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Risk of death of patients from general surgery units based on patient classification into international classification of disease (ICD-10) categories

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Summary

Introduction. We estimated the risk of death for patients admitted to general surgery units depending on the patients' classification by underlying diagnosis (according to international classification of diseases (ICD-10)).

Material and methods. The study was a retrospective analysis of mortality in general surgery units located at three university hospitals: N. Barlicki University Hospital No. 1 in Lodz, WAM University Hospital No. 2 in Lodz and B. Szarecki University Hospital No. 5. The study included 26020 patients treated in these units from 01.01.2003 to 31.12.2006. Patients were classified into the following diagnostic categories: malignant neoplasm, suspicion of malignant neoplasm, acute diffuse peritonitis, paralytic ileus, acute pancreatitis, other inflammatory conditions, bleeding from digestive tract, acute vascular disorders of intestines, states with peritoneal obliteration, perforation or peritonitis, states with acute hepatic failure or cirrhosis. Patients with none of these diagnoses were grouped into a low-risk category. The death risk groups formed in this way were subjected to further statistical analysis in order to estimate the occurrence of significant differences in mortality between the low-risk group and the other diagnostic groups. ***Results.*** Among the groups subjected to analysis only one (malignant neoplasm) demonstrated a significant difference in mortality in relation to the low-risk group in every general surgery unit subjected to analysis. Three risk factors (paralytic ileus, acute vascular disorders of intestines, states with peritoneal obliteration, perforation or peritonitis) manifested a significant difference in mortality in relation to the low-risk group in one of the three surgical units subjected to analysis. ***Conclusions.*** In conclusion, a patient hospitalised in general surgery unit with an underlying diagnosis of malignant neoplasm is a patient at increased risk of death. A patient hospitalised with an underlying diagnosis of paralytic ileus, acute vascular disorders of intestines or states with peritoneal obliteration, perforation or peritonitis is a patient with moderately increased risk of death. No conclusions can be drawn from this study about the risk of death for patients hospitalised with an underlying diagnosis of acute diffuse peritonitis, acute hepatic failure or cirrhosis due to the small sample size of these groups. *Anestezjologia i Ratownictwo 2008; 2: 124-132.*

Keywords: mortality, predictors, general surgery, hospitalization

Introduction

Mortality in general surgery units in hospitals in Poland depends on numerous factors. The most important ones include the profile of the admitted patients (the kind of pathology, procedure performed, the patients' age [1,2], severity of their clinical condition, the skills, knowledge, and experience of the unit staff, the model of postoperative care, cooperation with intensive care unit, and the unit sanitary conditions. Different scales are used (e.g. APACHE) to assess the risk of death of the hospitalised patients undergoing surgery in general surgery units. Such scales are also applied to assist in deciding which surgical procedure to use on a given patient, as they help determine the risk of death [3]. The five-grade scale ASA (American Society of Anesthesiologists) is probably the most commonly used scale for assessing a patient before surgery (operative risk grade). In the 1990s a few scales of point-failure (dysfunction) of organs were worked out to assess the most severely (critically) ill: SOFA (Sequential Organ Failure Assessment) [4-9], Brussels, MOD (Multiple Organ Dysfunction Score) [10], LOD (Logistic Organ Dysfunction Score). SOFA and Brussels scales were worked out during numerous consensus conferences, whereas MOD and LOD were developed on the basis of complex statistical analyses. These scales allow assessement of the prognosis, the pathological process dynamics and the degree of organ dysfunction. Other scales, such as the Bernstein-Parsonnet [11-14], the Cleveland Clinic Foundation [15] and EuroScore [16] scales are used in cardiosurgery and other medical branches.

As far as we know, none of the currently applied risk scales is based on the classification of basic diagnoses, e.g. on ICD-10. Sometimes single diseases (pathologies), more or less precisely defined, are a component of some risk scales used particularly in cardiology or cardiosurgery. In many studies, ICD-10 classification (as well as its earlier revisions) is used first of all for defining the studied groups of patients [17-20].

It seems reasonable to suppose that the basic diagnosis determines a certain level of mortality due to its reflection of the underlying pathological state. Thus, it may be concluded that in a relatively large group of patients with a high-risk ICD-10 diagnosis, even if ideal conditions of hospitalisation (treatment) are provided in general surgery units, mortality in these units will be >0. It seems obvious that different basic diagnoses (according to ICD-10) are associated with different risks of mortality.

