



Original Article

Hollow-Organ Perforation in the Emergency Department: Is Time to Diagnosis Prolonged in the Elderly?☆

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SUMMARY

Background: Hollow-organ perforations account for a significant proportion of acute abdomens requiring an emergent surgery. Failure to identify such emergencies, particularly among elderly patients, leads to high morbidity and mortality. Our study aimed to find out if old age is associated with prolonged time to diagnosis of hollow-organ perforations in the emergency department (ED).

Methods: We enrolled all ED visits with discharge diagnosis of hollow-organ perforations during the period from August 1, 2009 to July 31, 2011. Patients were further divided into the elderly group (aged ≥ 65 years) and the control group (aged < 65 years), and each patient was matched using a standard propensity-score greedy-matching algorithm. The hazard ratios (HRs) of delayed diagnosis and in-hospital mortality were compared accordingly.

Results: Two hundred and seventy-seven patients were enrolled in our study. The propensity-score-matching process selected 63 patients from each group for further analysis. In the subcohort, the elderly group was found to be unrelated to prolonged time to diagnosis (HR = 0.95, 95% confidence interval 0.67–1.35, $p = 0.767$). The in-hospital mortality was significantly higher in the elderly group. (22.2% vs. 4.8%, $p = 0.004$). Atypical presentation was the single independent factor related to prolonged time to diagnosis of hollow-organ perforation in the ED (HR = 0.34, 95% confidence interval 0.23–0.53, $p < 0.001$).

Conclusion: Our study evidently showed no significant difference in the time to diagnosis of hollow-organ perforation between old and young adults in the ED, suggesting that the high mortality of gastrointestinal perforation among the elderly is not associated with diagnostic delay.

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1. Introduction

Acute abdominal pain is a common complaint in elderly patients seeking emergency care¹. As the aging population is increasing rapidly in almost every country of the world, there will be more and more elderly patients that would present to the emergency department (ED) with abdominal pathologies. In fact, the assessment and evaluation of elderly patients with abdominal illnesses pose a real challenge to the emergency physicians (EPs), because

the presentation of common illnesses can be altered. Age-associated deterioration in both physical and cognitive functions could also influence clinical assessments, because history and physical examinations in the elderly people are more likely to be unreliable and nonspecific^{2–5}. Additional factors, such as underlying medical disorders and concomitant medication use, could be aggravated by any acute conditions and further complicate the diagnosis of the diseases^{6–8}. It has been shown that the elderly with abdominal pain are associated with a 20% greater length of stay in the ED compared with younger patients with similar complaints, and notably, nearly one-third of them require surgical interventions⁹. Misdiagnosis or delayed diagnosis of abdominal pain in the aged population is associated with high mortality independent of the timing of surgical interventions^{9,10}.

Hollow-organ perforation is a true and common life-threatening abdominal emergency requiring early surgical interventions^{1,11}.

☆ Conflicts of interest: All contributing authors declare that they have no conflicts of interest.

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Recent advances and progress in both surgical techniques and health-care quality have generally improved the outcome of bowel perforation; the prognosis in the aged population, however, remains poor, with an overall mortality rate of <10% in the general population¹², but as high as 30% in the elderly¹⁰. The mortality further increases while treatment is delayed, because the tolerance to such delay inversely correlates with age¹³. Early recognition of bowel perforation, particularly in the elderly population, is one of the key roles of EPs to facilitate surgical intervention.

The aim of the study was to investigate the diagnostic accuracy and efficiency of hollow-organ perforations among elderly patients compared with young ones in the ED. The results of this study could provide clinicians further insights into these frequently encountered surgical situations.

2. Materials and methods

2.1. Study setting and design

This study is a retrospective observational design. The Taipei Mackay Memorial Hospital is a medical center with 160,000 ED visits/y. On average, we manage approximately 20 patients with hollow-organ perforations every month.

First, we searched our electronic medical records of ED visits between the period of August 1, 2009 and July 31, 2011 to select patients with discharged diagnoses of hollow-organ perforations [the International Classification of Diseases (Ninth Revision) Clinical Modification codes 531.1, 531.2, 531.5, 531.6, 532.1, 532.2, 532.5, 532.6, 533.1, 533.2, 533.5, 533.6, and 569.83]. However, cases due to complications of marginal ulcers that are related to prior abdominal surgeries were not included [International Classification of Diseases (Ninth Revision) Clinical Modification: 534.1, 534.2, 534.5, and 534.6].

