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# Prognostic factors in acute mesenteric ischemia and evaluation with multiple logistic regression analysis effecting morbidity and mortality

## Czynniki prognostyczne w ostrym niedokrwieniu krezki i ocena ich wpływu na wskaźniki chorobowości i śmiertelności metodą regresji logistycznej

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**ABSTRACT:**

**Background:** Acute mesenteric ischemia (AMI) is a catastrophic abdominal emergency characterized by sudden critical interruption to the intestinal blood flow which commonly leads to bowel infarction and death. AMI still has a poor prognosis with an in-hospital mortality rate of 50–69%. This high mortality rate is related to the delay in diagnosis which is often difficult and overlooked. Early intervention is crucial and gives a chance for intestinal viability.

**Methods:** The charts of 140 patients who were hospitalized with AMI between May 1997 and August 2013 in Ege University Faculty of Medicine, Department of General Surgery were retrospectively reviewed. Demographical and clinical features of patients constituting the best predictors of morbidity and mortality were evaluated with Multiple Logistic Regression analysis by Enter method after adjustment for all possible confounding factors.

**Results:** Out of 140 patients, 77 were men (55%) and 63 were women (45%). The mean age was 66.6 ± 14.5 (16–94) years. Demographical findings, comorbidities, ASA scores, drugs used for mesenteric ischemia and diagnostic imaging materials were summarized. The most common comorbidities were cardiac problems (42.9%). Twenty-seven (19.3%) patients had diabetes mellitus. The median ASA score was 3. Abdominal computed tomography (CT) was the most commonly used imaging modality and it was performed in 119 (85%) patients. Twenty-five (17.9%) patients were in shock and 48 (34.3%) had acidosis. The time of delay between the onset of acute abdominal pain to surgery was <12 hours in 14 patients (10.0%), 12 to 24 hours in 46 patients (32.9%), and >24 hours in 80 patients (57.1%). The most common etiology in AMI was thrombus, in 69 patients (49.3%). The most affected or involved organ was both small and large bowel – in 80 patients (57.1%) in total. The most commonly performed surgery was small bowel resection – in 42 patients (30%). As many as 127 (90.7%) of all patients underwent surgery and 18 (12.9%) patients underwent a second-look laparotomy. Small bowel length of less than 100 cm was recorded in 46 patients (32.9%). The length of hospital stay was 7 days (1–90 days). Morbidities were found in 51 patients (36.4%) and death in 74 patients (52.9%).

**Conclusion:** The purpose of this study was to evaluate the prognostic factors of AMI to better understand it and optimize both medical and surgical management with improvement of treatment results. We suggested that the diagnosis of AMI should be based on suspicion of a clinician only and that laparotomy should be performed as soon as possible, before the onset of the clinical signs of peritonitis. Age and time of delay between the onset of acute abdominal pain and surgery longer than 24 hours are the most important prognostic factors for mortality in patients presenting with shock and acidosis.

**KEYWORDS:** acidosis, colectomy, logistic models, mesenteric ischemia, shock, short bowel syndrome, small intestine

**STRESZCZENIE:**

**Wprowadzenie:** Ostre niedokrwienie krezki (ang. *acute mesenteric ischaemia*; AMI) jest katastrofalnym w skutkach i wymagającym natychmiastowej pomocy stanem jamy brzusznej, będącym następstwem nagłego, krytycznego przerwania dopływu krwi do jelit i często prowadzącym do zawału jelita i zgonu. AMI wciąż charakteryzuje się niekorzystnym rokowaniem, ze wskaźnikiem śmiertelności wynoszącym 50–69% wśród pacjentów hospitalizowanych. Ten wysoki wskaźnik śmiertelności jest związany z opóźnieniem w rozpoznaniu, które często nastręcza trudności i może zostać niewłaściwie postawione. Wczesna interwencja ma kluczowe znaczenie dla zachowania żywotności jelit.

**Metody:** Dokonano retrospektywnej oceny dokumentacji klinicznej 140 pacjentów z AMI leczonych od maja 1997 r. do sierpnia 2013 w Klinice Chirurgii Ogólnej Wydziału Medycznego Uniwersytetu Ege. Parametry demograficzne i kliniczne, decydujące o najlepszych rokowaniach w zakresie chorobowości i śmiertelności, określono w analizie regresji logistycznej metodą wprowadzania (Enter) po uwzględnieniu poprawek na wpływ wszystkich możliwych czynników zakłócających.

