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Choice of First Emergency Room Affects the Fate of Patients With Acute Mesenteric Ischaemia: The Importance of Referral Patterns and Triage

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WHAT THIS PAPER ADDS

Although delay is a key modifiable factor in the treatment of acute mesenteric ischaemia (AMI), few studies have sought modifiable targets to reduce this parameter. This study found that the key factor is the type of emergency room (ER) the patient first encounters. If this ER was non-surgical, the time to surgical operation was approximately 15 h and mortality 75%, compared with 10 h and 50% mortality if the first ER was surgical. This study illustrates that patient pathway is a potential target for improvement in the treatment of AMI and the whole pathway needs to be involved and educated.

Objectives: Despite modern advances in diagnosis and treatment, acute arterial mesenteric ischaemia (AMI) remains a high mortality disease. One of the key modifiable factors in AMI is the first door to operation time, but the factors attributing to this parameter are largely unknown. The aim of this study was to evaluate the factors affecting delay, with special focus on the pathways to treatment.
Methods: This was a single academic centre retrospective study. Patients undergoing intervention for AMI caused by thrombosis or embolism of the superior mesenteric artery between 2006 and 2015 were identified from electronic patient records. Patients not eligible for intervention or with chronic, subacute onset, colonic only, venous, or non-occlusive mesenteric ischaemia were excluded. Patients were divided into two groups according to the first speciality examining the patient (surgical emergency room [SER], surgeon examining the patient first or non-surgical emergency room [non-SER], internist examining the patient first). The primary endpoint was first door to operation time and secondary endpoints were length of stay and 90 day mortality.
Results: Eighty-one patients with AMI were included. Fifty patients (62%) died during the first 30 days and 53 (65%) within 90 days. Presenting first in non-SER (vs. SER) was independently associated with a first door to operation time of over 12 h (OR 3.7 [95% CI 1.3—10.2], median time 15.2 h [IQR 10.9—21.2] vs. 10.1 h [IQR 6.9—18.5], respectively, $p = .025$). The length of stay was shorter (median 6.5 days [4.0—10.3] vs. 10.8 days [7.0—22.3], $p = .045$) and 90 day mortality was lower in the SER group (50.0% vs. 74.5%, $p = .025$).
Conclusions: The first specialty that the patient encounters seems to be crucial for both delayed management and early survival of AMI. Developing fast/direct pathways to a unit with both gastrointestinal and vascular surgeons offers the possibility of improving the outcome of AMI.

Keywords: Delay, Embolus, Emergency, Revascularisation, Thrombosis
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INTRODUCTION

Acute mesenteric ischaemia (AMI) is a relatively uncommon abdominal emergency, accounting for about 1:1000 of acute hospital admissions in Europe and the USA, yet incidence increases dramatically with age.[1—4] AMI has historically been a disease in which diagnosis is difficult, if not impossible, treatment nearly futile, and mortality very high.[5—7] Patients present with a wide variety of symptoms and only about 1% of acute abdomen cases are caused by AMI, which makes it difficult to transfer all patients immediately to the appropriate unit.[4] Computed tomography (CT) is today widely available in emergency rooms (ER), facilitating identification of anatomy consistent with a diagnosis of

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AMI.[8] Treatment of AMI has evolved from mere removal of necrotic material to revascularisation of the remaining bowel.[4,9] Minimally invasive revascularisation methods have emerged from technological development of endovascular treatment options.[4,5,10] Introduction of intestinal "stroke" units with multimodal treatment options have improved both bowel and life outcomes.[11,12] Despite better results in selected revascularisation series, the total AMI mortality has remained very high, usually cited at 42–69%.[4] In addition to the fact that AMI itself is highly deadly, patients presenting with AMI are usually elderly with several comorbidities.[4]

Much of the effort in the development of treatment strategies for AMI has recently focused on new endovascular treatments. Delays and pathways to treatment have gained much less attention, even though long delays are known to be a major contributory factor for outcome. Patients are often referred to a vascular centre too late, at the time of irreversible ischaemia. Potential reasons for long delays are a low index of suspicion, difficulties in diagnosis, and operation room logistics.[13,14] The sensitivity of CT to identify occlusion of the superior mesenteric artery (SMA) in the initial radiologist's report varies between 66% and 86%, and is significantly improved if suspicion of AMI is raised in the referral.[15]

Although delayed management is a key modifiable factor in the treatment of AMI, few studies have sought addressable targets to reduce it. The aim of this study was to analyse the various time delays in the treatment of AMI and to seek out the factors related to this process. Identifying the key steps in the care pathway may lead to shorter delays and ultimately better patient outcomes. Specifically, the role of the first ER where the patient presented was examined.

