Critical Care

TITLE: VARIABILITY OF ARTERIAL AND VENOUS BLOOD GAS AND CO-OXIMETRY MEASUREMENTS

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INTRODUCTION: Blood gas and CO-Oximetry measurements are used routinely to monitor progress and alter therapy. Since decisions are often based on infrequent spot checks, it is important to understand the intrinsic variability of these measurements. While arterial blood gas variability has been described (1), no data exist regarding arterial versus venous blood gas and CO-Oximetry measurement variability in a stable ICU patient population.

METHODS: Thirteen patients scheduled for open-heart surgery gave informed consent to a study approved by the Clinical Research Practices Committee. All patients were: 1) studied after arrival in ICU, 2) mechanically ventilated, and 3) hemodynamically stable. Thirteen q 5-min pairs of arterial and mixed venous blood samples were obtained over 1 h, and processed on an IL 1306 blood gas analyzer and an IL 282 CO-Oximeter (Instrumentation Laboratory, Lexington, MA). The pure error of each of the measured parameters, as a measure of the expected intrapatient variability, was calculated as the square root of the average interpatient variance.

RESULTS: The pure error for each of the measured parameters, shown in the table, excludes patient-to-patient variability. The remaining sources of variability are machine error, blood sampling error, and actual random fluctuations over time.

Measured Parameters	Pure Error	
	Arterial	Venous
pH	0.014	0.014
PO_2 mmHg	10.12	1.27
PCO_2 mmHg	1.48	2.04
$\%O_2$ Hgb	0.34	2.00
%CO Hgb	0.21	0.17
%Met Hgb	0.19	0.19

DISCUSSION: Pure error is a measure of the population standard deviation and provides an estimate of the expected variability of these measurements in stable patients. Since isolated blood gas determinations are frequently used to alter therapy, it is important to define the spontaneous variation that can occur over short intervals. It would appear that, of the parameters tested, PaO_2 is the most prone to short-term fluctuation. Changes less than 10 mmHg are likely to represent normal variability rather than actual significant physiologic changes.

References

1. Thorson SH, et al: Variability of arterial blood gas values in stable patients in the ICU. Chest 1983;84:14-18

TITLE : SEPTIC SHOCK : A GOAL-DIRECTED THERAPY.

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Therapeutic protocols in septic-shock patients include volume loading and the use of cardiovasoactive agents titrated against Mean Arterial Pressure (MAP) and Urine Flow (UF) (1). It has also been shown in high-risk patients that supranormal values of some parameters (Cardiac Index-CI-, Oxygen Delivery - DO_2 -, Oxygen Consumption - VO_2) could satisfactorily predict outcome (2). We designed for septic shock patients a goal-directed therapy to maintain or increase CI, DO2, and Systemic Vascular Resistance (SVR) to the previously defined supranormal values : 4.5 $l.min^{-1}.m^{-1}$, 700-800 dynes. sec.cm-5 and 550 $ml.min^{-1}.m^{-2}$ respectively (2).

After informed consent and institutional approval, 42 consecutive patients (32 men, 10 women, 57 ± 14 years) were prospectively studied. Diagnosis of septic shock was based on : 1) Systolic Blood Pressure < 90 mm Hg ; 2) Decreased organ perfusion (altered mental status, oliguria < 30 ml/h) ; 3) bacteriemia, or an identified source of infection. All patients presented with concomitant acute respiratory failure. Patients received broad spectrum antibiotic coverage and intravenous fluid resuscitation (1687 ± 327 ml) to maintain Pulmonary Capillary Wedge Pressure (PCWP) ± 12 mm Hg . After fluid challenge, 15 patients with CI ≥ 4.5 $l.min^{-1}.m^{-2}$, SVR ≤ 600 dynes. sec.cm^{-5} and oliguria were considered as being in hyperdynamic septic shock and were given norepinephrine (NE) as a single agent. When CI was < 4.5 $l.min^{-1}.m^{-2}$, dobutamine (Dob) was started first (19 patients) and NE was added to Dob when SVR was ≤ 600 dynes. sec. cm^{-5}. If there were any doubts, NE was started first. Eight additional patients, already treated by dob + dopamine at the time of admission to the ICU were given NE since they had CI ≥ 4.5 and SVR ≤ 600. The therapeutic protocol made it possible to fulfill all of the goals regarding CI, SVR and DO2 in all patients. In the 15 patients given NE alone, (1.1 ± 0.4 mcg.$kg.^{-1}$.min^{-1}), MAP increased from 55 ± 11 to 88 ± 10 mmHg ($p<0.001$), SVR from 380 ± 120 to 750 ± 120 dynes ($p<0.0001$), DO2 from 564 ± 47 to 630 ± 39 $ml.min^{-1}.m^{-2}$ ($p<0.05$), and CI did not change (5.7 ± 1.7 to 5.2 ± 1.5 $l.min^{-1}.m^{-2}$). In the 27 patients given NE (1.9 ± 0.9 mcg.$kg^{-1}.min^{-1}$) and dob (12 ± 0.9 mcg.kg^{-1}.min^{-1}), MAP increased from 57 ± 9 to 75 ± 12 mmHg ($p< 0.0001$), SVR from 620 ± 130 to 695 ± 176 dynes ($p < 0.0001$), DO2 from 608 ± 70 to 681 ± 50 ml. $min^{-1}.m^{-2}$ ($p < 0.01$), and CI from 3.9 ± 1.4 to 5.4 ± 1.4 $l.min^{-1}.m^{-2}$ ($p < 0.05$). A very favorable effect on U F was observed. It increased from 17 ± 11 to 100 ± 43 $ml.h^{-1}$ ($p<0.01$) in the NE group and from 19 ± 9 to 77 ± 31 $ml.h^{-1}$($p<0.01$) in the other group. Only 16 % of the patients remained oliguric. sixty-five % of the patients survived the episode of septic shock and overall hsopital mortality was 55 %. This goal-directed therapy based simultaneously on SVR, CI and DO2, yielded a high success rate for septic shock in these high-risk patients, all presenting with concomitant acute respiratory failure.

References :

1) Circulation 1966, 34 : 260-271

2) Chest 1988, 94 : 1176-1186