9. Monitoring/Data Management – Posters

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COMPARISON OF THORACIC ELECTRICAL BIOIMPEDANCE AND THERMODILUTION FOR THE MEASUREMENT OF CARDIAC OUTPUT IN MECHANICALLY VENTILATED PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

Franc Šifer, Igor Drinovec

Institute for Respiratory Diseases Golnik, Slovenia

During mechanical ventilation high fluctuations of intrathoracic pressures occur. No data have been presented as to the effects of positive pressure ventilation in patients with chronic obstructive pulmonary disease on the assessment of cardiac output from thoracic electrical bioimpedance. In order to evaluate a thoracic electrical bioimpedance system for the measurement of cardiac output, 40 paired values of cardiac output in 12 mechanically ventilated patients with chronic obstructive pulmonary disease were measured simultaneously with the standard thermodilution method. The data were plotted as the mean for the two measurement techniques versus the difference. The chosen acceptable difference for limits of agreement (mean difference $\pm$ 2SD) was set at 22%. The mean difference was 0,1 liter per minute and standard deviation 0,7 liter per minute (12,2%). 92% of differences for two measurement techniques did not exceed the chosen acceptable difference. The two methods are therefore considered to be in agreement. The continuous and noninvasive nature of impedance method and its simplicity of use makes this technology very useful for the titration of drug and fluid therapy. It provides warning from impending problems which might require immediate treatment.

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SIMULTANEOUS COMPARISON OF FIVE TECHNIQUES OF CARDIAC OUTPUT (CO) MEASUREMENT.

G. Thomson, L. Baker, E. Mawby, RM Leach.

OBJECTIVES: To compare 5 methods of CO measurement and to determine whether CO is measured reliably without pulmonary artery catheterisation (PAC).

SUBJECTS: Fifteen critically ill patients requiring cardiac output monitoring on a general intensive care unit. 14 patients required inotropic support. Mean FiO_2 0.5 ± 0.1 .

METHODS: A pulmonary artery catheter for continuous CO (CCO), bolus thermodilution CO (TD) and mixed venous saturation (SvO_2) measurements (Vigilance, Baxter), was placed through the internal jugular vein (IJV). Indirect Fick measurement of CO (FK) was determined from oxygen consumption (VO_2) measured by mass spectrometry (Airspect 2000) and arterial / mixed venous oxygen content difference. An oesophageal ultrasound probe (Abbott Laboratories) determined doppler CO (OD). Clinical estimates of CO (CE) were derived from a) mean pressure difference across the arterial bed divided by a clinical estimate of SVR, b) an estimate of cardiac stroke volume multiplied by heart rate. Blind measurements using all 5 techniques were taken over a 5 min period on 5 occasions (>20 mins apart). On each occasion 4 TD, 4 OD, 2-3 CE (by different clinicians), 1 CCO and 1 FK measurements were obtained. CO determined by each technique was compared with the mean of the 4 TD measurements (mean % standard error of 3.47) and correlation determined by regression analysis. Measurement bias and standard deviation were assessed by Bland-Altman statistical analysis.

RESULTS AND STATISTICAL ANALYSES The r^2 value (R), mean bias (MB; L/min) and means $\pm$ 2 standard deviations (MB $\pm$ 2SD; L/min) compared to TD are tabulated for each technique.

	CCO	FK	CE	OD
R	0.87	0.85	0.77	0.57
MB	-0.12	0.91	-0.3	-0.22
MB$\pm$2SD	-1.42 to 1.18	-0.97 to 2.79	-1.33 to 0.74	-2.05 to 1.62

CONCLUSION: Regression analysis showed close correlation (R value >0.75) between TD and other techniques of CO measurement except OD. The absolute measurement bias was greatest for FK but low for all other techniques. These results suggest that less invasive methods (i.e. not requiring PAC) may be of clinical value in the determination of cardiac output.

Intensive Care Unit, St Thomas' Hospital, London SE1 7EH.

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THE RELATIONSHIP BETWEEN CENTRAL VENOUS PRESSURE AND OTHER HEMODYNAMIC PARAMETERS IN PATIENTS ON MECHANICAL VENTILATION

P.J.Jensen, G.Michagin and P.K.Andersen

OBJECTIVE: To investigate the relationship between the central venous pressure (CVP) and other hemodynamic variables such as pulmonary capillary wedge pressure (PCWP), mean arterial blood pressure (MAP) and cardiac index (CI). **DESIGN:** Data were collected prospectively. **SUBJECTS:** 61 critically ill patients, without known ischemic heart disease, on mechanical ventilation who all were monitored by a pulmonary artery catheter were studied. **METHODS:** The relationship between CVP and PCWP, MAP and CI were evaluated using linear correlation analysis of each patients data sets. The statistical significant correlations were described as either nil (B=0), positive (B+) or negative (B-). **RESULTS:** A total of 800 hemodynamic profiles were measured. The number of hemodynamic profiles measured in each patient had a range of 5 to 35. The per cent (%) of significant correlations between CVP and PCWP was found to be 49% (only B+). Between CVP and MAP a significant correlation was found in 18% (B+ in 13% and B- in 5%). Finally a significant correlation between CVP and CI was found in only 14% (B+ in 5% and B- in 8%). **CONCLUSION:** No constant correlation exist between CVP and PCWP, MAP or CI in critically ill patients on mechanical ventilation. The CVP is a poor predictor of preload to the left ventricle (PCWP), systemic blood pressure and cardiac index in critically ill patients on mechanical ventilation. These results suggest that the Frank-Starling mechanism in these patients are modified to such an extent that the CVP should not be considered in clinical decision making.

Department of Anaesthesiology and Intensive Care, Odense Universityhospital. DK-5000 Odense, Denmark.

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PREDICTION OF ARTERIAL PRESSURE OF CARBON DIOXIDE (PaCO_2) BY CONTINUOUS MEASUREMENT OF CO_2 ELIMINATION (VeCO_2) WITH A METABOLIC MONITOR.

J. Peláez, MJ Asensio, M Jiménez, S Yus, P Villa, C Vaquero.

BACKGROUND. The CO_2 production (VCO_2) and elimination (VeCO_2) are the same in a hemodynamic and metabolic stable condition. With VeCO_2 we can calculate the deadspace: $\text{Vd/Vt} = 1 - 0.863 \times \text{VeCO}_2 / \text{PaCO}_2 \times \text{Ve}$

OBJECTIVES. 1. To assess the VeCO_2 and PaCO_2 changes with new ventilatory parameters. 2. To predict the final PaCO_2 .

DESIGN. An open prospective study. **SUBJECTS.** Twenty patients in stable condition receiving volume-controlled mechanical ventilation were studied with a metabolic monitor (Deltatrac™, Datex/Instrumentation).

METHODS. During changes in ventilatory parameters we measure VeCO_2 and VO_2 , and PaCO_2 before and after the modifications. 1. We study the time required to get the new equilibrium and the change in VeCO_2 (ΔVeCO_2) and PaCO_2 (ΔPaCO_2). 2. Assuming that Vd/Vt just after the onset of the new parameters and at the new equilibrium are the same:

$\text{PaCO}_{2\text{-predicted}} = \text{PaCO}_2^* \times \text{VeCO}_{2\text{-equilibrium}} / \text{VeCO}_{2\text{-1 minute}}$
where PaCO_2^* is the PaCO_2 before the change and $\text{VeCO}_{2\text{-1 minute}}$ is the CO_2 elimination in the first minute after the change. Finally we correlate the measured PaCO_2 with the calculated. The results are in mean $\pm$ SEM and the correlation with a significance of $p < 0.001$.

