Results Between 2004 and 2009 our crew evaluated for transfer on ECMO 15 ARDS patients (10 males), age 38 ± 15 years, BMI 28 ± 7, APACHE II score 26 ± 9, SOFA score 9 ± 4, Oxygenation Index 39 ± 17. The average distance was 133 ± 124 km. Two patients improved after NO trial and were transferred without ECMO. All of the other patients underwent venovenous ECMO: 11 with cannulation of femoral veins, one femoral–jugular veins and one with a DL cannula in the jugular vein. ECMO settings were (mean ± SD) BF 2.9 ± 0.8, GF 3.6 ± 1.6, GF FiO_2 1. Data have been recorded 30 minutes before and 1 hour after ECLS began: vv-ECMO granted a better clearance of pCO_2 (75 ± 20.5 vs 49.7 ± 7.9 mmHg, P <0.01), thus improving the pH (7.279 ± 0.10 vs 7.41 ± 0.06, P <0.01) and mean pulmonary arterial pressure (41 ± 11 vs 31 ± 5 mmHg, P <0.05) and allowing a reduction in respiratory rate (28 ± 11 vs 9 ± 4, P <0.01), minute ventilation (10.2 ± 4.6 vs 3.3 ± 1.7 l/min, P <0.01) and mean airway pressure (26 ± 6 vs 22 ± 5 cmH_2O, P <0.01). Arterial pO_2, mean blood pressure and heart rate did not show significant variations. After ECMO began, vasoconstrictor therapy (being administered to five patients) was quickly tapered. Neither clinical nor technical major complications were reported.
Conclusions ECMO employment at referral centers enabled long-distance, high-risk ground transportation.

P199

Effects of hypertonic saline on a pig model of acute lung injury induced by hydrochloric acid instillation

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Introduction Controversy exists over the possible beneficial effects of hypertonic saline (HS) in pulmonary inflammatory response, particularly in neutrophil immunomodulation [1,2]. This study was designed to investigate possible benefits of HS in the treatment of pigs submitted to experimental acute lung injury.
Methods Twelve anesthetized, tracheotomized pigs (25 to 30 kg) were mechanically ventilated by pressure, adjusted to 8 ml/kg tidal volume, with FiO_2 50%, and submitted to intratracheal instillation of 4 ml/kg hydrochloric acid (HCl) 0.1 N. They were then randomized to ALI group (n = 7) or ALI + HS group (n = 5), where animals of the latter group received 4 ml/kg intravenous hypertonic saline, 15 minutes after injury. Hemodynamic parameters, pulmonary compliance (C_{stat}), peak pressure (P_{peak}), plateau pressure (P_{plat}) and tidal volume (V_t) were analyzed at baseline (TBL), 15 minutes after HCl instillation (TALI) and hourly thereafter for 4 hours (T0 to T3). Bronchoalveolar lavage was performed at the end of the observation period for flow cytometry analysis of neutrophil burst activity. Postmortem histopathology of the right diaphragmatic lung was also performed in all animals.
Results After TALI, animals of both groups presented significant increases in P_{peak} and P_{plat}, and a decrease in C_{stat}, at all time points, when compared with TBL. V_t was preserved in both groups over time. There were significant differences between groups ALI and ALI + HS, respectively, in: central venous pressure (T0, T1 and T2), pulmonary artery occlusion pressure (T1 and T2) and pulmonary vascular resistance index (TALI). In the ALI group, significant differences related to TBL were found in mean arterial pressure (T1), mean pulmonary artery pressure (TALI, T0, T1, T2 and T3) and pulmonary vascular resistance index (TALI, T0, T3). In the ALI + HS group, there were significant differences related to TBL in mean arterial pressure (T0, T1, T2), mean pulmonary artery pressure (TALI, T0, T1, T2, T3), cardiac index (T0, T1, T2) and pulmonary vascular resistance index (T1, T2, T3). No differences were found between groups regarding histopathology and flow cytometry analyses.
Conclusions HS produced no significant benefit in the studied parameters regarding the lungs, in the proposed model of ALI.
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P200

Conventional mechanical ventilation can injury intact lungs in severe trauma patients

