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Should we confirm our clinical diagnostic certainty by autopsies?

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Abstract *Objective*: To evaluate the frequency of diagnostic errors assessed by autopsies.
Design and setting: Retrospective review of medical and pathological records in an 11-bed closed medical intensive care unit (ICU) at a 860-bed general hospital.
Patients and interventions: Patients who died in the ICU between January 1998 and December 1999. Medical diagnoses were rated into three levels of clinical diagnostic certainty: complete certainty (group L1), minor diagnostic uncertainty (group L2), and major diagnostic uncertainty (group L3). The patients were divided into three error groups: group A, the autopsy confirmed the clinical diagnosis; group B, the autopsy demonstrated a new relevant diagnosis which would probably not have influenced the therapy and outcome; group C, the autopsy demonstrated a new relevant diagnosis which would probably have changed the therapy and outcome.
Results: The overall mortality was 20.3 % (270/1331 patients). Autopsies were performed in 126 patients (46.9 % of deaths), more often in younger patients (66.6 ± 13.9 years vs 72.7 ± 12.0 years, $p < 0.001$), in patients with shorter ICU stay (4.7 ± 5.6 days vs 6.7 ± 8.7 days, $p = 0.054$), and in patients in group L3 without chronic diseases (15/126 vs 1/144, $p < 0.001$). Fatal but potentially treatable errors [group C, 12 patients (9.5 %)] were found in 8.7 %, 10.0 %, and 10.5 % of patients in groups L1, L2, and L3, respectively (NS between groups). An ICU length of stay shorter than 24 h was not related to the frequency of group C errors.
Conclusions: Autopsies are performed more often in younger patients without chronic disease and in patients with a low clinical diagnostic certainty. No level of clinical diagnostic certainty could predict the pathological findings.

Keywords Autopsy · Postmortem · Diagnostic errors · Premortem errors · Critical care

Introduction

Several studies have suggested that an autopsy may provide quality control in medical practice, facilitate new discoveries about pathogenesis and therapy, give feedback for clinical research protocols, provide epidemiological information, monitor public health, and serve to console and reassure grieving families [1, 2, 3, 4].

In the intensive care setting, the pace of diagnostic intervention is often accelerated by the rapidly changing and critical state of the patient. Additionally, establishing the diagnosis may be more difficult due to the patient's inability to provide a history.

On the other hand, the possibility of making correct premortem diagnoses has improved markedly with the routine use of diagnostic modalities such as echocardi-

ography, computed tomography scanning, hemodynamic monitoring, percutaneous biopsies, and endoscopy [2, 5].

The primary goal of our study was to determine the characteristics of patients selected for autopsy. Secondly, we evaluated the clinical importance of additional autopsy findings in comparison to established clinical diagnoses and causes of death in all patients who died in our medical intensive care unit (ICU).

Patients and methods

All patients who died in the medical ICU during a 2-year period (January 1998 through December 1999) were included in a retrospective study. The medical ICU at the 860-bed General Hospital is an adult, 11-bed, closed medical ICU. The study was approved by the Institutional Review Board, who waived the need for informed consent.

The medical records in our ICU are kept according to the problem-oriented record method. The problems detected on admission and during the patient's ICU stay were noted in each patient's record by the attending physician, including the date of onset and termination of the problem, and were later discussed during the regular daily meetings and rounds. Upon death of the patient, all staff members jointly discussed the problems that arose, persistent chronic disease before admission (heart failure, renal failure, chronic obstructive pulmonary disease, cirrhosis, diabetes), and the final clinical diagnoses were established.

Complete body autopsies were performed within 24 h of death, and the procedure included macroscopic and microscopic assessment of all internal organs and of the brain when indicated. In Slovenia, for all patients who die in hospital, an autopsy is legally required, and no family authorization is needed. However, the autopsy could be withheld upon request of the relatives in agreement with the attending physician and head of department.

The clinicians did not attend the autopsy regularly, and the attending physician sent a clinical report to the pathology department before the autopsy was conducted. Clinical-pathological meetings were held every 20 or 30 days. In these meetings, the clinical information was reported by the attending physicians. Medical records were rated in three levels of clinical diagnostic certainty as complete diagnostic certainty (group L1; e.g., septic shock due to native mitral valve endocarditis when the vegetations on the mitral valve had been confirmed by transesopageal echocardiography and the hemoculture was positive), minor diagnostic uncertainty (group L2; e.g., septic shock due to mechanical prosthetic valve endocarditis when vegetations less than 5 mm in diameter had been visualised on the prosthetic valve by transesopageal echocardiography and the hemoculture was positive), and major diagnostic uncertainty (group L3; e.g., all diagnoses modified by question mark or by words "possible" or "suspected" were automatically grouped in L3) [6].

