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Three waves of COVID-19 in a Norwegian local hospital

ORIGINAL ARTICLE

MARIUS MYRSTAD

marius.myrstad@vestreviken.no
Geriatrics, Stroke and Rehabilitation Section
Medical department
Vestre Viken Hospital Trust, Bærum Hospital
and
Department of Medical Research
Vestre Viken Hospital Trust, Bærum Hospital
He has been chiefly responsible for the idea, design, data collection and analysis, literature search, drafting and revision of the manuscript and approval of the submitted manuscript version.
Marius Myrstad, PhD, specialist in internal medicine and geriatrics, senior consultant.
The author has completed the ICMJE form and declares no conflicts of interest.

PETER SELMER RØNNINGEN

Department of Medical Research
Vestre Viken Hospital Trust, Bærum Hospital
He has contributed to the data collection, analysis and interpretation, drafting of the manuscript and approval of the submitted manuscript version.
Peter Selmer Rønningen, doctor and PhD scholar.
The author has completed the ICMJE form and declares no conflicts of interest.

ANDERS TVEITA

Medical Department
Vestre Viken Hospital Trust, Bærum Hospital
and

The KG Jebsen Centre for B-Cell Malignancies
Department of Immunology and Transfusion Medicine
Oslo University Hospital
He has contributed to the data collection and interpretation, drafting of the manuscript and approval of the submitted manuscript version.
Anders Tveita, PhD, specialty registrar and researcher.
The author has completed the ICMJE form and declares no conflicts of interest.

ELSE JOHANNE RØNNING

Infectious Diseases Section
Medical Department
Vestre Viken Hospital Trust, Bærum Hospital
She has contributed to the data collection and interpretation, drafting of the manuscript and approval of the submitted manuscript version.
Else Johanne Rønning, specialist in internal medicine and infectious diseases, senior consultant.
The author has completed the ICMJE form and declares no conflicts of interest.

PER ERIK ERNØ

Intensive Care Section
Department of Anaesthesia, Intensive Care and Surgery
Vestre Viken Hospital Trust, Bærum Hospital
He has contributed to the data collection and interpretation, drafting of the manuscript and approval of the submitted manuscript version.
Per Erik Ernø, specialist in anaesthesiology and senior consultant.
The author has completed the ICMJE form and declares no conflicts of interest.

ELIZABETH LYSTER ANDERSEN

Department of Medical Research
Vestre Viken Hospital Trust, Bærum Hospital
She has contributed to the data collection, analysis and interpretation, drafting of the manuscript and approval of the submitted manuscript version.
Elizabeth Lyster Andersen, doctor and PhD scholar.
The author has completed the ICMJE form and declares no conflicts of interest.

MARTE MEYER WALLE-HANSEN

Department of Medical Research
Vestre Viken Hospital Trust, Bærum Hospital

She has contributed to the data collection, analysis and interpretation, drafting of the manuscript and approval of the submitted manuscript version.
Marte Meyer Walle-Hansen, doctor and PhD scholar.
The author has completed the ICMJE form and declares no conflicts of interest.

ANDREW CAMPBELL ROBERTSON

Intensive Care Section
Department of Anaesthesia, Intensive Care and Surgery
Vestre Viken Hospital Trust, Bærum Hospital
He has contributed to the data collection and interpretation, drafting and revision of the manuscript and approval of the submitted manuscript version.
Andrew Campbell Robertson, specialist in anaesthesiology and senior consultant.
The author has completed the ICMJE form and declares no conflicts of interest.

MONICA THALLINGER

Intensive Care Section
Department of Anaesthesia, Intensive Care and Surgery
Vestre Viken Hospital Trust, Bærum Hospital
She has contributed to the data collection and interpretation, drafting and revision of the manuscript and approval of the submitted manuscript version.
Monica Thallinger, PhD, specialist in paediatrics and specialty registrar.
The author has completed the ICMJE form and declares no conflicts of interest.

JAN SVENDSEN

Infectious Diseases Section
Medical Department
Vestre Viken Hospital Trust, Bærum Hospital
He has contributed to the data collection and interpretation, drafting of the manuscript and approval of the submitted manuscript version.
Jan Svendsen, specialist in internal medicine and infectious diseases, and senior consultant.
The author has completed the ICMJE form and declares no conflicts of interest.

