1.1. Hospitals with occupancy rate for COVID-19 patients in ICU licensed beds above 60% (% of general hospitals with ICU licensed beds) (R-6)

1.1.1. Documentation sheet

Description	**Primary indicator** Share of hospitals with occupancy rate for COVID-19 patients in ICU (intensive care unit) licensed beds above 60% **Secondary indicators** Occupancy rate for COVID-19 patients in licensed ICU beds Occupancy rate for COVID-19 patients in open licensed ICU beds Occupancy rate for COVID-19 patients in operational COVID-19 ICU beds
Calculation	**Secondary indicators** Occupancy rate for COVID-19 patients in licensed ICU beds: numerator = number of COVID-19 patients hospitalised in ICU; denominator = number of licensed ICU beds. Occupancy rate for COVID-19 patients in open licensed ICU beds: numerator = number of COVID-19 patients hospitalised in ICU; denominator = number of licensed ICU beds – number of closed ICU beds due to staff absenteeism or force majeure. Occupancy rate for COVID-19 patients in operational COVID-19 ICU beds: numerator = number of COVID-19 patients hospitalised in ICU; denominator = number of COVID-19 patients hospitalised in ICU + number of available ICU beds for COVID-19 patients (available ICU beds for COVID patients can be licensed ICU beds (except closed ones) or surge ICU beds). **Primary indicator** Share of hospitals with occupancy rate for COVID-19 patients in ICU licensed beds above 60%: numerator = number of hospitals where occupancy rate for COVID-19 patients in (open) licensed beds > 60%; denominator = number of general hospitals with ICU licensed beds.
Rationale	Intensive care resources faced enormous pressure during the pandemic, resulting in some places in intensive care demand exceeding available supply.[1] Increasing occupancy rates in intensive care units have been associated with increasing mortality.[2] In response, many countries increased their ICU capacity, creating "surge" capacity. From mid-March 2020, all Belgian hospitals were urged to create extra bed capacity ("surge capacity"), notably in ICU units. In particular, on 17 March 2020, hospitals were required to "do everything possible to create extra capacity in ICU".[3] On 1 April 2020, hospitals registered a maximum total of 1 182 extra ICU beds, on top of the 1 993 licensed ICU beds, increasing total capacity by almost 60%. Later on, more concrete instructions were given regarding required number of surge beds, depending on the stage of the pandemic. For instance from 17 June 2020, hospital were required to create 15% extra capacity in the so-called phase 2A and an additional 25% in phase 2B. Belgium has been praised for its ability to quickly increase its beds capacity.[4, 5] However, it was rapidly noted that the increase in ICU bed capacity was difficult to manage due to a lack of nurses with ICU expertise.[6-8] An analysis of in-hospital mortality of COVID-19 patients treated in ICU in Belgium during the first wave has shown evidence that the "ICU overflow" (when the number of ICU beds occupied by COVID-19 patients exceeds the number of licensed ICU beds reserved for COVID-19 patients) was an explanatory variable of in-hospital mortality of COVID-19 patients.[9] From 30 September 2020, hospitals have been encouraged to search for a

	better distribution of COVID-19 patients between hospitals, rather than using extra ICU bed capacity.[8] The Patient Evacuation Coordination Center (PECC) was also mandated to help hospitals in the distribution of COVID-19 patients.[10] However, hospitals faced many challenges in organising interhospital transport, both within and outside the province or region, and no data are available on the number of inter-hospital transports via the PECC.[8, 11] Occupancy rate in ICU beds in Belgium is used here as a secondary indicator to give an indication of Belgium's ability to absorb the surge of COVID-19 patients (i.e. the ability to manage inflow of patients, keep occupancy rates under control and to limit overflows). However, an analysis at the national level does not allow to identify whether some hospitals were overloaded while others still had free capacity. Therefore, the principal indicator measures occupancy rates at the hospital level in order to capture variation between hospitals and provide insights on whether patients were distributed in a way that reduced mortality risks associated with overflow. The principal indicator is defined as the share of hospitals with a high occupancy rate for COVID-19 patients in ICU licensed beds. Indeed, although national occupancy rate could stay high, a better distribution of patients across hospitals will lead to a reduction in the share of "overflowed" hospitals. As reliable data on non-COVID-19 patients in ICU are not yet available, we follow Taccone et al. (2021)[9] and divide the number of COVID-19 patients by the number of licensed ICU beds reserved for COVID-19 patients that was set in March 2020 at 60% of the total number of licensed ICU beds.
Data source	FPS Public Health (Incident Crisis Management System (ICMS))[12] and Sciensano (Hospital Surge Capacity Survey)[13]
Technical definitions	Number of COVID-19 patients hospitalised in ICU: COVID-19 patients in ICU include both confirmed COVID-19 patients in ICU and suspected COVID-19 patients in ICU. Data are available from 20 March 2020 to 31 December 2022. Number of ICU closed beds: since October 2021, as part of the daily data registered in the context of surge capacity plans, hospitals must register the number of (ICU and non ICU) hospital beds that are "closed due to staff absenteeism or force majeure and not available for the hospitalisation of (COVID-19 or non COVID-19) patients". Data are available from 22 November 2021 to 31 December 2022. Number of operational COVID-19 ICU beds: number of COVID-19 patients hospitalised in ICU + number of available ICU beds for COVID-19 patients. Data are available from 20 March 2020 to 31 December 2022.
International comparability	No international comparison is available for the principal indicator. Based on a study by Berger et al. (2022)[4, 5], results on occupancy rates of COVID-19 patients in ICU during the first wave of the pandemic across Europe are presented.
Limitations	It is not possible to distinguish in the data the patients who are admitted in a surge ICU bed from those admitted in a licensed ICU beds. Similarly no information is available on the possible triage for admission in a licensed bed or a surge bed. Finally, no distinction can be made between different types of surge ICU beds, such as those created in general units, in operating rooms, or in former ICUs. A plausible assumption is that, at the hospital level, licensed beds were used in priority, so that surge beds were used only when all available licensed bed were occupied. However, no data are available on the number of non-COVID-19 patients admitted in an ICU bed, so that one cannot estimate when all licensed beds are occupied. We therefore defined an overflow as an occupancy rate for COVID-19 patients in licensed beds above 60%, because in the first Belgian Surge Capacity plans, 60% of licensed beds where reserved for COVID-19 patients. However, this cut-off is somewhat arbitrary. In order to keep occupancy rate under control, a strategy may have been not to admit COVID-19 patients in hospitals (or in ICU) although an admission was appropriate. The data do not allow to assess if COVID-19 patients that should have been admitted were refused. Five Belgian hospitals that may have admitted COVID-19 patients are not included in the analyses because they do not have licensed ICU beds. Since 28 June 2021, ICMS data are no longer registered on weekends and public holidays. The last available data were imputed to replace the missing data. Therefore, the occupancy rates are systematically the same on Friday, Saturday and Sunday. From 14 May 2022 to 14 September 2022, due to a cyber-attack, data are missing for all hospitals of one province. Consequently, the licensed beds of these hospitals were not taken into account in the overall calculations for the region and Belgium on these dates.

