Coping with Corona: The role of hospital care structures and capacity expansion in five countries

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1. Introduction

1.1 Observation period and case selection

One of the major challenges in care delivery during the COVID-19 pandemic worldwide was the management of hospital capacities, in particular in intensive care. This contribution aims to better understand the crisis response of five different health care systems during the first wave of the Corona pandemic: Denmark, Germany, Israel, Spain, and Sweden. Since this area is poorly researched from a comparative angle, it focuses on pre-pandemic hospital care structures as described by available resources (beds and staff) and the degree of concentration of specialist services in acute care – with a particular attention to intensive care –, as well as on capacity expansion during the crisis.

Resilience of health care systems is defined as the ability to prepare for, manage (absorb, adapt and transform) and learn from shocks (European Observatory et al. 2020). In line with criteria advanced by the OECD (2020a), we consider the following key characteristics of resilient health systems:

1. flexibility and adaptability in the use of existing resources, as well as planning for responding to surge in demand;
2. the ability to create surge capacity in the three fronts: staff, supplies, and space; and
3. the ability to avoid excess idle capacity

The study focuses on the period of the "first wave" of the Corona pandemic. Despite slight variations between the countries, the study period is thus largely uniform from a first occurrence in the months of (late) January / February 2020 to a first flattening of incidents in the months of June / July 2020.

Countries included in this study differ in terms of hospital ownership structures and as well as with regard to health system type and associated governance structures. As a social insurance country, regulation in the German healthcare system is characterized by a mix of self-regulation, state regulation and competition (Rothgang et al. 2010). Hospitals, including acute care, prevention and rehabilitation facilities, are owned by public (25%), private non-profit (31%), or private for-profit providers (43% of all hospitals) (OECD 2021). The Israeli population is also covered for health care services through social health insurance, where four sickness funds (so called health plans) are responsible for provision and payment of services. About half of the hospital beds are state-owned, and about one-third are owned by the largest health plan (Rosen

et al. 2015). Denmark and Sweden are two Scandinavian countries with state-led health care systems, where the majority of resources are publicly owned. Hospitals in Sweden are almost exclusively owned by the provincial parliaments or regions. The hospital landscape in Sweden and Denmark have undergone considerable centralization and concentration over the past decade (Anell et al. 2012). By contrast, the state-led Spanish National Health System (Sistema Nacional de Salud, SNS) is characterized by decentralization. In the hospital sector, according to OECD data, about 44% of all hospitals are public, 16% are private non-profit and 40% are private for profit facilities (OECD 2021). Many private clinics are small facilities that provide specialized services. Overall, according to national statistics, about 20% of all hospital beds available in Spain are in private facilities, both nonprofit and for-profit (MSCBS 2017). Private hospitals in Spain have a substantial contribution in the provision of secondary care (Bernal-Delgado et al. 2018).

1.2 Challenges in this cross-country comparison

What makes the intended cross-country comparison particularly challenging is that, in addition to ownership and care structures, the countries differ in many other aspects regarding the organization of the hospital sector. In Denmark and Sweden e.g., hospitals tend to be organized as systems or groups, so that some of the hospitals are found in multiple physical locations. Further, there are marked differences in the way how specialist outpatient care is regularly delivered i.e., in or outside the hospital. In the state-led health care systems of Denmark, Spain, and Sweden, specialized outpatient services are increasingly delivered in hospitals. In Israel, although all hospitals operate outpatient clinics, most specialized ambulatory care is provided in community-based settings (Rosen et al. 2015). German hospitals by contrast, have traditionally concentrated on inpatient care, thus most outpatient specialist care is delivered outside hospitals. All of these factors play a role in navigating Covid-19 patients through the health care system.

Beyond the hospital and outpatient care structures, the intersection between health care/hospital care and social care is also crucial with regard to the pandemic. After the Corona outbreak, the protection of older people in nursing homes was a serious gap in protection strategies in all selected countries during the first wave (Comas-Herrera et al. 2020). Of course, developments in the nursing home sector are also relevant for hospital capacity management. In Spain, for example, patients waiting for places in nursing homes often occupy beds in public hospitals to

bridge waiting times, a situation that put additional strain on Spanish hospitals during the pandemic. In Israel, the long-term care sector and the hospital sector appear to be more closely linked from an institutional perspective than in the other countries, as hospitals often include nursing home beds. In health statistics, the distinction between "acute care hospital" and "nursing home" is based on the majority of activities, measured in bed days (OECD 2021, Sources & Methods). Although we clearly recognize the importance of the overlap between health and social care, it is not possible in our study to explore this relationship more deeply.

With a view to international comparability, it should also be added that the countries considered obviously differ in numerous other contextual factors (Cacace et al. 2013). These include factors external to the pandemic, such as the level of generally available (health) resources prior to the pandemic, but also the degree of exposure to the Covid-19 outbreak, which varies by the age and morbidity structure of the population and by country-specific patterns of spread of Covid-19. The preparedness and strategies of health systems to respond to crises also vary, as does the severity and timing of lockdowns. All of these contextual factors play a role in crisis response and health system resilience, but cannot even be rudimentarily represented within the scope of this study, limiting the relevance of the factors we consider in the country comparison.

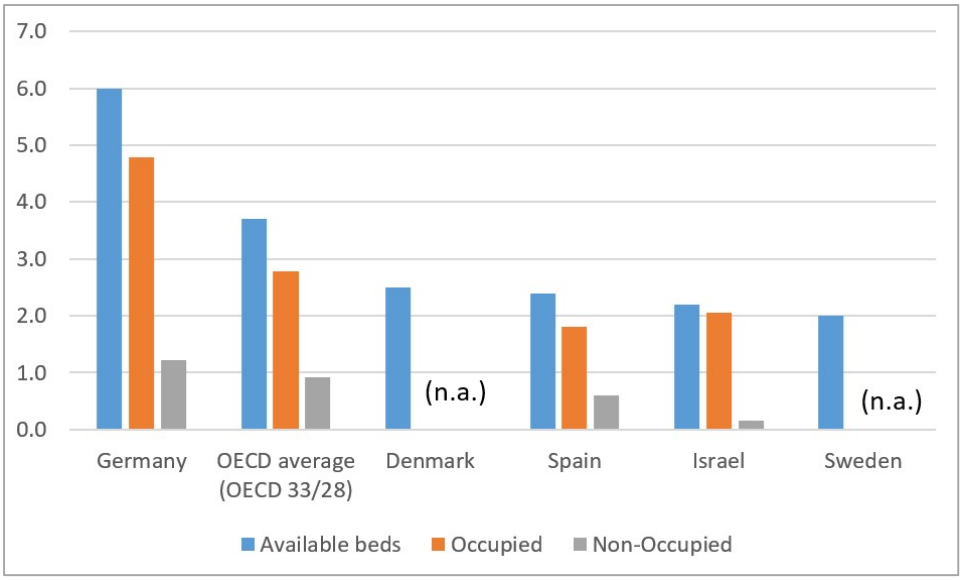
2. Pre-pandemic situation

2.1 Capacities in acute care

In order to create surge capacity, the number and occupancy of acute care beds in the pre-pandemic situation – in particular in intensive care – are the first indicators of interest for a comparative assessment of hospital care capacities and structures. This indicator is preferred over the number of hospitals, as hospitals differ in size.