RESULTS AND STATISTICAL ANALYSES.

1. VO_2 279 ± 46 ml/min; VeCO_2 218 ± 37 ml/min.

	Hipervent.	Hipovent.
T. VeCO_2 (min)	44 ± 10	73 ± 9
ΔVeCO_2	$71 \pm 16\%$	$38 \pm 7\%$
ΔPaCO_2	$26 \pm 4\%$	$26 \pm 7\%$

2. PaCO_2 before and after the modifications: 37.8 ± 8.1 mmHg and 37.2 ± 8.1 mmHg. The correlation between calculated and measured PaCO_2 : $r = 0.93$.
($y = 1.12x - 3.11$) ($p < 0.001$).

CONCLUSION 1. The VeCO_2 continuous monitorization identifies the point when the new steady state is reached after a change in ventilatory parameters. 2. The metabolic monitor is a useful technique to predict the PaCO_2 that results from these modifications.

Intensive Care Unit, Hospital La Paz, Paseo de la Castellana 261, 28046 Madrid. SPAIN.

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CLINICAL INFORMATION SYSTEMS (CIS): DO THEY CHANGE THE WAY WE WORK?

M. Imhoff

OBJECTIVES: Clinical Information Systems (CIS) can successfully replace paper-based documentation systems on the ICU. We tried to investigate whether CIS do not only change the working environment but may modify the work process on the ICU.

DESIGN: Prospective observational study on a 16-bed surgical ICU of a tertiary care center.

METHODS: In June 1992 a commercially available, unix-based CIS was installed on a 16-bed surgical ICU. During a transition period of 18 months the handwritten documentation was continued at 8 beds. The process of providing care with and without CIS was compared prior to, during, and after the transition period. Three aspects of the care process were analyzed: (a) documentation and patient record, (b) communication between health care professionals, and (c) planning of therapy and care.

RESULTS AND STATISTICAL ANALYSES: The area immediately and most obviously affected by the introduction of a CIS is the bedside documentation. The number of data objects that can be documented in a given time period is increased. Device related data can be automatically documented. Thus the intensity and comprehensiveness of data documentation is increased. The actual time sequence of the work flow did not change, which is most obvious in the documentation of non device related data such as patient observation and nursing procedure charting. Automatic calculations, especially fluid balance, offer the most felt workload reduction for nurses. The flow of information is the more affected the less frequent the health care professional has to directly interact with the patient. Nurses and physicians constantly on the ICU rely primarily on verbal communication and refer the CIS only for specific data retrieval, whereas attending physicians during official rounds retrieve their information to a major extent from dedicated review flowsheets that filter the most important physiological data. The concepts and the process of therapy planning are not changed by the CIS, as well as the medical principles of care. The striking difference is the consistency in which established standards can be applied through predefined worklists.

CONCLUSION: The installation of a CIS on a SICU only gradually changes the process of care. Documentation is changed in intensity, comprehensiveness and precision, whereas flow of information on the ICU is still mostly based on interpersonal, verbal communication. A CIS allows to consistently implement established medical standards and concepts. The major impact a CIS can have on the way we work on an ICU is the reduction of inter- and intraindividual variability in the process of care, the preprocessing of medical data, and the relief from repetitive, error-prone computational tasks. CIS can not change our medical concepts but can help to enact them more successfully.

Chirurgische Klinik, Städt. Kliniken, Beurhausstr. 40, D-44137 Dortmund, Germany

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4 YEARS PAPERLESS DOCUMENTATION WITH A CLINICAL INFORMATION SYSTEM (CIS) ON A SURGICAL INTENSIVE CARE UNIT

M. Imhoff, J.H. Lehner, D. Löhlein

OBJECTIVES: With the increasing number of commercially available CIS it still appears to be unclear whether they really can meet the needs for bedside ICU documentation. We evaluated the quality and efficiency of a computerized ICU documentation system.

DESIGN: Prospective observational study on a 16-bed surgical ICU.

METHODS: In June 1992 a commercially available, unix-based CIS was installed on a 16-bed surgical ICU. The goal was a paperless documentation at the bedside. After 4 years clinical experience with the system it was analyzed, whether the documentation could meet the users' demands and whether documentation was time-efficient.

RESULTS AND STATISTICAL ANALYSES: The current implementation of the CIS contains all parts of the patient record, including medication orders and plans of care. All documentation functions and standards that had been used prior to the CIS could be implemented in the bedside workstations. 100% readability, automatic data transfer and calculations reduce the probability of errors. Compared with the handwritten documentation the number of documented parameters could be increased from a maximum of 140 to a current maximum of more than 1500 without a greater expense of time. Automatic calculations, especially intake/output, and automatic data transfer result in time savings of up to 45 minutes per day per patient. Other areas require a more time due to a more comprehensive documentation, such as plans of care and nursing procedure charting, so that the overall time expense is similar to the handwritten documentation. In emergency situations automatic data transfer and a dedicated emergency flowsheet allow for the first time continuous on-line charting of all parameters and interventions. Plan of Care and medication flowsheets provide standards for treatment and care and provide the basis for consistent quality control. These tools may eventually allow a more efficient use of the expensive resources of the ICU. The patient record is available at all places throughout the ICU and cannot be lost. It is also immediately available for later review and at readmission of a patient. It was also observed, that maintaining and configuring a CIS require a considerable effort and expense in man-power and money.

CONCLUSION: The paperless medical record on the ICU with a CIS is far superior to paper-based solutions. It allows a more precise, comprehensive and reproducible documentation without additional workload. But due to the increasing pressure of health care costs, expensive equipment such as CIS can only be justified if they can also be used for automatic accounting and costs analysis. From the clinical perspective it appears that the users themselves are the central determinant whether a CIS can really improve work in the ICU.

Chirurgische Klinik, Städt. Kliniken, Beurhausstr. 40, D-44137 Dortmund, Germany

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THE ROLE OF CLINICAL INFORMATION SYSTEMS (CIS) IN BEDSIDE CLINICAL DECISION MAKING

M. Imhoff

OBJECTIVES: To investigate whether the data documented and stored in Clinical Information Systems (CIS) can be used to support decision making in intensive care.

DESIGN: Prospective observational study on a 16-bed surgical ICU of a tertiary care center.

METHODS: In June 1992 a commercially available, unix-based CIS was installed on a 16-bed surgical ICU. After bedside documentation with the CIS had been successfully established in the routine process of care two projects of further data processing were implemented: (a) on-line statistical analysis of monitoring data with time series analysis techniques (ARIMA), and (b) process control in the delivery of care for prevention of nosocomial pneumonia.

RESULTS AND STATISTICAL ANALYSES: For the analysis of monitoring variables at 1 min intervals ARIMA models were developed for an estimation period of 30 min. Prediction values from these models for the following data points were then compared to the actual values. With these models in all cases pathological changes could be differentiated from random variance. In patients after liver resections the effect of therapeutic interventions on hepatic venous oxygen saturation was estimated with interrupted ARIMA models. The time series before the therapeutic intervention was compared to changes under intervention using the same model including an intervention regressor. With all therapeutic interventions in all patients clinically relevant therapeutic effects could be statistically identified. Similarly, non-effective therapeutic maneuvers could be detected early, and eventually changes in therapeutic strategy initiated.

In an effort to control nosocomial pneumonia complete process control for nursing procedures was implemented for all relevant interventions. The resulting process instructions were implemented in the electronic plan of care. With an acceptable expense in workload a limitation of the inter- and intra-individual variance of quality of care could be achieved which could be measured by a reduction of individual errors in the delivery of care. Whether these changes result in an improved rate of complications is subject of an ongoing prospective clinical study.

