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SCIENTIFIC REVIEW

# One-Year Outcomes Following Emergency Laparotomy: A Systematic Review

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## Abstract

*Background* Emergency laparotomies (EL) are associated with significant morbidity and mortality. To date, 30-day mortality has been predominately reported, and been the focus of various national emergency laparotomy audits. Only a few studies have reported on the long-term mortality associated with EL. The aim of this study was to review the one-year mortality following EL.

*Method* A systematic review was conducted using PRISMA guidelines to identify studies published in the last 10 years reporting on long-term mortality associated with EL. The data abstracted included: patient demographics, pathology or type of operation performed for EL, post-operative mortality at 7-day, 30-day, 90-day, 1-year, beyond 1-year and inpatient, functional outcomes and risk factors associated with mortality. A quality assessment of included studies was performed.

*Results* Fifteen studies reporting long-term outcomes associated with EL were identified, including the results of 48,023 patients. The indications and/or pathologies for ELs varied. The 30-day mortality after EL ranged from 5.3% to 21.8%, and the one-year mortality ranged from 15.1 to 47%. The mortality in the six studies focusing on elderly patients ranged from 30 to 47%.

*Conclusion* The long-term mortality rate associated with EL is substantial. Further study is required to understand the 1-year mortality described in the studies and translate these findings for meaningful application into the clinical care of these patients.

## Introduction

Emergency laparotomy (EL) is a common general surgery procedure performed for a number of different indications, including sepsis, bowel perforation, intraabdominal bleeding, and others. It has traditionally been associated with a high morbidity and mortality [1]. Since the inception of the National Emergency Laparotomy Audit (NELA) in England and Wales, there has been a significant reduction in the 30-day mortality [1, 2]. Similar audits and studies have been replicated in other health care jurisdictions, including The Netherlands, Denmark, and Australia [3–6]. At the same time, significant improvements in outcomes from these surgeries have been reported, and various bundles of care advocated [7–9]. For example, the NELA risk score has been incorporated in many hospitals' routine clinical practice when assessing and counselling patients requiring EL [2, 3].

Risk assessment scores, such as Portsmouth-Physiological and Operative Severity Score (P-POSSUM), American College of Surgeons National Surgical Quality

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Improvement Program (ACS-NSQIP), American Society of Anaesthesiologists (ASA) score and CT volumetric assessment of sarcopenia, are useful tools in predicting and estimating the 30-day and in-hospital, mortality [10–12]. However, none have been evaluated for the use for longer term mortality and functional outcomes. There are various scores such as Rockwood Clinical Frailty Scale, Fried Phenotype, Clinical Frailty Scale which have been evaluated to assess frailty in various settings including elective and emergency surgeries [13, 14]. There tend to be an overestimation of frailty prevalence for emergency surgery [15]. Nevertheless, there is some recent evidence that the Emergency General Surgery Specific Frailty Index or the Trauma Specific Frailty Index may be able to pre-emptively identify frail geriatric patients undergoing emergency general surgical procedures to have multidisciplinary input for optimisation peri-operatively to reduce length of stay, readmissions and morbidities [16]. However, this will require validation in other cohort of patients including younger patients with comorbidities.

Other variables such as length of stay, days on the ventilator, days in the Intensive Care Unit and post-operative morbidity are often used as a measure for the "success" in surgical outcome [16]. Though these may be important for quality improvement in the hospitals, they may not represent what matters to the patient. The concept of "goals of care" (GOC), emphasizing early discussion with patients about their expectations, and in particular the ceiling of care, perhaps has a role in the management of this group of patients.

The aim of this study is to summarize the recent published data on long-term, i.e. beyond 30-day and in-hospital mortality, from EL. We hypothesized that considerable mortality occurs after the 30-day period and associated index hospital stay.

