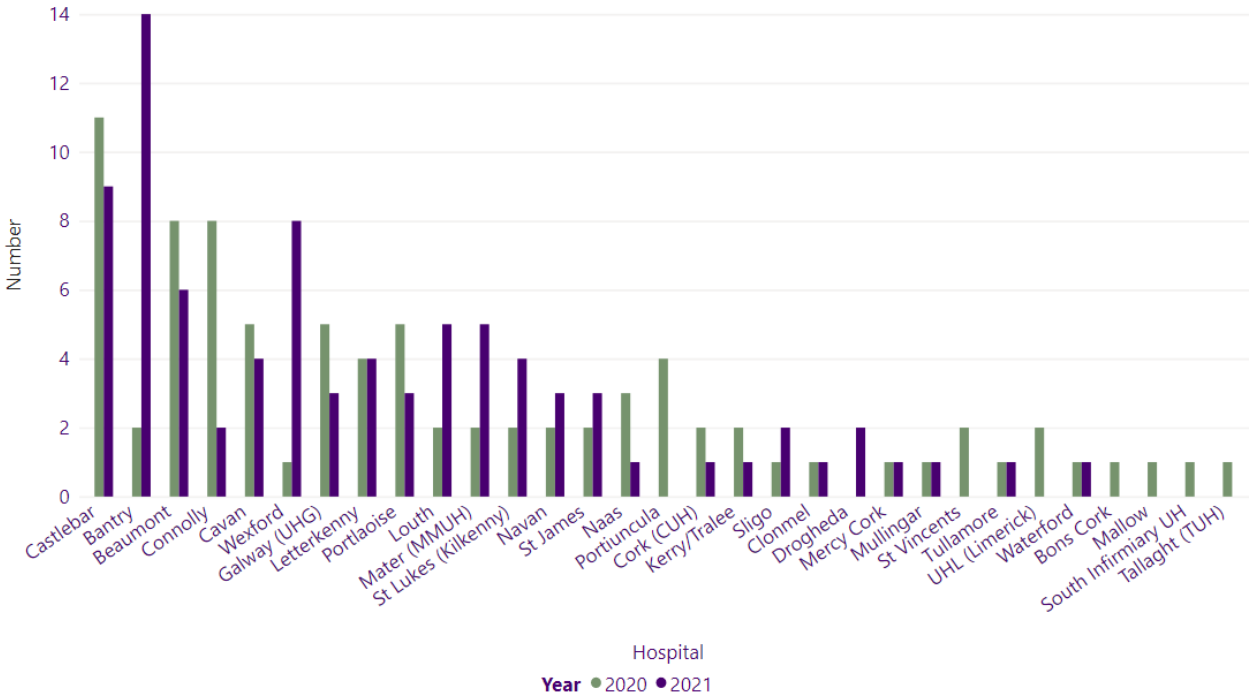

FIGURE 4.2 NUMBERS OF PATIENTS (COVID-19 AND NON-COVID-19) TRANSFERRED BY MICAS FROM EACH HOSPITAL DURING 2020 AND 2021
Hospitals are listed in the order of decreasing total numbers of transfers out for 2020 and 2021.
Data Source: MICAS Data

The number of patients (COVID-19 and non-COVID-19) transferred to each hospital by MICAS during 2020 and 2021 are listed in Figure 4.3. Additional transfers undertaken by the referring hospitals using their own staff are not included in this graph.

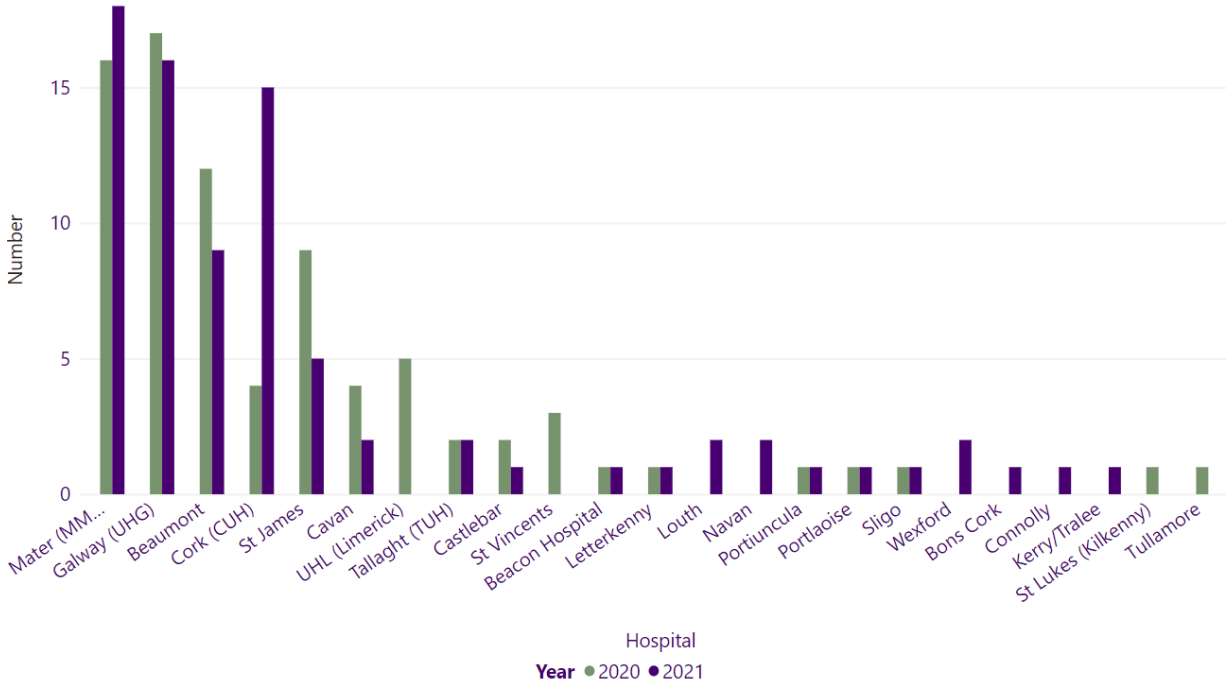

FIGURE 4.3; NUMBERS OF PATIENTS (COVID-19 AND NON-COVID-19) TRANSFERRED BY MICAS TO EACH RECEIVING HOSPITAL DURING 2020 AND 2021
Hospitals are listed in the order of decreasing total numbers of transfers for 2020 and 2021.
Data Source: MICAS Data

Indications for transfers of COVID-19 patients by MICAS over the period March 2020 to April 2021 are summarised in Figure 4.4.

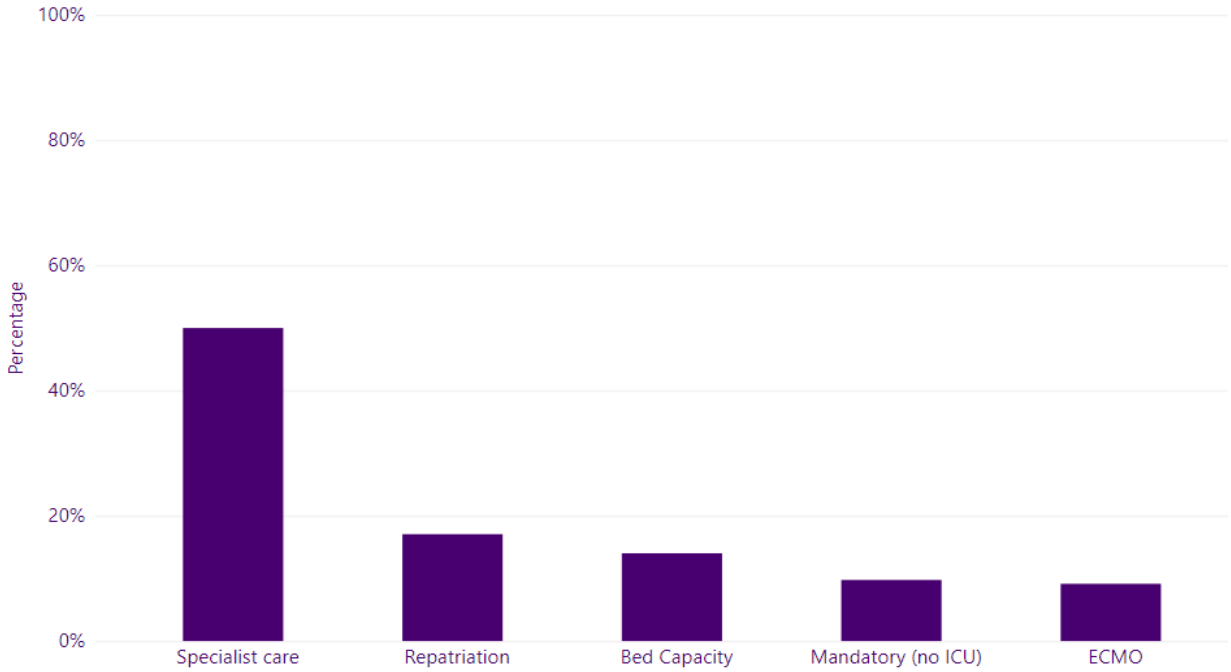

FIGURE 4.4; INDICATIONS FOR INTER-HOSPITAL TRANSFER OF COVID-19 PATIENTS BY MICAS 2020 TO 2021
See above for more detail on these categories
Data Source: MICAS Data

Data on MICAS transfers of COVID-19 patients shows the contribution made by all categories of hospitals during the pandemic (Figure 4.5). The largest category of transfers was from Model 3 to Model 4 hospitals. This aligns with the recommended Model of Care of the Critical Care Programme where 'spoke' (Model 3) hospitals would refer patients to 'hub' (Model 4) hospitals for more specialised ICU care or because of lack of ICU bed capacity. During Quarter 1 (January to March 2021), 35 out of 56 transfers from Model 3 to Model 4 hospitals were for increased complexity (more specialist) care (63%) and 21 were because of shortage of ICU beds in the referring hospital (37%).

