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Health care patterns and policies in 18 European countries during the first wave of the COVID-19 pandemic: an observational study

Dimitra Panteli[1,2], Christoph Reichebner [1], Tanja Rombey[1], Elke Berger[1], Juliane Winkelmann[1], Helene Eckhardt[1], Ulrike Nimptsch[1] and Reinhard Busse[1]

1 Department for Healthcare Management, Technische Universität Berlin, Berlin, Germany
2 European Observatory on Health Systems and Policies, Brussels, Belgium

Correspondence: Christoph Reichebner, Department of Health Care Management, Technische Universität Berlin, H80, Straße des 17, Juni 135, 10623 Berlin, Germany, Tel: +49 (0) 314 21020, e-mail: reichebner@tu-berlin.de

Background: The coronavirus disease 2019 (COVID-19) pandemic has developed into an unprecedented global challenge. Differences between countries in testing strategies, hospitalization protocols as well as ensuring and managing ICU capacities can illustrate initial responses to a major health system shock, and steer future preparedness activities. **Methods:** Publicly available daily data for 18 European countries were retrieved manually from official sources and documented in an Excel table (March–July 2020). The ratio of tests to cases, the share of hospitalizations out of all cases and the share of ICU admissions out of all hospitalizations were computed using 7-day rolling averages per 100 000 population. Information on country policies was collected from the COVID-19 Health System Response Monitor of the European Observatory on Health Systems and Policies. Information on health care capacities, expenditure and utilization was extracted from the Eurostat health database. **Results:** There was substantial variation across countries for all studied variables. In all countries, the ratio of tests to cases increased over time, albeit to varying degrees, while the shares of hospitalizations and ICU admissions stabilized, reflecting the evolution of testing strategies and the adaptation of COVID-19 health care delivery pathways, respectively. Health care patterns for COVID-19 at the outset of the pandemic did not necessarily follow the usual health service delivery pattern of each health system. **Conclusions:** This study enables a general understanding of how the early evolution of the pandemic influenced and was influenced by country responses and clearly demonstrates the immense potential for cross-country learning.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has developed into an unprecedented global challenge. As of 4 May 2021, there have been more than 150 million cases worldwide, with the death toll exceeding 3.2 million.[1] In the European Economic Area and UK, there have been more than 30 million cases with almost 680 000 deaths.[2]

Governments and health systems in Europe and around the world had to quickly adapt to this shock, in terms of curbing the spread of SARS-CoV-2, ensuring services for COVID-19 patients and maintaining essential health services beyond the pandemic. The need to increase surge capacity for acute and intensive care beds, combined with the need to prioritize the use of personnel and personal protective equipment for COVID-19 patients led to modifications in regular service provision, e.g. the cancellation of non-urgent elective surgeries.[3,4]

Assessing, analyzing and interpreting health system shocks contributes to the continuous improvement of health system resilience.[5] The emergence of cross-border health threats, such as COVID-19, underlines the need for understanding health system responses to optimize future preparedness.[6] Differences between countries in testing strategies, hospitalization protocols as well as ensuring and managing ICU capacities, particularly during the first wave of the pandemic, can be very useful in illustrating initial responses to a major health system shock and steer preparedness activities for the future.

These differences have been described on several platforms (e.g. on Our World in Data, or the COVID-19 Health System Response Monitor[7]) but have not yet been empirically analyzed in combination. Existing studies have focused on specific countries (e.g.[8,9]) or single aspects of health care (e.g.[10]).

The objective of this study was to compare COVID-19-related health care patterns across 18 European countries in light of their adopted policies to tackle the first wave of the pandemic; to discuss potential changes over time and provide insights for future pandemic preparedness.

Methods

This is a descriptive study of health care patterns in 18 European countries during the first wave of the COVID-19 pandemic based on publicly available data.

Data collection

Since 20 March 2020, the Department of Health Care Management at the Technische Universität Berlin has systematically collected the following daily data for 18 European countries and two Italian regions:

- number of COVID-19 cases,
- number of COVID-19 tests carried out or persons tested (see Supplementary material S1),
- number of current and/or cumulative hospitalized COVID-19 cases,

- number of current and/or cumulative COVID-19 cases in ICU care and
- number of current and/or cumulative ventilated cases (not analyzed further in this publication).