MATERIALS AND METHODS

This retrospective cohort study was performed in an academic teaching hospital (Helsinki University Hospital) that functions as a secondary and tertiary referral centre covering a population of approximately 1.5 million. Helsinki University Hospital is the only hospital within the area that treats vascular emergencies, and thus all patients with AMI within the catchment area are instructed to be referred there. Open, endovascular, and hybrid revascularisation options are available at all times. Patients who were treated for AMI in Helsinki University Hospital in 2006–2015 were identified from electronic patient records by conducting a search for the International Classification of Diseases 10 (ICD-10) code K55 (Vascular disorders of intestine) or Nomesco Classification of Surgical Procedures (NCSP) codes for procedures on mesenteric vessels (PCE17, PCF16, PCF17, PCHXX, PCJ17, PCN16, PCN17, PCP16, PCP17, PCQ16, PCQ17, PCQ99). An approval to conduct the study was obtained from the institutional review board.

Definitions

Patients were classified based on the ER type and specialty they were first presented. Generally, in Nordic countries, there are two types of ER – surgical ERs have surgeons (or surgical residents) in the ER seeing the patient first. Non-surgical ERs have internists (or more recently emergency medicine doctors) seeing the patient first, but may consult a surgeon if deemed necessary.

In this study, surgical emergency room (SER) was defined as any ER (secondary or tertiary) where the patient was seen first by a surgeon (or surgical resident). Non-surgical emergency room (non-SER) was defined as an ER where the patient was seen first by a primary care doctor, internal medicine doctor, or an emergency medicine physician. The training and experience of the staff in SER and non-SER are similar (both residents and attendings of respective specialities). SER and non-SER are located in the same premises in some of the hospitals, whereas in others they are located in different buildings.

In most hospitals, both primary care ER and secondary care ER (internal medicine or surgical ER, or both) work at the same premises, and an appointed triage nurse (by consulting an on call physician if deemed necessary) decides to which specialty and level of care the patient is referred first. If the patient presented to an ER with both surgical and internal medicine ER, the specialty to which the patient was referred first determined whether the patient was classified into the SER group or non-SER group. The hospital to which the patient is initially transported is decided by the paramedics (by consulting an on call pre-hospital emergency physician if deemed necessary). Patients with acute abdomen are instructed to be referred to a SER. Vascular centre refers to Helsinki University Hospital, which is where all the patients of this study were finally referred.

Timestamps of first ER presentation, CT scan, CT report, and arrival at vascular centre were extracted from electronic patient records. Time of diagnosis was the first time hospital notes mentioned AMI as the working diagnosis. Date of death was obtained from electronic patient records, which automatically updates the information from the Population Register Centre, enabling recording of mortality for all patients.

The Charlson comorbidity index (CCI) was used to assess comorbidity of patients.[16] Quick Sepsis Related Organ Failure Assessment (qSOFA) was used to evaluate organ dysfunction at the time of arrival at the vascular centre.[17]

Patients

Patient records were analysed and data regarding patient characteristics, hospital stay, treatment, and outcome were extracted manually. Patients with no AMI (incorrect diagnosis code), no timestamp available, non-occlusive or venous ischaemia, bowel ischaemia caused by strangulation, trauma, or isolated coeliac trunk stenosis as well as ischaemia isolated to the colon were excluded. Because the study aim was to analyse delays in the treatment of AMI, patients whose symptoms started in the hospital during treatment of another disease, who were not eligible for interventional treatment because of comorbidity or advanced age, who had a diagnosed chronic mesenteric ischaemia as well as patients with subacute onset of mesenteric ischaemia (defined as delay more than 48 h from symptom onset to vascular centre) were excluded, in an effort to limit the study group to patients with an acute disease.