The risk of mortality in "a model surgical unit" is a sum of many risks. The patients hospitalised there are at higher or lower relative risk of death depending on their age, underlying diagnosis, disease severity, prior surgical procedures, surgical procedure planned, and the length of patient hospitalization. Mortality in "a model surgical unit" is expected to increase in the case of a higher percentage of older patients, patients with life- and health-threatening underlying diagnoses, patients in severe condition, patients with many prior surgical procedures and those with emergency admissions. For the purposes of this study we considered only causes of mortality outside of the control of the surgical team: basic mortality in "a model surgical unit".

In a real surgical unit there are additional risk factors related to, among others, skills, knowledge and experience of the staff employed there, the model of postoperative care or the unit sanitary conditions which can significantly increase mortality, making basic mortality an index that should be used. Some risk factors can not be significantly modified. Therefore, identification of modifiable risk factors should be pursued to decrease real mortality in surgical units through appropriate organisational and prophylactic activities.

We attempted to estimate the risk of death of patients admitted to general units as a result of risk factors comprised in the ICD-10 diagnosis. We distinguished 10 diagnostic categories of mortality risk: malignant neoplasm, suspicion of malignant neoplasm, acute diffuse peritonitis, paralytic ileus, acute pancreatitis, other inflammatory conditions, bleeding from digestive tract, acute vascular disorders of intestines (included into basic diagnosis), states with peritoneal obliteration, perforation or peritonitis (included into basic diagnosis), states with acute hepatic failure or cirrhosis (included into basic diagnosis).

Based on their diagnoses, patients were sorted into the appropriate ICD-10 category, or were categorized into an 11th group if they did not fit into any of the other diagnostic groups. The 11 groups formed in this way were subjected to statistical analysis.

The aim of the study was to assess whether patients with in the 10 diagnostic categories faced a significantly different risk of death than those in the 11th group (those without any of the suggested death risk factors).

Material and methods

The study is a retrospective analysis of mortality in general surgery units located at three Medical University Hospitals in Lodz: N. Barlicki University Hospital No. 1 (UH 1), University Hospital No. 2 (UH 2) and University Hospital No. 5 (UH 5). The selection was determined for the following reasons: The Medical University in Lodz is the founding body of all the analysed hospitals; the hospitals are located only a few kilometres away from each other; the units have similar number of beds, educated medical and nursing staff; the heads of the units are professors; and health benefits are provided on the basis of the same list of benefits as part of a contract with the same payer – Lodz Provincial Branch of National Health Fund (LPB NHF).

The study was comprised of 26 020 patients treated in these units from 01.01.2003 to 31.12.2006. The statistical data obtained from the Provincial Centre of Public Health in Lodz (PCPH) were analysed. The obtained information concerned the number of the treated patients, the number of patients transferred, discharged or dead, the number of man-days, mean bed use, mean hospitalisation time, mean number of patients per bed and mortality. The statistical data at the disposal of PCPH are collected in a uniform way for the whole country. Transmission of data by the parties concerned is compulsory. Additionally data were used from questionnaires filled in by the heads of surgical units in Lodz province, including information on the unit, on the number and qualifications of medical staff, and surgical procedures performed. The questionnaire is completed every year on the order of the Provincial Consultant in general surgery.

In the first stage the structure of the hospitalised patients was analysed. A relative structure similarity index (Pw) was used to compare the structure of the analysed units:

$$Pw = \frac{\sum_{k=1}^{m} \min(u_{k1}, u_{k2})}{\sum_{k=1}^{m} \max(u_{k1}, u_{k2})}$$

uk1, uk2 – the indices of the structure of the investigated phenomenon in comparable units.

Relative structure similarity index assumes the values from the range (0, 1). The closer to 1 the value of these indices, the more similar the structures of the investigated phenomenon in comparable units. This could really use additional explanation. A sample calculation might be helpful.