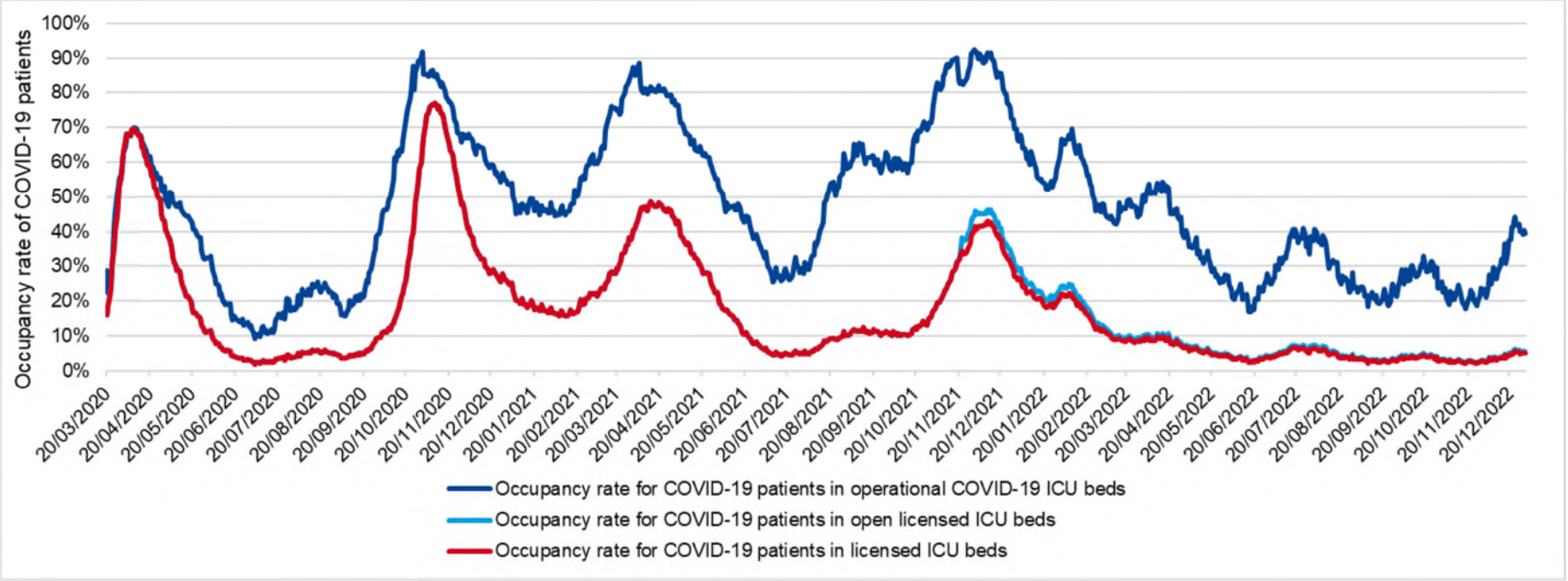
Dimension	Resilience
Related indicators	R-2 Number of hospital bed closures due to staff absenteeism or force majeure; R-4 Number of essential surgical hospital acts
Reviewers	Stijn De Kesel (FPS Public Health)

1.1.2. Results

Occupancy rates – Belgium

Figure 1 shows the evolution of the occupancy rate for COVID-19 patients in ICU beds in Belgium, according to different definitions of an ICU bed. The red line shows the occupancy rate for COVID-19 patients in licensed ICU beds. It can be seen that the occupancy rate in Belgium was very high during the two first waves of COVID-19. During the first wave, up to 69.7% of licensed ICU beds in Belgium were occupied by COVID-19 patients (on 8 April 2020). During the second wave, this rate reached 76.7% on 8 November 2020, meaning that only 23.3% of licensed ICU beds were available for non-COVID-19 patients. In the following COVID-19 waves, the occupancy rate of COVID-19 patients in licensed ICU beds increased again, but did not reach its previous maximum: it reached 46.8% on 7 April 2021 and 42.8% on 11 December 2021.

Figure 1 – Occupancy rate of COVID-19 patients in ICU beds, Belgium



From end November 2021 onwards, hospitals were asked to also register the number of ICU beds that were closed due to staff absences or force majeure and therefore not available for the treatment of patients. The light blue line on Figure 1 shows the evolution of the occupancy rate for

COVID-19 patients in open licensed ICU beds in Belgium, that is in licensed ICU beds that are not closed as previously defined. Correcting for these closed beds does not largely affect the conclusions regarding the evolution of the occupancy rate for COVID-19 in licensed ICU beds.

