RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

Predictors and outcome of early-onset pneumonia after out-of-hospital cardiac arrest

Dr. Dirk Pabst MD[1], Dr. Sonja Römer MD[1], Dr. Alexander Samol MD[1], PD Dr. Philipp Kümpers MD[2], Prof Dr. Johannes Waltenberger MD[1], Dr. Pia Lebiedz MD[1]

[1]Department of Cardiovascular Medicine

[2]Department of Internal Medicine D

- University Hospital of Münster, Germany –

Corresponding author:

Dirk Pabst M.D.

Department of Cardiovascular Medicine

University Hospital of Muenster

Albert-Schweitzer-Campus 1, A1

48149 Münster

Germany

Email: dirk.pabst@ukmuenster.de

Phone: +49-251-8346188

Fax: +49-251-8346190

Total word count (excluding Abstract and References): 2223

No conflict of interests

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

ABSTRACT

Introduction: Early onset pneumonia (EOP) after out-of-hospital cardiac arrest (OHCA) is frequently observed. Causative factors are loss of airway protection during cardiac arrest, pulmonary contusion and emergency airway management. We herein assessed the incidence, risk factors and clinical course of EOP and evaluated the impact of an early exchange of prehospitally inserted endotracheal tube (ETT).

Methods: In our retrospective analysis, we included 104 consecutive patients admitted to our ICU after OHCA between 2007 and 2012. All patients underwent therapeutic hypothermia. We analyzed clinical course, inflammatory parameters, clinical pulmonary infections score (CPIS), occurrence of EOP, duration of ventilator support, microbiological findings and short term outcome.

Results: 46.2% of the patients received an exchange of ETT directly after hospital admission. Neither ETT-exchange nor observed aspiration were associated with elevated either CPI-score or EOP or proof of microbiological agents in respiratory secretion. We found no differences in duration of ventilator support, paO_2/FIO_2-index, ICU days or outcome. C-reactive protein was significantly higher in patients with aspiration (p= 0.046). Gender, age, smoker status, aspiration, cause for cardiac arrest, first detected heart rhythm and use of supraglottic airways devices were not associated with EOP. Patients with EOP had a longer need for ventilator support (p=0.005), higher tracheotomy rate (p=0.031), longer ICU duration (p=0.005), higher CRP (p<0.0001), higher body temperature (p=0.003), higher CPIS (p<0.0001) and a lower paO_2/FIO_2 index (p=0.008).

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

Conclusions: Rate of EOP was not significantly influenced by the exchange of preclinically inserted ETT, but was associated with longer need for mechanical ventilation and ICU duration.

Respiratory Care

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

In the present study, we tested for the first time the hypothesis, whether the early exchange of the preclinically inserted and potentially contaminated endotrachael tube after out-of-hospital cardiac arrest influences the rate of early-onset pneumonia. Furthermore, we aimed to identify risk factors for the occurrence of early-onset pneumonia and evaluated the consequences during ICU stay.

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

PATIENTS AND METHODS

Patients and study design

After approval by our ethical board, we performed a retrospective observational study including all adult patients admitted to our medical intensive care unit between 2007 and 2012 after CPR by the emergency medical service (EMS) after OHCA. The study was performed in accordance with the Helsinki declaration.

All included patients were comatose at hospital admission and underwent therapeutic hypothermia (32-34°C) for 24 hours by external cooling with ice packs and a cooling mat as well as internal cooling by cold infusions. Changing of the endotracheal tube (ETT) was performed at random assuming an unsterile ETT handling during out-of-hospital CPR. Tube was also exchanged if the preclinical inserted ETT was too small for the patient´s body size. Supraglottic airway devices were replaced by ETT directly after hospital admission. Patients were excluded from data analysis, if they died within the first 24h after hospital admission.

In addition to demographic factors, smoking status, observed aspiration during CPR, causes for cardiac arrest, first detected heart rhythm and exchange of the ETT were obtained by medical chart review. Routine laboratory tests and physiological parameters, including Simplified Acute Physiology Score (SAPS) II were obtained for each patient on admission and daily during up to day 10. Whenever possible, we calculated the Clinical Pulmonary Infection Score (CIPS) (11), including body temperature, white blood cell count, assessment of purulent tracheal secretions, PaO_2/FiO_2 ratio, and chest x-ray between days 2-4 after ICU admission using the Surgical Care Net webpage (http://www.surgicalcriticalcare.net/Resources/CPIS.php).