The three most frequent groups of diagnoses according to ICD-10, C00; .....; C97, D00; ...; D89 and K00; ...; K93, were selected for further analysis. To compare objectively mortality in the units, in the above-mentioned three groups of basic diagnoses the number of hospitalisations (structure) and the number of deaths were modified. Patients were then sorted into one of the ten risk categories (malignant neoplasm, suspicion of malignant neoplasm, acute diffuse peritonitis, paralytic ileus, acute pancreatitis, other inflammatory conditions, bleeding from digestive tract, acute vascular disorders of intestines (included into basic diagnosis), states with peritoneal obliteration, perforation or peritonitis (included into basic diagnosis), states with acute hepatic failure or cirrhosis (included into basic diagnosis) or an 11th category if they did not fall into any of the previous diagnostic groups.

The death risk groups formed in this way were subjected to further statistical analysis in order to estimate the occurrence of significant differences in mortality between the groups.

Statistica 5.1 PL and Microsoft Office 97 software were used for statistical analysis and graphic presentation.

Appropriate statistical tests, dependent on the quantity, sample matching and the type of the investigated sample, were used to compare the parameters of different groups.

The tests for two means for independent samples were applied for statistical analysis (H0: $\mu 1 = \mu 2$; H1: $\mu 1 \neq \mu 2$).

To determine the correlations between the investigated traits Pearson's correlation coefficient was calculated. The result was given in the form of $p<p_{max}$ (e.g. $p<0,05$). This means that the correlation was found to be statistically significant at the distinguished level of significance.

Results

Table 1 demonstrates the structure of the analysed hospitalisation in the groups of patients: A00 – A99; ...; Z00 – Z99 according to the basic diagnosis in the chosen general surgery units in the years 2003-2006.

Table 1. The structure of hospitalised patients (in groups: A00 – A99; ...; Z00 – Z99) acc. to basic diagnosis in the investigated general surgery units in the years 2003-2006

	Together (UH No. 1; UH No. 2; UH No. 5)		UH No.1		UH No.5		UH No. 2	
Basic diagnosis acc. to ICD-10*	No. of patients	Structure index (%)	No. of patients	Structure index (%)	No. of patients	Structure index (%)	No. of patients	Structure index (%)
Total:	26020	100%	6612	100%	13718	100%	5690	100%
A00 - A99	43	0,165%	5	0,076%	34	0,248%	4	0,070%
B00 - B99	7	0,027%	1	0,015%	6	0,044%	0	0,000%
C00 - C97	3730	14,335%	355	5,369%	2599	18,946%	776	13,638%
D00 - D89	2843	10,926%	263	3,978%	1736	12,655%	844	14,833%
E00 - E90	1882	7,233%	596	9,014%	1010	7,363%	276	4,851%
F00- F99	3	0,012%	0	0,000%	0	0,000%	3	0,053%
G00 - G99	11	0,042%	4	0,060%	2	0,015%	5	0,088%
H00 - H95	1	0,004%	0	0,000%	1	0,007%	0	0,000%
I00 - I99	2252	8,655%	599	9,059%	715	5,212%	938	16,485%
J00 - J99	290	1,115%	7	0,106%	9	0,066%	274	4,815%
K00 - K93	11305	43,447%	3007	45,478%	6178	45,036%	2120	37,258%
L00 - L99	594	2,283%	267	4,038%	173	1,261%	154	2,707%
M00 - M99	61	0,234%	29	0,439%	9	0,066%	23	0,404%
N00 - N99	445	1,710%	66	0,998%	350	2,551%	29	0,510%
O00 - O99	3	0,012%	1	0,015%	1	0,007%	1	0,018%
Q00 -Q99	25	0,096%	3	0,045%	6	0,044%	16	0,281%
R00 - R99	891	3,424%	43	0,650%	768	5,598%	80	1,406%
S00 - S99	1423	5,469%	1278	19,328%	52	0,379%	93	1,634%
T00 - T98	175	0,673%	84	1,270%	41	0,299%	50	0,879%
Z00 - Z99	36	0,138%	4	0,060%	28	0,204%	4	0,070%

