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ORIGINAL ARTICLE

Admissions to Norwegian Hospitals during the COVID-19 Pandemic

JON HELGELAND[1], KJETIL E. TELLE[1], MARI GRØSLAND[1], BEATE M. HUSEBY[2], SIRI HÅBERG[3] & ANJA S. E. LINDMAN[1]

[1]Division for Health Services, Norwegian Institute of Public Health, Oslo, Norway, [2]Division of Health Intelligence and Policy, Norwegian Directorate of Health, Trondheim, Norway, and [3]Centre for Fertility and Health, Norwegian Institute of Public Health, Oslo, Norway

Abstract

Background: In mid-March 2020, the Norwegian government implemented measures to contain the coronavirus disease 2019 (COVID-19) pandemic, and hospitals prepared to handle an unpredictable inflow of patients with COVID-19. *Aim:* The study was performed to describe the changes in hospital admissions during the first phase of the pandemic. *Methods:* The Norwegian Institute of Public Health established a national preparedness register with daily updates on COVID-19 cases and the use of health services. We used individual-level information on inpatients from the electronic journal systems for all hospitals in Norway to estimate daily hospital admissions. *Results:* Before the onset of the pandemic in March, there was an average of 2400 inpatient admissions per day in Norway, which decreased to approximately 1500 in the first few days after lockdown measures were implemented. The relative magnitudes of the decreases were similar in men and women and across all age groups. The decreases were substantial for both elective (54%) and emergency (29%) inpatient care. The admission rate gradually increased and reached pre-pandemic levels in June. However, the reductions in admissions for pneumonia and chronic obstructive pulmonary disease seemed to persist. ***Conclusions:*** **The elective and emergency inpatient admission rates were substantially reduced a few days after the pandemic response measures were implemented. The ways in which the lack or postponement of care may have affected the health and well-being of patients is an important issue to be addressed in future research.**

Keywords: *COVID-19, health services, pandemic, emergency medicine*

Background

On Friday, 13 March 2020, the Norwegian government imposed containment measures to limit the spread of the coronavirus disease 2019 (COVID-19) pandemic.

The measures to reduce the frequency of social contact have differed throughout the course of the pandemic and across geographical areas, ranging from advice on social distancing to mandatory face masks on public transportation and even stricter measures, such as closing universities and cancelling cultural events.

In accordance with the national guidelines, hospitals prepared for the possibility of needing to admit a very large number of COVID-19 patients and reorganized to meet the potentially very high demand for critical care from patients with COVID-19. The availability of public transport was also reduced, making travel to hospitals more difficult, particularly in regions in which patients need to travel long distances to hospitals. The initial outbreak was largely contained, peaking at 67 cases per 100,000 inhabitants on 5 April [1]. The maximum number of patients simultaneously hospitalized with COVID-19 was 318 [2]. The hospitals were instructed to prepare for

Correspondence: Jon Helgeland, Division for Health Services, Norwegian Institute of Public Health, Folkehelseinstituttet, Postboks 222 Skøyen, 0213 Oslo, Norway. E-mail: Jon.Helgeland@fhi.no

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normal operations after the Easter holiday, which was from 3–14 April. The lockdown measures were gradually eased during May and June.

To preserve capacity for emergency conditions, elective procedures were postponed or cancelled [3,4]. Reports from Norway, as well as other countries, show a decline in emergency admissions at the start and peak of the pandemic [5-10]. It is therefore important to explore the effects of the COVID-19 pandemic on healthcare systems to understand the consequences of the healthcare systems' handling of the disease and potential implications for the population's health. Although reductions in admissions for some conditions could reflect lower actual incidences, possibly due to the measures taken to contain the spread of the virus, patients may also have been less inclined to seek medical care, and referrals to specialist care may have been delayed [11,12].

Intriguingly, there were reports in the media that the overall mortality in Norway seemed to decline during the pandemic [13].

Aims

The aim of the present study was to describe the changes in the use of hospital inpatient services in Norway during the initial response to the COVID-19 pandemic.

Methods

The Norwegian Institute of Public Health (NIPH), in collaboration with the Norwegian Directorate of Health, has compiled data sources with daily updated information on the COVID-19 pandemic and the use of health services in Norway. The data source, called 'Beredt C19', contains individual-level data and covers the entire population of Norway [14]. The purpose of Beredt C19 is to provide current data on how the pandemic and containment measures are affecting the population's health, the use of health services and health-related behaviours. There is a legal mandate to report new cases of infection with severe acute respiratory syndrome coronavirus 2 to NIPH's Reporting System for Infectious Diseases (MSIS). Beredt C19 contains daily updates from MSIS, as well as daily extracts from the electronic records systems of all public and publicly financed hospitals in Norway.