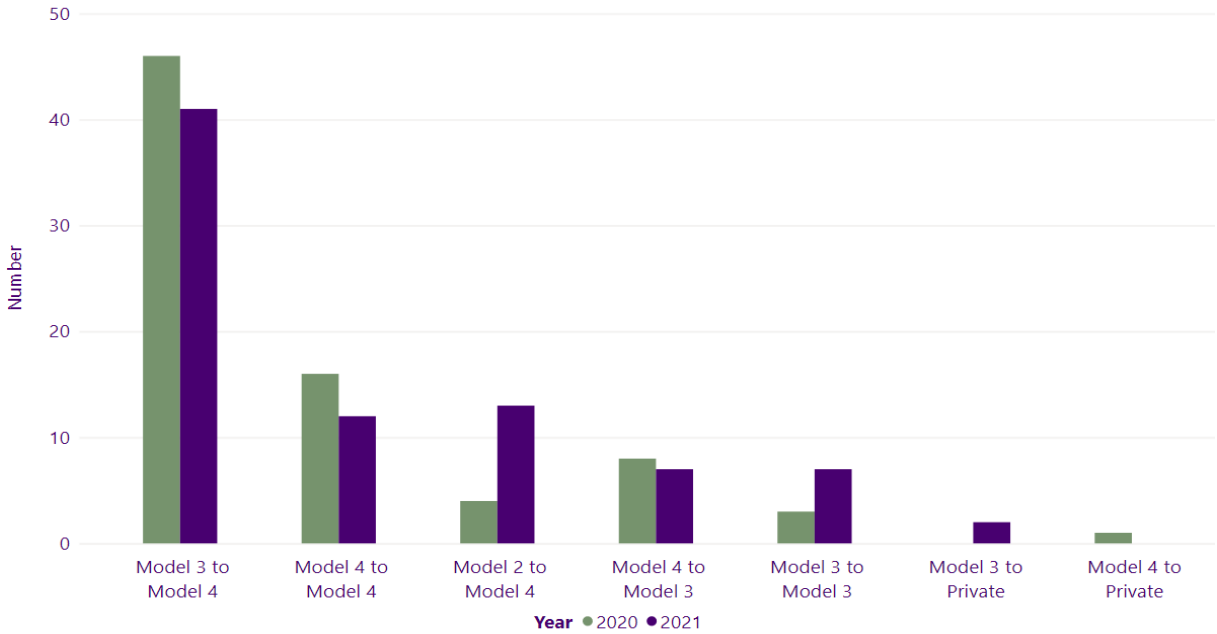

FIGURE 4.5. TRANSFERS OF COVID-19 PATIENTS BY MICAS BETWEEN MODEL 2, MODEL 3, MODEL 4 AND PRIVATE HOSPITALS, MARCH 2020 – APRIL 2021
Data Source: MICAS Data

Illness severity

The COVID-19 patients transferred were critically ill, as assessed by the supports provided during transfer (Table 4.2). There were no deaths during transfer.

TABLE 4.2. SUPPORTS PROVIDED TO COVID-19 PATIENTS TRANSFERRED BY MICAS, MARCH 2020 – APRIL 2021
Data Source: MICAS Data

COVID-19 patients transferred	188	%
Invasive airway	167	89%
FiO2 > 0.5	84	45%
Vasopressors required	77	41%
Deaths during transfer	0	0

HSE National Multi-Disciplinary COVID-19 Major Surge Working Group (CMSWG)

There was huge pressure on the resources of the Health Service during January and February 2021 with unprecedented numbers of patients requiring life-saving care in ICU.
To manage the surge in COVID-19 cases, HSE Acute Operations set up a multi-disciplinary working group consisting of medical, nursing, allied healthcare and clinical engineering professionals, representing critical care, respiratory medicine, drug management, critical care retrieval, O_2 delivery services, medical equipment and the hospital groups. **This was titled the** HSE National Multi-Disciplinary Critical and Respiratory COVID-19 Major Surge Working Group (CMSWG) and was chaired by Dr Vida Hamilton. Participants are listed in Appendix IV.

Objectives of the CMSWG

1. To ensure timely and equitable access to critical care for COVID-19 and non-COVID-19 patients during a time of unprecedented demand.
2. To ensure that resources nationally and in each acute hospital were managed optimally.
3. To provide immediate expert intervention to effect solutions to problems as they arose, driven by live data on occupancy, acuity and resource utilisation.

Operation of the CMSWG

The group met for 35 consecutive days during the peak of COVID-19 admissions to ICU

- Key data was collected in advance on the real-time situation in individual ICUs and the overall national situation. These data included:
  - Numbers of ICU beds staffed and occupied and of patients cleared for discharge and bed availability[9]
  - Numbers of patients undergoing invasive ventilation[10]
  - Numbers of COVID-19 admissions, deaths and discharges in ICU[11]
  - Data on activity outside ICU including use of advanced respiratory support (CPAP, HFNO and NIV), renal replacement therapy and hospital oxygen consumption (Figure 4.6).
- Staffing ratios and skill-mix
- Staff morale
- Availability of equipment for advanced respiratory support
- Supplies of consumables

Data on the supports provided to patients on hospital wards indicates enhanced levels of care compared to periods outside the surge in COVID-19 cases (Figure 4.6). This was related to the large numbers of patients with severe respiratory disease related to COVID-19. These enhanced levels of support in wards meant that ICU beds could be reserved for sicker patients which may partly explain why mortality rates, (unadjusted for risk) among COVID-19 patients admitted to ICU were higher at times of increased case numbers (Figure 3.12).

[9] Data provided from the NOCA ICU Bed Information System (ICU-BIS)
[10] Data provided from the NOCA ICU Bed Information System (ICU-BIS)
[11] Data provided from the NOCA ICU Bed Information System (ICU-BIS)

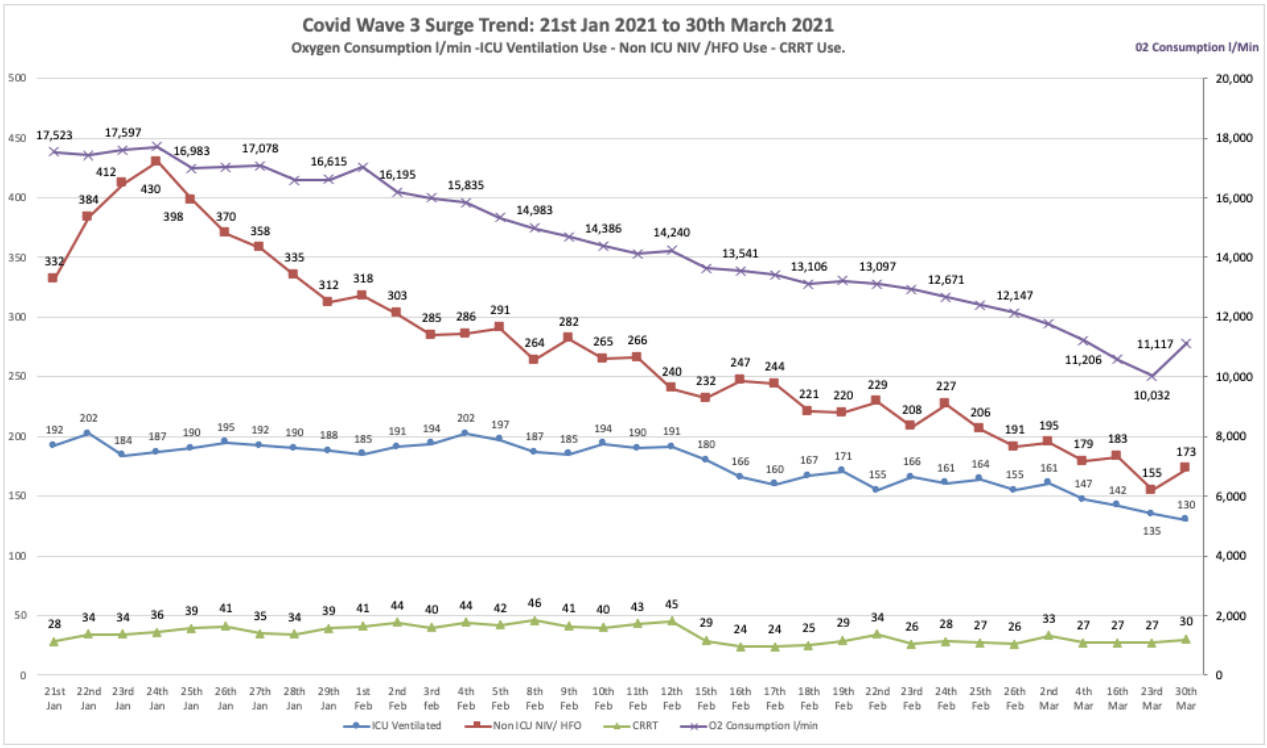

FIGURE 4.6. NUMBERS OF PATIENTS UNDERGOING ADVANCED RESPIRATORY SUPPORT (CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP), HIGH FLOW NASAL OXYGEN (HFNO), NON-INVASIVE VENTILATION (NIV), INVASIVE VENTILATION IN ICU, CONTINUOUS RENAL REPLACEMENT THERAPY (CRRT) IN ICU AND TOTAL NATIONAL OXYGEN CONSUMPTION DURING PERIOD OF PEAK COVID-19 ACTIVITY (21ST JAN 2021 TO 30TH MAR 2021)
Data Source: NOCA ICU-BIS Core dataset and from HSE Technical Services division data, presented at daily CMSWG meetings.

