

# Coordination of Hospitals in the Corona Pandemic

**Tobias Neidel** (✉ [Tobias.Neidel@uk-augsburg.de](mailto:Tobias.Neidel@uk-augsburg.de))

Augsburg University Hospital <https://orcid.org/0000-0003-1544-845X>

**Jakob Heins**

Augsburg University Hospital

**Katharina Herrmann**

Augsburg University Hospital

**André Martignoni**

Augsburg University Hospital

**Thomas Zinsmeister**

Augsburg University Hospital

**Roland Dettmar**

Augsburg University Hospital

**Markus Pukelsheim**

Augsburg University Hospital

**Jens O. Brunner**

University of Augsburg

**Axel R. Heller**

Augsburg University Hospital


---

## Research article

**Keywords:** Hospital Coordination, COVID-19, SARS-CoV-2, Pandemic, Disaster Management

**Posted Date:** October 19th, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-498417/v2>

**License:**  This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

---

# Abstract

## Background

The second wave of Corona-Pandemic posed the German Healthcare system to a major challenge. Due to the fast and wide spreading of SARS-CoV-2 in November 2020, the number of COVID-19-patients needing intensive care treatment was rapidly growing. Transferring patients between hospitals was necessary to prevent an overflow of treatment capacities within the ambulance district of Augsburg.

This project aimed to create a coordination structure that ensures an efficient guiding of all hospitals within the ambulance district Augsburg.

## Material and methods

An executive order of the Bavarian ministries of health and internal affairs<sup>1</sup> lead to the appointment of a Medical Director of Hospital Coordination (MDHC) within each ambulance district. Each hospital had to nominate a pandemic officer (PO). Based on the executive order and the "disaster management manual 100"<sup>2</sup> we established a hospital coordination structure for the ambulance district Augsburg.

## Results

Between October 18<sup>th</sup> 2020, and February 14<sup>th</sup> 2021, the staff of the MDHC coordinated 407 transfers of patients. 223 patients were treated on a general ward, 184 on intensive care units. The transfers prevented several impending triage situations. Using the coordination structure, the urgent reduction of a COVID-19 intensive care unit of a level 1 hospital from 7 to 2 beds was managed within 4 hours after alarm.

## Conclusions

Based on the "disaster management manual 100"<sup>2</sup> we were able to establish a hospital coordination structure that can withstand high pressure and ensured that impending triage situations were prevented. Urgent shortages of treatment capacities were balanced through the transfer of patients. The major problem was the lack of intensive care personnel.

# Background

In early December 2019, a local cluster of pneumonia was first reported in China in connection with a fish market in Wuhan<sup>3</sup>. Within the next few months, the initially localized outbreak of the previously unknown pathogen later termed SARS-CoV-2 developed into a global pandemic that poses an extreme challenge to healthcare systems worldwide.

Like other European countries, the pandemic has affected Germany in three waves so far. The first wave was relatively mild. The 14-day case notification rate per 100'000 population never exceeded 85 and the capacities of the intensive care units were not at risk at any time. After a phase of relaxation in the summer of 2020, the number of cases rose again at the beginning of October, reaching the highest 14-day case rates in January 2021 with 393 cases per 100'000 inhabitants<sup>4</sup>. The Free State of Bavaria was one of the most affected within Germany. The city of Augsburg was one of the first within Bavaria to get hit by the second wave. The 14-day case rate summited on the 6<sup>th</sup> of November with 764 cases/100'000 inhabitants<sup>5</sup>. This development was reflected from mid-October onwards in a continuously rising number of COVID-19 intensive care patients.

The emergency medical care in Bavaria is organized within 26 ambulance districts. Each ambulance district includes several counties. Within each ambulance district, the ambulance services and hospitals are organized to ensure the 24/7 medical care of the respective county residents.

On the 2<sup>nd</sup> of November 2020, the Free State of Bavaria published a general order, establishing a higher-level coordination of the hospitals within each ambulance district. The main task of the "Medical Directors of Hospital Coordination" (MDHCs) was to ensure the care of both COVID-19 and non-COVID-19 patients. For this purpose, the medical directors were given comprehensive authority to issue instructions to the subordinate hospitals in the respective ambulance district<sup>1</sup>.