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

Outcome definitions

- Early-onset pneumonia during the first 4 days after ICU admission was defined as the primary outcome. Early-onset pneumonia was confirmed, if a positive culture with pathogenic microorganisms was received from respiratory secretions of the patients. Endobronchial fluid samples were gathered by bronchoalveolar lavage or endotracheal aspiration (significance levels were 10^3 up to 10^5 dependent on dilution factor). In the absence of a microbiological prove, pneumonia was assumed, if the typical auscultation was combined with new pulmonary infiltrations in the x-ray (>24h), inflammatory reaction, purulent endotracheal aspirates and respiratory failure not explained by other causes such as pulmonary edema.
- In-hospital mortality (for survivors >24h) was defined as death in the hospital versus the patient being discharged from the hospital alive.
- We assessed the duration of overall ventilator support, the need for tracheotomy and the duration of endotracheal intubation for survivors > 24h. We analyzed the ICU duration in all patients.
- Secondary organ failure included renal and liver dysfunction and was defined as acute kidney injury (AKI) according to the Acute Kidney Injury Network (AKIN) (12) and/or fivefold elevation of liver transaminases above the upper reference values.

Statistical analysis

Values are expressed as mean ± standard deviation (SD). Continuous variables were compared using the Mann-Whitney rank sum test or the Wilcoxon signed-rank test as appropriate. Categorical variables were compared using the chi-squared test.

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

Correlations between variables were assessed by the Spearman rank correlation coefficient or pearson correlation if appropriate. Simple and multiple linear regression and binary logistic regression models were used to identify predictors of EOP or CPIS as well as days of ventilator support, ICUdays, hospital mortality and occurrence of severe sepsis, respectively. All tests were two-sided and significance was accepted at $P < 0.05$. Data analysis was performed using SPSS 20 (IBM®, Armonk, NY, USA).

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

RESULTS

We included 104 patients after successful resuscitation due to out-of-hospital cardiac arrest. All patients were treated with therapeutic hypothermia. Most patients (94.2%) had been orotracheally intubated by the emergency medical service during cardiocompression. In six patients (5.8%), a supraglottic airway device (laryngeal tube) was applied.

The median age was 58.5 (± 16.7) years, 77.9% were male. Most cardiac arrests were caused by primary cardiac disorders (n=85, 81.7%), in 18 patients (17.3%) cardiac arrest was caused by respiratory failure or asphyxia, one case remained obscure. First detected heart rhythm was ventricular fibrillation or pulseless ventricular tachycardia in 75%, asystole in 23.1% and electromechanical dissociation in 1.9%.

The overall hospital mortality was 23.1% (n=24). A total of 13 (12.5%) patients were directly dismissed from hospital, 67 (64.4%) were transferred to other hospitals or to rehabilitation centers.

A total of 48 (46.2%) patients received an exchange of ETT directly after hospital admission, in 56 (53.8%) patients the preclinically inserted ETT was left.

Spectrum of microorganisms found in respiratory secretions and antibiotic treatment

In 25 (24%) of the patients, we found pathogenic microbiological agents in respiratory secretions. In 15 patients, *Staph aureus* was found (of these 2 were MRSA), 3 patients had Streptococcus *species*, three had an *Escherichia coli*, one *Enterobacter aerogenes*, one *Aspergillus fumigatus*, one *Klebsiella pneumonia*, two *Heamophilius*

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

influenza, three *Candida glabrata*. In 7 patients, *Candida albicans* was found in respiratory secretions, which mostly represents a colonization rather than an infection. Only one patient had a positive blood culture with prove of *Haemophilus influenza*, in one case we found *Streptokokkus mitis* and 4 patients had coagulase-negative staphylococci that are contamination rather than infection.

A total of 78 patients (75%) received early antibiotic treatment with a trend towards more frequent use in patients with EOP (90% antibiotic treatment in patients with EOP versus 76.7% in patients without, p= 0.073).