The data were manually retrieved from various official online sources that routinely report daily numbers of all registered cases, tests and hospitalized patients in the respective country (e.g. websites of ministries of health, national research and public health institutes, official dashboards from national institutions and the Our World in Data website). The collected data were documented in an Excel database which is publicly available on the Department's website[11] and the Harvard Dataverse repository.[12]

When the database was first created, only countries reporting at least five positive cases per 100 000 inhabitants were included. As the pandemic progressed in Europe, the country sample was extended to include a mixture of geographic areas and health system setups. The sample was capped at 18 countries based primarily on data availability (only countries with publicly available daily values were included). When daily data for the period before 20 March 2020 were available, it was added to the database retrospectively. More information on the data collection methods including a detailed description of collected data, variable definitions, sources, first or last date of reporting and collection method per country (and region) can be found in Supplementary material S1.

To contextualize findings from the COVID-19 country data, two additional steps were undertaken:

a. information on related health care policies was collected from the COVID-19 Health System Response Monitor of the European Observatory on Health Systems and Policies for the same time period.7 The Monitor offers both detailed profiles of countries' health system responses to COVID-19 as well as cross-country analyses on specific areas. Collected information spanned testing strategies, as well as patient pathways and guidelines for treatment in the included countries (see Supplementary material S2); and
b. to better interpret health care patterns in response to COVID-19, it was necessary to understand at least some particulars of each country's health system at the outset of the pandemic. For this purpose, health care expenditure, utilization and hospital capacity data before the pandemic were extracted from the Eurostat health database.[13]

Analysis and statistical methods

Depending on data availability and quality per country, 7-day rolling averages per 100 000 population were calculated for additional and total numbers of COVID-19 tests, cumulative cases, cumulative hospitalizations and cumulative ICU admissions (see Supplementary material S3). Based on these calculations, the ratio of tests to cases, the share of hospitalizations out of all cases and the share of ICU admissions out of all hospitalizations were computed to determine the ratio of those who tested positive out of all tests performed (or all persons tested, depending on the source data), the share of COVID-19 cases hospitalized, and the share of hospitalized patients who required ICU admission (see figure 1).

The evolution of the ratio and shares over time was plotted from the beginning of data availability until 31 July 2020 (estimated end of the first wave in most included countries). Specific focus was placed on the values at the peak of the pandemic in each country, defined as the week with the highest rolling average of new cases and the point at which most countries were assumed to have reached a steady state (around 30 June 2020). A complementary paper examines data for current hospitalizations, ICU admissions and available hospital capacities more closely.[12]

Results

Country sample and baseline characteristics

The following 18 European countries were included in the analysis: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland (including Liechtenstein) and the UK. COVID-19 health care data were available for an average of 147 days (6 March–31 July 2020). Depending on data availability, ratios and shares (cases out of all tests/tested, hospitalized out of all cases, ICU admissions out of all hospitalized) could only be calculated for a subset of countries.

Table 1 shows selected baseline indicators for the studied countries, including size and age structure of the population, expenditures on different health care functions and information on health care capacities and utilization. At a glance, the sample includes countries with populations ranging from less than one million (Luxembourg) to more than 80 million (Germany). The share of the population older than 65 is highest in Italy (with 22.8%) and lowest in Ireland (14.1%). This variability is also found in ability (reflected in gross domestic product indicators) and willingness (reflected in health expenditure indicators) to pay for health care, as well as how this care is financed and organized.

Evolution of the first wave of the pandemic

Figure 2 shows the additional cases at peak and over the course of the pandemic for each of the included countries. Apart from Sweden, the peak was in March or April in all analyzed countries, Italy and Luxembourg being the first countries to reach the peak on 23 March 2020. With 24.4 new cases per 100 000 inhabitants, Luxembourg was by far the country with the highest number of new cases per 100 000 inhabitants at peak, followed by Ireland. By the end of May, the number of new COVID-19 cases had declined and remained low in most analyzed countries, with Sweden being the only country with new case numbers of over 5 per 100 000 inhabitants. Numbers of additional tests, hospitalizations and ICU admissions can be found in Supplementary material S3.