# The situation in the ambulance district Augsburg

The ambulance district Augsburg consists of the five counties Augsburg, Aichach-Friedberg, Dillingen, Donau-Ries, and the city of Augsburg and covers a population of approximately 915,000 residents (Figure 1).

There is a total of 16 hospitals in this ambulance district, which were placed under the management of the MDHC. The Augsburg University Hospital is the only tertiary care provider for the entire administrative district of Swabia.

The 14-day case rate in the city of Augsburg exceeded the value of 100 new cases/100'000 inhabitants for the first time on October 14<sup>th</sup>, 2020. At this point, the maximum from spring 2020 (71,8 cases/100'000 inhabitants) had already been exceeded<sup>5</sup>. Shortly thereafter, the increase in COVID-19 patients began. At first, an increased burden on the normal ward became noticeable. From October 27<sup>th</sup> on, the need for COVID-19 intensive care beds at the university hospital increased rapidly. On the following day, transfers of COVID-19 intensive care patients to surrounding hospitals had to be started to prevent overloading of the existing capacities. The maximum 14-day case rate was reached in Augsburg on November 6<sup>th</sup> with 764 cases/100'000 inhabitants. At this point, the city of Augsburg was the most affected one in Germany. Subsequently, the 14-day case rate remained above 400 cases/100'000 inhabitants until December 26<sup>th</sup>,

2020<sup>5</sup>. This led to sustained pressure on COVID-19 intensive care units. On December 13<sup>th</sup> and 25<sup>th</sup>, the maximum number of concurrent COVID-19 ICU patients in the ambulance district Augsburg was reached with 59 patients, representing approximately 45% of all intensive care beds.

At Augsburg University Hospital, a maximum of 43 intensive care beds could be provided for COVID-19 patients at the same time. Numerous transfers to surrounding hospitals prevented these capacities from becoming overloaded. At the beginning of February 2021, the situation in the COVID-19 intensive care units at ambulance district Augsburg eased considerably for the first time.

## Methods

### Management and personnel structure

The basic structures and principles for coordinating the hospitals were closely based on the German "disaster management manual 100" (DM100)<sup>2</sup>. The staff work is correspondingly divided into six subject areas (S1-S6): Personnel / Internal Service (S 1); - Situation (S 2); - Operations (S 3); Supply (S 4) Press and Media Relations (S 5); - Information and Communications (S 6). Also, care was taken to use already existing everyday structures. Using the usual division of the counties into command areas for major incidents, the counties of Donau-Ries and Dillingen were combined to form the coordination group north. The counties of Augsburg, Aichach-Friedberg, and the city of Augsburg were combined to form the coordination group south (Figure 1). A pandemic officer (PO) was nominated by each hospital or hospital-association as a member of the respective coordination group. From the group of POs, one coordination group leader north and south was appointed respectively. These were directly subordinate to the MDHC. Also, a coordinator for intensive care transfers was appointed for each coordination group (Figure 2).

A district coordinator at the level of the administrative district of Swabia was appointed for the superordinate coordination of the three ambulance districts.

Close coordination of the MDHC, the ambulance dispatch center Augsburg and the medical director of ambulance service took place. The staff of MDHC was provided by anesthetists with disaster medical background from the University Hospital Augsburg, the Augsburg Fire Department, and last-year medical students from the University Hospital Augsburg.

### Situation monitoring

The daily situation monitoring was mainly carried out via IVENA<sup>6</sup>. This web-based software is used in some regions of Germany in the regular ambulance service for the distribution of pre-hospital emergency patients. Herein all hospitals in Bavaria report at least once a day their current occupancy with COVID-19 patients, non-COVID-19 patients, as well as the available capacities separated into regular ward, IMC, and ICU. In urgent emergencies, the situation was queried by telephone. For the long-term assessment of the situation development, reports from the State Office for Health and the Government of Swabia were used. Also, the 14-day case rates of the assigned counties were continuously monitored and included in long-term planning. A bed utilization forecasting tool was developed by our group during the first COVID wave<sup>7</sup> and was incorporated into the situation assessment and action planning.