Risk factors for occurrence of early onset pneumonia

Linear regression analysis failed to identify gender (β= -0.091; 95% CI -2.613 – 1.364; p=0.529), age (β=0.078; 95% CI 0.035-0.06; p=0.59), cause for cardiac arrest (β=0.357; 95% CI -1.342-4.554; p=0.277), first detected heart rhythm (β=0.252; 95% CI -1.359-3.258; p=0.41), smoker status (β=0.258; 95% CI -0.314-2.287; p=0.133), confirmed aspiration (β=0.1; 95% CI -1.097-1.731; p=0.636), use of supraglottic airway device (β=0.135; 95% CI -1.597-3.715; p=0.424) or change of ETT (β=0.118; 95% CI -1.024-1.683; p=0.625) to influence CPI score,. Furthermore, we did not find any of this factors to influence the occurrence of EOP (gender: OR 1.926; 95% CI 0.255-14.529; p=0.525; age: OR 0.999; 95% CI 0.957-1.043; p=0.953; cause for cardiac arrest: OR 0.721; 95% CI: 0.032-16.484; p=0.838; first detected heart rhythm: OR 0.383; 95% CI: 0.031-4.677; p=0.452; smoker status: OR 2.864; 95% CI 0.840-9.760; p=0.093 aspiration: OR 1.369; 95% CI 0.384-4.881; p=0.628; use of supraglottic airway device: OR 0.709; 95% CI 0.046-10.822; p=0.804; exchange of ETT: OR 1.215; 95% CI 0.341-4.334; p=0.764).

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

Clinical consequences of early-onset pneumonia

Patients with early-onset pneumonia had a longer need for mechanical ventilation (225 ±199 hours compared to 128.3±145.5 hours; p=0.005), and associated to this fact a higher rate of tracheotomy (53.7% versus 32%, p=0.031) as well as a longer duration of orotracheal intubation (95.3±77 versus 68.6 ±51.8; p=0.027). Furthermore, patients with early-onset pneumonia had a longer stay on ICU (12.8 ±9.5 days compared to 8.7 ±7.4 days without pneumonia; p=0.005).

During the first 4 days after admission, the pneumonia patients had a higher maximal body temperature (p=0.003), an elevated maximal CRP (p<0.001), a higher maximal CPIS (P<0.001) and lower minimal oxygenation index (p=0.008) compared to patients without early-onset pneumonia whereas the maximal leukcocyte count did not differ significantly (Table 1).

Although duration of ventilator support and ICU stay was prolonged in patients with early-onset pneumonia, overall outcome did not differ in the groups with and without pneumonia (data not shown).

Impact of tube changing.

We neither found differences in CPI score and EOP criteria nor inflammatory parameters (such as body temperature, CRP or leukocyte count) during the course of treatment in the groups with or without ETT changing. Groups did not differ significantly with regard to frequency of proven microbiological infection of respiratory fluids (broncho-alveolar lavage or tracheal secretion), regarding their need for antibiotic treatment, tracheotomy rate, and oxygenation index (paO_2/FIO_2). Furthermore, we could not detect differences in duration of ventilator support,

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

maximal SAPSS II score, occurrence of additional organ failure, ICU days or survival (Table 2). Re-intubation rate was low (2.9%) and showed no associated with previous tube exchange.

Impact of aspiration.

In 34 (32.7%) of the patients, the emergency medical team confirmed an aspiration during CPR by visual diagnosis. Patients with proven aspiration did not develop elevated CPIS and did not have reduced oxygenation indices (paO_2/FIO_2), elevated SAPSS II scores, higher mortality rates, or a longer ICU stay. We found a significant higher maximal CRP value in patients with confirmed aspiration (18.1 ±8.9 mg/dL) compared to those without (14.5 ±8.2 mg/dL; p= 0.046), whereas maximal leukocyte count and maximal body temperature did not differ significantly (Table 3). Furthermore, we observed a trend towards higher EOP rates in patients with proven aspiration (64% EOP for aspiration versus 44.3% EOP in patients without aspiration, p=0.094) which failed to reached statistical significance.

Inflammatory parameters in pneumonia after OHCA

Figure 1 displays the course of leukocytes, CRP and Horowitz index (paO_2/FIO_2) during the first 10 days after OHCA. We found significant differences in CRP und Horowitz index between the pneumonia and no-pneumonia patients during day 4-7 after hospital admission.