Actions

- Identification of critical issues, agreement of an appropriate action and assignment to an individual for action
- Review of previous actions and outcomes
- Escalation of management issues to HSE senior management if necessary
- Assignment of extra equipment for O_2 supply to hospitals approaching full capacity
    - Assignment of equipment for advanced respiratory support to hospitals with shortages
    - Intervention with hospital management to support redeployment of 'general' nurses to ICU duty, with active engagement from the Critical Care Programme and Hospital Group nursing leadership
    - Identification of hospitals with vacant ICU beds to arrange acceptance of patients from hospitals whose ICUs were full via an 'ICU bed liaison' or 'Concierge' function
    - Arrangement of critical care retrieval to transfer patients from Units which were full
    - An ICU Bed liaison service was set up to facilitate sourcing an ICU bed for Units which were over-capacity. This could be initiated by the CMSWG or by the local ICU Consultant. Access was via the National Ambulance Service Critical Care and Retrieval Services (NASCCRS) who conveyed the request for an ICU bed to the on-call person in MICAS or in NOCA. During Quarter 1 2021, this 'concierge' service received 22 calls regarding 25 patients and assisted with placement of these patients.

Achievements of the Health Service to which the CMSWG contributed

- ICU beds were made available for all patients who were judged to potentially benefit, according to the information provided daily to NOCA and to CMSWG from the Units in the national ICU network.
- All Units used additional 'surge' capacity, but none became overwhelmed, despite having large numbers of staff on COVID-related leave.
- At the peak of case numbers, numbers of patients being managed on advanced respiratory support (CPAP or HFO or NIV) on the general ward were twice those undergoing invasive ventilation in ICU (Figure 4.6).
- 158 critical care transfers were undertaken by the MICAS service during the 'surge' period in Quarter 1 2021 (including COVID and non-COVID transfers)
- The mean ICU mortality during Jan - Feb 2021 for COVID-19 patients in ICU was 37.2% for Jan and Feb 2021.

Lessons learned from operation of CMSWG

- A central coordinating working group is essential during periods of crisis
- Representation of all relevant disciplines is required to decide and implement actions
- The working group should be limited in numbers to include only those who will contribute to decisions and implementation
- Input from front line staff is essential
- Discussions should be frank, realistic, solution-oriented and time-limited
- Structure is vital with an agenda and documentation of actions and outcomes
- Metrics are required to identify trends of clinical caseload, acuity and critical shortage of supplies
    - Real-time data from the ICU Bed Information System or other accurate data sources is essential in assessing needs and managing critical care resources.
    - The ICU bed liaison service fulfilled a useful role and should be formally structured on an ongoing basis.
- Impending crises can be identified and dealt with in advance of clinical incidents
- The key resource in determining ICU capacity is the number of experienced critical care nurses available.

Summary

1. Inter-hospital transfers of critically ill patients were a key element in management of the surges in COVID-19 admissions to ICU.
2. MICAS the specialist transfer service for ICU patients was essential in undertaking these transfers, especially as referring hospitals tended to be very busy without staff available for transfers.
3. The numbers of MICAS transfers closely tracked numbers of COVID-19 admissions to ICU. The numbers of transfers in Quarter 1 2021 were 129% greater than the same period in 2019.
4. Transfer via MICAS was safe with no deaths in this critically ill population.
5. A central coordination group was important in responding to the surges in COVID-19 activity in ICU.
6. The NOCA ICU Bed Information System provided accurate and real-time data which enabled a coordinated response. Data on activity outside ICU was also important in predicting impending crises.
7. Lessons learned from the operation of this coordinating group should be applied in preparing for future healthcare crises.

Chapter 6: Outcomes from COVID-19 in the Republic of Ireland, in the United Kingdom and in Northern Ireland

The Health Protection Surveillance Centre (HPSC) undertakes the monitoring and surveillance of communicable diseases in Ireland. HPSC collects data on each patient admitted to ICU with confirmed COVID-19. Their reports provide a summary of admissions, interventions and outcomes of COVID-19 patients in ICU in Ireland.

The Intensive Care National Audit & Research Centre (ICNARC) in the UK reports the audit data submitted by adult ICUs in England, Wales and Northern Ireland (UK) and in the Republic of Ireland (ROI). ICNARC has published weekly reports on COVID-19 cases in ICU in the UK since March 2020.

While the HPSC and ICNARC datasets are not identical, there are parallels which allow us to benchmark Irish activity and outcomes against the UK data. ICNARC also provide a separate report for Northern Ireland (NI) allowing comparisons between ROI and NI data also.

HPSC and ICNARC have divided their data into separate time periods to better reflect the changing patterns of the pandemic. 'Wave 1' in HPSC reports roughly corresponds to 'Wave 1' in ICNARC reports. HPSC 'Wave 2 + Wave 3' roughly correspond to 'Wave 2' in ICNARC reports (Table 6.1, Figure 6.1).

TABLE 6.1. TIME PERIODS COVERED BY COVID-19 REPORTS BY HPSC AND BY ICNARC

	HPSC reports	ICNARC reports	
Wave 1	16th Feb 2020 – 1st Aug 2020	Wave 1	1st Feb 2020 – 31st Aug 2020
Wave 2	2nd Aug 2020 – 21st Nov 2020	Wave 2-3	1st Sept 2020 – 6th July 2021
Wave 3	22nd Nov 2020 – 3rd July 2021		

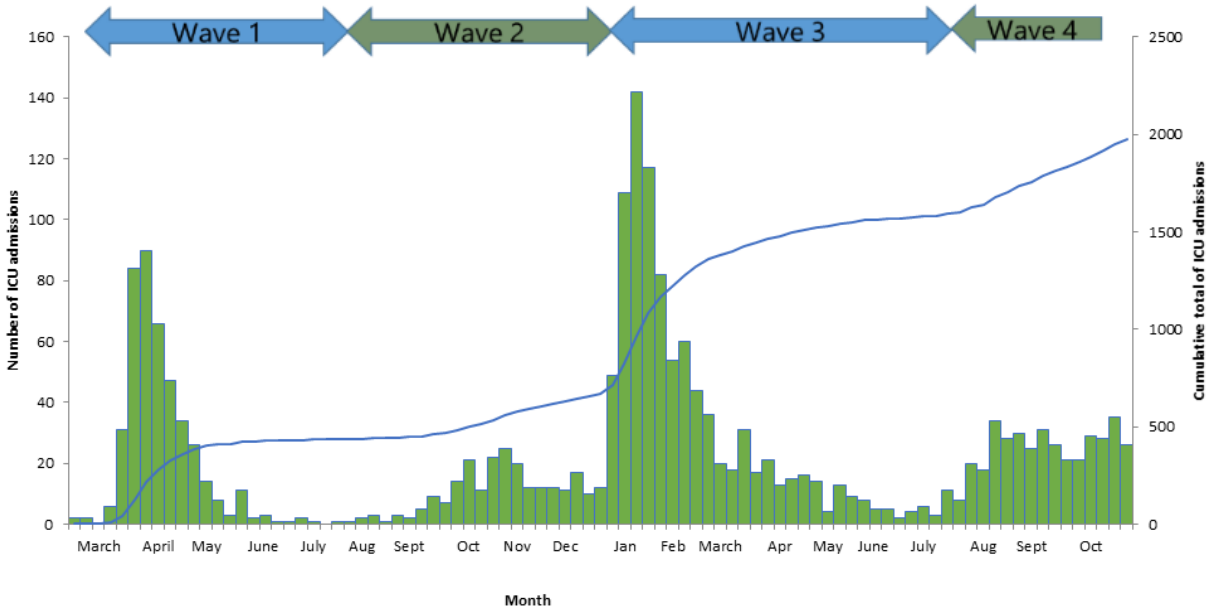

FIGURE 6.1. WEEKLY ADMISSIONS OF COVID-19 PATIENTS TO ICU IN THE REPUBLIC OF IRELAND (ROI), FEBRUARY 2020 TO SEPTEMBER 2021 SHOWING WAVES 1 TO 4. (Source HPSC Report 9th September 2021).
Data Source: HPSC

Demographics and pre-existing conditions

In ROI, median age increased from 60 in Wave 1, to 66 in Wave 2 and back to 62 in Wave 3 (Figure 6.2). Median age was 60 years in UK patients at for both periods. The median age in NI decreased from 62 in Wave 1 to 58 in Wave 2-3.

