Oral Sessions
Acute lung injury: Diagnosis and lung mechanics: 0389–0393

0389

DIAGNOSTIC STRATEGIES IN CANCER PATIENTS ADMITTED TO THE ICU WITH ACUTE RESPIRATORY FAILURE: A MULTICENTER RANDOMIZED CONTROLLED TRIAL

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CONTEXT. Fiberoptic bronchoscopy with bronchoalveolar lavage (FO-BAL) is an invasive diagnostic investigation that may cause respiratory deterioration in hypoxemic patients. Recently introduced noninvasive diagnostic tests may have modified the risk/benefit ratio of FO-BAL in cancer patients.

OBJECTIVE. To determine whether FO-BAL in cancer patients with hypoxemic ARF increases the need for mechanical ventilation (MV). A major secondary objective was to assess diagnostic benefits from FO-BAL added to noninvasive tests.

DESIGN. Multicenter randomized controlled trial.

SETTING. 16 intensive care units in France.

PATIENTS. 219 cancer patients with ARF of undetermined etiology not on MV at inclusion.

INTERVENTIONS. Early FO-BAL. Noninvasive diagnostic tests were performed in both groups.

MAIN OUTCOME MEASURES. The primary endpoint was the need for MV. The major secondary endpoint was whether noninvasive testing without FO-BAL was not inferior to noninvasive testing with FO-BAL. Sample size calculations were performed for both these endpoints.

RESULTS. 15% of patients had solid tumors and 85% had hematological malignancies. There were 36.1% neutropenic patients and 25% hematopoietic stem-cell transplant recipients. Treatments at ICU admission included antibacterial (80%), antifungal (29%), and antiviral (15%) agents. We found no significant differences regarding the need for MV (35.4 and 38.7% of patients in the invasive and noninvasive groups, respectively), proportion of patients with no diagnosis (20.4 vs. 21.7%), or 28-day mortality (29 vs. 33%). In the invasive-strategy group, the cause of ARF was identified by FO-BAL (performed within 1 (0-1) day after ICU admission) only in 18% of patients and by noninvasive tests only in 45% of patients ($P < 0.0001$).

CONCLUSIONS. FO-BAL in critically ill cancer patients with ARF did not increase the need for MV. Noninvasive testing alone was not inferior to noninvasive testing plus FO-BAL for identifying the cause of ARF. Patients with negative noninvasive tests on day 3 did not benefit from second-line FO-BAL. (ClinicalTrials.gov number, NCT00248443).

0390

FORAMEN OVALE OPENING DURING RECRUITMENT MANEUVER IN ALI/ARDS PATIENTS

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INTRODUCTION. Foramen ovale (FO) is a natural interatrial channel that seals soon after birth. However, it may persist into adulthood with a prevalence of 27% found in autopsy studies. FO may open during reversal of the normal interatrial pressure gradient, when intrathoracic pressure transiently increases (Valsalva maneuver). A recruitment maneuver (RM) resembles Valsalva maneuver and is performed in mechanically ventilated patients to reopen previously unventilated alveoli. Transesophageal echocardiography (TEE) with bubble test (agitated saline) is the "gold standard" to detect a right-to-left shunt. The aim of our study was to identify the prevalence of patent FO in mechanically ventilated patients with ALI/ARDS and to evaluate whether a RM may open a previously sealed FO.

METHODS. All patients who presented with or developed ALI/ARDS during ICU stay were enrolled in the study. Patients were ventilated in pressure control mode with Vt 6 ml/kg and PEEP 5–15 cmH2O. A TEE study with bubble test was performed at baseline and during a RM. The recruitment pressure used was the observed peak pressure in volume control mode when patients were ventilated with Vt 12 ml/kg. Recruitment pressure was applied for 20 s during an inspiratory hold and did not exceed 45 cmH2O. Five-seconds after the inspiratory hold a bubble test was performed through a central venous line and the passage of micro-bubbles to the left atrium was detected. Three subsequent tests were performed in each patient. FO opening was diagnosed by the presence of microbubbles in the left atrium within three cardiac cycles following the injection. Lung mechanics and blood gas exchange data were recorded during baseline and 20 min after recruitment.

RESULTS. Sixty-two patients (52M/10F) were enrolled in the study; among these, 25 presented with ARDS (Murray score ≥3), and 37 with ALI. RM improved the PaO2/FiO2 (from 142 ± 84 to154 ± 74 mmHg, p < 0.01) and lung compliance (from 39 ± 15 to 41 ± 16 ml/cmH2O, p < 0.01). FO was found open at baseline in 19 patients (29%) and it opened during RM in 4 additional patients. Overall PFO prevalence was 37%. The grade of the Right to Left shunt was II to III (6–25 microbubbles or more) in 22 patients. In one patient PFO was grade I at baseline and became grade II during recruitment. No statistical difference was found in the prevalence of PFO between ALI and ARDS patients, probably due to the limited number of patients.

CONCLUSION. In patients with ALI/ARDS there is a high prevalence of PFO (37%). The PFO grade of these patients is II-III and may substantially contribute to the hypoxemia. A recruitment maneuver may induce FO opening in a small number of patients.

0391

INTRA-TIDAL RECRUITMENT-DERECRUITMENT DURING MECHANICAL VENTILATION IN PATIENTS WITH ACUTE LUNG INJURY: A PET/CT STUDY

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INTRODUCTION. One of the mechanisms that has been identified as responsible for the development of VILI is intra-tidal recruitment-derecruiment. This cyclic alveolar opening and closure seems to trigger the inflammation response. By means of combined Positron Emission Tomography (PET) and Computed tomography we previously showed that lungs of patients with Acute Lung Injury (ALI), display an intense metabolic activity likely to reflect inflammation [1].

OBJECTIVES. Aim of this study was to evaluate, in patients with ALI/ARDS, if lung regions undergoing cyclic recruitment-derecruitment show an increased metabolic activity when compared to regions not aerated throughout the entire respiratory cycle.

METHODS. Ten patients with ALI (Age 67.1 ± 10.1, PaO2/FiO2 161 ± 95 mmHg, PEEP 12.5 ± 2.1 cmH2O) were transferred to PET/CT facility. Spiral CT scans were obtained at mean airway pressure, end-expiration, end-inspiration. After an intravenous dose of ^{18}FDG, a dynamic PET acquisition was performed. Lungs' profiles were manually outlined and two sub-regions of interest were obtained: regions not aerated both at end-expiration and at end-inspiration (NotAer), regions not aerated at end-expiration but aerated at end-inspiration (RecDerec). For this sub-regions we computed the ^{18}FDG influx constant (Ki), which reflects the rate of metabolic cellular activation. As the Ki is expected to increase with lung density, Ki were also normalized by the corresponding densities (Ki$_{norm}$).

RESULTS. The amount of NotAer and of RecDerec parenchyma were 36 ± 12 and 3 ± 8% of total lung weight. No difference was observed in Ki values between NotAer and RecDerec regions ($143 ± 78 × 10^{-4}$ ml/min/ml vs. $135 ± 85 × 10^{-4}$ ml/min/ml, $p = $ ns). When Ki values were normalized by the corresponding CT densities, Ki$_{norm}$ of RecDerec remained not higher than values of NotAer ($164 ± 103 × 10^{-4}$ ml/min/ml vs. $145 ± 76 × 10^{-4}$ ml/min/ml, $p = $ ns). The individual differences between Ki$_{RecDerec}$ and Ki$_{NotAer}$ were positively correlated with the duration of mechanical ventilation (r^2=0.5, $p < 0.05$), while no correlation was found with plateau pressure ($r^2 = 0.04$; $p = $ ns).

CONCLUSION. Overall we did not detect an increase in metabolic activity related to cyclic recruitment derecruitment, possibly for the modest amount of lung parenchyma involved; at the same time, however, metabolic activity of regions undergoing cycling recruitment/derecruitment increased (in comparison with regions of persistent collapse) with the duration of mechanical ventilation, suggesting, indeed that cycling recruitment/derecruitment promotes inflammation.

REFERENCE. 1. Bellani G et al (2009) Crit Care Med (in press)

0392

EFFECT OF PRONE POSITION AND PEEP ON CYCLIC RECRUITMENT-DERECRUITMENT (R/D), AND TIDAL HYPERINFLATION (TH) USING CINE-CT. PRELIMINARY DATA

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INTRODUCTION. ARDSnet strategy may not be protective for all patients with ARDS, because TH and expiratory derecruitment has been observed. Studies evaluating prone position (PP) with static CTscan suggest that this strategy could provide more protective mechanical ventilation, and that higher levels of PEEP could prevent expiratory derecruitment in recruiter patients. However, static images may not be a reliable method to assess a cyclic phenomenon. The goal of this study was to evaluate the effect of prone position and PEEP on R/D, and TH using cine-CT during uninterrupted MV with low tidal volume.

METHODS. 6 early ARDS (<72 h) ventilated patients, underwent a protocol in supine and PP at two levels of PEEP (5 and 15). All patients were sedated and paralyzed, connected to a pneumontach (Hans Rudolph, Inc.) including esophageal pressure. Cine-CTs of 12 seconds at 2 cm. above the dome of the diaphragm were performed (Somaton Sensation 64 Siemens; 0.5 s-24 images, 0.36 s/rotation, 24 × 1.2 mm slices, matrix of 512 × 512). Images were analyzed manually with software (PulmoÒ, Siemens). R/D and TH were determined as the change in non-aerated tissue (NAT, −100 to +100 HU), and hyperinflated tissue (HIT, −900 to −1,000) along respiratory cycle, expressed as % of total volume, respectively. The effects of PEEP 5, 15, and supine and prone position, on R/D and TH, were evaluated by t test. $p < 0.05$ was considered statistically significant.