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

DISCUSSION

Causes for early-onset pneumonia after successful pre-hospital resuscitation are multiple. Consequences of EOP such as prolonged ventilator support and ICU stay are of clinical and financial importance. The measures taken to reduce this pneumonia and its consequences after OHCA are very limited. We tested for the first time the hypothesis, whether incidence of EOP can be influenced by early exchange of preclinically inserted and potentially contaminated endotracheal tubes.

Impact of early ETT change under sterile conditions

Although the EOP is caused by different factors such as aspiration, pulmonary contusion by cardiocompression and emergency airway access rather than only by ventilator-associated lung injuries, EOP and VAP might have some etiologic factors in common. For VAP, different measures have been tested to reduce pneumonia rates in intensive care patients (13) (14) (15). Most of them aim at a reduction of bacterial colonization of ETT. Assuming an additional contamination of ETT during pre-hospital emergency airway access, we herein report for the first time results of an ETT change under sterile conditions after hospital admission. We could not detect differences in clinical course, inflammatory parameters and pneumonia rates after tube exchange compared to patients without. Hence, a simple exchange does not present an effective means for reduction of pneumonia rates. Neither demographic factors such as age, gender or smoking habits nor clinical features such as cause for cardiac arrest or confirmed aspiration could be identified as proven risk factors for the occurrence of EOP.

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

Use of Clinical Pulmonary Infection Score for diagnosis of early-onset pneumonia after OHCA

Due to known difficulties to determine early-onset pneumonia after successful resuscitation due to OHCA, we evaluated the value of the clinical pulmonary infection score (11) and showed a good correlation with previously used pneumonia scores after OHCA (4). CRP and body temperature are indicators of EOP, whereas the leukocyte count, which is one co-factor for the evaluation of the CPI score (11), did not show a good correlation with the occurrence of EOP in our patients.

Impact of supraglottic airway devices

Supraglottic airway devices are of growing importance in the preclinical emergency management. A very recent study demonstrated a favorable outcome of patients treated with primary ETT during pre-hospital resuscitation instead of supraglottic airway devices (16).

Although in our cohort, only 6 patients were admitted to hospital with laryngopharyngeal tube, we did not find an elevated rate of early-onset pneumonia in these patients, which clearly supports the use of these devices.

Impact of microbiologic findings and antibiotic treatment

A recent study by Davies et al (17) showed an improved outcome in patients after OHCA who received an early antibiotic treatment within the first 7 days. In our cohort, 75% of all patients received antibiotic treatment with a trend towards more antibiotic use in patients with EOP than in those without. We take this fact as a consequence to

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

the proven or suspected infection. Our data may not further contribute to the question, whether early antibiotic treatment may influence the patient´s outcome.

There are certain limitations of this study to be addressed. First, the study design is retrospective. Second, pneumonia scores such as CPIS and EOP-score are partly subjective, due to the differential evaluation of pneumonic infiltrations in x-ray and the difficulties in x-ray interpretation in ventilated patients in supine position. Furthermore, ICU days and duration of mechanical ventilation are not only caused by respiratory failure, but often are a consequence of bad neurological outcome. The patient´s outcome is rather caused by underlying disease and complications than by the occurrence of EOP. Therefore, impact of EOP occurrence on the ICU course is very limited.

In summary, our study failed to identify influenceable factors for early-onset pneumonia after successful resuscitation of OHCA patients. As previously reported the occurrence of EOP is associated with longer need for ventilator support and longer ICU duration and might therefore lead to high health care costs.

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

REFERENCES

1. **Bjork RJ, Snyder BD, Campion BC, Loewenson RB.** Medical complications of cardiopulmonary arrest. *Arch Intern Med.* 1982, 142(3):500-3.

2. **Mongardon N, Perbet S, Lemiale V, Dumas F, Poupet H, Charpentier J, Péne F, Chiche JD, Mira JP, Cariou A.** Infectious complications in out-of-hospital cardiac arrest patients in the therapeutic hypothermia era. *Crit Care Med.* 2011, 39(6):1359-64.