The same two experienced intensive care physicians (M.P., G.V.) assessed the level of clinical diagnostic certainty. If there was disagreement between them about the level of clinical diagnostic certainty, another experienced intensive care physician (B.K.) was consulted for an independent review. The medical record was rated in the level of clinical diagnostic certainty after agreement of all three physicians.

The clinical and pathologic diagnoses were classified in accordance with the standards of the World Health Organization [7]. Major diagnoses corresponding to the basic illness and the cause of death were used for further analysis.

After the autopsy results were presented, a panel of three intensive care physicians reviewed the findings and divided patients (using the same procedure as for the clinical diagnostic certainty rating) into three error groups:

- Group A – the autopsy confirmed the clinical diagnosis without any important new finding (fully correct diagnosis),
- Group B – the autopsy demonstrated a new relevant diagnosis which would probably have not influenced the therapy and outcome (nonfatal diagnostic error),
- Group C – the autopsy demonstrated a new relevant diagnosis which would probably have changed the therapy and outcome (fatal, but potentially treatable error).

The principal cause of death, which was defined as the disease or attack that triggered the chain of morbid events leading directly to death, and the terminal cause of death were not separately classified in the error groups. The greatest error from either the principal or terminal cause of death was used for rating in the error groups.

Statistical analysis

Characteristics of the study population were statistically assessed using the two-way Student's *t*-test. Results are presented as mean ± SD (range).

The statistical analysis of difference in diagnostic and therapy accuracy between groups was performed with chi-square test. Yates correction was used. A statistical computer program (Statistica 5.0 for Windows, StatSoft, Tulsa, Okla., USA) was employed in the data analysis.

A $p < 0.05$ was considered statistically significant.

Results

Mean admission APACHE II score of all patients admitted to the medical ICU during the study period was 17.2 ± 7.5. Of 1331 patients, 270 (20.3%) died. Autopsies were performed on 126 (46.6%) patients. The patients on whom autopsies were performed were significantly younger and tended to have a shorter ICU stay (Table 1).

In terms of the premortem clinical level of diagnostic certainty, 46.0%, 24.6%, 29.4% of patients were in groups L1, L2, and L3, respectively (NS).

The level of clinical diagnostic certainty influenced the decision to perform an autopsy. Compared with the nonautopsy group, autopsies were performed more frequently in patients with major clinical diagnostic uncertainty (group L3) (37/126 vs 15/144, $p < 0.003$) and less often in patients with complete diagnostic certainty (group L1) (58/126 vs 105/144, $p < 0.03$) (Table 2). The autopsy rate was significantly higher in patients without persistent chronic disease and major clinical diagnostic uncertainty (15/126 vs 1/144, $p < 0.003$) (Table 2).

In patients with a longer ICU stay, the frequency of major clinical diagnostic uncertainties (group C) tended to be lower than in patients with an ICU stay of less than 24 h (10/57 vs 28/69, $p = 0.058$) (Table 3).

Table 1 Characteristics of study population (*ICU* intensive care unit)

	No autopsy	Autopsy	Statistics
Number of patients	144 (53.4 %)	126 (46.6 %)	
Age (years)	72.7 ± 12.0 (26–93)	66.6 ± 13.9 (24–89)	$p < 0.0001$
Male/female	71/73	67/59	NS
Mean APACHE II score upon admission	21.0 ± 8.9 (15–38)	22.4 ± 7.7 (14–50)	NS
ICU stay less than 24 h *(n)*	50	69	$p = 0.051$
Direct ICU admission *(n)*	90	68	NS
ICU length of stay (days)	6.7 ± 8.7 (1–70)	4.7 ± 5.6 (1–28)	$p = 0.054$

Table 2 Influence of clinical diagnostic certainty and persistence of chronic disease on the decision to perform an autopsy (*Ac* acute disease, without pre-existent chronic disease, *Chr* acute disease with pre-existent chronic disease)

	No autopsy ($n = 144$)	Autopsy ($n = 126$)	Statistical value
Group L1 (Ac/Chr)	105 (26/79)	58 (19/39)	$p < 0.03$
Group L2 (Ac/Chr)	24 (3/21)	31 (10/21)	NS
Group L3 (Ac/Chr)	15 (1/14)	37 (15/22)	$p < 0.003$

After analysis of the pathological findings, a completely correct diagnosis [group A, 60 patients (47.6 %)] was found in 60.3 %, 40.0 %, and 34.2 % of patients in groups L1, L2, and L3, respectively (NS). Nonfatal diagnostic errors [group B, 54 patients (42.9 %)] were found in 31.0 %, 50.0 %, and 55.3 % of patients in groups L1, L2, and L3, respectively (NS). Fatal but potentially treatable errors [group C, 12 patients (9.5 %)] were found in 8.7 % (5/58), 10.0 % (3/31), and 10.5 % (4/37) of patients in groups L1, L2, and L3, respectively (NS) (Fig. 1).