**Wyniki:** W grupie 140 pacjentów 77 osób stanowili mężczyźni (55%), zaś 63 kobiety (45%). Średnia wieku wyniosła 66,6 ± 14,5 (16–94) lat. Podsumowano: dane demograficzne, dane o chorobach współistniejących, wyniki w skali ASA, dane nt.

stosowania leków związanych z niedokrwieniem krezki oraz materiały z badań diagnostyki obrazowej. Najczęstszymi chorobami współistniejącymi były problemy kardiologiczne (42,9%). U 27 (19,3%) pacjentów stwierdzono cukrzycę. Średni wynik w skali ASA wynosił 3. Najczęściej stosowaną metodą obrazowania była tomografia komputerowa (TK) jamy brzusznej, którą wykonano u 119 (85%) pacjentów. U 25 (17,9%) chorych stwierdzono wstrząs, zaś u 48 (34,3%) – kwasicę. Zwłoka między wystąpieniem ostrego bólu brzucha a zabiegiem wyniosła <12 godzin u 14 pacjentów (10,0%), od 12 do 24 godzin u 46 pacjentów (32,9%) i >24 godziny u 80 pacjentów (57,1%). Najczęstszą etiologią AMI był zakrzep (69 pacjentów, 49,3%). Najbardziej dotkniętymi bądź zajętymi narządami były jednocześnie jelito cienkie i grube (80 pacjentów, 57,1%). Najczęściej wykonywaną operacją była resekcja jelita cienkiego (42 pacjentów, 30%). Operacji chirurgicznej poddano 127 (90,7%) pacjentów, zaś 18 (12,9%) poddano laparotomii sprawdzającej. W przypadku 46 chorych (32,9%) stwierdzono jelito cienkie o długości poniżej 100 cm. Średni czas hospitalizacji wynosił 7 dni (1–90 dni). Wystąpienie chorób odnotowano u 51 pacjentów (36,4%), zaś wystąpienie zgonu u 74 pacjentów (52,9%).

**Wniosek:** Celem niniejszego badania była ocena czynników prognostycznych AMI, mająca prowadzić do lepszego zrozumienia AMI, optymalizacji metod leczenia zarówno niechirurgicznego, jak i chirurgicznego, oraz poprawy wyników leczenia. Sugerujemy, że diagnostykę AMI należy wykonywać w oparciu o samo podejrzenie, oraz że w przypadkach takich konieczne jest niezwłoczne wykonanie laparotomii, w miarę możliwości przed wystąpieniem klinicznych objawów zapalenia otrzewnej. Wśród pacjentów z obrazem klinicznym obejmującym wstrząs i kwasicę najważniejszymi parametrami prognostycznymi śmiertelności są wiek i zwłoka między wystąpieniem ostrego bólu brzucha a zabiegiem wynosząca więcej niż 24 godziny.

**SŁOWA KLUCZOWE:** jelito cienkie, kolektomia, kwasica, modele logistyczne, niedokrwienie krezki, wstrząs, zespół krótkiego jelita

## ABBREVIATIONS

**AMI** – Acute mesenteric ischaemia
**CT** – Computed tomography
**I-FABP** – Intestinal fatty acid binding protein
**LR** – Logistic Regression
**NOMI** – non-occlusive ischemia
**SD** – standard deviation
**TPN** – Total parenterally nutrition

## INTRODUCTION

Acute mesenteric ischemia (AMI) is a catastrophic abdominal emergency characterized by sudden critical interruption to the intestinal blood flow which commonly leads to bowel infarction and death [1]. AMI increases in countries with an expanding elderly population [2]. Despite the advances in medical diagnostics and treatment in the last decades, AMI still has a poor prognosis with an in-hospital mortality rate of 50–69% [3]. AMI is prevalent in older population and age has a negative effect on prognosis. In the reviewed literature, risk factors related to mortality and morbidity have been poorly analyzed due to the lack of prospective studies and small numbers of patients [4]. This high mortality rate is related to the delay in diagnosis, which is often difficult and overlooked [5, 6]. Early intervention is crucial and the potential for intestinal viability is 100% when symptoms are present for less than 12 hours, 56% if symptoms are present for 12 to 24 hours and only 18% if symptoms were neglected for over 24 hours before diagnosis [7, 8]. Therefore, the rate of success depends on rapid suspicion and appropriate management. The basis of the adequate management is early diagnosis, resection of the infarcted bowel, restoration of blood flow, second-look laparotomy, and supportive intensive care [4, 9].