RESULTS. We analyzed 6 patients (53 ± 21 y.o., 3 male), 42 ± 18 h of MV, APACHE II 24 ± 8, SOFA 12 ± 3, SAPS II 48 ± 10, PaO2/FiO2 176 ± 57, and compliance 33 ± 5 ml/cmH2O. R/D decreased when increase PEEP from 5 to 15 (5.3 ± 1.8 to 2.3±1.5% $p = 0.07$). We did not find significant change on R/D comparing supine versus PP ($p = 0.6$). TH increased, but not significantly, after increasing the level of PEEP, and it showed a trend to decrease in PP compared with supine position at PEEP 15 (3.5 ± 1.5 to 2.1 ± 0.9%, $p = 0.10$).

CONCLUSIONS. Although the sample size is small, our preliminary data suggest that R/D seems to be affected favorably by higher level of PEEP, and that prone position could reduce TH compared with supine at the same level of PEEP. Larger sample is needed to confirm these data (this study is already ongoing by our team).
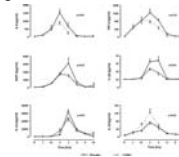
0393

ATTENUATION OF LUNG STRESS AND STRAIN DURING RECRUITMENT FOR ACUTE RESPIRATORY DISTRESS SYNDROME BY PRONE POSITION

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INTRODUCTION. Ventilator induced stress (trans-pulmonary pressure (PL = Pplateau - Peso)) and strain of lung parenchyma (tidal volume (VT)/end-expiratory lung volume (EELV) ratio) constitute major ventilator induced lung injury (VILI) determinants in severe acute respiratory distress syndrome (ARDS). We hypothesized that prone position (PP) may attenuate VILI in patients with early, severe ARDS and high potential for recruitment, which is defined by improved overall gas exchange (PaO2, PaCO2) and chest CT scan after positive end expiratory pressure (PEEP) setting from 5 to 15 cmH2O in volume-controlled ventilation.

METHODS.

Design. Prospective, nonrandomized interventional study.

Setting. Medical and surgical intensive care units, university tertiary care center.

Patients. Twenty-four consecutive patients, with early, severe ARDS and high potential for recruitment. After recruitment maneuver by PCV with incremental PEEP, these patients were ventilated with high PEEP (17 ± 2) and volume controlled mode according to optimal compliance by decremental PEEP trial.

Measurements. Hemodynamic and gas exchange variables were monitored. Respiratory mechanics including PL, lung (Cl), chest wall compliances (Ccw) and EELV were measured in baseline, prone and post-prone position.

MAIN RESULTS. The arterial oxygen tension/inspiratory oxygen fraction (PaO2/FiO2 = 85 ± 11 vs. 138 ± 15, $p < 0.01$) and arterial carbon dioxide tension (PaCO2 = 45 ± 6 vs. 41 ± 4, $p < 0.01$) improved from baseline to prone position. Cl increased and Ccw reduced from baseline to prone position ($p < 0.05$). Prone position resulted in reduced PL (8.8 ± 3.8 vs. 5.1 ± 2.4, $p < 0.05$). EELV increased ($1,022 \pm 103$ vs. $1,460 \pm 145$, $p < 0.01$) and strain of lung decreased from baseline to prone position (0.5 ± 0.08 vs. 0.35 ± 0.05, $p < 0.01$).

CONCLUSION. In early, severe ARDS, prone position can reduce VILI under optimization of positive end-expiratory pressure after recruitment maneuver.

SIRS and sepsis: 0394–0398

0394

MUSCLE OXYGEN CONSUMPTION IS RELATED TO THE DEGREE OF MICRO-VASCULAR DYSFUNCTION IN PATIENTS WITH SEVERE SEPSIS

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INTRODUCTION. Despite adequate resuscitation, microvascular alterations may persist in severe sepsis. Near-infrared spectroscopy (NIRS) has been proposed as a tool to quantify microvascular dysfunction in patients with sepsis. By inducing a vaso-occlusive test (VOT), a variety of NIRS-derived variables can be measured to assess local metabolic demand and microvascular dysfunction.

HYPOTHESIS. Muscle oxygen consumption (VO_2m) is related to the degree of microvascular dysfunction in patients with severe sepsis.

METHODS. Thenar muscle oxygen saturation (StO2) and muscle tissue hemoglobin index (THI) were measured by a tissue spectrometer (InSpectra[TM] Model 650, Hutchinson Technology Inc, MN) in patients with early severe sepsis. A VOT (upper limb ischemia induced by a rapid pneumatic cuff inflation around the upper arm) was performed at admission and after 6 h of resuscitation. The following variables were recorded: THI, the slope of the decrease in StO2 during the occlusion (desc slope; %/min) and the slope of the increase in StO2 following the ischemic period (asc slope; %/sec). VO_2m was calculated as the product of the inverse des slope value by the mean of THI over the first minute of arterial occlusion [1] and is expressed in arbitrary unit (a.u.).

RESULTS. We studied 29 patients (APACHE score: 23 ± 8, mortality rate 13/29 = 45%). During resuscitation asc slope increased in survivors (S) from 2.9 ± 1.1 to 5.0 ± 1.1%/s ($p < 0.001$) but not in non-survivors (NS) (from 1.8 ± 1.5 to 2.1 ± 1.2%/s; p: ns). VO_2m increased during resuscitation in S from 408 ± 134 to 506 ± 121 a.u. ($p < 0.005$) but not in NS (from 252 ± 119 to 232 ± 129 a.u.; p: ns). Both asc slope and VO_2m were higher in S than in NS after resuscitation ($p < 0.001$ and $p < 0.005$, respectively). VO_2m was correlated with asc slope at admission in S and NS ($r^2 = 0.36$, $p < 0.005$ and $r^2 = 0.68$, $p < 0.001$, respectively); after resuscitation, it was still correlated with asc slope in NS ($r^2 = 0.64$, $p < 0.001$) but not in S ($r^2 = 0.0004$, p:ns).

CONCLUSIONS. Muscle oxygen consumption is related to the degree of microvascular dysfunction in patients with severe sepsis before resuscitation. After resuscitation, this relation is still present in non-survivors but not in survivors. NIRS-derived dynamic variables during a VOT could be useful to identify and further resuscitate patients with persistent microvascular alterations.

REFERENCE. 1. Skarda et al (2007) Shock 27:348–353

0395

C1 ESTERASE INHIBITOR DIRECTLY ATTENUATES ACTIVATION OF THE HUMORAL INNATE IMMUNE SYSTEM IN THE ABSENCE OF COMPLEMENT ACTIVATION DURING HUMAN EXPERIMENTAL ENDOTOXEMIA

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INTRODUCTION. Animal experiments have demonstrated that administration of C1 esterase inhibitor (C1INH) can modulate the innate immune response and improve survival in models for trauma and sepsis. Interestingly, these effects appear to be independent from its inhibitory functions on the contact and complement system. During experimental human endotoxia the innate immune system is activated in the absence of contact-complement activation facilitating the study of C1INHs direct immunomodulating effects.

OBJECTIVES. The aim of the present study was to determine if C1INH has direct anti-inflammatory effects during human experimental endotoxemia.

METHODS. In a double-blind placebo-controlled study, 20 healthy volunteers received 2 ng/kg of *E. coli* lipopolysaccharide (LPS). C1INH (100 µ/kg) or placebo was infused after 30 min to prevent direct binding of C1INH to LPS. Afterwards blood was sampled at several time points to determine concentrations of C1INH antigen and activity, C4, cytokines, CRP and adhesion molecules.

RESULTS. In the placebo group, levels of C1 antigen and activity demonstrated a modest increase from 0.22 ± 0.01 to 0.25 ± 0.01 g/l and 1.06 ± 0.03 to 1.17 ± 0.03 U/ml (both $p < 0.01$). In subjects treated with C1INH, levels of C1INH antigen increased from 0.20 ± 0.01 to 0.54 ± 0.03 g/l and C1INH activity increased from 0.94 ± 0.03 to 2.42 ± 0.13 U/ml (over time both $p < 0.01$, between groups, both $p < 0.01$). In agreement with previous studies, concentrations of C4 remained low in both groups (over time and between groups: p = NS).

As illustrated in the figure, IL-6, TNF-α, MCP-1, IL-1β and IL-1RA were all increased following LPS administration. This response is significantly attenuated in the presence of C1INH. Interestingly, C1INH potentiated the production of the anti-inflammatory cytokine IL-10. Concentrations of CRP increased to 39 ± 4 mg/ml in the placebo group compared to 29 ± 2 mg/l in subjects treated with C1INH (between groups: p = 0.02). Concentrations of adhesion molecules VCAM, ICAM and P-selectin were increased during endotoxemia but did not differ between groups. The LPS-induced changes in heart rate, blood pressure and body temperature were also equal in both groups.

CONCLUSIONS. The present study is the first to demonstrate that C1INH administration has direct anti-inflammatory effects during human endotoxemia which are independent from complement activation or binding to LPS.

Effects of C1INH on cytokine concentrations

0396

RELATIONSHIP BETWEEN CARDIOVASCULAR SOFA SCORE AND HLA-DR EXPRESSION IN PATIENTS WITH SEPSIS

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INTRODUCTION. Immune hyporesponsiveness is a commonly reported feature of septic shock and is associated with poor outcome. In animal models of hemorrhagic shock, increased depth and duration of hypotension results in immune dysfunction as demonstrated by leukocyte functional assays [1]. However, this relationship has not been specifically evaluated in hypotension resulting from septic shock or in humans.

OBJECTIVES. To describe the relationship between severity of cardiovascular organ dysfunction defined by SOFA and expression of HLA-DR on the surface of circulating monocytes.

METHODS. We analyzed data from a subset of 567 patients who had cell-surface markers measured by flow cytometry in the GenIMS (Genetic and Inflammatory Markers of Sepsis, NIH R01 GM61992) study, a multicenter inception cohort of 2,320 patients presenting to the Emergency Department with suspected community-acquired pneumonia. We calculated total cardiovascular SOFA scores over the first three hospital days as a measure of the severity of shock. Patients were grouped into low (0, n = 329), intermediate (1, n = 124) and high (2+, n = 91) cardiovascular SOFA categories for purposes of analysis. HLA-DR expression on circulating monocytes was determined by flow cytometry, using standard techniques, from whole blood obtained at day 3 of hospitalization. Expression of HLA-DR on monocytes (calculated as percent gated positive) has been shown to correlate well with leukocyte functional assays and survival [2].

