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Contents

Monthly Volume 15 Number 12 December 27, 2023

REVIEW

2674 Antimicrobial approach of abdominal post-surgical infections

Fiore M, Corrente A, Di Franco S, Alfieri A, Pace MC, Martora F, Petrou S, Mauriello C, Leone S

MINIREVIEWS

2693 Indocyanine green fluorescence in gastrointestinal surgery: Appraisal of current evidence

Kalayarasan R, Chandrasekar M, Sai Krishna P, Shanmugam D

2709 Post-cholecystectomy iatrogenic bile duct injuries: Emerging role for endoscopic management

Emara MH, Ahmed MH, Radwan MI, Emara EH, Basheer M, Ali A, Elfert AA

ORIGINAL ARTICLE

Case Control Study

2719 Multidisciplinary diagnosis and treatment nutritional support intervention for gastrointestinal tumor radiotherapy: Impact on nutrition and quality of life

Hui L, Zhang YY, Hu XD

Retrospective Cohort Study

2727 Association between the early high level of serum tacrolimus and recurrence of hepatocellular carcinoma in ABO-incompatible liver transplantation

Han JW, Choi JY, Jung ES, Kim JH, Cho HS, Yoo JS, Sung PS, Jang JW, Yoon SK, Choi HJ, You YK

2739 Determining the need for a thoracoscopic approach to treat a giant hiatal hernia when abdominal access is poor

Pérez Lara FJ, Zubizarreta Jimenez R, Prieto-Puga Arjona T, Gutierrez Delgado P, Hernández Carmona JM, Hernández Gonzalez JM, Pitarch Martinez M

2747 Predictive value of Hajibandeh index in determining peritoneal contamination in acute abdomen: A cohort study and meta-analysis

Hajibandeh S, Hajibandeh S, Evans L, Miller B, Waterman J, Ahmad SJ, Hale J, Higgi A, Johnson B, Pearce D, Helmy AH, Naguib N, Maw A

Retrospective Study

2757 Efficacy of pantoprazole plus perforation repair for peptic ulcer and its effect on the stress response

Leng ZY, Wang JH, Gao L, Shi K, Hua HB

2765 Application of electroacupuncture in the prevention of low anterior resection syndrome after rectal cancer surgery

Xu LL, Xiang NJ, Cheng TC, Li YX, Chen P, Jiang ZW, Liu XX

World Journal of Gastrointestinal Surgery

Monthly Volume 15 Number 12 December 27, 2023

Contents

2774 Effects of remifentanil combined with propofol on hemodynamics and oxidative stress in patients undergoing resection of rectal carcinoma

Huang J, Tian WJ

2783 Percutaneous microwave ablation and transcatheter arterial chemoembolization for serum tumor markers and prognostics of middle-late primary hepatic carcinoma

Lin ZP, Huang DB, Zou XG, Chen Y, Li XQ, Zhang J

2792 Novel invagination procedure for pancreaticojejunostomy using double purse string sutures: A technical note

Li J, Niu HY, Meng XK

2799 Laparoscopic resection and endoscopic submucosal dissection for treating gastric ectopic pancreas

Zheng HD, Huang QY, Hu YH, Ye K, Xu JH

2809 Prediction of the lymphatic, microvascular, and perineural invasion of pancreatic neuroendocrine tumors using preoperative magnetic resonance imaging

Liu YL, Zhu HB, Chen ML, Sun W, Li XT, Sun YS

2820 Impact of hepatectomy and postoperative adjuvant transarterial chemoembolization on serum tumor markers and prognosis in intermediate-stage hepatocellular carcinoma

Hu YD, Zhang H, Tan W, Li ZK

Observational Study

2831 Analysis of nutritional risk, skeletal muscle depletion, and lipid metabolism phenotype in acute radiation enteritis

Ma CY, Zhao J, Qian KY, Xu Z, Xu XT, Zhou JY

Randomized Controlled Trial

2844 Holistic conditions after colon cancer: A randomized controlled trial of systematic holistic care *vs* primary care

Wang J, Qiao JH

Basic Study

2855 Mutational separation and clinical outcomes of *TP53* and *CDH1* in gastric cancer

Liu HL, Peng H, Huang CH, Zhou HY, Ge J

2866 Hepatic vagotomy blunts liver regeneration after hepatectomy by downregulating the expression of interleukin-22

Zhou H, Xu JL, Huang SX, He Y, He XW, Lu S, Yao B

META-ANALYSIS

2879 Recent evidence for subcutaneous drains to prevent surgical site infections after abdominal surgery: A systematic review and meta-analysis

Ishinuki T, Shinkawa H, Kouzu K, Shinji S, Goda E, Ohyanagi T, Kobayashi M, Kobayashi M, Suzuki K, Kitagawa Y, Yamashita C, Mohri Y, Shimizu J, Uchino M, Haji S, Yoshida M, Ohge H, Mayumi T, Mizuguchi T

2890 Prognostic role of serum carcinoembryonic antigen in patients receiving liver resection for colorectal cancer liver metastasis: A meta-analysis

Tang F, Huang CW, Tang ZH, Lu SL, Bai T, Huang Q, Li XZ, Zhang B, Wu FX

2907 Significance of carcinoembryonic antigen detection in the early diagnosis of colorectal cancer: A systematic review and meta-analysis

Wang R, Wang Q, Li P

CASE REPORT

2919 Primary repair of esophageal atresia gross type C *via* thoracoscopic magnetic compression anastomosis: A case report

Zhang HK, Li XQ, Song HX, Liu SQ, Wang FH, Wen J, Xiao M, Yang AP, Duan XF, Gao ZZ, Hu KL, Zhang W, Lv Y, Zhou XH, Cao ZJ

2926 Portal vein embolization for closure of marked arterioportal shunt of hepatocellular carcinoma to enable radioembolization: A case report

Wang XD, Ge NJ, Yang YF

2932 Removal of a large rectal polyp with endoscopic submucosal dissection-trans-anal rectoscopic assisted minimally invasive surgery hybrid technique: A case report