* (A00-B99) Infections or parasitic diseases; (C00-D48) Neoplasms; (D50-D98) Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism; (F00-F99) Mental and behavioural disorders; (G00-G99) Disease of the nervous system; (I00-I99) Diseases of the circulatory system; (J00-J99) Diseases of the respiratory system; (K00-K93) Diseases of the digestive system; (L00-L99) Diseases of the skin and subcutaneous tissue; (M00-M99) Diseases of the musculoskeletal system and connective tissue; (N00-N99) Diseases of the genitourinary system; (O00-O99) Pregnancy, childbirth and puerperium; (P00-P96) Certain conditions originating in the perinatal period; (Q00-Q99) Congenital malformations, deformations and chromosomal abnormalities; (R00-R99) Symptoms, signs and abnormal clinical and laboratory findings not classified elsewhere; (S00-T98) Injury, poisoning and certain other consequences of external causes; (Z00-Z99) Factors influencing health status and contact with health services.

Table 2. The number of hospitalisations and mortality in the groups of basic diagnoses with the same risk factor (after structure modification):

	Hospitalisations				Mortality			
Risk factors	UH No.1	UH No. 2	UH No.5	(UH No.1/ UH No.2/ UH No.5) Total	UH No.1	UH No.2	UH No.5	(UH No.1/ UH No.2/ UH No.5) Total
No risk factor	84,95	114,80	274,22	473,97	0,91%	0,00%	0,00%	0,16%
Malignant neoplasm	142,63	311,79	1044,24	1498,66	14,51%	6,21%	2,42%	4,36%
Suspicion of malignant neoplasm	50,98	163,59	336,48	551,05	7,69%	0,61%	0,12%	0,96%
Acute diffuse peritonitis	11,35	8,00	23,31	42,66	9,96%	25,00%	0,00%	7,34%
Paralytic ileus	36,88	26,00	75,77	138,65	12,34%	0,00%	0,65%	3,64%
Acute pancreatitis	73,76	52,00	151,54	277,29	2,73%	0,00%	0,61%	1,06%
Other inflammatory conditions	150,31	105,97	308,82	565,10	0,47%	0,54%	0,00%	0,22%
Bleeding from digestive tract	25,53	18,00	52,45	95,99	3,09%	0,00%	0,00%	0,82%
Acute vascular disorders of intestines	4,26	3,00	8,74	16,00	61,57%	0,00%	0,00%	16,38%
States with peritoneal obliteration, perforation or peritonitis	1489,57	1050,18	3060,38	5600,14	0,74%	0,49%	0,06%	0,32%
States with acute hepatic failure or cirrhosis	4,41	3,11	9,05	16,57	14,52%	12,87%	7,51%	10,44%
Total / mean	2074,61	1856,44	5345,02	9276,07	2,35%	1,53%	0,55%	1,15%

*if included into basic diagnosis

Table 3. Mortality and statistical significance in the groups of diagnoses with the same risk factor in relation to the groups of diagnoses without risk factor in general surgery units in selected hospitals (after structure modification):

	UH No.1		UH No.2		UH No.5		All	
Risk factor	Mortality	Statistical significance of the difference in mortality*	Mortality	Statistical significance of the difference in mortality*	Mortality	Statistical significance of the difference in mortality*	Mortality	Statistical significance of the difference in mortality
No risk factor	0,9064%	-	0,0000%	-	0,0000%	-	0,1625%	-
Malignant neoplasm	14,5126%	p<0.001	6,2126%	p<0.001	2,4247%	p<0.001	4,3626%	p<0.001
Suspicion of malignant neoplasm	7,6899%	NS	0,6113%	NS	0,1159%	NS	0,9636%	NS
Acute diffuse peritonitis	9,9584%	NS	25,0000%	NS	0,0000%	NS	7,3370%	NS
Paralytic ileus	12,3379%	p<0.05	0,0000%	NS	0,6467%	NS	3,6352%	p<0.04
Acute pancreatitis	2,7252%	NS	0,0000%	NS	0,6137%	NS	1,0639%	NS
Other inflammatory conditions	0,4724%	NS	0,5379%	NS	0,0000%	NS	0,2247%	NS
Bleeding from digestive tract	3,0943%	NS	0,0000%	NS	0,0000%	NS	0,8230%	NS
Acute vascular disorders of intestines**	61,5719%	p<0.02	0,0000%	NS	0,0000%	NS	16,3774%	NS
States with peritoneal obliteration, perforation or peritonitis**	0,7371%	NS	0,4856%	p<0.03	0,0575%	NS	0,3186%	NS
States with acute hepatic failure or cirrhosis**	14,5221%	NS	12,8738%	NS	7,5100%	NS	10,4414%	NS