SIGURD HAAKONSEN

Emergency Section
Medical Department

Vestre Viken Hospital Trust, Bærum Hospital
He has contributed to the data collection and interpretation, drafting of the manuscript and approval of the submitted manuscript version.
Sigurd Haakonsen, speciality registrar and acting senior consultant.
The author has completed the ICMJE form and declares no conflicts of interest.

ARNLJOT TVEIT

Department of Medical Research
Vestre Viken Hospital Trust, Bærum Hospital
and
Institute of Clinical Medicine
University of Oslo
He has contributed to the design of the study, data interpretation, literature search, drafting of the manuscript and approval of the submitted manuscript version.
Arnljot Tveit, head of department and professor.
The author has completed the ICMJE form and declares no conflicts of interest.

HÅKON IHLE-HANSEN

Medical Department
Vestre Viken Hospital Trust, Bærum Hospital
and
Department of Medical Research
Vestre Viken Hospital Trust, Bærum Hospital
He has contributed to the design of the study, data collection and interpretation, literature search, drafting of the manuscript and approval of the submitted manuscript version.
Håkon Ihle-Hansen, PhD, acting senior consultant and researcher.
The author has completed the ICMJE form and declares no conflicts of interest.

BACKGROUND

The objective of this article is to summarise the course of illness and treatment for patients with COVID-19 admitted to Bærum Hospital since the start of the pandemic.

MATERIAL AND METHOD

We present data from a prospective observational study with the aim of systematising knowledge about patients admitted because of COVID-19. All patients admitted to Bærum Hospital up to and including 28 June 2021 were

included. The results are presented for three waves of admissions: 9 March–23 June 2020, 21 September 2020–28 February 2021 and 1 March–28 June 2021.

RESULTS

A total of 300 patients, divided into 77, 101 and 122 in the three waves respectively, were admitted because of COVID-19. The number of hospital deaths during the three waves was 14 (18 %), 11 (11 %) and 5 (4 %) respectively. The average age of the patients was 67.6 years in the first wave and 53.3 years in the third wave. Altogether 204 patients (68 %) received medical oxygen or ventilation support, and 31 of these (10 % of all the patients) received invasive ventilation support. Non-invasive ventilation support was used as the highest level of treatment in 4 (8 %), 9 (13 %) and 17 (20 %) patients with respiratory failure in the three waves respectively. In the second and third wave, 125 out of 152 patients with respiratory failure (82 %) were treated with dexamethasone.

INTERPRETATION

Differences in patient characteristics and changes to treatment methods, such as the use of dexamethasone and non-invasive ventilation support, may have contributed to the apparent fall in mortality from the first to the third wave. Conditions that are not registered in the study, such as vaccination status, may also have impacted on mortality.

Main findings

The average age of patients admitted to Bærum Hospital because of COVID-19 was 68 years in the first wave of the pandemic and 53 years in the third wave.

Hospital mortality rates in the first and third waves of the pandemic were 18 % and 4 % respectively. In the second and third waves, 125 out of 152 patients with respiratory failure were treated with dexamethasone.

The *severe acute respiratory syndrome coronavirus 2* (SARS-CoV-2) has caused a global pandemic with more than 255 million confirmed infections and more than 5 million deaths (1). As of 17 November 2021, there were more than 232 000 confirmed infections, and 995 deaths had been caused by COVID-19 in Norway (2). The spread of infection through Norway has come in waves. The first wave from March to June 2020 was followed by three months of low infection rates. The second wave started in September 2020, with the number of infections falling from January 2021. From the end of February 2021, the number of infections started to rise again until the second half of March 2021 (2).

Since the start of the pandemic, the Norwegian Institute of Public Health has published weekly reports on hospital admissions, intensive care episodes and deaths. Until 17 November 2021, more than 5 900 persons had been hospitalised because of COVID-19. The most serious courses of illness were

characterised by respiratory failure with development of acute respiratory distress syndrome, and more than 1 100 (19 %) of the patients were admitted to intensive care (2). An early description of symptoms and courses of illness in the first 42 patients admitted to Bærum Hospital with COVID-19 was published in the Journal of the Norwegian Medical Association as early as 10 April 2020 (3). Since then, few complete descriptions of symptoms, treatment and course of illness from cohorts of COVID-19 patients admitted to Norwegian hospitals have been published, and as far as we are aware, only from the first wave of the pandemic (4–7). The Norwegian Pandemic Registry has reported selected patient characteristics and mortality for three waves of patients hospitalised for COVID-19 in Norway (8).