RESULTS. Day 3 HLA-DR expression had a significant inverse association with cardiovascular SOFA scores over the first three study days in one-way ANOVA analysis (low: 76.6 ± 16.0%; intermediate: 75.0 ± 16.6%; high: 67.2 ± 20.0%; $p < 0.0001$). After adjusting for age, race, sex, blood transfusion, comorbidity (Charlson), severity of illness (total noncardiovascular SOFA over first three days), mechanical ventilation use and ICU use, the association remained significant (p = 0.010). Day 3 monocyte HLA-DR expression was depressed in patients with high cardiovascular SOFA compared with low (p = 0.002) and intermediate (p = 0.021). A sensitivity analysis using highest daily cardiovascular SOFA score over first 3 days or highest daily noncardiovascular SOFA score for adjustment yielded similar results.

CONCLUSIONS. Severity of septic shock as measured by cardiovascular SOFA is independently associated with decreased monocytic HLA-DR expression.

REFERENCES. 1. Schmand JF, Ayala A, Chaudry IH (1994) Effects of trauma, duration of hypotension, and resuscitation regimen on cellular immunity after hemorrhagic shock. Crit Care Med 22(7):1076–1083. 2. Monneret G, Venet F, Pachot A, Lepape A (2008) Monitoring immune dysfunctions in the septic patient: a new skin for the old ceremony. Mol Med 14(1–2):64–78

0397

RACE/ETHNICITY IS AN INDEPENDENT PREDICTOR OF 30 DAY AND 1 YEAR ALL CAUSE MORTALITY AMONG PATIENTS HOSPITALIZED WITH SEPSIS

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INTRODUCTION. Sepsis is the tenth leading cause of death in the United States. One-third of patients with severe sepsis and half of all patients with septic shock die during hospitalization. We wanted to assess whether race/ethnicity differences are associated with short term and long term mortality among patients hospitalized with sepsis and severe sepsis.

METHODS. We retrospectively identified a cohort of 23,587 patients aged 50 or older hospitalized with sepsis or severe sepsis in a six year period. Sepsis was identified by primary discharge diagnosis ICD-9 codes. Random chart review showed 87% PPV. Each patient was followed for up to 12 months or until death. Race/ethnicity data were obtained using health plan data bases and geocoding methods. Five groups were identified: white, black, Hispanic, Asian/Pacific islander and others/unknown. The independent effect of race/ethnicity on 30 day and 1 year all cause mortality was analyzed with logistic regression methods adjusting for potential confounders of age, gender, and Charlson index of co-morbidities.

RESULTS. The mean age of the cohort was 72 ± 10 years and 52% were male. The cohort was 61% white, 15% Hispanic, 14% black, 5% Asian/Pacific islander and 5% other/unknown. Mortality rates for the whole cohort were 32 and 51% at the end of 30 day and 1 year follow-up periods, respectively. The hazard ratios for the 30 day and 1 year mortality analysis are shown in the table below. White and black race/ethnicity is associated with a greater risk of death at 30 days and one year in patients admitted for severe sepsis as compared to Hispanics and Asians/Pacific islanders after adjusting for co-morbidities associated with sepsis and mortality. Blacks have higher one year mortality compared to whites.

CONCLUSIONS. There are important racial/ethnic differences in both short term and long term mortality from sepsis patients. These should be taken into account when determining prognosis of patients with sepsis and severe sepsis.

Ethnicity	30 day HR (95% CI)	p value	1 year HR (95% CI)	p value
Black vs. White	1.01 (0.95–1.08)	0.72	1.08 (1.02–1.13)	0.005
Hispanic vs. White	0.89 (0.83–0.95)	0.0007	0.86 (0.82–0.91)	<0.0001
Asian/Pacific Is vs. White	0.88 (0.79–0.98)	0.023	0.90 (0.82–0.98)	0.012
Others/Unknown vs. White	1.05 (0.94–1.17)	0.37	0.89 (0.81–0.98)	0.014

30-day and 1 year hazard ratios
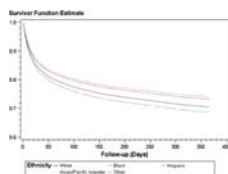
1 year mortality

0398

BUNGEE JUMPING INHIBITS INNATE IMMUNITY BUT ACTIVATES COAGULATION AND VASCULAR ENDOTHELIUM

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BACKGROUND. Critical illness is associated with a profound stress response and the release of endogenous stress hormones. These effects of endogenous stress hormones on the immune system are understudied and incompletely understood due to the lack of appropriate models. We aimed to elucidate the effects of an overwhelming acute stress response induced by a bungee jump on immune system and coagulation.

METHODS. 20 healthy volunteers were included in the study; half of the group was pre-treated for 3 days with the beta receptor blocking agent propranolol (propranolol) others received no pretreatment (control). Volunteers performed a bungee jump from a 70 m high crane placed on hospital grounds. Blood was drawn 2 h before, right before, right after and 2 h after the jump. Samples were analyzed for cytokine levels after ex vivo stimulation with lipopolysaccharide as well as ex vivo phagocytosis of labelled *Escherichia coli*, catecholamine levels and cortisol release as well as parameters of coagulation and fibrinolysis.

RESULTS. Catecholamine levels and plasma cortisol increased briefly but significantly relative to the bungeejump and decreased thereafter. Bungee jumping resulted in a reduced capacity of blood leukocytes to release TNF-α and IL-8 after ex vivo stimulation (Both $P < 0.05$ relative to time of jump). Furthermore, there was a diminished ability of blood monocytes to phagocytose *Escherichia coli*. These alterations were not influenced by the β adrenergic receptor blocker propranolol ($P > 0.05$ control vs. propranolol). In accordance, this immune suppressive phenotype was associated with a rapid down regulation of Lck/Fyn, a kinase recently shown to be involved in corticosteroids mediated immune suppression in monocytes ($P < 0.05$ relative to time of jump). Bungeejumping enhanced activation of the coagulation system and the vascular endothelium as evidenced by increased levels of factor VIII, tissue plasminogen activator, thrombin-antithrombin complexes as well as von Willebrand antigen (All $P < 0.05$ relative to time of jump). This enhanced activation was absent in volunteers pretreated with propranolol ($P > 0.05$ control vs. propranolol).

CONCLUSION. We here demonstrate that humans exposed to acute stress show profound alterations in several host response mechanisms implicated in the host response to infection that vary between inhibitory (innate immune functions such as cytokine production and phagocytosis) and stimulatory (activation of coagulation and endothelium). This immune suppressive phenotype was associated with a rapid down regulation of Lck/Fyn, a kinase recently shown to be involved in corticosteroids mediated immune suppression in monocytes, suggesting a mechanistic role for the brief rise in plasma cortisol levels. Whereas the inhibition of leukocyte functions was mediated via cortisol induced downregulation of Lck/Fyn, the enhancement of coagulation and endothelial cells relied on β adrenergic receptor stimulation by catecholamin.

Mental disorders from ICU to long-term follow-up: 0399–0404

0399

DELIRIUM SCORING AND SEDATION IN A UK ICU

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INTRODUCTION. The UK Clinical Pharmacy Association recommends that delirium assessment should be part of routine intensive care (ICU) management [1]. The Confusion Assessment Method for the ICU (CAM-ICU) allows physicians and nurses to reliably and rapidly diagnose delirium in patients with or without endotracheal tubes [2]. Our aim was to assess the incidence of delirium on our ICU using a validated screening tool, and to investigate its association with illness severity and sedation score.

METHOD. Over a two month period we assessed delirium status (via CAM-ICU) on patients admitted to our district general hospital ICU. We collected data on sedation using the Richmond Agitation-Sedation Score (RASS), APACHE II score, and organ support. Student's t test and Fisher's exact test were used for statistical analyses where appropriate.

RESULTS. We observed 60 patients equating to 318 patient days. The average age was 57.56% were female and 44% male. 38% were surgical patients and 62% medical. 19 (31.7%) patients assessed had delirium at some point during their admission. Prevalence of delirium was 17.3%. 17 of 29 ventilated patients experienced delirium at some point during their admission (59%). Patients who experienced delirium had greater APACHE II scores on admission (21.4 vs. 16.2, $p = 0.01$). Patients with delirium had greater organ support (1.9 organs verses 0.68, $p < 0.0001$). 47 of 73 (64.4%) patient days with a sedation score of less than or equal to −1 had delirium compared to 72 of 190 (37.9%) of patient days with a sedation score of zero or above. Delirium was therefore significantly associated with sedation ($p < 0.0001$).

CONCLUSIONS. Delirium scoring was feasible and easy to apply in a UK ICU. Delirium is common, particularly in ventilated patients and is associated with higher APACHE II scores on admission and greater number of organs supported. Unsedated patients had less delirium than sedated patients and this may reflect the contribution of sedative drugs to delirium or may reflect the difficulty of accurately scoring delirium using the CAM-ICU tool in sedated patients.

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0400

MEMORIES OF THE INTENSIVE CARE UNIT: CONTENTS AND PERSPECTIVES

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INTRODUCTION. The individual role or the set of memories of the Intensive Care (factual and/or delusional), as well as its correlation with the occurrence of psychopathological disorders is not yet entirely explained. The importance of quality of life related with wealth, and the concept of the role of memory, or its absence, has raised curiosity and investigation on this area, remaining the idea that the neurocognitive accompaniment of the patient is an essential tool for the care of the critical patient.

OBJECTIVES. The present study has two main goals: to gather the experiences of Intensive Care related as delusional or factual memories, and to establish its correlation with some psychopathological disorders identified in the post discharge.