## Methods and materials

### Literature search strategy, study selection and inclusion and exclusion criteria

A systematic literature search was performed in PubMED, EMBASE, Cochrane databases from January 2010 to until April 2021. The date was selected to reflect the advancement in modern surgical and imaging techniques with improved critical care which corresponded to the development of the interest in outcomes following emergency surgery since the first NELA initiative in the UK in 2013. The search terms were "emergency laparotomy" AND "outcome"; "emergency laparotomy" AND "mortality". The reference list from each study was manually cross-checked to identify potential further studies. Case reports, letters, conference abstracts and peer reviews were excluded. Similarly, paediatric populations (age $< 16$ years), and papers not reporting outcomes of one year or greater, were excluded. Paediatric population was excluded as they have a different pathological and physiological process. Studies with insufficient details on variables of interest for the study outcomes for data extraction were excluded after detailed review. Foreign language publications were not excluded.

The search strategy is summarized in a PRISMA flow diagram (Fig. 1).

### Data extraction and review

Two reviewers (ZN and DW) independently performed the literature search and reviewed the studies. Any discrepancy was resolved through discussion between both reviewers. A Microsoft Excel spreadsheet was created, and the following data collected: background of the study details, primary and secondary aims, inclusion and exclusion criteria, pre-operative risk assessment score(s) used, number of patients, basic demographics, pathology or type of operation performed in the emergency surgery, post-operative morbidity, mortality at 7-day, 30-day, 90-day, 1-year, beyond 1-year and inpatient, functional outcomes, method of follow-up and risk factors associated with mortality.

### Primary and secondary aims

The primary aim was to evaluate the 1-year and/or beyond mortality rate following EL. The secondary aims included the mortality rates at inpatient, 7-day, 30-day, 90-day if reported, mortality rates in geriatric population, morbidity and functional outcomes following EL.

The definition of "geriatric" for this study was guided by the studies which identified the study population as geriatric or patient population age $\geq 65$ years as commonly defined in the literature.

### Quality assessments

The quality of included studies was evaluated with the Newcastle–Ottawa scale (Table 1).

### Statistical analyses

A meta-analysis was not performed due to heterogeneity in the inclusion criteria as well as the outcome measures of the identified studies.