In this article we present patient characteristics, treatment, course of illness and mortality for patients admitted to Bærum hospital because of COVID-19 during three waves of infection over a period of 16 months from the start of the first outbreak.

Material and method

In the same week when the first patient was admitted with COVID-19 to Bærum Hospital we established a prospective observational study aiming to collect and systematise knowledge about patient characteristics, symptoms and course of illness on an ongoing basis. Bærum Hospital is one of Norway's largest local hospitals, with a catchment area that encompasses approximately 190 000 inhabitants in Asker and Bærum municipalities. In a normal situation, the medical department has 92 beds, and the intensive care section normally has a capacity of four ventilator beds and four medical observation beds. The methodology used in the study has been described in two previous publications on the characteristics and course of illness in the first 42 and 73 patients admitted to the hospital because of COVID-19 (3, 4).

The first patient in Bærum Hospital with confirmed SARS-CoV-2 was admitted 9 March 2020, and all patients who were admitted up to and including 28 June 2021 were included in the study.

We defined the first wave of the outbreak as the period from 9 March to 23 June 2020 and the second wave as the period from 21 September 2020 to 28 February 2021. In the period from 23 June 2020 to 21 September 2020 no patients were admitted to the hospital with COVID-19 as a cause. The third wave was defined as the period from 1 March 2021 to 28 June 2021. There was no hiatus in the admissions between the second and third waves, but 1 March was chosen as the start date for the third wave because the rate of admission increased markedly from this date. After 28 June 2021, some weeks with no new admissions passed. Patients with confirmed SARS-CoV-2 who had been admitted for reasons other than COVID-19 were excluded from the study.

Based on a review of patient records we estimated Charlson's Comorbidity Index (CCI), in which age and chronic diseases such as cardiovascular diseases, diabetes mellitus, dementia and cancer are given point scores (9).

We used the Norwegian translation of the Clinical Frailty Scale (CFS) to describe frailty based on information in the patient records on level of functioning and need for assistance two weeks prior to symptom onset (10, 11). A CFS score ≥ 5 indicates frailty, and a high score is an independent predictor of death in patients admitted to hospital for COVID-19 (12). Symptoms and symptom duration were registered based on information in the admission record. We calculated the NEWS2 score (National Early Warning Score 2) based on the first clinical examination in the emergency department. The NEWS2 system scores respiratory rate, peripheral oxygen saturation, systolic blood pressure, heart rate, level of consciousness/confusion and temperature from 1 to 3 points and oxygen treatment with 2 points (13). A NEWS2 score ≥ 5 indicates serious acute illness, and a high score upon admission predicts a serious course of illness and death in patients admitted to hospital with COVID-19 (14). Charlson's Comorbidity Index and NEWS2 score were calculated for all patients included in the study.

Hypoxaemia with a need for oxygen therapy was defined as respiratory failure. We have no overview of the reasons for oxygen therapy in each individual case, but the normal approach is to start administering oxygen at $SpO_2 \leq 93$ % in indoor air. Smoking, weight and height were registered when this information was available in the patient records. Body Mass Index (BMI) was calculated based on weight and height as documented in the patient records. Laboratory results were collected from the laboratory sheet in the patient records. Mortality was defined as death during hospitalisation, and was calculated by dividing the number of deaths in a wave by all patients admitted because of COVID-19 during the same wave.

Ethics

The study was approved by the data protection officer in Vestre Viken Hospital Trust (20/02772–1). The requirement for consent was waived, since this was a quality study that only used clinical data that had been routinely collected. Information on the study and the right to opt out was distributed by mail to surviving patients, but none made use of the right to withdraw.

Data processing

The data were registered in EpiData version 4.4.3.1 (EpiData Association, Odense, Denmark). Continuous variables are reported as averages. Since some of the average values were strongly affected by extreme values, we have chosen to also report medians with ranges (minimum–maximum). Categorical variables are reported as numbers and proportions (%). Since this study did not seek to investigate the effects of patient characteristics or treatments, and since any differences between the three waves were likely to be affected by variables that were not included in our study, we have chosen not to report results of comparative statistical analyses. The data processing was undertaken in SPSS version 25.0 (IBM, Armonk, NY, USA).

Results

From the start of the local COVID-19 outbreak in March 2020 until 28 June 2021, altogether 319 patients were admitted to Bærum Hospital with confirmed SARS-CoV-2. After exclusion of 17 patients who were hospitalised for reasons other than COVID-19 and two patients who had been transferred from other hospitals during the course of their illness, a total of 300 patients were included.

