Intrahospital transportation of mechanically-ventilated COVID-19 patients: a cohort study

Transporte intrahospitalario de pacientes con COVID-19 con ventilación mecánica: un estudio de cohort

The management of critically ill patients in the intensive care unit (ICU) requires investigations leading to numerous transports outside the unit.[1] Intrahospital transportation (IHT), defined as the movement of a patient from one physical location within the hospital to another, is one of the most frequently performed tasks in the care of ICU patients.[2,3] An emerging issue is the safety during IHT in ICU patients, especially those subjected to invasive mechanical ventilation (MV). Patients under MV are among the high-risk populations for IHT, with reported worsening of respiratory and other essential organ functions.[3–6] Various adverse events, including cardiopulmonary arrest, have been described during IHT.[2] During COVID-19 management, IHT is indicated in many situations, including radiologic images that could potentially change their management.[7] Conducting safe transportation of COVID-19 patients is therefore fundamental. The main objective of this study was to evaluate the incidence of major adverse event (AE) in IHT of severe COVID-19 patients, as well as the modifications in clinical parameters post-procedure.

A cohort study was conducted using retrospective data collected from June 2020 to April 2021 in an 800-bed tertiary hospital, including four clinical-surgical ICUs. All IHTs for diagnostic computerized tomography (CT) of patients who were hospitalized in ICUs and required transport to the diagnostic unit were analyzed. The study was approved by the local Ethics Committee (Plataforma Brasil number 66240017.0.0000.5530) and the requirement for informed consent was waived, and the confidentiality of individual patient data was preserved. All transports were carried out by a transport team consisting of an intensivist, nurse, and nursing technician, in a predefined transport protocol, that consists of the use of a transport monitor, a period of ventilatory stabilisation, a FiO_2 of 100% during transport, the assessment of the need for additional doses of sedatives, analgesics, or neuromuscular blockers (NMB), transport through the patient's own bed, and exclusive use of the transport route and elevator. Transport for the CT scan consists of a move between two floors, with the patient being transferred via their own ICU bed and using their own ventilator (Servo-air© or Servo-i© ventilator, Getinge AB, Sweden) or a transport ventilator (Drager Oxylog 3000 Transport Ventilator, Drager Germany). The total time between leaving the ICU and returning the patient was approximately 30 min.

Data were collected on the oxygenation index through the PaO_2/FiO_2 ratio; use of vasopressors before and after transport; need to start, combine, or increase sedatives, analgesics, or NMBs after transport; need for increased vasopressors after transport; and presence of an AE related to transport. AEs were divided into major and minor. Major AEs included death, cardiorespiratory arrest during transport or up to 6 h after the failure of devices involved with transport (MV, infusion pumps), and inadvertent removal of devices (tracheal tube, tracheostomy cannula, central venous access, arterial line, indwelling urinary catheter, or enteral tube). Minor AEs included desaturation (SaO_2 <90%), agitation, hypotension (new vasopressor or increase in vasopressor dose), or cardiac arrhythmias during or after transport. Continuous variables are presented as median and interquartile range, and categorical variables are presented as frequency and percentage. To compare continuous variables, the Wilcoxon test or Student's t-test was used for paired samples. Statistical significance was defined as $p < 0.05$. We used Jamovi 2.3.21.0 for all analyses.

In total, 170 patients were included in this study. The median SAPS 3 score was 68 points (56–77), and the SOFA score on the day of CT was 6 points.[4–8] The median age was 60 years (range, 50–67 years), and the male:female ratio was 63%:37%. Seventy transports (41%) were carried out in the time range between 11:59 pm and 8 am.

A total of 155 patients did not develop any AE. One patient had a major AE: mechanical ventilator malfunction during transport, requiring manual ventilation with the aid of an appropriate device. There were no occurrences of cardiorespiratory arrest, death, accidental extubation, or the pulling of other devices. As shown in Table 1, 15 patients (8.8%) presented with minor AEs, which were reversed with the established treatment.

The use of noradrenaline, as well as the PaO_2/FiO_2 ratio pre- and post-transport are described in Table 1. There was no difference in the median norepinephrine dose between pre- and post-transport, with a mean difference (MD) of 0 μg/kg/min (95% CI: -0.02, 0.02; p = 0.84). Patients who developed pre-transport AEs did not have a higher dose of noradrenaline compared to those who did not develop AEs: MD 0.01 μg/kg/min (95% CI −0.03–0.05; p = 0.62). Also, there was no difference in the PaO_2/FiO_2 ratio before and after transport (MD = 2; 95% CI −6–10; p = 0.58).