## MATERIALS AND METHODS

### Patients

The charts of 140 patients hospitalized for AMI between May 1997 and August 2013 in Ege University Faculty of Medicine, Department

**Tab. I.** Demographical and clinical features of patients.

| VARIABLES | N = 140 |
|---|---|
| **Age (years)** | 66.6 ± 14.5 |
| Range (years) | (16–94) |
| **Gender** | |
| Male | 77 (55.0%) |
| Female | 63 (45.0%) |
| **Co-morbidities** | 109 (77.9%) |
| Atherosclerosis | 8 (5.7%) |
| Diabetes mellitus (DM) | 27 (19.3%) |
| Cardiac | 60 (42.9%) |
| Other | 69 (49.3%) |
| **Predisposing drug use** | 14 (10.0%) |
| **ASA** | 3 (1–5) |
| **Time of delay between the onset of acute abdominal pain and surgery** | |
| <12 hours | 14 (10.0%) |
| 12–24 hours | 46 (32.9%) |
| >24 hours | 80 (57.1%) |
| **Acidosis** | 48 (34.3%) |
| **Shock** | 25 (17.9%) |
| **Imaging modalities** | |
| Computed tomography (CT) | 119 (85.0%) |
| Doppler ultrasonography | 9 (6.4%) |
| Angiography | 2 (1.4%) |
| Computed tomography (CT) + Doppler ultrasonography | 1 (0.7%) |
| Doppler ultrasonography + angiography | 2 (1.4%) |
| **Etiology** | |
| Emboli | 41 (29.3%) |
| Thrombus | 69 (49.3%) |
| Venous | 11 (7.9%) |
| Non-occlusive mesenteric ischemia (NOMI) | 17 (12.1%) |
| Thrombus + venous | 2 (1.4%) |
| **Involved organs** | |
| Small bowel | 51 (36.4%) |
| Large bowel | 9 (6.4%) |
| Both | 80 (57.1%) |
| **Type of treatment (medical or surgery)** | |
| Medical treatment | 13 (9.3%) |
| Exploration | 39 (27.9%) |
| Small bowel resection | 42 (30.0%) |
| Large bowel resection | 8 (5.7%) |
| Both small and large bowel resection | 34 (24.3%) |
| Embolectomy | 4 (2.9%) |
| **Second-look laparotomy** | 18 (12.9%) |
| **Small bowel length < 100 cm** | 46 (32.9%) |
| **Length of hospital stay (days)** | 7 (1-90) |
| **Morbidity** | 51 (36.4%) |
| **Mortality** | 74 (52.9%) |

**Tab. II.** Demographical and clinical features of patients from the morbidity and the absence of morbidity groups, with the statistical analysis (P-value).

