

Acid-Base Disorders in COVID-19 Patients with Acute Respiratory Distress Syndrome

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Introduction

The high tropism of SARS COV 2 virus not only for the respiratory tract can result in a high spectrum of disorders (ARF, AHF, AKI, coagulopathy, extensive microvascular thrombosis, a dysregulated inflammatory response, sepsis, MOF) that, influencing the patient homeostasis, could result in alteration of the acid-base balance. In non-COVID-19 critically ill patients, Stewart’s approach showed, compared to the traditional evaluation, based on Henderson–Hasselbalch equation, a greater identification of acid-base disorders.

Aim of the study

Investigate the distribution of acid-base disorders in patients with COVID-19 ARDS using both the Hender-son–Hasselbalch and Stewart’s approach. Explore if hypoxemia can influence acid-base disorders.

Material and Methods

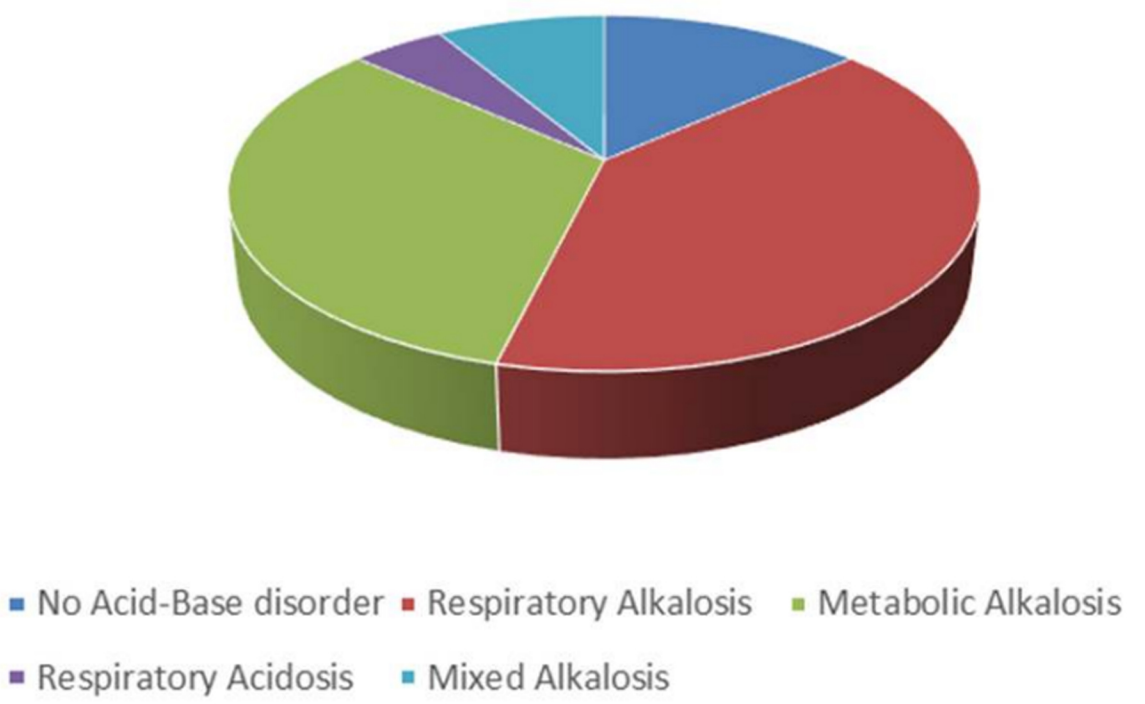
COVID-19 ARDS patients, within the first 48 h of the need for a non-invasive respiratory support, were retrospec-tively enrolled. Respiratory support was provided by helmet continuous positive airway pressure (CPAP) or by non-invasive ventilation. The reference value for pH was considered 7.38 - 7.42, for PaCO₂ 38 - 42 mmHg and for [HCO₃⁻] 22 - 26 mMol per liter. The reference value for the apparent SID was considered 38 - 42 mEq/L.