Polese L

2938 Successful treatment of invasive liver abscess syndrome caused by *Klebsiella variicola* with intracranial infection and septic shock: A case report

Zhang PJ, Lu ZH, Cao LJ, Chen H, Sun Y

2945 Duodenojejunostomy treatment of groove pancreatitis-induced stenosis and obstruction of the horizontal duodenum: A case report

Zhang Y, Cheng HH, Fan WJ

2954 Awake robotic liver surgery: A case report

Delvecchio A, Pavone G, Conticchio M, Piacente C, Varvara M, Ferraro V, Stasi M, Casella A, Filippo R, Tedeschi M, Pullano C, Inchingolo R, Delmonte V, Memeo R

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Monthly Volume 15 Number 12 December 27, 2023

Contents

ABOUT COVER

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The primary aim of *World Journal of Gastrointestinal Surgery* (*WJGS*, *World J Gastrointest Surg*) is to provide scholars and readers from various fields of gastrointestinal surgery with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

WJGS mainly publishes articles reporting research results and findings obtained in the field of gastrointestinal surgery and covering a wide range of topics including biliary tract surgical procedures, biliopancreatic diversion, colectomy, esophagectomy, esophagostomy, pancreas transplantation, and pancreatectomy, *etc.*

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ORIGINAL ARTICLE

Retrospective Cohort Study

Predictive value of Hajibandeh index in determining peritoneal contamination in acute abdomen: A cohort study and meta-analysis

Shahab Hajibandeh, Shahin Hajibandeh, Louis Evans, Bethany Miller, Jennifer Waterman, Suhaib JS Ahmad, Jay Hale, Adnan Higgi, Bethan Johnson, Dafydd Pearce, Ahmed Hazem Helmy, Nader Naguib, Andrew Maw

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Abstract

BACKGROUND

Hajibandeh index (HI), derived from combined levels of C-reactive protein, lactate, neutrophils, lymphocytes and albumin, is a modern predictor of peritoneal contamination and mortality in patients with acute abdominal pathology.

AIM

To validate the performance of HI in predicting the presence and nature of peritoneal contamination in patients with acute abdominal pathology in a larger cohort study and to synthesis evidence in a systematic review and meta-analysis.

METHODS

The STROBE guidelines and the PRISMA statement standards were followed to conduct a cohort study (ChiCTR2200056183) and a meta-analysis (CRD420-22306018), respectively. All adult patients undergoing emergency laparotomy for acute abdominal pathology were eligible. The accuracy of the HI was evaluated

using receiver operating characteristic (ROC) curve analysis in the cohort study and using weighted summary area under the curve (AUC) under the fixed and random effects modelling in the meta-analysis. The Quality Assessment of Diagnostic Accuracy Studies 2 criteria were used for methodological quality assessment of the included studies.

RESULTS

A total of 1437 patients were included (700 from the cohort study and 737 from the literature search). ROC curve analysis of the cohort study showed that the AUC of HI for presence of contamination, purulent contamination and feculent contamination were 0.79 [95% confidence interval (CI): 0.76-0.82, $P < 0.0001$], 0.76 (95%CI: 0.72-0.80, $P < 0.0001$), and 0.83 (95%CI: 0.79-0.86, $P < 0.0001$), respectively. The meta-analysis showed that the pooled AUC of HI for presence of contamination, purulent contamination and feculent contamination were 0.79 (95%CI: 0.75-0.83), 0.78 (95%CI: 0.74-0.81), and 0.80 (95%CI: 0.77-0.83), respectively.

CONCLUSION

The HI is a strong and accurate predictor of intraperitoneal contamination. Although the available evidence is robust, it is limited to the studies conducted by our evidence synthesis group. We encourage other researchers to validate performance of HI in predicting the presence of intraperitoneal contamination and more importantly in predicting mortality following emergency laparotomy.

Key Words: Hajibandeh index; Laparotomy; Mortality; Peritonitis; Contamination

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Core Tip: Hajibandeh index (HI), derived from combined levels of C-reactive protein, lactate, neutrophils, lymphocytes and albumin, can strongly predict presence and nature of peritoneal contamination in acute abdomen. The evidence is robust but limited to studies by our evidence synthesis group, hence we encourage other researchers to validate performance of HI in predicting the presence of intraperitoneal contamination and more importantly in predicting mortality following emergency laparotomy.

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INTRODUCTION

Presence of intraperitoneal contamination is considered as an important predictor of morbidity and mortality in patients with acute abdominal pathology[1]. Due to its prognostic significance, the presence of intraperitoneal contamination is taken into account by the commonly used prognostic scoring tools to predict the risk of postoperative morbidity and mortality in patients undergoing emergency operation for acute abdominal pathology[2,3]. Therefore, early detection of intraperitoneal contamination not only could facilitate the decision to operate in patients with acute abdominal pathology but also could potentially lead to more accurate preoperative risk assessment and more appropriate management decisions.

The knowledge about the presence of intraperitoneal contamination is only available intraoperatively; this would limit the predictive value of preoperative prognostic scoring tools. We developed the Hajibandeh index (HI) in order to be able to predict the presence and nature of intraperitoneal contamination in patients with acute abdominal pathology[4,5]. The HI includes C-reactive protein (CRP), neutrophils and lactate as nominators (their levels increase in abdominal sepsis) and albumin and lymphocytes as denominators (their levels decrease in abdominal sepsis)[4,5]. We previously demonstrated that it can predict the presence of intraperitoneal contamination in patients with acute abdominal pathology and postoperative mortality in patients undergoing emergency laparotomy[4,5]. A recent emergency laparotomy mortality risk predictor model, called HAS, includes the HI as one of its components as it remained in the model after a very strict multivariable analysis[6,7].

In this study we aimed to conduct a cohort study to validate the predictive significance of the HI in a larger cohort of patients and to conduct a systematic review and meta-analysis to determine the pooled accuracy of HI in predicting the presence and nature of intraperitoneal contamination.