In the daily data they register, hospitals must also register the number of ICU beds that are available for the treatment of COVID-19 patients. The number of operational COVID-19 ICU beds is calculated as the sum of occupied beds (i.e. the number of COVID-19 patients) and available beds. Contrarily to licensed ICU beds, the number of operational beds can change more frequently, depending on the number of licensed beds that are reserved for COVID-19 patients, the creation of surge ICU beds on top of the licensed ones, the intensity of non-COVID-19 hospital activity, etc. Contrarily to licensed ICU beds, these beds are dedicated to the treatment of COVID-19 patients only, therefore the occupancy rate in these beds does not provide any information on the availability of beds for non-COVID-19 patients. The dark blue line in Figure 1 shows that the occupancy rate for COVID-19 patients in operational COVID-19 ICU beds tended to follow the evolution of the COVID-19 waves. During the first wave it reached 70.0% on 8 April 2020. During the following waves, it reached 91.7% on 1 November 2020, 88.5% on 5 April 2021 and 92.4% on 1 December 2021.

The fact that the occupancy rate for COVID-19 patients in operational COVID-19 ICU beds approached 100% without reaching it shows the ability of the Belgian hospitals system to appropriately adapt its COVID-19 ICU capacity to the pandemic waves.

Occupancy rate – International comparison

In a country-level analysis comparing hospital capacity and utilisation during the first COVID-19 wave across Europe, Berger et al. (2022)[4, 5] showed that the occupancy rate for COVID-19 patients in ICU beds existing before the pandemic was above 100% in the Netherlands, Sweden, and the Lombardy region and close to 100% in Belgium and Italy. The shortage lasted approximately five weeks in Lombardy and Sweden and two weeks in the Netherlands. However, in all the countries studied, except in the Lombardy region, the surge capacity was sufficient to meet the increased demand.

Occupancy rates – Regional comparison

Figure 2 shows the evolution of the occupancy rate for COVID-19 patients in licensed ICU beds in the three regions of the country, compared to the national level (similar to the red line of Figure 1). Also at the regional level, the occupancy rate for COVID-19 patients in licensed ICU beds followed the COVID-19 waves and was higher during the first two waves than during the following waves.

Nevertheless, some regional differences appear. In particular, the occupancy rate for COVID-19 patients in licensed ICU beds was repeatedly higher in Brussels than in the other regions. During the first wave, it reached 86.9% in Brussels, compared to 67.6% in Wallonia and 68.8% in Flanders. Also, between waves, the occupancy rate for COVID-19 patients in licensed ICU beds remained higher than in the other regions.

Although the occupancy rates for COVID-19 patients in licensed ICU beds were quite similar in Wallonia and Flanders, during the second wave, this rate reached a maximum of 94.2% in Wallonia, compared to a maximum of 67.6% in Flanders and 79.2% in Brussels.

Figure 3 shows the evolution of the occupancy rate of COVID-19 patients in operational COVID-19 ICU beds in the three regions of the country, compared to the national level (similar to the dark blue line of Figure 1). The evolution over time is similar in Flanders and Wallonia although Wallonia often faced higher occupancy rates than Flanders. In Brussels, the evolution of occupancy rate for COVID-19 patients in operational COVID-19 ICU beds was different. In particular, the occupancy rate did not decrease as much as in the other regions during the first two waves. This occupancy rate was not inferior to 30% before July 2021 (this level was reached in other regions already in May 2020). Also, on several occasions in Brussels, the occupancy rate for COVID-19 patients in operational COVID-19 ICU beds reached 100%. This did not occur in the other regions.

Occupancy rates – Provincial comparison

Figure 4 and Figure 5 show the same occupancy rates as Figure 1 for each province. Due to the small number of ICU beds in some provinces (in particular Brabant Wallon and Luxembourg), the results must be interpreted

with more caution. Overall, the evolution of occupancy rates of COVID-19 patients in ICU beds was similar in all the provinces. Nevertheless, some differences can be observed. In particular, in contrast to the trend at the national level, the occupancy rate of COVID-19 patients in operational COVID-19 ICU beds (dark blue line) reached 100% in several provinces. Also, while the correction for closed ICU beds (light blue line) did not play a large role at the national level, a larger impact was observed in some provinces (in particular in Vlaams Brabant and Luxembourg). This is also true for the region of Brussels (result not shown).

Figure 2 – Occupancy rate of COVID-19 patients in licensed ICU beds, Belgium and regions