ICU length of stay shorter than 24 h is not related to frequency of group C errors (Fig. 2).

Tables 4 and 5 present characteristics of patients in whom the new autopsy finding would probably have changed the treatment.

Discussion

The majority of medical ICU patients who undergo autopsy have received an accurate premortem clinical diagnosis. Actual mortality (20.3 %) in our medical ICU was comparable to the predicted mortality by mean admission APACHE II score. In nonoperative ICU death rate of patients with mean admission APACHE II score 15–20 ranges between 18 % and 25 % [8].

In this study, 9.5 % of autopsy findings might probably have changed treatment. In the literature, a major diagnostic discrepancy was found in 5 %–40 % of all hospitalised patients and in 7 %–27 % of ICU patients [2, 3, 4, 5, 6, 9, 10]. A discrepancy rate of 27 % in ICU patients was found in a study with a lower autopsy rate (31 %), but probably in patients with more complex pathology [5].

The nonteaching hospitals have a higher rate of major discrepancy (40.1 % vs 32.1 %) and lower autopsy rate (20.3 % vs 32.2 %) compared with university hospitals [11]. The reasons for the low autopsy rates are as follows: economic (autopsy is costly and not reimbursable), legal (fear of litigation), attitudinal change ("time-consuming chore"), etc. [12].

Despite the high autopsy rate in our study, the possibility of bias exists because we performed more autopsies in younger patients without chronic disease and in patients with a shorter length of ICU stay. The clinical level of diagnostic certainty increases with the length of stay and influenced our decision to perform an autopsy. This indicates a bias toward clinico-pathologic discordance. Inappropriately high clinical diagnostic confidence was reported in patients with prolonged ICU stay, probably due to the staff's attention being diverted toward newly admitted patients and their acute pathophysiologic disturbances [13]. Nevertheless, our results showed no correlation between the level of clinical diagnostic certainty and potentially treatable errors in contrast to results reported in non-ICU patients [14].

Cognitive errors occur at all steps of the diagnostic process [15]. Four kinds of cognitive errors are identi-

Table 3 Influence of ICU length of stay on the level of clinical diagnostic certainty

	ICU stay less than 24 h	ICU stay more than 24 h	Statistical value
Number of patients	69	57	NS
Age (years)	66.7 ± 13.7 (26–89)	66.2 ± 14.1 (24–88)	NS
Number of Ac/Chr	35/34	10/47	$p < 0.02$
Group L1 (Ac/Chr)	30 (14/16)	28 (5/23)	NS
Group L2 (Ac/Chr)	11 (6/ 6)	19 (3/ 16)	NS
Group L3 (Ac/Chr)	28 (13/15)	10 (3/7)	$p = 0.058$