Figure 1 shows the overall rate of available acute care hospital beds per 1,000 of population before the pandemic (OECD 2020a). Acute care beds according to the OECD health statistics typically include beds for surgical and medical specialties, gynaecological and obstetrical services, and some psychiatric care beds; units providing intensive care are also included. The figure distinguishes occupied beds from non-occupied beds in Germany, Spain and Israel.

Figure 1: Hospital acute care beds per 1,000 population in five countries (2017 or nearest)



Source: *OECD 2021; OECD 2020a*

There are major differences between the countries in our study in terms of available acute care hospital beds. In 2017, Germany had 6.0 acute care beds available per 1,000 of population, this is one of the highest rates among the OECD countries; 61% above the OECD-average. Much fewer acute care beds are available in Denmark (2.5 per 1,000 population), in Spain (2.4), in Israel (2.2), and in Sweden (2.0). Sweden has one of the lowest rates amongst OECD countries.

Before the pandemic, occupancy rate of acute care beds was particularly high in Israel (93.3%) and – although no data is available from OECD statistics – in Sweden. According to the Swedish municipalities and county councils, occupancy rate of somatic beds in Sweden indicates a situation of overcrowding in Sweden's hospitals already before the pandemic (SKL 2020). In fact, the low density of hospital beds has led to access problems to inpatient specialist care in remote areas (Anell et al. 2012).

In Germany, occupancy rate of acute care hospital beds was 79.8%. It is worth noting, however, that the advantage of having a multiple of acute care beds available (6.0 compared to 3.7 on average of OECD countries), melts down to a marginal gain when looking at the rate of non-occupied beds (1.2 compared to 0.9). The reason is that German hospitals perform more surgical procedures compared to other countries and hospitalization rates are high. This cannot be explained by an older population or higher morbidity alone, thus indicating overtreatment, also in intensive care (Michalsen et al. 2021). Occupancy rate of acute care beds in Spain was 75.3%,

almost at OECD-average (75.2%). Although data on bed occupancy in acute care are not available from OECD-statistics for Denmark and Sweden, a conservative estimate is that average occupancy is high and even close to 100% (see also SKL 2020).

Table 1 shows the levels of hospitals employment in Denmark, Germany, Israel and Spain, distinguishing between physicians and professional nurses and midwives employed in hospitals. These indicators are not provided for Sweden, since in this country the statistics on health care personnel do not distinguish between ambulatory and inpatient care facilities.

Table 1: Hospital employment in Denmark, Germany, Israel, and Spain (2018 or nearest)

Row		***Denmark***	***Germany***	***Israel***	***Spain***
(1)	Physicians, density per 1,000 population (head counts)	3.1	2.4	2.2	2.4
(2)	Physicians, density per 1,000 population (FTE*)	3.0	2.1	2.4	n.a.
(3)	Professional nurses and midwives, density per 1,000 population (head counts)	7.2	5.6	3.2	3.6
(4)	Professional nurses and midwives, density per 1,000 population (FTE*)	6.4	4.2	2.8	n.a.
(5)	Nurse-to-bed ratio (head counts)	3.0	0.8	1.1	1.2
(6)	Nurse-to-bed ratio (FTE*)	2.6	0.6	1.0	n.a.
(7)	Number of physicians per 1,000 inpatient cases	19.3	8.1	n.a.	n.a.
(8)	Number of trained nurses and midwives per 1,000 inpatient cases	44.7	16.6	n.a.	n.a.

Source: *OECD 2021, Augurzky et al. 2020:32, *FTE: full-time equivalent*

The density of hospital physicians and nurses per 1,000 population is highest in Denmark compared with the other countries reported, which have 0.7 to 0.9 fewer physicians (line 1) and 1.6 to 4.0 fewer nurses per 1,000 inhabitants (line 3) in head count terms. Even more interesting and relevant is the "nurse-to-bed ratio" (line 5), which is the least favorable in Germany among these countries, even though also the OECD statistics ranks the overall number of physicians and nurses as high by international standards (OECD 2020a:7). In Germany, there are only 0.8

nurses per bed, while this ratio is more than three times higher in Denmark (3.0). This is confirmed by the evaluation of the number of trained nurses and physicians per 1,000 inpatient cases, which is only available for Germany and Denmark. It shows that the density of physicians (row 7) and nurses (row 8) is low in relation to the number of inpatient cases. Denmark has 2.6 times as many trained nurses and 2.2 times as many physicians per 1,000 inpatient cases compared with Germany.

Although they give a first impression, the limitations of these comparative data are also obvious: Since more outpatient services are provided in Danish hospitals, the ratio of health care staff to the number of inpatient beds and inpatient cases does not reflect the true workload per person. Nevertheless, it appears that the high number of acute care beds in Germany can also turn out to be a Potemkin village that belies the fact that they are not accompanied by adequate staffing. In the light of the pandemic it is interesting that the regulation of lower limits for nursing staff in nursing-sensitive hospital areas, including intensive care units (ICUs), that has been in force since October 2018 (Pflegepersonaluntergrenzen-Verordnung, PpUGV), was suspended during the first wave.

Due to the very high number of hospital acute care beds and its utilization, the ratio of nursing staff and physicians to hospital beds and also per inpatient case is particularly unfavorable in Germany. But there is also a glaring shortage of nurses in Israel. In 2018, the density of practicing nurses per 1,000 population was 5.0, compared with the OECD average of 8.7, while the number of physicians in the same year was 3.1 per 1,000 population, closer to the OECD average of 3.5 (OECD 2020b). Sweden and Spain also experienced staff shortages before the pandemic.

2.2 Specialization and concentration

It is assumed that more specialized hospitals in which highly specialized, complex care is provided in geographically concentrated hospital structures are better able to providing adequate care, also to Covid-19 patients (Böcken & Preusker 2021). Although data is weak, trends in specialization and concentration in hospital care can be identified for the countries.

Within our sample, Denmark and Sweden have the most centralized and specialized hospital systems. In these countries, a profound change in the hospital landscape has taken place, and hospitals are no longer monolithic units within healthcare systems, but rather networked, inte-

grated systems that also provide outpatient care. Accordingly in Sweden, depending on the statistics available, hospitals are counted as hospital groups (85 groups in Sweden) or as hospital sites (103 sites in Sweden) (Vården i siffror 2020). There are pulmonary departments operating in 38 hospitals, that is about 44% of all Swedish hospital groups (SLMF 2021, own calculations).