3. **Adrie C, Laurent I, Monchi M, Cariou A, Dhainaou JF, Spaulding C.** Postresuscitation disease after cardiac arrest: a sepsis-like syndrome? *Curr Opin Crit Care.* 2004, 10(3):208-12.

4. **Perbet S, Mongardon N, Dumas F, Bruel C, Lemiale V, Mourvillier B, Carli P, Varenne O, Mira JP, Wolff M, Cariou A.** Early-onset pneumonia after cardiac arrest: characteristics, risk factors and influence on prognosis. *Am J Respir Crit Care Med.* 2011, 184(9):1048-54.

5. **Mongardon N, Lemiale V, Perbet S, Dumas F, Legriel S, Guérin S, Charpentier J, Chiche JD, Mira JP, Cariou A.** Value of procalcitonin for diagnosis of early onset pneumonia in hypothermia-treated cardiac arrest patients. *Intensive Care Med.* 2010, 36(1):92-9. Epub 2009 Oct 21.

6. **Schurink CA, Van Nieuwenhoven CA, Jacobs JA, Rozenberg-Arska M, Joore HC, Buskens E, Hoepelman AI, Bonten MJ.** Clinical pulmonary infection score for ventilator-associated pneumonia: accuracy and inter-observer variability. *Intensive Care Med.* 2004, 30(2):217-24. Epub 2003 Oct 18.

7. **Levine SA, Niederman MS.** The impact of tracheal intubation on host defenses and risks for nosocomial pneumonia. *Clin Chest Med.* 1991, 12(3):523-543.

8. **Adair CG, Gorman SP, Feron BM, Byers LM, Jones DS, Goldsmith CE, Moore JE, Kerr JR, Curran MD, Hogg G, Webb CH, McCarthy GJ, Milligan KR.** Implications of endotracheal tube biofilm for ventilator-associated pneumonia. *Intensive Care Med.* 1999, 25(10):1072-1076.

9. **Inglis TJ, Millar MR, Jones JG, Robinson DA.** Tracheal tube biofilm as a source of bacterial colonization of the lung. *J Clin Microbiol.* 1989, 27(9):2014-2018.

10. **Rello J, Ollendorf DA, Oster G, Vera-Llonch M, Bellm L, Redman R, Kollef MH and Group., VAP Outcomes Scientific Advisory.** Epidemiology and outcomes of ventilator-associated pneumonia in a large US database. *Chest.* 2002, 122(6):2115-2121.

11. **Pugin J, Auckenthaler R, Mili N, Janssens JP, Lew PD, Suter PM.** Diagnosis of ventilator-associated pneumonia by bacteriologic analysis of bronchoscopic and nonbronchoscopic "blind" bronchoalveolar lavage fluid. *Am Rev Respir Dis.* 1991, 143(5 Pt 1):1121-1129.

12. **Mehta RL, Kellum JA, Shah SV, Molitoris BA, Ronco C, Warnock DG, Levin A and Network., Acute Kidney Injury.** Acute Kidney Injury Network: report of an initiative to improve outcomes in acute kidney injury. *Crit Care.* 2007, 11(2):R31.

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

13. **Rello J, Afessa B, Anzueto A, Arroliga AC, Olson ME, Restrepo MI, Talsma SS, Bracken RL, Kollef MH.** Activity of a silver-coated endotracheal tube in preclinical models of ventilator-associated pneumonia and a study after extubation. *Crit Care Med.* 2010, 38(4):1135-1140.

14. **Kollef MH, Afessa B, Anzueto A, Veremakis C, Kerr KM, Margolis BD, Craven DE, Roberts PR, Arroliga AC, Hubmayr RD, Restrepo MI, Auger WR, Schinner R and Group., NASCENT Investigation.** Silver-coated endotracheal tubes and incidence of ventilator-associated pneumonia: the NASCENT randomized trial. *JAMA.* 2008, 300(7):805-813.

15. **Coppadoro A, Berra L, Bigatello LM.** Modifying endotracheal tubes to prevent ventilator-associated pneumonia. *Curr Opin Infect Dis.* 2011, 24(2):157-162.

