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ORIGINAL PAPER

PULMONARY REHABILITATION WITHIN INTENSIVE CARE UNITS EXEMPLIFIED BY TRAFFIC COLLISIONS CASUALTIES

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ABSTRACT

Introduction. The early introduction of a rehabilitation procedure is of vital importance in the process of acting upon the respiratory system. In comprehensive therapy, pulmonary rehabilitation is perceived as an integral part of treatment for mechanically ventilated patients.

Aim. The aim of this work was to conduct a comparative analysis of pulmonary rehabilitation concerning patients who had sustained an injury as the result of traffic collisions, and were subsequently treated in an intensive care unit (ICU).

Materials and methods. Research material consisted of information contained in the medical documentation of 43 patients, ranging in ages from 15 to 57 years, treated in the ICU for injuries sustained during traffic collisions. This analysis involved the values of the parameters recorded first on admission of the patient to the unit, and then every 7 days thereafter, and finally upon discharge from the ICU, and included: arterial blood gasometry, pulsoxymetry, capnometry, body temperature, arterial blood pressure, and pulse rate.

Results and Discussion. Pneumonia occurred most frequently in patients ventilated mechanically during the period from the 15^{th} to the 28^{th} day of hospitalization and constituted 60% of the total occurring pneumonias. Deaths were observed more often in patients with acidosis and hypercapnia. Values of arterial oxygen saturation of hemoglobin (SaO_2) below 94% were recorded in that group of patients for whom therapeutic procedures ended in failure (40%). For the remaining patients, SaO_2

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values exceeded 94%. The analysis of our material showed divergences concerning the values of partial pressure of end-tidal carbon dioxide ($PetCO_2$) and partial pressure of carbon dioxide in the arterial blood ($PaCO_2$). The mean values of SaO_2 and percutaneous monitoring of hemoglobin oxygen saturation (SpO_2) were similar.
Conclusions. The length of stay within the ICU is significant with respect to the occurrence of complications in the form of pneumonia. Patients whose parameter values were within the norm during pulmonary rehabilitation attained spontaneous respiration at discharge. SpO_2 and $PetCO_2$ are of vital importance in the pulmonary rehabilitation process, complemented by regularly taken arterial blood gasometry measurements.

Key words: pulmonary rehabilitation, mechanical ventilation, gasometry

INTRODUCTION

The present work focuses on pulmonary rehabilitation concerning traffic collision casualties treated in the Intensive Care Unit (ICU). The specificity of pulmonary rehabilitation in intensive care involves the ability to adapt it to a constantly changing clinical condition of the patient, the type of injury sustained, and those therapeutic procedures administered [15, 23, 37, 38]. The lack of activities undertaken to rehabilitate the respiratory system may contribute to complications and result in death. Available data suggest that pulmonary rehabilitation is regarded as an integral part of the therapeutic process for mechanically ventilated patients [5, 6, 22, 32].

The reports of numerous authors allow us to conclude that the early introduction of an adequate rehabilitation procedure is of vital importance in the process of acting upon the respiratory system [3, 5, 9, 16, 17].

AIM

The aim of this work was to conduct a comparative analysis of pulmonary rehabilitation concerning patients who had sustained an injury as the result of traffic collisions, expressed in parameters depending upon the patient's condition at discharge and the type of participation in a traffic collision.

MATERIALS AND METHODS

Research material was obtained by comparing information contained in the medical documentation of 43 patients, ranging in ages from 15 to 57 years, treated in the Provincial Specialist Hospital in Olsztyn for injuries sustained during traffic collisions. These injured patients amounted to 17.84% of all patients treated from January 1, 2008 to December 31, 2008 in the ICU. The majority of hospitalized patients were male (30), i.e., 69.8% (Fig. 1).