Statistics

All statistical analyses were done using IBM SPSS Statistics version 23 (IBM Corp, Armonk, NY, USA). Mann—Whitney *U* or chi-square tests were used in univariable analyses. Multivariable analysis was performed using logistic regression. Variables with $p < .2$ in univariable analysis were selected for multivariable analysis, except for variables which could be expected to cause multicollinearity. The primary endpoint was first door to operation time, which was defined as the time from arrival at first ER to the onset of surgery. A two tailed p value $< .05$ was considered to be statistically significant.

RESULTS

Patient characteristics and symptoms

A total of 474 patients were identified based on the initial diagnosis and procedure code search. After applying the exclusion criteria, 81 patients remained for final analysis (Fig. 1). The basic characteristics of the included patients are shown in Table 1. Briefly, the patients were elderly (median age 78 years) with an equal sex distribution. The majority (n = 71, 88%) had some form of cardiovascular disease and approximately every third patient (n = 29, 36%) had diabetes. More than half of the patients (n = 46, 57%) had atrial fibrillation. Two thirds of all patients were independent, and 13 (16%) were residents of a nursing home or an assisted living facility. Abdominal pain was the most common symptom (n = 79, 98%), followed by vomiting/nausea (n = 48, 59%) (Table 2). CT was performed on 18 (22%) patients in the first ER, and 14 (17%) of the CTs were performed with intravenous contrast. CT was performed on 53 (65%) patients at the tertiary vascular centre, and overall 69 (85%) patients underwent CT before intervention. The most common first working diagnosis was unspecified acute abdomen (n = 28, 35%) (Table 2). On presentation at the vascular centre, abdominal guarding was present in 35 (43%) patients (Table 2). The diagnosis of AMI was made during laparotomy in 10 (12%) patients (Table 2).

Factors related to the delay

Factors associated with the delay were analysed in univariable analysis (Table S1). The first door to operation time was significantly shorter if the first medical centre was a surgical ER (10.1 h vs. 15.2 h, p = .025), if AMI was correctly diagnosed in the first medical centre (median 9.3 h vs. 13.9 h, p = .006), or if SMA occlusion was correctly identified in the CT (11.7 h vs. 18.0 h, p = .005) (Table S1).

In multivariable analysis, the first medical centre being SER was independently associated with a shorter first door to operation delay (Table 3).

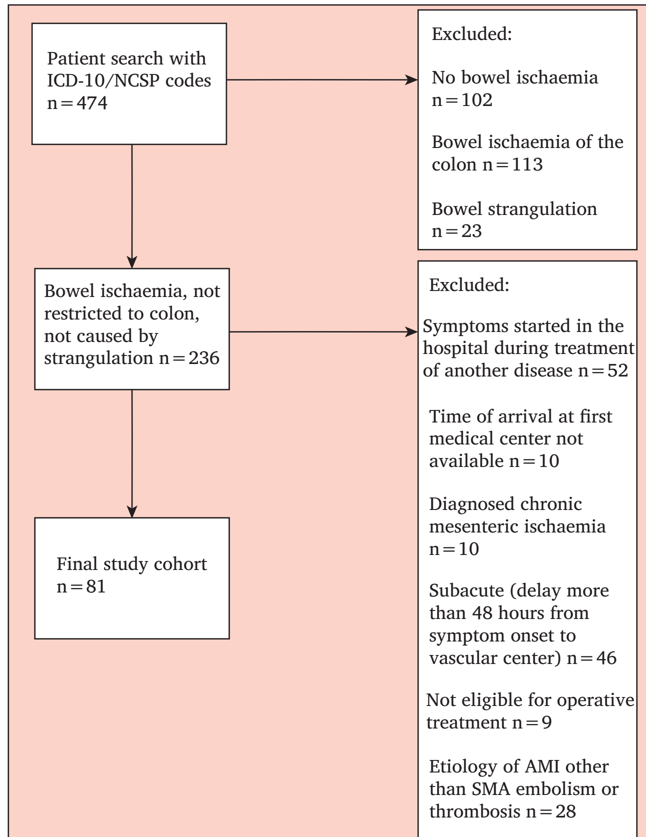

Figure 1. Flow chart of patient selection. AMI = acute mesenteric ischaemia; ICD = International Classification of Diseases; NCSP = Nordic Classification of Surgical Procedures; SMA = superior mesenteric artery.