### Operational tactics

The operational structure described above served as the basic framework for the operational tactics. The communication and command paths were directed along with this structure. Each hospital in the ambulance district had to treat COVID-19 patients if necessary. As far as the situation permitted, a COVID-19 focal hospital was designated within each hospital association. These were primarily responsible for treating COVID-19 patients. This enabled the CEOs of the hospital associations to concentrate resources and expertise in one of their hospitals. If the capacities of individual hospitals were fully occupied, transfer options were first sought within the coordination group. If there were no options, the search would continue within the second coordination group, then the neighboring ambulance districts Donau-Iller and Allgaeu, and then outside the administrative district of Swabia (Figure 3). If no intensive care bed within Bavaria could have been provided, the transfer would have been coordinated between clusters of several federal states<sup>8</sup>. However, this situation never occurred.

Also, approximately four COVID-19 ICU beds were always kept available at the University Hospital Augsburg for acute shortages of capacities. During the phase of maximum load from the beginning of December, all hospitals were required to maintain emergency respirator capacities. In the event of an acute shortage of intensive care beds, these were intended to provide a fallback level for a few hours, so that the staff MDHC was able to organize transfers.

Two transfer ambulances were kept ready by the dispatch center for the increased volume of transfers.

Weekly conference calls were held with the coordination groups for general situation briefings. Video conferences were held twice a week with the district coordinator and the MDHCs of the neighboring ambulance districts Allgaeu and Donau-Iller.

### Communication strategy

Each subordinate hospital provided a 24-hour contact number to the staff of MDHC. The staff itself also set up a telephone number that could be reached 24/7. However, the primary communication channel was a designated e-mail address of the staff. Also, a fax connection was provided. The e-mail address, as well as the fax, was controlled Mon-Fri from 07:15 to 16:00 o'clock. Time-critical matters were communicated via the central phone number of the staff.

## Determination of additional beds required

To determine the impact of transfers on bed occupancy, the number of additional beds required in the absence of transfers to external hospitals was examined retrospectively. Here, the transferred patients were given an additional length of stay (LOS) drawn from a stochastic distribution function and thus further listed in the system. After drawing a length of stay from this distribution function 10,000 times for each non-displaced patient, a confidence interval of additional bed occupancy per day could be obtained.

### Results

In the period from October 28<sup>th</sup> 2020, to February 14<sup>th</sup> 2021, a total of 407 transfers of COVID-19 patients were organized via the staff of MDHC. Of these, 223 were for normal ward patients and 184 intensive care patients. With 342 transfers (122 ICU, 220 ward), the vast majority could be realized within the ambulance district Augsburg. 65 transfers (62 ICU, 3 ward) were made to a hospital outside Augsburg's ambulance district. Of these, 26 intensive care patients and 3 normal care patients were transferred to a neighboring administrative district.

The need for transfers to balance capacity varied significantly over time from 6 transfers in calendar week 06/2021 to 47 transfers (both ward and ICU total) in calendar week 50/2020. The weeks with the highest need for transfers (week 47, week 50-51) each corresponded to a 2-week lag to peaks in 14-day case rates in the city of Augsburg<sup>5</sup>.

## Influence of transfers on the assurance of intensive care using the example of the University Hospital Augsburg.

The impact on the occupancy of additional COVID-19 patients in the ICU without transfers to other hospitals from November 2020 to January 2021 can be seen in Figure 4. The left vertical axis shows the number of additional COVID-19 beds needed in the ICU (without transfers between hospitals). The secondary vertical axis maps the number of transfers to other hospitals. The 90% confidence interval of the retrospective analysis is shown in gray. Additional occupancy peaks can be seen from mid to late November 2020 as well as mid-December 2020. During this period, there was also a high level of transfer to external hospitals (green diagram line).

Within the ambulance district Augsburg, the COVID-19 intensive care capacities of the level one and two hospitals were permanently utilized. At the university hospital, four to six intensive care beds were kept available as an emergency reserve for time-critical transfers. This made it possible to achieve rapid relief when the capacities of the surrounding hospitals were overloaded, and triage situations were impending within the next few hours. This happened several times in the period from November 2020 to January 2021.

Just before Christmas, an ICU of a level one hospital had to abruptly reduce bed capacity from seven to two beds due to a massive corona outbreak among nursing staff. Through the efficient use of the established command structure, the close cooperation with the ambulance dispatch center Augsburg and the provision of transfer physicians by the affected hospital, this operation could be handled within 4 hours.

A further increase in COVID-19 intensive care capacity was achieved in Augsburg through the cooperation of four hospitals. Two hospitals provided respirators, one hospital provided the necessary personnel and the fourth hospital provided the premises. This made it possible to provide an additional six COVID-19 intensive care beds in the ambulance district.