It is particularly challenging as patients move to an environment with a changed care setting, which carries the potential risk of deterioration of clinical parameters, equipment and facilities malfunction, and tubes and lines malfunction.[8] Despite this risk,[3] we demonstrated the safety of IHT with a relatively low incidence of AEs. Different definitions regarding a serious AE secondary to IHT, however, may lead to different incidences in the literature.[6] Our definition of AE is quite specific and may be one of the reasons for the incidence of AEs found. As it is a retrospective study, the incidence of AEs may be underestimated when compared to prospective studies. Our study was carried out in a population at risk for AEs, due to the high incidence of hypoxemia, the need for vasopressors, and the need for multiple infusions of sedatives, analgesics, and continuous neuromuscular blockers. However, our cohort presents data similar to another study in the literature on oxygenation stability in patients undergoing IHT.[5] The IHT process requires an interdisciplinary approach, in an established protocol.[2] This fact may be a protective factor that minimises AE related to transport, such as equipment checks, patient preparation, and an experienced transport team.[1,4] Our results corroborate this hypothesis, suggesting that IHT is a safe procedure in this context, when carried out under the best patient

Table 1 Prevalence of minor complications in the study.

Complications	N
Hypoxemia	9 (5%)
PaO_2/FiO_2 ratio pre-CT in patients who developed hypoxemia post-CT: median (IQR)	128 (107–131)
PaO_2/FiO_2 ratio post-CT in patients who developed hypoxemia post-CT: median (IQR)	106 (98–126)
New arrythmia	2 (1%)
Psicomotor agitation	4 (2%)
Pharmacological treatment after CT	
Increase in sedative dose	19 (11%)
New sedative agent	11 (6%)
Increase in analgesia dose	14 (8%)
New analgesic agent	6 (3%)
Increase in NMB drug dose	2 (1%)
New NMB drug agent	9 (5%)
Noradrenaline use	
Pre-CT	65 (38%)
Median dose pre-CT (IQR)	0.04 μ/kg/min (0–0.04 μ/kg/min)
Post-CT	55 (32%)
Median dose post-CT (IQR)	0.03 μ/kg/min (0–0.03 μ/kg/min)
Increase in vasopressor dose	11 (6%)
PaO_2/FiO_2 ratio	
Median PaO_2/FiO_2 ratio pre-CT (IQR)	168 (132–220)
Median PaO_2/FiO_2 ratio post-CT	167 (126–213)
Measurement of PaO_2/FiO_2 ratio pre-CT (h): median (IQR)	7 (3–13)
Measurement of PaO_2/FiO_2 ratio post-CT (h): median (IQR)	8 (6–11)

CT, computerized tomography; IQR, interquartile range; NMB, neuromuscular blocker.

safety practices, through structured preparation management for the procedure.

Authors contribution

SFP, study design, review data, wrote the manuscript; PHRS, study design, ethics approval, review data; MGP, study design, review the manuscript; LSM, study design, review the manuscript; WN, study design, review data, wrote the manuscript.

Ethics approval

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Sara Ferreira Pagliarini[a], Pedro Henrique Rigotti Soares[a,b], Matheus Golenia dos Passos[a], Leonardo da Silva Marques[a], Wagner Nedel[a,*]

[a] *Intensive Care Unit, Grupo Hospitalar Conceição, Porto Alegre, Brazil*
[b] *Medicine School, Universidade do Vale do Rio dos Sinos, São Leopoldo, Brazil*

* Corresponding author.
E-mail address: wagnernedel@uol.com.br (W. Nedel).

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Antes y después de la primera reanimación cardiopulmonar extracorpórea por hipotermia accidental en España

Before and after the first extracorporeal cardiopulmonary resuscitation due to accidental hypothermia in Spain

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El 3 de noviembre del 2019 se trasladó al Hospital Universitario Vall d'Hebron una mujer de 34 años en parada cardiorrespiratoria (PCR) por hipotermia accidental. Se trataba de una paciente rescatada en los Pirineos con una temperatura esofágica inicial de 19,4 °C, ritmo inicial de asistolia, cianosis en partes acras y midriasis bilateral arreactiva. La primera gasometría venosa presentaba un pH 6,8, potasio 4,6 y lactato 10,3. Se calculó un HOPE score del 88% por lo que se indicó soporte vital extracorpóreo (SVEC) con oxigenación por membrana extracorpórea (ECMO) venoarterial mediante canulación quirúrgica fémoro-femoral ipsolateral derecha. Tras recalentamiento progresivo a una velocidad de 3 °C/h, se consiguió una vez superados los 30 °C de temperatura central, la recuperación de la circulación espontánea tras una desfibrilación. La evolución fue favorable, pudiéndose retirar el soporte en ECMO a las 45 h y siendo alta a domicilio a los 11 días con una Cerebral Performance Category de 1[1,2].