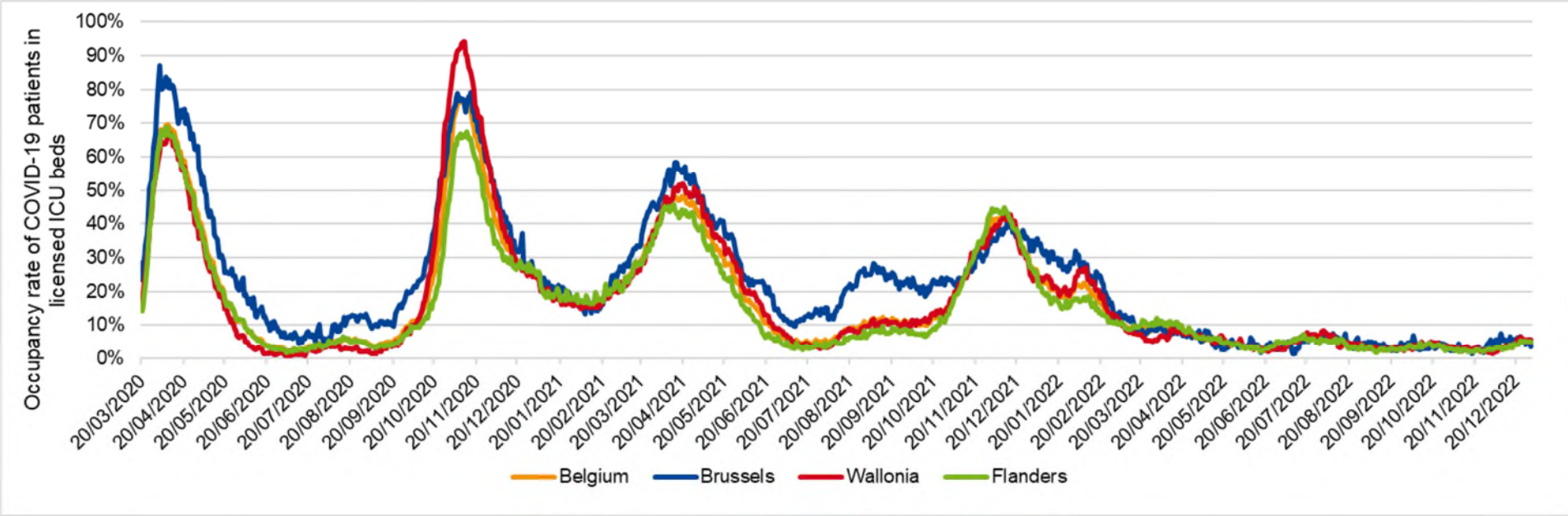


Figure 3 – Occupancy rate of COVID-19 patients in operational COVID-19 ICU beds, Belgium and regions