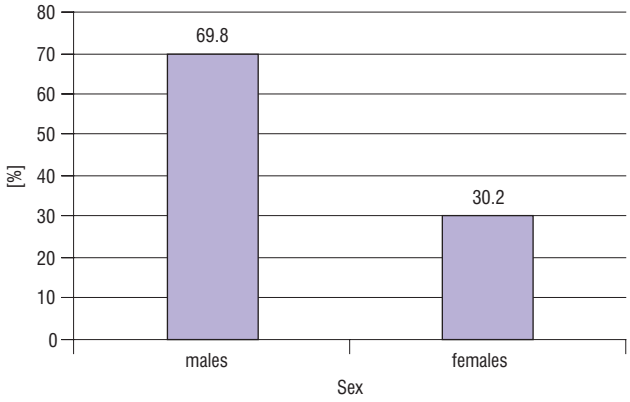

Fig. 1. Percentage of male and female patients in the study group

To achieve the aim of this study, the values of the parameters recorded on admission of the patient to the unit, and then every 7 days thereafter, and finally upon discharge from the unit were collected. These parameters included: arterial blood gasometry, pulsoxymetry, capnometry, body temperature, arterial blood pressure, and pulse rate. Mean values of each parameter for each patient were calculated from the obtained data. The study group was divided according to the participation in the traffic collision. The variables adopted were: driver, passenger, pedestrian. The group was differentiated according to the method of respiration upon discharge from the ICU, which determined the patient's condition. The following cases were considered: physiological breathing, i.e., via natural respiratory tract; tracheostomy, i.e., physiological breathing supported with a tracheostomy tube; mechanical ventilation, i.e., patients requiring mechanical ventilation following discharge from the unit; and death. The collected data were parameterized, and following their input into the data base, were statistically analyzed, and then correlations were determined.

RESULTS

Mean time spent in the ICU unit amounted to 16.88 days, 17.7 days for men, 10.38 days for women.

Statistical analysis conducted revealed that the type of participation in the traffic collision was not statistically significant for the hospitalization period in the ICU, the condition of the patient upon discharge, and the respiratory therapy period. An attempt was made to determine the correlation between the length of hospitalization in the ICU and the condition of the patient upon discharge. The study revealed no such correlation. The hypothesis of the correlation between systolic and diastolic pressure and pulse rate on the method of respiration at discharge was also dismissed.

The length of hospitalization within the ICU and its influence with respect to the occurrence of pneumonia were analyzed, assuming time intervals of up to 14 days, 15–28 days, and more than 28 days. As Fig. 2 indicates, pneumonia was much more frequent in patients during the time interval of 15–28 days, constituting 60% of the total occurring pneumonias. In the time interval of up to 14 days the incidence was much smaller and amounted to 25% of the total occurring pneumonias.

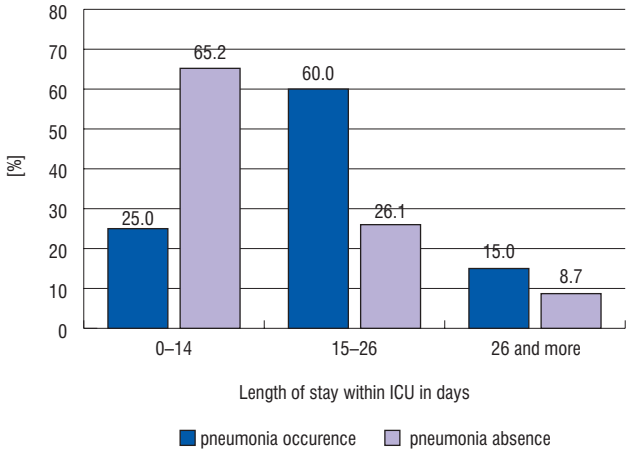

Fig. 2. Pneumonia in time intervals

The analysis of arterial pH values and their correlations with the condition of patients upon discharge from the ICU revealed that deaths were more frequent in patients with acidosis (80%). Patients who breathed spontaneously via a tracheostomy tube (75%) and physiologically (86.7%), generally had arterial pH values within the norm. As Fig. 3 indicates, patients who were not diagnosed with acidosis left the unit in better condition.