MATERIALS AND METHODS

The STROBE guidelines for observational studies and the PRISMA statement standards were followed to protocol, conduct and present this retrospective cohort study and systematic review, respectively[8,9]. The cohort study was registered in Chinese Clinical Trial Registry (Registration number: ChiCTR2200056183) and the systematic review was registered in PROSPERO (Registration number: CRD42022306018). The study was conducted in accordance with institutions' policies and internal arrangements approved by local Clinical Governance Unit. Considering the nature of this study, patient consent and approval by Research Ethics Committees were not needed.

Study design and patient selection

Cohort study: Consecutive adult patients undergoing emergency laparotomy in a General Surgery centre in the South Wales between January 2014 and January 2021 were included. The indications for emergency laparotomy included visceral perforation, intraabdominal sepsis of any source (anastomotic leak, colitis, intestinal fistula), intraabdominal collection, intestinal ischaemia, large bowel obstruction, small bowel obstruction, and intraabdominal bleeding. The patients who had laparotomy due to trauma were excluded. The included population in this study did not comprise the patients who underwent laparoscopic procedure. Moreover, patients without available preoperative levels of CRP, neutrophils, lactate, lymphocytes or albumin and those with haematological malignancy resulting in chronic elevated neutrophils or lymphocytes levels were excluded.

Meta-analysis: Search of electronic databases including CENTRAL, MEDLINE, EMBASE, CINAHL, and Scopus were performed to identify all retrospective or prospective observational studies evaluating accuracy of HI in predicting the presence of intraperitoneal contamination in patients with acute abdominal pathology. Appropriate keywords, thesaurus headings, search limits and operators were used to develop a comprehensive search strategy as shown in Supplementary material. The search strategy had no language restrictions and was last applied on 12 April 2023. Moreover, the reference lists of relevant reviews and articles were screened for more potentially eligible studies. The titles and abstracts of the articles identified through application of the above search strategy were screened, the full-texts of relevant articles were retrieved and the studies that met the eligibility criteria were selected. The methodological quality of the included studies were evaluated using the Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-2) criteria. The Review manager 5.4.1 software was used for constructing the risk of bias graphs. The above steps were performed by two independent authors and disagreements between the first two authors were resolved by involving a separate third author.

HI

The HI for each patient was calculated based on the formula shown in Supplementary material.

Outcome measure

Intraperitoneal contamination (presence and nature) were considered as the outcome measures. Intraperitoneal contamination was classified as serous, purulent, or feculent based on intraoperative finding of operating surgeon.

Data collection

All steps of data collection were performed by two independent authors and an independent third author was consulted in the event of disagreement. The authors who were involved in data collection were not involved in data analyses. We collected information on age, sex, American Society of Anesthesiologists (ASA) status, components of the HI, nature of intraperitoneal contamination, indication for laparotomy, and procedure performed.

Data synthesis and statistical analyses

Cohort study: The MedCalc 13.0 software was used for statistical analyses. The demographics, clinical characteristics and outcome data were presented using simple descriptive statistics. Data were summarized with mean ± SD or median and interquartile range (IQR) for continuous variables, and frequencies/percentages for categorical variables. Receiver operating characteristic (ROC) curve analysis was conducted to evaluate the discrimination of the HI by calculating the area under the curve (AUC)[10]. Binary logistic regression was used to evaluate classification of HI; the observed and predicted values for peritoneal contamination were cross-classified to construct classification table. All statistical tests were two-tailed and statistical significance was assumed at $P < 0.05$.

Meta-analysis: The weighted summary AUC under the fixed and random effects modelling was calculated using the methods described by Zhou *et al*[11]. The unit of analysis was an individual patient. The heterogeneity was quantified and reported as I^2 using Cochran Q test (χ^2). I^2 was interpreted as 0%-50% means low heterogeneity, 50%-75% means moderate heterogeneity, and 75%-100% means high heterogeneity. The results were reported in a forest plot with 95% confidence intervals (CIs).

RESULTS

A total of 1437 patients were eligible for inclusion; 700 patients from the cohort study and 737 patients from the literature search. Figure 1 demonstrates the study flow chart.