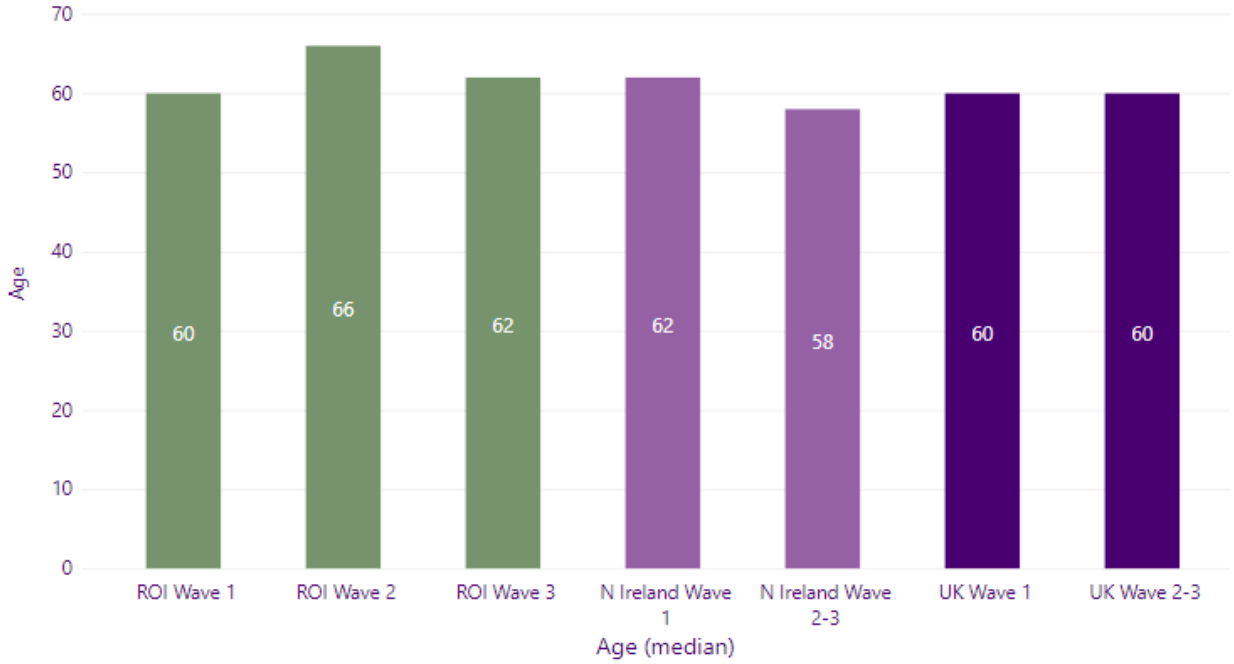

FIGURE 6.2. AGES OF COVID-19 PATIENTS IN ICU DURING WAVE 1, WAVE 2 AND WAVE 3 IN THE ROI, NI AND UK (YEARS, MEDIANS)
Data Source: HPSC and ICNARC

The proportion of ROI patients with a BMI ≥ 40 decreased from Wave 1 to Wave 3 while the opposite trend was seen in the UK and NI (Figure 6.3).

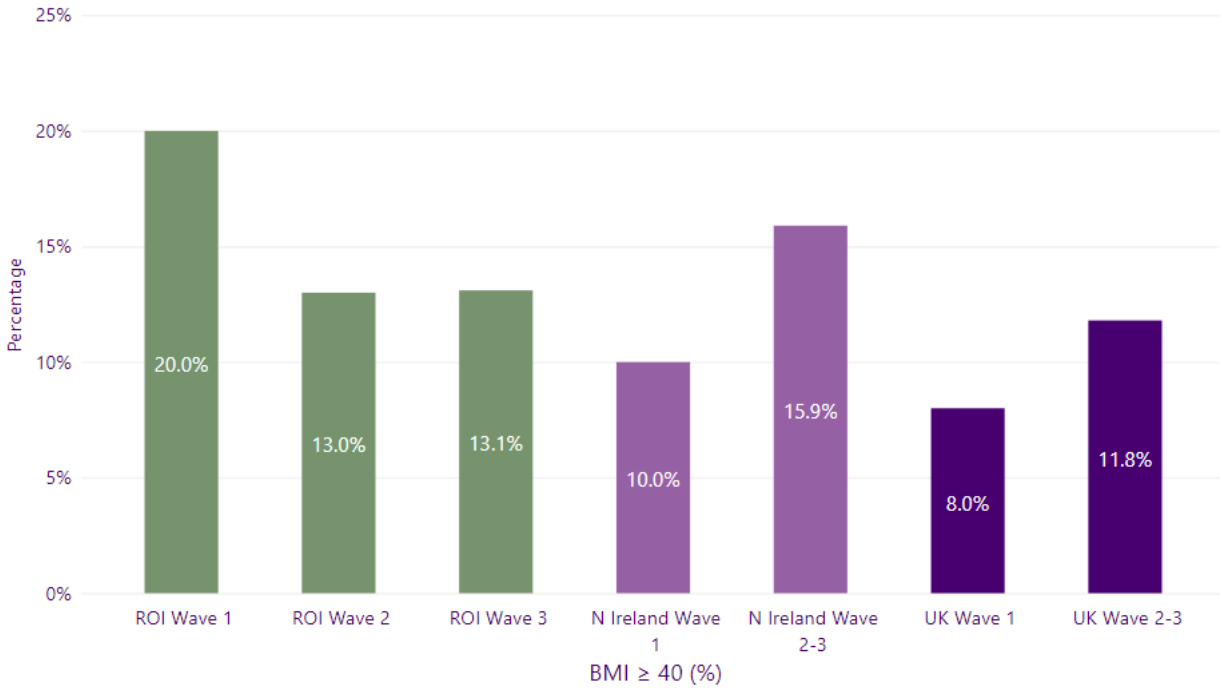

FIGURE 6.3. PATIENTS WITH A BMI ≥ 40 AS A % OF ALL ICU ADMISSIONS WITH COVID-19 DURING WAVES 1 TO 3
Data Source: HPSC and ICNARC

The proportion of patients with a history of pre-existing conditions (cancer or chronic respiratory disease) increased in Irish patients from Wave 1 to 3 (Figure 6.4). ICNARC definitions for pre-existing conditions are not comparable, preventing meaningful comparisons.

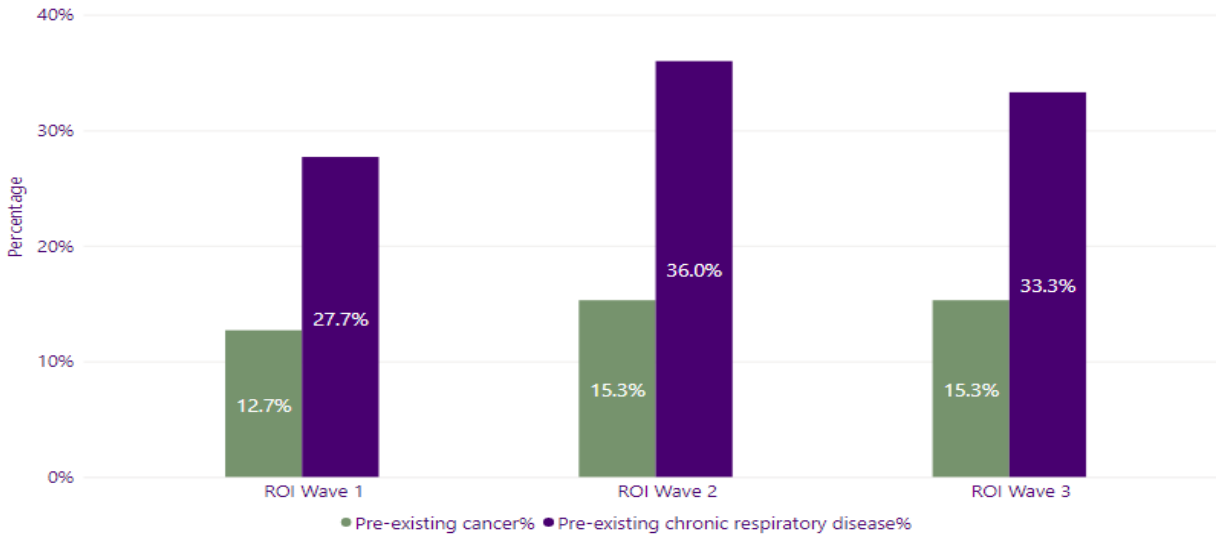

FIGURE 6.4. COVID-19 PATIENTS WITH A HISTORY OF PRE-EXISTING CANCER OR OF CHRONIC RESPIRATORY DISEASE ADMITTED TO ICU IN THE ROI DURING WAVES 1 TO 3
Data source: HPSC AND ICNARC

Interventions; invasive ventilation

The proportions of patients undergoing (i) invasive ventilation and (ii) dialysis, decreased in all 3 jurisdictions in Waves 2 and 3 compared to Wave 1 (Figure 6.5 and 6.6).

The proportions of COVID-19 patients in ICU who underwent invasive ventilation was similar in ROI and the UK during Wave 1 and during Wave 2-3. The proportion ventilated in NI was greater in all waves.

