

Retrospective Study

Impact of surgical delay on outcomes in elderly patients undergoing emergency surgery: A single center experience

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Abstract

AIM: To determine predisposing factors leading to surgical delay in elderly patients with acute abdominal conditions and its impact on surgical outcomes.

METHODS: A retrospective review of a total of 144 patients aged 60 years and older who had undergone emergency abdominal surgery between 2010 and 2013 at a regional general hospital was analysed. The operations analysed were limited to perforated or gangrenous viscus and strangulated hernia. Patient demographic features, time taken to obtain a computed tomography scan, time taken to surgery and the impact on postoperative morbidity and mortality were analysed.

RESULTS: The mean age was 70.5 ± 9.1 years and median time taken to surgery was 9 h. The overall mortality and complication rates (Clavien Dindo 3 and above) were 9% and 13.1% respectively. Diabetes mellitus was a significant predisposing factor which had an impact on surgical delays. Delays in surgery more than 24 h led to higher complication rates at 38.9% ($P = 0.003$), with multivariate analysis confirming it as an independent factor. Delays in obtaining a computed tomography (CT) scan was also shown to result in higher complication rates (Clavien Dindo 3 and above).

CONCLUSION: Delays in performing emergency surgery in elderly lead to higher complication rates. Obtaining CT scans early also may facilitate prompt diagnosis of certain abdominal emergencies where presentation is more equivocal and this may lead to improved surgical outcomes.

Key words: Outcomes; Delay; Emergency; Surgery; Elderly

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Core tip: Emergency surgery in elderly is regarded as a subject matter with growing interest as many countries are faced with an ever increasing aging population. The unique and varied characteristics of the elderly make surgical decisions and management an evolving conundrum and challenge. In this paper, we will discuss the outcomes of elderly patients undergoing emergency surgery in our institution, dwell deeper in possible factors that lead to surgical delay and also look into the relationships between surgical delay and surgical outcomes.

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INTRODUCTION

Like its many Asian counterparts, Singapore is expected to face an ageing population over the next few decades. As of 2012, the elderly (aged > 65) make up 10.5% of the population, and this number is expected to increase threefold by 2030. The management of elderly population has always been a challenging topic and surgical emergencies of the abdomen are more common in the elderly than in other population^[1,2]. Yet delays in appropriate surgical treatments are also higher in this population, which translates to poorer morbidity and mortality^[3,4]. Wakayama *et al*^[5] noted in gastrointestinal perforations, the mortality is doubled after a delay of > 12 h, eight fold after 24 h, and the tolerance to delay is inversely proportional to age.

There are numerous documented reasons for these delays. Firstly, the elderly population tends to have atypical presentation, with symptoms and signs frequently milder and less specific than in younger adults^[6]. Some studies also show that elderly patients are generally less likely than younger patients to receive analgesia due to multiple factors including depression, failures in memories and cognitive deficits that may hinder obtaining an accurate pain history^[7]. More importantly, elderly patients often have multiple medical conditions that require optimizations prior to surgery, which increases the time delay^[8]. The presence of coexisting diseases is also shown to be a stronger negative prognostic indicator on outcomes when compared to age^[9].

Given the conundrums in managing elderly patients, the aim of this study is to report our institution's experience in managing elderly patients undergoing emergency surgeries, paying particular attention to the

factors that lead to delays in early surgical interventions and also the impact of such delays on post-operative morbidity and mortality. Our hypothesis was that delays in surgery translated to poorer outcomes and by analyzing contributing factors to such delays, we could potentially reduce such delays and improve surgical outcomes in the elderly.

MATERIALS AND METHODS

A retrospective study was performed between 2010 and 2013 on a cohort of 144 elderly patients aged above 65 years old who had undergone emergency abdominal surgery at our institution, Khoo Teck Puat Hospital, Singapore. Since there is no one standard definition of emergency surgery, we defined emergency surgery as those who had undergone surgery within 48 h of admission to the hospital through the Emergency Department for an acute presentation. We limited the study to strangulated hernia, gangrenous or perforated viscus as these were the conditions that required immediate surgery upon diagnosis (unlike some cases of intestinal obstruction).