METHODS. The authors present the data of a prospective study, that took place at an ICU, and which was obtained at a 6 months follow up consultation where various auto-diagnosis tests were made and an interview guided by a doctor and a nurse took place. The memories were analyzed using the ICU Memory Tool. When measuring the psychopathological damages, three tests were used: Beck, Zung and PTSS-14.

RESULTS. The study comprised 526 patients. 70% didn't remember the time previous the UCI admission; 65% didn't remember the time during their stay in the UCI; 54.3% didn't remember the transfer for the ward; and only 15.1% remembers the entire hospitalization. According to the questionnaires, 27.4% remembered the family, 23.6% faces and 8.9% only remembered the dark. In what concerns the routine procedures, 20.3% remembered the traqueal tube, 19.4% the doctor's visit, 18.3% remembered voices, 16.5% lights, 12% the alarms and 10.1% the moment of aspiration. In what concerns the sensations evoked, 19.6% experienced haziness, 13.3% felt uncomfortable 12.9% were frightened, 11.2% felt pain and discouragement and 5.7% panicked. Hallucinations were recalled in 12.7%, dreams and nightmares in 12.5 and 5.1% felt that there was someone else trying to hurt them. After the hospital discharge, panic was described in 12.2% of the cases, mainly associated to immobilization and post UCI intrusive memories were noticed in 10.5%. Depression was identified in 38% of the patients, anxiety was noticed in 50% and PTSD (posttraumatic stress disorder) risk was recognized in 13% of the survivors. The authors applied a Chi-Square Test and found significant relation ($p < 0.05$) between some memories and risk of PTSD, like pain, dark, confusion, nightmares, intrusives memories and panic.

CONCLUSIONS. The memories (factual or delusional), although scanty, are mostly remembered as unpleasant situations of fear and anxiety in what concerns staff, equipment and the environment of the UCI. The authors emphasize the importance of the studies that allow a better recognition of adverse experiences and its modifications, improving the care services at the UCI and consequently contributing for the decrease of psychopathological morbidity.

0401

COGNITIVE DYSFUNCTION AFTER CARDIAC ARREST

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INTRODUCTION. Standardized and evidence based treatment protocols including, therapeutical hypothermia, has increased survival to above 50% in some reports after cardiac arrest (CA). At the same time functional outcome and mean age of the CA survivors have increased.

OBJECTIVES. We wanted to document the prevalence of cognitive dysfunction in a cohort of Norwegian CA survivors above 18 years of age with an acceptable functional outcome, i.e. Cerebral performance category (CPC) 1-2, between one and two years after CA. Secondary outcomes are the CA group's level of cognitive performance compared to a reference population and if there are a relationship between age, time since cardiac arrest, health related quality of life and cognitive function.

METHODS. We included 26 patients from two Norwegian centers. All patients were scored on CPC and on Mini-mental status (MMSE). Patients with pre-existing cerebral or psychiatric disorders or use/abuse of central stimulating or inhibiting medication were excluded due to increased risk of cognitive impairment not related to CA. 25 of the included patients scored above 20 on MMSE and were eligible for cognitive testing with the Cambridge Neuropsychological Test Automated battery (CANTAB). CANTAB is a semi-automated cognitive test battery where patients are presented to different tasks on a touch sensitive screen and responds by touching the screen. The CANTAB software contains an integrated reference population which allows us to express the patients' results as standardized z-scores. The patients were tested in four cognitive domains: Motor function (MOT), delayed memory (DMS), executive function (SOC) and episodic memory (PAL). All patients filled in the Short form 36 for assessment of HRQOL.

RESULTS. 12 of 25 (48%) were found to have a cognitive dysfunction. The CA groups level of performance in each tested cognitive domain compared to the reference population is shown i Table 1 (One sample t test, test value = 0).

TABLE 1 COMPARISON OF CA GROUP TO REF POPULATION

	Mean	95% CI	p
MOT	0,01	−0.19–0.21	0.91
DMS	−0,31	−0.78–0.17	0.2
SOC	−0,64	−1.03 to −0.24	0.003
PAL	−0,71	−1.3 to −0.16	0.014

We found no relationships between cognitive function and age, time since cardiac arrest or HRQOL.

CONCLUSION. 12 of 25 patients had a cognitive dysfunction according to our criterions [1]. We found significant difference in performance on executive function ($p = 0.003$) and episodic memory ($p = 0.014$), indicating respectively frontal and medial temporal lobe affection, in patients with no previous brain disorder and with a good functional outcome. In our CA group this did not affect HRQOL. We have no indications of cognitive improvement between one and two years after CA.

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0402

POST-TRAUMATIC STRESS DISORDER ONE YEAR AFTER ICU

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INTRODUCTION. Post-Traumatic Stress Disorder (PTSD) is a known complication after an ICU stay and its self-reported prevalence is of 5–64% of patients. Associated factors frequently reported are age, length of ICU stay, some medications and delusion memories. We sought to investigate its occurrence, associated factors and the potential impact on quality of life (QOL)1 year after ICU.

METHODS. Adults admitted to a surgical ICU, who stayed >36 h were included after informed consent. Variables were collected prospectively during the ICU stay and tested for association with PTSD [PCL -17 items] measured 1 year after discharge from ICU. QOL, life events and sleep medication were assessed in patients with/without PTSD.

RESULTS. Of 762 included patients, 642 (84%) completed the 1 year follow-up, 579(76%) were alive and 547 (72%) answered completely the questionnaire.

64 (12%) patients presented criteria of high PTSD. In the multivariate analysis, younger age, longer ICU length of stay, were independently associated with high PTSD as previously shown in the literature. New factors such as lower educational status, pre-existing depression or anxiety were found to be associated with occurrence of PTSD in our study. Patients with PTSD had significantly lower EuroQOL and SF-36 QOL outcomes even in physical domains, higher consumption of sleep medication, and significantly more financial problems, loss of work and interpersonal problems with their partners or relatives after 1 year compared to non PTSD patients, even adjusting for pre-ICU QOL and medication, and SAPS 2 at ICU admission.

CONCLUSION. PTSD is frequent 1 year after ICU. Several risk factors have been identified. PTSD probably impacts significantly on life 1 year after ICU.

0403

QUALITY OF LIFE AFTER A SURGICAL INTENSIVE CARE IS LOWER IN COMPARISON WITH THE GENERAL POPULATION AFTER A LONG-TERM (>6 YEARS) FOLLOW-UP

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INTRODUCTION. Treatment of surgical patients in the ICU comes with major disadvantages which have to be justified by an acceptable outcome and long-term quality of life (QoL). The aims of this study were to quantify the long-term QoL of more than 10 years of a large cohort of patients admitted to a surgical intensive care unit and to investigate the effects of age, gender and underlying disease on this long-term QoL.

PATIENTS/METHODS. QoL was measured with the EuroQol 5D+ in all surviving surgical ICU patients, admission between 1995 and 2000, after a mean follow up of 8 years. Patient characteristics, disease category, Apache II score and survival were prospectively registered. Using multivariable generalized linear regression analysis we compared the odds ratio's (OR) of the EQ-5D index and the VAS every variable individually. Quality of life was compared to an age and gender adjusted general population using the T test analysis.

RESULTS. 834 patients survived the ICU and were available for follow up. In 598 (72%) patients the health-related QoL was measured. Oncological surgery patient had a weighted health status (WHS) comparable to the reference population. Only vascular surgery had a significant decrease in WHS, OR −0.1. Age (OR −0.002 per life year), gender (0.063 male/ female) and ICU length of stay (LOS; −0.003 per day) were all independently associated with long-term QoL. ICU LOS > 1 week showed a significant decrease in health-related QoL. Age and gender were associated with a higher chance of problems in all EuroQol dimensions. In all patients, WHS was higher than the patient's own actual self-rated health status on the VAS. Vascular, G-I and general surgery patients had a significant decrease in self-rated health status when compared to the reference population, OD −10.2, −6.4 and −8. No difference in QoL was seen between patients in different follow up years.

CONCLUSION. Patients have considerable impairments of their quality of life 8 years after ICU admission. Factors like age, gender, ICU length of stay and vascular and general surgery patients were all independently associated with long-term impairments of QoL. There was an overall decrease of QoL compared to the general population.

0404

LONG-TERM OUTCOME, HEALTH-RELATED QUALITY OF LIFE AND COST-UTILITY ANALYSIS OF ACUTE RESPIRATORY FAILURE IN INTENSIVE CARE UNITS

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INTRODUCTION. Acute respiratory failure (ARF) is the most common organ dysfunction in the critically ill. Because high daily intensive care unit (ICU) cost is associated with the use of mechanical ventilation (MV) to treat ARF, the amount of resources spent on this patient group is important. Due to increased ICU costs in addition to previously reported reduced long-term outcome of ARDS and patients needing MV, cost-effectiveness analyses based on health-related quality of life (HRQOL) assessment are warranted.

METHODS. During an 8-week study period (from 16 April 2007 to 10 June 2007) 958 adult patients were treated with ventilatory support over 6 hours during (=FINNALI-cohort). The HRQOL of these patients was assessed by EQ-5D questionnaire at ICU admission and at 12 months. Gained QALYs were estimated adding the expected age- and sex-matched lifetime for survivors at 12 months. For patients dying before 12 months the exact lifetime after hospital discharge was used. For those alive but with no response to EQ-5D, the QOL was estimated using the age- and sex-matched values of the respondents. All hospital costs for the whole study population were divided by the number of hospital survivors, and by all gained QALYs.

RESULTS. One year mortality was 35% (95% CI 32–38%). EQ-5D index median (IQR) at admission and at 12 months were 0.75 (0.56–0.89) and 0.70 (0.45–0.89), respectively, which are lower than those of age- and sex-matched general population. In the oldest age group, EQ-5D index was comparable with the matched reference values. Mean (±SD) QALYs were15(±13) for all patients and 15 ± 13 and 14 ± 12 for non-ALI/ARDS and ALI/ARDS, respectively. The mean cost was 19,696€ per hospital survivor, and 1,131€ per one QALY.
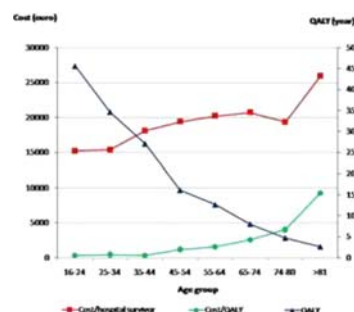
Cost and QALYs of hospital survivors

CONCLUSIONS. One year survival was moderately high. ARF patients did not achieve their pre-ICU QOL at 12 months. Despite lower HRQOL compared to reference values at 12 months, cost per QALY gained seems to be reasonable in acute respiratory failure.