CONCLUSION: Secondary data analysis from a CIS can help in the bedside decision process. Time serious analysis can provide statistical help in the evaluation of on-line monitoring data and of therapeutic interventions. Moreover, process control concepts integrated into the CIS can improve consistency and reproducibility in clinical decision making. The important advantage is that a CIS helps to realize these concepts of decision support without a major increase in workload for the health care professional.

Chirurgische Klinik, Städt. Kliniken, Beurhausstr. 40, D-44137 Dortmund, Germany

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QUANTIFICATION OF THE EFFECT OF p50 CHANGES ON PvO₂G. Vignali, A. Guadagnucci, M. Mariotti, A. Baratta, A. Vignali¹, A. Rutili, G. Tullii²

The effect on mixed venous pO₂ of a shift to the left in the oxygen hemoglobin binding curve (OBC) depends on the difference between the arterial oxygen content (CtO₂) and the artero-venous oxygen content differences C(a-v)O₂ of the basal and shifted curves. To quantify this effect we calculated pxO₂ (ie the value of PvO₂ if no changes in p50 would have occurred) in 20 critically ill patients. pxO₂, obtained by a modification of Siggaard-Andersen computerized algorithm, is determined by the patient's CtO₂, C(a-v)O₂ and the p50.

Objectives: To compare PvO₂ measured with pxO₂.

Methods: 40 artero-venous paired blood samples, drawn before and after that a leftward shift in p50 >10% was occurred, were analysed at 37°C using the ABL500 Radiometer for pO₂, pCO₂ and pH, and the OSM3 Radiometer for HbO₂%, HbCO% and MetHb%. p50 was calculated on mixed venous blood using Siggaard-Andersen's computerized algorithm. The program was therefore modified to allow the generation of the OBC from venous p50 values. The program was tested to recalculate PvO₂, on the OBC, subtracting from CtO₂ the C(a-v)O₂ values. pxO₂ was calculated, on the OBC generated from basal p50 values, subtracting from CtO₂ the C(a-v)O₂ measured after that the leftward shift in OBC was occurred. Mean time between paired measurements was 9.1 ± 2.2 hours.

Results: The modified program allowed the calculation of PvO₂ and a close linear relationship between PvO₂ measured and PvO₂ recalculated was found (N° 40, R-squared=0.99%, p<10⁻⁷). Recovery from acid-base disturbances induced a decrease in p50 from 32.1±5.4 to 26.2±2.4 mmHg, p<10⁻⁶. The leftward shift of OBC, without significant changes in either CtO₂ or oxygen uptake, caused a decrease in PvO₂ from 38.3±7.6 to 32.5±4.8 mmHg, p<0.005. pxO₂ was significantly higher than measured PvO₂ (40±6 versus 32.5±4.8 mmHg, p<10⁻⁶). Changes in p50 were strongly related to the differences between pxO₂ and PvO₂ (N° 20, R-squared= 92.6%, p<10⁻⁶).

Conclusion: These data show that the shift to the left of the oxygen binding curve account for the decrease in PvO₂ occurring with recovery from acid base disturbance. Calculation of pxO₂ could be a useful tool to quantize this effect.

² ICU, S. Giovanni di Dio Hospital, Firenze. ¹ L.S. E. Fermi, Massa. ICU, S.S. Giacomo e Cristoforo Hospital, 54100 Massa, Italy.

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EFFECTS OF DOBUTAMINE INFUSION ON OXYGEN SUPPLY DEPENDENCY IN PATIENTS WITH SEPTIC SHOCK

C Sanft, C Spies, G Oschmann, W Schaffartzik

OBJECTIVES: Oxygen delivery (DO_2) and oxygen consumption (VO_2) are increasingly monitored parameters in critically ill patients. There still remain controversies about an oxygen supply dependency in critical illness particularly with respect to VO_2 determination by either indirect calorimetry (VO_{2m}) or fick calculation (VO_{2c}). The purpose of this study was to investigate the changes in VO_{2m} and VO_{2c} following DO_2 increase by dobutamine infusion in sepsis.

DESIGN: Prospective controlled study in an intensive care unit.

SUBJECTS: 30 patients in septic shock.

METHODS: Following approval of the ethical committee and written informed consent from the relatives baseline measurements were performed and then DO_2 increased by dobutamine infusion starting with 5 $\mu\text{g/kg/min}$ up to a maximum dose of 10 $\mu\text{g/kg/min}$. Calorimetry was obtained with the Metabolic Monitor 7250 integrated in the Ventilator 7200 (Puritan Bennett, Carlsbad, CA).

RESULTS AND STATISTICAL ANALYSES: Results were expressed as mean $\pm$ standard deviation.

	baseline	dobutamine 5 $\mu\text{g/kg/min}$	dobutamine 10 $\mu\text{g/kg/min}$
VO_{2c} (ml/min/m ²)	145 $\pm$ 24	150 $\pm$ 24 *	156 $\pm$ 21 **
VO_{2m} (ml/min/m ²)	178 $\pm$ 33	184 $\pm$ 31 ***	188 $\pm$ 21 ***
DO_2 (ml/min/m ²)	640 $\pm$ 201	709 $\pm$ 195 ***	778 $\pm$ 210 ***
VCO_2 (ml/min/m ²)	139 $\pm$ 24	145 $\pm$ 26 ***	147 $\pm$ 18 ***
RQ	0.80 $\pm$ 0.05	0.80 $\pm$ 0.05	0.79 $\pm$ 0.05
PCWP (mmHg)	14 $\pm$ 3	14 $\pm$ 3	14 $\pm$ 2 *
CI (l/min/m ²)	4.6 $\pm$ 1.5	5.2 $\pm$ 1.5 ***	5.7 $\pm$ 1.6 ***

Table 1 Hemodynamic, blood gas and metabolic parameters during dobutamine infusion. *** = $p < 0.001$ ** = $p < 0.01$ * = $p < 0.05$ versus baseline.

A Student's paired t-test corrected by z-transformation was used to compare baseline and final measurements. A $p < 0.05$ was considered significant.

CONCLUSION: With the new ventilator-integrated Metabolic Monitor 7250 accurate and continuous monitoring of calorimetric data in critically ill patients is available. In contrast to previous studies using indirect calorimetry the new Metabolic Monitor shows a moderate oxygen supply dependency which may be related to the integrated algorithms using ventilatory parameters. However, this requires further investigations.

Intensive Care Medicine, Benjamin Franklin Hospital, 12200 Berlin; Germany

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NEAR-INFRARED MEASUREMENT OF CEREBRAL OXYGENATION IN THE PERIOPERATIVE PHASE OF LIVER TRANSPLANTATION

T Gondos, M. Árkosy

OBJECTIVES: To investigate the clinical value of the non-invasive monitoring of regional cerebral oxygenation by reflective near-infrared spectroscopy during liver transplantation.

DESIGN: Retrospective analysis of a prospectively collected database.

SUBJECTS: Ten adult patients in the intra- and early postoperative phase of orthotopic liver transplantation (OLT).

METHODS: Those patients were involved in this preliminary study who had continuous hemodynamic monitoring in the intra- and early postoperative phase of OLT completed by monitoring of cerebral oxygenation using cerebral spectroscopy (INVOS 3100, Somanetics, Michigan, USA). The patients with unreliable spectroscopic sign (2 cases with primary biliary cholangitis) were excluded from this study. Every patient was treated by the same surgical and anesthesiological protocol. From the whole database only the following most important parameters, in respect of cerebral oxygenation, were analysed: regional cerebral oxygen saturation (rSO_2), mixed venous oxygen saturation (SvO_2 - OPTICATH, Abbott GmbH, Wiesbaden), cardiac output (CO - thermodilution technic, Hewlett-Packard bedside monitor), and the mean arterial pressure (MAP). Regression analysis was used to evaluate the relationships among these parameters.