### Discussion

During the second wave of the Corona pandemic in Germany (Oct 2020-Feb 2021), the ambulance district succeeded in establishing a resilient management, communication, and coordination system that withstood even considerable pressure situations. The capacities of the clinics were used effectively and acute shortages were quickly compensated. Adequate care for both COVID-19 and non-COVID-19 patients was always ensured.

For efficient handling of this situation, a continuous accurate situation report was of utmost importance. In addition to the regular telephone and video conferences, the IVENA<sup>6</sup> database was the most important tool for monitoring the situation, as the hospitals reported their occupied and available bed capacities on this platform daily. The problem here was that some hospitals had initially reported very high capacities, which, however, were not operable in terms of personnel. This problem had to be solved very soon, as it was not possible to coordinate the capacities in this way. After only beds that could be operated were reported, effective coordination of the hospitals could be ensured.

The biggest problem in the second wave, however, was the pronounced and widespread staff shortage, especially among nursing staff. The hospitals within the ambulance district Augsburg could have provided significantly more COVID-19 intensive care beds if staffing levels had been better. This would presumably have made some patient transports, which represent a clear risk for seriously ill COVID-19 patients, unnecessary.

During the first wave in spring 2020, auxiliary hospitals were frequently addressed by the government of Bavaria. Auxiliary hospitals were formerly used hospital buildings, that had not been used for years but could have been reactivated within a few weeks. These buildings were not part of the operational plan in the second wave. In our view, auxiliary hospitals have only a very limited operational value. In particular, the significant and widespread lack of staff would make the operation of such facilities much more difficult and almost impossible. Staffing them purely by volunteers from aid organizations also does not

appear to be expedient. On the one hand, many of these workers are already involved in the health sector on a full-time basis. On the other hand, only COVID-19 patients with mild symptoms could have been treated in these facilities due to the medical qualification of the potential volunteer workers. However, there has never been a comparable shortage in the COVID-19 normal wards as in the COVID-19 intensive care units.

An essential success factor of the second wave was efficient and appreciative communication between all involved parties in the ambulance district Augsburg. Close contact between the pandemic officers of the hospitals and the staff of the MDHC is just as essential as close coordination with the responsible shift leaders of the ambulance dispatch center and the medical director of the ambulance service. A close and appreciative exchange with the MDHCs of the neighboring ambulance districts and the coordinator of the administrative district of Swabia is also indispensable for the overall management of capacities. In addition, the close cooperation with the mayors, provincial councils and the district president was decisive in providing the political decision-makers at the level of the Free State with a situation report and pointing out possible solutions. Also, proactive communication of the measures with the press can prevent uncontrolled reporting and the spreading of rumors.

## Conclusion

The second wave of the Corona pandemic posed a major challenge to the hospitals in the ambulance district Augsburg. An overload of intensive care capacities could only be avoided by several hundreds of transfers between hospitals. The DM100<sup>2</sup>, which is used as a guideline for command structures for major incidents in Germany, provides a good basic structure to coordinate hospitals effectively. Efficient, proactive, and close communication is one of the most important factors for success.

## Abbreviations

CEO	Chief Executive Officer
COVID-19	Corona Virus Disease 19
DM100	Disaster Management Manual 100
ICU	Intensive Care Unit
IMC	Intermediate Care
IVENA	Interdisziplinärer Versorgungsnachweis
LOS	Length of Stay
MDHC	Medical Director of Hospital Coordination
PO	Pandemic Officer

## Declarations

### Ethics approval and consent to participate

Data acquisition and analysis was approved by the institutional review board (BKF 2020-13) of the University hospital Augsburg.

Consent for publication

Not applicable

### Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

### Competing interests

The authors declare that they have no competing interests

### Funding

No funding was received.

### Authors' contributions

TN is the main author of the manuscript and chief of staff of MDHC. JH proofread the manuscript and provided the statistical calculations. AM, KH, TZ, RD, and MP worked in the staff of MDHC. AH is the Medical Director of Hospital Coordination and proofread the manuscript.

## Acknowledgments

We want to thank all pandemic officers for the outstanding cooperation during the pandemic.