Similarly, in Denmark, there are 21 hospitals, many with several physical locations. Denmark is also characterized by a special approach to specialization according to functions or "layers", which are distributed - partly overlapping - among the hospitals or hospital organizations. Specialization in the Danish healthcare system is not static, but adapts to technological change and even to the acquired knowledge of staff. Pulmonary units are embedded/integrated in various different departments, in principle, all hospitals have general medical departments that deal with non-specialized pulmonary conditions. Five hospitals are specifically designated at the regional specialization level to deal with complicated pulmonary infections that do not respond to standard therapy. Highly specialized pulmonary treatment includes a number of different functions/conditions that are spread across several hospitals, most of them located in three hospitals (Herlev og Gentofte Hospital, Aarhus Universitetshospital, and NBG OUH Odense Universitetshospital). Transplantations and treatments requiring close interaction with specific other highly specialized functions are located at Rigshospitalet (National Hospital); there are collaborating departments in the two other regions (and a few additional hospitals) for specific functions.

Table 2: Distribution of functions in Danish hospitals/hospital organizations

	Syd	Nord	Midt	Sjælland	RegH/capitol (+Bornholm)
Somatic hospitals*	4	3	6	6	6
Joint acute functions	5	3	4	4	6
pulmonary disease/respiratory medicine**	4	3	6	6	6

*Hospital organizations. - often with several physical locations

** Highly specialized in 3 hospitals + collaborating hospitals in the other regions. - Others with main/regional specialization level

Source: *own*

In Israel, specialist services tend to be dispersed throughout outpatient clinics and general acute care hospitals, but lungs wards are not broadly available in all hospitals. Larger acute care hospitals are located in the center of the country. The Ministry of Health in Israel determines the

capacity of each hospital and ward, and allocates human resources (and some funding) accordingly. Regional distribution is not uniform, underserved areas are located in the north but particularly in the south of the country.

Due to the decentralized planning approach in Spain, hospitals are rather evenly distributed in the seventeen Autonomous Communities (ACs) (and the two Autonomous Cities of Ceuta and Melilla). In Spain, most hospitals are small, there are only 18 hospitals with more than 1000 beds; thus the hospital care system – together with the German case – can be described as the least concentrated. Specialties are widely and rather evenly distributed among hospitals; pulmonary medicine, for example, is represented in about 60% of all hospitals (474 out of 778 hospitals), as shown in the overview in Table 3.

Table 3: Specialization on pulmonary diseases in hospitals

Country	
Denmark	Pulmonary units in nearly all hospitals; ca. 10 (out of 25) hospitals or groups with *specialized* pulmonary units
Sweden	38 (out of 85) hospitals with pulmonary units (44%)
Germany	128 (out of 1.915) hospitals with pulmonary units (6%)
Spain	474 (out of 778) hospitals with pulmonary units (60%)
Israel	Lung wards concentrated in few acute care hospitals

Source: *eSundhet.dk 2020; Ministry of Health Israel 2020; MSCBS 2017; Svensk Lungmedicinsk Förening 2020; Statistisches Bundesamt 2018*

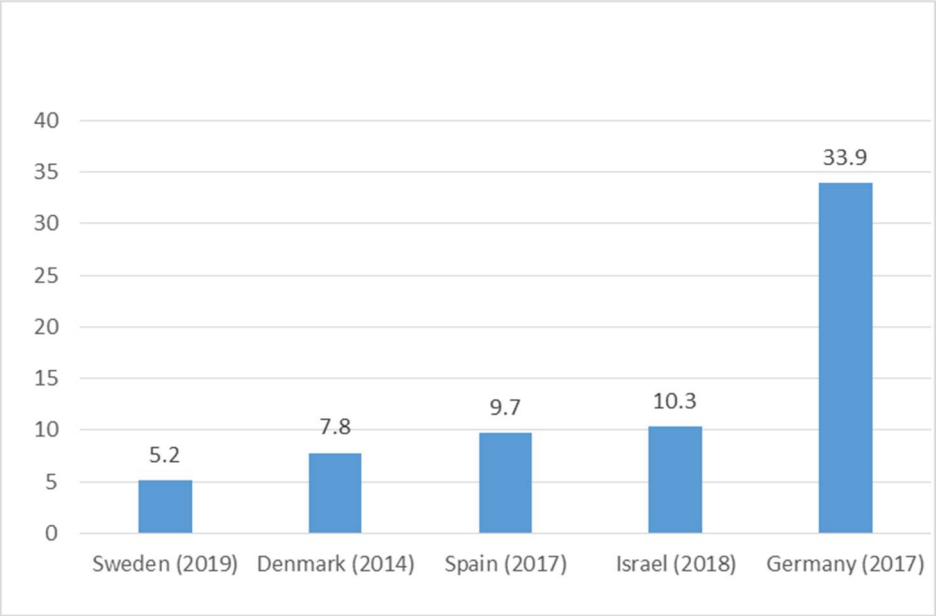
From a conceptual point of view, however, it should be noted that there is a lack of comparative data and, above all, comparative concepts for describing and measuring specialization and centralization. Further research is needed on how these factors can be conceptualized and measured.

2.3 Intensive care capacities

There was also a wide variance in rates of intensive care beds prior to the pandemic among the countries surveyed. Germany was already before the pandemic equipped at a high rate with 33.9 intensive care beds per 100,000 inhabitants in 2017; average occupancy rate was at 79% (SMC 2020). Israel (in 2018) and Spain (in 2017) had less than one-third of the intensive care bed rates available in Germany, i.e., 10.3 in Israel and 9.7 per 100,000 inhabitants in Spain. The Scandinavian countries have fewer intensive care beds per 100,000 inhabitants, 7.8 in Denmark

(in 2014) and 5.2 in Sweden (in 2019), as shown in Figure 2. It needs to be noted, though, that Israel had considerable reserves in intensive care capacity even before the pandemic, due to the high crisis-preparedness of the country. Respiratory intensive care units (ICUs) in Israel are rather evenly distributed in hospitals, but it needs to be taken into account that most hospitals are in the center of the country.

Figure 2: Intensive care beds per 100,000 population in five countries (before the pandemic)



***Source**: own calculations based on OECD* 2020a:11, SIR 2020, Ministry of Health Israel 2020a; MSCBS 2017

The total number of intensive care beds also includes some beds in pediatrics and neonatology that are not primarily suitable for the care of Covid-19 cases. If these are factored out, the number of available intensive care beds per 100,000 population drops significantly from 10.3 to 8.6 in Israel, but only moderately from 9.7 to 9.5 in Spain (Ministry of Health Israel 2020a; MSCBS 2017, own calculations). In Sweden, there are 4 ICUs for children, however, these were used for treating Covid-19 patients. In Germany, the total number of available intensive care beds in 2017 (about 28,000) includes about 3,000 beds (11%) for adults and pediatrics/neonatology that are not primarily relevant for the care of Covid-19 patients. The ratio of available beds for the care of Covid-19 patients thus decreases from 33.9 to 30.3 per 100,000 population.