RESULTS: 98 data sets were analysed. The average rSO_2 value was $68.1 \pm 7.2\%$, SvO_2 was $79.2 \pm 7.3\%$, CO was 7.9 ± 2.2 l/min, and MAP was 79 ± 11 mmHg. No significant correlation was found among these parameters when they were analysed as a whole (rSO_2 vs. SvO_2 $r=0.137$, rSO_2 vs. CO $r=0.286$, rSO_2 vs. MAP $r=0.378$). However, at revascularization it was found that rSO_2 value decreased parallel by the decrease of MAP and CO, therefore the data were divided into two groups: Group A - MAP > 70 mmHg (n=65), Group B - MAP ≤ 70 mmHg (n=33). In Group A the correlation did not change significantly (rSO_2 vs. SvO_2 $r=0.316$, rSO_2 vs. CO $r=0.060$, rSO_2 vs. MAP $r=0.290$). In Group B the correlation coefficients improved significantly (rSO_2 vs. SvO_2 $r=0.663$, rSO_2 vs. CO $r=0.643$, and rSO_2 vs. MAP $r=0.423$).

CONCLUSION: Even this is a preliminary study with low case number, it seems to us, that monitoring of the cerebral oxygenation status by near-infrared spectroscopy is a useful tool for preventing prolonged cerebral hypoxia during OLT, because it gives an early warning sign to the altered cerebral perfusion and metabolism.

Intensive Care Unit, Transplantation and Surgical Clinic, Semmelweis Medical University, 1082 Budapest, Baross u 23. Hungary

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TRANSESOPHAGEAL ECHOCARDIOGRAPHY AND POST-OPERATIVE EVALUATION OF LEFT VENTRICULAR PERFORMANCE

Jović M, Popović Z, Radomir B, Ilić V, Panić G, Babić M, Popović A, Bojić M

OBJECTIVES: To evaluate left ventricular function after mitral valve replacement (MVR) for mitral valve regurgitation (MR)

DESIGN: The randomised prospective study.

SUBJECTS: Intra and postoperative usage of TOE has provided us with the opportunity to monitor and evaluate ventricular volumes and wall motion, as well as valve function. But, this leaves us without information about the dynamic performance of the ventricle as the pump. The indices based on pressure-volume relationships may be useful in these situations.

12 pts (8 men, 4 women, ages 48 ± 7 years, EF $60 \pm 8\%$) with grade III-IV mitral regurgitation were divided in two groups: Group A (undergoing MVR with preservation of annulo-papillary continuity) and Group B (undergoing MVR with chordal severance)

METHODS: LV volume (by M-mode TOE) was measured simultaneously with radial artery and pulmonary capillary wedge pressures. Load was varied by NTG bolus. LV elastance (Eps), calculated as a slope of the peak systolic pressure/end systolic volume ratio. Measurements were done before CPB, at the end of operation, 12 hours later in the ICU and 10 days later.

RESULTS: Eps. declined in both groups after CPB ($p=0.018$), but the decrease was greater in Group B ($p=0.06$). Eps correlated well with systolic pressure/end systolic volume ratio ($R=0.85$). However, systolic pressure/end-systolic volume ratio showed a smaller decline ($p=0.037$).

CONCLUSION: Eps, a load independent index of LV function, proved to be a sensitive means of assessment of post-operative LV dysfunction in our patients. This may improve decision-making concerning pharmacological intervention in the post-operative period.

Department of Anaesthesia Institute of Cardiovascular Diseases "Dedinje", Milana Tepica 1, 11000 Belgrade, Yugoslavia

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EVALUATION OF PRELOAD INDICATORS IN A GROUP OF MECHANICALLY VENTILATED CRITICAL PATIENTS
E Pierucci, C Ghermandi, A Morigi, R Morgagni, M Nastasi, R Rossi, G Martinelli

OBJECTIVES: The aim of this paper is to analyse the validity and clinical utility of traditional preload indicators, as central venous pressure (CVP) or pulmonary capillary wedge pressure (PCWP), and the meaning of a pure volume indicator, as intrathoracic blood volume (ITBV). **DESIGN:** Prospective, non intervention study. **PATIENTS:** Twenty-six patients, who entered ICU in consequence of medical or surgical pathologies (1st day mean SAPS II: 50, SD: 15, limits: 23 - 74; mean age: 57 yrs, SD: 17.4, limits: 22 - 79). **METHODS:** After six hours of ICU stay, a 7.5 F pulmonary artery catheter and a 4 F femoral artery catheter, with thermistor and fiberoptics, were inserted in all patients. The catheters were connected to "COLD System" (Pulsion Medizintechnik, Munchen, FRG), an integrated monitoring system which uses double indicator technique and measures blood volumes, as ITBV (expressed in mL/m² BS). All patients were in CMV (PEEP < 8 cm water), haemodynamic management was realized in order to optimize cardiac output (CI) and oxygen delivery (DO_2). Infusion of crystalloids and colloids was guided by measurements of CVP and PCWP. All parameters were measured at the beginning of the study (T0), and after 6 (T1), 12 (T2), 24 (T3) and 36 (T4) hours. The statistical analysis was performed studying the relationships between preload parameters and CI or DO_2 , considering the absolute values in the times of study or the 6,12-hours differences (d). The test of linear correlation was used and the value of Pearson's coefficient (r) was analysed. Levels of $p < 0.05$ were accepted. **RESULTS AND STATISTICAL ANALYSIS:** There were no relationships between CVP or PCWP and CI, considering absolute values ($r=0.10$, $p=ns$; $r=-0.10$, $p=ns$) or 6,12-hours differences ($r=0.03$, $p=ns$; $r=-0.02$, $p=ns$). A moderate relationship was present for absolute values between ITBV and CI ($r=0.42$, $p<0.001$) or DO_2 ($r=0.36$, $p<0.001$). Good relationships were present in the study of 6,12-hours differences (dCI-dITBV: $r=0.77$, $p<0.001$; d DO_2 -dITBV: $r=0.70$, $p<0.001$). If we consider ten patients who had ITBV < 1000 mL/m² BS in T0, it is possible to observe more interesting relationships between ITBV and CI or DO_2 , for absolute values (CI-ITBV: $r=0.62$, $p<0.001$; DO_2 -ITBV: $r=0.40$, $p<0.005$) and 6,12-hours differences (dCI-dITBV: $r=0.77$, $p<0.001$; d DO_2 -dITBV: $r=0.72$, $p<0.001$). Also in this group there were no relationships between CVP or PCWP and CI or DO_2 . **CONCLUSIONS:** CVP and PCWP may be misleading in management of preload in mechanically ventilated patients, on the contrary ITBV may be useful to optimize haemodynamic condition. This situation is important especially when preload is the main determinant of cardiac output.

Institute of Anaesthesiology and Intensive Care - University of Bologna - ITALY

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Our experience with a "fuzzy" program to drive mechanical ventilation

S. Faenza, F. Cuccolini, G. Martinelli, E. Sarti

Objective

Several systems, regulating the mechanical ventilation, have been proposed. The aim of these methods is connected with the problem of simulating the physiological control, which is over during anesthesia and muscles paralysis or coma. Generally, the control is based on mathematical models. Our purpose is to follow the "fuzzy" logical approach based on experimental data and experience.