Figure 1 shows the number of newly admitted patients, the number admitted to the intensive care unit and the number admitted to regular wards because of COVID-19 each day. The highest number of patients hospitalised on the same date was 29, and the highest number of intensive-care patients was 9.

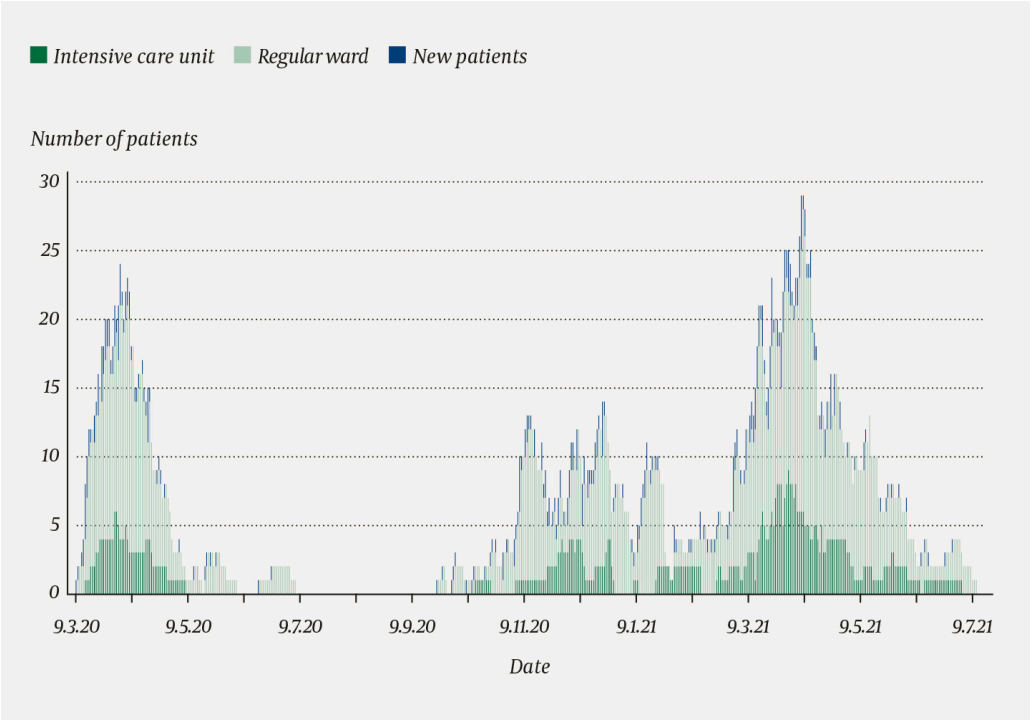

Figure 1 Patients admitted to Bærum Hospital because of COVID-19 in the period 9 March 2020–28 June 2021 (n = 300). The columns show the total number of patients admitted, the number of patients in the intensive care unit, the number of patients in regular ward and the number of newly admitted patients for each day in this period.

Figure 2 provides an overview of the patients included in the study and mortality in each wave. Altogether 30 patients (10 %) died during hospitalisation, whereof 14 (18 %) during the first wave, 11 (11 %) during the second wave and 5 (4 %) during the third. The average age of the patients who died was 79.5, 78.7 and 67.8 years respectively.