* statistical significance of mortality difference in the group of basic diagnoses with appropriate risk factor in relation to the group of basic diagnoses without risk factor

** if included into basic diagnosis

Table 4. Patients aged 60 years and more, emergency admission and mortality in the group of hospitalised patients with the diagnosis C00 – C97 in the years 2003-2006

	UH No.1			UH No.5			UH No.2		
Years	Patients aged 60 years and more	Emergency admission	Mortality	Patients aged 60 years and more	Emergency admission	Mortality	Patients aged 60 years and more	Emergency admission	Mortality
2006	68,96%*	26,72%*	13,24%	63,45%	9,90%	1,27%	67,36%	7,25%	3,63%
2005	56,64%*	19,47%*	14,47%	66,49%	11,48%	1,58%	71,43%	30,05%	7,88%
2004	71,32%*	14,73%*	12,64%	62,27%	10,67%	1,07%	70,66%	16,77%	7,78%
2003	61,43%	7,86%	18,55%	66,67%	21,78%	2,64%	73,71%	26,76%	12,68%

* - unit code: 4500 and 4650

The relative structure similarity indices of the hospitalised patients in general surgery units in the selected hospitals according to the basic diagnosis (as groups: A00 – A99; ...; Z00 – Z99) were respectively: University Hospital (UH) No. 1 / UH No. 2 – 0,511; UH No. 1 / UH No. 5 – 0,549; UH No. 2 / UH No. 5 – 0,637 and 0,418 together for UH No. 1 / UH No. 2 / UH No. 2 / UH No. 5.

The three most frequent diagnoses according to ICD-10 were subgroups of C, D and K, which : constituted 68,71% of hospitalised patients, and which were subjected to further analysis. After modification of the number of hospitalisations (structure) and the number of deaths in these groups, appropriate risk factors were ascribed to diagnoses.

Table 2 presents the number of hospitalisations and mortality in the groups of diagnoses (after structure modification).

Among the groups subjected to analysis only one (malignant neoplasm) demonstrated a significant difference in mortality in relation to patients in the 11th group (low-risk category). Three risk groups (paralytic ileus, acute vascular disorders of intestines, states with peritoneal obliteration, perforation or peritonitis) manifested a significant difference in mortality in relation to the low-risk group in one of the three general surgery units subjected to analysis.

Table 3 displays the detailed data.

The group of patients diagnosed with malignant neoplasm (C00–C97) (the highest risk group) was subjected to a very detailed analysis aiming at explaining the higher mortality of this group. The data for patients 60 years or older, emergency admissions and mortality in the years 2003-2006 are presented in table 4. A negative correlation was detected between the percentage of emergency admissions and mortality in the group of hospitalised patients with the diagnosis C00–C97 in UH No. 1 surgical units in the years 2003-2006: r = -0,71448 ($p<0,05$) (determination coefficient $r^2= 0,51048$). A positive correlation was found between the percentage of patients aged 60 years older and mortality in the years 2003-2006 in UH No. 5 surgical unit: r =0,803481 ($p<0,02$) (determination coefficient $r^2 = 0,645582$) and also between the percentage of emergency admissions and mortality: r = 0,968807 ($p<0,0001$) (determination coefficient $r^2= 0,938586$). A positive correlation was found between the percentage of patients aged 60 years older and mortality and between the percentage of emergency admissions and mortality in the group of hospitalised patients with C00 – C97 diagnosis in the years 2003-2006 in UH No. 2 surgical unit. The respective correlation coefficients are: 0,980784 ($p<0,0001$) (determination coefficient $r^2 = 0,961938$) and 0,758359 ($p<0,03$) (determination coefficient $r^2 = 0,575108$).

Discussion

Basic diagnosis, as it has been mentioned in the introduction, influences mortality. ICD-10 classification is a widely applied classification of diseases and health problems. A detailed description of ICD-10 classification can be the basis for drawing conclusions about the probability of the occurrence of complications and death. The authors found that belonging to one of ten diagnostic groups could indicate a higher risk of death for patients hospitalised in general surgery units.