Design

We select the following measured variables connected with the ventilation pattern:

- end tidal CO₂ (EtCO₂);
- plateau pressure during inflation (P_{plat});
- peripheral saturation of O₂ (SpO₂);
- inspired fraction of O₂;
- respiratory rate (RR);
- tidal volume (TV).

Methods

A datex capnomatic ultima was connected with a servo ventilator 900c and with a PC Olidata using a fuzzy logic program. 10 patients, subjected to pulmonary lobectomy, have been ventilated following the algorithm.

Results

A correction of data base has been necessary during one lung ventilation. The fig.1 illustrates the relation between the measured parameters and the given ones. Fig.2 illustrates an example of the obtained results on the controlled parameters.

Dept. of Surgery, ICU and Trasplant, via Massarenti 9, 40138 Bologna -Italy-.

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MULTIMODALITY NEUROMONITORING BASED CPP / P(t)O₂ AND THERAPEUTICAL CONSEQUENCES IN CASES OF SEVERE BRAIN INJURY

TJ Kuhn and BL Bauer

OBJECTIVES: Measurement of brain tissue oximetry (P(t)O₂) is a new and helpful monitoring method in situations with brain edema and raised ICP. In order to prevent secondary brain damage by hypoxia and hypotension we indicate this monitoring system as soon as possible after admitting to the neurosurgical ICU.

DESIGN AND SUBJECTS: All patients with severe brain injury (GCS < 8) and CT-findings Marshall > III° are monitored by an ICP-probe (CAMINO) and the LICOX P(t)O₂-probe; the data are fixed in ZEPPELIN NEUROMONITORING-SYSTEM and the ICU-treatment of these patients is based on CPP, MAP and P(t)O₂. The monitoring was done during 8 days (m). The monitoring probes are implanted by a special staff within three hours after admitting the hospital. Further indications for neuromonitoring are SAB IV° and diffuse brain edema in other situations.

Results: Up to now we monitored 20 patients with severe brain injury. (13 male, 7 female) The measurement was applied during an average von 10 days. The presenting data shows significant effects of increasing brain tissue PO₂ in modulating hyperventilation, preoxygenation before tracheal suctioning, in- and decreasing MAP and therapy of bronchospasm. Data will be presented in measuring diffuse brain edema and cerebral hypoxia during cerebral perfusion stop.

CONCLUSION: Multimodality Neuromonitoring is a helpful system in ICU-treatment of severe brain injured patients; optimizing P(t)O₂ to prevent secondary ischemic tissue damages is based on hemodynamic parameters, such as MAP and CPP. CPP should be elevated on levels of > 80 mmHg, MAP should be elevated on levels of >90 mmHg.

Dep. of Neurosurgery, Philipps-University Hospital, Baldinger Straße, D 35033 Marburg/FRG

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EVALUATION OF AN INTEGRATED NITRIC OXIDE DELIVERY/MONITORING SYSTEM

B O'Hare, P Betit, JE Thompson, DL Wessel

OBJECTIVES: We tested a prototype mechanical ventilator with fully integrated mass flow-regulated nitric oxide (NO) delivery and electrochemical (EC) monitoring devices designed for neonatal and paediatric use.

DESIGN: A prospective laboratory model analyzing bias and precision of NO/NO₂ measurements at 64 different ventilator settings, repeated 5 times.

METHODS: We compared "set" NO concentrations that were dialled in, to NO levels that were measured by the prototype's EC instrument positioned on the expiratory side of the circuit and to other EC (NOxBOX) and chemiluminescence (CL) devices on both the inspiratory and expiratory sides. The set versus measured NO were recorded over a range of neonatal (3kg) and paediatric (20kg) conditions: respiratory rates of 12 and 30 breaths per minute; tidal volume of 10 and 18 ml/kg; inspired FiO₂ of 0.21 and 0.9; ventilatory modes of synchronized intermittent mandatory ventilation (SIMV)/Pressure Control (PC) or SIMV/ Volume Control; NO doses of 10 and 80 ppm; with all monitors on the expiratory side. Then, 2 monitors [NOxBOX and CL] were inserted separately in the inspiratory limb and the sequence of measurements was repeated. 640 values were analyzed at 10 and 80 ppm NO.

RESULTS AND STATISTICAL ANALYSES: The bias (estimated mean difference) measured by EC monitors was 10% or less of the set ventilator NO dose. CL measured lower levels of NO at 80 ppm and high FiO₂, consistent with the known errors associated with CL attributable to "quenching".

	Chemiluminescence		NOxBOX		300/NO-B
	Inspiratory	Expiratory	Inspiratory	Expiratory	Expiratory
Bias 10 ppm	-0.3	-1.2	0.1	0.03	1.3
95% CI	(-0.7, 0.2)	(-1.6, -0.7)	(-0.2, 0.3)	(-0.5, 0.6)	(1, 2.1)
Bias 80 ppm	-6.7	-17.6	3.5	0.9	-0.9
95% CI	(-8.3, -5)	(-19, -16.2)	(2.5, 4.4)	(-0.5, 2.3)	(-2.5, 3.1)

CONCLUSION: The Siemens Servo 300/NO-B ventilator accurately delivers and monitors NO in our neonatal/paediatric bench model. An exception occurred for the delivery of NO set at 10ppm in the neonatal model-SIMV/PC mode when 13.7 ppm (mean) was recorded. Further modifications of this prototype ventilator may provide an improved safety and convenience profile for NO treatment in young children compared to existing technology.

Cardiac Intensive Care Unit Office, Farley 653, Children's Hospital, Harvard Medical School, 300 Longwood Ave., Boston, Ma 02115, USA.

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A COMPARISON OF THERMODILUTION AND THORACIC ELECTRICAL BIOIMPEDANCE MEASUREMENTS OF CARDIAC OUTPUT IN PIGS

CJ Broomhead, SJ Wright, KJ Kiff, PS Withington, L Strumlin

Objectives: Thermodilution (TD) is a commonly used method to measure cardiac output. Thoracic electrical bioimpedance (TEB) is a simple, non-invasive method. We have investigated the agreement between these two techniques.

Design: Prospective observational study.

Subjects: Seven large white pigs weighing between 45 and 55 kg.

Methods: The pigs were anaesthetised and Swan-Ganz catheters were inserted. The thoracic bioimpedance monitor was applied. Values were recorded every ten minutes. Infusions of adrenaline were increased in increments of 2.5 mcg/min to produce a range of cardiac outputs.

Results and statistical analysis: Data was collected for TD cardiac outputs from 2 to 15 l/min. A total of 338 paired data points were collected. The correlation coefficient was 0.984 with p<0.01. More importantly data was also analysed according to the method described by Bland and Altman¹. The mean of the differences was 0.01 with a standard deviation of 0.51 and a normal distribution of values. The standard error of the mean was 0.03, and with 337 degrees of freedom, the 95% confidence interval by t-test analysis is -0.05 to +0.07.

Conclusion: There is a good agreement between TEB and TD measures of cardiac output when used in pigs. TEB will be a useful research and clinical tool.

1. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 1986 1(8476):307-10.

Supported by a grant from the Intensive Care Society.
Intensive Care Unit, The Royal Hospitals Trust, Whitechapel Road, London, E1 1BB, United Kingdom.

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SIMPLIFYING NITRIC OXIDE ADMINISTRATION AND ANALYSIS.