The data thus included all patient contacts present in the electronic records systems of Norwegian hospitals every day from 1 January 2020 up to and including November 2020. This included information about in- and outpatient contact, sex and age, diagnoses, and whether the admission was emergency or elective. All data are registered with a personal identification number carried by all residents in Norway. We identified hospitalized patients who had been diagnosed with ICD-10 (Norwegian version) code U07.1: 'COVID-19 with detected virus'.

A separate data set, which was obtained from the Norwegian Patient Register (NPR) for the years 2015–2019, was used as a reference for daily admission rates [15]. This data set contained all inpatient admissions for somatic care for patients with a valid personal identification number [16]. Weekly numbers of deaths for the years 2015–2020 were obtained from Statistics Norway [17].

We described trends in inpatient hospitalizations for all conditions, for common emergency conditions and for COVID-19 during the first 11 months of 2020. We computed the number of admissions per day and length of stay (LOS) for elective and acute care among demographic subgroups and by hospital trust. We also computed daily emergency admission rates for stroke, acute myocardial infarction (AMI), congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), acute appendicitis, and pneumonia (excluding COPD exacerbations and COVID-19). (Diagnostic codes can be found in Supplemental Table A2.) We also compared the total admission rates for residents across the eleven Norwegian counties. Spearman's rank correlation was used to determine the association between population density and the reduction in the admission rate among counties.

As there were large differences in the number of patients on weekdays and weekends/holidays, we smoothed the graphs using 7-day moving averages (averages including 3 days before and after the specified day). In the graphs, admissions numbers from previous years were shifted to have the same overall mean in the pre-lockdown period as those in 2020. The data from previous years did not contain psychiatric or substance abuse admissions.

We compared the mean daily admissions and mean LOS during 2020 between those admitted in the period just after the initiation of the lockdown (13 March to the beginning of the Easter holidays on 3 April) and those admitted in the period before the initiation of the lockdown (1 January–12 March). Confidence intervals for the relative change were obtained assuming Poisson distributions for the admission numbers and lognormal distributions for LOS. For each set of comparisons, confidence intervals were adjusted for simultaneity by Scheffé's method.

The weekly rate of mortality, from 16 March to 28 June, was modelled with a quasi-Poisson model,