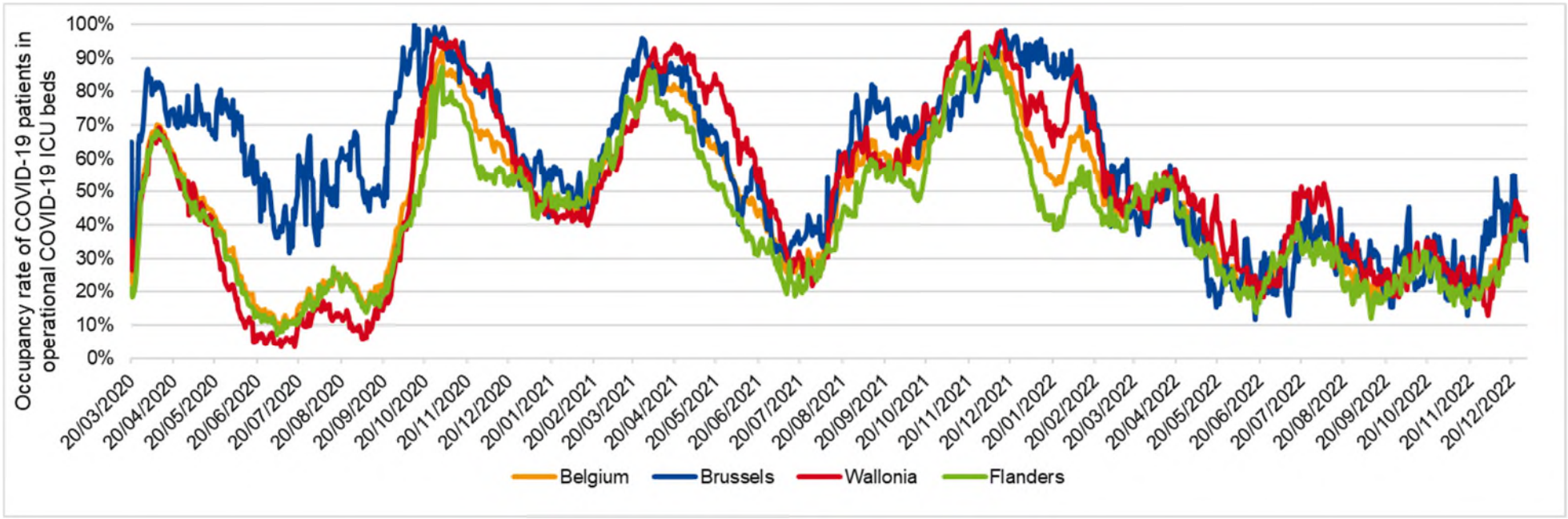


Figure 4 – Occupancy rate of COVID-19 patients in ICU beds, Flemish provinces

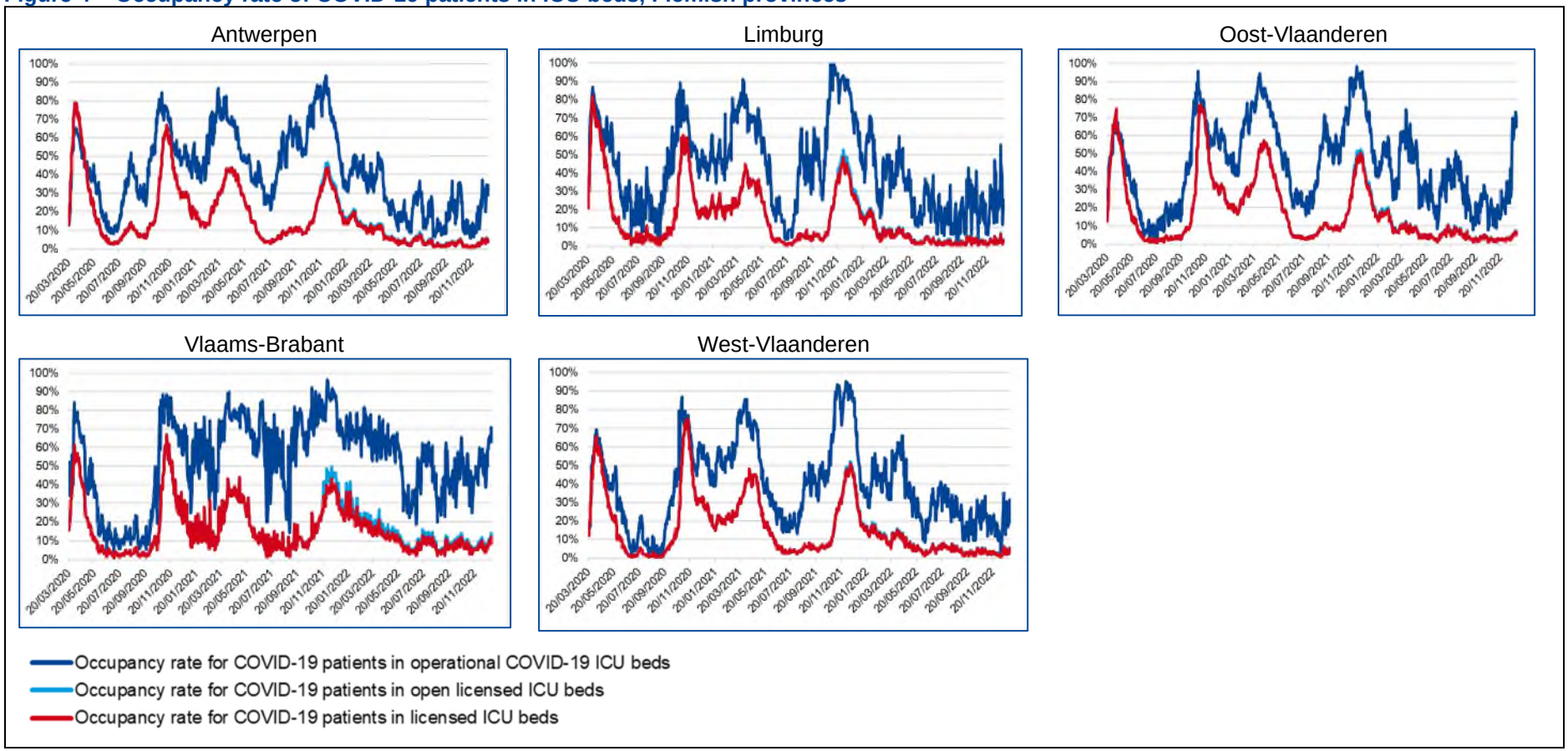
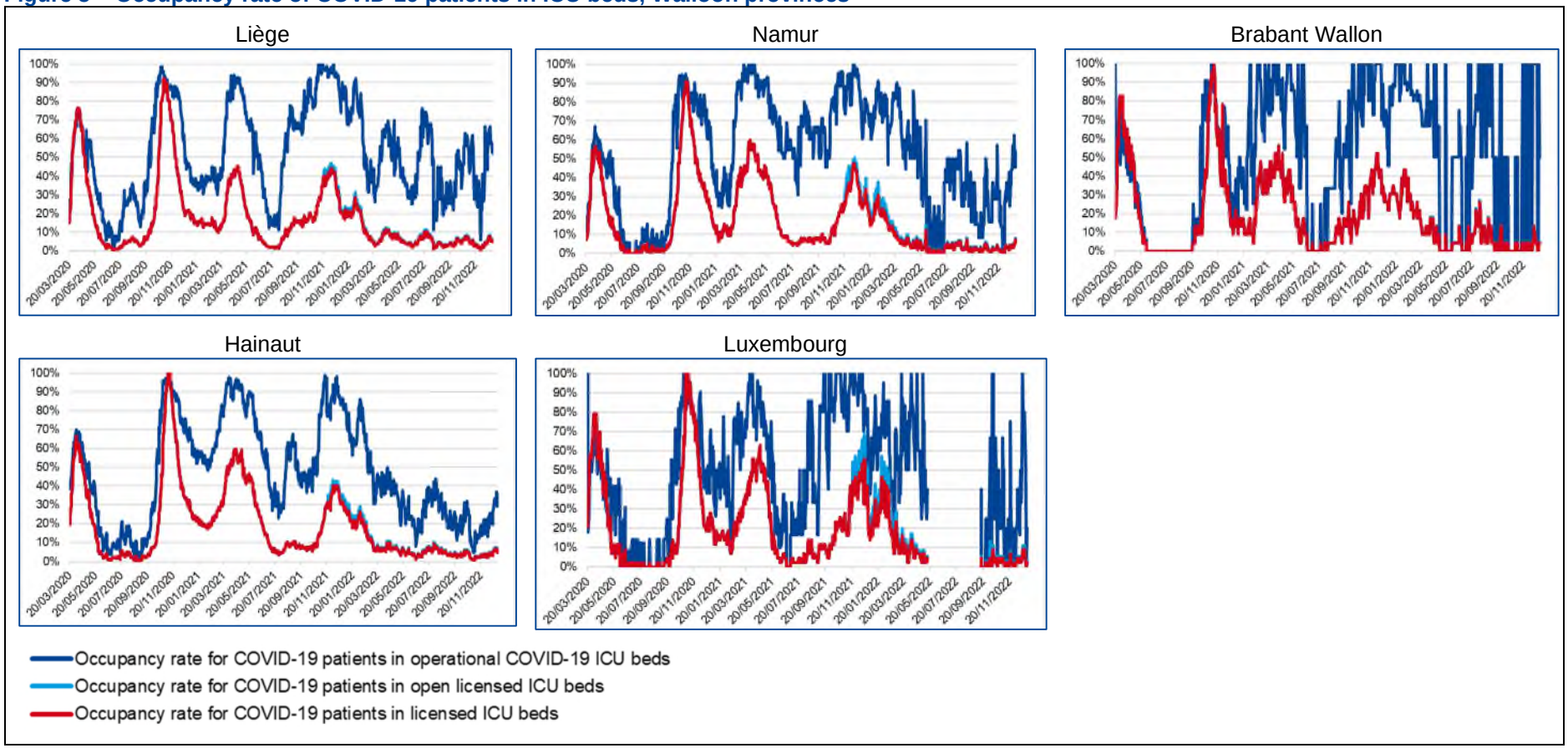