JLG Amaral, J-J Roubey, L Gallart, M Munechika, P Coriat

Objectives: Analysis of a simplified method of nitric oxide administration.**Design:** comparison between calculated, electrochemically detected NO/NO₂ concentrations and values obtained in different sites by a rapid response chemiluminescent analyser.**Subjects:** Artificial model.

Method: NO flow (NOF) to get the desired amount of NO [NOd] (1, 5 or 10 ppm) to be administrated continuously (Moryia flowmeter, São Paulo, Brazil) at the inspiratory limb (120 cm from Y-piece) of the respiratory circuit was calculated from Minute Volume (MV) and tank (900 ppm Air Liquid, France) concentration [NOt] using the formula: $NOF = [NOd] \times MV/[NOt]$. Ventilatory (Cesar ventilator Taema, France) parameters were set: FiO₂ 1, VT 550 ml, RR 20/minute, PEEP 10 cmH₂O, Insp. flow 54 l/min (constant), Ti/Tot 30%, Paw max 30 cmH₂O, mean Paw 14 cmH₂O. Two NO/NO₂ analysers were used: the electrochemical NOxBOX (Bedfont, UK) sampling just after the Y-piece, and by the chemiluminescent Sérés 4000 (Aix-en Provence, France) sampling at 4 different sites: 1) just before the Y-piece; 2) at the distal port of a Hi-Lo Mallinckrodt tube between Y-piece and the artificial lung (Dual Lung TTL, Michigan, USA); 3) at the artificial lung; and 4) at the expiratory limb of the circuit. NO/NO₂ concentrations and generated curves were registered (ES 1000 Gould Instr., USA).

Results: Mean, maximal and minimum NO concentrations (ppm) (see text).

Calculated	NOxBox	Insp.Limb	Mallinckrodt	Lung	Exp.Limb
0	0.3	0.0	0.0	0.0	0.0
1	1.2	1.0	1.0	1.4	1.4
		1.3	0.1	1.3	0.9
5	6.0	3.8	5.8	5.6	7.2
		7.6	1.2	7.4	4.9
10	11.4	10.9	11.2	12.2	12.8
		12.2	3.5	12.2	9.3
				10.7	10.3
				13.8	11.6

When detected, NO₂ concentrations were always under 1 ppm.**Conclusions:** Continuous NO flow can be administrated safely and accurately in the respiratory circuit. Rapid response systems shows inspiratory NO concentration oscillations due to accumulation during expiratory phase.

Unité de Réanimation Chirurgicale, D.Anesthésie. GH Pitié-Salpêtrière, 47-83, boulevard de l'Hôpital, 75651 PARIS Cedex 13, FRANCE and D.Anesthésie, Dor & Terapia Intensiva, UNIFESP-EPM, Rua Botucatu, 740 - 04023-900 São Paulo SP BRAZIL

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USEFULNESS OF VOLUMETRIC PULMONARY ARTERY CATHETER IN CRITICALLY ILL PATIENTS.

F.Michard, M.Wysocki, H. Millet, M.A.Wolff, B.Herman

Right ventricular (RV) volumes have been proposed as better index of preload than pressures, but the usefulness of volumetric pulmonary artery catheter (VPAC) to guide fluid loading in critically ill patients remains unclear.

Methods: Between 1992 and 1995, right heart catheterization was systematically performed using VPAC. Post-hoc analysis was done to select valid measures of cardiac index (CI) and RV ejection fraction (REF), i.e. those with ≥ 3 boluses (10 ml of 0-5°C saline randomly started over the respiratory cycle) and no alert message given by the monitor (Explorer® Baxter-Edwards, Irvine, CA). Stroke volume index (SVI) = CI/Heart rate, RV end-diastolic volume index (EDVI) = SVI/REF and variability (standard deviation/mean value) for CI (V_{ci}), REF (V_{ref}) and EDVI (V_{edvi}) were calculated. For V_{ref} <10%, correlation analysis between right atrial pressure (RAP), pulmonary artery occlusion pressure (PAOP), EDVI and SVI were performed and repeated for different EDVI threshold values.

Results: 57 patients had at least one valid measure and a total of 273 were analyzed. V_{ci} was 4.9% $\pm$ 3.8, V_{ref} 9.2% $\pm$ 6.5 (p<0.05 vs V_{ci}), V_{edvi} 9.6% $\pm$ 7.7. For V_{ref} <10% (n=181) no correlation was found between RAP, PAOP and SVI while a significant one (p<0.001) even weak (r = 0.45) was found between EDVI and SVI (graph). Correlation was better for low EDVI values (table). Similar results were obtained when using only one measure (the first) per patient.

Conclusion: REF and EDVI variabilities were large, but significant and clinically relevant correlation was observed between EDVI and SVI for EDVI <100 mL/m², suggesting that VPAC may be useful in hypovolemic patients.

Intensive Care Unit, Institut Mutualiste Montsouris, 75674, Paris, France

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COLD SYSTEM PARTIAL BLOOD VOLUMES, LUNG WATER AND LIVER FUNCTION AFTER CORONARY ARTERY BYPASS-GRAFTING

M.Peyerl, O. Gödje, T. Fischlein, U. Pfeiffer, B. Reichart

Objectives: The purpose of the study was to document the progress of the volumetric variables, lung water and liver function as provided by the arterial thermal dye dilution (aTDD) in postoperative CABG patients (pts).

Methods: 30 pts randomly selected were studied 3, 12, 24 hours after surgery. The COLD system (PULSION) used the aTDD to record the following variables: cardiac index (CIa), stroke volume (SV), the cardiac function index (CFI), intrathoracic blood volume (ITBV), total blood volume (TBV), right heart (RHEDV), right ventricular (RVEDV) and left heart (LHEDV) end-diastolic volume, extravascular lung water (EVLW), plasma disappearance rate (PDR) and whole blood clearance (CB) of the indocyanine green (ICG) dye. Central venous pressure (CVP), pulmonary capillary wedge pressure (PCWP), mean arterial pressure (MAP), heart rate (HR) and Glasgow Coma Scale were measured. Means and standard deviations (sd) have been computed from a total of 270 measurements and compared to a group of uncomplicated non-cardiac (nc) surgical pts on mechanical ventilation (n=27).

Results: (table shows indices; * / # = p < 0.05; * = to previous value; # = 24hour vs nc group)

Variable:	3 hours mean $\pm$ (sd)	12 hours mean $\pm$ (sd)	24 hours mean $\pm$ (sd)	non-cardiac mean $\pm$ (sd)
CIa	3.3 $\pm$ (0.8)	*4.0 $\pm$ (1.0)	3.9 $\pm$ (0.8)	4.2 $\pm$ (0.8)
SVIa	34.2 $\pm$ (7.6)	*43.1 $\pm$ (9.2)	44.5 $\pm$ (9.8)	49.4 $\pm$ (10.0)
HR	98.0 (14.8)	*92.5 (11.6)	88 (12.0)	75.4 (10.2)
CFI	5.0 $\pm$ (1.3)	*5.4 $\pm$ (1.2)	*5.0 $\pm$ (1.0)	6.3 $\pm$ (0.7)
ITBV	865.1 $\pm$ (163.3)	*921.5 $\pm$ (153.3)	*999.0 $\pm$ (230.5)	898.3 $\pm$ (103.2)
CVP	6.6 $\pm$ (2.3)	6.2 $\pm$ (2.5)	5.5 $\pm$ (2.4)	7.1 $\pm$ (3.0)
PCWP	5.4 $\pm$ (2.2)	6.1 $\pm$ (2.1)	*7.5 $\pm$ (2.4)	5.2 $\pm$ (2.1)
TBV	2621.3 $\pm$ (461.1)	*2787.7 $\pm$ (377.6)	*3010.8 $\pm$ (557.4)	2934.3 $\pm$ (312.2)
RVEDVI	111.0 $\pm$ (23.7)	*128.7 $\pm$ (26.9)	128.3 $\pm$ (25.6)	108.3 $\pm$ (18.2)
RHEDVI	252.2 $\pm$ (46.3)	*294.6 $\pm$ (57.8)	294.3 $\pm$ (57.5)	321.1 $\pm$ (52.2)
LHEDVI	444.3 $\pm$ (155.8)	448.1 $\pm$ (114.2)	*507.1 $\pm$ (176.7)	*311.2 $\pm$ (64.2)
EVLWI	6.6 $\pm$ (3.3)	6.2 $\pm$ (2.1)	6.7 $\pm$ (2.8)	6.5 $\pm$ (1.6)
CB	670.2 $\pm$ (208.3)	719.8 $\pm$ (190.3)	721.6 $\pm$ (243.6)	624.9 $\pm$ (126.2)
PDR	25.3 $\pm$ (5.2)	25.7 $\pm$ (5.5)	*23.5 $\pm$ (5.0)	21.5 $\pm$ (3.5)
GCS	5.2	12.1	14.5	-