Pre-operatively, 120 out of 144 patients underwent computed tomography scans of the abdomen and pelvis (CTAP) as part of their diagnostic workup and the other 18 patients had diagnoses confirmed *via* plain radiographs. The remaining 6 patients had clinically irreducible hernias which turned out to have gangrenous bowel.

The primary outcomes measured were mortality and surgical complication rates, based on the Clavien Dindo grading system^[10]. Delays to surgeries were stratified into 4 groups: 1-6 h, 7-12 h, 13-24 h, and more than 24 h and compared against the rates of in-hospital mortality and complication rates. We defined patients to have major morbidity when they had a complication Clavien-Dindo grade 3 and above either requiring surgical intervention or high dependency/ICU supportive care.

To elucidate possible predisposing factors for surgical delay, we looked at the patients' comorbidities based on the Charlson's weighted comorbidity index. This index is widely used in the geriatric population giving different weights to different comorbidities^[11]. It was first used to predict lifespan but subsequently had been found to be useful to predict risk of surgery in the geriatric population^[12]. We also studied other factors including medications, cognition, mobility, nursing home residency, American Society of Anesthesiologists (ASA) physical status classification system and hemodynamic status on admission. We then measured the time interval taken to surgery, defined as time of arrival at the emergency department to the time emergency surgery was performed. In a subgroup of patients, we also measured the time interval taken to complete CTAP upon admission. Multivariate analysis was then performed to compare complication rates and mortality against surgical delays, adjusting for independent effects of predisposing factors on surgical delays.

Table 1 Distribution of cases according to diagnosis (*n* = 144)

Indications	Patients, <i>n</i> (%)	Mortality ¹ , <i>n</i> (%)	Morbidity ² (Clavien Dindo 3 and above)
Strangulated hernia			
Inguinal	3 (2.0)	0 (0)	0 (0)
Obturator	2 (1.4)	0 (0)	0 (0)
Periumbilical	1 (0.7)	0 (0)	0 (0)
Hollow viscus perforation			
Esophagus	1 (0.7)	0 (0)	0 (0)
Gastric ulcer	39 (27.0)	5 (12.8)	7 (17.9)
Duodenal ulcer	13 (9.0)	0 (0)	3 (23)
Gallbladder	2 (1.4)	0 (0)	0 (0)
Small bowel	12 (8.3)	0 (0)	2 (16.7)
Colonic malignancy	8 (5.6)	3 (37.5)	3 (37.5)
Colonic diverticulitis	6 (4.2)	1 (16.7)	1 (16.7)
Appendix	37 (25.7)	0 (0)	0 (0)
Gangrenous viscus			
Small bowel gangrene	10 (6.9)	4 (40)	4 (40)
Large bowel gangrene	3 (2.0)	0 (0)	0 (0)
Empyema gallbladder	7 (4.8)	0 (0)	0 (0)

¹Overall mortality *n* = 13 (9%); ²Overall patients with severe morbidity (Clavien Dindo 3 and above) *n* = 20 (13.8%).

All analyses were done using IBM SPSS statistics ver 20.2. Univariate analyses for categorical variables were done with χ^2 test and Fisher exact test and continuous data were analyzed by using Student *t* test and analysis of variance method. Multivariate analyses were done using multinomial and binary logistic regression methods. A 2 tailed *P* value of less than 0.05 was taken to be statistically significant in this study.