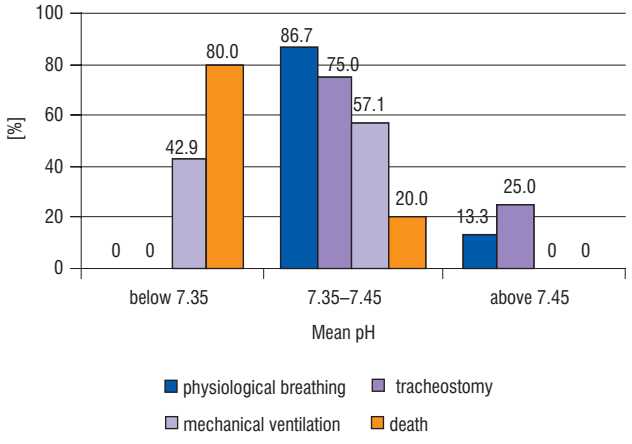

Fig. 3. Percentage of studied patients concerning arterial pH ranges

The analysis of specific data collected in Tab. 1 reveals that patients breathing spontaneously via a tracheostomy tube (93.8%) and physiologically (86.7%) most often exhibited partial pressure of carbon dioxide in the arterial blood ($PaCO_2$) values within the norm, i.e., 35–45 mmHg. Deaths were most frequently observed among patients with hypercapnia (60%). In 71.4% of patients transferred to other units who required mechanical ventilation, normocapnia was recognized.

Tab. 1. Correlation between $PaCO_2$ mean value and the method of respiration upon discharge from the ICU

Mean $PaCO_2$	Condition upon discharge from ICU									
	physiological breathing		tracheostomy		mechanical ventilation		death		total	
	n	%	n	%	n	%	n	%	n	%
Below 35	1	6.7	1	6.3	0	0.0	0	0.0	2	4.7
35–45	13	86.7	15	93.8	5	71.4	2	40.0	35	81.4
Above 45	1	6.7	0	0.0	2	28.6	3	60.0	6	14.0
Total	15	100.0	16	100.0	7	100.0	5	100.0	43	100.0

Arterial oxygen saturation of hemoglobin (SaO_2) below 94% was noted in that group of patients for whom therapeutic procedures ended in failure (40%). For the remaining patients, SaO_2 values exceeded 94%. The results are presented in Tab. 2.

Tab. 2. Correlation between mean SaO_2 and the method of respiration upon discharge from the ICU

Mean SaO_2	Condition upon discharge from ICU									
	physiological breathing		tracheostomy		mechanical ventilation		death		total	
	n	%	n	%	n	%	n	%	n	%
Below 94	0	0.0	0	0.0	0	0.0	2	40.0	2	4.7
94–98	9	60.0	8	50.0	3	42.9	1	20.0	21	48.8
Above 98	6	40.0	8	50.0	4	57.1	2	40.0	20	46.5
Total	15	100.0	16	100.0	7	100.0	5	100.0	43	100.0

Data analysis showed divergences concerning the values of partial pressure of end-tidal carbon dioxide ($PetCO_2$) and $PaCO_2$. The mean values of SaO_2 and percutaneous monitoring of hemoglobin oxygen saturation (SpO_2) were similar.

Mean values of gasometry parameters over time were compared in order to illustrate the changes. Fig. 4 shows the comparison of $PaCO_2$ mean values. A decrease in this parameter values was observed, indicating the improvement of health conditions, in those patients requiring further ventilation. In the group breathing physiologically and via a tracheostomy tube, $PaCO_2$ values were within the norm. In patients who subsequently died, this parameter values were extremely unstable.

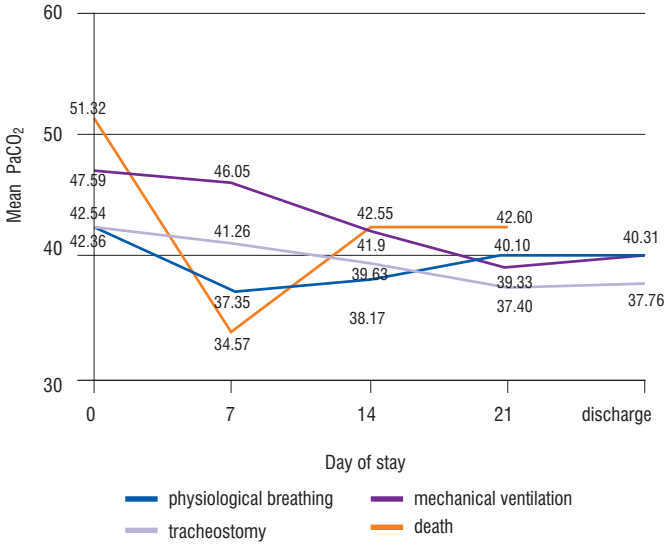

Fig. 4. $PaCO_2$ mean values within 24 hours from admission, on the 7th, 14th, 21st day, and on the day of discharge, in groups according to the method of respiration upon discharge

DISCUSSION

Until recently pulmonary rehabilitation has been believed to be within the scope of pulmonology, which may have resulted from the fact that numerous authors discuss its applicability in chronic obturative pulmonary diseases [8, 18, 28, 29]. Presently, reports and scientific papers examine the issues of pulmonary rehabilitation with reference to many specialties [12, 22, 35, 37].

