staffing was measured in hours per patient per day needed (NAS score of 100 equals to one registered nurse per 8-h shift).
Results: In the total population studied (N = 106), 60% were boys, median age was 3.7 (0.7–11.8) years, emergency admissions were 69.1%, median length of stay was 5 (3–16) days, comorbidities were found in 41.8%, clinical severity (PELOD-2) scale showed that the risk of death was 4.91% and crude mortality was 7.3%. Mean NAS score was 76.75 (± 15.18) corresponding to a mean provided nursing care time of 1105.27 (± 218.64) minutes, TISS-28 score was 26.78 (± 6.84) that is 851.67 (± 217.61) minutes, and NEMS was 27.41 (± 7.01) minutes, equivalent to 871.66 (± 222.76) minutes. TISS-28 scale was found to have a moderate positive statistically significant linear correlation with the NAS scale ($r = 0.543$, $p < 0.001$) and a strong positive correlation with the NEMS scale ($r = 0.764$). The Bland–Altman concordance test showed that 5.4% of the total recordings differed from the upper and lower limits of agreement of the P-NAS and TISS-28 scales. Patients admitted to PICU from the Emergency Department had a significantly higher daily NAS nursing workload compared to patients admitted from the Operating Room [76.64 (± 10.29) vs. 67.82 (± 10.67), $p = 0.003$]. NAS nursing workload was found to have a positive linear statistically significant correlation with the length of stay of patients in PICU ($r = 0.562$, $p < 0.001$), that is, patients with a higher NAS score tended to have a longer length of stay. The discriminative ability of the severity and outcome prognostic scale scores and nursing workload scales between patients who survived and those who died was high (AUC 0.929, 95% CI 0.849–1.0, $p < 0.001$) (Fig. 1). According to NAS scale, shortage of registered nurse staffing were identified in all rotation shifts; morning shift -0,70 (± 0,99) nurses, evening shift -0,84 (± 0,95), and night shift -0,85 (± 0,94) (all $p < 0,001$).
Conclusions: NAS, TISS-28 and NEMS proved to be reliable and valid tools in pediatric ICUs. The NAS scale is superior to others in assessing nursing workload. The discriminative ability of the severity and outcome prognostic scale scores and nursing workload scales between patients who survived and those who died was high. Addtionally, NW scales demonstrated that optimal nurse staffing in the PICU requires additional nurses.

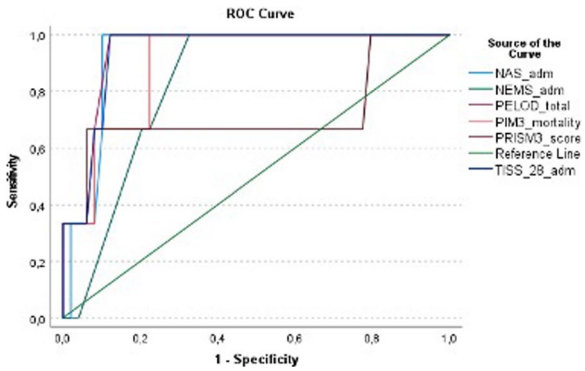

Fig. 1 (abstract 001048) ROC analysis. Discriminative ability of Nursing Workload Tools of clinical severity and outcome in critically ill children

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Topic: Critical care organisation, quality management, information systems, outcomes

001049

Risk factors and impact on long-term outcomes of early systemic insults after TBI. A CENTER-TBI study