Pathway to treatment

As the first ER was the strongest predictor of delay, pathways to treatment were examined in more detail. Of 81 patients, 51 presented first to non-SER, 14 to SER without vascular on call, and 16 to SER with vascular on call (vascular centre). Of the 51 patients presenting first to non-SER, 8 (16%) were referred to SER without vascular on call, while 43 (84%) patients were referred to SER with vascular on call. Basic patient characteristics were similar regardless of whether patients presented to SER or non-SER initially (Table 1). There were no differences regarding aetiology (embolism vs. thrombosis), specific symptoms, or duration of symptoms between patients arriving first at SER or non-SER (Table 2). CT was more often obtained in the first ER if the patient presented first to SER and the first working diagnosis was more often mesenteric ischaemia in SER (Table 2). The most common incorrect diagnoses in the SER group were ruptured abdominal aneurysm (n = 6, 20%) and unspecified acute abdomen (n = 3, 10%). In the non-SER group, the most common incorrect diagnoses were non-

Table 1. Basic demographics based on first emergency room (surgical or non-surgical) of presentation

	All $n = 81$ n (%)	Surgical emergency room (ER) $n = 30$ n (%)	Non-surgical ER $n = 51$ n (%)	p value
Age, median (interquartile range, IQR) in years	78.0 (69.0–85.0)	81.0 (65.3–84.0)	77.0 (70.0–85.0)	.51
Sex, female	39 (48.1%)	15 (50.0%)	24 (47.1%)	.80
Comorbidities				
Hypertension	50 (61.7%)	16 (53.5%)	34 (66.7%)	.23
Atrial fibrillation	46 (56.8%)	16 (53.5%)	30 (58.8%)	.63
Atherosclerosis	27 (33.3%)	9 (30.0%)	18 (35.3%)	.63
Coronary artery disease	33 (40.7%)	12 (40.0%)	21 (41.2%)	.92
Cerebrovascular disease (stroke/transient ischaemic attach [TIA])	15 (18.5%)	4 (13.3%)	11 (21.5%)	.63
History of thromboembolism	5 (6.2%)	2 (6.7%)	3 (5.9%)	.89
Diabetes				.86
with complications	4 (4.9%)	1 (3.3%)	3 (5.9%)	
without complications	25 (30.9%)	9 (30.0%)	16 (31.4%)	
No cardiovascular diseases	10 (12.3%)	2 (6.7%)	8 (15.7%)	.23
Charlson comorbidity index				1.00
0	1 (1.2%)	0 (0%)	1 (2.0%)	
1–2	19 (23.5%)	7 (23.4%)	12 (23.6%)	
3–4	25 (30.8%)	10 (33.4%)	15 (29.4%)	
> 4	36 (44.4%)	13 (43.3%)	23 (45.1%)	
American Society of Anaesthesiologists (ASA) physical status classification				.60
I–II	1 (1.2%)	0 (0%)	1 (2.0%)	
III–IV	49 (60.5%)	17 (56.7%)	32 (62.8%)	
V	27 (33.3%)	11 (36.7%)	16 (31.4%)	
Medication				
Anticoagulant[a]	20 (24.7%)	5 (16.7%)	15 (29.4%)	.15
Antiplatelet[b]	43 (53.1%)	18 (60.0%)	25 (49.0%)	.43
Statin	33 (40.7%)	11 (36.7%)	22 (43.1%)	.60
Functional status				.63
Independent	57 (70.4%)	21 (70.0%)	36 (70.6%)	
Partially dependent	11 (13.6%)	3 (10.0%)	8 (15.7%)	
Resident of a nursing home or an assisted living facility	13 (16.0%)	6 (20.0%)	7 (13.7%)	

ASA = American Society of Anaesthesiologists physical status classification; ER = emergency room; IQR = interquartile range; TIA = transient ischaemic attack.
[a] Warfarin, direct oral anticoagulant, low molecular weight heparin.
[b] Acetylsalicylic acid, dipyridamole, or clopidogrel.

specific acute abdomen ($n = 25$, 49%) and gastroenteritis ($n = 4$, 8%) (Table 2). In patients with known atherosclerosis ($n = 27$), AMI was correctly suspected in nine (33%) patients. In patients with known atrial fibrillation ($n = 46$), AMI was correctly suspected in 13 (28%) patients (Table 2).