## Authors' information

TN was the chief of staff of MDHC during the three waves of the pandemic and responsible for setting up the command-and-control structure in the ambulance district Augsburg.

JH was a data-scientist at the chair of Health Care Operations/Health Information Management, University of Augsburg. He provided the headquarters of MDHC with important calculations about the current situation and future developments.

## References

1. Bayerisches Staatsministerium für Gesundheit und Pflege. BayMBl. 2020 Nr. 618 - Verkündungsplattform Bayern. <https://www.verkuendung-bayern.de/baymbl/2020-618/> (accessed 2 Apr2021).
2. Ständige Konferenz für Katastrophenvorsorge und Katastrophenschutz. Führung und Leitung im Einsatz Dienstvorschrift DV 100. 1999[https://www.bbk.bund.de/SharedDocs/Downloads/BBK/DE/FIS/DownloadsRechtundVorschriften/Volltext\\_Fw\\_Dv/SKK\\_Dv\\_100.pdf;jsessionid=48D7241\\_\\_blob=publicationFile](https://www.bbk.bund.de/SharedDocs/Downloads/BBK/DE/FIS/DownloadsRechtundVorschriften/Volltext_Fw_Dv/SKK_Dv_100.pdf;jsessionid=48D7241__blob=publicationFile) (accessed 25 Jul2020).
3. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y *et al.* Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet* 2020; **395**: 497–506.
4. European Center for Disease Control. Week 16, 2021. <https://covid19-country-overviews.ecdc.europa.eu/> (accessed 1 May2021).
5. Stadt Augsburg. Fallzahlen - Stadt Augsburg. <https://www.augsburg.de/umwelt-soziales/gesundheit/coronavirus/fallzahlen> (accessed 2 Apr2021).
6. Steul K, Jung H-G, Heudorf U. Heat-related morbidity: real-time surveillance via rescue service operations data from the interdisciplinary care capacity proof system (IVENA). *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz* 2019; **62**: 589–598.
7. Römmele C, Neidel T, Heins J, Heider S, Otten V, Ebigbo A *et al.* Bed capacity management in times of the COVID-19 pandemic: A simulation-based prognosis of normal and intensive care beds using the descriptive data of the University Hospital Augsburg. *Anaesthesist* 2020; : 1–8.
8. Gräsner J-T, Hannappel L, Zill M, Alpers B, Weber-Carstens S, Karagiannidis C. COVID-19-Intensivpatienten: Innerdeutsche Verlegungen. *Dtsch Arztebl* 2020; **117**: A 2321-3.