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Introduction Conventional mechanical ventilation (MV) may cause additional lung injury in ALI/ARDS due to overdistention of aerated lung regions (high Vt) and cyclic lung reopening (low PEEP level). Hyperproduction of inflammatory mediators is one of the side effects in these cases. This factor could delay or prevent resolution of respiratory failure [1,2]. However, it is not clear whether conventional mechanical ventilation damages intact lungs. The aim of this study was to evaluate the effects of conventional and protective mechanical ventilation on intact lungs in patients with severe trauma.
Methods A prospective, randomized controlled trial in trauma patients with mechanical ventilation for extrapulmonary indications. The protocol was approved by the local ethics committee. Seventy-eight patients were randomized to conventional (Vt 10 to 12 ml/kg IBW, PEEP 5 cmH_2O – n = 39) or protective (Vt 5 to 6 ml/kg IBW, PEEP 10 cmH_2O – n = 39) mechanical ventilation. TNFα, IL-1β and IL-6 levels in plasma and BAL fluids were measured on 1, 2, 3, 5 and 7 days of MV. Frequency of ALI (AECC criteria) and VAP were evaluated. The endpoints of this study were the length of MV, LOS in ICU and outcome on 28 days.
Results In first 3 days ALI was revealed in 26 patients (66.6%) in the conventional and 10 patients (26.5%) in the protective MV groups (P = 0.001; OR 4.375, 95% CI 2.227 to 8.189). ARDS occurred in four patients (10,2%) of the conventional MV group (LIS >2) and no one in the protective MV group (P <0.0001). Levels of TNFα, IL-1β and IL-6 in BAL fluids were significantly higher in the conventional MV group from 1 to 7 days with maximal increase on day 3 (542 ± 44/91 ± 11; 315 ± 35/86 ± 10; 1,092 ± 160/111 ± 18, P <0.0001). No differences were found in levels of TNFα, IL-1β and IL-6 in plasma samples. VAP occurred in 31 patients (83.7%) of the conventional and nine patients (23%) of the protective MV groups (P = 0.0001; OR 17.2, 95% CI 5.5 to 54.3). The length of MV was 17.4 ± 6 vs 12.8 ± 3 (P = 0.0001; OR 4.2, 95% CI 1.5 to 11.5), LOS in the ICU was 21.9 ± 5.6 vs 15.75 ± 2.9 (P = 0.0002; OR 2.0, 95% CI 0.18 to 23.6). The 28-day mortality was not significantly different in the groups.
Conclusions Conventional MV for more than 72 hours in patients with severe trauma and intact lungs can cause lung injury, and increase duration of MV and LOS in the ICU.
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P201

Protective effect of methylprednisolone on ventilator-induced diaphragm dysfunction is dose dependent

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Introduction Administration of 80 mg/kg methylprednisolone has been shown to prevent controlled mechanical ventilation (CMV) diaphragm dysfunction in rats, partly by inhibiting the calpain system [1]. The current experiments determined whether lower doses of corticosteroids will also provide protection against ventilator-induced diaphragm dysfunction.
Methods Rats were assigned to a control group or to 24 hours of CMV receiving a single injection of saline or 5 mg/kg (low MP) or 30 mg/kg (high MP) of methylprednisolone.
Results Diaphragm force production was decreased after CMV but significantly more in the low MP group while similar to controls in the high MP group. Atrophy of the type IIa fibers was only present in the low MP group. Atrophy of the type IIx/b fibers was more severe in the low MP group than in the CMV group while no atrophy was observed in the high MP group. Diaphragm calpain activity was increased after CMV (+93%, P <0.05 vs C) and in the low MP group (+83%, P <0.05 vs C), while it was similar to controls in the high MP group. Expression of calpastatin was

decreased in the CMV and the low MP group (–18%, P <0.05 vs C) but its level was preserved to control levels in the high MP group. Analysis of the caspase-3 mediated cleavage of α_{II}-spectrin revealed that CMV induced a significant rise in caspase-3 activity when compared with C (+194%, P <0.001). Caspase-3 activity was similarly increased in the MP-5 and the MP-30 groups (+96% and +78% respectively, P <0.05 vs C) but this increase was significantly less compared with that of CMV. Significant negative correlations were found between calpain activity and diaphragm force (–0.50 <r <–0.41, P <0.05) as well as with CSA of the type IIx/b fibers (r = –0.57, P <0.02). Significant positive correlations were observed between calpastatin and diaphragm force (0.43 <r <0.54, P <0.05) and calpastatin and CSA of the type IIx/b fibers (r = 0.57, P <0.02).

Conclusions The ability of corticosteroids to protect against CMV-induced diaphragmatic contractile dysfunction and atrophy are dose dependent with only high doses of corticosteroids providing protection.

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P202

Alveolar recruitment with non-invasive mechanical ventilation (C-PAP) in patients with nonobstructive respiratory failure

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Introduction Non-invasive mechanical ventilation (NIMV) is able to reduce reintubation especially in patients with exacerbation of COPD. Results have not been reached in critically ill patients with nonobstructive respiratory failure (NORF). However, the NIMV in most of these studies has been applied without making an effort to open the lung and adjusting the C-PAP after opening up the lung using a clinical approach. Our aim was to evaluate the effects of applying recruitment manoeuvres (RM) with C-PAP and titrate it according to clinical decremental C-PAP trial in patients with NORF.

Methods NORF patients for whom NIMV was indicated between January 2008 and July 2009 were included and submitted to the NIMV-RM protocol when a trained team was available. Bi-PAP and a full face mask were used. The inclusion criteria were at least two of the following: respiratory rate (RR) >30, accessory muscle activity, saturation ≤90% with FiO_2 ≥50% and consolidation areas on thorax X-ray. Gradual increasing of C-PAP (2 cmH_2O) was used from 10 to 20 cmH_2O. Each level of C-PAP was sustained for 5 minutes according to tolerance. The C-PAP after RM was adjusted when the maximal tidal volume (VT) was reached, pulse oximetry (PO) did not show any substantial change and when the patient was comfortable. Demographic data, APACHE II score and lung injury score (LIS) were measured. Cardiac rate (CR), RR, arterial pressure (AP), PO, minute ventilation (VE) and percentage of mask leak (PML) were recorded through the RM. Arterial blood gases were measured pre-RM, 1, 12 and 24 hours after RM. Variables are expressed as median (range). ANOVA by repeated measures or Kruskal–Wallis was used, P <0.05 was considered significant.