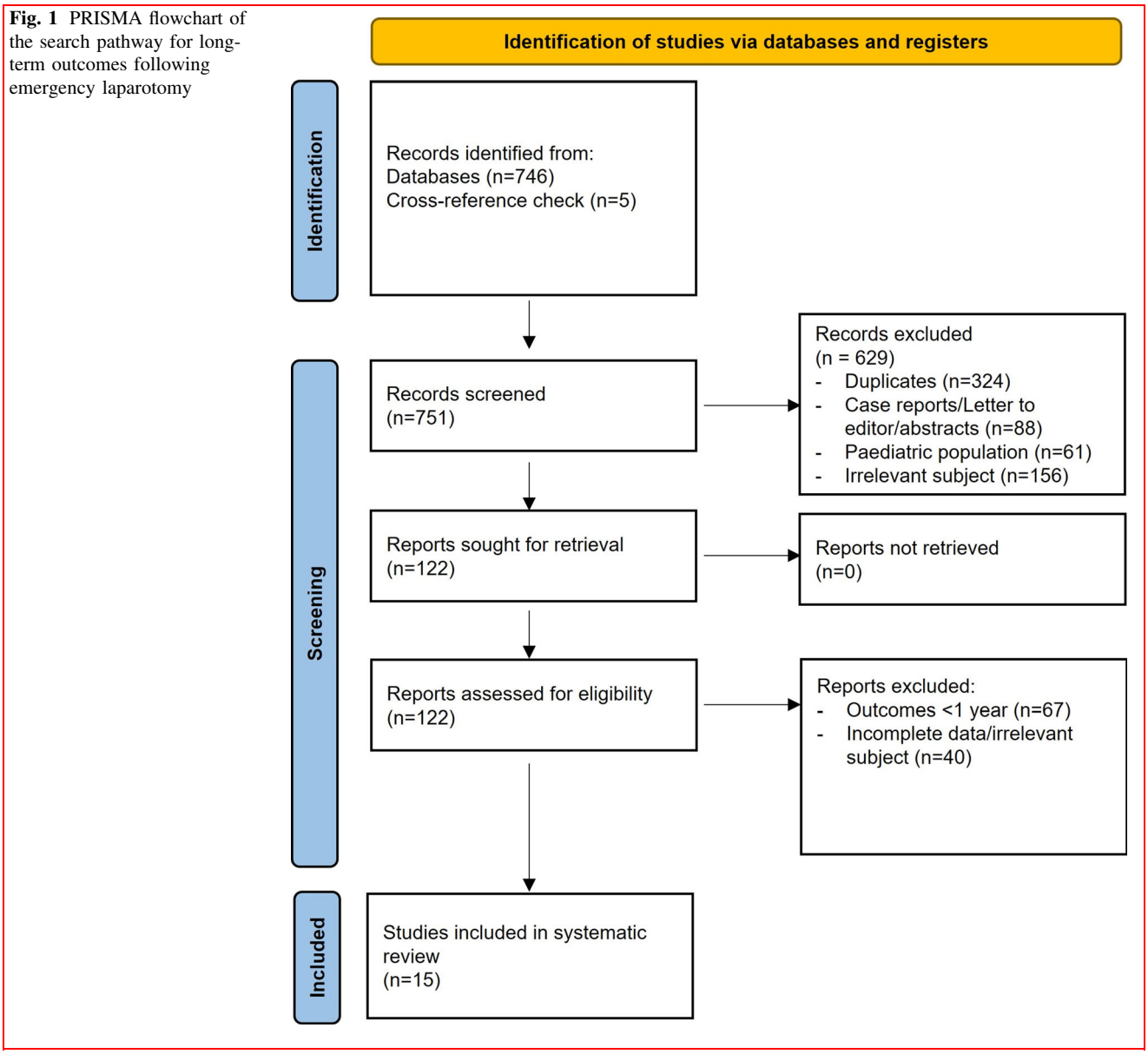


**Fig. 1** PRISMA flowchart of the search pathway for long-term outcomes following emergency laparotomy

## Results

### Study characteristics

A total of fifteen studies were included in the final analysis (Table 2) [4, 10, 12, 17–28]. Of the fifteen studies, seven studies were from the UK, five from the Scandinavian region, two from Asia and one from Australasia. The majority (eleven studies) were retrospective in design; of which three were retrospective study on prospectively collected database. Four studies were formally designed as a prospective observational cohort study. The majority of included studies presented patients attended in the last twelve years; only three studies included data from the years between 2000 and 2009.

The primary and secondary aims differed in all studies. Four studies evaluated long-term outcomes as a primary aim [4, 10, 18, 24]. All the studies investigated ELs with different exclusion criteria. The type of emergency laparotomy included was not standardized.

### Demographics, Pathology/Type of surgery (Table 3)

A total of 48,328 patients were included from the fifteen studies. The largest cohort ($n$ = 32,285) originated from a Danish registry [4]. The indications for the ELs varied across studies and are not classified in a uniform or standard fashion. Similarly, the definition of an EL varied. Studies had a particular variable approach towards appendicectomy procedures; in the large Danish cohort [4],

**Table 1** Newcastle–Ottawa quality assessment scales for both cohort and case control studies

| Study | Selection (Cohort studies) | | | | Comparability | Outcomes | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Representativeness of the exposed cohort | Selection of the non-exposed cohort | Ascertainment of exposure | Demonstration that outcome of interest was not present at start of study | | Assessment of outcomes | Length of follow-up | Adequacy of follow-up cohorts | |
| Awad et al. (2012) [17] | ★ | ★ | ★ | ★ | – | ★ | ★ | ★ | 7 |
| Green et al. (2013) [22] | ★ | ★ | ★ | ★ | – | ★ | ★ | ★★ | 8 |
| Watt et al. (2014) [18] | ★ | ★ | ★ | ★ | – | ★ | ★ | ★★ | 8 |
| Tengberg et al. (2017) [23] | ★ | ★ | ★ | ★ | – | ★ | ★ | ★ | 7 |
| Trotter et al. (2018) [10] | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★★ | 9 |
| Jeppesen et al. (2019) [4] | ★ | ★ | ★ | ★ | – | ★ | ★ | ★ | 7 |
| Hajibandeh et al. (2020) [26] | ★ | ★ | ★ | ★ | – | ★★ | ★ | ★★ | 9 |
| Barazanchi et al. (2020) [12] | ★ | – | ★ | ★ | ★ | ★★ | ★ | ★★ | 9 |
| Aakre et al. (2020) [19] | ★ | – | ★ | ★ | – | ★ | ★ | ★★ | 7 |
| Barazanchi et al. (2020) [12] | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | 8 |
| Vilches-Moraga et al.(2020) [27] | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | 8 |
| Alder et al. (2021) [24] | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | 8 |
| Study | Selection (Case control studies) | | | | Comparability | Outcomes | | | Total |
| | Case definition adequate | Representativeness | Control selection | Definition of controls | | Ascertainment of exposure | Same method of Ascertainment | Non response rate | |
| Moller et al. (2019) [25] | ★ | ★ | – | ★ | ★ | ★ | ★ | ★ | 7 |
| Chua et al. (2020) [20] | ★ | ★ | – | ★ | ★ | ★ | ★ | – | 6 |
| Goh et al. (2020) [19] | ★ | ★ | – | ★ | ★ | ★ | ★ | – | 6 |
| Maghami et al. (2021) [28] | ★ | ★ | – | ★ | ★ | ★ | ★ | – | **6** |