Results

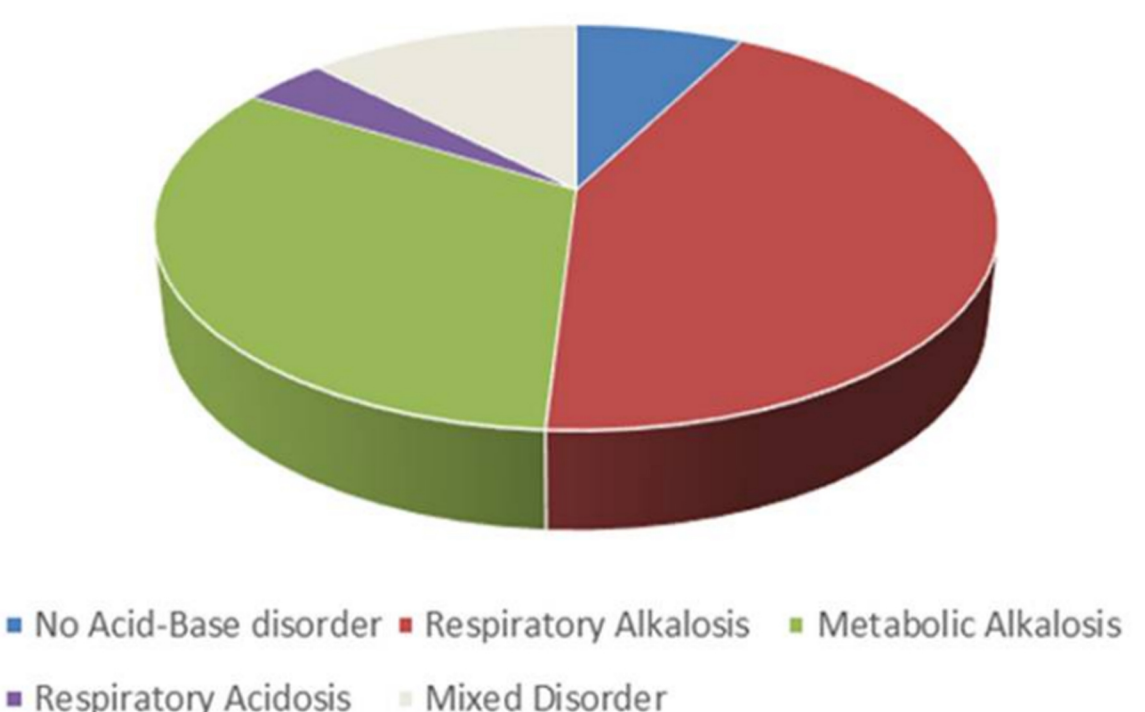
One hundred and four patients were enrolled, 84% treated with CPAP and 16% with non-invasive ventilation. Using the Henderson–Hasselbalch approach, 40% and 32% of patients presented respiratory and metabolic al-kalosis, respectively; 13% did not present acid-base disorders. Using Stewart’s approach, 43% and 33% had a respiratory and metabolic alkalosis, respectively; 12% of patients had a mixed disorder characterized by normal pH with a lower SID. The severe hypoxemic and moderate hypoxemic group presented similar frequencies of respiratory and metabolic alkalosis.