Health care patterns over the course of the first wave

Tests

At peak, the ratio of all tests performed (or all persons tested) to confirmed cases varied considerably among countries (figure 3(A)). In Norway, which had among the highest testing rates in Europe, only one out of 22 tests performed was positive (and 21 were negative). In contrast in the Netherlands 1 out of 5 tests was positive, indicating lower, potentially more targeted testing activity. Among the analyzed countries, two clusters can be discerned despite overall heterogeneity: countries with a test-to-case ratio above 10 (e.g. Denmark, Estonia, Finland, Germany, Greece and Norway), and those with a ratio below 10 (e.g. Belgium, France, Ireland, Italy, the Netherlands, Sweden, Switzerland and the UK) at peak.

In all countries, the ratio between tests and confirmed cases increased over time. The ratio increased most in Denmark and Greece, reaching more than 30 tests per confirmed case 30 days after the peak and exceeding 100 at the end of the observation period. In Luxembourg, the ratio took off steeply as of June and more than doubled between that time and the end of the observation period, attributable to the large-scale testing strategy implemented in May 2020.

Hospitalizations

The share of cases hospitalized at peak (figure 3(B)) varied substantially across countries, between over 70% in France and under 10% in Norway. Here, one group of countries shows a high share of hospitalizations (>50%) at the peak (France, Spain and the UK), while

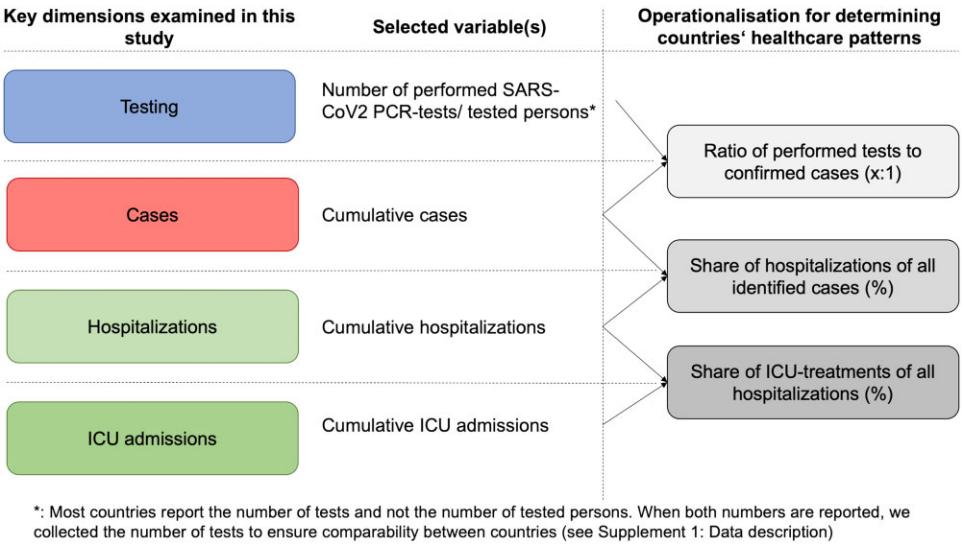

Figure 1 Analysis framework

another seems to have dealt with the majority of cases outside of hospitals, resulting in a relatively low share (<20%) (Germany, Ireland, Switzerland and Norway). In some countries (e.g. Belgium and the Netherlands) the treatment of COVID-19 patients seems to have been more evenly distributed between the hospital and community settings.

Following the peak, the shares of hospitalized cases decreased and then largely stabilized in most countries; they kept slightly decreasing in the two countries with the highest shares of hospitalizations (France and Spain). In Norway, there was a notable increase after the peak before the trend levelled off. In Switzerland and Germany, the share remained almost the same over the entire observation period. This could reflect that countries adapted and then established their chosen COVID-19 health care delivery pathway, depending on health system setup, capacities and other country-level policies.

ICU admissions

At the peak of the first wave, the share of those requiring ICU treatment out of all patients hospitalized ranged from 11% (Spain) to 31% (Germany) (figure 3(C)). This variation could partly be explained by more selective hospitalization strategies in Germany, but also the high case numbers and hospitalization rates in Spain as well as different ICU admission protocols. Following the peak, shares slightly decreased and thereafter remained almost constant in all countries.