16. **Wang HE, Szydlo D, Stouffer JA, Lin S, Carlson JN, Vaillancourt C, Sears G, Verbeek RP, Fowler R, Idris AH, Koenig K, Christenson J, Minokadeh A, Brandt J, Rea T and Investigators., The ROC.** Endotracheal intubation versus supraglottic airway insertion in out-of-hospital cardiac arrest. *Resuscitation.* 2012, Jun 1. [Epub ahead of print].

17. **Davies KJ, Walters JH, Kerslake IM, Greenwood R, Thomas MJ.** Early antibiotics improve survival following out-of hospital cardiac arrest. *Resuscitation.* 2012, pii: S0300-9572(12)00889-1. doi: 10.1016/j.resuscitation.2012.11.004. [Epub ahead of print].

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

FIGURE LEGEND:

Figure 1: A) Oxygenation index during the first 10 days after OHCA in patients with and without EOP. Significant differences were found on day 4 (p=0.009), day 5 (p=0.003) and day 6 (p=0.031). B) Leukocyte count. No significant differences in leukocyte course in patients with and without early-onset pneumonia could be detected. C) CRP values differed significantly between the groups on day 3 (p=0.006), day 4 (p=0.052), day 7 (p=0.017)

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

Table 1~~3~~: Comparison of patients with and without EOP

	Early-onset pneumonia (n=54, 51.9%)	**No early-onset pneumonia (n=50, 48.1%)**	**p value**
Male gender	42 (77.8%)	39 (78%)	1.000
Age	56.3 (±16)	61 (±17)	0.163
smoker	23 (67.6%)	9 (42.9%)	0.094
ICU mortality	11 (20.4%)	13 (26%)	0.642
Max SAPSS II	71 (±13)	72.2 (±21)	0.253
Aspiration	22 (40.7%)	12 (24%)	0.094
Laryngeal tube	3 (5.6%)	3 (6%)	1.000
Tube exchange	26 (48.1%)	22 (44%)	0.698
Tracheotomy	29 (53.7%)	16 (32%)	**0.031***
Duration of mechanical ventilation (h)	225 (±199)	128.3 (±145.5)	**0.005***
Duration of orotracheal intubation	95.3 (±77)	68.6 (±51.8)	**0.027***
Antibiotic treatment	45 (90%)	33 (76.7%)	0.073
ICU days	12.8 (±9.5)	8.7 (±7.4)	**0.005***
Organ failure	14 (25.9%)	15 (30%)	0.668
Need for re-intubation	1 (2%)	2 (4%)	0.617
Max CRP (mg/dL)	18.9 (±8.2)	12.2 (±7.6)	**<0.001***
Max leukocytes (tsd/µL)	17.4 (±6.3)	16.4 (±6.1)	0.317
Max body temperature (°C)	38.5 (±0.9)	38.2 (±0.9)	**0.003***
Max CPIS	5.1 (±1.9)	3 (±1.5)	**<0.001***
paO_2/FIO_2 at admission	259 (±128)	285 (±106)	0.236
paO_2/FIO_2 minimal	141 (±49)	182 (±76)	**0.008***

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

Table 2: Patient´s characteristics and group comparison between patients with and without exchange of ETT (values are presented as mean ± SD or absolute and relative numbers)