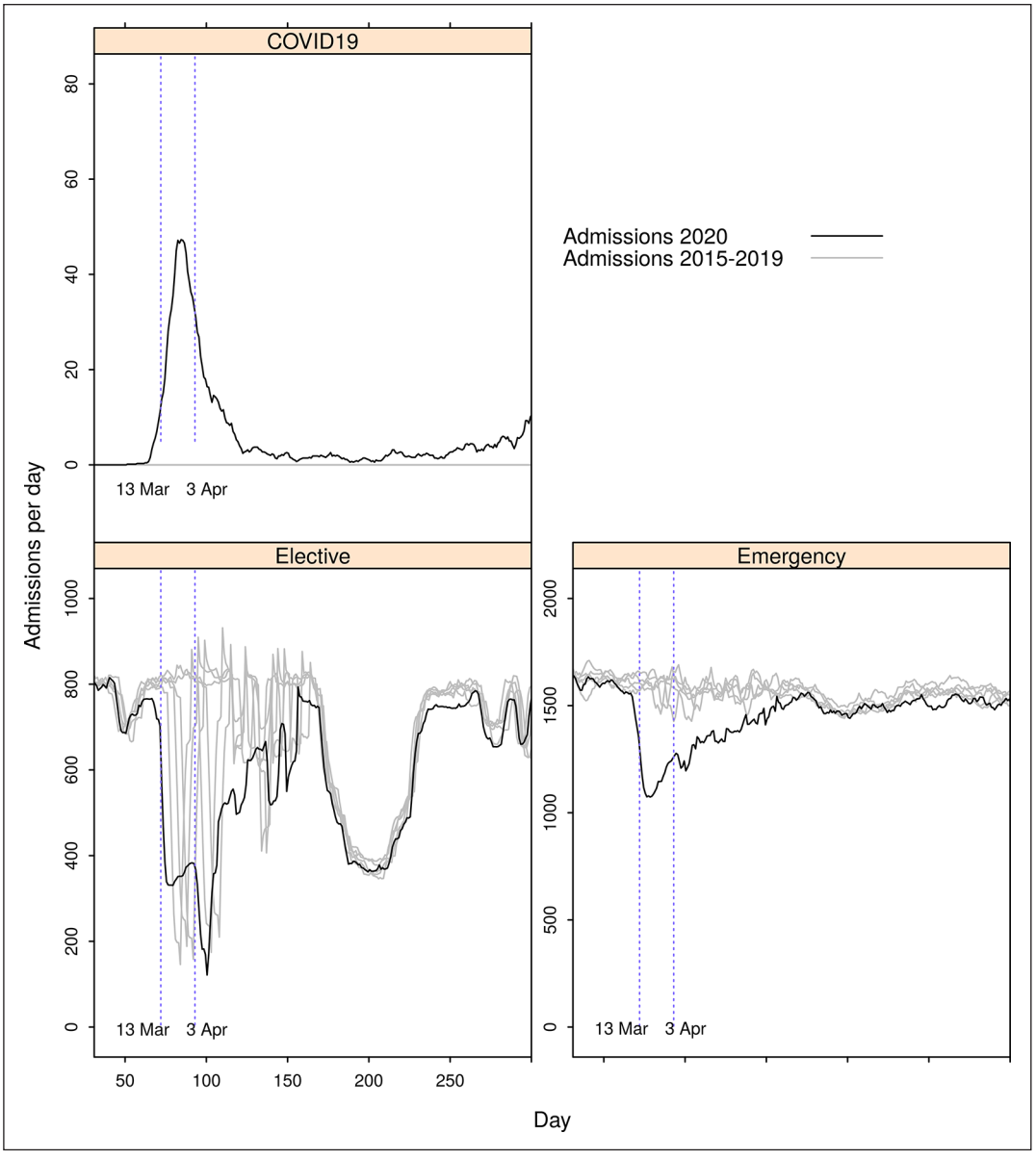

Figure 1. Daily inpatient admissions in 2020 and 2015–2019. Graphs for 2015–2019 are shifted to have the same mean as in 2020 in the period up to 13 March.

assuming a linear trend and using a dummy variable for 2020 and an interaction term between the dummy variable and the trend. The population sizes on 1 January were used to standardize the rates.

Analyses were performed using R, versions 3.5.1 and 3.6.2 [18].

Use of the NPR data 2015–2019 and Beredt C19 data is covered by Data Protection Impact Assessments conducted by the NIPH. The review established that approval from an external ethics board review was not required for the use of NPR data 2010–2017. This was also confirmed for Beredt C19 by the Ethics Committee of South-East Norway (4 June 2020, #153204)

Results

Before the implementation of the control measures in response to the pandemic, that is, prior to 12 March, there was a daily average of approximately 2300 inpatient admissions per day, and there were approximately 1500 inpatient admissions from 13 March to the beginning of the Easter holiday (3 April), as shown in Figure 1 and Table I. This represents 43 and 28 admissions per 100,000 inhabitants, respectively. The relative decrease was 54% (95% confidence interval 52–56%) for elective admissions and 29% (95% confidence interval 27–31%) for emergency admissions. The impact on admissions

Table I. Daily admission rates before and after March 13, 2020, overall and for selected conditions. Also shown are relative reductions (%) with the simultaneous 95% confidence intervals.

Condition	1 Jan–12 Mar	12 Mar–3 Apr	Relative reduction (%)
Elective	777	357	54 (51.7–56.1)
Emergency	1610	1150	28.9 (26.9–30.9)
AMI	28.2	21.5	23.9 (6.6–38)
Stroke	28.3	24.1	14.8 (–3.64 to 29.9)
CHF	28.8	17.9	37.7 (22.3–50)
Appendicitis	20.1	16.8	16.3 (–5.83 to 33.7)
Pneumonia	74.1	40.6	45.2 (36.6–52.6)
COPD	55.3	31.6	42.8 (32.6–51.6)

Note: AMI: acute myocardial infarction; CHF: congestive heart failure; COPD: chronic obstructive pulmonary disease.

due to the Easter holiday is apparent in Figure 1. The admission rates gradually increased after the Easter holiday and were close to the pre-lockdown numbers by early June. Compared with trends in previous years, as shown in Figure 1, the cumulative loss of elective admissions was approximately 20,000. The elective admissions rate graph shows large downward fluctuations unrelated to the lockdown in all years that are due to vacation periods and public holidays.