RESULTS

A total of 144 patients underwent emergency surgery. The mean age was 70.5 (9.1 SD), with 87 males and 57 females. The two leading causes of surgical emergency were perforated gastric ulcer and perforated appendicitis shown in Table 1. The total number of deaths was 13, representing an overall mortality of 9%. We found that the highest rates of mortality occurred in patients presenting with small bowel gangrene (40%) followed by perforated colonic malignancy (37.5%). There were 6 cases of strangulated hernia but none resulting in death. Table 2 highlights the post-operative outcomes in our series. There were 20 patients which had more serious post-operative complication (Clavien Dindo grade 3 and above), indicating a major morbidity rate of 13.8%. Nine patients required repeat surgery (6.2%) mainly for post-operative bleeding, anastomotic leakage and anastomotic stenosis. The mean length of hospital stay was 11 d.

The median time taken from presentation to surgery was 9 h (range 1-48 h). The primary independent variable of delay in surgery was further categorized into 4 groups for risk estimation: 1-6 h, 7-12 h, 13-24 h, and more than 24 h. Table 3 shows the relationship between the stratified times and the mortality and complication rates. There were no statistically significant

Table 2 Outcomes after emergency abdominal surgery

Outcome	Patients (<i>n</i> = 144)	(%)
Surgical		
Post op ileus	11	7.6
Wound infection	13	9
Abdominal abscess	4	2.7
Anastomotic leak	4	2.7
Post op bleeding	2	1.4
Medical		
Respiratory complication	32	22.2
Cardiac complication	20	13.8
Renal complication	12	8.3
Cerebrovascular complication	1	0.7
Thromboembolic complication	5	3.5
Others	6	4.2
Return to OR		
Post op bleeding	2	1.4
Anastomotic leak	4	2.7
Anastomotic stenosis	1	0.7
Abdominal collection	1	0.7
Others	1	0.7

differences in mortality between the groups. But when comparing complication rates, we found that 7 out of 11 patients (38.9%) had complications when surgery was delayed more than 24 h, which was much higher compared to the other groups (*P* = 0.003).

Patients undergoing surgery for any viscus other than the appendix also had a higher mortality rate (13 out of 94) than those with appendiceal diseases (*P* = 0.026). There were no mortalities observed in the latter group. Regardless, after adjusting for ASA, diabetes mellitus, comorbidity index, bedbound patients and nonappendiceal cases, surgeries delayed > 24 h was found to be an independent factor associated with Clavien 3 and above complications; ORs was 12.7 (CI: 1.19-136.5, *P* = 0.035) as highlighted in Table 4.

Of the predisposing factors analyzed which might potentially delay surgical intervention, only diabetes mellitus was found to be a significant factor in patients with surgical delays > 24 h, shown in Table 5. The other factors including cognitive impairment, pre-admission medications, comorbidity index, bedbound state, presence of hypotension on arrival in the ED were found to have no significance on the time taken to surgery.

In a sub-set analysis of the 120 patients who underwent CTAP, the mean time taken to perform at computed tomography (CT) scan was 7.5 h. Incidentally, we noted that patients which required a longer time to perform CT scans ended up with higher complication rates. Table 6 reveals that the mean time taken to perform CT scan in patients with post-operative complications (Clavien Dindo grade 3 and above) was 13.1 h, compared to those with lesser complications being 6.5 h (*P* = 0.006). However again, no association was found between time to CT imaging and mortality rates.

DISCUSSION

As the number of persons reaching old age continues

Table 3 Stratified time to surgery against morbidity and mortality

		Stratified by time to surgery				Total	P value
		1-6 h	6-12 h	13-24 h	> 24 h		
Clavien 2 and below		32	56	25	11	124	0.003 ^a
Clavien 3 and above		7	5	1	7	20	
% of total		17.9%	8.2%	3.8%	38.9%	13.9%	
Total		39	61	26	18	144	0.351
Mortality	No	34	58	24	15	131	
	Yes	5	3	2	3	13	
% of total		12.8%	4.9%	7.7%	16.7%	9%	
Total		39	61	26	18	144	

^a*P* < 0.05 statistically significant difference between groups.