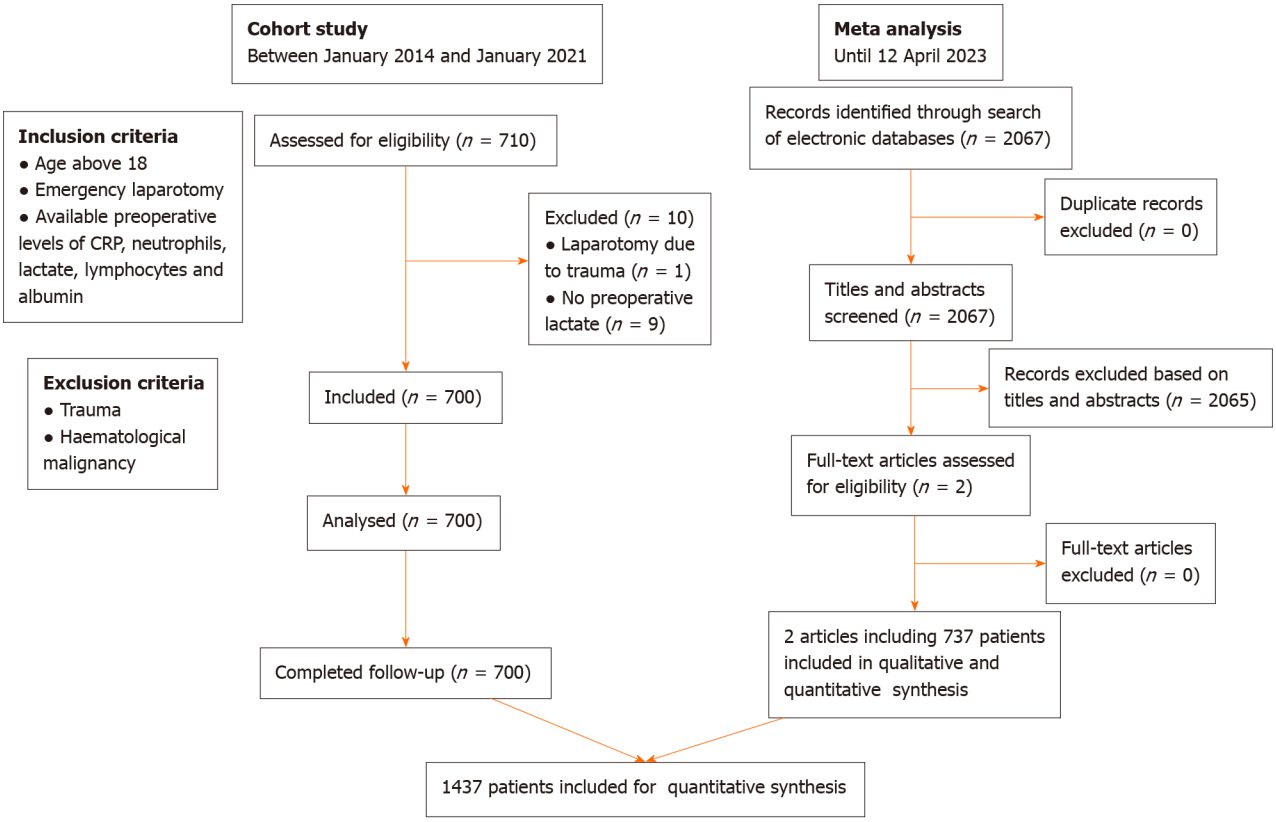

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Figure 1 The study flow diagram.

Risk of bias in included studies

The outcomes of methodological quality assessment based on the QUADAS-2 criteria are shown in Figure 2. In summary, the included studies, including the current study, were judged to be of low risk of bias in terms of patient selection, index test, reference standard, and flow and timing.

Baseline patient characteristics

Cohort study: Among the included population, 37% (261/700) were male and 63% (439/700) were female with mean age of 63 years (95%CI: 62-65). In terms of ASA status, 5% (35/700) were classified as ASA 1; 35% (245/700) as ASA 2; 39% (273/700) as ASA 3; 19% (131/700) as ASA 4; 2% (16/700) as ASA 5. Emergency laparotomy was performed due to colonic perforation in 16% (110/700), small bowel perforation in 6% (43/700), perforated peptic ulcer in 5% (34/700), large bowel obstruction in 11% (81/700), small bowel obstruction in 39% (270/700), colitis in 4% (26/700), intestinal ischaemia in 8% (54/700), anastomotic leak in 4% (28/700), intraabdominal collection in 4% (31/700), and other indications in 3% (23/700). Intraperitoneal contamination was present in 32% (222/700) patients; 18% (126/700) had purulent contamination and 14% (96/700) had feculent contamination. The median preoperative HI was 19.01 (IQR: 3.89-87.28) (Table 1).

Meta-analysis: Among the included population, 41% (590/1437) were male and 59% (847/1437) were female with mean age 63 years (95%CI: 62-64). In terms of ASA status, 7% (100/1437) were classified as ASA 1; 32% (460/1437) as ASA 2; 42% (603/1437) as ASA 3; 17% (244/1437) as ASA 4; 2% (30/1437) as ASA 5. Emergency laparotomy was performed due to colonic perforation in 16 % (235/1437), small bowel perforation in 5 % (78/1437), perforated peptic ulcer in 8% (112/1437), large bowel obstruction in 13% (182/1437), small bowel obstruction in 37% (536/1437) patients, colitis in 2% (33/1437), intestinal ischaemia in 6% (92/1437), anastomotic leak in 3% (39/1437), intraabdominal collection in 5% (65/1437), and other indications in 5% (65/1437). Intraperitoneal contamination was present in 29% (423/1437) patients; 15% (219/1437) had purulent contamination and 14% (204/1437) had feculent contamination. The median preoperative HI was 21.3 (IQR: 4.2-117.9).

Outcome synthesis

The AUC for HI was 0.79 (95%CI: 0.76-0.82, $P < 0.0001$) based on ROC curve analysis (Figure 3A). Analysis of classification table showed that HI classified 72% of cases correctly. Meta-analysis of 1437 patients from 4 cohorts of patients showed that the pooled AUC of HI for presence of any peritoneal contamination was 0.79 (95%CI: 0.75-0.83). The heterogeneity was judged to be low ($I^2 = 0\%$, $P = 0.639$) (Figure 4A).

