293

EFFECTS OF INTRAVENOUS N-ACETYLCYSTEINE(NAC)ON RESPIRATORY FUNCTION IN ACUTE LUNG INJURY(ALI)

M.-D.Schaller,G.Domenighetti,P.M.Suter,M.-Ch. Laverrière,R.Ritz,R.Ruffmann,Cl.Perret.

To determine whether i.v.NAC has beneficial effects in patients with mild-to-moderate ALI in terms of ventilatory support(VS),FIO2 requirements,evolution of the lung injury score(LIS),development of severe lung injury(ARDS)and mortality rate,we prospectively enrolled 61 adult patients with ALI to receive either NAC 40 mg/kg/day or Placebo(PL)during 3 days.Respiratory dysfunction was assessed daily considering the need of VS,the FIO2 necessary to achieve a PaO2 of 70 to 80 mmHg and the evolution of 3 components of the LIS (chest X-ray,PaO2-FIO2 ratio and respiratory system compliance).Data were collected at baseline (day 0),on the first 3 days after admission to the ICU and on discharge.NAC and PL groups(32 vs 29 patients)were comparable at entry in terms of SAPS and values of the LIS.At day 0, 69% of the patients were ventilated in the NAC group versus 76% in the PL group;at day 3, 83% of the NAC treated patients did not require any further VS, versus 52% in the PL group(p=0.01).PaO2/FIO2 improved significantly(p=0.05)from day 0 to day 3 only in the NAC group.The LIS showed a signifi - cant improvement(p=0.003)in the NAC treated group within the first 10 days of treatment;no change was observed in the PL group.3 patients in each group progressed to ARDS.The one-month mortality rate was 22% for the NAC and 35% for the PL group **In conclusion**,early treatment with NAC seems to affect favourably pulmonary gas exchange and decrease the need for prolonged VS in patients with mild-to-moderate ALI.

Medical and Surgical ICUs,Hospitals of Lausanne, Locarno,Geneva,Basel,Switzerland.

294

EFFECTS OF APROTININ IN HEMORRHAGIC COMPLICATIONS OF PATIENTS WITH ARDS TREATED BY ECCO2R-LFPPV.

M Belghith, F Brunet, JP Mira, JJ Lanore, B Renaud, I Hamy, S Schlumberger, P Toulon, JF Dhainaut.

Bleeding remains a troublesome complication in pts with ARDS under ECCO2R-LFPPV, and seems related to the persistant activation of coagulation-fibrinolysis system as a consequence of blood contact with foreign surfaces, despite the use of heparin. Aprotinin, a broad-based proteinase inhibitor, has been successfully used to decrease bleeding in open heart surgery (Ann Thorac Surg 1987; 44: 640), but has never been evaluated in pts with bleeding during prolonged by-pass. The aim of this study was to assess the effects of aprotinin infusion (2.10^6 KIU intra-venously, and 5.10^5 KIU/h in constant infusion) in 11 ARDS pts who experienced bleeding and enrolled in a prospective clinical trial of a cohort of 40 pts treated by ECCO2R-LFPPV. This subgroup developed 14 episodes of acute hemorrhage. 9 episodes were spontaneous: bleeding appeared at the insertion sites of the catheters and bronchial suctions became hemorrhagic with biological signs of hyperfibrinolysis (group I), and 5 episodes were due to hemothorax related to a pleural drainage during by-pass (group II). In group I, bleeding rapidly vanished in 8/9 cases after aprotinin infusion with progressive improvement of coagulation abnormalities (Table 1), while no effect was observed in group II ($p<.008$, Fisher's test). No difference was observed in SAPS, OSF, Murray's score, and presence of sepsis between the 2 groups.

TABLE 1

		Fb (g/l)	PT (%)	APTT (sec)	D-dimers (µg/ml)	RBC (u/day)
Group I	H0	3.2	60	70	9.5	3.7
	H24	3.1	58	116	5.1*	1.7
Group II	H0	2.6	48	105	3.9	9.4
	H24	1.8	42	121	6.0	17**

Fb = fibrinogen, PT = prothrombin time, APTT = activated partial thromboplastin time, RBC = red blood cells, * p≤.05 H0 vs H24, ** Group I vs II.