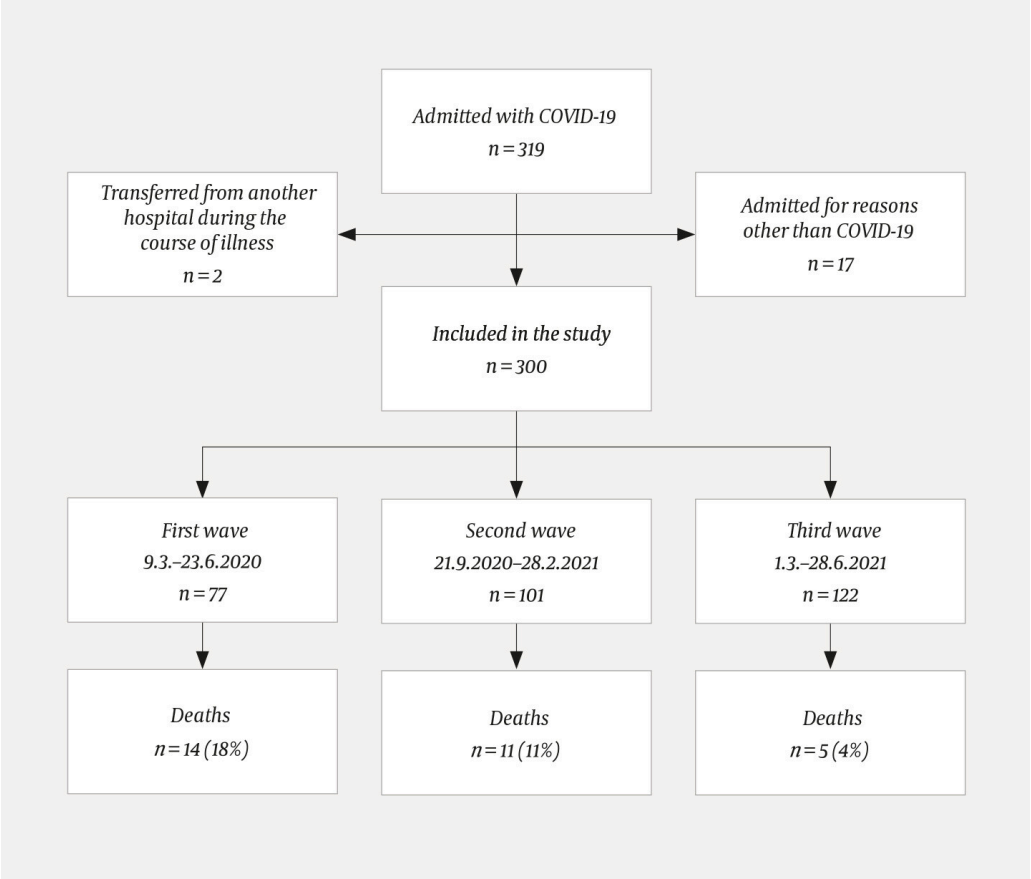

Figure 2 Distribution of the study population (n = 300) by the three waves of infections and mortality in each wave.

The average age of the admitted patients was 59.7 years, and 189 (63 %) of them were men. Table 1 shows selected patient characteristics. The average age of patients admitted during the three waves was 67.6, 61.5 and 53.3 years respectively, and the age composition varied from one wave to the next (Figure 3).

Table 1

Selected characteristics in patients admitted to Bærum Hospital because of COVID-19 in the first (9.3.–23.6.2020), second (21.9.2020–28.2.2021) and third (1.3.–28.6.2021) wave of infections, *n* = 300. Average (median; range) unless otherwise specified. CFS = Clinical Frailty Scale.

Characteristic	First wave (*n* = 77)	Second wave (*n* = 101)	Third wave (*n* = 122)
Age (years)	67.6 (71; 30–95)	61.5 (60; 21–97)	53.3 (51; 23–82)
Men, number (%)	46 (60)	66 (65)	77 (63)
Body mass index (kg/m^2)[1]	25.8 (25.6; 16.8–37.0)	27.2 (27.0; 16.3–42.5)	28.5 (27.3; 18.6–49.7)
Smoker, current or previous, number (%)[2]	27 (38)	27 (32)	39 (34)
CFS score[3]	3.0 (2; 1–7)	2.6 (2; 1–7)	2.5 (2; 1–7)
Charlson's comorbidity index	3.4 (3; 0–14)	2.6 (2; 0–10)	1.5 (1; 0–9)

Characteristic	First wave (n = 77)	Second wave (n = 101)	Third wave (n = 122)
Frail (CFS score ≥ 5), number (%)	20 (26)	10 (10)	7 (6)
Comorbid conditions, number (%)			
Hypertension	21 (27)	23 (23)	28 (23)
Diabetes mellitus	11 (14)	18 (18)	23 (19)
Other	34 (44)	45 (45)	40 (33)

[1]Information on body mass index was missing for 12 patients in the first wave, 10 in the second and 5 in the third.

[2]Information on smoking was missing in 6 patients in the first wave, 16 in the second and 8 in the third.

[3]Based on patient record information on level of functioning and need for assistance two weeks prior to symptom onset.