	All (n=104)	**Tube exchange (n=48)**	**No tube exchange (n=56)**	**P**
Male gender	81 (77.9%)	40 (83.3%)	41 (73.2%)	0.244
Age	58.5 (± 16.7)	56.3 (± 17.7)	60.4 (± 15.8)	0.207
ICU mortality	24 (23.1%)	10 (20.8%)	14 (25.5%)	0.210
Max SAPSS II	71.6 (± 17.2)	69.5 (± 22.7)	72.7 (± 13.5)	0.735
Aspiration	34 (32.7%)	19 (39.6%)	15 (26.7%)	0.209
Tracheotomy	45 (43.3%)	20 (41.7%)	25 (44.5%)	0.843
Duration of mechanical ventilation (h)	180.2 (±182.5)	164 (±168)	195 (±195)	0.564
Ventilator-free days	15.5 (±10.8)	16.5 (±10.6)	14.6 (±11.1)	0.475
Pathogenic microbiological agents	25 (24%)	13 (27.1%)	12 (21.4%)	0.646
Antibiotic treatment	78 (75%)	42 (87.5%)	36 (64.3%)	0.089
ICU days	10.8 (±8.7)	9.4 (±7.6)	12 (±9.6)	0.128
ICU free days	13.3 (±10)	14.9 (±9.7)	12 (±10.1)	0.140
Organ failure	28 (26.9%)	11 (22.9%)	18 (32.1%)	0.381
Need for re-intubation	3 (2.9%)	2 (3.8%)	1 (2.1%)	1.000
Max CRP (mg/dL)	15.6 (±8.5)	15.5 (±8.4)	15.8 (±8.8)	0.978
Max leukocytes (tsd/µL)	16.9 (±6.3)	16 (±5.7)	17.8 (±6.6)	0.155
Max body temperature (°C)	38.4 (±0.9)	38.3 (±0.8)	38.4 (±0.9)	0.969
Early-onset pneumonia	53 (51%)	26 (54.2%)	27 (48.2%)	0.562
Max CPIS	4 (±2)	4.4 (±2.3)	3.8 (±1.8)	0.329
paO_2/FIO_2 at admission	271.4 (±118.2)	279.5 (±120.6)	264.4 (±117)	0.639
paO_2/FIO_2 minimal	160.5 (±66)	159.6 (±73.5)	161.3 (±60)	0.662

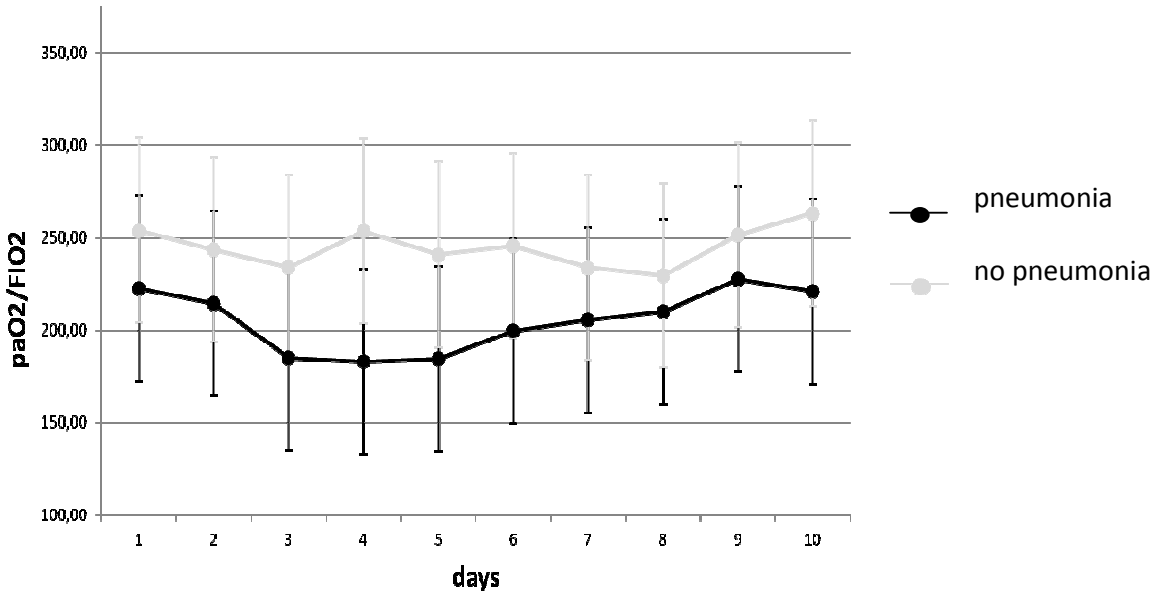
RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

Table 3: Patient´s characteristics and group comparison between patients with an without confirmed aspiration (values are presented as mean ± SD or absolute and relative numbers)