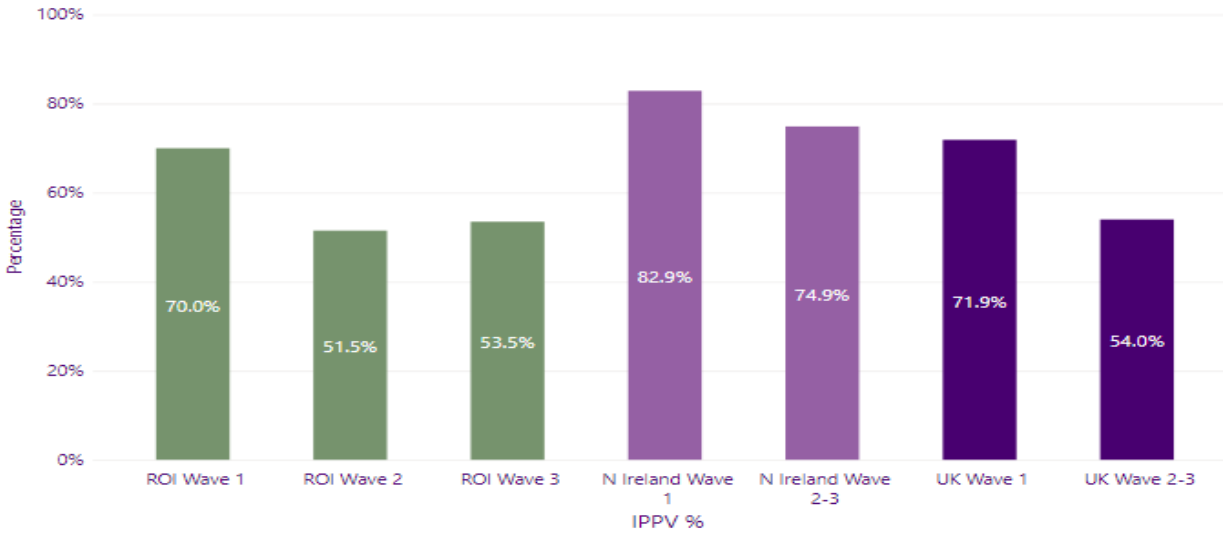

FIGURE 6.5 PROPORTION OF PATIENTS ADMITTED TO ICU WITH COVID-19 IN RE ROI, NI AND THE UK WHO UNDERWENT INVASIVE VENTILATION DURING WAVES 1 TO 3 (%)
Data Source: HPSC and ICNARC

Renal replacement therapy

The proportion of patients who underwent continuous renal replacement therapy decreased in later waves in all 3 jurisdictions (Figure 6.6).

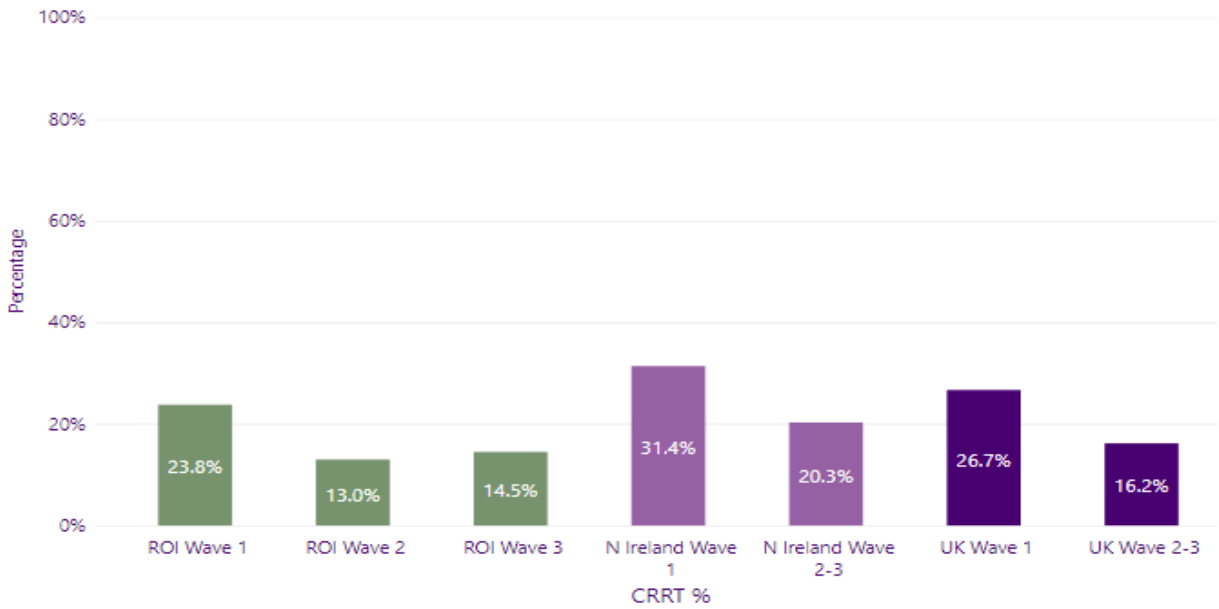

FIGURE 6.6. PROPORTION OF PATIENTS ADMITTED TO ICU WITH COVID-19 WHO UNDERWENT DIALYSIS IN ROI, NI AND THE UK DURING WAVES 1 TO 3 (%)
Data Source: HPSC and ICNARC

Mortality

ICU mortality was higher in the UK than ROI in Wave 1 (consistent with the findings of the ICNARC COVID-19 report in Chapter 5). ICU mortality in NI was close to the ROI mortality.

UK mortality in the Wave 2-3 period was similar to Wave 1. However, mortality in both ROI and NI increased in Waves 2-3 compared to Wave 1 and mortality was similar across all 3 jurisdictions in Waves 2-3 (Figure 6.7).

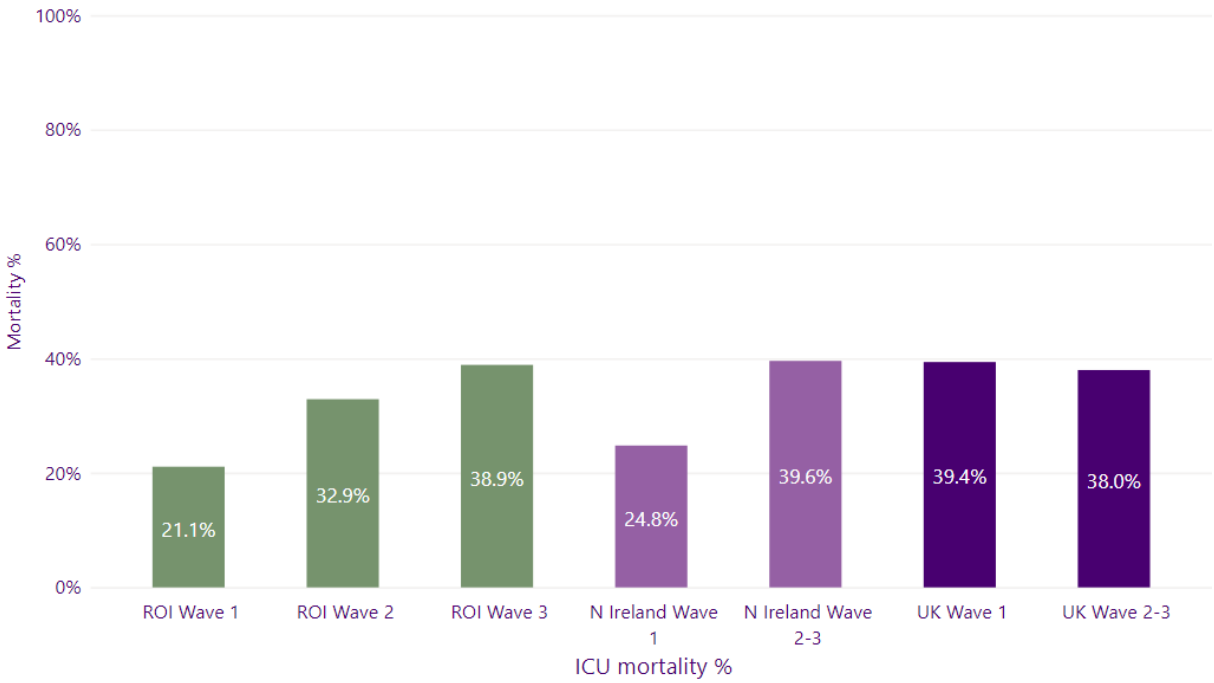

FIGURE 6.7: ICU MORTALITY OF PATIENTS ADMITTED TO ICU WITH COVID-19 IN IN ROI, NI AND THE UK DURING WAVES 1 TO 3 (%)
Data Source: HPSC and ICNARC