Figure 5 – Occupancy rate of COVID-19 patients in ICU beds, Walloon provinces



Hospitals overflow – Belgium

The previous analysis does not show how patients were distributed between hospitals. Also it does not indicate whether COVID-19 patients were treated in existing ICU beds or in surge ICU beds. Nevertheless, there are indications that it was more appropriate to treat COVID-19 patients in existing ICU beds (with existing ICU staff expertise) rather than in surge beds. Therefore a situation where some hospitals are overloaded and rely on their surge capacity, while other still have regular ICU beds available, should be avoided. An analysis of in-hospital mortality of COVID-19 patients treated in ICU in Belgium during the first wave has shown that the "ICU overflow" (when the number of ICU beds occupied by COVID-19 patients exceeds the number of licensed ICU beds reserved for COVID-19 patients) was an explanatory variable of in-hospital mortality of COVID-19 patients.[9]

During the first wave, a maximum of 70.4% of hospitals in Belgium faced an overflow in the ICU (i.e. an occupation rate above 60% of the licensed ICU beds). This share reached 80.6% during the second wave. However, after that, hospitals have searched for a better distribution of COVID-19 patients between hospitals, instead of using extra ICU bed capacity.

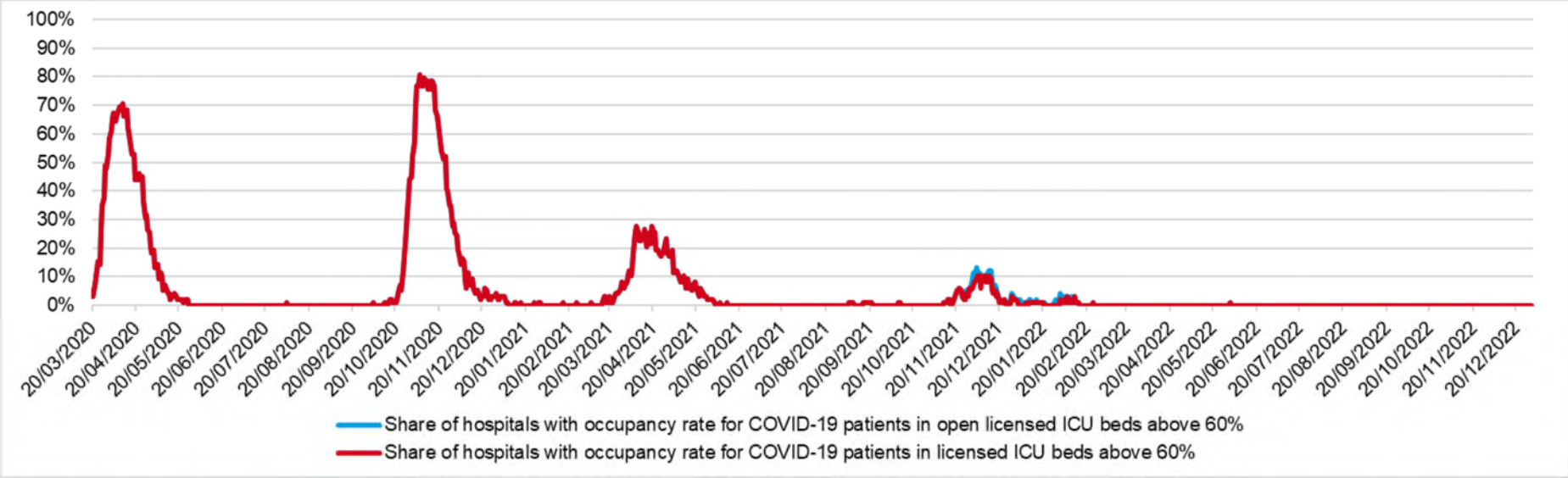
In April 2021, while the occupancy rate for COVID-19 patients in licensed ICU beds was still close to 50% at the national level (see Figure 1), only 30% of the hospitals presented an ICU overflow. And in December 2021, when the occupancy rate for COVID-19 patients in licensed ICU beds was again above 40% at the national level, only 10% of the hospitals presented an ICU overflow.

Figure 6 shows the share of Belgian hospitals experiencing such an ICU overflow. The ICU overflow as defined by Taccone et al. (2021)[9] (an occupancy rate for COVID-19 patients in licensed ICU beds above 60%) is shown in red. In addition, the light blue line shows the impact of correcting for beds that are closed due to staff absenteeism or force majeure, once this information was available (from end November 2021 onwards).

During the first wave, a maximum of 70.4% of hospitals in Belgium faced an overflow in the ICU (i.e. an occupation rate above 60% of the licensed ICU beds). This share reached 80.6% during the second wave. However, after that, hospitals have searched for a better distribution of COVID-19 patients between hospitals, instead of using extra ICU bed capacity.

In April 2021, while the occupancy rate for COVID-19 patients in licensed ICU beds was still close to 50% at the national level (see Figure 1), only 30% of the hospitals presented an ICU overflow. And in December 2021, when the occupancy rate for COVID-19 patients in licensed ICU beds was again above 40% at the national level, only 10% of the hospitals presented an ICU overflow.

Figure 6 – Share of hospitals with occupancy rate for COVID-19 patients in ICU licensed beds above 60%, Belgium



Hospitals overflow – Regional comparison

Figure 7 shows the same information (share of hospitals with occupancy rate for COVID-19 patients in ICU licensed beds above 60%) at the regional level. During the first wave, a larger share of hospitals were overloaded in Brussels than in the other regions. During the second wave, this share is the highest in Wallonia (with at some point all hospitals in the region having more than 60% of their licensed ICU beds occupied by COVID-19 patients). These regional differences are in line with regional differences observed in the occupancy rates (Figure 2).

In April 2021 however, the occupancy rate for COVID-19 patients in licensed ICU beds was still close to 50% in the three regions of the country, but only 21.6% of the hospitals in Flanders faced ICU overflow, compared to 41.7% in Wallonia and 54.5% in Brussels. Later on, these regional differences disappeared.