Results Fourteen patients were included. Age, APACHE II and LIS were: 56 (17 to 80); 14 (4 to 21) and 2 (1.3 to 2.7). The PaO_2/FiO_2 ratio increased from 169.1 ± 69.7 (basal) to 261 ± 106 after 1 hour of RM (P = 0.02).Improvement was preserved at 12 and 24 hours, 280 ± 69 and 295 ± 73, respectively. The C-PAP level 1 hour after RM was 14.9 ± 2.4, and 14.1 ± 1.9 at 24 hours post RM. The hemodynamic stability, RR, AP, PML and VE did not change during and after the RM.

Conclusions RM with gradual increments of C-PAP is safe. RM in patients with NORF could be an alternative to rescue patients with poor outcome with NIMV alone.

P203

N-acetylcysteine attenuates ventilator-induced diaphragm dysfunction in rats

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Introduction Controlled mechanical ventilation (CMV) results in diaphragmatic dysfunction. Oxidative stress is an important contributor to ventilator-induced diaphragm dysfunction, since 18 hours of CMV lead to increased protein oxidation and increased lipid peroxidation. We hypothesized that administration of an antioxidant, *N*-acetylcysteine (NAC), would restore the redox balance in the diaphragm and prevent the deleterious effects of CMV.

Methods Anesthetized rats were submitted for 24 hours to either spontaneous breathing while receiving 150 mg/kg NAC (SBNAC) or saline (SBSAL) or to CMV while receiving 150 mg/kg NAC (MVNAC) or saline (MVSAL).

Results After 24 hours, diaphragm forces were significantly lower in MVSAL compared with all groups. Administration of NAC completely abolished this decrease such that forces produced in the MVNAC group were comparable with those of both SB groups. Protein oxidation was significantly increased in MVSAL (+53%, P <0.01) and was restored in MVNAC. Diaphragm caspase-3 activity was significantly increased in MVSAL compared with SBSAL (+279%, P <0.001). Caspase-3 activity was also increased in the MVNAC group (+158.5%, P <0.01) but to a significantly lesser extent compared with that of MVSAL. Calpain activity was significantly increased after CMV (+137%, P <0.001 vs SBSAL), while it was similar to SB groups in the MVNAC group. Significant negative correlation was found between calpain activity and diaphragm tetanic force (r = –0.48, P = 0.02).

Conclusions These data show that the administration of NAC was able to preserve the diaphragm from the deleterious effects of CMV. NAC inhibits the increase in oxidative stress and proteolysis and reduces the decrease in force generating capacity of the diaphragm.

P204

In vitro muscle contraction force measurements on isolated and entire rat diaphragms

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Introduction Inactivity of the diaphragmatic muscles during mechanical ventilation leads to atrophy and contractile dysfunction. Up to now, *in vitro* force measurements were performed only on single diaphragmatic muscle strips. Our intention was to find out how mechanical and electrical stimulation influences the condition of the diaphragm as a whole organ. To determine the status of the diaphragm, muscle contraction forces were measured on entire rat diaphragms.

Methods We used an earlier described bioreactor [1] as the cultivation and measurement device for the whole rat diaphragm. The bioreactor consists of a pressure chamber and a supply chamber that are separated by a very flexible and soft membrane [2]. On this membrane the sample diaphragm is placed. By application of certain gas volumes (0 to 1.5 ml) in the pressure chamber, diaphragms are deflected to various levels of pretension. Diaphragms were electrically stimulated at each deflection level 10 times (750 ms duty cycle, 100 ms stimulation time, 5 ms pulse width, 200 Hz frequency). Pressure changes caused by muscle contraction were recorded inside the pressure chamber and muscle contraction forces were calculated. After initial force measurements, diaphragms were exposed for 6 hours to one of four different treatments: nonstimulated storage (control), cyclic mechanical deflection, electrical stimulation every 20 minutes, combination of cyclic deflection and electrical stimulation. After 6 hours another force measurement was performed. Supernatants were collected after 6 hours and investigated for IL-6 activity.

Results Depending on the level of deflection of the diaphragms, muscle contraction force increased from 0.1 N (volume 0.6 ml) to 0.7 N (volume 1.5 ml). A larger pretension of the diaphragm resulted in larger muscle contraction force. After treatment, muscle contraction force decreased in all groups. Muscle contraction force was smallest in the passive control group (0.05 N), larger and similar in the electrically stimulated (0.1 N) and combination (0.09 N) groups and largest in the mechanically deflected group (0.15 N). IL-6 activity increased after 6 hours of treatment.

Conclusions We conclude that it is possible to perform force measurements on whole rat diaphragms in our *in vitro* model. Additionally, the diaphragms can kept alive for >6 hours to apply different stimulation