Table 4 Multivariate analysis of factors associated with Clavien Dindo grade 3 and above complications

Factors	Odds ratio	95%CI	P value
Surgical delay > 24 h	12.75	1.19-136.57	0.035 ^a
Surgical delay > 12 h	0.45	0.05-3.89	0.467
ASA score ≥ 3	0.53	0.16-1.68	0.278
Diabetes mellitus	1.97	0.56-6.87	0.288
Comorbidity index score ≥ 4	0.64	0.06-7.27	0.716
Bedbound patients	1.53	0.09-25.43	0.765

^a*P* < 0.05 statistically significant difference between groups. ASA: American Society of Anesthesiologists.

Table 5 Multivariate analysis of predisposing factors associated with surgical delay > 24 h

Predisposing factors	Odds ratio	95%CI	P value
ASA score ≥ 3	2.66	0.77-9.26	0.123
Comorbidity index score ≥ 4	1.29	0.19-8.57	0.787
Diabetes mellitus	4.08	1.32-12.55	0.014 ^a
Bedbound patients	0.54	0.02-18.32	0.73
Cognitive impairment	0.45	0.03-6.63	0.566
Chronic analgesia	0.26	0.03-2.33	0.23
Anticoagulants	0.71	0.15-3.36	0.669
Nursing home resident	5.57	0.31-100.25	0.244

^a*P* < 0.05 statistically significant difference between groups. ASA: American Society of Anesthesiologists.

to grow, there is a concomitant and imperative need to provide surgical care to an ever increasing number of older patients. There has also been an increase in operations performed for patients older than 65 years old, which is generally accepted as baseline age for geriatric surgery^[13]. Increased age alone should not be the sole reason to deny surgery in the elderly^[14]. Van Geloven reported on patients over age 80 who presented to the emergency department with abdominal pain and found 27% required surgery, with an overall mortality of 17% that doubled to 34% among those who required operative intervention^[15].

Delays before surgical treatment are often recognized as a contributor to adverse outcomes in emergency surgery and can lead to increased mortality rates^[9,16]. Our results appears consistent with these studies and

Table 6 Mean time taken to perform computed tomography against morbidity and mortality

	n	Mean time taken to perform CTAP	Standard error mean	P value
Clavien 2 and below	19	6.5 h	3.436	0.006 ^a
Clavien 3 and above	101	13.1 h	0.776	
Mortality	Yes	12	11.667	0.119
	No	108	7.139	

^a*P* < 0.05 statistically significant difference between groups. CTAP: Computed tomography scans of the abdomen and pelvis.

we noticed a higher rate of post-operative complications (Clavien Dindo grade 3 and above) occurring when surgery was delayed especially when delay was greater than 24 h. With respect to predisposing factors associated with delays greater than 24 h, diabetes mellitus (DM) came up as an independent predisposing factor contributing to delay in surgical intervention as shown in Table 3. We propose that DM could have contributed to a blunted physiological response and hence atypical presentations. FT de Dombal previously described how the case mix and disease evolution is very different in the elderly population and emphasizes the importance of having a greater sense of awareness in diagnosis^[17]. Similarly, for elderly patients with DM, symptoms may be misleading resulting in diagnostic and possible subsequent surgical delays; hence a high index of suspicion is required.

We believe that the type of surgical emergencies, independent of time, also has a direct impact on the morbidity and mortality. Perforated appendicitis constituted the second most common cause in this study. The incidence of perforation in acute appendicitis is estimated to be 20%-30% but increases to 32%-72% in patients above 60 years of age^[18]. However, these patients tend to have better outcomes compared to the rest who presented with acute abdomen. In our study, none of the 37 patients who presented with perforated appendicitis had significant morbidity (Clavien 3 and above) or mortality. In stark contrast, we noted a total of 20 morbidities and 13 mortalities in the remaining population. In particular, 40% and 37.5% of patients with small bowel gangrene and perforated colonic

malignancies respectively had significant complications that eventually resulted in death. Guo *et al.*^[19], in his study of 233 patients with perforated malignant colonic obstructions, recorded a 24.5% 30-d post-operative mortality, regardless of the Dukes cancer staging. Previous studies have also reported hollow viscus perforations, acute biliary diseases and strangulated hernias accounting for the majority of reasons for emergency surgery in elderly^[14,20]. These conditions often have similar presentations and early accurate diagnosis is paramount in facilitating appropriate treatment.