Hospitals overflow – Provincial comparison

Figure 8 and Figure 9 show the same analysis at the provincial level, with results consistent with the regional analysis.

Figure 7 – Share of hospitals with occupancy rate for COVID-19 patients in ICU licensed beds above 60%, Belgium and regions

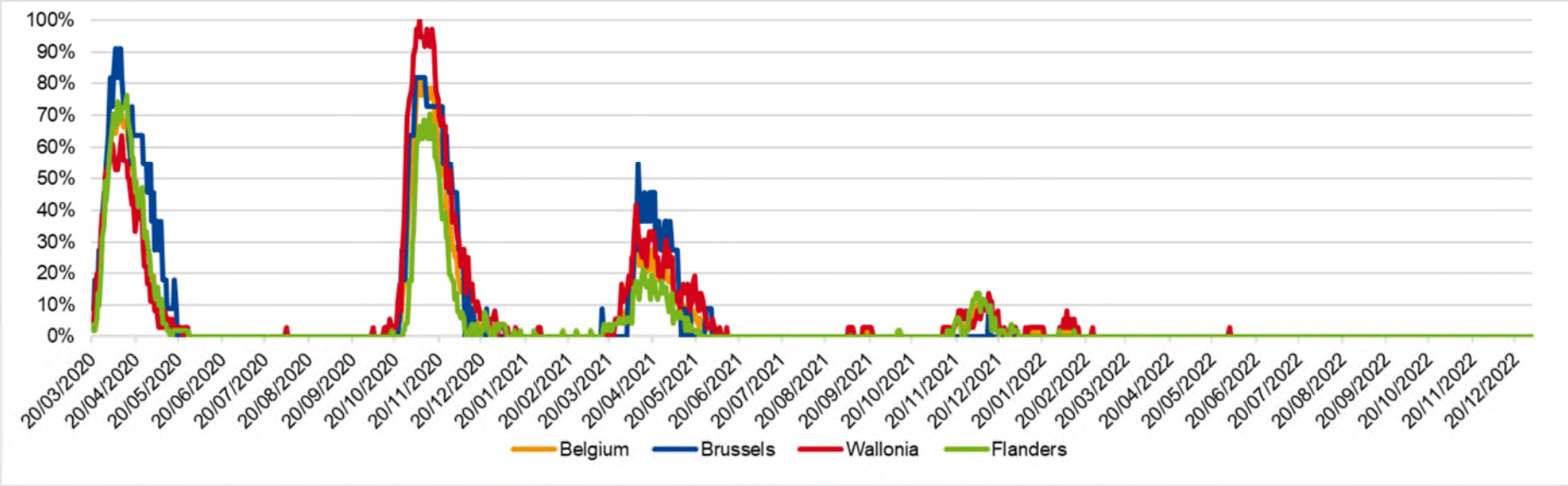


Figure 8 – Share of hospitals with occupancy rate for COVID-19 patients in ICU licensed beds above 60%, Flemish provinces

