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LETTER

Inter-regional transfers for pandemic surges were associated with reduced mortality rates

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Dear Editor,

The spread of the coronavirus disease 2019 (COVID-19) pandemic has shown important spatial heterogeneity of in-hospital COVID-19 cases and deaths between countries and regions. Across metropolitan France, the healthcare system has been overwhelmed by the pandemic surge unequally over the regions, leading to the inability to provide care in areas with outpaced resources [1, 2]. In response, mass inter-regional transfers of critically ill patients have been organized. Distribution of evacuation and mutual-aid agreements were coordinated by Regional Health Authorities, and not as a typical day-to-day transfer system. Critical care transports were performed by specialized ground and aeromedical teams (including intensivists and emergency physicians). However, the evacuation of multiple critically ill patients raised important issues [3]. Overall, we do not know whether the mortality rates of transferred patients are closer to the ones observed in the sending regions, or conversely, in the host regions. The objective was to assess whether patients transferred from outpaced regions had better outcomes compared to patients with similar severity taken in charge in the regions with surges in patient volume.

We performed a cross-sectional study using data from the French hospital discharge database (HDD), exhaustive for all public and private hospitals. We included patients from the three metropolitan French regions that organized mass inter-regional transfers. Patients were included according to the following criteria: adults (≥ 18 years old), with invasive mechanical ventilation, admitted in intensive care unit (ICU) between 2020-03-01 and 2020-05-31, with ICD-10 diagnosis code of COVID-19. To identify whether inter-regional transfers were associated with the ICU case fatality, a multivariate logistic regression model was carried out, including variables with $p < 0.2$ in bivariate analysis. A descending stepwise process was used to select the final model. The Supplement details the methods.

Among the 6160 patients included, ICU-to-ICU inter-regional transfers were realized for 400 patients (6.5%) (Supplementary Fig. 1). Patients were less likely to be transferred if they had a higher Charlson comorbidity index or initial specific care supports such as prone position, renal replacement therapy, ECMO (Table 1 upper section). Age, sex, and SAPS II were not associated with the decision of transfer. Case fatality was 39.5% (2278/5760) for patients not transferred and 14.3% (57/400) for patients transferred. Among the factors significantly associated with case fatality, ICU-to-ICU inter-regional transfers were predictors of survival (adjusted OR: 0.26 [0.2–0.3], $p < 0.0001$) after adjustment on comorbidities and severity (Table 1 lower section).

This study has limitations: (i) the study is from the "first wave", therapeutic approaches have evolved since; (ii) healthcare systems vary across countries; thus our results should be extrapolated with caution; (iii) the lack of granularity of the database could be a limiting factor, but conversely it is an exhaustive real-life record of all patients hospitalized without initial selection bias.

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Table 1 Factors associated with the decision of ICU-to-ICU inter-regional transfer of critically ill COVID-19 patients from French regions that organized mass interregional transfers and factors associated with case fatality in mechanically ventilated COVID-19 patients hospitalized in regions that organized mass inter-regional transfers (Bourgogne-Franche-Comté, Grand Est, Ile-de-France; March–May 2020)