| VARIABLES | NO MORBIDITY | PRESENCE OF MORBIDITY | P-VALUE | OR (95%CI) |
|---|---|---|---|---|
| **Age (years)** | 66.0 ± 15.4 | 67.8 ± 12.7 | 0.463 | 1.009 (0.895–1.034) |
| **Male gender** | 48 (%53.9) | 29 (%56.9) | 0.737 | 1.126 (0.563–2.252) |
| **Co-morbidities** | 65 (%82.3) | 44 (%95.7) | **0.031** | 4.738 (1.026–21.888) |
| Atherosclerosis | 6 (%7.6) | 2 (%4.3) | 0.709 | 0.553 (0.107–2.861) |
| Diabetes mellitus (DM) | 15 (%19.0) | 12 (%26.1) | 0.352 | 1.506 (0.634–3.579) |
| Cardiac | 36 (%45.6) | 24 (%52.2) | 0.476 | 1.303 (0.629–2.700) |
| Other | 44 (%55.7) | 25 (%54.3) | 0.884 | 0.947 (0.456–1.966) |
| **Predisposing drug use** | 10 (%11.2) | 4 (%7.8) | 0.520 | 0.672 (0.200–2.265) |
| **ASA** | 3 (1–5) | 3 (1–4) | 0.238 | 1.190 (0.830–1.707) |
| **Time of delay between the onset of acute abdominal pain and surgery** | | | | |
| <12 hours | 10 (11.2%) | 4 (7.8%) | - | 1 |
| 12–24 hours | 30 (33.7%) | 16 (31.4%) | 0.667 | 1.333 (0.360–4.935) |
| >24 hours | 49 (55.1%) | 31 (60.8%) | 0.470 | 1.482 (0.456–5.486) |
| **Acidosis** | 26 (40.6%) | 22 (55.0%) | 0.153 | 1.786 (0.804–3.968) |
| **Shock** | 13 (19.4%) | 12 (30.8%) | 0.184 | 1.846 (0.743–4.589) |
| **Etiology** | | | | |
| Emboli | 24 (27.0%) | 17 (33.3%) | 0.426 | 1.354 (0.642–2.858) |
| Thrombus | 45 (50.6%) | 24 (47.1%) | 0.761 | 0.899 (0.451–1.790) |
| Venous | 1 (1.1%) | 1 (2.0%) | 1.000 | 1.101 (0.340–3.562) |
| Non-occlusive mesenteric ischemia (NOMI) | 7 (7.9%) | 4 (7.8%) | 0.521 | 0.697 (0.231–2.107) |
| **Involved organs** | | | | |
| Small bowel | 33 (37.1%) | 18 (35.3%) | 0.833 | 0.926 (0.452–1.897) |
| Large bowel | 7 (7.9%) | 2 (3.9%) | 0.487 | 0.478 (0.095–2.394) |
| Both | 49 (55.1%) | 31 (60.8%) | 0.510 | 1.265 (0.628–2.549) |
| **Type of management** | | | | |
| Medical treatment | 12 (13.5%) | 1 (2.0%) | 0.052 | 0.128 (0.016–1.018) |
| Exploration | 29 (32.6%) | 10 (19.6%) | 0.099 | 0.505 (0.222–1.147) |
| Small bowel resection | 24 (27.0%) | 18 (35.3%) | 0.301 | 1.477 (0.704–3.099) |
| Large bowel resection | 5 (5.6%) | 3 (5.9%) | 1.000 | 1.050 (0.240–4.588) |
| Both | 17 (19.1%) | 17 (33.3%) | 0.059 | 2.118 (0.965–4.649) |
| Embolectomy | 2 (2.2%) | 2 (3.9%) | 0.622 | 1.776 (0.242–13.002) |
| **Second-look laparotomy** | 12 (13.5%) | 6 (11.8%) | 0.770 | 0.856 (0.300–2.437) |
| **Small bowel length < 100 cm** | 26 (40.0%) | 20 (43.5%) | 0.714 | 1.154 (0.537–2.481) |
| **Length of hospital stay (days)** | 7 (1–52) | 9.5 (1–90) | **0.018** | 1.049 (1.018–1.081) |

OR – Odds Ratio, CI – Confidence Interval.

**Tab. III.** Statistical Analysis for all possible confounding factors effecting morbidity (Including shock and acidosis as risk factors).

| VARIABLES | ODDS RATIO | %95 CONFIDENCE INTERVAL | WALD | P-VALUE |
|---|---|---|---|---|
| **Shock** | 7.713 | 1.726–34.465 | 7.155 | **0.007** |
| **Surgery (exploration)** | 0.215 | 0.052–0.894 | 4.468 | **0.035** |
| **The length of hospital stay (days)** | 1.064 | 1.024–1.105 | 10.086 | **<0.001** |
| (excluding shock and acidosis as risk factors) | | | | |
| **VARIABLES** | **ODDS RATIO** | **%95 CONFIDENCE INTERVAL** | **WALD** | **P-VALUE** |
| **Co-morbidities** | 3.557 | 0,692–18.288 | 2,307 | 0.129 |
| **ASA** | 1.173 | 0.709–1.942 | 0.387 | 0.534 |
| **Type of surgery** | | | | |
| Exploration | 0.564 | 0.195–1.633 | 0.291 | 0.291 |
| Small and large bowel resection | 1.213 | 0.460–3.201 | 0.696 | 0.696 |
| **Length of hospital stay (days)** | 1.049 | 1.016–1.083 | 8.633 | **0.003** |

**Tab. IV.** Multiple Logistic Regression (LR) analysis by Enter method after adjustment for all possible confounding factors effecting morbidity(excluding Shock and Acidosis as risk factors).