The results of this study show that from among the diagnostic groups only patients with malignant neoplasm are at a uniformly increased death risk (4,3626% vs. 0,1625%; $p<0,001$). The remaining groups have not been shown to a sufficient degree to be at an increased mortality risk.

However, attention should be paid to the fact that patients in three of these groups (paralytic ileus, acute vascular disorders of intestines and states with peritoneal obliteration, perforation or peritonitis) were at increased risk of death in at least one of the analysed hospitals. However, the risk of death for patients in these groups was much less than for patients with malignant neoplasm. Groups of patients with acute diffuse peritonitis or acute hepatic failure or cirrhosis require further analysis. The mortality rate in these groups did not differ statistically from the group of patients without these conditions. Most probably, an insufficient sample size made determination of a significant difference impossible. It should be noted that we performed statistical calculations after modification of the structure and sample size. The aim of the modification was to enable the comparison of mortality not only within one unit but also between units. Decrease of the sample size in accordance with the value of relative structure similarity indices was the effect of this procedure. If this had not been done, the comparison of individual units would not have been possible but the statistical analysis could have been performed on a larger sample within each unit.

The results presented in table 4 are particularly noteworthy. It contains the data related to the percentage of patients aged 60 years and more, emergency admissions and mortality in the group of patients with the diagnosis C00 – C97 in the years 2003-2006. It is a well-known fact that the patients' age and emergency admissions affect the mortality of hospitalised patients in surgical units. It should be reflected in the correlations calculated here, as was seen in the data from UH No. 5 and UH No. 2. The obtained values of determination coefficients (r^2) demonstrated that both the patients' age and emergency admission are correlated with mortality in the analysed surgical units. In the case of UH No. 5 emergency admission is more important, whereas in UH No. 2 the patients' age was more important.

However, in UH No.1 a negative correlation was observed between the percentage of emergency admissions and mortality in the group of patients hospitalised in UH No.1 surgical unit in the years 2003-2006: $r = -0,71448$ ($p<0,05$) ($r^2 = 51048$) and no correlation was seen between the patients' age and mortality. In our opinion, this result suggests the existence of some additional factors affecting significantly the change in mortality in this hospital.

We also investigated the causes of significant differences in real mortality between surgical units of particular hospitals. The following were analysed: skills, knowledge and experience of the staff, the unit space conditions, equipment, postoperative care model, cooperation with intensive care unit as well as sanitary conditions in the unit.

Each of the units investigated in this study functions on the basis of a signed contract with Lodz Provincial Branch of National Health Fund. Thus, each unit had to meet the formal and legal requirements including equipment and staff which was confirmed by inspections carried out by LPB NHF inspectors. High qualifications of medical staff in each of these units also result from the fact that all the analysed units are at the same time teaching university departments. In the authors' opinion skills, knowledge and staff experience, sanitary conditions, unit space conditions and equipment are therefore unlikely to affect significantly the mortality difference between the analysed units.

The analysis of internal functioning principles of general surgery units in individual hospitals demonstrated that these departments are very similar. However, fundamental differences were observed in the principles and practice of postoperative care. In B. Szarecki University Teaching Hospital No. 5 in Lodz the postoperative care in recovery rooms of the surgical unit is provided exclusively by anaesthesiologists and anaesthesiological nurses. The equipment and monitoring apparatus in the recovery room is exactly the same as it is in the intensive care unit. In the other surgical units (N. Barlicki University Teaching Hospital No. 1 and WAM University Teaching Hospital No. 2 in Lodz) postoperative care is provided by surgeons and surgical nurses. The equipment and monitoring apparatus are typical for a recovery room.

Conclusions

In conclusion, this study of comparative mortality of patients hospitalized in basic surgery units indicates that those with a diagnosis of malignant neoplasm are at increased risk of death. A patient hospitalised with a diagnosis of paralytic ileus, acute vascular disorders of intestines or states with peritoneal obliteration, perforation or peritonitis is a patient with a moderately increased risk of death. Patients diagnosed with acute diffuse peritonitis or acute hepatic failure or cirrhosis require further study, since the sample size was too small to determine whether they are at increased risk. Differences in mortality between surgical units at different hospitals may be due to the model of postoperative care employed.

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