Intensive care occupancy rates are not available for Sweden and Denmark, neither from the OECD or from national statistics, but they are probably high by international standards. According to own calculations based on SIR (2020), occupancy rate in Sweden is 80% on average.

While in Germany and Denmark intensive care capacities are evenly distributed across the country, in Sweden there is a concentration in metropolitan areas (Bauer et al. 2020). In Spain, the occupancy rate in public hospitals was 60.1% in 2018, and 40.1% in private hospitals. Of these hospitals, public hospitals reported 3.566 functioning ICU beds (excluding neonatal ICU) and private hospitals reported 900 ICU beds, for a total of 4.466 ICU beds. Public hospitals thus provided 79.8% of all functioning ICU beds, and private hospitals, 20.1% (Ministerio de Sanidad, 2018, Table 6.2).

The number of doctors specialized in pulmonary diseases is known only for the German case (about 1.080, according to Statistisches Bundesamt, 2018), no other country reports this number, indicating serious data gaps.

More importantly, systematically collected data on trained nursing staff in intensive care are not available in any of the countries considered. In Spain, there is also no legal definition of an ICU nurse, and nurses can be recruited from different care areas, depending on demand. In 2018 the Spanish Society of Intensive Care Nurses and Coronary Units (Sociedad Espanola de Enfermeria Intensiva y Unidades Coronarias, SEEIUC) promoted a study in ICUs in Spain where, among other issues, nurse to patient ratios were requested. Only one unit (0.6%) had a ratio of 1:1, 46.8% had a 1:2 ratio, 22.2% had a 1:3 ratio, 2.5% had ratios between 1:4 and 1:6, and 27.9% had varying ratios depending on the shift." (SEEIUC, 2020, p. 49). Overall, the average ICU nurse/patient ratio is estimated at well below the 1:2 ratio recommended by the national health ministry.

2.4 Data availability in intensive care

Data on the availability of intensive care units and beds varied widely among countries. At the time of the pandemic outbreak, up-to-date data on intensive care capacity were available only in Sweden. Sweden has maintained a registry since 2001, which was changed to daily updates right after the Covid-19 outbreak. In all other countries, data on this important management tool for surge capacity planning, were outdated at the time of the pandemic outbreak.

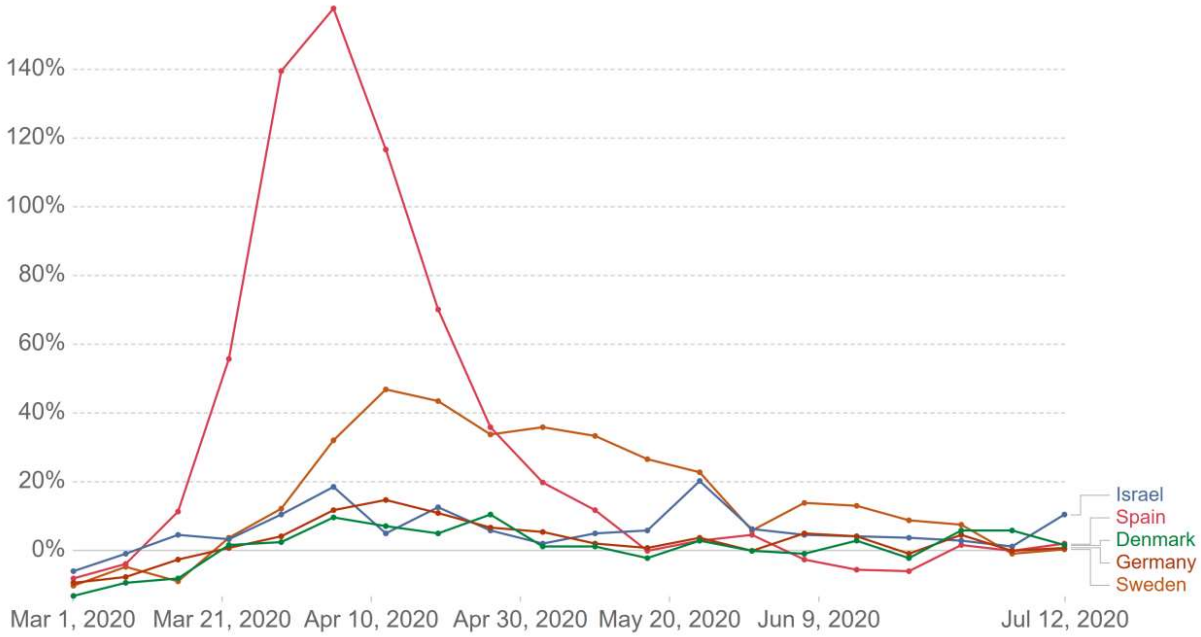
Even after the outbreak of the pandemic, data reporting proceeded at different pace. In Denmark, the Danish Health Authority has reported the number of intensive care beds and ventilators since the beginning of March 2020. In Spain, data on ICU bed occupancy were provided by most Autonomous Communities by 29 March 2020 (Ojeda 2020); in addition, data on total hospitalizations, ICU admissions, discharges, and deaths by region were available and updated

on a daily basis in most ACs. In Germany, it took until around mid-April 2020 until these figures were available for all German hospitals. Since then, they have been updated daily and reported publicly. In Israel, by contrast, the Ministry of Health did not introduce a centrally organized database with up-to-date information on bed occupancy at individual hospitals until July 2020, i.e., at the very beginning of a second wave in Israel.

3. Excess mortality in five countries

Figure 3 compares the excess mortality in the countries under study using data from the Human Mortality Database, and the World Mortality Dataset. Shown is the "P-score", an indicator that shows the percentage difference between the number of weekly deaths in 2020 and the average number of deaths in the same week over the previous five years (2015–2019) (Our World in Data 2021).

Figure 3: Excess mortality during Covid-19: Deaths from all causes compared to previous years, all ages



Source: *Our World in Data (2021)*

For this study, excess mortality is preferred over other measures, such as the number of Covid-19 cases or the number of Covid-19 related deaths, as it reflects the direct and indirect impact of the pandemic on deaths. It captures all deaths, even if not tested or diagnosed correctly, thus also avoiding the distinction of dying *of* the coronavirus or *with it*, and it measures the indirect mortality impact of the pandemic by capturing the many ways in which it has affected health

systems and living conditions, for example, when the pandemic causes health systems to collapse or when resources are diverted from other areas so that people die from not receiving adequate health care, either because their treatment was delayed or because they avoided the health care system by their own choice. Excess mortality during the first wave of the pandemic was observed in Spain, in particular between mid-March and mid-May, with the P-score peaking on April 5 (158%). In Sweden, although the curve was much flatter, it lasted longer i.e., from end of March to end of June, and peaked on April 12 (47%). There is only a short period in the second half of May, where excess mortality is observed in Israel with a sudden surge to 20% on May 24. Excess mortality is also observable in Germany, starting end of March and peaking around mid-April (15%), and declining in the first half of May.