On arrival at the vascular centre, guarding and qSOFA scores were similar regardless of whether patients first presented to SER or non-SER (Table 2).

Details of the various time delays

The various time delays were compared in more detail between patients presenting first at SER vs. non-SER. Door to CT, door to diagnosis, and door to operation times were all shorter in the SER group compared with the non-SER group (Table 2).

Primary operative treatment

Of the 81 patients, four (5%) underwent endovascular therapy only. Of those undergoing laparotomy ($n = 77$), extensive and unsalvageable bowel necrosis was found in 14 (18%) patients, and because of poor prognosis these patients underwent laparotomy only. Of the remaining patients, 20 (26%) underwent bowel resection only, 15 (19%) underwent revascularisation without bowel resection, and 28 (36%) underwent revascularisation followed by bowel resection (Table 4). The abdominal cavity was left open in nine (12%) patients with plans to undergo a second look laparotomy. Consultation with a vascular surgeon was mentioned in 13 of the 20 patient records (65%) who underwent bowel resection only.

There were no significant differences in the choice of operative treatment between the SER and non-SER groups, including the number of futile laparotomies (Table 4).

Outcomes

Median follow up time was 1.3 weeks (IQR 0.2–59.4), because of the high mortality. Fifty patients (62%) died during the first 30 days and 53 (65%) during the first 90 days. Although there were no significant differences in the

Table 2. Symptoms, imaging, clinical presentation and delays based on first emergency room (surgical or non-surgical) of presentation