Abdominal pain constitutes 10%-15% of all complaints in older persons seen at our Emergency Department and this indolent, nonspecific nature of initial symptom is what makes accurate diagnosis difficult. Radiological imaging is often employed in aiding diagnosis in these conditions, however while advances in diagnostic skills and improvements in diagnostic facilities improve diagnostic accuracy, delay in performing these investigations can impact surgical outcomes^[21]. Hence we also sought to determine the potential effect of delay in obtaining radiological diagnosis on eventual outcomes as well.

While the leading cause for acute abdomen in our series was peptic ulcer, perforations of small bowel, colonic diverticulitis, colonic malignancies and gallbladder were other causes in our study population. Because of the atypical manifestation of these acute abdominal conditions in the elderly, a CT scan is often helpful. In our series, we noted that in the 120 patients where a CT scan was performed, a greater complication rate (Clavien 3 and above) was observed when the scan was delayed. The mean time to taken to perform CT scan in patients where more serious complications were observed was found to be significantly higher than those with less severe complications as discussed earlier. Delays in performing CT scans in the former group could be attributed to several reasons namely hemodynamically unstable patients requiring further resuscitation and even transferring to high dependency or ICU first, delayed presentation of illness, lack of physical signs at first presentation, inability to illicit proper history from uncommunicative or cognitively impaired patients, and also patients presenting with acute kidney injury requiring intravenous rehydration before performing a contrasted CT scan. The breakdown of the time attributed to the aforementioned factors were not the focus of this particular study but could be looked into with greater detail in subsequent studies.

According to Table 3, we noticed that the overall morbidity seemed to initially decrease with time when surgery was performed within 24 h. However beyond 24 h, it was noted there was the highest percentage of patients with Clavien 3 and above complications (7 out of 18 patients, 38.9%). This bimodal representation could possibly be explained by there being 2 groups of patients: The first group where patients were more stable and diagnosis was made early with resultant earlier operation performed and the second group where

patients were more unstable and required a period of resuscitation first before undergoing an operation. In the latter group, the patients were initially too unstable to perform a CT scan resulting in delayed diagnosis and hence a delay in surgery. The 25 patients who eventually underwent surgery after 24 h were mostly patients already in severe sepsis and this could have explained the majority of them ending up with greater complications post-operatively.

Therefore, we believe that in an elderly population where symptoms of abdominal pain maybe equivocal, the threshold to perform CT scan should be lowered. Once a decision is made to perform a scan, one should expedite its execution to reduce any delays. The earlier a CT scan is performed, the sooner a definitive diagnosis is made and this minimizes total time delay till surgery is performed. Ultimately, we believe this possibly could reduce the severity of post-operative complications especially in patients presenting with the specific conditions in this study. Omari *et al.*^[22] has also suggested that the early use of CT scan can cut short the way to appropriate treatment for perforated viscus.

There are certain limitations to this study. Firstly, it is a retrospective study and we were unable to take into account the delays which occurred before presentation to the ED. We also did not look into other specific causes which resulted in delays besides those encountered in obtaining CT scans and also the factors that result in a delay in performing a scan. A prospective study can be performed looking at these causes so we can identify other areas to improve and reduce delays in surgery. Lastly, the study also does not include a comprehensive list of all emergency surgeries in the elderly as certain conditions such as cholecystitis and intestinal obstruction are sometimes treated with a trial of conservative management first. The majority of the conditions included in the study were either perforated viscus or gangrenous viscus hence outcome measures should be compared with only this specific group of patients.