The reason for bringing excess mortality in here is to emphasize that this outcome indicator is influenced by many other factors, within and also outside the health care system. The important point to be raised here, is that the many deaths that occurred in nursing homes were an important driver of excess mortality. The problem has been severe in all countries, however as the comparative data from Comas-Herrera et al. (2020) show, the countries also have been affected to different degrees. The number of care home resident deaths as percentages of all Covid-19 deaths reported on 26 June 2020 is: 35% in Denmark, 39% in Germany, 45% in Israel, and 49% in Sweden (p. 19). In Spain, it is estimated that 68% of all deaths were in nursing homes, although there is some ambiguity in the reported data as some regions differentiate between deaths of people who have been diagnosed with Covid-19 and deaths with symptoms, who have not been diagnosed (p.14). It is important to keep in mind that the responses to the pandemic focusing the hospital care sector, as shown in the next chapter, are only one component leading to these outcome, and they are probably not the most important one.

4. Response to the pandemic

4.1 Governance

During a pandemic, the question of leadership or "governance" is crucial to respond in an effective way. According to Steve Thomas & colleagues, an effective and participatory leadership with strong vision and communication is core to a resilience-enhancing strategy in health care systems (European Observatory et al. 2020:16). However, it needs to be noted that tensions can exist between the aim to involve stakeholders at all levels of crisis reaction and a clear, quick chain of command. Differentiated approaches to adapting and applying existing contingency plans therefore are required (Böcken & Preusker, 2021).

A clear benefit of a centralized structure, for example, became evident in the procurement of personal protective equipment (PPE) and face masks. When the global shortage affected all the countries studied more or less equally, centralized purchasing helped making procurement rapid, efficient and well-coordinated (OECD 2020b). Israel, in this respect, had advantages due to its highly centralized structure, which was also followed in the procurement chain. It should be added that this country also had higher stock levels even before the outbreak of the pandemic due to the political-military situation. Procurement was particularly poorly coordinated in Spain; initiatives by the central government here came significantly too late and without coordination with the AC.

As contingency plans and protocols are supportive to an effective governance, it should be noted that all countries in the sample have general pandemic or crisis preparedness plans. However, with respect to speed and scope of the spread, the Sars-Cov2 virus was a new challenge and the preparedness plans were not completely fit to cope with it. Spain was the first country in our sample that came under pressure from the pandemic. Here, experience with Zika and Ebola outbreaks was available, but there was no reference to those plans in the national government response during the first wave of the pandemic. Israel had holistic preparedness plans for national disasters, and had been training the entire system for such events. It is the country that probably developed the most stringent central planning during the pandemic. Here, the communication channel was directly between the Israeli Ministry of Health and individual hospitals. The centralization of policy and resources by the Israeli Ministry of Health thus plays a key role in the response of the system; additional capacity was created quickly. Against this background, it is also interesting to note that Israel was the only country in our comparison to indicate a fairly precise number of Covid-19 cases above which hospitals would be overloaded. Over time, this figure was adjusted to reflect the increase in capacity.

Central plans to deal with the pandemic and manage capacity were also quickly developed in Denmark and Sweden, but not in Germany and Spain. In Germany, although the Federal Ministry of Health (BMG) was authorized by law to take measures to prevent and avert the crisis without the consent of the Länder, there was no central plan in the crisis situation. On the contrary, there was a constant need for coordination between the federal and state governments during the first wave of the pandemic. In Spain, the complete lack of central planning during the pandemic and the lack of coordination, both among regions and between regions and the national government, was one of the main causes of significant problems in the system during the first wave of the pandemic.

Both Sweden and Denmark developed strong central leadership and close coordination between regional and central levels of government during the first wave of the pandemic. The regions in Sweden, which are also the owners of the public hospitals, took early responsibility for expanding intensive care capacity. This was done in close coordination with the central government, which in turn secured funding for this expansion.

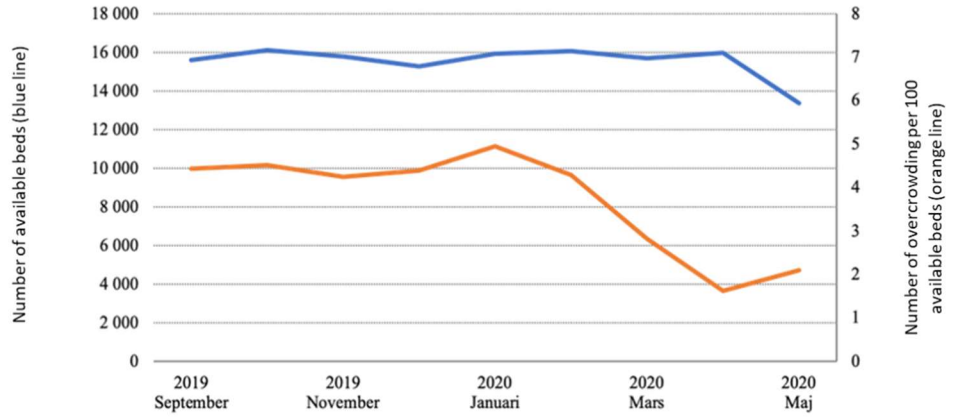
4.2 Hospital capacity expansion

To expand hospital capacity, hospitals in all countries, with the notable exception of Spain, received centralized instructions to postpone, as far as possible, all scheduled treatments and surgeries in order to keep capacities free for the care of Covid-19 patients. Of course, also in Spain non-elective treatments were postponed, however, as indicated above, there was a lack of central guidance instructing the hospitals.

In Spain, public hospitals adopted a scaling protocol for scheduling elective surgeries, while private and especially private specialized hospitals voluntarily canceled elective surgeries. In the Spanish ACs with higher population density, the increase in the number of beds was driven by regional differences in demand. The aim was thus to meet regionally varying needs. At the peak of the first wave, the hardest-hit ACs were forced to build field hospitals to accommodate patients. In Spain, regional governments have some legal control of private hospitals. At the outbreak of the first wave of the pandemic, there was likely a lack of political will to take up the private resources in some regions. So the role of Spanish private hospitals was minor even though it was a central government rule that allowed to use these capacities. In the end, this decision proved to be very problematic in view of the high proportion of private beds, including ICUs, and the high number of deceased.

In Sweden, from January 2020 onwards, there has been a large drop in overcrowding, reflecting that care has been reorganized and the beds have been made available to accommodate Covid-19 patients. Additional capacity was made available since patients did not seek care to the extent they did before the pandemic (SKL 2020).