Factors associated with the decision of ICU-to-ICU inter-regional transfer	Bivariate analysis				Multivariate analysis (n = 6111[a])		
	TOTAL	Transfer		*p* value	Adjusted OR	CI 95	*p* value
	(*n* = 6160- 100%)	(*n* = 400—6.5%)					
	N	*N*	%				
Age							
< 65 years-old	3236	216	6.7	0.54	Ref		
≥ 65 years-old	2924	184	6.3		0.99	[0.8–1.2]	0.92
Sex							
Male	4515	294	6.5	0.92	Ref		
Female	1645	106	6.4		0.91	[0.7–1.2]	0.43
SAPS II							
Mean	43.5	42.0		0.07			
< 30	1261	80	6.3	0.31	Ref		
[30–40]	1614	117	7.2		1.19	[0.9–1.6]	0.27
≥ 40	3236	198	6.1		1.03	[0.8–1.4]	0.81
Charlson Comorbidity Index							
Mean [min–max]	1.51 [0–17]	0.75 [0–6]		< .0001	0.73	[0.7–0.8]	< 0.0001
Specific care supports during the first stay							
Central venous catheter	4071	269	6.6	0.61	-		
Continuous hemodynamic monitoring	3770	275	7.3	0.001	1.75	[1.4–2.2]	< 0.0001
Vasoactive treatment[b]	4842	306	6.3	0.29	-		
Non invasive ventilation / high flow oxygenotherapy	2126	53	2.5	< 0.0001	0.29	[0.2–0.4]	< 0.0001
Invasive ventilation with prone position	3282	151	4.6	< 0.0001	0.53	[0.4–0.7]	< 0.0001
Renal replacement therapy	1104	22	2	< 0.0001	0.37	[0.2–0.6]	< 0.0001
ECMO	277	3	1.1	0.002	0.20	[0.1–0.6]	0.006
Factors associated with case fatality	**Bivariate analysis**				**Multivariate analysis (*n* = 6,111[a])**		
	TOTAL	**Death**		***p* value**	**Adjusted OR**	**CI 95**	***p* value**
	(*n* = 6,160–100%)	**(*n* = 2,335 –37.9%)**					
	N	***N***	**%**				
Age							
< 65 years-old	3236	906	28	< .0001	Ref		
65–79 years-old	2705	1264	46.7		2.49	[2.2–2.8]	< 0.0001
≥ 80 years-old	219	165	75.3		9.82	[7–13.8]	< 0.0001
Sex							
Male	4515	1757	38.9	0.007	Ref		
Female	1645	578	35.1		1.15	[1.0–1.3]	0.03
SAPS II							
Mean	43.5	48.5		< .0001			
< 30	1261	322	25.5	< .0001	Ref		
[30–40]	1614	499	30.9		1.05	[0.9–1.3]	0.64
≥ 40	3236	1495	46.2		1.45	[1.2–1.7]	< 0.0001
Charlson Comorbidity Index							
Mean [min–max]	1.51 [0–17]	1.86 [0–17]		< .0001	1.09	[1–1.1]	< 0.0001
Specific care supports							
Central venous catheter	4265	1629	38.2	0.48	–		

Table 1 (continued)

Factors associated with case fatality	Bivariate analysis				Multivariate analysis ($n=6,111$[a])		
	TOTAL	Death		*p* value	Adjusted OR	CI 95	*p* value
	($n=6,160$–100%)	($n=2,335$ –37.9%)					
	N	*N*	%				
Continuous hemodynamic monitoring	4047	1519	37.5	0.41	–		
Vasoactive treatment[b]	5080	2065	40.7	< 0.0001	1.48	[1.3–1.8]	< 0.0001
Non invasive ventilation / high flow oxygenotherapy	2417	645	26.7	< 0.0001	0.44	[0.4–0.5]	< 0.0001
Invasive ventilation with prone position	3538	1451	41	< 0.0001	1.38	[1.2–1.6]	< 0.0001
Renal replacement therapy	1280	791	61.8	< 0.0001	3.09	[2.7–3.6]	< 0.0001
ECMO	398	214	53.8	< 0.0001	2.35	[1.9–3]	< 0.0001
Inter-regional transfer	400	57	14.3	< 0.0001	0.26	[0.2–0.3]	< 0.0001

Adjusted OR < 1 refers to a decreased probability of inter-regional transfer

[a] Missing data SAPS II $n=49/6,160$

[b] Dobutamin, dopamin, epinephrine, norepinephrine

The regions overwhelmed by the pandemic surge have experienced an unprecedented shortage of ICU beds and qualified ICU staff. We demonstrated that the benefit to remove patients from areas with outpaced resources was greatly superior to the risk of complication due to long-distance transfers of ventilated patients. In conditions with regional planning and trained teams [3], ICU evacuations are an appropriate solution to help manage the spatial dimension of the pandemic.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1007/s00134-021-06412-3.

Abbreviations

HDD: Hospital discharge database; ICU: Intensive care unit; SAPS II: Simplified Acute Physiology Score II; SD: Standard deviation.

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Author contributions

AG, LGG, LG, EL conceived and designed the study and were involved in drafting the manuscript. LG performed the data retrieval and LG, EL, AG, and LGG performed the statistical analysis. LG, EL, AG, AK and LGG were involved in the interpretation of the data, in drafting the manuscript and made critical revisions to the discussion section. LG, EL, AG, AK, and LGG read and approved the final version to be published.

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Availability of data and materials

Restrictions apply to the availability of these data and so are not publicly available. However, data are available from the authors upon reasonable request and with the permission of the institution.

Declarations

Conflicts of interest

The authors declare that they have no conflict of interest.

Ethics approval and consent to participate

No nominative, sensitive or personal data of patients have been collected. Our study involved the reuse of already recorded and anonymized data. The study falls within the scope of the French Reference Methodology MR-005 (declaration 2205437 v 0, august 22nd, 2018, subscripted by the Teaching Hospital of Tours), which requires neither information nor consent of the included individuals. This study was consequently registered with the French Data Protection Board (***CNIL*** MR-005 number #2018160620).

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