Relation of health care patterns and country-level policies

The COVID-19 Health System Response Monitor of the European Observatory on Health Systems and Policies helped to identify a broad range of country-level policies that were introduced and adapted over the course of the pandemic to mitigate the spread of SARS-CoV-2 and provide health services (see Supplementary material S2).

In several of the included countries, testing was initially reserved or prioritized for hospitalized patients or those requiring hospital admission with symptoms attributable to COVID-19 (e.g. the Netherlands, Norway, Spain, Sweden, Switzerland and UK); this needs to be taken into account when interpreting the relationship between number of tests (or persons tested) and number of cases, as well as number of tests and number of hospitalizations (the latter relationship is not explored mathematically in this article). The expansion of testing capacities and the development of track-and-trace policies enabled the broadening of testing criteria in several countries at different points in time. In some countries, criteria were broadened in April and/or May to include additional groups or all symptomatic citizens (e.g. Denmark, Germany, Spain and Sweden), while in others the expansion to all symptomatic citizens followed in June (e.g. the Netherlands, Norway and the UK). This is clearly visible in the course of the test-to-case ratio in Denmark (figure 3(A)), which takes off after the end of April and reflects both the expanded capacities and testing criteria and the decline in identified cases. The same effect can be seen, albeit to a lesser degree, in the curve for Norway, which rises more rapidly as of June. A continuous increase in testing capacities in combination with the broadening of testing criteria and the decline in case numbers explains the steady increase in the ratio of performed tests to identified cases in most included countries. The inverse relationship (confirmed cases to number of tests performed/individuals tested), or test positivity rate, is often used to assess the sufficiency of testing strategies and the level of community transmission and would have shown the opposite trends here (steady decrease in most included countries for the duration of the observation period).

Several countries reported managing COVID-19 (suspected) cases primarily at hospitals in the very beginning of the pandemic (e.g. France, Spain and the UK). In other countries, patients with no or mild symptoms were managed at home or treated outside the hospital since more or less the onset of the pandemic (e.g. Germany), corresponding to relatively low numbers of patients treated in hospital. Thresholds for ICU admissions were not adequately described among country policies to allow further interpretation of the differences in ratios between countries seen in figure 3(C), probably reflecting a corresponding lack of clearly defined policies for ICU treatment.

Discussion

This study highlights the substantial variation in COVID-19 health care patterns among selected European countries and puts these patterns in relation to relevant country-level policies. As reflected in healthcare utilization data (table 1), some included countries (e.g. France and Switzerland) traditionally rely more on the inpatient setting to provide services (discharges from hospitals relatively high and outpatient consultations relatively low among included countries), while in others (e.g. the Netherlands and Spain) the use of outpatient care is more pronounced. One could assume that health care patterns at the outset of the pandemic would follow the usual health service delivery pattern of each health system. This study

Table 1 Selected demographic, economic and health care-related indicators for the included countries (all data from EUROSTAT[13])

