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METEOROLOGICAL PARAMETERS AND SEVERITY OF ACUTE PULMONARY EMBOLISM EPISODES

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Abstract: Frequency of acute pulmonary embolism episodes has been previously shown to correlate significantly with meteorological factors in the period preceding their occurrence. The purpose of the study was to analyze the relation of meteorological factors and the severity of acute pulmonary embolism, expressed by the CT-based pulmonary obstruction score. A retrospective analysis of medical data of 182 consecutive patients with acute pulmonary embolism diagnosed with CT pulmonary angiography was performed. Severity of pulmonary obstruction was assessed by analysis of CT pulmonary angiography examinations, and defined with pulmonary obstruction score by Qanadli *et al.* The study group was divided into low (L group, 95 patients) and high PE severity (H group, 87 patients), with a cutoff value of 50% of maximum pulmonary obstruction score. Meteorological data collected for the relevant time period were: air temperature, humidity, atmospheric pressure, visibility, wind speed and precipitation. No significant differences in seasonal distribution of pulmonary embolism episodes were observed. Episodes of more severe pulmonary embolism were preceded by periods of lower atmospheric pressure (1,016.35 hPA for group H, *vs.* 1,016.35 hPa for group L, $p=0.022$). No significant relations between other meteorological factors and severity of PE were observed. The reported finding shows the need of further research on the nature of meteorological factors influence on the course of pulmonary embolism, which should be analyzed not only regarding the frequency, but also severity of PE episodes.

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INTRODUCTION

The influence of meteorological conditions on cardiovascular morbidity and mortality, including acute coronary syndromes e.g. myocardial infarction, stroke and arrhythmias has been known for a long time. Deep vein thrombosis (DVT) and acute pulmonary embolism (PE) are conditions of high clinical and public health importance, with high mortality [21]. Approximately 90,000 cases/year [16] are observed annually in Poland, with the number of suspected and confirmed cases constantly rising[20].

The aim of the study was to analyze the influence of meteorological factors on the severity of acute PE episodes.

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MATERIAL AND METHODS

Medical documentation of 182 patients with acute PE, diagnosed with computed tomography pulmonary angiography between January 2007–December 2009, was retrospectively analyzed. Severity of pulmonary obstruction was defined by Qanadli *et al.* score [17]: the pulmonary arterial tree was analyzed as well as the central arteries and 20 segmental arteries, and each segmental artery was scored depending on the degree of its obstruction: with 2 points in the case of complete obstruction or 1 point for partial obstruction. Obstruction of proximal pulmonary arteries was scored proportionally to the number of segmental arteries arising from it. Therefore, total pulmonary obstruction score was 40 points. Based upon histogram analysis, the study group was divided into low (L group, 95 patients) and high PE severity (H group, 87 patients), with a cutoff value of 21 points, i.e. >50%.

Patients were hospitalized at the tertiary care academic institution, located in a city of moderately warm european continental climate, 51°14' N 22°34' E, at the mean height of about 200 meters above sea level.

Meteorological data collected for the relevant time period were: air temperature, humidity, atmospheric pressure, visibility, wind speed and precipitation. Mean time of onset of symptoms was 4.25 days, and the meteorological conditions in the 10 days preceding the diagnosis were used, as recently suggested elsewhere [2]. Comorbidities or risk factors were not analyzed in this study.

Statistical analysis. Distribution of PE severity and differences between seasons were analyzed with Kruskall-Wallis test. The differences of the meteorological parameters between the PE severity-based study groups were assessed with Mann-Whitney test. Pearson test was used to assess the linear correlation of pulmonary obstruction score and meteorological parameters. For all tests, p value <0.05 was considered to indicate statistical significance. Data was analyzed using SPSS 16.0 (SPSS Inc., Chicago, IL) statistical package. The study was performed in compliance with the relevant local and international law, as well as institutional guidelines.

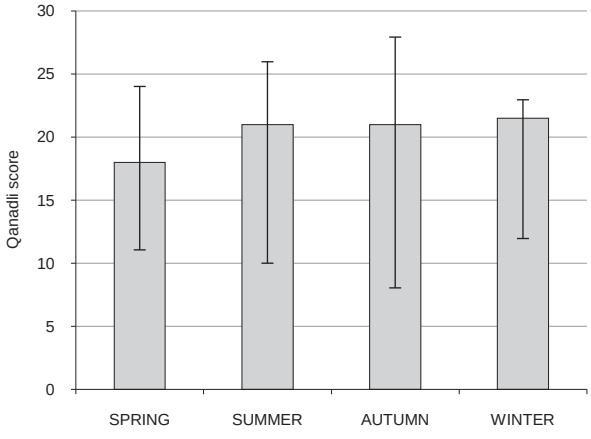

Figure 1. Seasonal distribution of Qanadli score [points] in patients with acute PE. No significant differences were observed. Bars represent median values, whiskers: 95% confidence interval.

RESULTS

Seasonal distribution of the PE severity is presented at Figure 1. No significant difference of severity of PE episodes between the seasons was observed . Descriptive analysis of the included meteorological parameters is presented at Table 1. Mann-Whitney analysis showed a significantly (p=0.02) higher pulmonary obstruction to occur preceded by the periods of low atmospheric pressure (Fig. 2). No significant linear correlations of the pulmonary obstruction score with meteorological parameters were observed.