	All $n = 81$ n (%)	Surgical emergency room (ER) $n = 30$ n (%)	Non-surgical ER $n = 51$ n (%)	p value
Symptoms				
Abdominal pain	79 (97.5%)	30 (100.0%)	49 (96.1%)	.27
Diarrhoea	36 (44.4%)	13 (43.4%)	23 (45.1%)	.88
Haematochezia	15 (18.5%)	5 (16.7%)	10 (19.6%)	.74
Vomiting/nausea	48 (59.3%)	16 (53.3%)	32 (62.7%)	.41
Duration > 24 h	19 (23.5%)	9 (30.0%)	10 (19.6%)	.44
Imaging (in first ER)				
None	37 (45.7%)	3 (10.0%)	34 (66.7%)	<.001
Abdominal plain X-ray	14 (17.3%)	3 (10.0%)	11 (21.6%)	.18
Computed tomography (any)	18 (22.2%)	13 (43.3%)	5 (9.8%)	.001
with intravenous contrast material	14 (17.3%)	10 (33.3%)	4 (7.8%)	<.001
without intravenous contrast material	4 (4.9%)	3 (10.0%)	1 (2.0%)	.11
First working diagnosis				<.001
Acute mesenteric ischaemia (AMI)	23 (28.4%)	15 (50.0%)	8 (15.7%)	
Acute abdomen, not specified	28 (34.6%)	3 (10.0%)	25 (49.0%)	
Intra-abdominal infection	5 (6.2%)	2 (6.7%)	3 (5.9%)	
Ileus	4 (4.9%)	1 (3.3%)	3 (5.9%)	
Gastrointestinal bleeding	3 (3.7%)	0 (0%)	3 (5.9%)	
Gastroenteritis/colitis	5 (6.2%)	1 (3.3%)	4 (7.9%)	
Ruptured aortic aneurysm	6 (7.4%)	6 (20.0%)	0 (0%)	
Acute coronary syndrome	2 (2.5%)	1 (3.3%)	1 (2.0%)	
Decreased general condition	2 (2.5%)	0 (0%)	2 (3.9%)	
Other[a]	3 (3.7%)	1 (3.3%)	2 (3.9%)	
Correct working diagnosis in patients with atherosclerosis, $n = 27$	9 (33.3%)	6 (66.7%), $n = 9$	3 (16.7%), $n = 18$	.05
Correct working diagnosis in patients with atrial fibrillation, $n = 46$	13 (28.3%)	7 (43.8%), $n = 16$	6 (20.0%), $n = 30$	.17
Clinical presentation at vascular centre				
Guarding	35 (43.2%)	9 (30.0%)	26 (51.0%)	.07
Quick sepsis related organ failure assessment (qSOFA)				.49
0	28 (34.6%)	12 (40.0%)	16 (31.4%)	
1	37 (45.7%)	14 (46.7%)	23 (45.1%)	
2	13 (16.0%)	4 (13.3%)	9 (17.6%)	
3	3 (3.7%)	0 (0%)	3 (5.9%)	
C reactive protein (CRP), mg/L (median, interquartile range, IQR)	73 (18–193)	93 (11–195)	71 (18–163)	.83
Creatinine, μmol/L (median, IQR)	103 (65–137)	95 (66–153)	105 (64–135)	1.00
Lactate, mmol/L (median, IQR)	2.9 (1.9–5.2)	2.5 (1.8–4.5)	3.1 (1.9–7.5)	.22
Imaging at vascular centre				
Computed tomography (CT) (any)	53 (65.4%)	17 (56.7%)	36 (70.6%)	.20
with intravenous contrast material	32 (39.5%)	5 (16.7%)	20 (39.2%)	.94
without intravenous contrast material	21 (25.9%)	12 (14.8%)	16 (31.4%)	.15
Mesenteric ischaemia diagnosis made at laparotomy	10 (12.3%)	3 (10.0%)	7 (13.7%)	.62
Aetiology				.20
Embolism	41 (50.6%)	18 (60.0%)	23 (45.1%)	
Thrombosis	40 (49.4%)	12 (40.0%)	28 (54.9%)	
Time, median (IQR) in hours				
Door to CT ($n = 79$)	5.5 (2.7–10.6)	2.7 (1.8–4.9)	8.4 (4.3–12.1)	<.001
Door to surgical ER ($n = 51$)	n/a	n/a	3.5 (2.4–7.1)	n/a
Door to diagnosis ($n = 77$)	6.5 (2.8–12.9)	3.1 (0.8–6.8)	10.0 (5.1–15.9)	<.001
CT to operation ($n = 79$)	5.5 (3.4–9.0)	6.0 (3.6–16.5)	5.3 (3.4–8.8)	.28
Door to operation ($n = 81$)	12.6 (9.2–19.7)	10.1 (6.9–18.5)	15.2 (10.9–21.2)	.03

AMI = acute mesenteric ischaemia; CRP = C reactive protein; CT = computed tomography; ER = emergency room; IQR = interquartile range; qSOFA = quick sepsis related organ failure assessment.

[a] Intra-abdominal infection, perforation.

Table 3. Multivariable analysis on parameters affecting first door to operation time and 90 day mortality

	First door to operation time >12 h OR (95% CI)	90 day mortality OR (95% CI)
First emergency room (ER)		
Surgical	Reference	Reference
Non-surgical	3.7 (1.3–10.2)	3.2 (1.03–9.6)
No antiplatelet medication at presentation		4.8 (1.45–15.9)
Dependent		6.9 (1.63–29.1)
Quick sepsis related organ failure assessment (qSOFA) > 0 on arrival at vascular centre		4.7 (1.5–14.3)

ER = emergency room; qSOFA = quick sepsis related organ failure assessment; OR = odds ratio; CI = confidence interval.

rate of intensive care unit (ICU) admission or ICU stay, shorter hospital stay (median 6.5 days [4.0–10.3] vs. 10.8 days [7.0–22.3], $p = .045$), as well as lower 90 day mortality (50% vs. 75%) were noted in the SER group compared with the non-SER group (Table 4). Factors associated with 90 day mortality in univariable and multivariable analyses were non-SER as the first ER (OR 3.2), no antiplatelet medication on presentation (OR 4.8), patient dependency (OR 6.9), and qSOFA > 0 on arrival to the vascular centre (OR 4.7) (Table S2).