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Introduction: Traumatic Brain Injury (TBI) outcomes are determined by the severity of the primary injury and secondary injuries (SIs) – such as hypoxia and hypotension [1–2]. SIs can boost the initial damage and ultimately worsen long-term disability and mortality [3–4].
Objectives: This study explores the incidence of early SIs and their association with derangements in metabolic profile, the higher therapeutic burden in the acute phase, six-month mortality, and neurological outcome.
Methods: This is an observational analysis of adult TBI patients admitted to the Intensive Care Unit enrolled in the CENTER-TBI study [5]. To detect the occurrence of early SIs, we examined data recorded in the prehospital setting and at hospital arrival. A hypotensive episode was defined as a measured systolic blood pressure (SBP) < 90 mmHg or a clinical definition of shock. A hypoxic episode was described as an estimated arterial partial pressure of oxygen (PaO2) < 60 mmHg and/or peripheral oxygen saturation (SpO2) < 90% or as evidenced by cyanosis, apnea, or respiratory distress.
According to the occurrence of secondary insults, patients were allocated into four different groups: "Hypoxia", "Hypotension", "Both" and "None". For each group, we evaluated: demographics, TBI mechanism, Glasgow Coma Scale at admission, Marshall CT score, strategy for intracranial pressure management, presence of extracranial injuries, need for neurosurgery and extracranial surgery (e.g., damage control interventions), need for mechanical ventilation (and eventually tracheotomy), rate of blood transfusions, biochemical profile. Comparison between the characteristics of the groups was conducted by chi-squared or Wilcoxon rank sum test – depending on the nature of the variables.
Glasgow Outcome Scale – Extended (GOSE) was used to determine 6-month neurological outcome and mortality; any value ≤ 4 was considered as an "unfavorable outcome".
Results: Among the study population ($n = 1,695$ patients), a hypoxic event was reported in 158 (9.3%) patients, a hypotensive event in 142 (8.4%), and both hypoxia and hypotension in 115 (6.8%).
Both SIs were associated with the most deranged biochemical profile and the highest rate of extracranial injury. Hypotension alone or combined with hypoxemia was independently associated with the need for extracranial surgery and unfavorable neurological outcome (Figure 1). Ultimately, a higher 6-month mortality was observed among patients suffering from both SIs.
Conclusions: The incidence of early SIs was lower compared to previous studies [6–7]. However, SIs still represent an important factor contributing to patient's outcomes. Thus, prompt recognition of SIs and their risk factors can be pivotal in early and ICU clinical management.

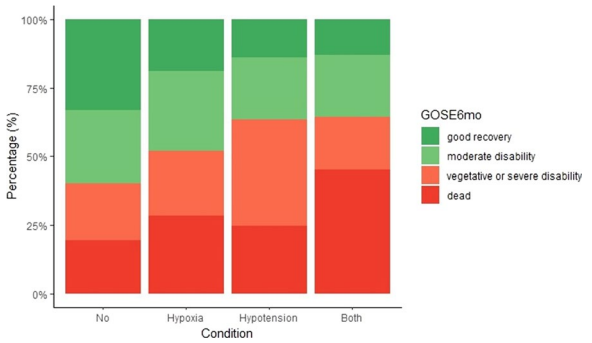

Figure 1 (abstract 001049) Outcome distribution in patients with and without SIs. GOSE6mo: Glasgow Outcome Scale—Extended at 6 months from TBI. GOSE 1: dead (red). GOSE 2–4: vegetative state or severe disability (orange). GOSE 5–6: moderate disability (light green). GOSE 7–8: good recovery (dark green)

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Topic: Neurointensive care

001050

A novel extracorporeal carbon dioxide removal technique with regional citrate-based anticoagulation: an experimental model

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Introduction: Extracorporeal carbon dioxide removal (ECCO2R) allows protective ventilation in patients with acute respiratory failure (1, 2), but requires systemic anticoagulation with subsequent increased risk of hemorrhage, especially with low blood flows (3). In clinical setting, citrate represents the most widespread molecule used for regional anticoagulation (RA); however, because of limited clearance, citrate can only be applied to extracorporeal blood flows lower than the ones required for ECCO2R. New techniques have been proposed to overcome these limitations (4).

Objectives: This study aims to evaluate feasibility, safety, and efficacy of a new extracorporeal technique that combines a low flow ECCO2R and continuous renal replacement therapy (CRRT) using a RA with citrate and a novel system for citrate removal.