Conclusion: 1. ITBV, TBV, EVLW, RVEDV, RHEDV, PDR, CB, CVP and PCWP do not show significant differences to the nc group. 2. LHEDV compared to the nc group is remarkably increased, most likely due to the already preoperatively enlarged left ventricle. 3. TBV and ITBV document an increase in circulating blood volume during 24 hours. 4. PCWP does not at all reflect the tremendously increased LHEDV.

Dept. of Cardiac Surgery, University of Munich, Klinikum Großhadern, 81377 Munich

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ACCURACY AND REPRODUCIBILITY OF PULMONARY ARTERY AND ARTERIAL THERMAL AND THERMAL-DYE-DILUTION VARIABLES IN CARDIAC SURGERY PATIENTS

M.Peyerl, O. Gödje, T. Fischlein, U. Pfeiffer, B. Reichart

Objective: Although the trans-cardiopulmonary thermal dye dilution monitoring has gained more and more acceptance, no data has been published so far concerning accuracy and reproducibility compared to pulmonary artery catheter (PAC) thermomodulation.

Methods: The investigation was performed in 30 patients (pts) with uncomplicated postoperative courses after aorto-coronary bypass. Standard hemodynamic monitoring included PAC cardiac index (CIpa) measurements (SIEMENS 1281). Concerning accuracy the same thermal bolus injection was used for calculation of arterial cardiac index (CIa) with the COLD System (PULSION). With regard to reproducibility both the PAC and the arterial thermal dye dilution catheter were connected to the COLD System for calculation of the following variables: CIpa, CIa, the cardiac function index (CFI), intrathoracic blood volume (ITBV), global end-diastolic volume (GEDV), total blood volume (TBV), right heart (RHEDV) and right ventricular (RVEDV) end-diastolic volume, left heart end-diastolic volume (LHEDV), extravascular lung water (EVLW), plasma disappearance rate (PDR) and whole blood clearance (CB) of the indocyanine green dye. Correlation coefficients (r), variation coefficients from 3 repetitive injections (vc) and Bland-Altman analyses were computed from a total of 450 measurements (table shows indices).

Results: The Bland-Altman plot of CIpa vs CIa showed CIa to be larger for 0.17 ± 0.31 l/min/m² (mean $\pm$ standard deviation).

Variable	r	Variable	vc (%)	Variable	vc (%)
CIpa/CIa	0.96	CIa	5.9	RHEDVI	4.8
SVIpa/SVIa	0.95	CIpa	5.1	RVEDVI	6.0
		CFI	3.3	LHEDVI	10.2
		ITBVI	5.9	TBVI	6.8
		GEDVI	6.8	PDR	15.7
		EVLWI	8.8	CBI	17.6

Conclusion: 1. CFI, ITBV, GEDV, TBV, and PAC-derived RHEDV and RVEDV measured with the COLD System show a very good reproducibility. 2. LHEDV measurement is influenced by an asynchronous variation of PAC and arterial thermomodulation. 3. EVLWI was well within the normal range (mean 6.6ml/kg). This is why vc must be interpreted as deviation within the normal range. 4. The higher vc in PDR and CB are caused by successive ICG injections. Preceding injections influence the following measurements causing constantly increasing results. Therefore only the first PDR and CB measurement may be interpreted as an index of global liver function.

Thus volumetric pulmonary artery and arterial indicator dilution measurements with the COLD System have proven to be reliable and reproducible under clinical conditions.

Dept. of Cardiac Surgery, University of Munich, Klinikum Großhadern, 81377 Munich.

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GASTRIC TONOMETRY DURING LIVER TRANSPLANTATION. pH_i - A DELAYED MARKER OF EARLY GRAFT FUNCTION ? **CG Krenn, A Baker, P Krafft, E Narzt, CK Spiss, H Steltzer**

Objectives: Conventionally used markers and examinations of early graft function (EGF) are often time consuming and dependent on numerous factors, besides that results are often misleading.

The purpose of this study was to examine the utility of gastric tonometry, a minimally invasive technique to detect splanchnic oxygenation deficits (1), during liver transplantation (LTX) in comparison to other markers of EGF as CO₂ production.

Methods: Gastric pH_i measurements were obtained serially in 6 consecutive patients, who underwent orthotopic LTX due to cirrhosis (n=5) and acute liver failure (n=1). Measurements were achieved using a gastric tonometer, filled with 3ml of normal saline following the producers instructions. (Trip NGS Catheter, Tonometrics, Mass., USA) Simultaneously arterial and mixed venous blood samples were obtained for blood gas analysis. Samples were taken after induction of anaesthesia (baseline/timepoint 1) in the anhepatic phase (tp2) and after implantation of the graft hourly (tp3,4,etc.) as long as patients were mechanically ventilated. Data were expressed as a mean $\pm$ SD and were calculated using ANOVA.

Results: Baseline pH_i (tp1/ 7,21 $\pm$ 0,23) decreased during anhepatic phase (tp2/ 7,12 $\pm$ 0,21) and increased two hours after revascularisation significantly (tp4/ 7,35 $\pm$ 0,11). In the course of further measurements it remained stable or did not change significantly. Arterial pCO₂ decreased from baseline (tp1/ 32,1 $\pm$ 4,4) to anhepatic phase (tp2/ 31,4 $\pm$ 3,1) and increased shortly after revascularisation of the liver (tp3/ 37,3 $\pm$ 2,0) significantly. (graph)

Conclusion: PH_i changed significantly during LTX. Due to the limited experience we are unable to determine the importance of gastric tonometry as a marker of EGF yet.

1) Int.Care Med 1994;20:452

Dept. of Anest. and Int. Care, Univ. of Vienna, Waehringer G. 18, A -1090 Vienna

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Spectral edge frequency in patients with severe head injury **H. Theilen, M. Ragaller, D.M. Albrecht**

Objectives: It has been claimed that spectral edge frequency (SEF) is a suitable item for the estimation of the depth of anaesthesia [1]. These investigations have been performed in patients without an underlying cerebral dysfunction. However, the question arises whether this method is as appropriate for sedated patients on intensive care unit (ICU) with an additional impairment of cerebral integrity.