These preliminary results suggest that bleeding occurring during ECCO2R-LFPPV is able to vanish after aprotinin infusion, except in cases of hemothorax related to pleural drainage. Thoracotomy at the bedside only may cure such a bleeding.

Medical ICU, Cochin Port-Royal University Hospital, Paris, F75014

Respiratory mechanics II

295

AUTOMATIC COMPENSATION OF TUBE RESISTANCE IN CPAP AND IPS

B. Fabry, J. Guttmann, L. Eberhard, W. Bertschmann, G. Wolff

Background: In CPAP with inspiratory pressure support (IPS) the level of support is independent of the patient's inspiratory effort. However, the resistive work of breathing increases progressively with inspiratory flow due to the flow-dependent resistance of the endotracheal tube (ETT). **Question:** How can we modify the airway pressure generated by the ventilator in order to compensate the resistive work caused by the ETT independently of the ventilatory pattern? **Investigations:** In the laboratory we measure the pressure drop across commercial endotracheal tubes (ΔP_{ETT}) at sinusoidal flow, V'max = ± 2 l/s; f = 15/min. Results separated for inspiration and expiration are fitted to the equation [1]

[1] $\Delta P_{ETT}(t) = K_1 \cdot V'^{K2}$.

At the patient we measure flow (V') and airway pressure (P_{aw}) and calculate intratracheal pressure (P_{trach}) in real time using the formula [2].

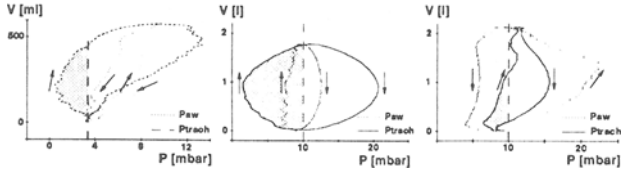
[2] $P_{trach}(t) = P_{aw}(t) - \Delta P_{ETT}(t)$

To compensate ETT resistance, inspiratory pressure support must be increased by the current pressure drop across the ETT. To this end we access the demand flow control of a ventilator by feeding back an error signal P_{aw}-P_{SP} generated by an external unit, where P_{SP} is the set point of the airway pressure calculated as follows:

[3a] $P_{SP}(t) = PEEP + \Delta P_{ETT}(t) + IPS$ (inspiration)

[3b] $P_{SP}(t) = PEEP + \Delta P_{ETT}(t)$ (expiration)

with V(t) = actual volume, IPS = inspiratory pressure support. **Results:** The coefficients for an ETT of 8 mm ID and 323 mm length were found to be K_1=8.21, K_2=1.94 for inspiration and K_1=9.18, K_2=1.75 for expiration. Using these coefficients, the continuously measured airway pressure/volume curve and the calculated intratracheal pressure/volume curve can be superimposed. Fig. 1 shows a breath with PEEP = 3.4 mbar and IPS = 5 mbar. Despite inspiratory pressure support, considerable additional ventilatory work occurs. In Fig. 2 we measured p_{aw} and p_{trach} with CPAP = 10 mbar at sinusoidal flow (V'_{max} = 1.3 l/s) generated by a lung simulator (C = 50 ml/mbar). Fig. 3 shows the same breath but with a ventilator modified according to equ. 3. Additional work due to the ETT is notably reduced. **Consequences:** In spontaneous breathing with inspiratory pressure support the dominant resistive work is caused by the ETT and is markedly influenced by gas flow, i. e. by the patient's ventilatory pattern. A continuously adapted pressure support permits a minimum of additional ventilatory work with a minimum of pressure load.



Clinical Physiology, Clinic for Cardiac and Thoracic Surgery, Department of Surgery, University of Basel/Switzerland, CH-4031

296

WORK OF BREATHING AND PRESSURE TIME PRODUCT DURING BIPHASIC POSITIVE AIRWAY PRESSURE AND ASSISTED SPONTANEOUS BREATHING VENTILATION.