Table 1 Baseline characteristics of the included studies and included population

	Current study	Hajibandeh 2021	Hajibandeh 2020	Hajibandeh 2020	Meta-analysis
Country	United Kingdom	United Kingdom	United Kingdom	United Kingdom	United Kingdom
Journal	-	*Int J Colorectal Dis*	*J Perioper Pract*	*J Perioper Pract*	-
Design	Retrospective cohort	Prospective cohort	Retrospective cohort	Retrospective cohort	Meta-analysis
Number of patients	700	269	234	234	1437
Description of included patients	Patients undergoing emergency laparotomy	Patients undergoing emergency laparotomy	Patients undergoing emergency laparotomy	Patients undergoing emergency laparotomy	Patients undergoing emergency laparotomy
Age, mean (95%CI)	63 (62-65)	64 (62-66)	60.2 (58-62)	62(60-65)	63 (62-64)
Male, *n* (%)	261 out of 700 (37%)	123 out of 269 (46%)	100 out of 234 (43%)	106 out of 234 (45%)	590 out of 1437 (41%)
Female, *n* (%)	439 out of 700 (63%)	146 out of 269 (54%)	134 out of 234 (57%)	128 out of 234 (55%)	847 out of 1437 (59%)
ASA, *n* (%)					
1	35 out of 700 (5%)	9 out of 269 (3%)	23 out of 234 (10%)	33 out of 234 (14%)	100 out of 1437 (7%)
2	245 out of 700 (35%)	54 out of 269 (20%)	85 out of 234 (36%)	76 out of 234 (33%)	460 out of 1437 (32%)
3	273 out of 700 (39%)	158 out of 269 (59%)	94 out of 234 (40%)	78 out of 234 (33%)	603 out of 1437 (42%)
4	131 out of 700 (19%)	43 out of 269 (16%)	30 out of 234 (13%)	40 out of 234 (17%)	244 out of 1437 (17%)
5	16 out of 700 (2%)	5 out of 269 (2%)	2 out of 234 (1%)	7 out of 234 (3%)	30 out of 1437 (2%)
Indication for laparotomy, *n* (%)					
Small bowel obstruction	270 out of 700 (39%)	94 out of 269 (35%)	88 out of 234 (38%)	84 out of 234 (36%)	536 out of 1437 (37%)
Large bowel obstruction	81 out of 700 (11%)	34 out of 269 (13%)	39 out of 234 (17%)	28 out of 234 (12%)	182 out of 1437 (13%)
Perforated peptic ulcer	34 out of 700 (5%)	27 out of 269 (10%)	23 out of 234 (10%)	28 out of 234 (12%)	112 out of 1437 (8%)
Small bowel perforation	43 out of 700 (6%)	10 out of 269 (4%)	14 out of 234 (6%)	11 out of 234 (5%)	78 out of 1437 (5%)
Colonic perforation	110 out of 700 (16%)	47 out of 269 (17%)	36 out of 234 (15%)	42 out of 234 (18%)	235 out of 1437 (16%)
Intestinal ischaemia	54 out of 700 (8%)	25 out of 269 (9%)	5 out of 234 (2%)	8 out of 234 (3%)	92 out of 1437 (6%)
Intraabdominal collection	31 out of 700 (4%)	4 out of 269 (2%)	12 out of 234 (5%)	18 out of 234 (8%)	65 out of 1437 (5%)
Colitis	26 out of 700 (4%)	5 out of 269 (2%)	0 out of 234 (0%)	2 out of 234 (1%)	33 out of 1437 (2%)
Anastomotic leak	28 out of 700 (4%)	3 out of 269 (1%)	4 out of 234 (2%)	4 out of 234 (2%)	39 out of 1437 (3%)
Other	23 out of 700 (3%)	20 out of 269 (7%)	13 out of 234 (5%)	9 out of 234 (3%)	65 out of 1437 (5%)
Intraperitoneal contamination, *n* (%)	222 out of 700 (32%)	67 out of 269 (25%)	72 out of 234 (31%)	62 out of 234 (27%)	423 out of 1437 (29%)
Purulent contamination, *n* (%)	126 out of 700 (18%)	17 out of 269 (6%)	44 out of 234 (19%)	32 out of 234 (14%)	219 out of 1437 (15%)
Feculent contamination, *n* (%)	96 out of 700 (14%)	50 out of 269 (19%)	28 out of 234 (12%)	30 out of 234 (13%)	204 out of 1437 (14%)
Preoperative HI, median (IQR)	19.01 (3.89-87.28)	25.2 (4.5–121.1)	23.3 (3.6–130.4)	32.2 (4.9–144.3)	21.3 (4.2-117.9)

CI: Confidence interval; ASA: American Society of Anesthesiologists; HI: Hajibandeh index; IQR: Interquartile range.

Nature of contamination

Purulent contamination: Based on ROC curve analysis, the AUC for HI was 0.76 (95%CI: 0.72-0.80, $P < 0.0001$) (Figure 3B). Analysis of classification table showed that HI classified 80% of cases correctly. Meta-analysis of 1437 patients from 4 cohorts of patients showed that the pooled AUC of HI for purulent contamination was 0.78 (95%CI: 0.74-0.81). The heterogeneity was judged to be moderate ($I^2 = 54\%$, $P = 0.09$) (Figure 4B).