News in cardiac intensive care and sedation: 0405–0409

0405

INTENSIVE VERSUS CONVENTIONAL INSULINOTHERAPY AFTER ELECTIVE AND ON-PUMP MYOCARDIAL REVASCULARIZATION: A PROSPECTIVE AND RANDOMIZED STUDY

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INTRODUCTION. Strict glycemic control is increasingly recognized as an important goal in a broad spectrum of critically ill patients, even in the absence of pre-existing diabetes. In cardiac surgery patients, hyperglycemia was found to be an independent post-operative risk factor for the development of hyperlactatemia and associated with increased morbidity and mortality.

OBJECTIVE. To analyze the inflammatory and clinical response of the patients submitted to intensive or conventional insulinotherapy in a specific clinical context.

METHODS. *Design.* Analysis of a prospective and randomized collected database. *Setting.* Intensive Care Unit (ICU) in an University Hospital. *Patients.* A total of 50 patients aged 30–80 (ASA II-III) submitted to elective on-pump myocardial revascularization from September 2006 to June 2008. *Randomization.* on ICU admission, once obtained a preoperative informed consent, the patients were randomly assigned to Group 1 (intensive insulinotherapy during the first 24 h of ICU stay aimed at glucose levels between 80 and 110 mg/dl) or Group 2 (conventional insulinotherapy during the first 24 h of ICU stay aimed at glucose levels between 160 and 180 mg/dl). The study was approved by the local ethic committee. *Data collection.* Preoperative and each hour (during the first 24 h in ICU) assessment of Glucose and Lactate blood levels; Hemodynamic parameters on ICU admission and after 2, 6, 12 and 24 h. Preoperative and postoperative (12 and 36 h after ICU admission) assessment of Cytokines (TNFɑ, IL6, IL8, IL10), C-Reactive Protein (CRP), White Blood Cells (WBC) and Platelets (PLT) blood levels. Preoperative and continuous assessment of Body Temperature (BT). Admission, Total Maximum (TMSOFA) and D SOFA score. Infection Probability Score (IPS) 36 h after ICU admission and ICU length of stay (LOS). *Statistics.* Within-between groups analysis, one-way ANOVA and unpaired *t* test were used when appropriate.

RESULTS. The preoperative and operative variables were comparable between the two groups (p = NS for all measurements). Glucose and Lactate blood levels were lower in Group 1 ($p < 0.0001$). Haemodynamic parameters were comparable between Groups except Stroke Volume Index that was higher in Group 1 ($p < 0.05$). WBC, TNFɑ, IL8, IL6, and CRP blood levels were lower in Group 1 ($p < 0.0001$), PLT and IL10 blood levels was higher in Group 1 ($p < 0.0001$). BT was comparable between groups. Admission and TM SOFA score were lower in Group 1 ($p < 0.0001$), D SOFA score was comparable between Groups. IPS was lower in Group 1 ($p < 0.01$). No difference in ICU LOS.

CONCLUSION. Intensive insulinotherapy after elective and on-pump myocardial revascularization significantly modulates the inflammatory response. Different inflammatory patterns could correlate with different clinical response as suggested by SOFA and IP score analysis.

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0406

RISK INDICATORS INFLUENCING EARLY VS. LONG-TERM SURVIVAL AFTER CARDIAC SURGERY: A POPULATION-BASED STUDY

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INTRODUCTION. Cardiac surgery treats diseases which may reduce patient's life expectancy. Analysis of concomitant risk indicators for short- and/or long term survival are important for clinicians [1].

PATIENTS AND METHODS. Data from 4,374 patients operated between 1997 and 2001 at the university hospital Vienna were taken from the data base. The national statistic office provided information about any death until the end of 2005. Early versus long-term survival was cut at one year after the operation. Risk indicators with a remarkable difference in short- and long-term influence were investigated with all patients and all risk factors plus interaction terms modeling the change in their influence.

RESULTS. A total of 321 patients died within the first 30 days (7.3%); 201 patients died within the first year and 111 during year 2. We found interaction terms modeling the change in influence of the selected risk indicators. As an example higher weight had a positive effect within the first year. Thereafter it was not of significant importance anymore. Interaction for this risk indicator was found to be significant in the corresponding Cox-regression analysis $P = 0.017$ which indicates that weight influences survival differently within and after year 1. Contrarily extracardiac arteriopathy had a negative effect within the first year and on long-term outcome. Interaction for this risk indicator was also found to be significant $P < 0.001$. Chronic renal failure and diuretic treatment had no influence during the first year but a negative effect subsequently. Thoracic aortic surgery, insertion of an intraaortic balloon pump after surgery had negative influence within the first year only. Congestive heart failure was negative within the first year only whereas transfusion of packed red blood cells had a negative throughout the entire observation period.

CONCLUSION. We differentiated between patient-, disease-, surgery-related and age/gender related risk indicators. "Continued to live" was dependent on individual risk profile, less on age and gender as compared with life expectancy of normal population.

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0407

EVALUATION OF ICU DELIRIUM: VALIDITY AND RELIABILITY OF THE DELIRIUM DETECTION SCORE

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INTRODUCTION. Using a validated delirium assessment tool significantly improves the ability of physicians and nurses to identify delirium in intensive care unit (ICU) patients [1–2]. The Delirium Detection Score (DDS) is an 8-item scale modified from the Clinical Withdrawal Assessment for Alcohol, revised scale (CIWA-Ar) and was initially developed for measuring severity of delirium in ICU patients [3]. Until now the DDS was still lacking validation against the Diagnostic and Statistical Manual of Mental Disorders IV criteria for delirium [4].

OBJECTIVE. The aim of this study was to validate the DDS against DSM-IV criteria for the use in ICU patients.

METHODS. Prospective cohort study: after local ethics committee approval (Approval No. EA2/022/06), we included 156 patients aged >60 years, newly admitted to the ICU after a surgical procedure staying in the ICU for at least 24 h. Exclusion criteria were pre-existing psychosis, dementia or depression, non-German-speaking and inability to communicate due to severe hearing loss or brain injury. Trained staff members (nurses and doctors) performed DDS ratings on the first postoperative day (POD). These evaluations were compared against the reference standard, a delirium expert (blinded to the study) who used DSM-IV criteria. Statistics: receiver operating characteristics (ROC) analysis, kappa statistics.

RESULTS. 63 out of 156 patients (40%) were identified as delirious by the reference standard during the study. The ROC analysis for the DDS revealed an AUC of 0,841 (confidence interval = 0.772 to 0.895). Based on the ROC calculations, using a cut-off value >2, the DDS had a sensitivity of 0.85 and a specificity of 0.77. The 42 paired observations revealed a "substantial" interrater reliability kappa statistics: 0.79) between nurse and trained staff members.

CONCLUSION. Using a cut-off value >2 the DDS showed ability for adequate detection of delirious patients in the ICU.

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0408

POSTOPERATIVE HEMODYNAMIC FUNCTION AFTER ANESTHETIC INDUCTION WITH ETOMIDATE FOR CARDIAC SURGERY WITH CARDIO PULMONARY BYPASS. A RANDOMIZED, CONTROLLED, DOUBLE BLIND STUDY

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INTRODUCTION. Cardiopulmonary bypass (CPB) leads to clinically relevant post-operative systemic inflammatory response syndrome (SIRS) for nearly one-third of patients. Because of its excellent hemodynamic tolerance, etomidate is widely used in cardiac surgery, but it inhibits cortisol synthesis and may contribute to postoperative hemodynamic alterations and intensify the SIRS symptoms. The aim of the study was to evaluate adrenal and hemodynamic functions following etomidate induction of cardiac anaesthesia with CPB.

METHOD. In a monocentric, randomized, controlled double blind study, we have compared a single etomidate injection to propofol for anaesthesia induction. In both group propofol was used for maintenance of anaesthesia. Exclusion criteria included, corticoid therapy within the last 3 months, surrenal insufficiency, emergency surgery, ongoing infectious diseases, aortic stenosis (prohibiting propofol use), and acute coronary syndrome during the last three weeks. Percentage of patients under epinephrine during the first 48 postoperative hours was used as primary endpoint. Impaired adrenal function was defined as a cortisol response less than 250 nmol/l after corticotropin stimulation (tetracosactrin 250 µg) performed at 12th, 24th and 48th after etomidate injection. Hemodynamic objectives were specified and a goal directed protocol was used.

RESULTS. 50 patients in each group have been included. There was no difference in patients' characteristics between the two groups. Norepinephrine was administered in 20 and 17 patients in propofol and etomidate group respectively (40 vs. 34%, ns). Duration of norepinephrine administration was not significantly different (Fig. 1). Adrenal insufficiency was significantly more frequent in group etomidate at H12 (100 vs. 41% $p < 0.05$), and H24 (85.4 vs. 25% $p < 0.05$) but not at H48 (21.7 vs. 10.5% $p = 0.17$).
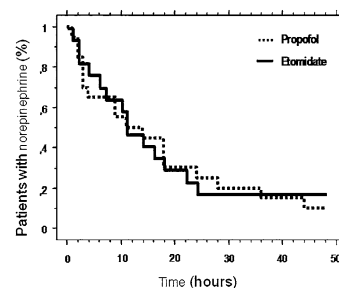

Fig. 1 Duration of norepinephrine administration

CONCLUSION. Although etomidate blocks adrenal function during at least 24 h, we did not shown a significant difference in vasoactive drug administration in scheduled cardiac surgery under CPB.