DISCUSSION

In this study, the most important prognostic factor for the patients with AMI was the type of ER at which the patients were examined first. Patients examined first at a surgical ER had shorter first door to operation times (10 vs. 15 h), shorter hospital stays (7 vs. 11 days), and lower 90 day mortality rate (50% vs. 75%) compared with those examined first at a non-surgical ER. Although selected in retrospect the two groups were similar with regard to medical history, clinical presentation, final diagnosis (embolism vs. thrombosis), and selected treatment, suggesting that there is an element of chance that has an effect on the choice of the initial ER and outcome. Triage nurses and paramedics should be educated in an attempt to minimise incorrect referrals.

Various studies have stressed the need for more efficient diagnostic tests and shorter delays in the treatment of AMI.[3,13,18] Previous studies have shown that clinical suspicion and CT imaging are crucial components of delay.[13–15] The study by Lehtimäki et al. also found that radiological detection of AMI on CT is improved if the clinician suspects the diagnosis.[15] The present study found both clinical

Table 4. Primary intervention and outcomes, based on whether or not first emergency room was surgical

	All $n = 81$ n (%)	Surgical emergency room (ER) $n = 30$ n (%)	Non-surgical ER $n = 51$ n (%)	p value
Primary intervention				
Endovascular treatment only	4 (4.9%)	2 (6.7%)	2 (3.9%)	.58
Laparotomy, exploration only	14 (17.3%)	3 (10.0%)	11 (21.6%)	.18
Laparotomy, bowel resection only	20 (24.7%)	4 (13.3%)	16 (31.4%)	.07
Laparotomy, vascular procedure only	15 (18.5%)	7 (23.3%)	8 (15.7%)	.39
Embolectomy	13 (16.0%)	5 (16.7%)	8 (15.7%)	
Bypass grafting	2 (2.5%)	2 (6.7%)	0 (0%)	
Endarterectomy	0 (0%)	0 (0%)	0 (0%)	
Endovascular therapy	0 (0%)	0 (0%)	0 (0%)	
Laparotomy, bowel resection and vascular procedure	28 (34.6%)	14 (46.7%)	14 (27.5%)	.08
Embolectomy	14 (17.3%)	6 (20.0%)	8 (15.7%)	
Bypass grafting	10 (12.3%)	4 (13.3%)	6 (11.8%)	
Endarterectomy	1 (1.2%)	1 (3.3%)	0 (0%)	
Endovascular therapy[a]	3 (3.7%)	3 (10.0%)	0 (0%)	
Irreversible bowel ischaemia	62 (76.5%)	21 (70.0%)	41 (80.4%)	.29
Open abdomen	9 (11.1%)	6 (20.0%)	3 (5.9%)	.15
Intensive care unit (ICU) admission	29 (35.8%)	10 (33.3%)	19 (37.3%)	.72
ICU free time[b], median (interquartile range, IQR), in days	5 (1–24)	12 (1–26)	4 (0–24)	.19
Length of ICU stay within 28 days, median (IQR), in days	5.0 (2.8–7.3)	5.0 (3.8–6.3)	4.0 (2.0–8.0)	.36
Length of hospital stay, median (IQR), in days	8.8 (5.9–15.5)	6.5 (4.0–10.3)	10.8 (7.0–22.3)	.05
30 day mortality	50 (61.7%)	15 (50.0%)	35 (68.6%)	.10
90 day mortality	53 (65.4%)	15 (50.0%)	38 (74.5%)	.02

ICU = intensive care unit; IQR = interquartile range; ER = emergency room.
[a] Endovascular therapy was performed via groin puncture prior to laparotomy.
[b] Time period in which patient was not in ICU and alive within 28 days from intervention.

suspicion and CT imaging to be related to the status of the first medical centre. It is widely recommended that patients with a suspicion of AMI should be imaged with prompt CT angiography.[3,4,19] However, the present material was too small to detect a difference between contrast and non-contrast enhanced CT.