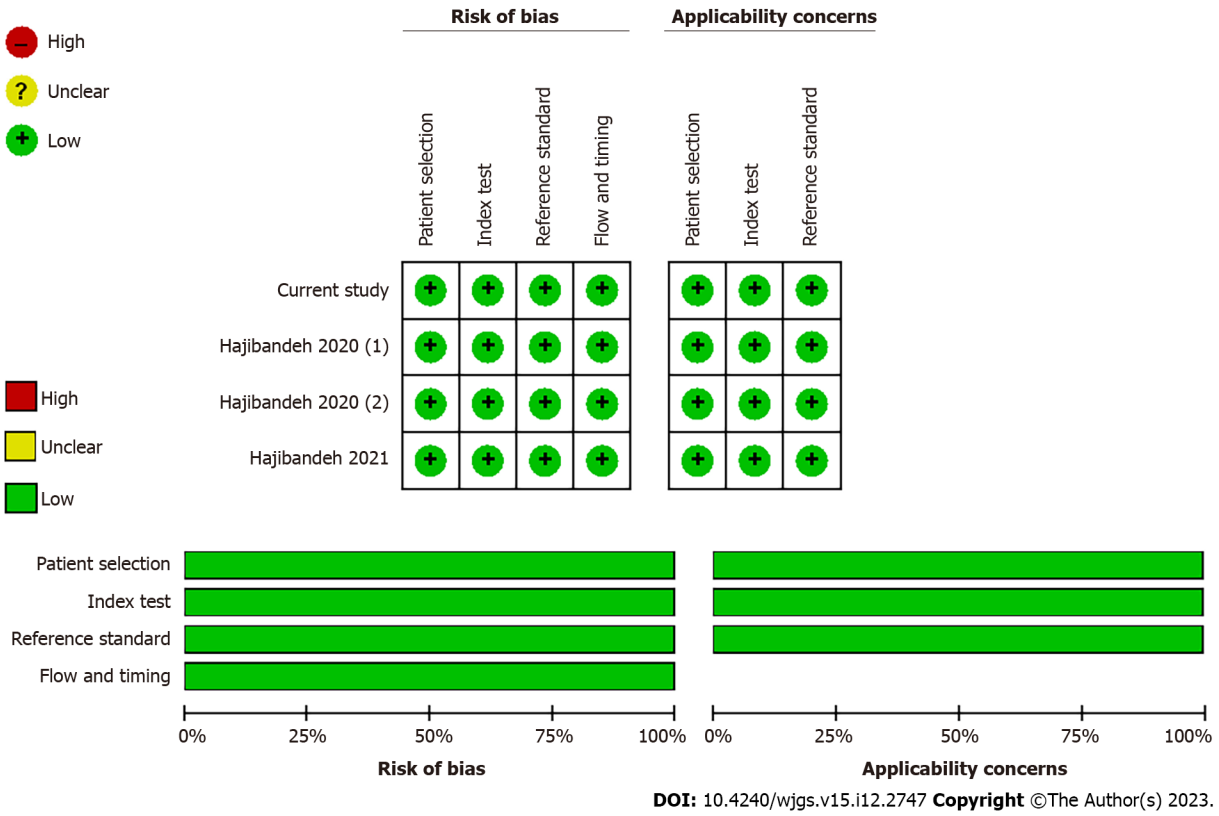

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Figure 2 The outcomes of methodological quality assessment of the included studies using the Quality Assessment of Diagnostic Accuracy Studies 2 criteria.

Feculent contamination: Based on ROC curve analysis, the AUC for HI was 0.83 (95%CI: 0.79-0.86, $P < 0.0001$) (Figure 3C). Analysis of classification table showed that HI classified 84% of cases correctly. Meta-analysis of 1437 patients from 4 cohorts of patients showed that the pooled AUC of HI for feculent contamination was 0.80 (95%CI: 0.77-0.83). The heterogeneity was judged to be low ($I^2 = 0\%$, $P = 0.453$) (Figure 4C).

DISCUSSION

We conducted a cohort study and a systematic review with meta-analysis to validate the accuracy of HI in predicting the presence and nature of intraperitoneal contamination in patients with acute abdominal pathology. Analysis of 1437 patients showed that the HI is strong and relatively accurate predictor of purulent and feculent intraperitoneal contamination in patients with acute abdominal pathology. The clinical and statistical heterogeneity among the included studies were low and the quality of the available evidence was judged to be high as indicated by low risks of bias in terms of patient selection, index test, reference standard, and flow and timing.

The HI is a novel index which was first developed in 2020. Due to its novelty, the predictive value of HI has only been assessed by our previous studies[4,5]. Although this may induce potential publication bias and may affect the generalisability of the findings, the consistency of our findings within different centres and different populations may reflect the robustness of our results. In fact, we have evaluated the predictive value of HI in patients with acute abdominal pain presenting to different centres in North West of England, North Wales, and South Wales. In doing so, the HI has consistently demonstrated very good predictive value in detection of intraperitoneal contamination in all centres.

The presence of intraperitoneal contamination in patients with acute abdominal pathology has a significant prognostic value and is taken into account for predicting postoperative mortality and morbidity by several prognostic tools including the Portsmouth-Physiological and Operative Severity Score for the enumeration of Mortality and morbidity (P-POSSUM)[2], the National Emergency Laparotomy Audit (NELA) model[3], and the Mannheim peritonitis index (MPI)[12]. However, as mentioned earlier, the knowledge about presence of intraperitoneal contamination is only available intraoperatively which would limit the predictive value of prognostic scoring tools such as P-POSSUM, NELA, and MPI. The HI is the only available index that predicts the presence of peritoneal contamination before performing an operation; this could potentially improve the accuracy of the aforementioned prognostic tools and inform decision-making more objectively.

The good performance of HI in predicting presence of intraperitoneal contamination can be easily explained. Peritoneal contamination, tissue necrosis, or intestinal ischaemia is associated with elevated levels of lactate, neutrophil, and CRP (nominator of HI) and decreased levels of lymphocyte and albumin (denominator of HI)[4,5], hence the more severe the