0409

SEVOFLURANE SEDATION AFTER CORONARY ARTERY BYPASS GRAFTING REDUCES TROPONIN T RELEASE

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INTRODUCTION. Anesthetic preconditioning contributes to reduced myocardial injury after ischemia in animal studies and in clinical settings [1, 2]. Animal studies indicate that similar effects may be achieved if inhaled anesthetics are given shortly after an ischemic event [3]. A new device enabling delivery of inhaled anesthetics in the ICU—the Anesthetic Conserving Device (AnaConDa®)—is available [4].

OBJECTIVES. To evaluate if inhaled sevoflurane—administered during mechanical ventilation after coronary bypass surgery (CABG)—exerts myocardial protective effects (postconditioning), compared with intravenous propofol.

METHODS. 100 patients scheduled for CABG with cardiopulmonary bypass (CPB) were included in this randomized clinical trial. Anaesthesia including the use of sevoflurane prior to and after CPB, was provided according to a standardized protocol. After surgery patients were randomized to postoperative sedation - with either inhaled sevoflurane (Sevo) via the Ana-ConDa® or intravenous propofol (Prop). Patients were sedated (target sedation depth MAAS 2-3) for a minimum of 2 h. Thereafter extubation was performed when predefined extubation criteria were met. The primary endpoint was difference in Troponin T (TnT) from baseline at 12 and 72 h after completed surgery.

RESULTS. TnT increase from preoperative baseline was significantly lower in the sevoflurane group compared to the propofol group (12 h TnT difference (Sevo) 0.22 ± 0.29 vs. (Prop) 0.36 ± 0.28 [$p = 0.02$], 72 h difference (Sevo) 0.11 ± 0.23 vs. (Prop) 0.26 ± 0.33 [$p = 0.01$]). The differences remained essentially unchanged after multiple regression modelling to control for potential confounders (CPB time, intraoperative defibrillations, blood glucose).

CONCLUSIONS. The results of our study indicate that sevoflurane sedation during routine mechanical ventilation after CABG with CPB may protect the myocardium against ischemia-reperfusion injury—as measured with TnT at 12 and 72 h, compared to conventional propofol sedation. The clinical significance of this finding needs further investigation.

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Neuro/emergency medicine 2: 0410–0414

0410

CEREBRAL OXYGENATION AND METABOLISM DURING INTRACRANIAL PRESSURE CORRECTION WITH 15% MANNITOL AND 7,2% NACL IN 6%HES 200/0.5 IN PATIENTS WITH INTRACRANIAL HEMORRHAGE

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INTRODUCTION. The aim of our study was to estimate the dynamics of brain oxygen tension ($PbrO_2$) and metabolism during intracranial hypertension correction with 15% mannitol and 7.2% NaCl in 6% HES 200/0.5 (HyperHAES).

METHODS. We analyzed 39 episodes of increased intracranial pressure (ICP) correction with 15% mannitol ($n = 22$) or "HyperHAES" ($n = 17$) in 9 patients with intracranial hemorrhage (4 with aneurismal SAH, 5 with severe TBI) and GCS 4-8. Monitoring of ICP, systemic hemodynamics and cerebral microdialysis was used in all patients. $PbrO_2$ was investigated in 5 patients. Microdialysis and $PbrO_2$ catheters were placed into "lesioned" and "intact" brain tissue. ICP > 20 mmHg was the indication for treatment. The ICP, $PbrO_2$, glucose, lactate, pyruvate, glycerol concentrations and lactate/pyruvate ratio in cerebral interstitial fluid were measured before infusion of the investigated solutions and 30 and 120 min after it.

RESULTS. FiO_2, Hb, PaO_2, $PaCO_2$, PaO_2/FiO_2, blood temperature and serum glucose concentration were stable and comparable between groups during the study. The duration of ICP reduction below 20 mmHg was 121 ± 58 min for 15% mannitol and 258 ± 122 min for "HyperHAES" ($p < 0.001$). Administration of the investigated solutions was associated with slight $PbrO_2$ increase. 15% mannitol infusion did not change brain metabolism in "intact" and "lesioned" tissue. "HyperHAES" administration was accompanied with significant increase of glucose and pyruvate concentration in "intact" and "lesioned" brain tissue. Glucose(intact) was 0.7(0.4;1) mmol/l before infusion, 1(0.7;1.6) mmol/l at 30 min ($p < 0.05$) and 1.2(0.8;1.6) mmol/l at 120 min ($p < 0.05$) after infusion. Glucose(lesioned) was 0.5(0.4;1) mmol/l before infusion, 1.1(0.6;1.2) mmol/l at 30 min ($p < 0.05$) and 1.25(0.8;1.4) mmol/l at 120 min ($p < 0.05$) after infusion. Pyruvate(intact) was 95(59;133) mµmol/l before infusion of "HyperHAES", 96(79;134) mµmol/l at 30 min ($p < 0.05$) and 121(78;130) mµmol/l at 120 min ($p < 0.05$) after infusion. Pyruvate(lesioned) was 68(50;115) mµmol/l before infusion of "HyperHAES", 94(75;127) mµmol/l at 30 min ($p < 0.05$) and 123(85;150) mµmol/l at 120 min ($p < 0.05$) after infusion. Lactate/pyruvate ratio increased slightly in "intact" tissue and did not change in "lesioned" areas. 15% mannitol and "HyperHAES" administration did not change the glycerol concentration in "intact" and "lesioned" brain tissue. We observed the same dynamics of cerebral oxygenation and metabolism in patients with aneurismal SAH and severe TBI.

CONCLUSION. 7.2% NaCl in 6%HES 200/0.5 infusion results in prolong ICP reduction in comparison with 15% mannitol and is accompanied with slight increase of $PbrO_2$ and significant improvement of glycolysis in brain tissue.

0411

CEREBRAL BLOOD FLOW (CBF) DERANGEMENTS IN ANEURISMAL SUB-ARACHNOID HEMORRHAGE (ASAH): PERFUSION CT (PCT) UTILITY

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INTRODUCTION. Following aSAH, vasospasm (VS) is the main cause of cerebral blood flow (CBF) reduction, linked to a 1.5-3-fold increase in mortality. VS detection isn't simple. In this setting PCT [1] may help to detect CBF disturbances in aSAH with the potential to drive clinical practice to optimize CBF.

OBJECTIVES. We aimed to measure CBF(ml/100 g/min) with PCT and to correlate clinical and radiological data in order to disclose any correlation between CBF changes and neurological outcome.

METHODS. Patients with aSAH documented by CT angiography (CTA) or by digitally subtraction angiography (DSA) were managed according to our institution protocol for aSAH including in the first 24–48 h and on day 7 ± 1 a CT, PCT and CT angiography (CTA).We calculated CBF by PCT as ratio between cerebral blood volume (CBV) and mean transit time (CBF = CBV/MTT). Eight regions of interest (ROIs) were drawn bilaterally. We identified the minimum CBF and the maximum MTT among the 8 ROIs with PTC on day 1 and 7. Demographic data, radiological scores, systemic and cerebral complications were also recorded. We defined neurological deterioration (ND) as a 2 point GCS reduction or new focal deficits. VS was diagnosed in presence ND and/or by transcranial Doppler (TCD) and/or by angiographic arterial narrowing. Outcome was measured at discharge and 6 months after aSAH by the Glasgow Outcome Scale (GOS), dichotomized as favourable (3–5) and unfavourable (1–2). We compared the lowest CBF between the 8 ROIs to GOS at 6 months and the variation of CBF between the 2 PCT (ΔCBF). Spatial perfusion heterogeneity (PH) was calculated by the relative dispersions (as coefficient of variation RD = Standard deviation of CBF/mean CBF) from the PCTs. The relationship between PH, VS and GOS was studied with Pearson correlation.

RESULTS. 37 patients (26 F, 11 M, mean age 58.3) were studied. Global mean CBF was 37.5 ± 16.7 ml/100 g/min. We found a statistically significant inverse relationship between Fisher grade ($p = 0.011$) and the lowest CBF in the ROIs. Worse clinical presentation (lowest Hunt Hess) was associated to lowest CBF (22.35 ± 11.5; $p = 0.036$). The relationship between the dichotomized GOS and perfusion heterogeneity on day 7, calculated as relative dispersions on PCT was significant ($p = 0.009$). ΔCBF was 0.38 ± 0.25 with t test. Perfusion heterogeneity 1 week after aSAH was significantly correlated to documented presence/absence of VS ($p = 0.039$).

CONCLUSIONS. PCT may detect CBF derangements in patients with a SAH. Not surprisingly, poor grade aSAH is associated with lower CBF and worse outcome. PCT detects CBF changes within days and might help to improve therapies and ameliorate outcome.

REFERENCE. 1. Binaghi S et al (2007) AJNR Am J Neuroradiol 28:750–758

0412

OUTCOME OF HYPONATRAEMIA IN NEUROINTENSIVE CARE: THE RESULTS OF A FIVE-YEAR PROSPECTIVE STUDY

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INTRODUCTION. Hyponatraemia is a frequent and, due to brain oedema, important electrolyte dysbalance in acute brain diseases. The aim of our study was to evaluate all hyponatraemias in patients (pts) with acute brain diseases and observe differences in outcome between light and severe hyponatraemia.

METHODS. According to prospective standard protocol for hyponatraemia (serum sodium < 135 mmol/l) which included the measuring and calculating of renal function parameters, we evaluated all 1,546 pts hospitalised with acute brain diseases in our neurologic-neurosurgical care unit (NNICU) over a period five years. Light hyponatraemia was defined as serum sodium between 135 and 130 mmol/l and severe hyponatraemia <130 mmol/l. We compared incidence of cerebral complications, Glasgow Outcome Scale (GOS) upon discharge from NNICU and mortality in NNICU between these two groups.