It is noteworthy that the data did not suggest an increase in elective admission rates relative to historical levels during the summer and autumn.

Across the eleven counties in Norway, the relative reductions in admissions ranged from 32% to 42%, as shown in the Supplemental Table A1. The reductions appeared to increase from the counties with the highest population density to those with the lowest, with a Spearman's rank correlation coefficient of −0.6. The one-sided test for a negative rank correlation was significant ($p = 0.028$).

The relative decreases in admissions were similar across sex and age groups (see Supplemental Figures A3 and A4).

The rates of emergency admissions for the six previously mentioned conditions are shown in Figure 2 and Table I. The estimated reduction in admissions ranged from 14% to 45%. The simultaneous confidence intervals did not include zero except for those for stroke and appendicitis. The admission rates gradually increased and were comparable to those in previous years by 1 July. The exceptions were admissions for COPD and pneumonia, which remained at the reduced levels.

The LOS decreased by 4.7% for emergency admissions overall (95% confidence interval 1.6–7.7%). For the six conditions, the estimated decreases ranged from 2.6% for appendicitis to 15% for stroke. However, the simultaneous confidence intervals all crossed zero (see Table II).

The weekly number of deaths in Norway is shown in Figure 3. The level on 1 July was approximately 6.4% lower in 2020 than in the previous 5 years (95% confidence interval 2.0–10.6%). In addition, the decrease over the March to July period was estimated to be somewhat more rapid in 2020, but the difference was not significant.

Discussion

As the COVID-19 pandemic spread in Norway at the beginning of March, the hospitals were instructed to reduce normal operations and prepare for a large number of patients with COVID-19, many of whom would need intensive care. We found reductions in elective and emergency inpatient admissions of 59% and 29%, respectively, from 13 March to 3 April. The decreases were broadly similar across age, sex and hospital trust and were inversely correlated with population density across counties. We found a slight reduction in the LOS for emergency admissions. The reduction in emergency care was smaller and less consistent across diseases than has been reported elsewhere [5]. Admission rates returned gradually to pre-pandemic levels by June, except for those for COPD and pneumonia.

The decrease in emergency hospitalizations may have resulted from a reduction in the actual incidences of diseases. For instance, it has been claimed that the incidence of acute myocardial infarction has been reduced, possibly due to changes in lifestyle or less air pollution [9,19,20]. In addition, it is likely that social distancing has led to a reduced burden of respiratory tract infections, which is a possible explanation for the reduced rates of emergency admissions for COPD and pneumonia. A similar phenomenon was noted in an earlier study, and the authors postulated that social distancing and the use of face masks led to an actual decrease in the burden of respiratory tract infections and eventually a reduction in COPD exacerbations [21].

Another explanation is that the patients' threshold for seeking healthcare was higher or that the threshold for referring patients to hospitals changed. Preliminary figures from the Norwegian Directorate of Health show that the number of new referrals to specialist health services fell by 27% in March and 39% in April [22].

The decreases in admission rates in mid-February and the beginning of April, particularly for elective care, were expected due to the winter vacation and Easter holiday. The reasons for the decrease in emergency care will probably prove to be different in various diagnostic and patient groups. If the actual incidences of emergency conditions in Norway