## Figures

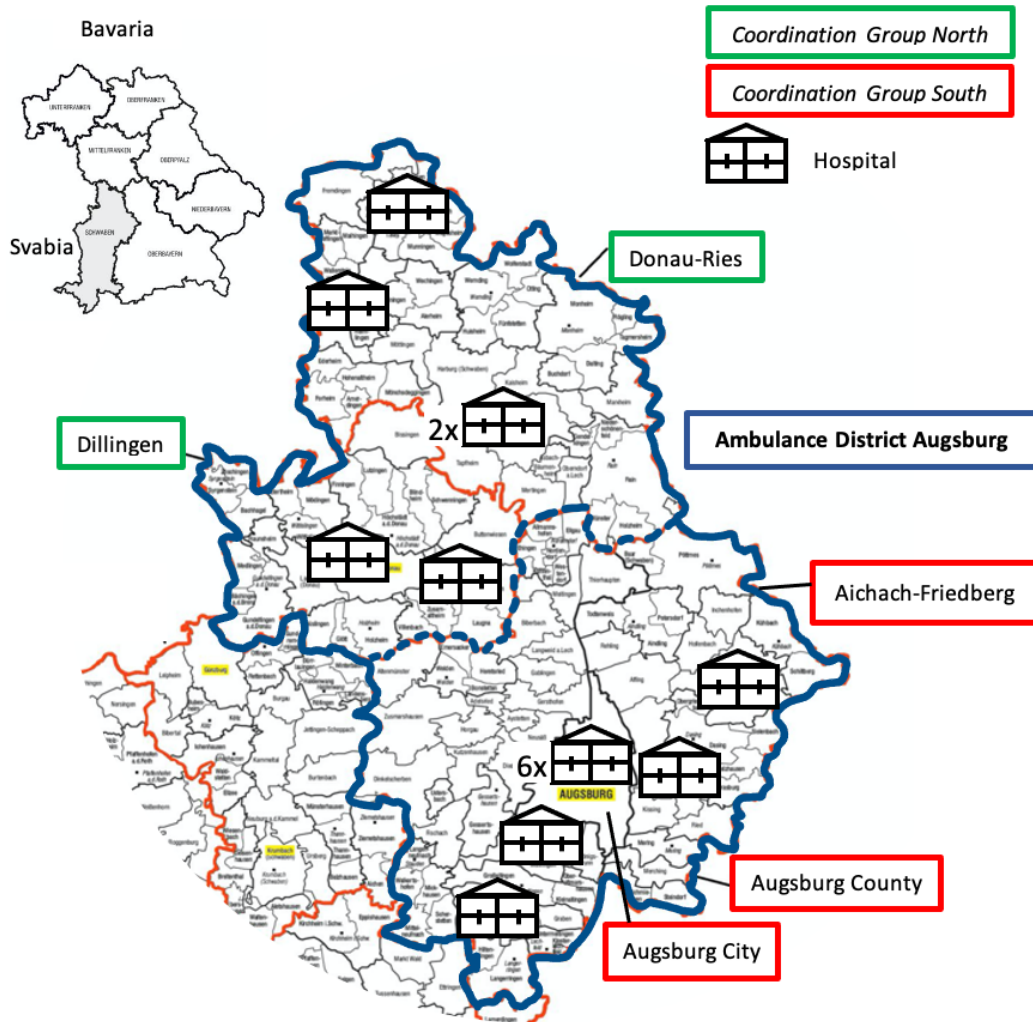


Figure 1

Map of the Ambulance District Augsburg in northern Swabia. The location of the hospitals under command of the MDHC is shown. The city of Augsburg and the counties are marked accordingly to their belonging coordination groups.