| VARIABLES | ODDS RATIO | %95 CONFIDENCE INTERVAL | WALD | P-VALUE |
|---|---|---|---|---|
| **Co-morbidites** | 3.557 | 0.692–18.288 | 2.307 | 0.129 |
| **ASA** | 1.173 | 0.709–1.942 | 0.387 | 0.534 |
| **Type of Surgery** | | | | |
| Exploration | 0.564 | 0.195–1.633 | 0.291 | 0.291 |
| Small and large bowel resection | 1.213 | 0.460–3.201 | 0.696 | 0.696 |
| **Stay of Hospital (Day)** | 1.049 | 1.016–1.083 | 8.633 | **0.003** |

of General Surgery were retrospectively reviewed. The collected data included: age, gender, co-morbidities, administration of drugs, alcohol consumption, smoking habit, ASA score, delay to surgery, acidosis, presence of shock at the time of admission, preoperative diagnostic methods, etiology of the ischemia, the location of the ischemic intestinal segment, surgical procedure, need of second-look laparotomy, length of the remaining intestinal segment, length of hospital stay, morbidity and in-hospital mortality. The considered co-morbidities were cardiac problems (heart failure, ischemic heart disease, atrial fibrillation), diabetes mellitus, hypertension and other co-morbidities (chronic liver disease, chronic renal failure, peripheral vascular disease, chronic obstructive pulmonary disease and neurological disorders). Previous intake of digoxin, anticoagulant and antiplatelet medicines was considered as use of drugs increasing the risk of embolism, especially in the context of atrial fibrillation. The ethical approval was obtained from the Thai Clinical Trial Registry with an identification number TCTR20180517006.

If arterial pH was less than 7.34, it was considered as acidosis. If the patient had low blood pressure (<90 mmHg), tachycardia (>100/min.), confusion and dehydration, this was considered as shock. The time of delay between the onset of acute abdominal pain and surgery was categorized as <12 hours, 12 to 24 hours, and >24 hours. Imaging results (mesenteric doppler ultrasonography, angiographic and abdominal computed tomography and angiography) were also recorded. The patients who underwent surgery were divided into five groups: exploration (widespread intestinal necrosis), only small bowel resection, only large bowel resection, both small bowel and large bowel involvement and resection, and vascular surgical procedures.

The etiology of ischemia was recorded based on the surgical, clinical and histopathological findings.

Cases of second-look laparotomy and those with small bowel length of less than 100 cm were also recorded.

## Statistical Analysis

Data analysis was performed using SPSS for Windows, version 11.5 (SPSS Inc., Chicago, IL, United States). Whether the distributions of continuous variables were normal or not was determined by Kolmogorov-Smirnov test. Continuous variables were shown as mean ± standard deviation (SD) or median (min-max), where applicable. While the mean differences between groups were compared by Student's t-test, the Mann-Whitney U test was applied for comparisons of the median values. Nominal data were analyzed by Pearson's Chi-Square or Fisher's exact test, where applicable. The best predictor(s) of morbidity were evaluated with

**Tab. V.** Demographical and clinical features of the survival and mortality group, with the statistical analysis (P-value).