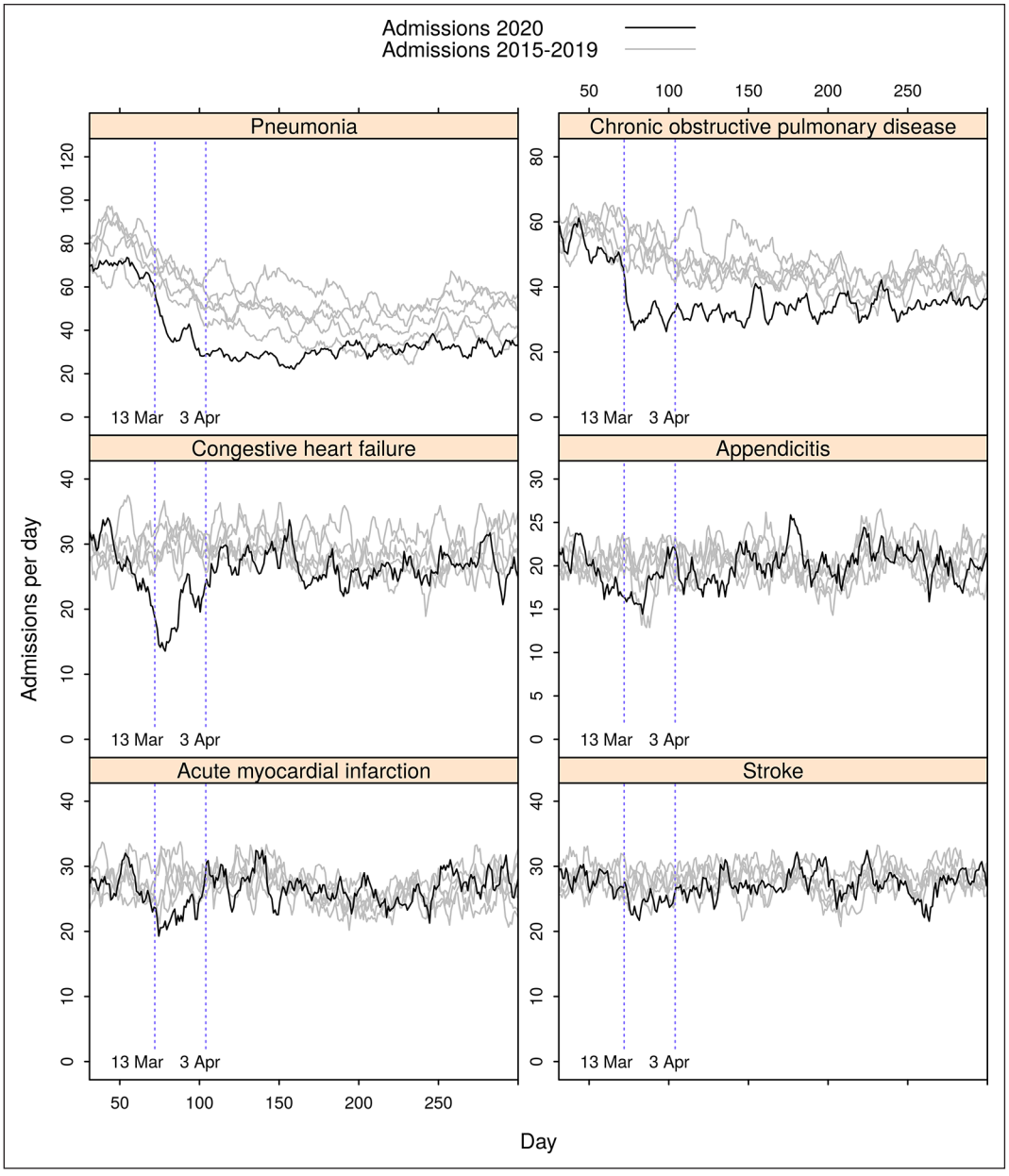

Figure 2. Daily emergency admissions in 2020 and 2015–2019 for selected conditions. Graphs for 2015–2019 are shifted to have the same mean as in 2020 in the period up to 13 March.

remained unchanged, we might have expected the hospitalized cases to be more severe. Although we see some variation across emergency groups, it is intriguing that we observed a small reduction in the LOS, which is not consistent with increased case severity.

There is an important ongoing discussion, in Norway and elsewhere, about whether all customary hospital care is necessary or beneficial and whether some hospital care should be replaced by primary care [23-26]. Whether this discussion has influenced prioritization during the pandemic is an interesting question for future research.

We found a large decrease in inpatient care in all the country's health trusts. Although there have been far more patients with COVID-19 in hospitals in Oslo than elsewhere in the country, we found no association between the county-level reduction in overall admission rates and the number of admissions for COVID-19. The reduction was lower in Oslo than in the rest of the country. However, an association was not expected. First, it was the preparation for the potential large influx of COVID-19 patients that motivated the changes in the operation of the hospitals. In which counties the large influx

Table II. Median LOS before and after 13 March 2020, overall and for selected conditions. Also shown are relative reductions (%) with the simultaneous 95% confidence intervals.