The present mortality rates (51% in the SER group and 72% in the non-SER group) did not differ significantly from previously published mortality figures of 42–69%.[10,20–23] Lower rates of mortality for AMI have been presented[24] but the mortality figures are significantly influenced by a selection bias, when only revascularised patients are reported. To focus specifically on AMI and avoid cases with subacute onset, patients with a prolonged referral (more than 48 h) and in hospital initiated symptoms were excluded, a decision that led to a smaller, but more homogenous patient group with acute and severe AMI. Also the present material includes specifically only arterial AMI, whereas patients with venous mesenteric ischaemia were excluded as they have a more favourable prognosis and different delay pattern.[25–28]

Some studies have shown increasing mortality with increasing first door to operation time,[14,29,30] although this was not detected in the present study. This could be a result of the heterogeneity of the patient sample despite efforts to homogenise the cohort. Another reason could be that patients with more serious symptoms travel through the system faster. These patients usually have more severe disease and, hence, higher mortality. Patients with less severe disease often have less serious symptoms, thus it may take more time to proceed to operation. These patients might be able to tolerate longer delays, possibly because of the extent and anatomy of the obstruction (partial vs. total, proximal vs. more distal), among others. This disparity of patients could offer a possible explanation for the lack of correlation between delay and outcome. A report from Sweden did not find any correlation between survival and delay from onset of symptoms to operation.[10] In the present study, efforts were made to further subgroup occlusions with regards to number of side branches prior to the occlusion, length of occlusion, etc., but the number of contrast enhanced CTs remained too small to draw any conclusions. To achieve fast track diagnosis and revascularisation, these patients must be identified from a large cohort with more or less non-specific symptoms. A high level of suspicion and a low threshold for contrast enhanced CT imaging should be practiced.[19] The fear of acute kidney injury should not prevent proper diagnostics for this deadly disease, especially as the nephrotoxicity of contrast media has been questioned.[31] Once the diagnosis is suspected and confirmed, immediate treatment should be undertaken. The vascular surgeons choose the method of revascularisation and should be capable of performing all forms of interventions either by themselves or together with endovascular operators. There is a suggestion in the literature that endovascular treatment should be favoured, but all comparative studies suffer from selection bias.[4,32] Therefore, the level of evidence is low, and the choice of treatment must ultimately be made on an individual basis.

Antiplatelet medication at presentation and patients with a good functional status had a better outcome, whereas qSOFA >0 was associated with a higher mortality (Table 4). Because this is a retrospective analysis, it is not possible to show clear causation, but it is hypothesised that antiplatelet medication might inhibit progression of the thrombotic cascade and thus limit the severity of the event.

A good functional status predicted a better outcome, which could be because of less comorbidity and hence lower risks of organ failure. It might also be that more aggressive treatment was pursued in this patient group.

qSOFA is used as a bedside estimate to identify patients with suspected infection who would benefit from ICU treatment. It consists of an evaluation of Glasgow Coma Scale, respiratory rate, and systolic blood pressure. Deterioration of these values can, in addition to infection, be a sign of more extensive disturbance of vital functions and bowel ischaemia, which would explain why a higher qSOFA was associated with higher mortality.

This study has several limitations. As a retrospective study there is an inherent risk of information bias and misclassifications. By identifying and excluding clearly different patient groups (Fig. 1), attempts were made to make the material more homogenous and to focus on acute and severe AMI. Despite this, the pattern of the disease remains variable and limits the conclusions that can be drawn from the material. Focusing on arterial AMI made the study groups smaller and posed challenges to the statistical analysis. On the other hand, the strength of this study is the population based study design, which diminishes selection bias.

To improve the outcomes of AMI, the first door to operation times need to be shortened. One of the main findings of the present study was that these patients fare better if they present directly to units with surgical expertise. The awareness of paramedical units and ER personnel performing triage should be improved. The referral patterns need to be improved and all suspected AMI patients should find their way without delay to a unit performing revascularisations, either dedicated intestinal “stroke” centres or, as in the present situation, centralised on call units with possibilities for multidisciplinary treatment at all times.[11,12] The present results highlight that these units should also take a role in education and design of the whole treatment chain starting from first responders. Future studies should try to identify simple clinical combinations of symptoms that could guide the triage and improve the outcome of AMI patients.

CONCLUSIONS

The first specialty that the patient encounters seems to be crucial for both delayed management and early survival of AMI. Developing fast/direct pathways to a unit with both gastrointestinal and vascular surgeons offers the possibility of improving the outcome of AMI.

CONFLICT OF INTEREST

None.

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APPENDIX A. SUPPLEMENTARY DATA

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