RESULTS. Hyponatraemia occurred in 245 (16%) pts (mean age 57 ± 14 years, M 132). There were 110 (56%) pts with stroke, 59 (24%) pts with tumour, 38 (16%) pts with trauma and others. Over a five-year period cerebral salt wasting (CSW) syndrome was diagnosed in 26 (11%) pts (diuresis $3,677 \pm 1,126$ ml/day; fU_Na+ 654 ± 213 mmol/day, $p < 0.001$; C_Na+ 0.058 ± 0.019 ml/s, $p < 0.001$; FE_Na+ 0.029 ± 0.01 $p < 0.001$). No patient had syndrome of inappropriate secretion of antidiuretic hormone (SIADH). The majority of pts had normal measured serum osmolality (275–295 mmol/kg, 184, 75% pts) due to mannitol, higher levels of glycaemia and urea.

From 245 pts, there were only 46 (19%) with severe hyponatraemia. This group were in NNICU longer ($p = 0.003$), had longer dysnatraemia ($p < 0.001$) and more cerebral complications ($p = 0.039$) than pts with light hyponatraemia. Between these groups there were no differences in fluid intake ($p = 0.824$, ml/day), daily sodium intake ($p = 0.269$, mmol/day) and diuresis ($p = 0.612$, ml/day). Furthermore, no significant difference was observed in Glasgow Coma Scale on onset of hyponatraemia ($p = 0.649$), GOS upon discharge from NNICU ($p = 0.725$) and mortality in the NNICU ($p = 0.901$).

CONCLUSION. Light hyponatraemia, in comparison with severe hyponatraemia lasted, significantly longer and had more cerebral complications, although with no negative influence on patients' outcomes. Our results showed that CSW, rather than SIADH, is the typical syndrome in patients with hyponatraemia in neurointensive care.

0413

HOSPITAL OUTCOME PREDICTORS IN NON-TRAUMATIC INTRACRANIAL HEMORRHAGE

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INTRODUCTION. Cardiovascular disorders have been mainly studied in patients with aneurysmal subarachnoid hemorrhage [1]. The data on outcome and impact of cardiovascular changes in intracranial hemorrhage as a whole is scarce.

OBJECTIVES. To evaluate cardiovascular morbidity and outcome predictors in patients with ICU admitted non-traumatic intracranial hemorrhage.

METHODS. Three-year (2005–2007) retrospective cohort study in a university level ICU. Adult patients with non-traumatic intracranial hemorrhage admitted within 96 h from hospital admission were included. Age, sex, medical history, APACHE II and radiological findings of primary head CT were recorded on admission. SOFA scores, cardiac troponin I (cTNI), C-reactive protein (CRP) and pulmonary edema (PE) were recorded on days 0 to 3. Neurological outcome and mortality were evaluated by Glasgow Outcome Score (GOS) at hospital discharge. Patients were categorized as presence/absence of aneurysm (A+/A−), subarachnoid hemorrhage (SAH+/SAH−) and outcome (poor outcome, GOS 1–2 and good outcome, GOS 3–5).

RESULTS. 236 patients were analyzed. The etiology of hemorrhage was A+ in 139 (58.9%) patients. The type of hemorrhage was SAH in 127 (91.4%) patients in A+ -group and 15 (15.5%) in A- -group. cTNI was >0.06 μg/L in 36 (31.9%) patients in A+ group versus 21 (26.3%) patients in A- group ($p = 0.427$) but 40 (35.7%) patients in SAH+ -group versus 17 (21.0%) in SAH- -group ($p = 0.037$). There were no difference in PE incidence between A+ versus A- group and SAH+ versus SAH- group. The outcome was poor in 42 (30.2%) patients in A+ -group and 43 (44.3%) in A- -group ($p = 0.028$). Outcome predictors are presented in Table 1. Additionally, IVH Sum score ($p < 0.001$), ICH volume ($p < 0.001$), diffuse cerebral edema ($p < 0.001$) and midline shift ($p = 0.008$) were associated with poor outcome but SAH Sum score was not. According to the multivariate logistic regression analysis APACHE II, SOFA max and the use of anticoagulants were significant predictors for poor outcome [OR 1.08 ($p = 0.007$), OR 1.44 ($p < 0.001$) and OR 3.04 ($p = 0.005$), respectively].

TABLE 1

	GOS 1–2 (N = 85)	GOS 3–5 (N = 151)	P value
Age (Y), Mean (SD)	59 (12)	55 (13)	0.015
Anticoagulant use, n/N (%)	25/75 (33)	21/132 (16)	0.005
Non-aneurysmal bleeding n/N (%)	43/85 (51)	54/151 (36)	0.028
APACHE II, Mean (SD)	26.4 (6.0)	21.2 (6.7)	<0.001
SOFA Max, Mean (SD)	9.5 (2.2)	6.8 (3.1)	<0.001
SOFA Cardiovascular Max, Mean (SD)	3.0 (1.3)	2.4 (1.6)	0.001
TNI >0.06 μg/mL, n/N (%)	27/71 (38)	30/122 (26)	0.052
CRP >100 mg/mL, n/N (%)	36/81 (44)	41/150 (27)	0.013
Pulmonary edema, n/N (%)	14/77 (18)	28/147 (19)	>0.9

CONCLUSION. Severity of illness on admission, severity of organ dysfunctions, severity of head CT findings other than SAH component and previous use of anticoagulants are predictors of poor outcome. cTNI release is associated with SAH component. cTNI, level of cardiovascular dysfunction and CRP release are associated with poor outcome.

REFERENCE. 1. van der Bilt et al. (2009) Neurology72:635–642

0414

FUNCTIONAL IRON DEFICIENCY IS ASSOCIATED WITH A HIGHER BLOOD TRANSFUSION RATE IN ICU PATIENTS

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BACKGROUND. ICU patients often need blood transfusion, but no reliable predictors at ICU admission of transfusion requirements are available. We hypothesized that ICU patients with lower bone-marrow capacity may be at higher risk for developing anemia requiring blood transfusion.

OBJECTIVE. To determine whether functional iron deficiency was associated with transfusion requirements in ICU patients.

DESIGN. Prospective observational study

SETTING. General ICU.

PATIENTS. 62 patients, after excluding those transfused on or before ICU admission.

MEASUREMENTS AND MAIN RESULTS. We recorded age, diagnosis, severity score (SAPS3), presence of sepsis, ICU complications, ICU treatments, and transfusion-free interval. Functional iron deficiency was defined as reticulocyte hemoglobin content <29 pg. We also recorded ICU and hospital outcome. The statistical analysis included multiple logistic regression and hazard-function for transfusion. Twenty-three patients (37%) presented functional iron deficiency on ICU admission. Patients with functional iron deficiency tended to be sicker and more likely to have sepsis than those without iron deficiency. They were also more prone to complications, particularly acute renal failure (39 vs. 13% $p = 0.02$) and ICU-acquired infection (30 vs. 10% $p = 0.04$). The overall transfusion rate was 22.6%, being much higher in patients with functional iron deficiency than in those without (39.1 vs. 12.8%, $p = 0.02$). Median ICU stay was also longer in patients with functional iron deficiency (8 vs. 5 days, $p = 0.01$). Differences in mortality did not reach statistical significance.
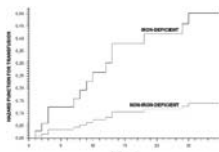
CONCLUSIONS. Functional iron deficiency is very common at ICU admission and is associated with higher transfusion requirements.

Monitoring and assessment of the Cardiovascular System: 0415–0419

0415

MONITORING OF SUBLINGUAL BLOOD VELOCITY USING LASER SPECKLE IMAGING

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INTRODUCTION. Sublingual hemodynamical variables have been shown to be indicators of patient status in the ICU.

OBJECTIVE. The objective of this research is to develop a reliable, accurate, easy-to-use, and cost-effective technique for monitoring sublingual hemodynamic changes of patients.

METHOD. A study using 20 healthy volunteers was performed to investigate the utility of laser speckle imaging (LSI) for obtaining quantitative measurements of sublingual blood velocity in humans. The protocol was approved by the Institutional Review Board of Riverside Regional Medical Center in Newport News, Virginia. The LSI system was developed using commercially available components. The system consists of a laser source, a CCD camera with collection optics, a pulse sensor for triggering image acquisition, and a computer for controlling system operation, and processing and storing data. The computer programs for data acquisition, analysis and display were written in Microsoft Visual C++. The imager is aimed at the sublingual area and focused. A pulse sensor attached to the ear lobe is used to synchronize the image collection to the cardiac pulse. The image is collected and the data are retrieved from the camera and examined to see if there are any saturated pixels and/or if the image intensity is too low. Adjustments are made until an image with acceptable intensity is collected. Two or more images of the same scene are collected at different exposure times. The subject was instructed to swish his/her mouth repeatedly (at least three times) with warm water (average temperature 55.4°C). The measurements were then repeated. The sublingual temperature was also measured immediately after image collection. The subject was instructed to swish his/her mouth repeatedly (at least three times) with cold water (3.7°C). Again, the measurement procedure was repeated. Immediately after image collection, the sublingual temperature was again measured. The duration of the subjects' active participation was about 1 h. Only one measurement session was required.

RESULTS. SBV values range from 0.07 to 0.13 cm/s for all three temperatures in all subjects, with the averaged "mean SBV" for all subjects being 0.086, 0.079, and 0.091 cm/s for cool, normal, and warm temperatures, respectively. SBV values at both warm and cool temperatures increase from those at normal temperature, with the warm stimuli increasing more than the cool stimuli do, 15 vs. 9%, respectively.

CONCLUSION. Using a student t test for paired data, the probabilities that the normal, cool, and warm data are from the same distribution were calculated. The results demonstrate that the LSI system is capable of detecting changes in SBV of 2% at a significance level of better than 10%.

0416

PERCUTANEOUS LEFT VENTRICULAR ASSIST DEVICES VERSUS INTRA-AORTIC BALLOON PUMP COUNTERPULSATION FOR TREATMENT OF CARDIOGENIC SHOCK: A META-ANALYSIS OF CONTROLLED TRIALS

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INTRODUCTION. Safety and efficacy of percutaneous left ventricular assist devices (PVADs) have been compared with intra-aortic balloon pump (IABP) counterpulsation in cardiogenic shock. We performed a meta-analysis of randomized controlled trials to evaluate potential benefits of PVAD on hemodynamics and 30-day survival.