Country	Total population (million)	% over 65 years of age	GDP at market price in EURO, per capita	Health expenditure				Consultation of medical doctor (private practice or outpatient) per capita	Discharges from hospitals per 100 000 inhabitants	Curative hospital beds per 100 000 inhabitants
				in EURO, per capita	% of GDP	% spent on outpatient curative and rehabilitative care	% spent on inpatient curative and rehabilitative care			
Austria	8.86	18.8	43 600	4501	10.3	26.0	32.6	6.6	n.a.	535
Belgium	11.52	18.9	40 290	4150	10.3	20.1	26.8	7.2	16 833	497
Denmark	5.82	19.6	52 190	5256	10.1	30.4	25.1	3.8	n.a.	236
Estonia	1.33	19.8	19 660	1312	6.7	29.8	22.2	5.6	n.a.	336
Finland	5.53	21.8	42 370	3829	9.0	33.9	22.5	4.4	16 161	284
France	67.32[a]	20.0[a]	35 100[a]	3969	11.3	18.3	27.3	5.9[d]	18 553	304
Germany	83.17	21.5	40 480	4627	11.5	21.6	26.2	9.9[e]	25 478[d]	602[d]
Greece	10.72	22.0	16 750[a]	1328	7.7	18.4	42.7	3.3	n.a.	363
Ireland	4.96	14.1	67 270	4613	6.9	19.9	25.5	5.0[c,e]	n.a.	279
Italy	59.64	22.8[b]	29 300	2534	8.7	23.5	27.1	n.a.	11 169	259
Liechtenstein	0.04	17.9	149 300[a]	8380	5.5	33.3	27.9	9.0[d,e]	4095	102
Luxembourg	0.63	14.4	98 640	5221	5.3	26.8	25.2	5.8[a]	n.a.	370
The Netherlands	17.41	19.2	44 920[a]	4480	10.0	26.5	19.3	9.0	8976	269
Norway	5.37	17.2	69 710	6960	10.1	21.5	25.5	4.5	16 349	313
Portugal	10.30	21.8	19 950	1877	9.5	38.9	17.5	n.a.	n.a.	329
Spain	47.33	19.4	25 770[a]	2310	9.0	29.9	24.9	7.3[d]	10 471	250
Sweden	10.33	19.9	46 260	5041	10.9	28.5	20.2	2.7	13 875	197
Switzerland	8.61	18.5	73 180	8327	11.9	28.9	25.3	4.3[d]	16 958	361
UK	67.03[a]	18.4	36 440	3646	10.0	25.8	22.9	n.a.	n.a.	n.a.
Year	2019	2019	2018	2018	2018	2018	2018	2018	2018	2018

a: Provisional.
b: break in time series.
c: estimated.
d: 2017 data and edefinition differs.
GDP, gross domestic product; n.a., not available.
Notes: The System of Health Accounts[13] underpinning EUROSTAT data distinguishes outpatient from inpatient care based on whether patients are formally admitted to hospital requiring an overnight stay. This means that outpatient services may also be delivered at hospital facilities depending on how health care is organized in each country, but patients are not admitted and do not stay overnight. Differences in definition (as indicated by the letter 'e' next to some data points in this table) need to be considered when interpreting data.

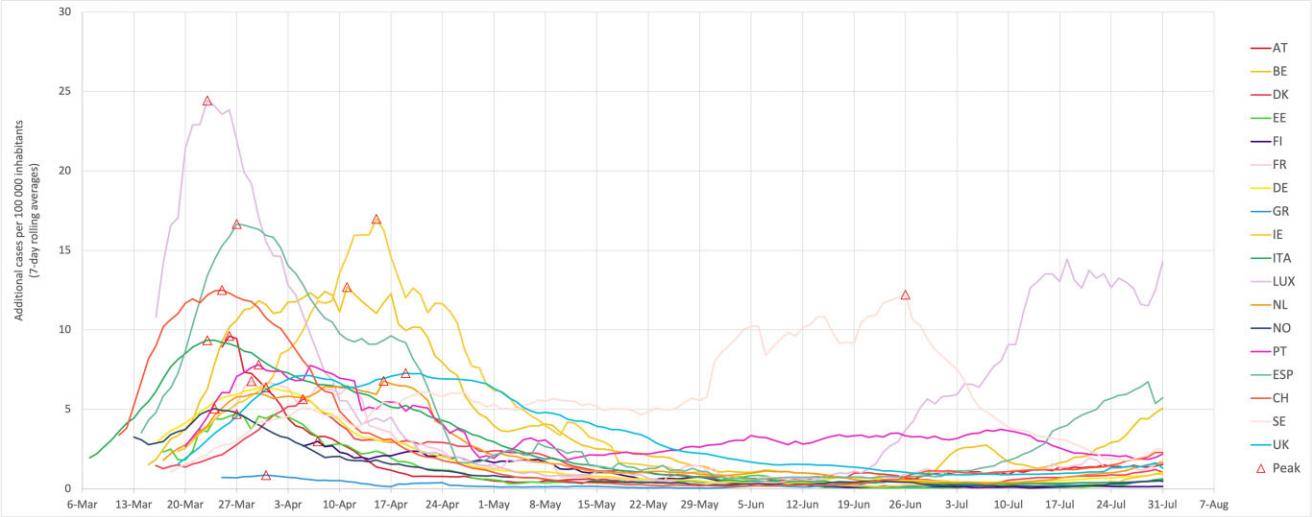

Figure 2 Additional cases/100 000 inhabitants at peak (triangle) and over the course of the pandemic

shows that this was not necessarily the case among included countries during the first wave of the pandemic in 2020.