Hasta la fecha en nuestro país se había publicado otro caso en MedicinaIntensiva de PCR por hipotermia accidental reanimada durante 3 h, pero se trataba de una PCR intrahospitalaria y no había experiencias previas de reanimación cardiopulmonar (RCP) extracorpórea en estos pacientes[3].

El caso inicialmente expuesto se trata del primer caso en España de reanimación exitosa en una paciente con PCR extrahospitalaria por hipotermia accidental y de la reanimación más larga publicada a nivel nacional. Tras casi 5 años del accidente, la paciente presenta un estado de bienestar general excelente. Para realizar una evaluación de la funcionalidad en las actividades de la vida diaria, se pasó un test de Barthel que mostró una puntuación de 100/100. También se pasó un test multidimensional de calidad de vida percibida por la persona (World Health Organization Quality of Life scale abbreviated [WHOQOL-BREF]). Una psicóloga realizó un vaciado del test mostrando una puntuación total de 125/130 (10/10 área general, 34/35 física, 26/30 psicológica, 15/15 social y 40/40 ambiental). Estos datos muestran que la recuperación, tras una reanimación tan larga ha sido completa y que la reintegración a una vida normal en todas sus esferas ha sido exitosa.

En Cataluña desde el 2010 se han realizado más de 19.000 rescates en el medio natural, siendo casi el 50% rescates en montaña[4]. Durante las 2 últimas décadas se han producido otros casos de PCR por hipotermia accidental. Con la autorización del comité de ética del Hospital Arnau de Vilanova (CEIC-1308) y mediante un análisis de los atestados de la unidad de intervención en montaña de Mossos d'Esquadra y Grup de Rescat de Muntanya de Bombers d'Andorra, se recopilaron todos los accidentes mortales por hipotermia accidental desde el año 2000 hasta el 2024 en el Pirineo de Cataluña y Andorra (tabla 1). Se documentaron un total de 29 casos. El 65,5% eran de género masculino con una mediana de edad de 40 años (RIC 35-48). El 48,2% de los casos se produjeron fuera de la época invernal. La actividad más practicada fue el esquí de montaña, seguida de excursionismo, mientras que las localizaciones que agruparon la mayoría de los casos fueron la comarca del Ripollés (51,7%) y Val d'Aran (24,1%). En el 69% de las víctimas no se inició ninguna medida de RCP y solo 4 víctimas (13,8%) fueron trasladadas a un centro ECMO. Agrupando los datos por número de accidentes, se produjeron un total de 17 (6 invierno, 5 otoño, 4 verano y 2 primavera). Estos datos muestran que el 64,7% de los accidentes fueron en épocas no invernales.

Estos resultados deben alertar sobre la desestacionalización de accidentes por hipotermia accidental y la necesidad de valoración minuciosa de cada caso por personal entrenado en hipotermia. Actualmente, sigue siendo una entidad poco reconocida sobre la que recaen muchos sesgos en la valoración y manejo[5]. Sin la presencia de frío ambiental o un entorno desencadenante (alta montaña, ahogamiento o terreno nevado), puede resultar complejo sospechar la presencia de hipotermia. Sin embargo, la hipotermia coexiste en nuestro medio, tanto en ambientes rurales como urbanos, y no pensar en ella puede acarrear infradiagnosticarla. A su vez, los casos más graves pueden, por falta de conocimiento o protocolos, desestimarse para su traslado a un centro donde pueda realizarse SVEC.

Algunos casos concretos, como el expuesto al inicio del manuscrito, demuestran que existe la posibilidad de sobrevivir a una PCR extrahospitalaria por hipotermia accidental pese a la presencia de marcadores habituales de mal pronóstico en normotermia (asistolia, acidosis, lactato, end-tidal de dióxido de carbono, tiempo de PCR, midriasis arreactiva). Del total de casos expuestos que no fueron reanimados, resulta imposible saber si hubiera cambiado su pronóstico o si era necesario iniciar RCP, pero al igual que ocurre en enfermedades muy específicas para las que existen circuitos