Mortality in patients who underwent invasive ventilation

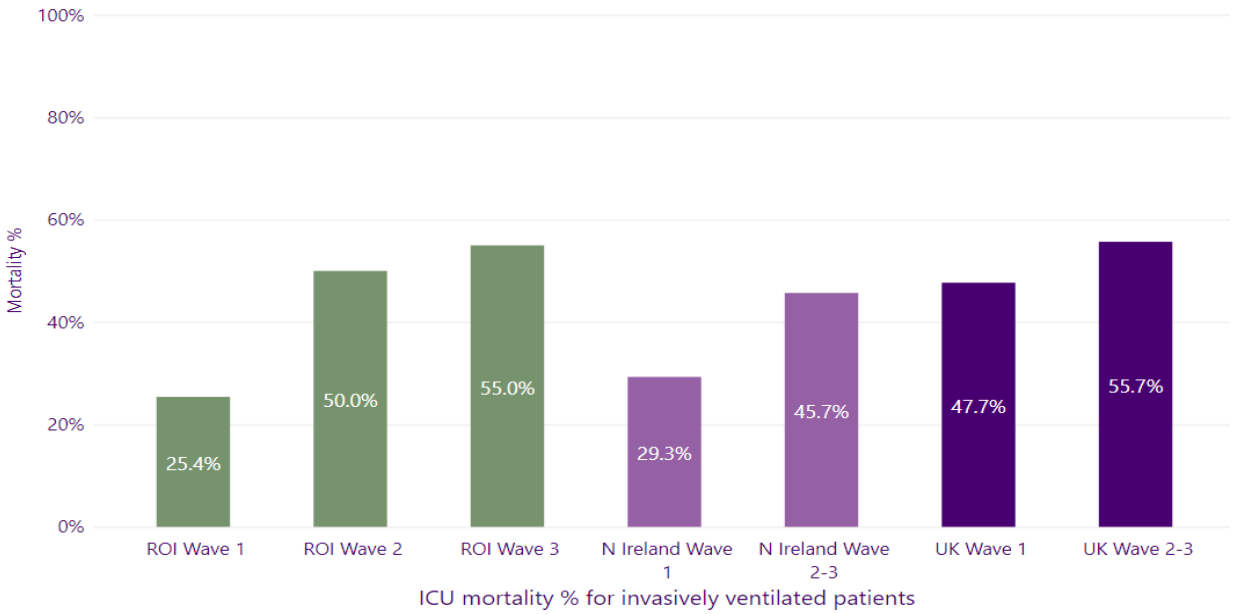

FIGURE 6.8. ICU MORTALITY OF PATIENTS WITH COVID-19 WHO UNDERWENT INVASIVE VENTILATION AFTER ADMISSION TO ICU IN ROI, NI AND THE UK DURING WAVES 1 TO 3 (%)
Data Source: HPSC and ICNARC

Patients who did not undergo invasive ventilation

During Waves 2 - 3 fewer patients admitted to ICU with COVID-19 underwent invasive ventilation than in Wave 1. This was noted in all three jurisdictions (Table 6.2, Figure 6.9).

TABLE 6.2. PATIENTS WHO DID NOT UNDERGO INVASIVE VENTILATION AFTER ADMISSION TO ICU WITH COVID-19 AS A % OF ALL PATIENTS ADMITTED TO ICU WITH COVID-19, DURING WAVES 1 TO 3
Data Source: HPSC and ICNARC

	ROI Wave 1	ROI Wave 2	ROI Wave 3	ROI Wave 2-3	NI Wave 1	NI Wave 2-3	UK Wave 1	UK Wave 2-3
Total	429	166	921	1087	140	462	10,953	26,550
No IPPV	122	78	404	482	22	105	2809	9249
No IPPV % of total	28%	47%	44%	44%	16%	23%	26%	35%

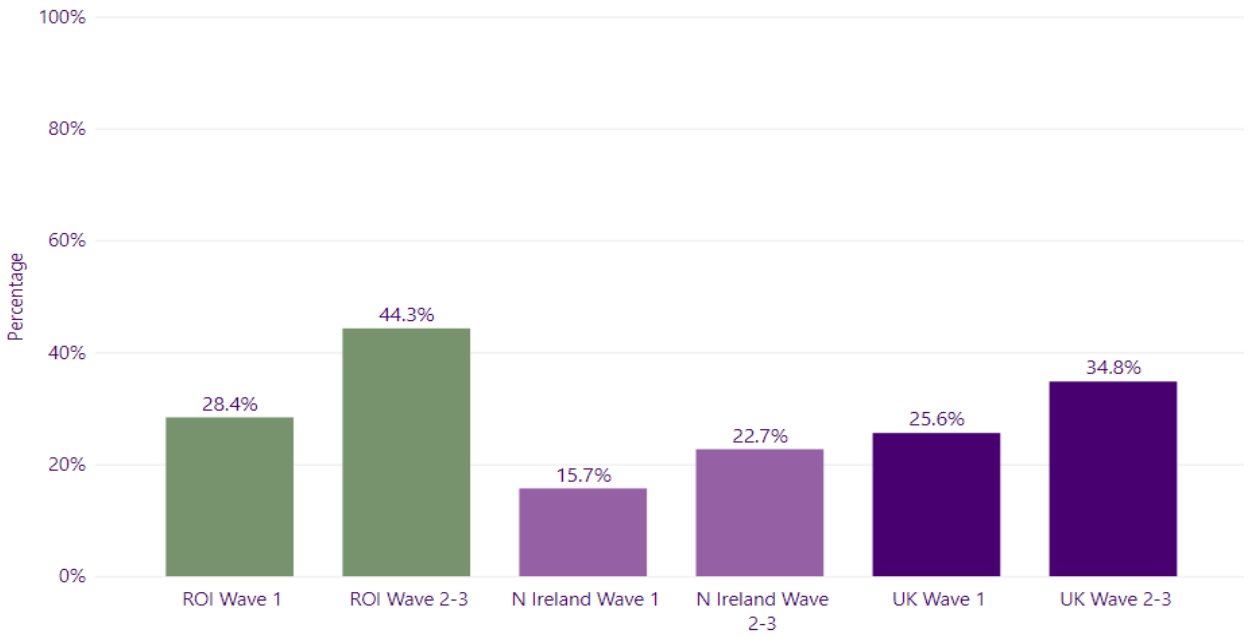

FIGURE 6.9. PATIENTS WHO DID NOT UNDERGO INVASIVE VENTILATION DURING ADMISSION TO ICU WITH COVID-19 DURING WAVES 1 TO WAVE 3 IN ROI, NI AND THE UK
Data Source: HPSC and ICNARC

Mortality in patients not invasively ventilated

A similar pattern in mortality was seen in ICU patients who did not undergo invasive ventilation. Mortality was higher in the UK than Ireland in Wave 1 but mortality in Irish ICUs increased in Waves 2 and 3 to reach similar levels to the UK (Table 6.3, Figure 6.10). Mortality in NI paralleled that in ROI, lower than the UK in Wave 1 and increasing to UK levels in Wave 2-3.

These patients represent a group of patients in whom a trial of care in ICU was judged appropriate but invasive ventilation was not judged to add benefit. This decision would have been on an individual basis in the context of associated advanced co-morbidities, or new diagnoses or organ failures arising during their ICU stay.

TABLE 6.3. MORTALITY RATE OF PATIENTS ADMITTED TO ICU WITH COVID-19 BUT NOT INVASIVELY VENTILATED, DURING WAVES 1 TO 3
Data Source: HPSC and ICNARC

	ROI Wave 1	ROI Wave 2	ROI Wave 3	ROI Wave 2+3	NI Wave 1	NI Wave 2-3	UK Wave 1	UK Wave 2-3
Left ICU; died + discharged	122	78	404	482	22	105	2809	9112
Died	14	13	72	85	2	21	545	1925
Mortality rate	11.5%	17%	18%	17.6%	9%	20%	19.4%	21%

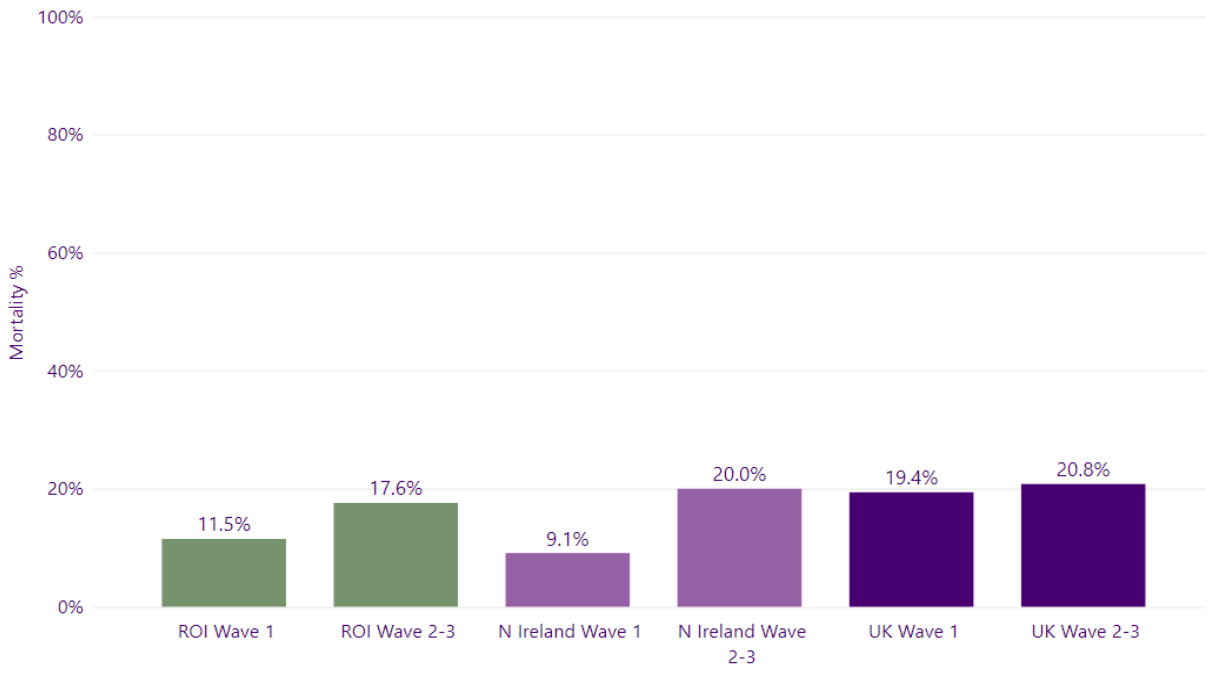

FIGURE 6.10. MORTALITY RATE OF PATIENTS ADMITTED TO ICU WITH COVID-19 BUT NOT INVASIVELY VENTILATED, DURING WAVES 1 TO 3
Data Source: HPSC and ICNARC

Mortality increased in the UK in Wave 2-3 both for (i) patients undergoing ventilation (Figure 6.8, 6.11) and (ii) those undergoing dialysis (Figure 6.11) No data are available for mortality in ROI patients undergoing dialysis.