Patients were excluded if they were: (1) transferred from other hospitals; (2) presented with out-of-hospital cardiac arrest; (3) incorrectly coded; (4) presented with complications of recent surgeries; and (5) returned ED visits.

Two authors independently reviewed all medical records and data (M.Y.H and C.S.L). Every patient was followed from the time of ED arrival until the time the diagnosis was made. The time of diagnosis was defined by either the time the diagnostic imaging study was obtained, or the time the diagnostic exploratory laparotomy was performed. Data analysis was performed by authors Y.C.S. and W.H.C, upon completion of data collection. The institutional review boards of the Mackay Memorial Hospital have approved the study.

2.2. Covariates

Age, sex, initial vital signs, and laboratory results were directly retrieved from computerized records. We further reviewed all the medical charts to gather the detailed information, such as comorbidities, chief complaints, and in-hospital mortality. The time to diagnosis was defined by the time interval between the ED arrival and when diagnostic interventions were performed (i.e., operations or imaging studies).

The following covariates were then recorded on a standard form for each patient: age, sex, time to diagnosis, atypical presentation (chief complaints other than abdominal pain), fever (blood temperature >37.8°C), tachycardia (heart rates >100 beats/min), shock (systemic blood pressure <90 mmHg), leukocytosis (white-blood-cell counts >10,000/uL), diabetes, history of abdominal surgery, malignancies, history of peptic-ulcer disease, perforation sites (stomach, small bowel, or colon perforation), and in-hospital mortality.

2.3. Statistical analysis

The SAS statistical package version 9.2 (SAS Institute, Inc., Cary, NC, USA) and STATA version 11.2 (StataCorp, College Station, TX, USA) were both used for data analysis. The continuous variables were compared using the *t* test, and the categorical variables with Pearson's Chi-square test.

For the study interest, patients aged ≥65 years were classed into the elderly group, and patients aged <65 years were labeled as the control group. The 95% confidence interval (CI) and *p* values were reported, and a *p* value < 0.05 was considered significant.

2.4. Regression model

We used survival analyses to deal with the factors that might be associated with prolonged time to diagnosis of hollow-organ perforation. All enrolled patients were followed from ED arrival until the diagnosis was established. There was no censored case in our cohort. The Cox proportional-hazard regression model was used to calculate the hazard ratios (HRs) of age after adjustments for sex, atypical presentation, fever, tachycardia, shock, leukocytosis, diabetes, history of abdominal surgery, malignancies, history of peptic ulcer, and perforation sites to evaluate if the time to diagnosis would be prolonged as age increases.

2.5. Propensity-score methods

Second, we performed a propensity-score-matched analysis to evaluate if the time to diagnosis of hollow-organ perforations would be prolonged in the elderly group. The propensity score was the conditional probability for the elderly under possible confounders. Sex, atypical presentation, fever, tachycardia, shock, leukocytosis, diabetes, history of abdominal surgery, malignancies, history of peptic ulcer, and perforation sites were added into a multivariable logistic-regression model to predict the effect in the elderly.

The predicted probability from the model was used as the propensity score for each patient. We then matched each patient in the elderly group to the patient in the control group with the closest propensity score using a standard greedy-matching algorithm¹⁴. After the 1:1 matched groups were assembled, the HR of prolonged time to diagnosis was computed.

3. Results

We identified 413 cases of hollow-organ perforations diagnosed in the ED during the 2-year study period. By reviewing of medical records, 277 patients that met our inclusion criteria were enrolled for further analysis. The selection process is summarized in [Figure 1](#). There were 118 patients in the elderly group and 159 in the control group. The baseline characteristics of both groups are shown in [Table 1](#). Patients in the elderly group are male predominant, and are also found to be more likely to have atypical presentation, diabetes, malignancies, medical history of peptic ulcer, colon perforations, and higher in-hospital mortality. Before adjustment for possible confounding variables, the average time to diagnosis was 4.8 hours (95% CI 3.5–6.0) in the elderly group, and 3.3 hours (95% CI 2.5–4.1) in the control group, respectively. The unadjusted HR for diagnosis in the elderly group is 0.744 (95% CI 0.58–0.95, *p* = 0.016), indicating the time to diagnosis in the elderly tends to be prolonged.

In the multivariate Cox regression model (see [Table 2](#)), age was not shown to be a significant factor for prolonged time to diagnosis after adjustments for the aforementioned covariates (HR = 1.00, 95% CI 0.99–1.00). Atypical presentation was the single significant

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