Methods: Six healthy swine (39 ± 7 kg) were mechanically ventilated and connected to a low-flow (0.35 L/min) custom-made venous-venous extracorporeal circuit for ECCO2R and CRRT which includes anionic ion-exchange resins charged with chloride for citrate removal, and cationic resins charged with sodium for calcium removal. Hydroelectrolytic balance was achieved through ultrafiltration (1000 ml/h) and three different anionic ion-exchange resins (100% bicarbonate (HCO3-); 100% hydroxide (OH-); 60% HCO3- and 40% OH-) tested in a randomized 1-h steps. A 0.2 M solution of sodium citrate (66%) and citric acid (34%) was continuously infused at the circuit inlet (4 mmol/L). Plasma citrate and free calcium concentrations were measured on arterial blood, and on extracorporeal blood inlet (downstream of citrate infusion) and outlet. Minute ventilation (MV) was changed to maintain a constant arterial pressure of carbon dioxide (50 ± 2 mmHg). Samples were collected at the end of each step for blood gas, electrolytes, and citrate dosage. Data were also collected at baseline before connection to the extracorporeal circuit.

Results: During ECCO2R, MV decreased from 7.27 ± 1.31 l/min to 3.4 ± 0.70 l/min, and it remained stable during 60%HCO3-/40%OH- (3.05 ± 0.64 l/min, *p 0.68*), further decreased during 100% OH- step (1.86 ± 1.04 l/min, $p < 0.01$), and slightly increased during 100% HCO3- (4.23 ± 0.91 l/min, *p 0.04*, Figure *1*). During citrate infusion, regional free calcium concentrations remained below the RA threshold, while citrate concentration, downstream the infusion port, was 5.51 ± 0.68 mmol/L and decreased after the citrate-removal system (*Table* **1*). At the end of the study, the arterial total calcium/ionized calcium ratio was 1.99 ± 0.25. Minimal changes occurred in arterial pH and sodium concentration, but not in chloride concentration. The blood outlet pH during OH- step was significantly higher compared to all the others.

		Baseline	ECCO2R	100%HCO3-	60%HCO3-/40%OH-	100%OH-	p
ARTERY	Ca++(mmol/l)	1.44 ± 0.07	1.30 ± 0.08	1.32 ± 0.08	1.28 ± 0.07	1.27 ± 0.07	< 0.01
	Citrate (mmol/l)	0.05 ± 0.03	/	0.60 ± 0.21	0.64 ± 0.14	0.73 ± 0.17	< 0.01
	pH	7.41 ± 0.02	7.42 ± 0.02	7.45 ± 0.03	7.44 ± 0.02	7.43 ± 0.03	< 0.01
	Na+(mmol/l)	136.3 ± 2.5	137.7 ± 2.6	138.8 ± 2.0	139.5 ± 1.6	138.7 ± 1.6	< 0.01
	Cl-(mmol/l)	104.0 ± 1.4	102.3 ± 1.6	103.3 ± 2.7	103.2 ± 1.6	103.3 ± 1.8	0.3
INLET	Ca++(mmol/l)	/	1.32 ± 0.08	0.35 ± 0.03	0.33 ± 0.14	0.33 ± 0.10	< 0.01
	pH	/	7.39 ± 0.01	7.08 ± 0.03	7.05 ± 0.11	7.04 ± 0.09	< 0.01
OUTLET	Ca++(mmol/l)	/	1.00 ± 0.05	0.25 ± 0.03	0.20 ± 0.02	0.21 ± 0.03*	< 0.01
	Citrate(mmol/l)	/	/	1.13 ± 0.13	1.17 ± 0.24	1.32 ± 0.30	0.05
	pH	/	7.84 ± 0.04	7.71 ± 0.05	7.88 ± 0.06	8.14 ± 0.11	< 0.01

Conclusions: Combining ECCO2R with blood flow of 0.35 l/min and CRRT with citrate regional anticoagulation and a novel ion exchange resin-based system for citrate removal was feasible. System for citrate removal based on ion exchange resins was feasible and enabled a reduction in MV. The OH- anion exchange resulted in the most significant reduction in MV, albeit with the lowest safety profile.