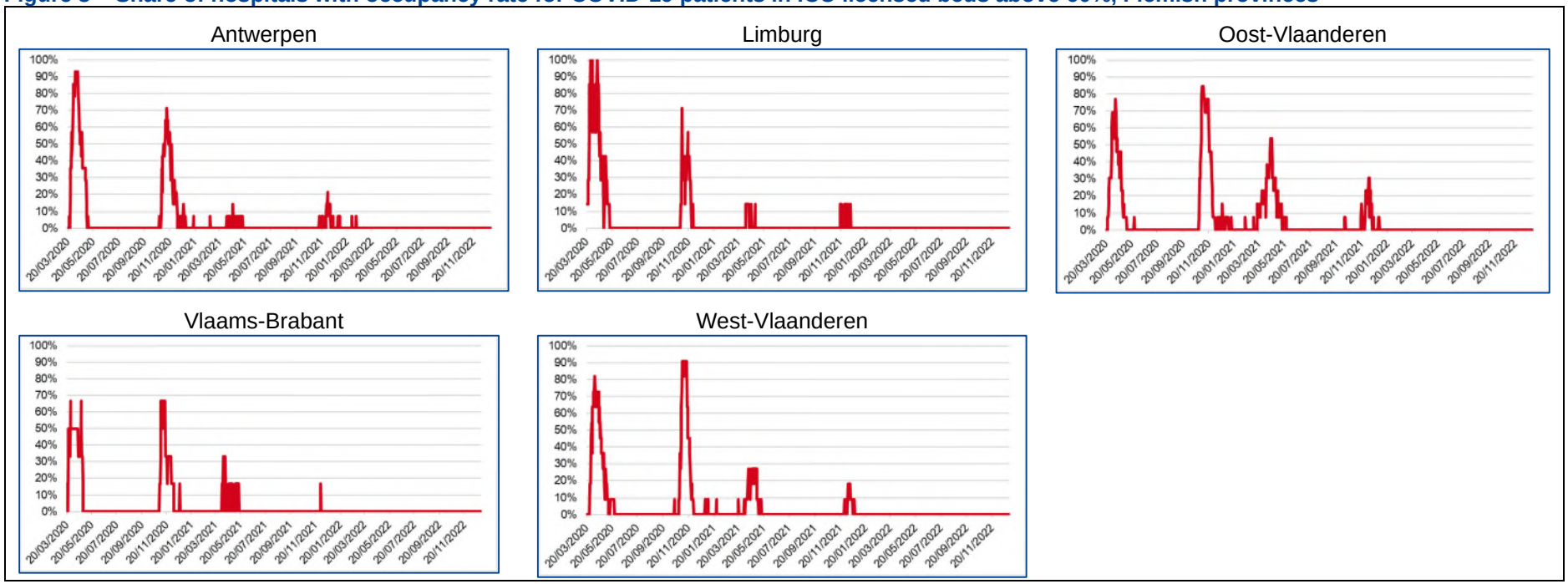
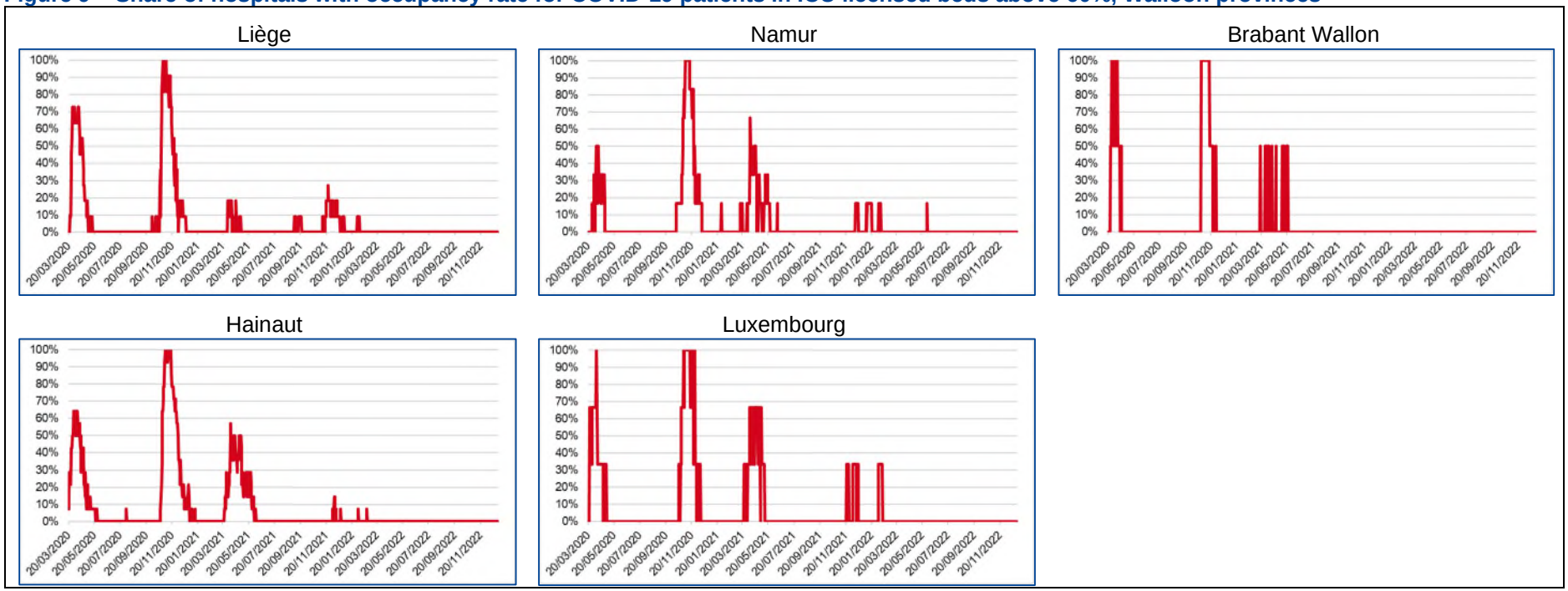


Figure 9 – Share of hospitals with occupancy rate for COVID-19 patients in ICU licensed beds above 60%, Walloon provinces



Key points

- **During the first wave, up to 69.7% of licensed ICU beds in Belgium were occupied by COVID-19 patients. During the second wave, this rate reached 76.7%. In the following waves it increased again, but did not reach its previous maximum: it reached 46.8% in April 2021 and 42.8% in December 2021.**
- **The occupancy rate for COVID-19 patients in operational COVID-19 ICU beds reached 70.0% during the first wave and 91.7% during the second. Then it reached 88.5% in April 2021 and 92.4% in December 2021.**
- **The fact that the occupancy rate for COVID-19 patients in operational COVID-19 ICU beds approached 100% without reaching it shows the Belgium's ability to appropriately adapt its COVID-19 ICU capacity to the pandemic waves.**
- **The occupancy rate for COVID-19 patients in licensed ICU beds was repeatedly higher in Brussels than in the other regions. During the first wave, it reached 86.9% in Brussels, compared to**

67.6% in Wallonia and 68.8% in Flanders. Also, between waves, the occupancy rate for COVID-19 patients in licensed ICU beds remained higher in Brussels than in the other regions.

- **During the second wave, the occupancy rates for COVID-19 patients in licensed ICU beds reached a maximum of 94.2% in Wallonia, compared to a maximum of 79.2% in Brussels and 67.6% in Flanders.**
- **The occupancy rate for COVID-19 patients in operational COVID-19 ICU did not decrease as much between waves in Brussels than in the other regions. Also, at several occasion in Brussels, the occupancy rate for COVID-19 patients in operational COVID-19 ICU beds reached 100%. This did not occur in the other regions.**
- **During the first wave, a maximum of 70.4% of hospitals in Belgium faced an overflow in the ICU (i.e. an occupation rate above 60% of the licensed ICU beds). This share reached 80.6% during the second wave. In April 2021, while the occupancy rate for COVID-19 patients in licensed ICU beds was still close to 50%, only 30% of the hospitals presented an ICU overflow. In December 2021, when the occupancy rate for COVID-19 patients in licensed ICU beds was again above 40% at the national level, only 10% of the hospitals presented an ICU overflow.**
- **During the first wave, a larger share of hospitals were overloaded in Brussels than in the other regions. During the second wave, this share was the highest in Wallonia. In April 2021, while the occupancy rate for COVID-19 patients in licensed ICU beds was still close to 50% in the three regions of the country, only 21.6% of the hospitals in Flanders faced ICU overflow, compared to 41.7% in Wallonia and 54.5% in Flanders. Later on, these regional differences disappeared.**

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