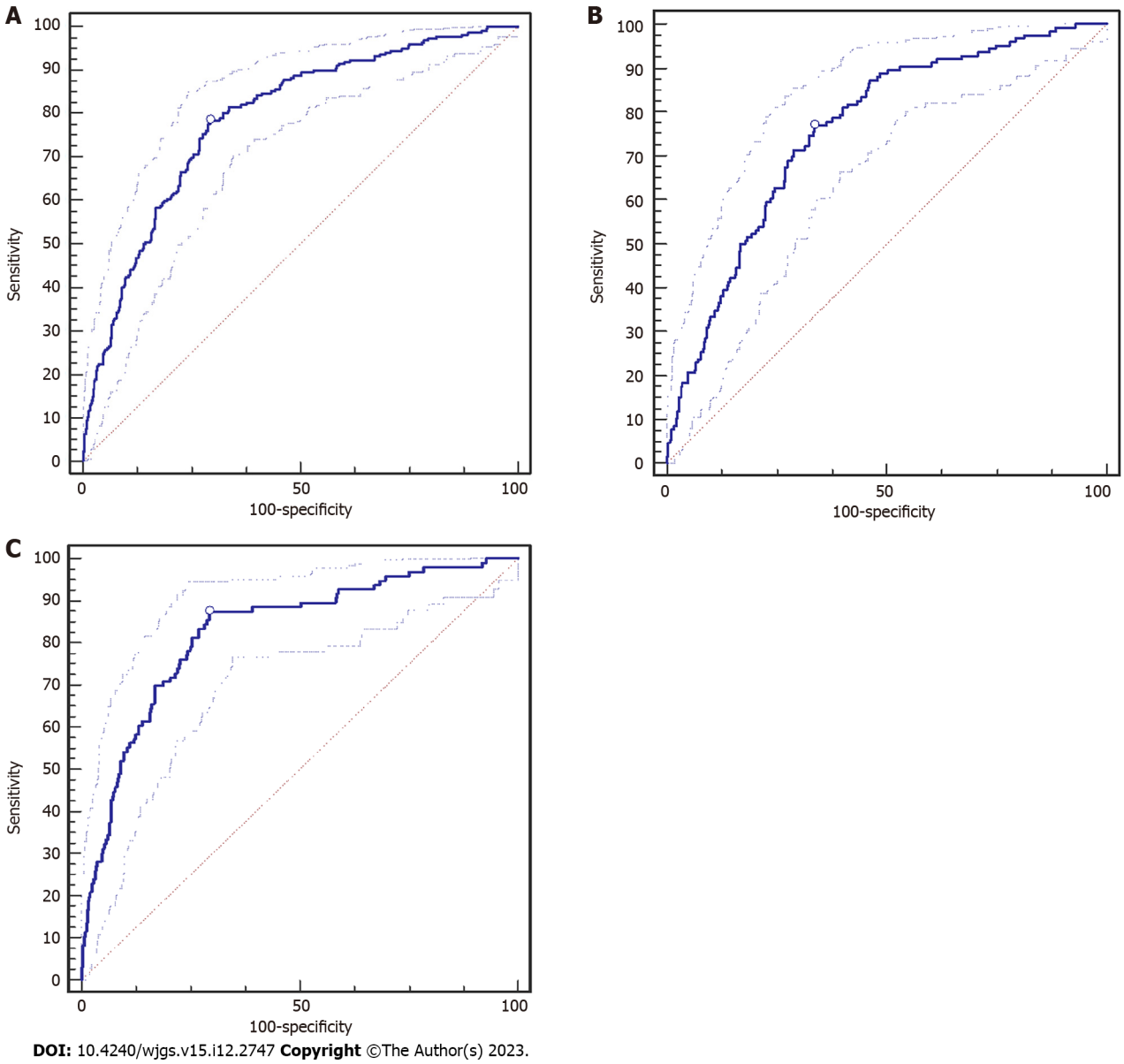

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Figure 3 Results of receiver operating characteristic curve analyses of Hajibandeh index. A: Presence of contamination; B: Purulent contamination; C: Feculent contamination.

underlying sepsis due to abdominal pathology, the higher the HI. In our previous study, we showed that HI can also predict the risk of mortality following emergency laparotomy[4,6]. Based on the available evidence, sepsis and septic shock are major predictors of mortality[13]. Therefore, high HI due to underlying sepsis can potentially be a predictor of postoperative mortality[6]. We believe that HI may be even better predictor of mortality than being a predictor of intraperitoneal contamination. The main rationale for this is the fact that in presence of intraabdominal tissue ischaemia which is associated with high mortality, the levels of neutrophil, lactate, and CRP would increase significantly resulting in a high HI without evidence of intraperitoneal contamination. In such scenario, the HI could falsely predict presence of intraperitoneal contamination while it would predict the mortality correctly.

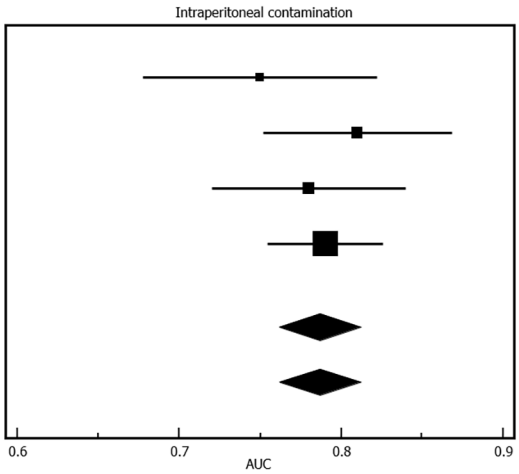
The HI has a potential to be included in preoperative mortality risk assessment tools as recently shown in a predictive model called HAS[6]. The HAS model includes HI, ASA status, and sarcopenia as its components and is the first model with excellent discrimination (AUC: 0.96), calibration, and classification in predicting mortality after emergency laparotomy[6]. It uses HI to take into account the severity of abdominal pathology and it uses ASA status and sarcopenia to take into account the physical status of the patient in terms of co-morbidities, frailty, and physiological reserve[6].

The systematic and objective methodology, adequate statistical power, similar baseline characteristics of the included studies and populations, and low risks of bias within the included studies support the internal validity of the results. Nevertheless, this study is associated with some limitations. The included studies have been performed by our team; this may induce potential publication bias and may affect the generalisability of the findings. Considering the fact the number of included studies was less than 10, we could not formally assess the risk of publication bias. Selection bias cannot be excluded due to retrospective design of the study. In order to minimise the risk of selection bias, we recruited two independent authors for data collection, we separated the authors involved in data collection from the authors conducted

A

Study	Sample size	AUC	Standard error	95%CI
Hajibandeh 2020	234	0.75	0.037	0.68 to 0.82
Hajibandeh 2020	234	0.81	0.029	0.75 to 0.87
Hajibandeh 2021	269	0.78	0.031	0.72 to 0.84
Current study	700	0.79	0.018	0.75 to 0.83
Total (fixed effects)	1437	0.79	0.013	0.76 to 0.81
Total (random effects)	1437	0.79	0.013	0.76 to 0.81

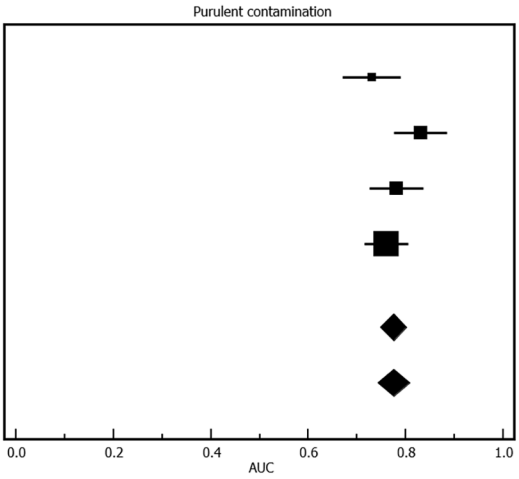
Heterogeneity: Q = 1.69; df = 3 (P = 0.639); I^2 = 0%