For instance, in both France and Spain, a large share of COVID-19 cases in the beginning of the pandemic were hospitalized. This observation may be more intuitive for France, where health care delivery usually relies on the inpatient setting as reflected in high hospital discharge rates (see above and table 1). Interestingly, both France and Spain have fewer hospital beds per 100 000 inhabitants (304 and 250 acute beds, respectively, see table 1) than the average of the analyzed countries (327 beds). On the other hand, Germany has relative overcapacity in the inpatient setting (602 beds per 100 000 inhabitants) but hospitalized only around 20% of all COVID cases during the first wave. However, the country also has a tradition of care provided outside of hospitals, including diagnostic laboratories and specialist consultations, and leveraged its public health structures early on to keep COVID-19 cases out of the hospital.[14] In that sense, it is not surprising that a high share of those finally admitted to the hospital required ICU treatment, as less severe cases were not hospitalized in the first place (and are thus not reflected in the hospital data). Norway, despite being on the low side of the spectrum for ambulatory contacts and among the highest for hospital discharges pre-pandemic, largely dealt with COVID patients outside of hospitals. It is important to note that this analysis is based on national-level data. However, particularly in federally organized countries (e.g. Germany) and countries where the responsibility for delivering health care is decentralized (e.g. Italy, Spain), approaches along the dimensions examined in this article were not uniform.[15] As such, variation in patterns within countries is masked here; this could provide impetus for further analyses.

The evolving nature of testing strategies based on both scientific advice and capacity expansion is reflected in the data shown in this study. At the beginning of the pandemic, most countries in Europe tested people with severe symptoms (mainly those needing hospitalization or already hospitalized); several also tested frontline health and social workers, contacts of known cases and vulnerable groups.[16] The negative relationship between the ratio of all tests performed (or all persons tested) to confirmed cases and the share of cases hospitalized described in the results is not surprising: in countries where testing capacities were initially limited and thus reserved for hospitalized patients with symptoms or more severe cases (e.g. Spain and UK), it follows that out of identified cases, a higher share was hospitalized compared to countries with broader testing criteria. Notably, this analysis also does not account for COVID-19 cases contracted within hospitals,[17] which would also be counted as patients with COVID-19 occupying hospital beds. The World Health Organization (WHO) advised to expand testing in order to detect COVID-19 cases early, isolate them and trace contacts and monitor epidemiological developments as accurately as possible; among included countries, community-wide testing was piloted by some in April 2020 but was not implemented at larger scale until later, and that not by all countries. This is not surprising, as the required laboratory capacities were not equally easy to surge in all health systems. Countries with sustained investment in relevant health infrastructure, including laboratory equipment, technicians, logistics systems and information technology, were bound to face fewer challenges in scaling up testing quickly and sustainably.

Regarding hospitalizations, previous advice on public health emergencies highlighted the need to separate those with light from those with heavy symptoms, supporting the logic of keeping (COVID-19) patients out of the hospital as much as possible.[12] Many countries moved to change patient pathways or the way care was organized within health care facilities.[14,18] Uncertainty about the course of COVID-19 can in part explain the fact that this did not seem to happen everywhere, at least at the early stage of the first wave of the pandemic. For instance, it could explain the high share of hospitalizations in the UK, where pathways to keep patients out of the hospital were established early, in part combined with remote monitoring at home via oximeters distributed by general practitioners[19] and the creation of virtual COVID-19 wards operated by hospitals;[20] uncertainty could have impacted the extent to which these pathways were implemented. Several countries worked to ensure that hospitals were not the first point of contact for (suspected) COVID-19 cases. In Belgium, public campaigns were launched in the media to discourage people from seeking out hospitals directly for diagnosis or treatment.[7] In March 2020, Luxembourg transformed three GP offices usually covering out-of-hours care into special consultation and triage centres, to keep COVID-19 patients out of the hospital to the extent possible.[14,21]

Protocols and practices for admitting patients to the ICU will likely have differed among countries. On the one hand, bed scarcity necessitated difficult prioritization decisions.[22,23] At the same time, and particularly for those with underlying conditions, an ICU admission may mean overall deterioration, an extremely long recovery and an unlikely return to a functional condition.