E. Calzia, K.H. Lindner, U. Schirmer.

The aim of our study was to compare the respiratory efforts in terms of work of breathing of patient (WOBpat, [J/l]), work of breathing of ventilator (WOBvent, [J/l] and pressure-time-product (PTP, [cmH_2O*s/min]) during assisted spontaneous breathing (ASB, a ventilator technique synonym to pressure support ventilation) and biphasic positive airway pressure (BiPAP).
We studied 19 intubated patients during weaning after cardiac surgery. The patients were breathing spontaneously and supported by equivalent pressure levels with both respirator modes (BiPAP Phigh 15 and 10cmH_2O, Plow 5cmH_2O, Thigh 2s, Tlow 4s, abbreviated B15 and B10; ASB pressure support 15 and 10cmH_2O, CPAP 5cmH_2O, abbreviated A15 and A10). The WOB was calculated by the Campbell's diagram method, the PTP was obtained by integration of the area between the chest wall static recoil pressure and the esophageal pressure curve.

Results (mean±SD):

	WOBtot	WOBvent	WOBpat	PTP
B15	1.19±0.07	0.94±0.10+	0.26±0.13+	92±42+,*
A15	1.21±0.10	0.97±0.10+	0.23±0.13+	57±24+,*
B10	1.18±0.18	0.61±0.09+	0.57±0.22+	136±44+,*
A10	1.20±0.18	0.70±0.10+	0.50±0.18+	104±28+,*

+ means p<.01 B15 vs. B10 and A15 vs. A10
* means p<.01 B15 vs.A15 and B10 vs. A10

We conclude that both modes are suitable for reducing spontaneous respiratory efforts by increasing ventilator support, but BiPAP is more exhaustive as shown by higher PTP levels.

Department of Anaesthesiology, Ulm University Hospital, Steinhövelstr. 9, 7900 Ulm, Germany

297

FLOW RESISTIVE CHARACTERISTICS OF EXHALATION SYSTEM OF VENTILATORS. M. Lessard, F. Lemaire, L. Brochard.

Breathing through a highly resistive expiratory system may induce dynamic hyperinflation and auto-PEEP. Therefore we compared the flow resistive characteristics of the exhalation systems of different ventilators. Two components of the expiratory system might participate to the overall resistance to flow: 1.time to full opening of the expiratory valve, 2.resistance of the expiratory circuit. The ventilators were studied in the same conditions using a lung simulator (Vt=500mL). First we measured the time required for expiratory flow to be maximal ($t_{\dot{V}MAX}$). Secondly we recorded expiratory airway pressure and flow to calculate expiratory system resistance (R). Lastly we measured the volume trapped (V_{EE}) in the lung simulator (compliance 50 ml/cmH_2O) with decreasing expiratory times.

	$R_{0.5}$	$R_{1.0}$	$t_{\dot{V}MAX}$	$V_{EE1.0}$	$V_{EE0.6}$
BIRD 8400 ST	1.8	2.9	100	20	180
CESAR	2.0	3.3	75	10	200
DRAGER EVITA	3.2	3.7	75	10	100
ENGSTROM ERICA	2.8	4.9	150	170	>500
HAMILTON VEOLAR	2.8	2.2	75	40	190
OHMEDA ADVENT	4.0	3.6	100	30	210
OHMEDA CPU-1	5.6	4.2	100	30	190
PB 7200a	2.6	4.2	150	30	420
SIEMENS 900B	3.4	5.5	25	20	510
SIEMENS 900C	4.0	5.7	25	100	450

$R_{0.5}$, $R_{1.0}$: R(cmH_2O/L/sec) at expiratory flow 0.5L/sec, 1.0L/sec respectively; $V_{EE1.0}$, $V_{EE0.6}$: V_{EE} (ml) at expiratory time = 1.0 sec, 0.6 sec respectively.

We conclude that the exhalation system of some ventilators offer a significant resistance to expiratory flow. At high respiratory rate this may induce dynamic hyperinflation and might explain alterations in the inspiratory work of breathing.

Service de Réanimation Médicale, INSERM U296, Hôpital Henri Mondor, 94010 Créteil, France.