Our study demonstrates clearly that delay in performing emergency surgery in elderly lead to higher complication rates. Elderly patients presenting with abdominal pain should be admitted and prudently evaluated with a view to avoid diagnostic and thus surgical delays. Obtaining CT scans early also may potentially facilitate earlier diagnosis of perforated or gangrenous viscus, especially in this group of patients where clinical presentations may be more atypical, and thus possibly lead to improved surgical outcomes.

COMMENTS

Background

With an ever increasing ageing population faced in most countries, there is an expected rise in the number of surgical emergencies encountered. Elderly patients are an entirely different group of patients with their multiple comorbidities, cognitive impairment, altered body physiology and more fragile state contributing to the challenges in their management. Many studies have looked into outcomes of emergency surgery but few have focused on the predisposing factors that lead to delay in surgery and how such delays impact

outcomes.

Research frontiers

Delays in surgery are often inherent in any healthcare system and more studies can be performed to look into the breakdown of each contributing factor with the intention to improve workflow processes and system practices to reduce such delays. With a reduction in delays to surgery, there can be anticipated greater improvements in patient outcomes.

Innovations and breakthroughs

By studying at the predisposing factors that lead to delay in surgery, the authors can have a higher index of suspicion in certain groups of patients. The authors have found that patients with diabetes mellitus were at higher risk of having a delay in surgery and this could be due to blunted physiologic response. The authors also have noted a delay in performing a computed tomography scan resulted in higher complication rates and hence the authors intend to look into ways to reduce such delays in future studies.

Applications

The study results suggest that delays in surgery in elderly patients lead to higher complication rates and it is crucial to identify patients with predisposing factors which may lead one to have higher index of suspicion. Such patients should also have any scans (if indicated) expedited to reduce any delays and ultimately improve surgical outcomes as well.

Terminology

Certain acute abdominal emergencies include perforated or gangrenous viscus and strangulated hernia. Any defect in the walls of abdominal viscus result in peritoneal soiling and eventual peritonitis. Gangrene of the viscus occurs when there is inadequate blood supply most often from vascular occlusion and sepsis usually ensues. Such conditions are usually terminal unless surgical intervention is performed. Hence it is crucial to identify such conditions promptly and initiate surgery at the earliest possible chance to improve outcomes.

Peer-review

Dr. Ong *et al* reported clinical outcomes in the elderly patients who came to ER in the single center. They reviewed morbidity and mortality of the 144 patients and tried to identify clinical factors to predict poor clinical outcomes. Overall the article is interesting and manuscript is well written.