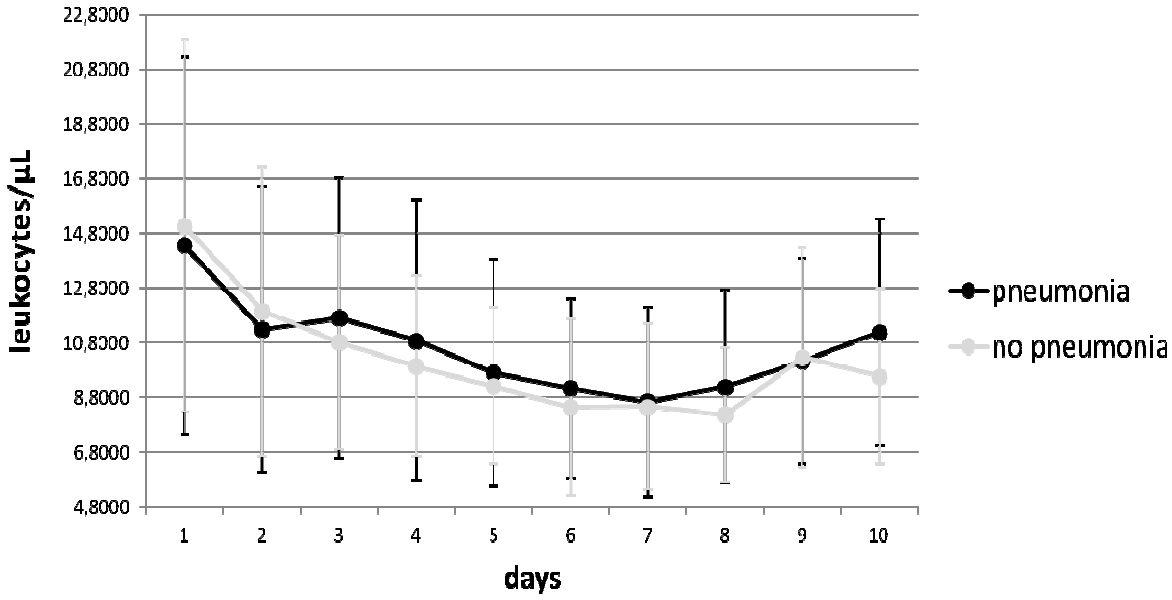
	All (n=104)	**Confirmed aspiration (n=34)**	**No aspiration (n=70)**	**P**
Male gender	81 (77.9%)	29 (85.3%)	52 (74.3%)	0.223
Age	58.5 (± 16.7)	56 (±17.1)	59.7 (±16.5)	0.291
ICU mortality	24 (23.1%)	6 (17.6%)	18 (25.7%)	0.460
Max SAPSS II	71.6 (± 17.2)	72.2 (±16.6)	71.2 (±15.3)	0.540
Tracheotomy	45 (43.3%)	17 (50%)	28 (40%)	0.401
Duration of mechanical ventilation (h)	180.2 (±182.5)	202 (±215)	168 (±164)	0.476
Ventilator free days	15.5 (±10.8)	16 (±10.6)	15.2 (±11)	0.894
Pathogenic microbiological agents	25 (24%)	9 (26.5%)	16 (22.9%)	0.807
Antibiotic treatment	78 (75%)	30 (90.9%)	48 (80%)	0.242
ICU days	10.8 (±8.7)	10.7 (±8.9)	10.8 (±8.8)	0.929
ICU free days	13.3 (±10)	14.3 (9.9)	12.8 (±10.2)	0.617
Organ failure	28 (26.9%)	9 (26.5%)	20 (28.6%)	1.000
Need for re-intubation	3 (2.9%)	0	4 (4.4%)	0.333
Max CRP (mg/dL)	15.6 (±8.5)	18.1 (±8.9)	14.5 (±8.2)	**0.046***
Max leukocytes (tsd/µL)	16.9 (±6.3)	16.5 (±5.5)	17.1 (±6.6)	0.949
Max body temperature (°C)	38.4 (±0.9)	38.4 (±0.9)	38.3 (±0.9)	0.445
Early-onset pneumonia	53 (51%)	22 (64.7%)	31 (44.3%)	0.094
Max CPIS	4 (±2)	4,4 (±2)	3.8 (±2)	0.168
paO_2/FIO_2 at admission	271.4 (±118.2)	305 (±136)	258 (±109)	0.128
paO_2/FIO_2 minimal	160.5 (±66)	156 (±75)	163 (±62)	0.536

RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

A



B



RESPIRATORY CARE Paper in Press. Published on March 05, 2013 as DOI: 10.4187/respcare.02307

C