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Full Length Article

Timing of pulmonary embolism diagnosis in the emergency department

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ABSTRACT

Background: Patients with pulmonary embolism (PE) benefit from rapid diagnosis and treatment. The aim of the present study is to examine factors that contribute to the time between admission at the emergency department and diagnosis of PE (= time to diagnosis TTD).
Methods: This retrospective study included 241 patients with symptomatic PE that were admitted at the emergency department. Patient records were reviewed to obtain the relevant clinical information. Patients were assigned in one of three groups according to their TTD: short TTD ≤ 2 h; intermediate TTD > 2 h and ≤12 h; and prolonged TTD > 12 h. The groups were compared for differences in clinical factors. Furthermore multiple linear regression analyses based on TTD was performed.
Results: Factor that significantly contribute to a very short TTD < 2 h are tachycardia and a high embolus burden. Factors that significantly contribute to a diagnosis <12 h are embolus burden, no COPD present, patient admitted at day shift, and a less pathologic ratio of ventricle axis. Multiple regression analyses identified increased age and low embolus burden as the strongest, independent factors for prolonged TTD.
Conclusions: Patients with higher embolus load or signs of severe PE including tachycardia were most likely diagnosed within 2 h after presentation. More effort should be put in a faster diagnostic process in older patients and in patients with COPD.

1. Introduction

It is undisputed that patients with pulmonary embolism (PE) benefit from a rapid diagnosis and treatment [1,2]. The process includes onset of symptoms, admission to hospital, diagnosis and treatment.

In previous studies a mean time interval from symptom onset to hospital admission of 6 to 10 days was reported [3–7]. While these studies reported valuable data on the time before hospital admission, they have several deficiencies: (i) onset of symptoms is easily confounded, especially in a retrospective study design and when symptoms begin gradually or are non-specific [2]; (ii) clinical factors have no influence on the time between symptom onset and hospital admission [2]; and (iii) computed tomography pulmonary angiography (CTPA), digital subtraction pulmonary angiography and perfusion or ventilation/perfusion lung scintigraphy were used as diagnostic methods, rather than CTPA alone.

The time from admission to diagnosis is objectively measurable. In the further text this time to diagnosis will be abbreviated as TTD. Previous studies reported a mean TTD of 24 to 48 h [3,8]. However, in these reports different diagnostic methods were mixed and therefore the results are not comparable to a modern hospital scenario.

Two recent reports included only CTPA examinations [1,2]. They found a number of factors that were associated with a TTD of more than 12 h [2], and 48 h [1], respectively.

The aim of the present study is (I) to examine factors that contribute to a very short TTD of <2 h, and (II) to analyze which factors influence the TTD in patients that are diagnosed >2 h.

2. Materials and methods

2.1. Study design

All CTPA examinations with the specific aim to search for PE that were conducted at a hospital of maximum care (Halle University Hospital) from 01/2005 to 01/2010 were reviewed by AGB an AS (2.767 CTPA examinations in 2.543 patients). In 512 CTPA examinations – corresponding to 496 patients – PE was found. Incidental findings of PE in CT examinations were not included.

The records of these 496 patients were reviewed by two independent reviewers (RB and BN). Patients were excluded if they were referred from another hospital with the diagnosis of PE (6 patients); or if patient records were not available or incomplete (131 patients).

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When the TTD was longer than 100 h patients were also excluded (2 patients). In these cases the assumption that PE was present at admission was considered uncertain. Patients were also excluded if not admitted at the emergency department (116 patients).

Time of CTPA diagnosis was defined as the time interval between patient admission at the emergency department and CTPA examination. Patient admission was defined as the time when the patient's insurance card was read. Reading the insurance card is always the first step upon entering the emergency ward. Patients without insurance card or patients in compromised hemodynamic condition are registered upon entering the emergency ward in a similar way.

Patients were assigned to one of three groups according to TTD: short TTD ≤ 2 h; intermediate TTD > 2 h and ≤12 h; and prolonged TTD > 12 h. The 2 h delineator was arbitrarily chosen to identify patients in whom PE was obviously suspected or in whom diagnosis was considered urgent. The 12 h delineator was chosen to allow comparison with a previous study [2]. Treatment methodology was same among all patients following the guidelines of the diagnosis and management of acute pulmonary embolism as defined by the European Society of Cardiology [15]. High risk patients underwent thrombolysis or embolectomy.

Please note that the definitions of 'short' and 'prolonged' TTD are descriptive and made for study purposes only. The definitions and are not meant to judge diagnostic speed in a certain setting.

Demographic factors, symptoms, multiple morbidities, vital signs, laboratory data, and organizational factors were assessed in each group from patient records. For a complete listing of all factors that were included see Table 1.