METHODS. All controlled trials using PVAD (2 using TandemHeart and 1 using Impella) in patients with cardiogenic shock were included.

RESULTS. After device implantation, PVAD patients had higher cardiac index (mean difference (MD) 0.35 L/min/m², 95% CI 0.09;0.61; Fig. 1), higher mean arterial pressure (MD 12.8 mmHg, 95% CI 3.6;22.0) and lower pulmonary capillary wedge pressure (MD −5.3 mmHg, 95% CI −9.4;−1.2) compared to IABP patients. The pooled estimate of the relative risk revealed no significant difference in 30-day mortality (RR 1.06, 95% CI 0.68; 1.66; Fig. 2) using PVAD compared to IABP. In patients treated with PVAD, a trend toward a higher incidence rate of leg ischemia (RR 2.59, 95% CI 0.75; 8.97) was observed. Device-related bleeding (RR 2.35, 95% CI 1.40; 3.93; Fig. 3) was significantly more frequently observed in TandemHeart patients.
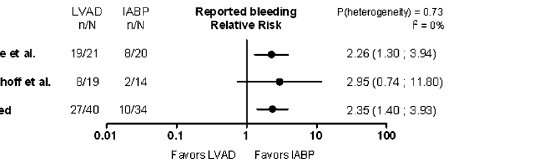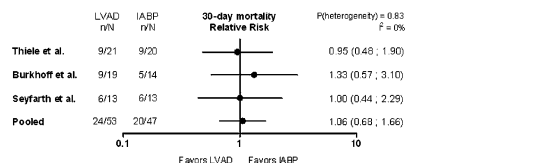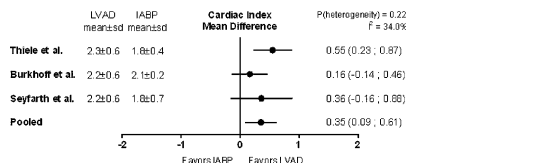
CONCLUSION. Although PVAD provides superior hemodynamic support in patients with cardiogenic shock compared to IABP, use of these more powerful devices did not improve early survival. These results are not in favour of PVAD as first-choice approach in the mechanical management of cardiogenic shock.

0417

DIFFERENT PRELOAD PARAMETERS TO ASSESS FLUID RESPONSIVENESS IN FULL VENTILATED CRITICALLY ILL PATIENTS, BASED ON PULSE POWER ANALYSIS

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INTRODUCTION. In full ventilated patients with hypotension and oliguria values of central venous pressure (CVP) under 12 mmHg and stroke volume variation (SVV) or pulse pressure variation (PPV) over 15% have been proposed as indication for fluid challenge.

OBJECTIVE. Our aim was to assess the ability of these parameters to predict fluid responsiveness in these patients and to compare the response to 500 mL of NaCl 0.9% with the response to passive leg raising (PLR). Responders were defined as patients with an increase stroke volume (SV) >10%. All the monitoring was made analyzing the pulse power with LiDCOplus® monitor.

METHODS/DESIGN. Prospective study.

SETTING. 13-bed mixed intensive care unit.

Patients: All full ventilated patients monitored with LiDCOplus® monitoring who underwent a volume challenge because hypotension and/or oliguria and at least one parameter of hypovolemia (CVP, SVV or PPV) during 2008. Data collected: demographic and ventilator setting and hemodynamic parameters pre PLR, Post PLR and post fluid challenge with 500 mL NaCl 0.9%. Statistical Analysis. Continuous variables expressed as mean ± SD. Comparison before and after was done using a paired Student's t test. Then receiver operating characteristic (ROC) curves were generated by varying the discriminating threshold of each variable.

RESULTS. 23 patients were included, 2 patients lost (1 arrhythmia and 1 because change in management during protocol). Mean age 61.4 (±14.1); 71% male; body surface 1.78 (±0.14); APACHE II 22.7 (±6.4), SOFAmax 10.9 (±3); Septic 86%. Median of: tidal volume 500 mL (R 400–600); respiratory rate 18 x′(R 13–25); mean airway pressure 12 mmHg (6–21); airway plateau pressure (4 patients) 18 mmHg (R 12–26). Mean: heart rate 95x′ (±16); arterial pressure 71 mmHg (±11); urine output 0,49 cc/kg/h (±,7); Median: CVP 10 mmHg (R 5–13); SVV 12% (R 6–30); PPV 13% (R 6–45). Nine patients were responders to fluid challenge (43%). AUC: CVP mmHg 0.551 (95% CI 0.322–0.765); PLR response 0.875 (95%CI 0.658–0.975); SVV% 0.556 (95%CI 0.326–0.769); PPV% (95%CI 0.297–0.742). The correlation of Delta SV from PLR versus fluid challenge had a $R^2 = 0.475$ ($p = 0.0003$).

CONCLUSIONS. In our group of patients the changes in stroke volume, assessed by pulse power analysis, induced by PLR predict preload responsiveness in ventilated patients with close correlation-sheep. CVP, SVV or PPV predict preload responsiveness poorly.

0418

EARLY BEDSIDE ASSESSMENT OF SYSTEMIC ENDOTHELIAL FUNCTION PREDICTS OUTCOME IN INTENSIVE CARE

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INTRODUCTION. The endothelium regulates vascular homeostasis and may have a central role in the pathophysiology of organ dysfunction. Current in vivo methods to assess endothelial function are impractical for clinical use within the intensive care unit (ICU). Surrogate markers of endothelial dysfunction such as microalbuminuria (assessed by urinary ACR) have previously been shown to predict mortality in critical care.

Pulse wave analysis (PWA) measures the change in pulse wave augmentation following administration of endothelium-dependent (EDV) and independent (EIDV) agonists. The endothelial function index (EFI) is the ratio of EDV to EIDV and provides a measure of in vivo systemic endothelial function which can be assessed at the bedside. The predictive value of this method in critical care is currently unknown.

METHODS. A prospective observational study was conducted in an adult ICU. All consecutive patients were approached. PWA was performed within 24 h of admission. Urine was analysed for ACR and severity of illness scores were calculated. Collected serum was analysed for adhesion molecules using a commercially available multiplex bead array.

RESULTS. 99 patients were studied. There were 83 survivors and 16 non-survivors. The EFI was significantly lower in non-survivors ($p < 0.0001$ Mann Whitney U, Fig. 1). ACR was increased in non-survivors ($p = 0.012$) as were the APACHE II ($p = 0.032$), SAPS II ($p = 0.005$) and SOFA ($p = 0.009$) scores. The area under ROC curve was highest for EFI (98.99%) and it was the only test to predict mortality in the subgroups of medical, surgical, trauma and sepsis patients.
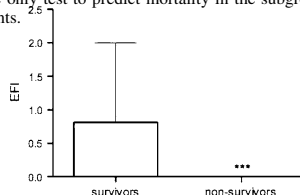

Fig. 1 EFI in survivors versus nonsurvivors

Soluble forms of the adhesion molecules ICAM-1($p = 0.03$), VCAM-1($p = 0.0005$) and P-Selectin ($p = 0.05$) where increased among non-survivors.

An EFI < 10% or an ACR > 2.3 mg/mmol were sensitive predictors of ICU mortality. However the EFI demonstrated superiority in that its values for sensitivity, specificity, positive and negative predictive values were higher (Table 1).

TABLE 1 PREDICTIVE PROPERTIES OF EFI AND ACR

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
EFI < 10%	100	94.92	80	100
ACR > 2.3 mg/mmol	93.75	46.91	28.30	97.72

CONCLUSIONS. PWA can be used to assess systemic endothelial function at the bedside in ICU. EFI is an accurate predictor of ICU mortality irrespective of the aetiology of critical illness and is superior to other predictive indices. Further investigation is warranted to assess the clinical significance of this novel bedside test.

0419

COMPARISON OF THREE ECHOCARDIOGRAPHIC METHODS FOR ESTIMATING MEAN PULMONARY ARTERY PRESSURE: ARE THEY ACCURATE?

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BACKGROUND. Pulmonary Hypertension (PH) is defined as a mean pulmonary artery pressure (MPAP) >25 mmHg at rest. The estimation of MPAP by right heart catheterization (RHC) is considered the gold standard; however, its invasiveness limits its repeated and frequent use. Thus, a non-invasive estimate of MPAP is desirable. The aim of this study was to compare the accuracy and precision of three proposed echocardiographic methods for estimating the MPAP.

METHODS. We prospectively studied 102 patients with simultaneous RHC and echocardiography. MPAP was echocardiographically calculated by 3 methods: (1) Mayo Clinic Florida Method (MCF) (adding the right ventricular-right atrial mean systolic gradient to the right atrial pressure), (2) Chemla formula (MPAP = $0.61 \times$ SPAP + 2 mmHg), and (3) Syyed formula (MPAP = $0.65 \times$ SPAP + 0.55). Using the MPAP obtained by standard RHC as the gold standard, we compared the accuracy and precision of the MCF method with those of the Chemla and Syyed formulas.

RESULTS. The mean (standard deviation) of differences between echocardiographically calculated MPAP by MCF, Chemla and Syyed methods and RHC-obtained MPAP were −1.6 (7.7) mmHg, −3.7 (7.4) mmHg and −3.2 (7.6) mmHg, respectively. Median absolute differences were 5.5 (MCF), 5.6 (Chemla, P=0.45 vs. MCF), and 5.9 mmHg (Syyed, $P = 0.21$ vs. MCF), and accuracy (±10 mmHg) was 81% (MCF), 77% (Chemla) and 76% (Syyed).

CONCLUSIONS. The echocardiographic estimation of MPAP by the MCF, Chemla and Syyed methods are similarly accurate and therefore are suitable for widespread clinical use.