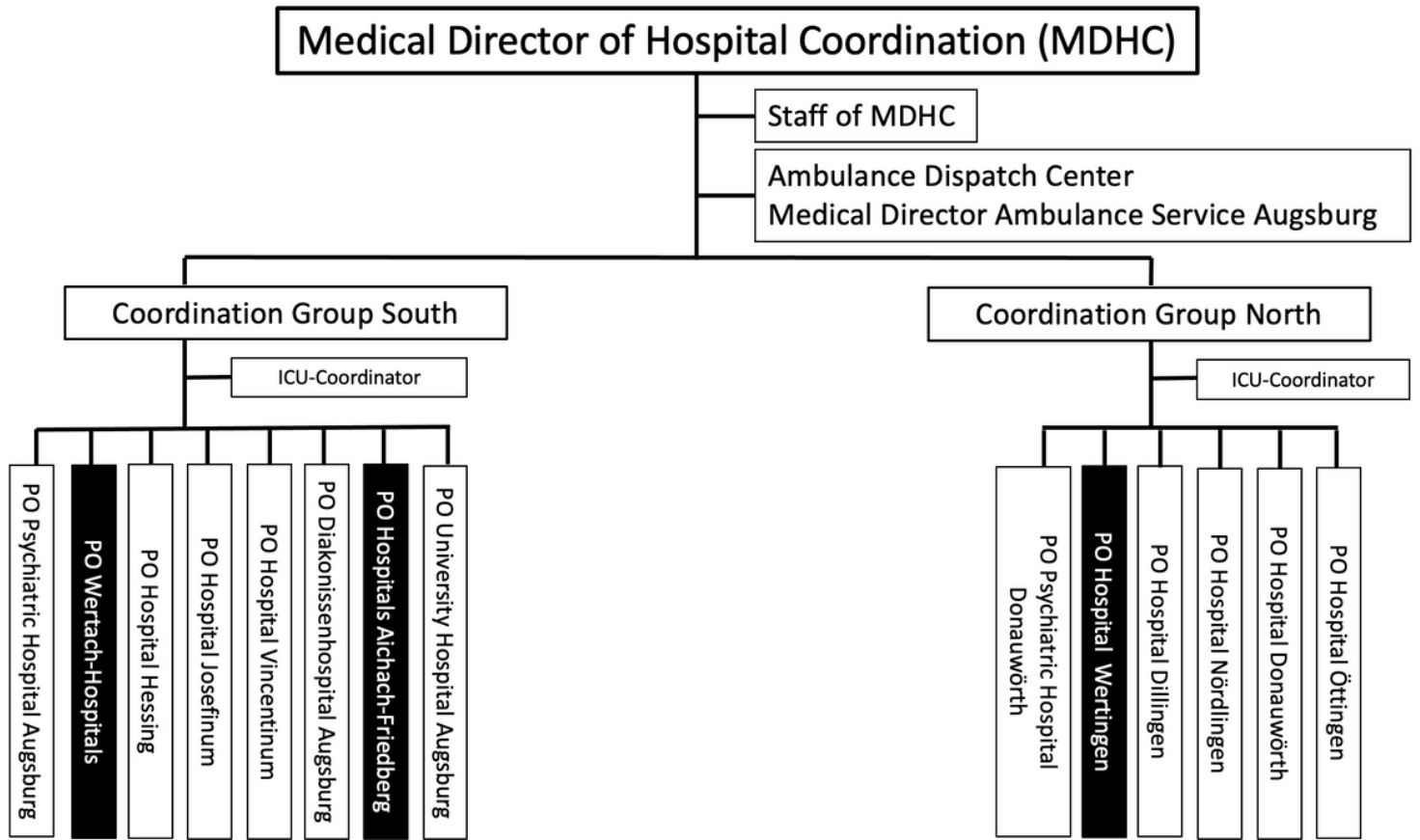


Figure 2  
 Command-and-control chart of MDHC Augsburg. The hospitals/hospital-associations with a black background were commissioned to designate a COVID-19 focal hospital.