Condition	1 Jan–12 Mar	13 Mar–3 Apr	Relative reduction (%)
Elective	2.19	2.19	4.6 (–0.88 to 9.9)
Emergency	2.57	2.34	4.7 (1.6–7.7)
AMI	4.1	3.74	13.6 (–1.5 to 26.5)
Stroke	5.12	4.12	14.6 (–3.4 to 29.5)
CHF	4.77	4.12	8.7 (–12.8 to 26.1)
Appendicitis	1.66	1.63	2.6 (–16.3 to 18.4)
Pneumonia	4.03	3.83	5.8 (–7.4 to 17.3)
COPD	4.0	3.43	11.1 (–2.6 to 23)

Note: AMI: acute myocardial infarction; CHF: congestive heart failure; COPD: chronic obstructive pulmonary disease.

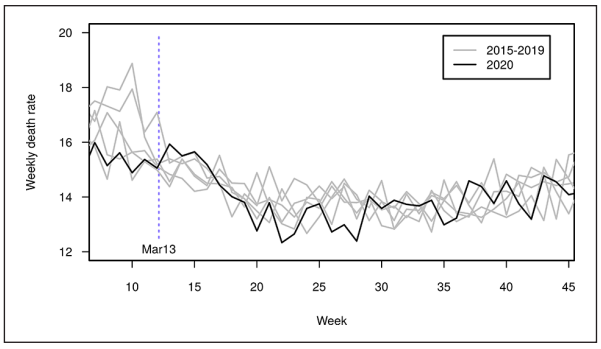

Figure 3. Weekly numbers of deaths in Norway per 100,000 inhabitants (as per 1 January each year) for 2020 and 2015–2019.

would occur was difficult to predict. The result of this uncertainty was that we had to prepare all acute care hospitals. Second, measures were implemented throughout Norway to prevent unnecessary travel and social contact. Patients throughout the country could not or did not want to visit health service facilities. Since the reduction in admission rate was somewhat larger in the less densely populated than in the more densely populated counties, reduced availability of public transport may have been a factor affecting healthcare-seeking behaviour.

A limitation of our study is that we have only examined care in hospitals, but there are many indications that there has at least been no increase in consultations in primary healthcare services [22]. In other healthcare systems, the use of telephones and other electronic formats for outpatient visits has increased during the pandemic [27]. We used a data set restricted to somatic care to enable comparisons with previous years. As somatic admissions account for approximately 90% of the total and as there is little reason to expect significant differences in the evolution over the year among different types of care, we believe this restriction has limited consequences with regard to our findings.

The Norwegian expert group that performs socioeconomic assessments of infection control measures pointed out that health losses associated with reduced care incur large costs [28]. The report indicates that allocating extra resources to expand capacity to prevent COVID-19 patients from displacing other patients could be socioeconomically beneficial.

Approximately 20,000 fewer patients were admitted for elective care from mid-March up to and including June 2020 compared with previous years. If hospitals were to admit these patients in, for example, a 6-month period, the daily admissions would increase by more than 20% relative to the normal level. Even when spread over a longer period, such an undertaking would clearly be very challenging for the health system. As we found no apparent increase in elective admissions in the second half of 2020, any backlog must have been handled by prioritizing the patients.

The question remains about how the absence of or delay in care in recent months will affect patient health in the long term. The slightly reduced LOS after the reduction in admission rates and the lower overall mortality after 13 March compared with previous years are preliminary indications that the impact has been moderate in the medium term. This contrasts with the excess mortality seen elsewhere [29]. More precise knowledge about which patient groups have been affected will provide important information that can be used by the health authorities when addressing any new waves of the pandemic. Even more important, but much more difficult, is determining how the absence or postponement of elective and emergency care has affected the future need for health services and the patients' health and well-being.

Conclusions

In Norway, there was a substantial reduction in both emergency and elective inpatient admissions after the hospitals prepared for the potentially overwhelming surge of admissions of COVID-19 patients. The reduction was largest in the first month after the implementation of pandemic containment measures. Admissions gradually returned to normal levels after 3 months, except for those for COPD and pneumonia, which seemed to stabilize at lower levels.

The clinical consequences of fewer hospitalizations remain unknown and warrant longer-term studies. Nevertheless, the observed reduction in admissions should raise serious concerns about the well-being and health outcomes of patients who did not receive care or had care postponed.

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ORCID iD

Jon Helgeland https://orcid.org/0000-0002-9348-7844

Supplemental material

Supplemental material for this article is available online.

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