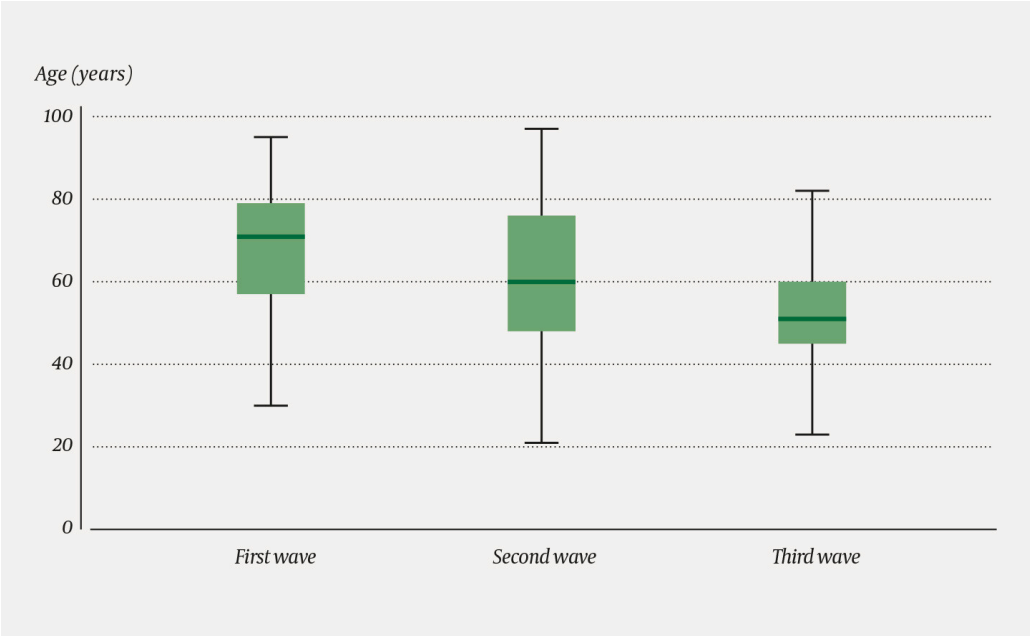

Figure 3 Age distribution of patients admitted to Bærum Hospital because of COVID-19 by age group in the first (n = 77), second (n = 101) and third (n= 122) wave of infections, n = 300. The figure shows the median, the second and third quartiles and the range (min.–-max.) for age in each wave.

Table 2 shows symptoms and selected findings for the three waves. There were no clear differences in symptoms, inflammation markers or NEWS2 scores upon admission. The patients were hospitalised for an average number of 10.3 days (median 10; range 2–39) in the first wave, 9.3 (7; 1–64) in the second and 11.7 (9; 1–80) in the third. Altogether 59 (79 %), 99 (98 %) and 113 (93 %) patients received venous thromboembolism prophylaxis. A total of 5 (7 %), 5 (5 %) and 4 (3 %) patients were diagnosed with venous thromboembolism.

Table 2

Symptoms reported upon admission, NEWS2 score in the emergency department and inflammation markers in patients admitted to Bærum Hospital because of COVID-19 during the first (9.3.–23.6.2020), second (21.9.2020–28.2.2021) and third (1.3.–28.6.2021) wave of infections, *n* = 300. Average (median; range) unless otherwise specified. NEWS2 = *National Early Warning Score 2*.

	First wave (*n* = 77)	Second wave (*n* = 101)	Third wave (*n* = 122)
Days with symptoms prior to admission	8.5 (7; 0–22)	7.3 (7; 1–21)	7.3 (8; 0–20)
Symptoms, number (%)			
Cough	47 (61)	56 (55)	67 (55)
Dyspnoea	49 (64)	58 (57)	83 (68)
Fever	55 (71)	71 (70)	97 (80)
Reduced general condition	61 (79)	72 (71)	94 (77)
Other	52 (68)	85 (84)	91 (75)
NEWS2 score ≥ 5 upon admission, number (%)	33 (43)	46 (46)	53 (43)
NEWS2 score upon admission	4.3 (4; 0–13)	4.6 (4; 0–13)	4.2 (4; 0–12)
CRP (mg/L) upon admission	61 (50; 3–257)	71 (51; 3–307)	74 (47; 4–293)
CRP (mg/L), highest value during the hospitalisation period[1]	127 (119; 3–432)	102 (77; 3–441)	109 (98; 4–407)
Ferritin (µg/L) upon admission[2]	685 (472; 66–3 283)	678 (440; 29–6 195)	688 (458; 13–6 152)
Ferritin (µg/L), highest value during the hospitalisation period[2]	1 213 (833; 28–5 603)	1 144 (716; 47–8 216)	1 338 (750; 16–33 511)
Lymphocytes ($\times 10^9$/L) upon admission[3]	1.1 (1.0; 0.2–4.9)	1.1 (1.0; 0.3–3.2)	1.0 (0.9; 0.2–2.6)
Lymphocytes ($\times 10^9$/L), lowest value during the hospitalisation period[3]	0.9 (0.7; 0.1–2.9)	0.9 (0.9; 0.1–2.0)	0.8 (0.8; 0.1–2.6)

[1]Information on CRP during hospitalisation was missing for 1 patient in the first wave, 2 in the second and 1 in the third.