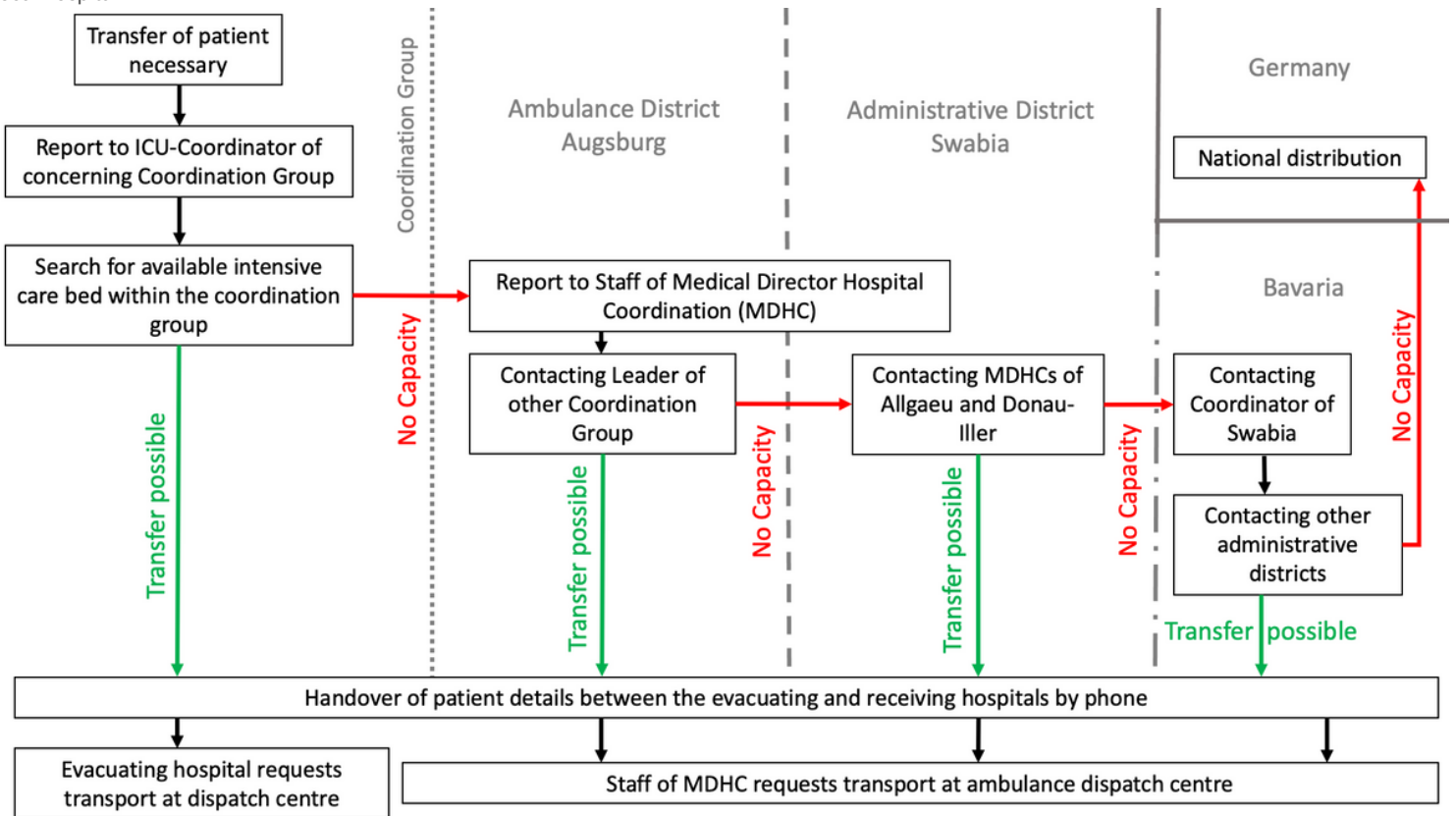




Figure 3

Communication scheme for arranging necessary transfers of intensive care patients due to capacity constraints.

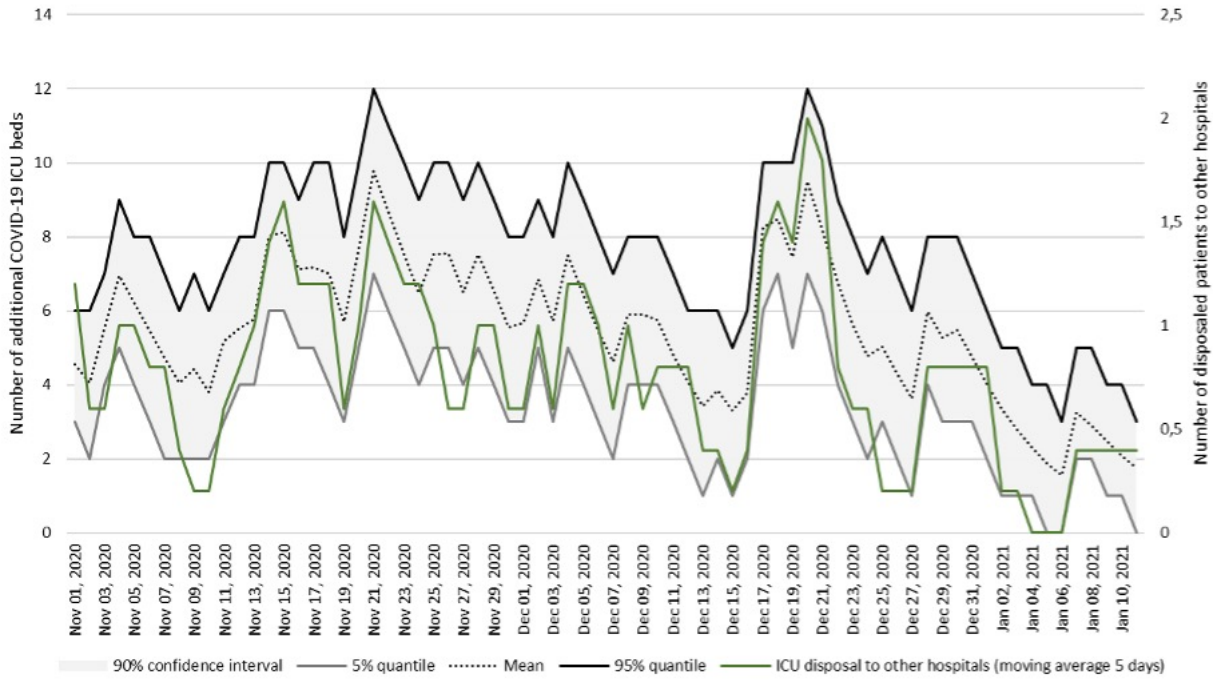


Figure 4

Impact of ICU-transfers on the required ICU-capacities for COVID-19 patients. Additional number of ICU-beds required for COVID-19 patients compared to the number of transfers to external hospitals (secondary axis) in the period from November 2020 to January 2021 at Augsburg University Hospital.