| VARIABLES | SURVIVAL | MORTALITY | P-VALUE | OR (95%CI) |
|---|---|---|---|---|
| **Age (years)** | 61.6 ± 15.3 | 71.1 ± 12.2 | **<0,001** | 1.053 (1.024–1.082) |
| **Female gender** | 24 (36.4%) | 39 (52.7%) | 0.052 | 1.950 (0.990–3.842) |
| **Co-morbidities** | 46 (83.6%) | 63 (90.0%) | 0.290 | 1.761 (0.611–5.074) |
| Atherosclerosis | 5 (9.1%) | 3 (4.3%) | 0.299 | 0.448 (0.102–1.962) |
| Diabetes mellitus (DM) | 8 (14.5%) | 19 (27.1%) | 0.089 | 2.189 (0.876–5.471) |
| Cardiac | 19 (34.5%) | 41 (58.6%) | **0.008** | 2.679 (1.289–5.567) |
| Other | 31 (56.4%) | 38 (54.3%) | 0.817 | 0.919 (0.452–1.871) |
| **Predisposing drug use** | 9 (13.6%) | 5 (6.8%) | 0.176 | 0.459 (0.146–1.447) |
| **ASA** | 2 (1–4) | 3 (1–5) | **<0.001** | 3.108 (1.969–4.906) |
| **Time of delay between the onset of acute abdominal pain and surgery** | | | | |
| <12 godzin | 13 (19.7%) | 1 (1.4%) | – | 1.000 |
| 12–24 hours | 27 (40.9%) | 19 (25.7%) | **0.040** | 9.148 (1.101–75.981) |
| >24 hours | 26 (39.4%) | 54 (73.0%) | **0.002** | 27.000 (3.349–217.653) |
| **Acidosis** | 13 (26.0%) | 35 (64.8%) | **<0.001** | 5.243 (2.256–12.185) |
| **Shock** | 4 (7.4%) | 21 (40.4%) | **<0.001** | 8.468 (2.656–26.993) |
| **Etiology** | | | | |
| Emboli | 15 (22.7%) | 26 (35.1%) | 0.107 | 1.842 (0.872–3.890) |
| Thrombus | 31 (47.0%) | 40 (54.1%) | 0.403 | 1.328 (0.683–2.584) |
| Venous | 9 (13.6%) | 4 (5.4%) | 0.094 | 0.362 (0.106–1.236) |
| Non-occlusive mesenteric ischemia (NOMI) | 11 (16.7%) | 6 (8.1%) | 0.122 | 0.441 (0.153–1.269) |
| **Involved organs** | | | | |
| Small bowel | 30 (45.5%) | 21 (28.4%) | **0.036** | 0.475 (0.236–0.958) |
| Large bowel | 7 (10.6%) | 2 (2.7%) | 0.084 | 0.234 (0.047–1.170) |
| Both | 29 (43.9%) | 51 (68.9%) | **0.003** | 2.829 (1.416–5.651) |
| **Type of management** | | | | |
| Medical treatment | 12 (18.2%) | 1 (1.4%) | **<0.001** | 0.062 (0.008–0.489) |
| Exploration | 11 (16.7%) | 28 (37.8%) | **0.005** | 3.043 (1.368–6.772) |
| Small bowel resection | 22 (33.3%) | 20 (27.0%) | 0.416 | 0.741 (0.359–1.529) |
| Large bowel resection | 6 (9.1%) | 2 (2.7%) | 0.148 | 0.278 (0.054–1.427) |
| Both | 12 (18.2%) | 22 (29.7%) | 0.112 | 1.904 (0.856–4.236) |
| Embolectomy | 3 (4.5%) | 1 (1.4%) | 0.343 | 0.288 (0.029–2.835) |
| **Second-look laparotomy** | 9 (13.6%) | 9 (12.2%) | 0.795 | 0.877 (0.326–2.360) |
| **Small bowel length < 100 cm** | 16 (31.4%) | 30 (50.0%) | **0.047** | 2.188 (1.004–4.764) |
| **Length of hospital stay (Days)** | 9 (1–67) | 4.5 (1–90) | 0.318 | 0.988 (0.966–1.011) |

OR – Odds Ratio, CI – Confidence Interval.

**Tab. VI.** Statistical analysis for all possible confounding factors effecting mortality (Including shock and acidosis as risk factors).

| VARIABLES | ODDS RATIO | 95% CONFIDENCE INTERVAL | WALD | P-VALUE |
|---|---|---|---|---|
| **Age (years)** | 1.098 | 1.029–1.172 | 8.060 | **0.005** |
| **Time of delay between the onset of acute abdominal pain and surgery** | | | | |
| < 12 hours | 1.000 | – | – | – |
| 12–24 hours | 8.019 | 0.660–97.485 | 2.269 | 0.102 |
| > 24 hours | 101.890 | 6.634–1564.789 | 11.007 | **<0.001** |
| (excluding shock and acidosis as risk factors) | | | | |
| **VARIABLES** | **ODDS RATIO** | **95% CONFIDENCE INTERVAL** | **WALD** | **P-VALUE** |
| **Age (years)** | 1.090 | 1.034–1.148 | 10.370 | **<0.001** |
| **Predisposing drug use** | 0.105 | 0.017–0.638 | 5.997 | **0.014** |
| **ASA** | 3.308 | 1.487–7.356 | 8.606 | **0.003** |
| **Time of delay between the onset of acute abdominal pain and surgery** | | | | |
| < 12 hours | 1.000 | – | – | **<0.001** |
| 12–24 hours | 7.933 | 0.746–84.399 | 2.947 | 0.086 |
| > 24 hours | 48.195 | 4.256–545.712 | 9.795 | **0.002** |
| **Resection involving large bowel** | 0.035 | 0.003–0.364 | 7.902 | **0.005** |

Multiple Logistic Regression (LR) analysis by Enter method after adjustment for all possible confounding factors. Forward LR elimination method was applied for discrimination between survivals and deaths. Any variable whose univariable test had a P value of <0.25 was accepted as a candidate for the multivariable model along with all variables of known clinical importance. Odds ratios and 95% confidence intervals for each independent variable were also calculated.

A P value of less than 0.05 ($P < 0.05$) was considered statistically significant.

