Anesthesiology
V 75, No 3A, Sep 1991

A238

TITLE: STRESSING THE CRITICALLY ILL PATIENT: THE CARDIOPULMONARY AND METABOLIC RESPONSE TO CHEST PHYSICAL THERAPY

AUTHORS: C. Weissman, MD and M. Kemper, BA
AFFILIATION: Departments of Anesthesiology and Medicine, College of Physicians and Surgeons, Columbia University, New York, New York 10032

The cardiopulmonary reserve of critically ill patients is difficult to determine since conventional exercise tests cannot be performed in this group of patients. We, therefore, analyzed the cardiac, pulmonary, and metabolic changes that occur during chest physical therapy (CPT) to determine whether CPT could be used to assess cardiopulmonary reserve. CPT was used because it is frequently performed in ICU patients and previous studies have shown that oxygen consumption ($\dot{V}O_2$) increased an average of 40% during CPT (1).

Twenty-three mechanically ventilated (IMV mode) adult surgical ICU patients with indwelling pulmonary artery and radial artery catheters who had undergone major abdominal or thoracic surgery were studied. Carbon dioxide elimination ($\dot{V}CO_2$), $\dot{V}O_2$, and minute ventilation (VE) were determined with a Datex Deltatrac (Senormedics, Yorba Linda CA). Arterial and mixed venous blood samples were analyzed for hemoglobin, O_2 saturation, PO_2, and PCO_2. Oxygen content (CaO_2, $C\bar{v}O_2$) and O_2 extraction ratio ($ER=[CaO_2-C\bar{v}O_2]/CaO_2$) were calculated, as were O2 delivery ($DO_2 = \dot{V}O_2/ER$) and cardiac output ($CO=\dot{V}O_2/[CaO_2-C\bar{v}O_2]$). Alveolar ventilation was calculated ($\dot{V}A=[\dot{V}CO_2\ (0.863)\ /PaCO_2$). Metabolic and hemodynamic measurements and blood samples were obtained while the patients were at rest (points A and B); during CPT, once after one side had been completed (C) and once after the other side was done (D); and 15 and 30 minutes after the completion of CPT (E and F). The sequence of CPT maneuvers was standardized. This study was approved by the Institutional Review Board. Informed consent was not required.

	A	B	C	D	E	F
$\dot{V}O_2$ ml/min	227	240	330*	333*	248+	235+
$\dot{V}CO_2$ ml/min	182	190	240*	257*	205+	190+
ER	0.24	0.24	0.31*	0.31*	0.25+	0.24+
DO_2 ml/min	1005	1050	1098	1116*	1034	990+
CO l/min	7.19	7.47	7.76	7.93*	7.33	7.09+
$\dot{V}_E$ l/min	9.2	9.5	12.8	12.9	10.5	9.5
$\dot{V}A$ l/min	4.4	4.7	5.6*	6.0*	4.8+	4.1+
$PaCO_2$ torr	35.9	35.4	37.8*	38.0*	37.4*	36.5
HR bpm	95	95	104*	107*	102	97+
SV ml/beat	73	76	72	74	69	72
SVR d-s/cm^{-5}	1089	997	1133	1398	1164	1101
SBP torr	137	136	155*	156*	137+	126+

Different ($p<0.05$) than A-(*), than C-(+)
HR - Heart Rate SV - Stroke Volume
SVR - Systemic Vascular Resistance

Chest physical therapy increased oxygen demand ($\dot{V}O_2$) by an average of 48±33%. This increase was met mainly by increasing ER and to a small degree by an increasing DO_2. There were associated modest elevations in CO, HR, and SBP, but not SVR or SV. There were increases in VE and VA. However, these increases were insufficient to adequately eliminate all the CO_2 produced resulting in small but significant increases in $PaCO_2$ during and immediately following CPT.

CPT results in marked physiological alterations. It may be helpful to further assess whether the response to this oft performed ICU therapy is useful in assessing the cardiac and pulmonary reserve of critically ill patients. Also further examination of the response of patients with various disease states (e.g. sepsis, cardiac failure) and receiving cardioactive drugs (e.g. beta-adrenergic antagonists) seems warranted.

References
1. Chest 86:815-818, 1984.

A239

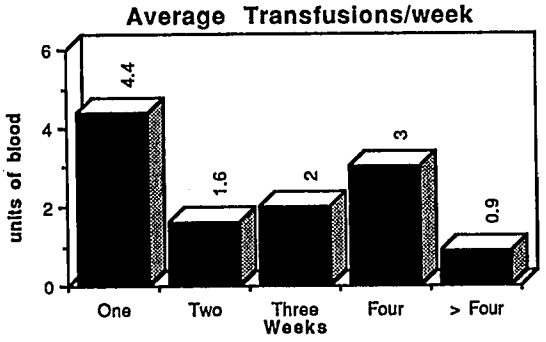
Title: ANEMIA IN THE CHRONIC ICU PATIENT: TRANSFUSION REQUIREMENT AND ROLE OF PHLEBOTOMY

Authors: A. Gettinger, M.D., K.C. Parsonnet, M.P.H., and H.L. Corwin, M.D.
Affiliation: Departments of Anesthesiology and Medicine, Dartmouth-Hitchcock Medical Center, Dartmouth Medical School, Hanover, NH 03756

Introduction: Anemia is commonplace in the critically ill patient. The etiology of this anemia is likely multifactorial in many patients. It has been suggested that phlebotomy accounts for much of the anemia although its precise contribution has not been quantitated. Similarly, the transfusion requirement of the long term ICU patient is not known. We determined the transfusion requirement of patients with prolonged ICU admissions and the relationship of transfusion to phlebotomy.

Methods: All patients admitted to the ICU during 1990 with length of stay greater than one week were included for study. Data regarding anemia, blood transfusion, and phlebotomy were obtained from institution databases and chart review. The amount of blood phlebotomized was estimated by the number of diagnostic tests and the average cc's of blood for each test (this is standardized in our ICU). The relationship between variables was examined using multiple linear regression.

Results: A total of 607 patients were admitted to the ICU during the study period. One hundred forty two (23%) had an ICU length of stay of greater than one week (mean 19.6 days). These patients received a total of 1,154 units of homologous blood during their ICU admission. This transfusion requirement was not solely a function of early blood loss, but rather a constant 2 to 4 unit/week transfusion requirement (see figure).



These same patients had a total of 176 liters of blood drawn during their ICU course. This phlebotomy, similar to transfusion, was a constant 200-400 cc/week. Only 39% of the transfusion requirement could be explained by phlebotomy ($p<.001$).

Discussion: We have found that the chronic ICU patient population has an extraordinary transfusion requirement which is ongoing throughout the ICU course. The blood loss in these patients which can be accounted for by phlebotomy, although substantial, only partially explains the transfusion requirement. This suggests that other as yet unidentified factor(s) are responsible for the anemia seen in the ICU patient population. The potential morbidity and cost associated with blood transfusions make identification of these factors and the development of alternative therapeutic interventions of great importance.