27.5% of patients had a pathology associated with the vermiform appendix, while other studies excluded these pathologies.

### Mortality (Fig. 2)

*Inpatient, 7-day, 30-day, 90-day*

Six studies reported the inpatient mortality rates, ranging from 2.5 to 24% [4, 20, 21, 26–28]. One study reported the 7-day mortality rate at 12.1% [4]. Eleven studies reported the mortality rates at 30-day, ranging from 5.3 to 21.8% [4, 10, 12, 18–21, 23, 24, 26, 27]. Four studies reported the mortality rates at 90-day which ranged from 20 to 34% [4, 21, 24, 27].

*1-year, beyond 1-year*

The 1-year mortality reported in the fifteen studies ranged from 9.2 to 47%. For the three studies that reported beyond 1-year mortality rates, all reported further increase in the rates [17, 22, 24]. Of these three studies, only one reported the median follow-up of 19 months (range 16–23).

*Geriatric population*

Six studies investigated geriatric population undergoing EL [21, 22, 24, 26–28], consisting of 1187 patients with the mean or median age in the range of 79 to 85 years old. While the exclusion criteria were not uniform, the pathology or operation performed during EL were predominantly for small and large intestinal pathology/surgery. The 1-year mortality following EL in this subgroup ranged from 30 to 47%.

### Functional outcomes

Five of the fifteen studies reported functional outcomes [19–21, 24, 26, 27], and four of these studies focused on the geriatric patients [19, 21, 24, 27]. There were considerable geographical differences in discharge destination: 65% of patients in the Norwegian study [21] were discharged to a nursing home as compared to only 0.6% and 0.7% of patients, in two Singaporean studies [19, 20]. Across studies, around one-fifth of patients (range 12.4–20%) required rehabilitation/community hospital stepdown. More detailed functional outcomes were not reported. No detailed definitions of rehabilitation or discharge facility destinations were offered by the various studies.

### Quality assessment of the studies (Table 1)

Of the 15 included studies, three were classified as very good studies, nine were classified as good studies and three were classified as satisfactory studies based on the Newcastle–Ottawa scale for both cohort and case control studies.

## Discussion

The 1-year mortality following EL in this systematic review ranged from 9.2% up to 47%. This considerable mortality was markedly greater than the 30-day mortality reported by the same studies. While a few case series have reported these long-term mortalities following EL, this study represents the first systematic review of these data. Clinical efforts and current quality improvement projects appear to have largely focused on shorter term outcomes.

Recent attention on the short-term outcomes of EL has been associated with a significant reduction in mortality at 30-day [2, 8]. The improvements have been attributed to various "bundles of care", which ordinarily include more timely theatre access, early specialist involvement from surgery and anaesthetics, the use of peri-operative goal-directed fluid therapy, planned admission to intensive care units, and better patient selection [2, 7, 9, 23, 29]. Aggrawal et al. showed the use of 6-point evidence-based bundle reduced the unadjusted and risk-adjusted mortality rates 30-day following EL [8]. This improvement has also been observed in a rural hospital setting [29, 30].