298

WORK OF BREATHING (WOB) DURING CONTINUOUS POSITIVE AIRWAY PRESSURE SYSTEMS (CPAP) AND T-PIECE (TP) DURING WEANING FROM MECHANICAL VENTILATION (MV) IN ACUTE RESPIRATORY FAILURE (ARF) AND NEUROLOGICAL PATIENTS.

J.Mancebo, I.Vallverdú, E.Bak, A.Ortiz, S.Benito, A.Net.

The use of CPAP and TP is common in the period of weaning from MV although their respective efficiency, depending on the type of disease, has not been evaluated. To analyse the impact on WOB and respiratory mechanics of CPAP delivered by demand valve (DV) or by a modified continuous flow, called flow-by (FB) and TP, we have studied 14 patients weaning from MV (7 patients were recovering from a neurological disease and 7 from an ARF). All breathed through 4 systems: 1) DV-CPAP,2) FB using a base flow of 10L/min (FB10), 3) FB using a base flow of 20 L/min (FB20) and 4) TP. All CPAP modes were studied with the Puritan-Bennett 7200a ventilator; the sensivity of FB was set at 1L/min. and was 0.5 cmH2O during DV-CPAP. The level of PEEP set on the ventilator was unchanged. Signals of airflow, airway, esophageal and gastric pressures were digitized and adquired by an IBM 55SX computer in order to calculate WOB (from Campbell's diagrams), Pdi (Pga-Peso), PEEP and autoPEEP (PEEPi), dynamic lung compliance (Cdyn) and breathing pattern. Differences between 4 modes were analyzed by two-way ANOVA. The results (mean±SEM) were as follows:

	WOB J/min	WOB J/L	Cdyn ml/cmH2O	Pdi cmH2O	PEEPi cmH2O	PEEP cmH2O
Neurological patients(n=7)						
DVCPAP	5.9±1	.62±.05	84±7	6.9±.8	.82±.18	7.1±.2
FB10	5.6±.7	.58±.05	82±9	6.6±.8	.87±.17	7.6±.3
FB20	5.8±1	.57±.06	94±10	6.8±1	.94±.19	8.2±.3
TP	6.7±1	.62±.08	84±8	8±.9	1.4±.41	------
P=	0.33	0.86	0.2	0.1	0.29	<.001
ARF patients (n=7)						
DVCPAP	7.2±.8	.74±.05	58±9	9.8±.9	.42±.1	7.6±.7
FB10	5:8±.7	.62±.06	63±8	8.5±1.1	.50±.17	8.2±.7
FB20	6.6±.7	.7±.06	63±9	9.6±1	.52±.2	8.8±.7
TP	9.3±1.8	.9±.12	67±	12±1.4	1.3±.56	------
P=	0.01	0.007	0.4	0.03	0.05	<.001

During weaning from MV, CPAP may be better than TP in terms of WOB, but only in those patients who do not present with neurological diseases; additionally, during FB20 are generated higher PEEP levels.

Supported by grants from FISss 91/0174 and HF-61 (Spain).

Servei Med Intensiva. Hospital Sant Pau. Avda. Sant Ant. Mª Claret 167. Barcelona. (Spain)

299

INSPIRATORY MUSCLE EFFORT DURING SIMV: THE EFFECTS OF FLOW-BY AND PRESSURE CONTROL. R. Giuliani, V.M. Ranieri, L. Mascia, T. Fiore.