DISCUSSION

CT pulmonary angiography has recently become a gold standard of PE diagnostic imaging. It has important advantages over other modalities, including simultaneous assessment of pulmonary vessels, mediastinal structures and lung parenchyma, as well as direct visualization of the thrombus [8]. Multidetector scanners allow assessment of pelvic and lower limbs thrombosis, which is the most common source of embolic material. Therefore, diagnostic algorithms based

Table 1. Clinical characteristics of the study groups and meteorological conditions preceding the PE episodes.

	Low PE severity: group L			High PE severity: group H			p
	Median	Minimum	Maximum	Median	Minimum	Maximum	
Qanadli score	12.5	1	21	25	11	36	**<0.001**
Air temperature [ºC]	8	-16	22	8	-7	25	0.590
Humidity [%]	76	33	99	80.5	38	99	0.067
Atm. pressure [hPa]	1,017.4	1,005	1,037.5	1,016.35	991.3	1,037.6	**0.022**
Visibility [km]	14.7	3.1	26.8	13.9	1.2	30	0.344
Wind speed [km/h]	10	3	23	9	3	30	0.586
Precipitation [cm]	0	0	1	0	0	3.4	0.232

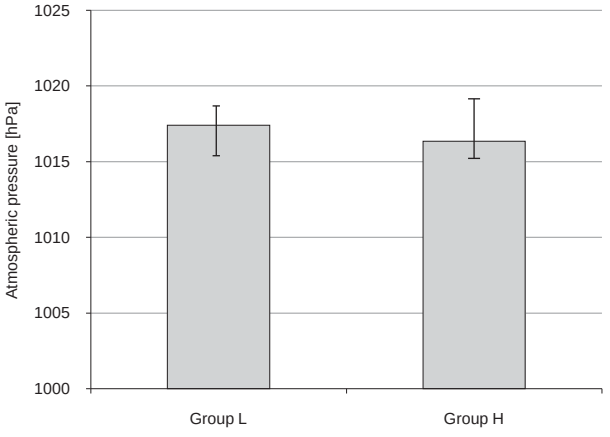

Figure 2. Atmospheric pressure in periods preceding occurrence of low (Group L) and high (Group H) severity PE episodes, p=0.022. Bars represent median values, whiskers: 95% confidence interval.

on CT are reported to be more cost-effective than those based on other imaging modalities [24].

Pulmonary obstruction scores are extremely useful in clinical practice. The pulmonary obstruction score suggested by Qanadli *et al.* [17] has a recognized status in the diagnostic process of PE [25]. Application of pulmonary obstruction scores improves communication with clinicians, by objective definition of PE severity, but most of all, it allows identification of patients with severe prognosis [20, 25] and at high risk of complications. Recently, Bazeed *et al.* [1] reported, that a pulmonary obstruction score above 50% and RV/LV ratio >1.5 are useful diagnostic criteria for severe PE and poor patient outcome. Similarly, according to Collomb *et al.* [3] and Qanadli *et al.*, the score correlates with the haemodynamic severity of PE, with a mean score of 54% in patients who require thrombolytic or surgical treatment. Metafratzi *et al.* [12] showed a significant correlation between the obstruction score and blood gas values in patients; this has also been reported to correlate significantly with the D-dimer level [6].

High score has been linked with mortality [25], with the risk increasing at 60% of pulmonary obstruction, a result also confirmed by van der Meer *et al.*, who showed a significant increase of mortality in patients with an obstruction score of 40% and above [23]. However, other authors [7, 15, 22] do not confirm this finding. Therefore, the pulmonary obstruction score is a good indicator of the severity of PE, as it correlates well with parameters of patients' clinical status, although not clearly linked with the increased mortality.

Meteorological conditions have been linked to multiple diseases since the beginnings of medicine. Seasonal occurrence of particular conditions varies from the anecdotal to the obvious. Therefore, meteorological parameters are under constant research to analyze their relation with the frequency or severity of particular conditions.

Atmospheric pressure has been shown to influence cardiovascular morbidity. Smith *et al.* [18] recently published an analysis of almost 200 cases of ruptured abdominal aortic aneurysm observed over a 6-years period, which they linked with low atmospheric pressure on the same day, with a mean value of 1,012.6 ± 0.78 mB on days with aortic rupture, and 1,014.5 ± 0.25 mB on no-rupture days. Houck *et al.* [9] report a significant correlation between a decrease in atmospheric pressure and the occurrence of acute myocardial infarction on the next day. According to Dawson *et al.* [4], a decrease in atmospheric pressure was associated with increased rate of haemorrhagic stroke admissions after a 48 hour period. We recently reported [19] more frequent PE episodes in periods of low atmospheric pressure and low humidity in male patients; therefore, our aim was to assess the relation between severity of PE and the meteorological conditions. We observed significantly lower atmospheric pressures preceding the occurrence of high severity PE. Low atmospheric pressure has been related to increased occurrence with other cardiovascular and pulmonary episodes [13]. De Takats *et al.* [5] reported an increase in the number of PE episodes in periods of low atmospheric pressure. Similar results were obtained by Meral *et al.* [11]. Furthermore, Masotti *et al.* [10] observed a strong inverse correlation between atmospheric pressure and number of PE cases in surgical patients. Although Őztuna *et al.* [14] reported a positive correlation between air pressure and frequency of PE, they admit that their findings may be influenced by specific climatic setting of the seaside region.

To summarize, statistically significantly lower atmospheric pressure preceded high severity PE episodes defined by high CT pulmonary obstruction scores. This is a new observation on the influence of meteorological factors on PE. This finding brings a new insight into the nature of weather impact on PE morbidity, which opens new perspectives in research on this topic.

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