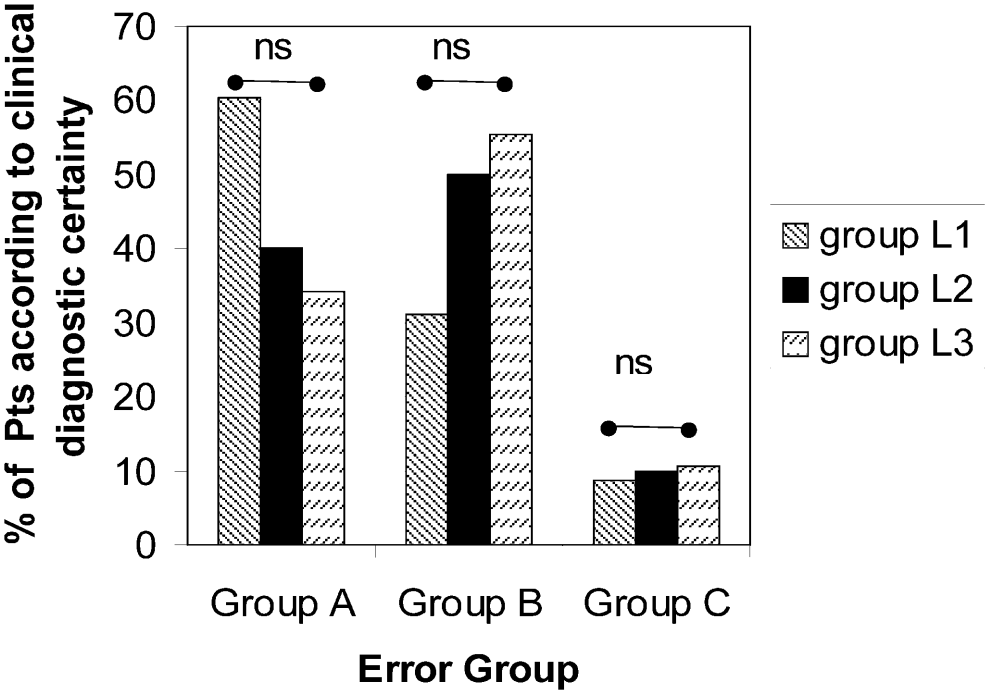

Fig. 1 Distribution of patients according to clinical level of diagnostic certainty in error groups

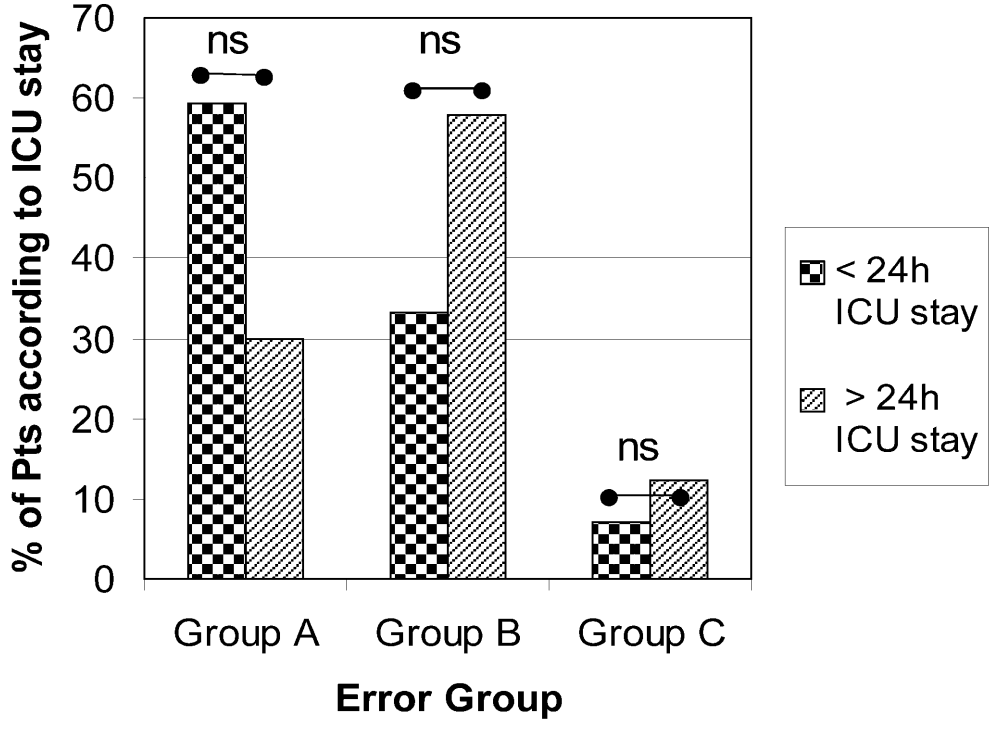

Fig. 2 Influence of ICU stay on error groups

fied: omission, premature conclusions, inadequate synthesis, and wrong formulation [16]. Omission and inadequate synthesis are negatively correlated with the degree of training of the treating physician and lead to a false-negative diagnosis. Premature conclusions are independent of the physician's clinical experience but correlate with overconfidence in findings and are associated with a false-positive diagnosis. A correct diagnosis is a complex interaction of clinical cognition and diagnostic test. Diagnostic tests with high sensitivity and speci-

Table 4 Error group C in patients staying less than 24 h in ICU (*CT* computed tomography)

Patient	Clinical diagnosis	Diagnostic work-up	Autopsy finding	Possible treatment
1	Hypovolemic/hemorrhagic shock/hemoptysis	Chest radiograph, echocardiography, gastroscopy, bronchoscopy	Pulmonary artery perforation with Swan-Ganz catheter	Surgery
2	Hypovolemic shock, coma due to liver cirrhosis, acute renal failure	Gastroscopy	Hemothorax after subclavian vein catheterization	Surgery
3	Shock with high central venous pressure, right heart failure, coma	Chest radiograph, head CT scan, echocardiography	Massive pulmonary embolism	Thrombolytic therapy
4	Septic shock, pleural empyema, acute renal failure	Chest radiograph, abdominal ultrasound, echocardiography	Perinephric abscess, progression in the thorax	Surgery/drainage
5	Septic shock of unknown origin, acute renal failure	Chest radiograph, abdominal ultrasound, echocardiography	Pyonephrosis	Surgery/drainage