The efficacy of SIMV to wean patients from mechanical ventilation has been questioned on the basis that the ventilatory pump continues to be active at all levels of ventilator assistance. Flow-by trigger (FB) may require less inspiratory effort than demand-flow trigger (DF) during both, assisted (assist) and spontaneous (spont) ventilation. Besides, it has been shown that work of breathing during constant pressure (CP) ventilation is smaller than during constant flow (CF) ventilation. To verify the hypothesis that FB and CP may better adapt spontaneous breaths to assisted breaths during SIMV, the effects of FB and CP ventilation on breathing pattern and inspiratory effort were studied in 9 patients during weaning from mechanical ventilation. SIMV rate was varied to obtain a full ventilatory support condition (SIMV 100%), a condition where assist and spont breaths were alternated (SIMV 50%) and a totally spontaneous ventilation condition (SIMV 0%). Flow, volume and esophageal pressure (Pes) were measured. VT and inspiratory time during CF and CP ventilation were identical. FB did not change total (assist+spont) respiratory frequency and tidal volume in both SIMV-CF and SIMV-CP at all levels of ventilatory support. Tidal swing in Pes (ΔPes) and pressure-time index for Pes ($\int$Pes), an index of respiratory muscle oxygen consumption, were reduced by FB during assist and spont breaths at all levels of ventilatory support in both CF and CP ventilation. ΔPes and $\int$Pes were smaller during CP than during CF ventilation, only for the assisted breaths at SIMV rates of 100% and 50% with both FD and FB triggers. The biggest reduction in ΔPes and $\int$Pes was observed during the assisted breaths set with CP ventilation and FB trigger. During SIMV 50% set with CF, ΔPes and $\int$Pes did not differ for assist and spont breaths. However, they were lower during assist than during spont breaths at 50% SIMV-CP, this difference being the biggest with SIMV set with CP ventilation and FB trigger. Our data indicate that FB reduced inspiratory effort compared to DF at all levels of ventilatory support in both SIMV-CF and SIMV-CP. Inspiratory effort during SIMV-CP was lower than during SIMV-CF ventilation in both FB and FD conditions. During 50% of SIMV the adaptation to assisted breaths was better during CP than during CF ventilation with either FB and DF.

Istituto di Anestesiologia e Rianimazione, Università di Bari, Policlinico, Piazza Giulio Cesare 70100, BARI, ITALIA.

300

ENERGY COST AND DIAPHRAGMATIC FUNCTION BEFORE AND AFTER LAPAROSCOPIC CHOLECYSTECTOMY

F. Erice, Y. Salib, J. Meakins, G. Fox and S. Magder. Royal Victoria Hospital and Meakins-Christie Labs, McGill University, Montréal, Québec (CANADA).

Experimental and clinical evidence suggests that diaphragmatic dysfunction is the primary cause of ventilatory impairment after upper abdominal surgery. Recently, the laparoscopic cholecystectomy (LC) has been introduced as a new surgical procedure to minimize the stress related to the standard intervention and reduce hospitalization. However diaphragmatic contractility and metabolic needs after LC have not yet been assessed. We studied 10 adult patients (8♀, 2♂; age range 23-71) undergoing elective LC, free of any cardiorespiratory disease. The subjects received the standard anesthetic treatment for the surgical procedure. We measured breath-by-breath respiratory gas exchange with indirect calorimetry, the pattern of breathing and resting ventilatory volumes, before and 3 hrs after surgery. Respiratory drive was assessed by $P_{0.1}$ against $PetCO_2$. Transdiaphragmatic pressure was used to directly estimate diaphragmatic contractility. All the patients showed a marked decrease in Pdi_{max}, ranging from 29 to 79% of the preop. value. This was associated with a significantly lower Vt ($p < 0.01$) and higher PetCO2 ($p < 0.01$). Concurrently, Ti/Ttot decreased ($p < 0.05$), breathing frequency increased ($p < 0.02$) but $\dot{V}E$ did not change. These results suggest that V_D/V_T was larger postoperatively. Respiratory drive was augmented in 6 patients, despite 5 of them receiving full doses of morphine for pain relief. None of these differences in respiratory drive seemed to be related to the magnitude of drop of Pdi. In 3 patients, in whom the test was repeated 24-48 hrs after surgery, there was an increase in the drive to breathe above baseline, but Pdi_{max} was still depressed. In all subjects neither $\dot{V}O_2$ nor $\dot{V}CO_2$ significantly changed in the immediate post-op. We conclude that, although LC seems not to increase metabolic demands in the early postoperative period, it impairs diaphragmatic function. The increased V_D/V_T may be a consequence of the reduced diaphragmatic contribution to tidal breathing with predominant activation of ribcage and accessory muscles. LC can still lead to the same postoperative pulmonary complications as the standard surgical procedure.