Figure 4 Number of available hospital beds / number of overcrowding per 100 available hospital beds in Sweden between September 2019 and May 2020



Source: *SKL 2020*

In Israel, Sweden and Denmark hospital beds, as well as intensive care capacity, were flexibly opened or closed according to need. In Denmark, some regions created specialized departments / clinics for Covid-19 patients. These were quickly reintegrated into the regular structure when the Covid-19 caseload declined. This demonstrates a high degree of flexibility in increasing and decreasing capacity and a rapid reduction in the backlog of elective surgeries. Capacity in (the few existing) private facilities was mobilized but – as the first wave was quickly under control – did not have to be used.

In Germany, to increase the capacity of available hospital beds in the pandemic, the "Act to compensate for Covid-19-related financial burdens on hospitals and other health care facilities" (Covid-19-Krankenhausentlastungsgesetz) went into effect on March 27, 2020. It provided that hospitals that postpone or suspend scheduled interventions will receive a lump sum of 560 euros per day for each hospital bed that is vacant (starting July 1, 2020, the flat rate has been differentiated according to case-mix index and average length of stay) (Osterloh 2020).

However, not only the quantity but also the quality of hospital resources is relevant in the response to the pandemic. Here, for example, the existence of hospital networks, as already prevalent in Denmark and Sweden for system reasons, plays a role. Also the degree of digital integration and networks between hospitals is therefore highly relevant for the rapid adaptability of the healthcare system. Already before the pandemic, there were considerable differences in the

degree of digitalization of health care systems of the countries, as the Digital-Health-Index in Table 4 shows. Accordingly, in particular in Germany a catch-up process is indicated.[1]

Table 4: Digital-Health-Index

Denmark	72,47
Israel	72,45
Spain	71,36
Sweden	68,30
Germany	30,02

Source: *Bertelsmann Stiftung (n.y.). https://www.bertelsmann-stiftung.de/de/unsere-projekte/der-digitale-patient/projektthemen/smarthealthsystems#c1203567*

With respect to digitalization it is also useful to look at ambulatory care structures outside of hospitals, as surge capacity in health care systems may also be released by delivering ambulatory care services in new, innovative ways. The use of telemedicine for primary care consultations provides one example of such innovation (European Observatory et al. 2020:15). Within the first wave of the pandemic, countries have used remote consultations, remote management of COVID-19 patients and digital tools to manage essential supplies (Fahy 2020). In Germany, although the system was poorly prepared, already during the first wave of the pandemic more than ten times as many teleconsultations were performed in March 2020 compared to previous months (19,500 in March vs. 1,700 in January and February) (Pantelli 2020). However, also the reimbursement system was poorly prepared for such a technologic change. In order to ensure that online health care services are reimbursed adequately, the benefit basket of the sickness funds needed modification to allow for more extensive reimbursement of teleconsultations.

4.3 Increasing intensive care capacities

Increasing intensive care capacity and providing ventilators were a focus of crisis response in all countries including Germany, although levels were already high. In Germany, it was also stipulated that hospitals creating additional intensive care capacity will receive a one-time grant

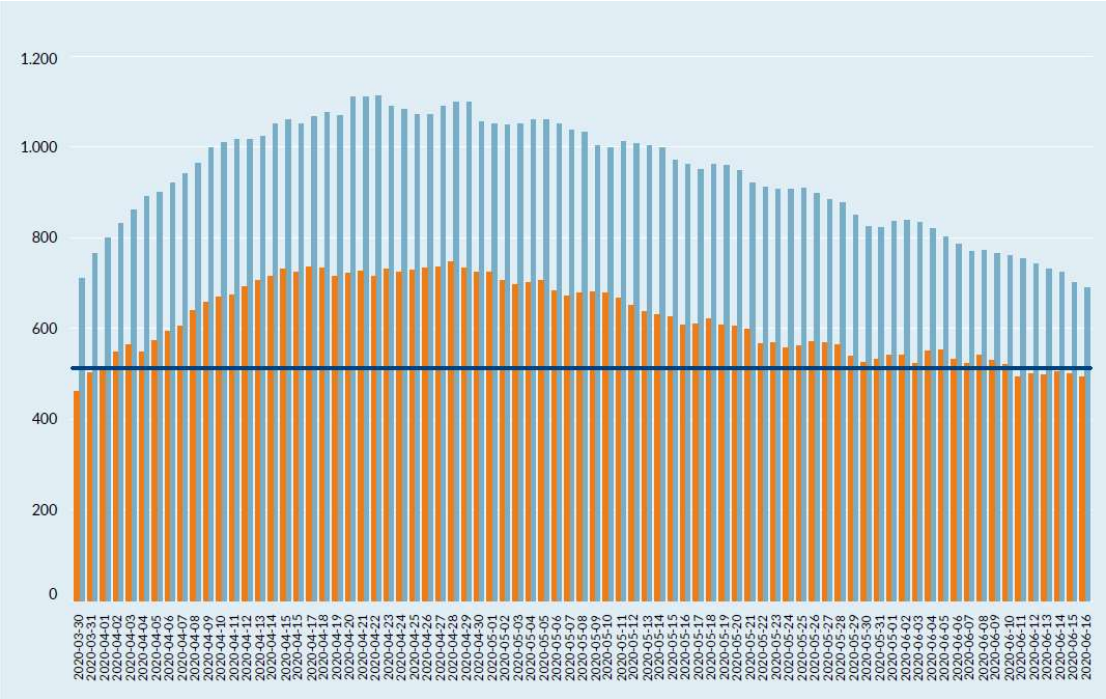
[1] An effort to boost digital infrastructure in hospitals has been initiated by the Hospital Future Act (Krankenhauszukunftsgesetz, KHZG) in October 2020. Of course, this came too late to be of use in the first wave of the pandemic.

of 50,000 euros, as it was intended already from the beginning of the pandemic, that intensive care capacities should be doubled. However, no criteria were set for the expansion of capacity, so that even small hospitals that did not maintain appropriate intensive care staff could receive funding.

Israel, Denmark and Sweden were quick to flexibly adjust ICU capacity to meet emerging needs. In the case of Israel, it can be assumed that this was more of an "ad hoc" adjustment, as the database was not established until July. However, this expansion effort was made possible because of direct communication between the government and hospital providers. What is more, Israel could draw on the considerable reserve capacities in intensive care.

Sweden, most remarkably, was not only able to quickly expand its overall intensive care capacity to meet demand. This country was also able to scale back capacity expansions remarkably quickly as Covid-19 cases declined, as Figure 5 shows.