2.2. CTPA acquisition and review

The CT scanners used during the study period were two 64-multidetector CT systems (Somatom Sensation 64, Siemens, Erlangen, Germany; Aquillon 64, Toshiba, Neuss, Germany).

All patients in the study group underwent the same CTPA protocol. 60 ml of an iodinated intravenous contrast medium (Solutrast© 370 with 370 mg iodine/ml, Bracco Imaging Germany GmbH, Konstanz, Germany) were given at a rate of 2.0 ml/s. Typical imaging parameters were 120 kVp, 150–300 mAs, slice thickness 2 mm, and a pitch of 0.6–1.2 depending on body size. Automatic bolus timing was used with effective delays of 12–25 s.

The stored images of all included patients were reviewed by 3 radiologists with 1 year (NS), 5 years (AGB) and ten years (AS) experience to assess the morphologic embolus burden and to measure the short ventricle axes (for details see below). The reviewers were free to use any window setting and both standard and lung kernel reconstructions. Multiplanar reformatting was available at a separate workstation (Vitrea; Vital Images, Minnetonka, Minnesota, USA).

2.3. Factors

In general, laboratory and measurable clinical factors were only considered when measurement was within 24 h after hospital admission. When there was more than one measurement available for a particular factor (e.g. heart rate) then the one that was closest to the time of admission was used.

Data on age, gender, body mass index, diabetes, malignancy, and chronic obstructive pulmonary disease (COPD) were directly taken or calculated from the patient records. When no information was available the factor was considered negative. Acute dyspnoea was considered present when patients described acute onset of respiratory symptoms.

Organ insufficiency was defined in the same way like in the Acute Physiology And Chronic Health Evaluation (APACHE-II) score [9]. Estimated glomerular filtration rate was calculated using the Modification of Diet in Renal Disease formula based on creatinine measurements (performed on Beckman Coulter DXC800, Beckman Coulter, Germany).

Cardiac Troponin was considered increased when >0.5 ng/ml. Troponin testing was based on a troponin I (Beckman Coulter, Germany) assays. Troponin measurements were not available in 30 patients.

The PE embolus burden was assessed as outlined by Mastora [10]. The obstruction at the level of the mediastinal, lobar, and segmental arteries was quantified by a percentage score, and the sum of the percentages gave the global embolus burden with a maximum of 300%. The sum can be higher than 100% because at each of the three levels an obstruction of 100% is possible.

The ratio of the short axes of the right and left ventricle diameter is the measurement that is most commonly used to detect right ventricular dysfunction [11–13]. This measurement was performed, as described by others [14].

When the patient's insurance card was read between 8:00 a.m. and 4:00 p.m. the patient was considered as admitted at day shift.

2.4. Statistical analysis

Calculation of Table 1 and Table 2: Collected data were evaluated by means of descriptive statistics: absolute and relative frequencies, median and 25% - 75% interquartile. The two-tailed Mann Whitney U test was used to estimate statistical differences between groups for continuous non-categorized variables. The chi square test was used to estimate

Table 1
Factors that contribute to a rapid diagnosis of PE. Items are sorted in order of ascending p-Value.

Factor	TTD ≤ 2 h[a] (n = 70)	TTD > 2 h[a] (n = 171)	p-Value	
Tachycardia: >100 beats/min [yes]	77% (54)	55% (94)	<0.05	Sign.
Embolus burden Mastora [%]	57 (17–85)	32 (8–61)	<0.05	
Ratio of short axes right ventricle/left ventricle	1.2 (0.9–1.4)	1.1 (0.9–1.3)	0.06	Trend
Male gender [yes]	37% (26)	49% (84)	0.11	
Organ insufficiency as defined in APACHE II [yes]	44% (31)	55% (94)	0.17	
COPD [yes]	13% (9)	20% (34)	0.20	
Hypotension: systolic pressure < 100 mm Hg [yes]	31% (22)	24% (41)	0.23	
Malignancy [yes]	19% (13)	26% (45)	0.24	
Body mass index [kg/m^2]	28.2 (24.2–31.8)	27.1 (23.8–31.1)	0.26	
Cardiac troponin increased [yes]	19% (13)	12% (21)	0.34	No contribution
Estimated glomerular filtration rate [ml/min]	78 (51–105)	69 (51–99)	0.47	
Age [years]	62 (55–73)	65 (52–75)	0.48	
Oxygen saturation [%]	91 (87–95)	92 (87–96)	0.64	
Diabetes [yes]	24% (17)	26% (45)	0.82	
Acute dyspnoea [yes]	60% (42)	55% (94)	0.85	
Admitted at day shift [yes]	54% (38)	53% (91)	0.88	

Abbreviation: TTD time to diagnosis, CTPA computed tomography pulmonary angiography.
[a] Median (25%–75% interquartile range) of continuous non-categorized variables and percent (number) of categorical variables.