## RESULTS

Out of 140 patients, 77 were men (55%) and 63 were women (45%). The mean age was 66.6 ± 14.5 (16–94) years. Demographical findings, comorbidities, ASA scores, administration of drugs for mesenteric ischemia and diagnostic imaging materials were summarized in Tab. I. As many as 109 (77.9%) patients had comorbid diseases. The most common comorbidities were cardiac problems (42.9%). A total of 27 (19.3%) patients had diabetes mellitus. The median ASA score was 3 (1–5). Abdominal computed tomography (CT) was the most commonly used imaging modality and it was performed in 119 (85%) patients. Twenty-five (17.9%) patients were in shock and 48 (34.3%) patients had acidosis. The time of delay between the onset of acute abdominal pain and surgery was <12 hours in 14 patients (10.0%), 12 to 24 hours in 46 patients (32.9%), and >24 hours in 80 patients (57.1%). The most common etiology in AMI was thrombus – in 69 patients (49.3%). The most commonly affected or involved organ was both the small and large bowel – in 80 patients (57.1%) in total. The most frequently performed surgery was small bowel resection – in 42 patients (30%). As many as 127 (90.7%) patients underwent surgery and 18 (12.9%) had a second-look laparotomy. Small bowel length of less than 100 cm was recorded in 46 patients (32.9%). The mean length of hospital stay was 7 days (1–90 days). The presence of morbidities was found in 51 patients (36.4%) and death in 74 patients (52.9%). Having at least one comorbid disease significantly influenced morbidity ($P = 0.031$). Also, the length of hospital stay was statistically related to the morbidity rate ($P = 0.018$) (Tab. II.). After Multiple LR analysis by Enter method following adjustment for all possible confounding factors affecting morbidity, the shock parameter was statistically significant, with a P value of 0.07. Exploration surgery was statistically significant, with a P value of 0.035. The length of hospital stay was statistically significant with a P value of <0.001 (Tab. III.). If the patients with shock and acidosis were excluded because of the loss of data with a rate of 30% for confounding factors, only the length of hospital stay was statistically significant, with a P value of 0.003 (Tab. III.). Age, cardiac comorbidities, ASA scores, the time of delay between the onset of acute abdominal pain and surgery, the presence of acidosis and shock, the involved organs (small bowel and both), type of surgery and medical treatment (Intravenous hydration and antibiotic therapy) and small bowel length of less than 100 cm were factors statistically significant for mortality (Tab. IV.). As far as medical treatment is concerned, we can suggested that early hydration and antibiotic therapy should be started and continued until the diagnosis is confirmed. After Multiple LR analysis by Enter method following adjustment for all possible confounding factors affecting mortality; age and the time of delay between the onset of acute abdominal pain and surgery >24 hours were statistically significant, with a P value of

**Tab. VII.** Multiple Logistic Regression (LR) analysis by Enter method after adjustment for all possible confounding factors effecting mortality (excluding Shock and Acidosis as risk factors).

| VARIABLES | ODDS RATIO | %95 CONFIDENCE INTERVAL | WALD | P-VALUE |
|---|---|---|---|---|
| **Age (years)** | 1.090 | 1.034–1.148 | 10.370 | **<0.001** |
| **Predisposing drug usage** | 0.105 | 0.017–0.638 | 5.997 | **0.014** |
| **ASA** | 3.308 | 1.487–7.356 | 8.606 | **0.003** |
| **Time of delay between onset of acute abdominal pain to surgery** | | | | |
| < 12 hours | 1.000 | – | – | **<0.001** |
| 12–24 hours | 7.933 | 0.746–84.399 | 2.947 | 0.086 |
| > 24 hours | 48.195 | 4.256–545.712 | 9.795 | **0.002** |
| **Resection involving large bowel** | 0.035 | 0.003–0.364 | 7.902 | **0.005** |

0.005 and <0.001, respectively (Tab. V.). If the patients with shock and acidosis were excluded because the loss of data with a rate of 30% for confounding factors, age, use of drugs, ASA scores, time of delay between the onset of acute abdominal pain and surgery >24 hours, and surgery type involving large bowel resection were statistically significant (Tab. V.). (Cardiac comorbidities are not included in Tab. VI. and VII. because of only using acidosis and shock as a parameter).