[2]Information on ferritin upon admission was missing in 32 patients in the first wave, 9 in the second and 5 in the third. Information on ferritin during hospitalisation was missing in 10 patients in the first wave, 2 in the second and 1 in the third.

[3]Information on lymphocytes upon admission was missing in 1 patient in the second wave and 1 in the third. Information on lymphocytes during hospitalisation was missing in 2 patients in the first wave and 1 in the third.

A total of 204 patients (68 %) were treated for respiratory failure, and the proportion of patients with respiratory failure remained stable throughout the three waves: 52 out of 77 (68 %), 69 out of 101 (68 %) and 83 out of 122 (68 %)

patients were treated for respiratory failure in the first, second and third wave respectively. Of these, 143 (70 %) were treated with a nasal catheter and 30 (15 %) with a high-flow nasal cannula (Optiflow) or non-invasive ventilation support as the highest level of treatment for respiratory failure. A total of 31 patients (15 %) were treated with invasive ventilation support, and there was an average of 5.9 days (median 5; range 1–28) between admission and intubation of these patients. Twenty-one of these 31 patients were treated with non-invasive ventilation support or a high-flow nasal cannula for an average of 5.3 days (3); (1–23) prior to intubation. In the second and third waves, 53 out of 69 (77 %) and 72 out of 83 (87 %) patients with respiratory failure were treated with dexamethasone for an average of 12 (10; 1–64) days. Forty-three of these patients (28 %) received dexamethasone for more than 10 days. Table 3 shows the treatment of respiratory failure in the three waves.

Table 3

Treatment and mortality among patients with respiratory failure admitted to Bærum Hospital because of COVID-19 during the first (9.3.–23.6.2020), second (21.9.2020–28.2.2021) and third (1.3.–28.6.2021) wave of infections, *n* = 204. Average (median; range) unless otherwise specified.

	First wave (*n* = 52)	Second wave (*n* = 69)	Third wave (*n* = 83)
Nasal catheter, number (%)[1]	39 (75)	53 (77)	51 (61)
Non-invasive ventilation support, number (%)[1, 2]	4 (8)	9 (13)	17 (20)
Invasive ventilation support, number (%)	9 (17)	7 (10)	15 (18)
Days hospitalised prior to invasive ventilation support	3.4 (2; 1–8)	10.7 (8; 2–28)	5.1 (5; 1–11)
Days treated with invasive ventilation support	16.0 (18; 2–25)	14.4 (8; 4–36)	11.9 (8; 4–49)
Died during hospitalisation after treatment with invasive ventilation support, number (%)[3]	5 (56)	4 (57)	4 (27)

[1]Number of patients who received such treatment as their highest level of treatment for respiratory failure.

[2]Includes patients who were treated with a high-flow nasal cannula.

[3]Proportion of all patients treated with invasive ventilation support.

Discussion

The number of patients admitted to Bærum Hospital with COVID-19 followed the same trend as in society as a whole, in three waves. In all three waves, but in the first in particular, Bærum Hospital had a high number of admissions in

relation to the number of inhabitants and the number of hospitalised patients in Norway as a whole (2). According to the report from the Norwegian Pandemic Registry, mortality among patients admitted to Norwegian hospitals amounted to 7.7 %, 7.2 % and 4.8 % in the three waves respectively, while the average age was 59.8, 58.8 and 53.7 years (8). We believe that the significantly higher mortality in Bærum Hospital during the first wave can largely be attributed to the higher average age. Most of the patients who died in our hospital during the first wave were vulnerable or frail, and the majority were considered too frail to tolerate ventilation treatment (4). Local infection outbreaks in nursing homes were among the reasons why so many elderly, frail patients were admitted to Bærum Hospital during the first wave. The outcomes from Bærum Hospital during the second and third waves are more likely to be representative of patient cohorts in Norwegian hospitals, since both average age and mortality were more comparable to the national average and published data from hospital cohorts in Norway in the first wave (5, 6, 8). Among 70 COVID-19 patients included in a study from Østfold Hospital, mortality amounted to 10 % (7 out of 70), and in Oslo University Hospital 13 deaths occurred among 169 (7 %) patients included in a study conducted during the first wave of the outbreak (6).