REFERENCES

- 1 Bugliosi TF, Meloy TD, Vukov LF. Acute abdominal pain in the elderly. *Ann Emerg Med* 1990; **19**: 1383-1386 [PMID: 2240749 DOI: 10.1016/S0196-0644(05)82602-2]
- 2 Fenyö G. Diagnostic problems of acute abdominal diseases in the aged. *Acta Chir Scand* 1974; **140**: 396-405 [PMID: 4851359]
- 3 Karanikas ID, Liakakos TD, Koundourakis SS, Tzorakis SE, Dendrinos SS. Emergency operations in the elderly: management and outcome. *Int Surg* 1996; **81**: 158-162 [PMID: 8912083]
- 4 Kettunen J, Paajanen H, Kostiainen S. Emergency abdominal surgery in the elderly. *Hepatogastroenterology* 1995; **42**: 106-108 [PMID: 7672756]
- 5 Wakayama T, Ishizaki Y, Mitsusada M, Takahashi S, Wada T, Fukushima Y, Hattori H, Okuyama T, Funatsu H. Risk factors influencing the short-term results of gastroduodenal perforation. *Surg Today* 1994; **24**: 681-687 [PMID: 7981538 DOI: 10.1007/BF01636772]
- 6 Kane E, Fried G, McSherry CK. Perforated peptic ulcer in the elderly. *J Am Geriatr Soc* 1981; **29**: 224-227 [PMID: 7229233 DOI: 10.1111/j.1532-5415.1981.tb01771.x]
- 7 Jones JS, Johnson K, McNinch M. Age as a risk factor for inadequate emergency department analgesia. *Am J Emerg Med* 1996; **14**: 157-160 [PMID: 8924137 DOI: 10.1016/S0735-6757(96)90123-0]
- 8 Escarce JJ, Shea JA, Chen W, Qian Z, Schwartz JS. Outcomes of open cholecystectomy in the elderly: a longitudinal analysis of 21,000 cases in the prelaparoscopic era. *Surgery* 1995; **117**: 156-164 [PMID: 7846619 DOI: 10.1016/S0039-6060(05)80079-0]
- 9 Fenyö G. Acute abdominal disease in the elderly: experience from two series in Stockholm. *Am J Surg* 1982; **143**: 751-754 [PMID: 7091511 DOI: 10.1016/0002-9610(82)90052-6]
- 10 Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 2004; **240**: 205-213 [PMID: 15273542 DOI: 10.1097/01.sla.0000133083.54934.ae]
- 11 Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987; **40**: 373-383 [PMID: 3558716 DOI: 10.1016/0021-9681(87)90171-8]
- 12 Tan KY, Konishi F, Tan L, Chin WK, Ong HY, Tan P. Optimizing the management of elderly colorectal surgery patients. *Surg Today* 2010; **40**: 999-1010 [PMID: 21046496 DOI: 10.1007/s00595-010-4354-5]
- 13 Rosenthal RA, Zenilman ME. Surgery in the elderly. In: Townsend, Sabiston Textbook of Surgery 18th ed, W.B. Saunders Co, Philadelphia, 2008: 371-398
- 14 Arenal JJ, Bengoechea-Beeby M. Mortality associated with emergency abdominal surgery in the elderly. *Can J Surg* 2003; **46**: 111-116 [PMID: 12691347]
- 15 van Geloven AA, Biesheuvel TH, Luitse JS, Hoitsma HF, Obertop H. Hospital admissions of patients aged over 80 with acute abdominal complaints. *Eur J Surg* 2000; **166**: 866-871 [PMID: 11097153 DOI: 10.1080/110241500447254]
- 16 North JB, Blackford FJ, Wall D, Allen J, Faint S, Ware RS, Rey-Conde T. Analysis of the causes and effects of delay before diagnosis using surgical mortality data. *Br J Surg* 2013; **100**: 419-425 [PMID: 23225342 DOI: 10.1002/bjs.8986]
- 17 de Dombal FT. Acute abdominal pain in the elderly. *J Clin Gastroenterol* 1994; **19**: 331-335 [PMID: 7876517 DOI: 10.1097/0004836-199412000-00016]
- 18 Lee JF, Leow CK, Lau WY. Appendicitis in the elderly. *Aust N Z J Surg* 2000; **70**: 593-596 [PMID: 10945554 DOI: 10.1046/j.1440-1622.2000.01905.x]
- 19 Guo MG, Feng Y, Liu JZ, Zheng Q, Di JZ, Wang Y, Fan YB, Huang XY. Factors associated with mortality risk for malignant colonic obstruction in elderly patients. *BMC Gastroenterol* 2014; **14**: 76 [PMID: 24735084 DOI: 10.1186/1471-230X-14-76]
- 20 Gürleyik G, Gürleyik E, Unalmışer S. Abdominal surgical emergency in the elderly. *Turk J Gastroenterol* 2002; **13**: 47-52 [PMID: 16378274]
- 21 Salem TA, Molloy RG, O'Dwyer PJ. Prospective study on the role of the CT scan in patients with an acute abdomen. *Colorectal Dis* 2005; **7**: 460-466 [PMID: 16108882 DOI: 10.1186/1749-7922-9-6]
- 22 Omari AH, Khamash MR, Qasaimeh GR, Shammari AK, Yaseen MK, Hammori SK. Acute appendicitis in the elderly: risk factors for perforation. *World J Emerg Surg* 2014; **9**: 6 [PMID: 24428909]

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