Table 5 Error group C in patients staying more than 24 h in ICU (*MOF* multiple organ failure)

Patient	Clinical diagnosis	Diagnostic work-up	Autopsy finding	Possible treatment
1	Gram-negative septic shock/ ascending cholangitis	Chest radiograph, abdominal ultrasound, abdominal-CT	Cholangiolithiasis	Endoscopic sphincterotomy/surgery
2	Septic shock, MOF, endocarditis	Chest radiograph, echocardiography, abdominal ultrasound	Miliar tuberculosis	Begin antituberculous therapy
3	Pleural empyema, hemochromatosis, acute respiratory failure, MOF	Chest radiograph, echocardiography, abdominal ultrasound, abdominal-CT	Pulmonary thrombemboli	Heparin in therapeutic range
4	Cardiogenic shock, acute myocardial infarction, acute renal failure, right heart failure	Chest radiograph, echocardiography	Pulmonary thrombemboli	Thrombolysis
5	Septic shock, spontaneous peritonitis, hemochromatosis	Chest radiograph, echocardiography, abdominal ultrasound, abdominal-CT	Gut perforation	Surgery
6	Septic shock, pneumonia, chronic alcoholism	Chest radiograph, echocardiography, abdominal ultrasound, abdominal-CT	Pyometritis	Surgery
7	Septic shock of unknown origin, posthemorrhagic shock due to gastric ulcer hemorrhage, acute renal failure	Chest radiograph, echocardiography, abdominal ultrasound	Pyonephrosis	Surgery/drainage

ficity are necessary but not sufficient for a correct diagnosis. Selection and interpretation of the tests as well as clinical cognition before and after procedures must be as accurate as the tests [2].

In previous investigations, major diagnostic errors included pulmonary embolism, infection, myocardial infarction, and aortic dissection [12]. In our study, recognition of septic origin remains the crucial unresolved problem. Seven of 12 fatal but potentially treatable errors were due to unrecognised septic origin. The abdominal ultrasound, regularly used in the ICU setting and performed by a radiologist trained in abdominal ultrasound, was not accurate enough to detect an abdominal origin of sepsis and frequently gave misleading results. The accuracy of ultrasound in detecting intra-abdominal abscess ranges between 40 % and 90 % and depends on many factors (patient's size, location, size of the lesion, clinical experience and skill of the operator). The combined use of computed tomography, ultrasound, and nuclear investigations could improve our ability to detect origins of sepsis [17].

We did not miss any aortic dissection, acute endocarditis, or pericardial tamponade because of the availability of continuous transthoracic and transesophageal echocardiography compared with previous reports [18]. Massive pulmonary embolism was not diag-

nosed in two patients because it was not suspected in a comatose patient with hypercapnic respiratory failure staying less than 24 h in the ICU and in a patient with advanced left heart failure staying more than 24 h in the ICU.

Contrary to other studies, autopsies also confirmed two clinically suspected but not proved complications of resuscitation procedures. Pulmonary artery perforation, which has a reported incidence of approximately 0.1 %–0.2 %, was the first such complication after 2105 pulmonary artery catheter insertions in our ICU [19].

In contrast to the surgical ICU, where the rate of discrepancy increases with the length of stay, mainly because of an increased number of unrecognised infections, it seems that in the medical ICU, the length of stay does not influence the rate of discrepancy [20].

Our study has some limitations. Although we tried to minimize the risk of subjectivity, the concept of avoidable death (fatal but probably treatable errors) by itself should be considered only in relative terms. It depends on many factors that can vary among different institutions such as interindividual variations of the professional skills of the consulting and attending physicians, the perception of the cost-benefit ratio of a certain diagnostic investigation in an individual patient, and 24 h availability of diagnostic and therapeutic procedures.

The present study demonstrates that autopsy might be important source of relevant data for education and quality control in critically ill patients despite the availability of sophisticated diagnostic tests.

In conclusion, in the medical ICU, autopsies are performed more often in younger patients without chronic disease and low clinical diagnostic certainty. No level of clinical diagnostic certainty could predict the pathological findings. Despite diagnostic improvement, autopsy remains the essential verification of the clinical diagnosis in critically ill patients.

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