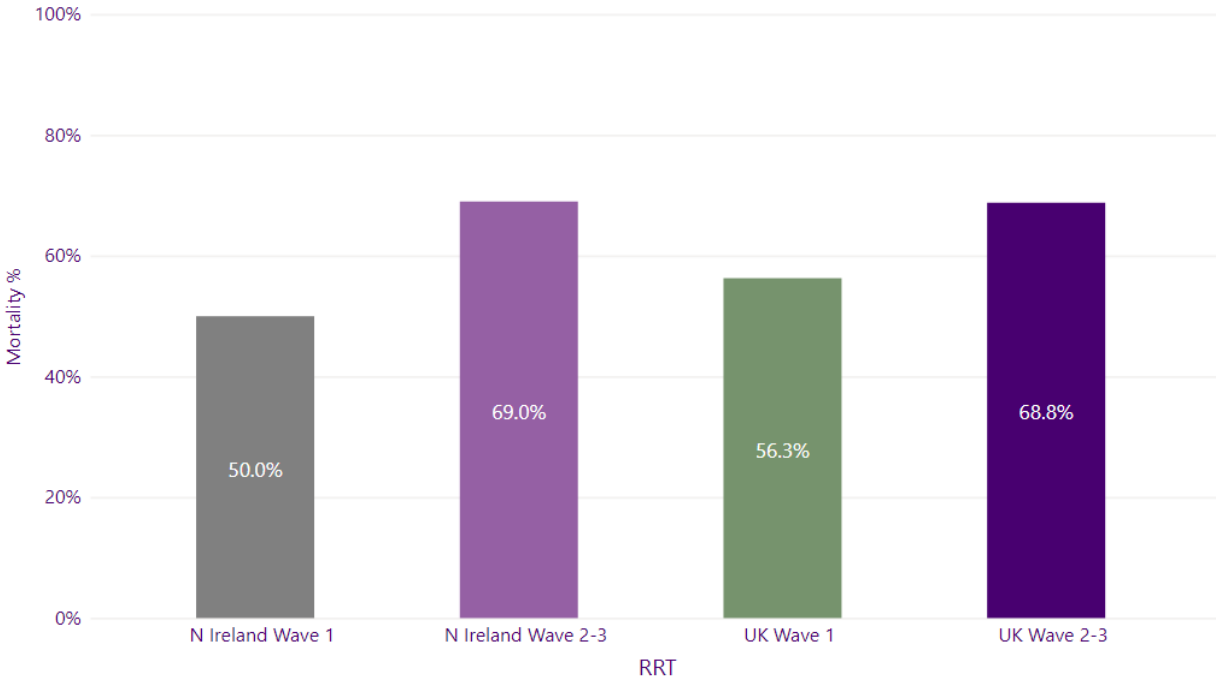

FIGURE 6.11. MORTALITY IN NI AND UK PATIENTS ADMITTED TO ICU WITH COVID-19 WHO UNDERWENT DIALYSIS (RRT) DURING WAVE 1 AND WAVE 2-3
Data Source: HPSC and ICNARC

Length of stay

Length of stay (LOS) in ICU for ICU survivors was shorter in Waves 2-3 in ROI, the UK and NI (Figure 6.12). Length of stay in ICU for ICU non-survivors increased in all three jurisdictions (Figure 6.12). The reasons for these changes in LOS are unclear.

Data for patients in Wave 3 may underestimate LOS as not all patients had left ICU at the time of reporting and those who remained were more likely to have a prolonged LOS. However, the numbers of patients remaining in ICU in early July were very small relative to the total number of patients admitted during Wave 2-3.

FIGURE 6.12. LENGTH OF STAY (LOS) IN ICU FOR ICU SURVIVORS AND ICU NON-SURVIVORS IN ROI, NI AND THE UK OVER THE COURSE OF WAVES 1 TO 3 (DAYS, MEDIANS)
Data Source: HPSC and ICNARC

During Wave 1, the numbers of admissions to ICU per 100,000 population in the UK were almost double the rate in ROI which was greater again than in NI (Figure 6.13). Admissions to ICU were similar in ROI and NI in Wave 2-3 and considerably less than in the UK. These data should be considered in the context of the numbers of ICU beds adjusted for population. Numbers of ICU beds per 100,000 population were 10.5 in the UK (OECD data, 2020, Figure 2), 5.2 in ROI (NOCA/CCP census 2020) and 5.9 in NI (DOH dashboard, December 2020).

The duration of Wave 2-3 was more than twice that of Wave 1 which accounts for greater numbers than in Wave 1.

FIGURE 6.13. NUMBERS OF PATIENTS ADMITTED TO ICU WITH COVID-19 PER 100,000 POPULATION DURING WAVE 1 AND WAVES 2-3 IN ROI, NI AND THE UK
Data Source: HPSC and ICNARC

Data Acknowledgement

The data for the UK and Northern Ireland 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.

The data for the Republic of Ireland were collected and reported by the Health Protection Surveillance Centre, Health Service Executive (HSE).

Summary

1. Mortality in ROI was significantly higher in Wave 3 than in Wave 1. Mortality approached UK levels in Wave 3, having been lower in Wave 1
2. A smaller proportion of patients in ICU underwent invasive ventilation or dialysis. This pattern was seen in the UK and NI also.
3. Mortality in ICU patients who did not undergo invasive ventilation increased from Wave 1 to Waves 2-3. This was noted in all three jurisdictions.
4. Length of stay for survivors in ICU decreased while length of stay for non-survivors increased. This pattern was seen in the UK and NI also.
5. Data for ROI in Wave 3 were very similar to those for the UK in Wave 3.
6. Metrics for the UK (patient characteristics, organ support and outcomes did not change significantly between Wave 1 and Wave 2-3.
7. A number of possibilities should be considered to explain the increased mortality in ROI in Wave 3:
    i. Patients had more factors to increase risk e.g., increased age (Figure 6.2), co-existing disease like cancer or respiratory disease (Figure 6.4).
    ii. the increased length of stay for non-survivors in Waves 2-3 suggests there was no tendency to limit the duration of care.
    iii. a virulent and transmissible strain (alpha) of the COVID-19 virus was prevalent
    iv. a greater use of advanced respiratory support (CPAP, HFNO, NIV) in the wards meant only patients refractory to these therapies were referred to ICU.
    v. the routine use of dexamethasone had altered the course of the disease in Wave 3 by keeping less severe patients from deteriorating to need ICU so that a different cohort were admitted to ICU
    vi. the routine use of dexamethasone may have increased the incidence of opportunistic infections like aspergillus due to immunosuppression, but international data are awaited to verify this.
    vii. reports from formal ICU audit are awaited to give further insights into these interesting data. The NOCA National ICU Audit Report and the ICNARC Report on COVID-19 patients will provide risk-adjusted data on outcomes to afford greater analysis and insight into the above considerations.

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Broman, L. et al. (2021) Extracorporeal membrane oxygenation for COVID-19 during first and second waves, Lancet Respiratory Medicine, [Accessed: 20/06/2021] https://doi.org/10.1016/S2213-2600(21)00262-9

The Royal College of Physicians in Ireland: Information for women who are pregnant or breastfeeding about the COVID-19 vaccine https://www.rcpi.ie/news/releases/information-for-women-who-are-pregnant-or-breastfeeding-about-the-covid-19-vaccine-update/ [Accessed: 14/10/2021].

Appendix I: ICU-BIS Data definitions

ICU-BIS Core Dataset Definitions v14

DB_Field Name	Field Description	Notes
DT_Upd	Date and time last updated	
HospID	Internal ID for each hospital on BIS	
Hosp_short	Short code for each hospital	
HospGrpID	Hospital Group ID	
HospGrp	Hospital Group each hospital is associated with	
HID_UNIT	Internal Database ref on National ICU Audit System	
UnitType	Type of Critical Care Unit - types are ICU, HDU, Mixed ICU, CTHDU and Off-unit	
LOC_unit	Level3 ICU Beds and Level2 ICU Beds	
isLIVE	PAS/CIS Interface enabled from hospital to BIS	
nTotal_beds	Total potential physical Bed Capacity (n)	
nOpen_beds	Number of fully staffed beds which are open today	
nOccup_beds	Beds that are occupied by an ICU/HDU patient.	
nActVent	Total Number of patients (Covid and Non-Covid) receiving Invasive Ventilatory support via ET tube or tracheostomy	
nVacant_beds	Beds not occupied by an ICU/HDU patient & not reserved for another admission	
nDischReady_beds	Cleared for Discharge (subset of 'Occupied beds') (n) Patients declared ready for discharge by a Doctor with authority to discharge from the Unit	
nReserved_beds	Reserved Beds - bed assigned for a specific patient Patients accepted for Unit admission by a person with authority to admit to the Unit (e.g. on call Unit consultant)	
nClosed_Beds	Number of Total Beds that are not available for use by patients e.g. due to lack of resources	
nCovidConf	Confirmed COVID cases in Unit (n) Patients positive for COVID on admission to ICU, or who became positive for COVID while in ICU. These remain COVID-confirmed while in ICU, even if swabs become negative	
nCovidRIP	Deaths of COVID-confirmed patients in your Unit between 8am - 8am previous day.	
nCovidVent	COVID cases invasively ventilated (n) Ventilated via ET tube or tracheostomy	