Given the finding of a high long-term mortality rate in this review, we submit that the next challenge is to find improvements affecting these late outcomes [31]. There was no difference in 180-day mortality in the EPOCH study which attempted to implement a 37-element care bundle at 93 hospitals across UK in patients undergoing emergency general surgery [9]. A similar observation was seen in the outcomes following neck of femur fractures. Trevisan et al. recently demonstrated a significant reduction of the short-term mortality rates (12.5% to 6.9%) over a 15-year period, but the long-term mortality rates remain stagnant despite an increase in comorbidities [32].

Risk assessment scores have been developed to guide prognostication of short-term outcomes. The ACS-NSQIP risk calculator was evaluated in a study of patients > 90 years old undergoing emergency general surgery but was found to have underestimated mortality and morbidity at 30-day [11]. Despite nine of the studies included patients above the age of 16 years, the mean or median age in the studies was distributed around the age of 60 years; the risk

**Table 2** The characteristics of the studies included in the analysis, including exclusion criteria

| Author/Year/Country | Study design | Setting | Study period | Primary aim | Secondary aim | Exclusion criteria |
|---|---|---|---|---|---|---|
| Awad et al./2012/UK [17] | Prospective observational | University teaching hospital | 15 Sep 2008–December 2008 | 30-day mortality | ICU/HDU length of stay, LOS, discharge destination, overall, in hospital, 12-month, 24-month mortality | Vascular surgical procedures, laparotomy elsewhere, open appendicectomy, laparoscopic cholecystectomy |
| Green et al./2013/UK [22] | Retrospective | Secondary hospital | 1 January 2005–1 January 2010 | Morbidity and mortality associated with emergency laparotomy for a clinically acute abdomen in patients aged > 80 | – | Laparoscopy alone, procedures involving inguinal incision for hernia repair, simple appendicectomy |
| Watt et al./2014/UK [18] | Retrospective | University teaching hospital | June 2010–May 2012 | **30-day mortality, age-related 30-day mortality and overall, 1-year mortality** | Any factors affecting morbidity and mortality | Laparoscopic procedures, laparoscopic converted to open (not requiring laparotomy), local anaesthetic cases, non-general surgical cases, vascular surgical cases |
| Tengberg et al. / 2016/ Denmark [23] | Retrospective | University teaching hospital | 1 January 2012–31 December 2012 | | | Appendicectomy, diagnostic procedures, cholecystectomy, simple herniotomy without bowel resection, subacute internal herniorrhaphy after Roux-en-Y gastric bypass surgery, subacute surgery for IBD, subacute colorectal cancer surgery, pregnant women, polytrauma, urology, gynaecology, vascular (except mesenteric ischemia) |
| Trotter et al./2018/UK [10] | Prospective observational | York NHS Foundation Trust hospitals | October 2014–October 2015 | **Mortality at 30-day and 1-year** | Discharge to non-independent living | Without CT scan within 30 days of surgery |
| Jeppesen et al./2019/ Denmark [4] | Prospective observational | Nationwide cohort | January 2003–21 December 2013 | **Short- and long-term mortality (7, 30, 90, 365 days)** | frequency of GI reoperations, acute readmissions and post-operative complications at 30- and 90-days following surgery | Abdominal surgery within 30 days prior to the admission |
| Goh et al./2020/ Singapore [19] | Retrospective | Secondary hospital | January 2017-December 2017 | Emergency laparotomy outcomes in an acute hospital | Factors associated with 30-day mortality and explore perioperative outcomes in elderly patients | Trauma-related laparotomy, vascular, gynaecology emergencies, relook laparotomies |
| Chua et al./2020/ Singapore [20] | Retrospective of a prospective audit database | University hospital | January 2015–December 2017 | To measure outcomes which the elderly population face following emergency laparotomy | To determine the burden risk factors has on predicting survival following emergency laparotomy | Patients < 18 of age |