The prevalence of risk factors such as hypertension and diabetes mellitus was relatively constant during the three waves, which is consistent with findings made by the Norwegian Pandemic Registry (8). Body mass index appears to have been higher during the second and third waves. This is also consistent with data from the Norwegian Pandemic Registry, where the average body mass index was 27.7 and 29.3 kg/m^2 in the first and third waves respectively (8). A number of studies have shown that overweight predisposes patients to a serious course of COVID-19, most likely because of low-grade respiratory failure caused by excessive abdominal volume (15). Furthermore, it is known from other patient groups that overweight is associated with inflammation, which can have a bearing on COVID-19 (16).

The treatment of severe respiratory failure has changed since the start of the pandemic. No consensus has yet been reached on the best treatment method, and practices vary. Treatment with dexamethasone was frequently used for respiratory failure during the second and third waves, on the basis of temporary evidence from the RECOVERY trial, published in July 2021 (17). Since more prolonged treatment with steroids is associated with an increased risk of adverse effects (18), such treatment beyond ten days was assessed on an individual basis for patients with severe respiratory failure. In the intensive care unit, patients were systematically placed in the prone position, and to a lesser extent also patients with less severe respiratory failure. At the start of the pandemic, non-invasive ventilation support and high-flow nasal cannulas were little used for reasons of infection control, but such treatment was somewhat more widely used during the second and third waves. Whether the timing of intubation affects mortality in patients with COVID-19 and severe respiratory failure is a contentious issue (19, 20). We assessed the timing of intubation for each patient individually in light of the degree of respiratory failure, response

to non-invasive ventilation support, amount of respiratory distress in the patient and how long the patient had been ill, as well as other factors such as the effect on circulation and lactate level.

Better knowledge and more experience may have helped improve the treatment of respiratory failure and prevent serious complications as the pandemic progressed. At an early stage venous thromboembolism was identified as a frequent complication of COVID-19 (4, 21), and eight out of ten patients were provided with thrombosis prophylaxis in the first wave. In the second and third waves, this proportion exceeded 90 %.

Even though changes in treatment methods may have helped reduce mortality, other factors, such as the spread of different virus variants in society and vaccination status, may also have had an impact. The B.1.1.7 virus variant (the British variant) became dominant during the second wave (2) and was reported to be associated with higher mortality than the original virus (22). The B.1.617.2 variant (Delta) was detected in Norway in mid-April 2021 and rapidly became dominant in Viken county and the city of Oslo (23). However, the number of hospitalised and deceased patients with a confirmed Delta infection remained low until 15 August 2021 (24). Unfortunately, we had no access to complete data on virus variants for our study, but new variants do not appear to have caused a rise in mortality among the hospitalised patients included in the study. In Norway, vaccination against COVID-19 started on 27 December 2020, and elderly people and those with risk factors were vaccinated first. It is difficult to estimate how the gradually increasing proportion of vaccinated persons in the population during the second and third waves affected the mortality of hospitalised patients. However, since elderly, frail persons are at the highest risk of serious illness and death from COVID-19, there is reason to assume that the lower mortality during the third wave is largely attributable to the fact that this group had been vaccinated, and that the vaccine was effective in preventing serious illness and death.

Especially during the first wave, the lack of clarity on the infection situation in society and rapid increase in the number of patients hospitalised with COVID-19 led to a considerable burden on hospitals as well as staff. In April 2020, 25 days after admission of the first COVID-19 patient to the hospital, a maximum number of 24 patients were hospitalised at the same time. Until May 2020, the response time for COVID-19 tests was up to 24 hours, and there were hence many patients with undetermined infection status. In periods with many admissions, the capacity was increased in both the intensive care and the infection units by measures such as reducing the number of elective surgeries, converting a post-operative unit into an intensive care unit and opening a new ward.

Conclusions

Two out of three patients admitted to Bærum Hospital because of COVID-19 were treated for respiratory failure. Changes in both patient characteristics and treatment methods, e.g. use of dexamethasone and non-invasive ventilation support, may have contributed to the apparently lower mortality during the

second and third waves of infection. Factors that are not registered in this study, such as information on vaccination status, may also have had an impact on mortality.

This article has been peer reviewed.

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