Figure 5: Total capacity and occupancy in intensive care in Sweden (March to June 2020)

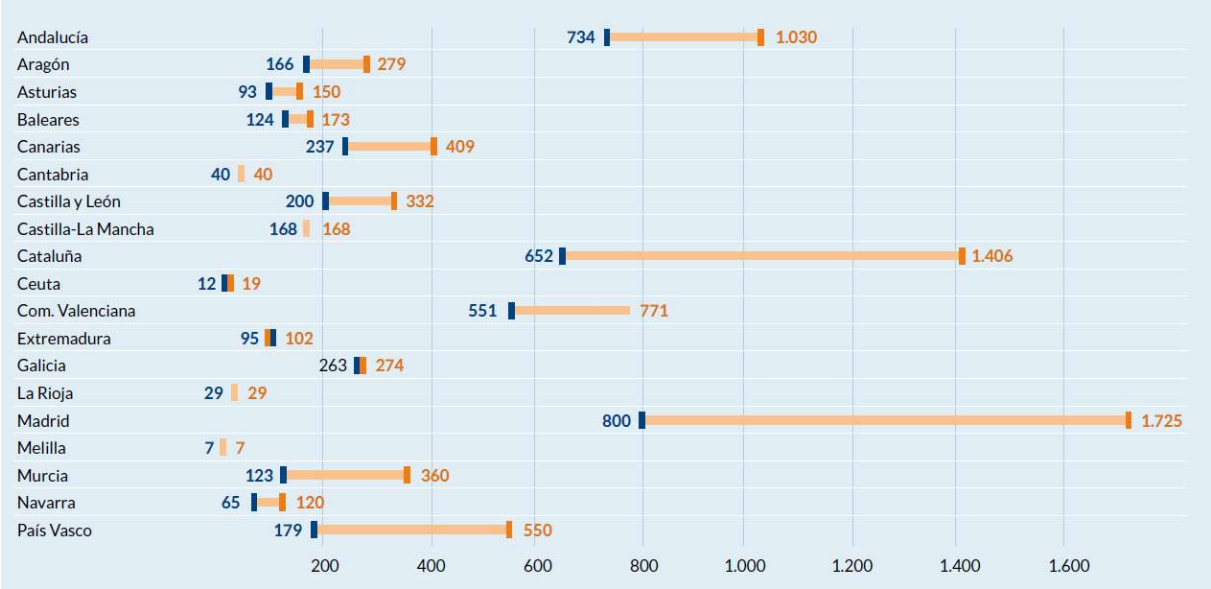


Source: *SKL 2020: 24; Svenska Intensivvårdsregistret (SIR 2021); own calculations*
red: Patients in intensive care; blue: total intensive care capacity; blue straight line: average intensive care capacity in 2019 = 512 beds

In the Spanish case, despite a generally overburdened health care system, a lack of centralized control and, by and large, a lack of interregional coordination, the increase in the number of

intensive care beds substantial. AC Madrid's capacity was extended dramatically via the construction of field hospitals. As of 2 April 2020, the Ministry of Health estimated that the number of ICU beds had doubled. Before the coronavirus crisis in Spain there were 348 ICUs with 4,404 beds. The public hospitals had 3,508 and the private ones 896. At present, the number of places, according to the – not-very rigorous – information provided by the communities and the Ministry of Health, would be 8,422. In less than a month, the system has doubled its ICU capacity (Sáiz-Pardo, 2020, own translation). What is more, the increase was concentrated in those regions that were heavily affected by Covid-19, as shown in Figure 6.

Figure 6: Changes in the number of intensive care beds 2017 - 2020, Spain



Source: *Ojeda 2020*

As a result, Spain saw a particularly demand-driven expansion of intensive care capacity. This was possible because AC governments monitored the situation and had been warned by the Spanish Society of Intensive, Critical and Coronary-Unit Medicine (SEMICYUC) of the impending crush of patients.

4.4 Health care personnel

Although this is emphasized only in the Swedish and Israeli case studies, it can be assumed that there was a serious shortage of health care workers in all of the countries studied. This was exacerbated in Spain as a high proportion of healthcare worker was infected with Covid-19 during the first wave. Here, 24.1% of all COVID-19 infected persons were health care workers; in Germany, this proportion was at 5.2%.

To counteract the staff shortage, healthcare providers in all countries canceled planned treatment appointments, especially surgeries. In addition, personnel were recruited from reserves, including, for example, medical students or retired health care workers. In Germany, the so-called "provisional nursing charge value", which hospitals can receive from the sickness funds as compensation for health personnel, was increased from 146 euros to 185 euros. To increase staffing of ICUs, trained nursing personnel was shifted from regular to intensive care. However, due to the speed with which the pandemic occurred, the qualification of these skilled nurses to provide critical care was poorly organized, so critical care nurses who were already overworked had to take over this qualification. As already mentioned, the existing regulation defining obligatory lower limits for staffing with trained nursing personnel in ICUs was suspended to allow hospitals to fall short of this limit.

In Sweden, the countermeasures took place very early, at the very beginning of the pandemic. In Spain, the above-mentioned flexibility (non-specialization) of nursing professionals, a massive national effort to recruit recently retired doctors and nurses to work in intensive care, and a change in regulation to allow medical school students (MRI) to graduate early may have helped to create surge capacity.

In addition, health professionals in ambulatory care, such as GPs, physicians and psychotherapists were compensated for income losses caused by the pandemic situation, i.e. due to decreased demand for health services (Waitzberg et al. 2020).

5. Discussion

5.1 Flexibility in the use of existing resources and response planning

The following Table 5 summarizes the situation of hospital care structures in Denmark, Germany, Israel, Spain, and Sweden before the pandemic.

Table 5: Summary existing resources

	Denmark	**Germany**	**Israel**	**Spain**	**Sweden**
Acute care beds per 1,000 pop. Occupancy rate	2.5 ~ 100%	6.0% 79.8%	2.2 93.3%	2.4 75.3%	2.0 ~ 100%
Nurse-to-bed ratio (Head counts)	3.0	0.8	1.1	1.2	n.a.
Specialisation (pulmonary units)	General: all hospitals Specialized: 10/25 hospitals	128/1,915 hospitals (6%)	Concentrated in few acute care hospitals	474/778 hospitals (60%)	38/85 hospitals (44%)
Intensive care beds per 100,000 pop.	7.8	33.9	10.3	9.7	5.2
Data availability ICU, pre-pandemic	Outdated	Outdated	Outdated	Outdated	Registry

Source: *own compilation*

Looking at the situation before the pandemic, access to hospital care resources varied greatly between countries. Germany, in particular, was at an advantage because it had many times the number of hospital beds for acute care, including ICUs. However, the high number of beds did not correspond with the number of available staff, as shown by the low nurse-to-bed ratio. What is more, 75% to 80% of beds were occupied before the pandemic, thus limiting the flexibility in the use of existing resources. In relation to the large hospital sector, only few departments are specialized in pulmonary medicine in Germany.