This study allowed for an overview of COVID-19 health care patterns during the first wave of the pandemic, and for a general understanding of how the early evolution of the pandemic influenced and was influenced by country responses. It has several limitations, both in methodology and scope. The main methodological limitation relates to uncertainties regarding data quality and completeness; this pertains to the data on health care collected from public sources and the information on country responses reported on the Health System

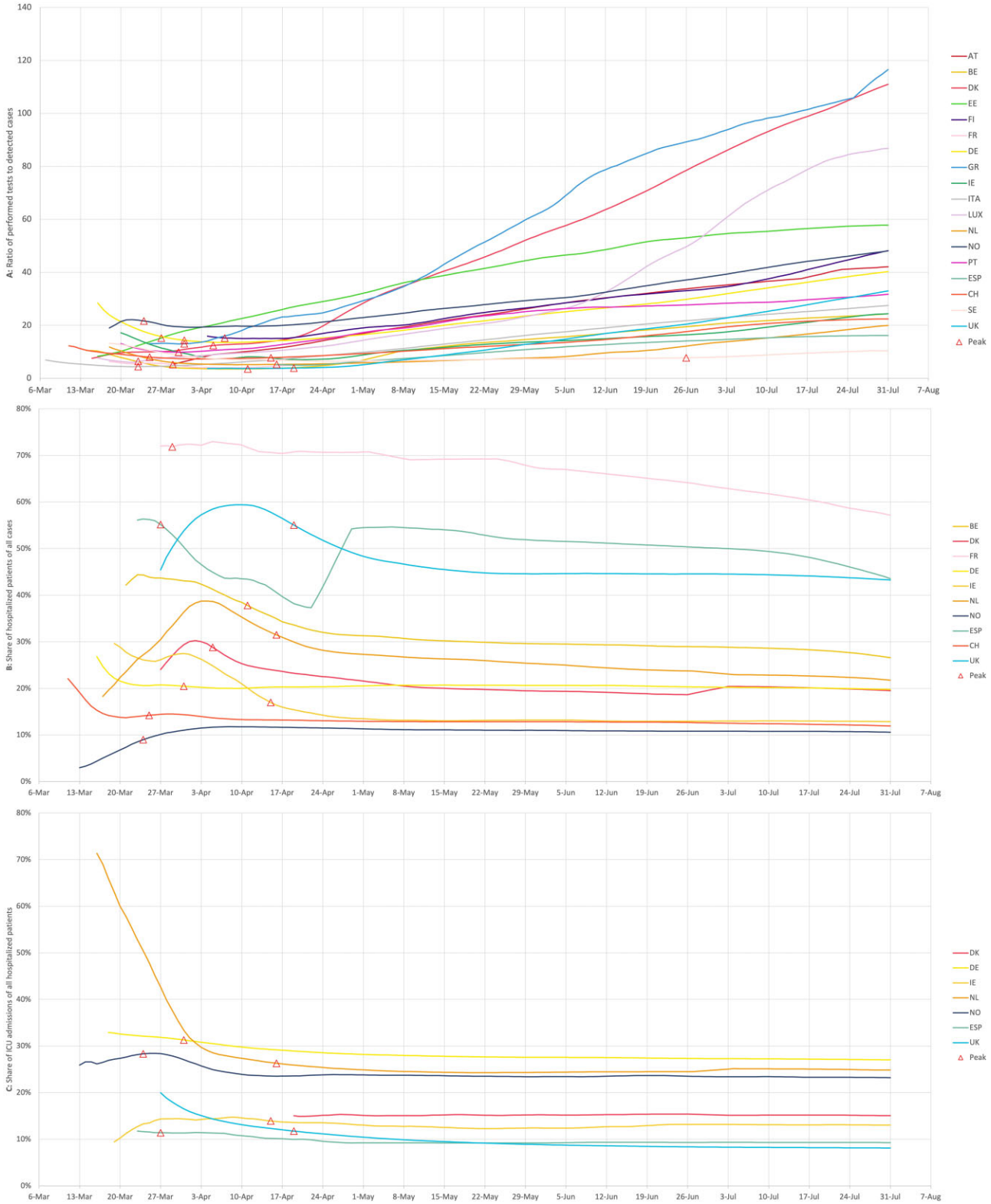

Figure 3 Ratio of performed tests to detected cases at peak (triangle) and over the course of the pandemic (A), share of hospitalized patients of all cases at peak (triangle) and over the course of the pandemic (B) and share of ICU admissions of all hospitalized patients at peak (triangle) and over the course of the pandemic (C)