## DISCUSSION

AMI is a catastrophic disease that if not treated promptly, leads to a high mortality rate – of 50–69% [5, 4, 10, 3]. Without any treatment, or if laparotomy alone is performed, the mortality is almost 100% [2]. Early diagnosis is critical for protecting the blood supply of bowels and for preventing ischemia [2, 9]. AMI is often perceived as an uncommon emergency and its estimated incidence is 1/1000 hospital admissions, thus it is not given priority in the differential diagnosis of acute abdominal pain [1, 10]. AMI can result from emboli, arterial or venous thrombus, or non-occlusive ischemia (NOMI) secondary to low-flow states [11, 9]. Early diagnosis generally depends on clinical awareness and suspicion [10]. Nevertheless, its high mortality rate because of the aggressive nature of the disease, the need to be aware of all causes, clinical presentations and treatment of AMI before infarction occurs can dramatically impact the survival [1]. Resuscitation should be started as soon as possible while the diagnosis is suspicious [12]. Various laboratory tests have been suggested as early diagnostic parameters for AMI with a limited predictive value [2, 10, 13]. Serum lactate and D-dimer levels are the most useful markers in case of intestinal ischemia. In ESTES Guidelines, it is recommended that a normal serum lactate level does not exclude acute mesenteric ischemia and could not be used for diagnosis. It can be used just as a marker of disease progression [3, 14]. Intestinal fatty acid binding protein (I-FABP) and D-dimer are the most useful markers and I-FABP shows more specificity than D-dimer because of its tissue specificity [14]. However, as long as it shows promising results, the clinical application of I-FABP is not practiced [15]. After a mesenteric vascular occlusion, it has also been shown that acidosis occurs but it has low specificity [2]. Radiological changes are not specific until infarction has occurred and the most predictive sign is gas in the portal vein at computed tomography [10]. In our study, age has a statistically significant effect on mortality. A history of cardiac disease was found to be a statistically significant risk factor of mortality [2, 12], as in our study. The presence of shock during the initial evaluation was strongly related to mortality [2]. In our study, shock has also a statistically significant effect on mortality. Acidosis was statistically related to mortality in some studies, as our study. But it is tested by means of arterial blood samples and in the early stage of the disease, which is generally not performed; only in serious cases [4]. The use of angiography and its potential advantages are still debatable. It allows for identification and treatment of some possible causes of AMI [4, 10]. However, some difficulties in performing angiography in critically ill patients may delay surgery. The most serious potential drawback is critical delay in correction of vascular insufficiency due to angiography [11]. If laparotomy can be performed before irreversible ischemia occurs, embolectomy has a great impact on surgical results [10]. Colonic involvement with ischemia and colonic plus small intestinal involvement were negative prognostic factors of mortality [4]. In our study, colonic involvement had a statistically significant effect on mortality. Intestinal resection had a protective effect compared with medical treatment and laparotomy alone; the length of hospitalization had a significant effect on morbidity. Time of delay between the onset of acute abdominal pain and surgery longer than 24 hours had a significant effect on mortality. After excluding shock and acidosis as confounding factors due to the loss of 30% of data, age, use of predisposing drugs and ASA scores were found to have a significant effect on mortality. Short bowel syndrome is directly related to the length of the remaining small bowel [5]. Oral feeding should be delayed and total parenteral nutrition (TPN) must be started in managing patients with short bowel syndrome and continued until bowel adaptation begins [12]. In our study, 46 patients (32.9%) had small bowel length of less than 100 cm, which had a statistically significant effect on mortality. A second-look laparotomy is generally performed 12 to 24 hours after the first operation to evaluate the blood flow in bowels for an additional loss of flow [13]. Anticoagulative treatment should be initiated after surgery except for contraindications but no studies answer the question of how long it should be maintained [11, 5]. In our study, age and time of delay between the onset of acute abdominal pain and surgery longer than 24 hours were the most important parameters that predicted the mortality in patients presenting with shock and acidosis, so clinical awareness and suspicion for early diagnosis are of critical importance.

## CONCLUSION

The purpose of this study was to study the prognostic factors of AMI to better understand it in order to optimize both medical and surgical management and improve treatment results. Early diagnosis is of critical importance for protecting the blood supply of bowels and preventing ischemia. We suggested that the diagnosis of AMI is based on clinician's suspicion and that laparotomy is performed as soon as possible, before the clinical signs of peritonitis. Age, cardiac comorbidities, ASA scores, delay between the onset of acute abdominal pain and surgery, presence of acidosis and shock, involved organs (small bowel and both bowels), type of surgery and medical treatment, as well as small bowel length of less than 100 cm had a statistically significant impact on mortality. If laparotomy can be performed before irreversible ischemia occurs, embolectomy has a great impact on surgical results. The goal of surgery is to preserve bowel, if possible, and to perform intraoperative assessment of viability accurately.

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