B

Study	Sample size	AUC	Standard error	95%CI
Hajibandeh 2020	234	0.73	0.031	0.67to0.79
Hajibandeh 2020	234	0.83	0.028	0.77to0.88
Hajibandeh 2021	269	0.78	0.028	0.72to0.83
Current study	700	0.76	0.023	0.72to0.81
Total (fixed effects)	1437	0.78	0.014	0.75to0.80
Total (random effects)	1437	0.78	0.018	0.74to0.81

Heterogeneity: Q = 6.45; df = 3 (P = 0.09); I^2 = 54%



C

Study	Sample size	AUC	Standard error	95%CI
Hajibandeh 2020	234	0.78	0.031	0.71to0.83
Hajibandeh 2020	234	0.79	0.031	0.73to0.85
Hajibandeh 2021	269	0.78	0.028	0.72to0.83
Current study	700	0.83	0.024	0.78to0.88
Total (fixed effects)	1437	0.80	0.014	0.77to0.83
Total (random effects)	1437	0.80	0.014	0.77to0.83

Heterogeneity: Q = 2.63; df = 3 (P = 0.453); I^2 = 0%

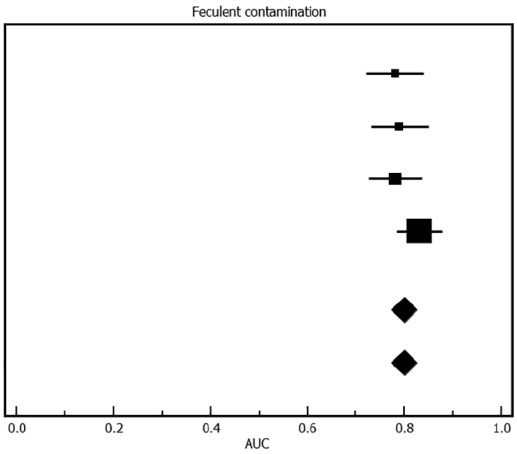


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Figure 4 Forest plot of the area under the curve of Hajibandeh index. A: Presence of intraperitoneal contamination; B: Purulent contamination; C: Feculent contamination. AUC: Area under the curve; CI: Confidence interval.

data analyses, and we performed appropriate subgroup analyses.

CONCLUSION

The HI is a strong and accurate predictor of the presence and nature of intraperitoneal contamination in patients with acute abdominal pathology. Although the available evidence is robust, it is limited to the studies conducted by our evidence synthesis group. We encourage other researchers to validate performance of HI in predicting the presence of intraperitoneal contamination and more importantly in predicting mortality following emergency laparotomy.

ARTICLE HIGHLIGHTS

Research background

Intraperitoneal contamination leads to increase in levels of C-reactive protein (CRP), lactate, neutrophils and lead to decrease in levels of lymphocytes and albumin. Hajibandeh index (HI), which includes CRP, neutrophils and lactate as nominators and albumin and lymphocytes as denominators, has been developed to predict peritoneal contamination and postoperative mortality in patients with acute abdominal pathology.

Research motivation

Presence of intraperitoneal contamination is an important predictor of morbidity and mortality in patients with acute abdominal pathology and it is taken into account by preoperative prognostic scoring tools. Therefore, early detection of intraperitoneal contamination is very important.

Research objectives

The objective of the study was to validate accuracy of HI in predicting the presence and nature of peritoneal contamination in patients with acute abdominal pathology.

Research methods

The STROBE guidelines and the PRISMA statement standards were followed to conduct a cohort study and a meta-analysis, respectively. The accuracy of the HI was evaluated using receiver operating characteristic curve analysis in the cohort study and using weighted summary area under the curve (AUC) under the fixed and random effects modelling in the meta-analysis.

Research results

Analysis of 1437 patients showed that HI can accurately predict the presence of peritoneal contamination in patients with acute abdominal pathology (AUC: 0.79, 95% confidence interval: 0.75-0.83).

Research conclusions

The HI is a strong and accurate predictor of intraperitoneal contamination in patients with acute abdominal pathology.

Research perspectives

HI is an objectively derived index from basic biomarkers and is worth attention for inclusion in emergency laparotomy preoperative risk assessment tools. It is a strong predictor of intraperitoneal contamination and postoperative mortality. The available evidence is robust but is limited to the studies conducted by our evidence synthesis group. The predictive performance of HI needs to be externally validated by other researchers.

FOOTNOTES

Co-first authors: Shahab Hajibandeh and Shahin Hajibandeh.

Author contributions: Hajibandeh S contributed to the conception and design of this study; Evans L, Miller B, Waterman J, Hale J, Higgi A, Johnson B, and Pearce D participated in the data collection; Hajibandeh S and Hajibandeh S took part in the analysis and interpretation of this manuscript, and wrote the article; all authors contributed to the critical revision of the article of this study; and all authors approved the final article.

Institutional review board statement: The study was conducted in accordance with institutions' policies and internal arrangements approved by local Clinical Governance Unit. The study was a retrospective cohort study and meta-analysis involving non-identifiable data from hospital and electronic databases, hence patients' consent and approval by Research Ethics Committees were not required.

Informed consent statement: The study was a retrospective cohort study and meta-analysis involving non-identifiable data from hospital and electronic databases, hence patients' consent was not required.

Conflict-of-interest statement: All the authors report no relevant conflicts of interest for this article.

Data sharing statement: The data and materials related to this study will be available upon reasonable request from the corresponding author.

STROBE statement: The authors have read the STROBE Statement-checklist of items, and the manuscript was prepared and revised according to the STROBE Statement-checklist of items.

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