Response Monitor. Furthermore, the comparability of quantitative data across countries is limited, e.g. due to different data collection methods and definitions of variables (see Supplementary material S1). Regarding scope, this study focused on acute care for COVID-19 patients. This paints an incomplete picture of country responses in at least two ways: one, there is no consideration of patients competing for the same capacities (e.g. ICU beds) for other conditions or the range of health services that had to be postponed or remodelled to enable COVID care; and two, some COVID-19 patients are faced with mid- and long-term health consequences, many still largely unknown, what is in the meantime known as long COVID.[24] This has the potential to impact their need for a range of health services beyond the focus of this study (e.g. respiratory and neurological rehabilitation, dialysis, etc.).

Towards the end of the observation period of this study, numbers slowly started to grow again in several countries, a trend which in hindsight led to the 'second wave', peaking in late autumn 2020. Subsequent patterns of healthcare utilization will differ, reflecting both differences in the epidemiological course of the pandemic (e.g. regarding the age of hospitalized and ICU patients), the evolution of management of COVID-19 patients[25] and other country policies; further analysis based on the described data is planned in due time.

One of the objectives of this study was to provide insights for future pandemic preparedness. At the time of analysis, not enough time had elapsed to allow for a robust investigation of the concrete implications of the identified patterns on (patient) outcomes. However, this study constitutes the necessary first step towards understanding the importance of cross-country learning for enabling future pandemic preparedness. By carrying out a systematic assessment and comparison of key variables and initial approaches to tackling the pandemic, it uncovered substantial variability, highlighting the potential for further investigation and identification of good practice. For instance, the differences in the share of hospitalizations could serve as an impetus for discussion regarding capacity planning, regarding both physical (i.e. beds and equipment) and human resources. Future studies could explore links to additional variables, such as average length of hospital stay[26–28] and patient outcomes (e.g. number of deaths attributed to COVID-19).

In conclusion, this study described differences in COVID-19 health care patterns during the first wave of the pandemic, which are only partially explained by underlying health system characteristics. It highlights the importance of such analyses to enable cross-country learning. Numerous initiatives are already underway to ensure that lessons learned are translated into future preparedness and resilience policy. Further analyses of the later stages of pandemic management will yield additional insights. Sufficient funding to further evaluate the impact of pandemic responses on outcomes, and transparent sharing of results should be prioritized.

Supplementary data

Supplementary data are available at *EURPUB* online.

Data availability statement

The data underlying this article are available in Harvard Dataverse, at https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/02CFBB.

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Conflicts of interest: RB reports grants from the German Federal Ministry of Education and Research, grants from the World Health Organization, grants and other funding from the Federal Ministry of Health, and grants from the German Innovation Fund for projects outside the scope of the submitted work. The Department of Health Care Management at the Technische Universität Berlin, which employed all authors while the study was conducted, receives grants from several funding bodies not related to this work. UN receives funding from the German Research Foundation. In October 2020, DP started working for the European Observatory on Health Systems and Policies, a partnership hosted by the World Health Organization. The submitted work is independent from all above relationships.

Key points

- There was substantial variation across countries regarding the ratio of tests to cases and the share of hospitalizations and ICU admissions.
- In all countries, the ratio of tests to cases increased over time while the shares of hospitalizations and ICU admissions stabilized, reflecting the evolution of testing strategies and the adaptation of COVID-19 health care delivery pathways, respectively.
- Health care patterns for COVID-19 at the outset of the pandemic did not necessarily follow the usual health service delivery pattern of each health system.
- Public availability and accessibility of relevant daily data varied across countries.
- This study highlights the importance of cross-country learning for optimizing pandemic preparedness and response.

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