Therapeutic processes in ICU often require the application of mechanical ventilation, which necessitates intubation or tracheostomy [19]. The activities performed upon the patient involve comprehensive therapy, in which pulmonary rehabilitation has been considered to be an integral part of treatment for mechanically ventilated patients [5, 6, 32]. Pulmonary rehabilitation is defined as a multidisciplinary program of care that is individually devised for a given patient and aims at stabilizing and reversing adverse changes in the respiratory system [15, 18, 24, 30]. According to the definition, the activities performed upon the patient are individually tailored and designed, both in terms of their range and intensity [12]. Many authors claim that rehabilitation activities should be constantly supervised, with the use of a 24-hour non-invasive monitoring system of life functions, and periodical invasive control tests, in order to follow the changes in recorded parameters, detect disorders early, and react appropriately in time [3, 4, 13, 32, 33].

A standard monitoring parameter in ICU is end-tidal concentration or pressure of CO_2 [9]. In physiological conditions, the values of the partial pressure of CO_2 in arterial blood and in exhaled air are similar, and the difference is only that of a few mmHg [34]. Clinical test results point to the need for complementing the monitoring process with invasive $PaCO_2$ measurements due to vast divergences between the values [9, 10, 22].

Available subject literature does not discuss patients divided into groups on the basis of the method of respiration upon discharge. However, some correlations with the adopted variables have been noticed. Values within the norm have been more often observed in patients who breathed spontaneously in a physiological way or via a tracheostomy tube.

The application of artificial ventilation often contributes to complications in the form of pneumonia [19, 25]. Available data also indicate the more frequent occurrence of this complication in mechanically ventilated patients [3, 21, 22, 31]. The treatment aims at prevention of complications and pulmonary rehabilitation. In comprehensive therapy, the issue of pneumonia should not be overlooked because it may become a significant epidemiological factor. The effect of pneumonia as regards prognosis is the subject of numerous discussions [21].

In the analyzed research material, it has been observed that the length of hospitalization within the ICU influenced negatively the occurrence of pneumonia. Similarly, other authors emphasize the correlation between pneumonia and the length of stay in the ICU, which is sometimes connected with intubation or mechanical ventilation period [3, 22, 36]. Berlly et al. [3] have shown that pneumonia risk increases from 1% to 3% per each day of intubation. Preventing pneumonia via the introduction of pulmonary rehabilitation is the subject of numerous studies [1, 25, 26]. Ahrens et al. [1] conducted a prospective, randomized study involving 234 patients from Intensive Care Units in various centers. They proved that the risk of developing pneumonia was less in patients who underwent pulmonary rehabilitation than in the control group, whereas the lenght of stay in the ICU did not differ between the groups. Ntoumenopoulos et al. are of a different opinion [25]. The study they conducted concerning 46 patients suggested that physiotherapy did not decrease the incidence of pneumonia in mechanically ventilated patients in an ICU.

Numerous authors also discuss the cost-effectiveness of treatment via shortening the stay in an ICU and reducing complications [7, 15, 20]. When analyzing our research material concerning the influence of the type of participation in traffic collisions with respect to the length of respiratory therapy and that time spent in the ICU, we have shown no significant correlations.

The overview of available subject literature indicates that over the centuries the effectiveness of pulmonary rehabilitation was based solely on the length of its application and experience [22]. In the era of scientific development, pulmonary rehabilitation is regarded as a set of activities based on scientific evidence [24]. Various authors

are, however, not uniform concerning its effectiveness. Many researches emphasize the need of further research as quite necessary in order to evaluate clinical benefits [2, 5, 32, 39].

CONCLUSIONS

1. The length of stay within the ICU is significant with respect to the occurrence of complications in the form of pneumonia.
2. The types of participation in traffic collisions (driver, passenger, pedestrian) do not influence the course of rehabilitation or the method of respiration upon discharge from the ICU.
3. Patients whose parameter values were within the norm during the pulmonary rehabilitation process attained spontaneous respiration at discharge.
4. Percutaneous monitoring of SpO_2 and $PetCO_2$ are of vital importance in the pule monary rehabilitation process, complemented by regularly taken arterial blood gasometry measurements.

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