DB_Field Name	Field Description	Notes
nDischCovidConf	Discharges of COVID-confirmed patients to a ward between 8am-8am previous day	Added in v7 on 03/04/2020
TAKEON_DT	Date hospital was added to BIS	
CovidExtra1	Extra COVID field if needed. Not in use	
nSuspectCovidCases	Suspected COVID cases in Unit (n) COVID suspected on clinical grounds but no confirmatory test to date. Do not include patients isolated as a precautionary measure pending test results if not suspicious clinically.	Added in v5 on 30/03/2020 - Retired v14 May 31st 2021
nSuspectCovidRIP	Suspected COVID Deaths in Unit (n) - COVID Deaths during previous 24hrs (8AM to 8AM) – update at 10AM daily	Added in v5 on 30/03/2020 - Retired v13 Apr 18th 2021
nSuspectCovidVent	Suspected COVID cases invasively ventilated (n) Ventilated via ET tube or tracheostomy	Added in v5 on 30/03/2020 - Retired v14 May 31st 2021
nAdmitCovidConf	Admissions of COVID-confirmed patients in last 24 hrs (n) – update at 10AM daily New patients who have tested positive for COVID during this hospital stay, plus patients with a newly positive test for COVID while in ICU; do not include patients already documented as 'New' e.g. readmissions to ICU or transfers from another ICU/HDU	Added in v8 on 10/04/2020
nAdmitCovidSuspect	Admissions of COVID-suspected patients in last 24 hrs (n) – update at 10AM daily	Added in v5 on 30/03/2020 - Retired v14 May 31st 2021
nIHD_RT	Patients who underwent intermittent haemodialysis in last 24 hours (8am-8am)	Added in v9 on 24/04/2020
nCRRT_RT	Patients receiving continous renal replacement therapy	Added in v9 on 24/04/2020
DT_Extract	Date/time for time period of extract	Added in v6 on 03/04/2020

Appendix II: ICU-BIS daily data dissemination and usage

Timely data was a key factor in managing the pandemic. Data from ICU-BIS is issued daily to many stakeholders. This data is incorporated in internal hospital, hospital group, HSE and DOH dashboards. Data was also used to inform the public, for modelling, research and open data.

Data Recipients

Group	Group Name
HPSC	Health Protection Surveillance Centre
IEMAG	Irish Epidemiology modelling Advisory Group
CSO	Central Statistics Office
NCAGL/CCO	HSE Clinical Management Report to CCO and Acute operations HSE
CCO	The Office of the Chief Clinical Officer
SDU	Special Delivery Unit, HSE
DoH	Department of Health
ESRI	Economic and Social Research Institute
QID	Quality Improvement Division /HSE
RCSI HG	Royal College of Surgeons, Hospital Group
IEHG	Ireland East Hospital Group
DMHG	Dublin Midlands Hospital Group
SSWHG	South Southwest Hospital Group

Public Reporting from ICU-BIS

Data from ICU-BIS provides public information on ICU admissions, discharges, bed occupancy, acuity of care, bed availability for many information portals and websites.

Portal/Website	URL
HSE COVID-19 daily operations updates	https://www.hse.ie/eng/services/news/newsfeatures/covid19-updates/coronavirus-daily-operations-updates.html
Ireland's COVID-19 Data Hub :ICU Section (Government of Ireland)	https://covid19ireland-geohive.hub.arcgis.com/
Ireland's Open Data Portal : COVID-19 NOCA ICUBIS Historic Time Series (Government of Ireland)	https://covid-19.geohive.ie/datasets/c8208a0a8ff04a45b2922ae69e9b2206_0
Weekly COVID-19 country overview (ECDC)	https://covid19-country-overviews.ecdc.europa.eu/

Appendix III: Data Sources – Organisation Information

The Irish National ICU Audit (INICUA): ICNARC and NOCA data

INICUA collaborates with the Intensive Care National Audit and Research Centre (ICNARC) audit organisation in England. They advise NOCA, monitor the quality of data, and analyse the data in order to provide quarterly and annual reports on activity and on the quality of care in ICUs. INICUA collects two different kinds of data from participating units across Ireland.

1. The Intensive Care National Audit and Research Centre (ICNARC) dataset for Irish National ICU Audit (INICUA) is sent for benchmarking to ICNARC in the UK
2. The local dataset supports the INICUA dataset and both are reported on from local databases in each hospital.

- UK Case Mix Programme (CMP) Dataset: ICNARC.
  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. https://www.icnarc.org

Health Protection and Surveillance Centre (HPSC) data

HPSC undertakes the monitoring and surveillance of communicable diseases in Ireland. Disease surveillance is an information-based activity involving the collection, analysis and interpretation of large amounts of data from a variety of sources. The collection of surveillance data must be standardised on a national basis and be made available at local, regional and national level. HPSC plays an important role in forecasting and responding to disease outbreaks and incidents of regional, national and international significance.
HPSC has six main areas of responsibility:
1. Surveillance of some of the major communicable diseases.
2. Operational support
3. Training communicable disease control professionals
4. Research
5. Policy advice
6. Public information

- CIDR data:
  Computerised Infectious Disease Reporting (CIDR) is a web-based information system developed to manage the surveillance and control of infectious diseases in Ireland.

Retrieval Information: Mobile Intensive Care Ambulance Service (MICAS) data

The specialist transfer service for critically ill adult patients is called the Mobile Intensive Care Ambulance Service (MICAS), part of the National Ambulance Service Critical Care and Retrieval Services (NASCCRS). MICAS operates from three regional hubs in Dublin, Galway and Cork (MICAS East, West and South respectively). These patients require skilled medical and nursing care to replicate the level of care they have been receiving in the ICU of the referring hospital. Their care may include mechanical ventilation, vasopressor support, an intra-aortic balloon pump or extra corporeal life support (ECLS).

The MICAS service provides a trained team of an ICU nurse, an ICU doctor, an Emergency Medical Technician and an ambulance specially equipped for transfer of the critically ill. More recently, Critical Care Paramedics have provided additional support for the service.

Mater Extra Corporeal Membrane Oxygenation (ECMO) Team: ECMO data

- The Mater ECMO service was developed in 2009 and is based in the Intensive Care Unit (ICU). It is the only place in Ireland that provides ECMO to adult patients. Patient care is provided by a specialised team that includes critical care medical staff and specialist nursing staff. The team is supported by our cardiothoracic surgery, perfusion and cardiology teams.

Appendix IV: HSE National Multi-Disciplinary COVID-19 Major Surge Working Group (CMSWG) Members

Name	Organisation
Dr V. Hamilton	National Clinical advisor and Group lead, Acute Operations, HSE. (Sept 2019-Aug 2021)
Dr M O'Connor	National Clinical Advisor and Group Lead, Acute Operations, HSE (Sept 2021 – to date)
Ms E. Benton	General Manager, Office of the National Clinical Advisor and Group Lead, Acute Hospital Operations Division
Ms E. Brown	Portfolio Manager, Office of the National Clinical Advisor and Group Lead, Acute Operations HSE
Mr D. Clarke	Estates Manager, Engineering Adviser, Office of National Director of Capital & Estates
Mr D. Cribbin	Nurse Lead Critical Care Programme, HSE
Mr P. Dempsey	ICU-BIS Assistant Manager, NOCA
Dr D. Menzies	National Clinical Lead for Adult Critical Care Retrieval/Mobile Intensive Care Ambulance Service, HSE
Dr D. Doherty	Clinical Director for Adult Critical Care Retrieval/Mobile Intensive Care Ambulance Service, HSE
Dr R. Dwyer	National ICU Audit and ICU-BIS Clinical lead, NOCA.
Ms A. Fitzgerald	Deputy National Director, Acute Operations, HSE
Mr G. Flynn	National Clinical Head of Medical Devices, HSE
Dr C. Henry	Chief Clinical Officer, HSE
Dr F. King	Chief Pharmacist, HSE Acute Hospitals, Drug Management Programme
Dr B. Marsh	Lead for ICU Surge, HSE Critical Care Programme, Chair ICU Audit Governance Committee
Mr R. McDermott	Medical Equipment Management Lead, HSE
Ms B McNicholas	Consultant Intensivist and Nephrologist, UHG
Ms B. Moran	Information Manager, NOCA
Dr R. Morgan	Consultant Respiratory Physician, Beaumont Hospital
Dr D. Murphy	National Clinical Lead for Respiratory Medicine, HSE
Dr M. Power	Critical Care Programme Clinical lead, HSE
Ms U Quill	National Clinical Programmes in Critical Care & Anaesthesia, Programme Manager,
Mr P. Reid	Chief Executive Officer, HSE
Ms F. Treanor	National ICU-BIS and Audit Manager, NOCA
Ms E. Whelan	Chief Director of Nursing & Midwifery & Quality. DMHG, HSE
Mr L. Woods	National Director for Acute Hospitals, HSE

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