In Denmark, followed by Spain and Sweden, the majority of hospitals have specialized departments for pulmonary diseases, so these hospitals were well prepared to treat Covid-19 patients adequately. Of course, Spain was disadvantaged because it was the first country in our sample to be affected by the pandemic in the first wave.

In intensive care, a high level of preparedness was also observed in Israel, especially when considering the high number of ventilators in reserve, which were already in stock before the pandemic. However, just like all other countries with the notable exception of Sweden, precise and up-to-date data on the available resources in intensive care was not available at the outbreak of the pandemic. What is more, it took a considerable time span until this information was available in Israel.

5.2 Ability to create surge capacity

The ability to create surge capacity is crucially dependent on the governance of capacity management. According to this study, a strong central leadership and close coordination between regional and central levels of government is important. While the capacities in the Spanish health care system were expanded in those areas in which they were needed, the hospital care system was completely overwhelmed due to the speed and the vehemence of the first wave. In this situation, it was a clear deficit that the coordination between policy-making levels in the decentralized Spanish health system was poor. Another coordination problem in the Spanish health system prevented the successive inclusion of private hospital capacity. Denmark and Sweden, in contrast, responded very quickly; in both countries, strong central leadership and close coordination between regional and central levels of government were developed during the first wave of the pandemic.

In the state-led healthcare systems, the financing of additional hospital beds was regulated by the state - or in Israel, by the Ministry of Health. In the competitively structured German hospital system, however, it was up to the hospitals themselves to offer the capacity, even if the hospitals were not designated to do so due to a lack of specialization in pulmonary medicine. The flat rate that was offered to compensate for every vacant bed had unfavorable effects as this form of compensation disadvantaged large - and more specialized - hospitals.

At the beginning of the pandemic, all countries took action by postponing non-elective operations. With regard to the patient pathways, it can be seen that numerous learning steps were already taken in the course of the first wave of the pandemic. While hospitalization rates were initially high, especially in Israel where all Covid-19 patients were hospitalized at the beginning, over time only severe cases were admitted to hospitals. It is interesting to note that although the overall hospitalization rate in Germany is low despite the high acute care bed stock, a large number of people, including quite elderly people, have entered intensive care.

Although there were significantly fewer beds available in Denmark for the treatment of Covid-19 patients compared to Germany, these were in more highly specialized departments. These hospitals therefore were better able to provide care for the Covid-19 patients, whereas transfers between hospitals (from smaller to bigger and thus also from not or less specialized to more specialized hospitals) were necessary in Germany. Besides inefficiencies, this means that patients were also exposed to considerable burdens through transportation.

The division of responsibilities between the hospital care sector and ambulatory care is also crucial for the quality of the response to the pandemic. However, even more effective proved the strategy to keep mild cases entirely out of the delivery system, as it was done in Sweden and Denmark. Here mild cases were kept completely out of the inpatient and ambulatory care system by consistently relying on video-consultations and telemedicine. Another intersection in the health care system, however, that between health care and social care, was neglected in all countries, as shown by the high proportion of deaths in nursing homes.

5.3 Avoiding excess idle capacity

A particular example of the rapid adjustment of resources to demand and thus the avoidance of empty capacities is the management of intensive care capacities in Sweden. Here, intensive care capacities were built up promptly and then reduced again once the incidence flattened out. The central element here is farsightedness, anticipating not only the increase in demand but also the need to contract when incidences level off. A key factor here is the excellent data on ICU capacity, which in the form of the registry in Sweden has brought enormous benefits in managing ICU capacity.

6. Conclusion

To conclude, a first finding is that a high level of acute care and intensive care beds, as witnessed in German hospitals, is only of limited use in reaction to the pandemic. Although the high level of beds provides a "buffer" in the crisis response, it cannot be regarded as a guarantee for an adequate crisis response as the number of non-occupied beds is decisive. Rather, the decisive factor in the crisis situation is the availability of qualified personnel, especially in (intensive) care, and the ability to mobilize personnel reserves available in the system. Staffing of hospital beds, and in particular the availability of (highly) qualified nurses, is the crucial “bottleneck” in all countries.

Specialization and centralization in the inpatient sector are particularly advanced in the Scandinavian countries. This goes hand in hand with close integration of the outpatient sector. The healthcare systems of Sweden and Denmark, which are set up in this way, have clear structural advantages that have been conducive to targeted and rapid navigation of COVID-19 cases through the healthcare system from the outset.

Maintaining capacity is costly, especially in intensive care. A functional equivalent to high bed capacities is rapid adjustment of capacity as needed, as observed in Sweden, or a good preparedness plan, as perceived in Israel. Indispensable to this flexibility in the provision of services is the availability of data on existing and built-up capacity, especially in intensive care, and a robust digital infrastructure. Sweden was the only country in our sample to have information on the number and location of intensive care beds at the onset of the pandemic. This country thus had clear advantages for timely expansion and reduction of capacity.

Against this background it is a main deficiency in all countries, that data on nursing staff in intensive care are not available, not during the first wave, and not to date. From a research perspective, strong efforts to improve the data availability are indicated here.

A centralized governance structure is crucial for flexibility and adaptability in the use of existing resources and a timely expansion of capacities. In Sweden, Denmark, and Israel, this enabled both a rapid increase in intensive capacities and a flexible adjustment when incidences flattened out. Coordinated decisions about resources, referral guidelines and treatment guidelines lead to a better performance, in particular if there is a direct feedback-link between regulators and providers, as in Israel. However, it is not only important to adapt capacities quickly, regional distribution according to need must also be taken into account. In Spain, although the country certainly has been hit most severely by the crisis and was overwhelmed by the number of Covid-19 cases, the autonomy of regional and even local governments and providers helped expanding capacities in those areas where they were most urgently needed. If governance is decentralized, therefore, robust mechanisms for coordinating and aligning efforts across governance levels seem important.

Finally, the extent to which systems succeed in shifting light cases to the outpatient system and keeping physician-patient contacts low, as in Sweden, or even avoiding them altogether, as in the Danish example, is also of paramount importance. This is supported by video conferencing technology. In crisis situations, therefore, the degree of digitalization of the healthcare system is also crucial to strengthening the resilience of healthcare systems in general and hospital care in particular.

Limitations of this study can be seen in particular in the numerous contextual factors that could not be included, or only to a limited extent. Also, this analysis is limited to the first wave of the Covid-19 pandemic thus analyzing the “initial shock”, while the second and third waves had

different characteristics and responses. In addition, the general strategies of countries in the crisis response vary, particularly the severity and timing of the stringency of lockdowns. Multiple factors play a role in the crisis response, limiting the explanatory power of the factors considered in this comparison. Still, we find some indications that are worth further investigation. From the point of view of this study, there is a need for further research on concepts that compare countries, especially on specialization and centralization in the inpatient sector. There are hardly any internationally comparable data available in this area. Particular deficits in data availability we identified also with regard to medical and nursing staff in intensive care.

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