Methods: To investigate this issue we measured 90% - SEF in 12 patients with cerebral injury for 24 hours on ICU who required mechanical ventilation. The results were correlated with the grade of sedation and the plasma concentration of benzodiazepines, which has been used as sedative if necessary. Furthermore, the mean frequency of the native EEG has been estimated to assess the extent of alteration of the electrophysiological cortical activity and has been compared with the 90% - SEF. The grade of sedation has been classified by the addition of the Glasgow Coma Score and a 5-scale-sedation score subdivided according to the clinical reaction of the patients to endotracheal suctioning. **Results:** The mean SEF of all 12 patients investigated has been 10.27 $\pm$ 4.35, the mean sedation score was 9.7 $\pm$ 3.96. The benzodiazepine-concentration ranged between 11.7 and 652.3 nmol/l. The correlation-coefficient of SEF and the grade of sedation has been 0.3, the correlation-coefficient of SEF and the plasma-benzodiazepine-concentration has been 0.17. The correlation coefficient between the frequency of the native EEG and SEF has been 0.93. **Conclusions:** According to the results of the present study spectral edge frequency is not a suitable method to estimate the depth of sedation in patients with an existing cerebral injury. However, the inadequate measurement is not caused by the inability of SEF to represent the electrical activity of the brain but by the underlying cerebral dysfunction thus causing an altered cortical electrical activity in the brain. Since native EEG and SEF showed a pronounced correlation SEF might be able to monitor cortical activity in sedated patients on ICU.

1. Gurman GM (1994). Assessment of depth of general anesthesia. Observations on processed EEG and spectral edge frequency. Int J Clin Monit Comput 11: 185-189

Universitätsklinikum Dresden, Dept. of Anaesthesiology, Fetscherstraße 74, D-01307 Dresden, Germany

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THE REALATIONSHIP BETWEEN GASTRIC MUCOSAL pH AND APACHE III SCORE AFTER CARDIAC SURGERY (INITIAL RESULTS) **J Llagunes, JC Catala, JI Marques, JJ Peña, D Barbas, F Aguar, F Grau**

OBJECTIVES: To evaluate the relationship of gastric mucosal pH_i and APACHE III in the first postoperative day

DESIGN: Prospective study.

SUBJECTS: After etical committee approval and informed consent, 16 postoperative cardiac patients were studied. Exclusion criteria: EF<0.4, hepatic, pulmonary or renal disfunction and oesophageal or gastric pathology.

METHODS: For monitoring splanchnic perfusion a tonometer was inserted into the stomach, and pH_i was calculated at 6 (T1) and 18 (T2) hours after admission to the ICU. The APACHE III was recorded the next morning after surgery (T2). The Henderson-Hasselbach equation was used in order to calculate the gastric mucosal pH_i. pCO₂ was obtained from samples of saline from tonometer and bicarbonate concentration from blood samples. Samples were analyzed in Radiometer ABL 505 (Copenhagen, Denmark). All patients were given ranitidine po before surgery and iv in the ICU. Linear regression was used to analyze changes in postoperative pH_i values and APACHE III. All values were expressed as mean $\pm$ SD.

RESULTS: pH_i mean were 7,33 $\pm$ 0,08 and 7,35 $\pm$ 0,08 at T1 and T2 respectively. There were no differences in pH_i at T1 or T2 between CABG and valvular surgery. There was not correlation between APACHE III and pH_i at T1 and T2 in all patients. In two patients were complications, one died and the other has a poor neurologic prognosis, pH_i values were normal in both and APACHE III was 43 and 54 respectively.

CONCLUSION: This study suggests that gastric mucosal pH_i in postoperative heart surgery patients is not a good predictor of severity of illness.

Intensive Care Unit, University General Hospital, Tres Cruces s/n, 46014-Valencia. Spain

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CORRELATION BETWEEN EXTRAVASCULAR LUNG WATER (EVLW) AND DIFFERENT PARAMETERS QUANTIFYING LUNG INJURY

Navarrete-Sánchez, I., Ruiz-Bailén, M., Guerrero-López F., Colmenero-Ruiz M., Fernández-Mondéjar E., Vázquez-Mata G.

Introduction: The determination of Extravascular Lung water (EVLW) permits the quantification of pulmonary oedema in critical care patients. The objective of this paper is the analysis of the correlation between EVLW and different parameters employed in the quantification of lung injury: "Lung Injury Score" (LIS), PaO₂/FiO₂ and Qva/Q_t ratios.

Material and method: We performed 29 determinations of EVLW by the Double Indicator method (using "Pulsion COLD 2 021" computer) in seven patients admitted to our ICU for acute respiratory failure. These results were correlated with the above-mentioned parameters.

Results:

Conclusions: Our study demonstrates a very good correlation between EVLW and LIS, and a good correlation between EVLW and PaO₂/FiO₂ and Qva/Qt ratios.

INTENSIVE CARE UNIT. HOSPITAL "VIRGEN DE LAS NIEVES". GRANADA. SPAIN

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SUPRASTERNAL DOPPLER ULTRASOUND DOES NOT IDENTIFY HIGH RISK SURGICAL PATIENTS

F.J. Lamb, A Rhodes, D Duane, RM Grounds and ED Bennett

Objectives: Shoemaker was able to identify patients who were at high risk from postoperative morbidity and mortality [1]. Boyd reported that increasing their oxygen delivery (DO₂) above 600 ml/min/m² markedly reduces these risks [2]. The suprasternal Doppler ultrasound (DU) maybe a non invasive method to identify these patients before surgery.

Design, subjects & methods: Forty nine surgical patients fulfilling Shoemaker's criteria were studied before surgery with the DU and minute distance (MD), stroke distance (SD), peak velocity (PV) and corrected flow time (Ftc) were recorded from the aortic arch, transcutaneously. The patients' routine care included insertion of a pulmonary artery and radial artery catheters. Arterial blood was analysed for haemoglobin concentration (Hb) and oxygen saturation (SaO₂). Right atrial (RAP) and pulmonary artery occlusion pressures (PAOP) were recorded and using the thermodilution technique, cardiac output (CO) was measured and indexed oxygen delivery was calculated.

Results & statistics: Prior to intervention 5 patients of the 49 achieved a DO₂>600 ml/min/m² and 44 did not. The data are presented as medians (ranges), and the 2 groups were analysed using the Mann Whitney U test, significance was set at p<0.05. The group with high DO₂ were significantly younger, 56(43-74) vs 73(49-92) years and less vasoconstricted, systemic vascular resistance 1051(747-1276) vs 1541(649-3420) dynes s cm⁻⁵. SD measured by DU, decreases with age and overall actual SD for all the patients was 77% of the normal age predicted value [3]. Four of 5 patients who achieved a DO₂>600 ml/min/m² had a measured SD less than predicted and as did 28 of 44 patients in the DO₂<600 ml/min/m² group. For these two groups the ratios of actual SD to the age predicted value were calculated and were not significantly different, 0.77 (0.29-2.21) vs 0.78 (0.43-1.10) cm. There was no difference between the two groups for the other measurements acquired using the DU, MD 1073(114-1411) vs 697(232-2400) cm, PV 61(45-71) vs 51(24-87) cm/s and Ftc 0.44(0.32-0.60) vs 0.35(0.24-0.63) ms.

Conclusions: Forty four patients of the 49 identified by Shoemaker's criteria needed preoperative therapy to increase their oxygen delivery when they were assessed using a PA catheter. From the DU, measurement of SD can be used to monitor left ventricular function and it showed there was impaired ventricular function in both groups. However the DU did not identify patients who did not need treatment before surgery.

1 Shoemaker Chest 88;94:1176. 2 Boyd JAMA 93;270:2699. 3 Metcalfe Lancet 89;1371.

Dept of Intensive Care Medicine, St George's Hospital, London, UK SW17 0QT