	Study Population	No Acid-Base Disorder	Respiratory Alkalosis	Metabolic Alkalosis due to aSID	Other Alkalosis	Respiratory Acidosis	Mixed Disorder	p
Number (%)	104 (100)	8 (8)	45 (43)	20 (19)	14 (14)	4 (4)	13 (13)	-
Age, years	60 (53–69)	58 (53–64)	60 (53–68)	61 (50–70)	60 (54–68)	64 (58–69)	62 (58–65)	0.943
Female gender, n (%)	28 (27)	1 (12)	8 (18)	11 (52)	6 (43)	25 (1)	8 (1)	0.654
BMI, kg/m ²	28 (25–33)	25 (25–28)	28 (25–31)	28 (26–34)	28 (26–33)	30 (26–36)	30 (30–30)	0.734
Time from symptoms to ED, days	6 (4–8)	6 (4–7)	5 (4–8)	4 (4–6)	6 (4–8)	6 (5–8)	7 (5–7)	0.783
Respiratory rate, bpm	19 (17–24)	19 (17–26)	19 (18–22)	18 (16–22)	18 (16–22)	19 (18–22)	19 (16–24)	0.668
FiO ₂	70 (60–70)	70 (60–70)	70 (60–70)	70 (60–70)	60 (60–70)	75 (70–75)	60 (60–70)	0.532
PEEP, cmH ₂ O	8 (7.5–10)	10 (7.5–10)	7.5 (7.5–10)	8 (7.5–10)	8 (7.5–10)	10 (9–10)	10 (7.5–10)	0.141
Borg Score	0 (0–0)	0 (0–1)	0 (0–1)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–1)	0.145
WOB Score	1 (1–2)	1 (1–3)	1 (1–2)	1 (1–2)	1 (1–2)	1 (1–2)	1 (1–2)	0.971
Arterial pH	7.44 (7.43–7.46)	7.41 (7.40–7.42)	7.45 (7.44–7.48)	7.45 (7.44–7.46)	7.44 (7.45–7.46)	7.36 (7.36–7.36)	7.41 (7.40–7.42)	<0.001
PaCO ₂ , mmHg	38 (35–41)	41 (40–42)	35 (33–36)	40 (39–42)	39 (38–42)	48 (45–54)	37 (34–43)	<0.001
PaO ₂ , mmHg	123 (92–155)	96 (81–190)	120 (93–165)	122 (90–152)	126 (97–145)	124 (92–195)	138 (88–145)	0.983
PaO ₂ /FiO ₂	199 (139–246)	221 (118–298)	199 (138–276)	173 (150–230)	168 (146–240)	188 (148–278)	198 (143–234)	0.923
HCO ₃ ⁻ , mMol/L	25.8 (24.1–27.4)	25.6 (24.2–25.9)	24.7 (23.6–25.6)	27.4 (26.4–29.6)	28.0 (26.9–29.4)	26.2 (24.4–28.5)	23.4 (22.0–27.0)	0.001
BE, mMol/L	1.6 (0.1–3.6)	1.6 (0.9–1.9)	0.5 (–0.6–1.4)	3.4 (2.4–6.0)	3.6 (2.5–6.1)	0.25 (–1.7–2.8)	1.4 (–2–3.6)	0.001
Apparent SID, mEq/L	36.6 (34.9–38.2)	38.6 (38.0–39.1)	38.9 (38.4–39.4)	42.2 (42.1–43.0)	40.0 (38.6–40.5)	38.8 (38.0–39.6)	35.6 (34.4–37.4)	0.034
Sodium, mEq/L	136 (134–138)	139 (136–139)	136 (133–139)	137 (135–138)	137 (135–138)	137 (136–138)	137 (134–139)	0.437
Potassium, mEq/L	4.1 (3.8–4.3)	4.2 (4.0–4.4)	4.0 (3.8–4.3)	4.0 (3.7–4.2)	4.1 (3.7–4.3)	4.3 (4.1–4.5)	4.3 (4.0–4.4)	0.198
Chloride, mEq/L	103 (100–105)	102 (99–103)	103 (101–105)	101 (100–104)	101 (100–104)	102 (100–104)	103 (102–106)	0.209
Lactates, mMol/L	1.3 (1.0–1.7)	1.1 (0.9–1.3)	1.3 (1.1–1.6)	1.1 (1.0–1.4)	1.1 (1.1–1.4)	2.0 (1.4–2.6)	1.7 (1.2–1.9)	0.087

Handerson-Hasselbach Approach Classification



Stewart's Approach Classification



Conclusions

The most frequent acid-base disorders were respiratory and metabolic alkalosis using both the Henderson–Has-selbalch and Stewart’s approach. Stewart’s approach detected mixed disorders with a normal pH probably gen-erated by the combined effect of strong ions and weak acids. The impairment of oxygenation did not affect acid-base disorders.