**Table 2** continued

| Author/Year/Country | Study design | Setting | Study period | Primary aim | Secondary aim | Exclusion criteria |
|---|---|---|---|---|---|---|
| Aakre et al./2020/Norway [19] | Retrospective | University hospital | January 2015–December 2016 | 30-day mortality | 30-day mortality, 1-year mortality, in-hospital complications, and level of care at discharge | Pure palliative surgery and emergency vascular surgery |
| Moller et al./2020/Denmark [25] | Retrospective | Nationwide cohort | 2003–2014 | To explore the association between socioeconomic position and the incidence of non-malignant emergency laparotomies involving resection, ostomy, or drainage and the association between individual socioeconomic position and one-year postoperative mortality | – | Reoperations and primary diagnosis involving cancer |
| Barazanchi et al./2020/New Zealand [12] | Retrospective | Tertiary hospital | May 2012-June 2017 | To assess the most commonly used risk prediction tools for emergency laparotomy and to provide external validation for the newly developed NELA risk prediction tool. To examine the discrimination and calibration of the NELA, P-POSSUM, ACS-NSQIP and APACHE-II tools | To explore the impact of adding measures of patient frailty and nutritional status to the aforementioned tools | Patients undergoing gastrointestinal surgery performed either during acute admission or for reoperation following complications after an elective surgery were included. Obstetric/gynaecological, cholecystectomies, appendectomies, aortic/iliac, and trauma procedures were excluded |
| Vilches-Moraga et al./2020/UK [27] | Prospective Observational | Tertiary hospital | 8th Sep–30 March 2017 | To describe the long-term impact of frailty and impairments in functional status, mobility and cognition in older patients undergoing emergency laparotomy | – | Remain as inpatient > 90 days prior to the final date of data collection |
| Hajibandeh et al./2021/UK [26] | Retrospective | Secondary and tertiary hospitals | April 2014-August 2019 | 30-day mortality | In-hospital mortality and 1-year mortality | Trauma-related laparotomy |
| Alder et al./2021/UK [24] | Retrospective of a prospective audit database | Tertiary hospital | July 2015–July 2016 | **All- cause mortality at median follow-up with an aim to capture 18–24 months follow-up data** | LOS, morbidity, postoperative QOL and change in the clinical frailty scale | |
| Maghami et al./2021/Sweden [28] | Retrospective | University hospital | 1 Jan 2015–31 Dec 2016 | Utilizing pre-operative beta-blockade in this patient cohort (geriatric patients undergoing emergency laparotomy) reduces mortality and post-operative complications | – | – |

In Bold: primary outcomes investigating long-term outcomes following emergency laparotomy

**Table 3** The basic demographics, type of surgeries included and pathology or operations performed

| Author/Year/Country | No. of patients | Age | Sex (Male:Female) | Type of surgery | Operation or pathology (n or %) |
|---|---|---|---|---|---|
| Awad et al./2012/UK [17] | 85 | 66 (median) (50–75) | – | Emergency laparotomy | – |
| Green et al./2013/UK [22] | 100 | 85 (mean) (80–96) | 2:1 | Patients > 80 years of age undergoing emergency laparotomy for intestinal conditions or secondary peritonitis | Hernia 12, secondary peritonitis 37, colonic obstruction 40, colonic anastomotic leak 1, Aorto-bifemoral graft removal 1, intra-abdominal bleeding 1, bowel ischemia 5, pseudo-obstruction 1, colovesical fistula 1, AAA repair 1 |
| Watt et al./2014/UK [18] | 446 (477 laparotomies) | – | 223:223 | All patients who underwent emergency laparotomy | Resection with no stoma 130, Resection with stoma 86, No resection with no stoma 141, No resection with stoma 41, Palliative bypass 18, others 30 |
| Tengberg et al./2016/Denmark [23] | 826 (+ 198 laparoscopic converted) | – | – | All patients > 17 years requiring emergency laparotomy or laparoscopy | – |
| Trotter et al./2018/UK [10] | 259 | – | 125:134 | Non resuscitative Emergency laparotomy | Obstruction 141, perforation 83, ischaemia 23, haemorrhage 8, colitis 4 |
| Jeppesen et al./2019/Denmark [4] | 32,285 | 67 (median) (53–78) | 14,688:17,597 | Patients > 18 years who underwent emergency laparotomy | Intestine 37.6%, appendix 27.5% |
| Goh et al./2020/Singapore [19] | 152 | 49 (< 65yo); 75 (> 65yo) | 96:80 | Patients > 16 years old who underwent emergency laparotomy | Perforated gastric/duodenal ulcer 34, colorectal cancer (obstructed/perforated) 31, intestinal obstruction secondary to adhesions 23, bowel ischemia 16, perforation of intestine 19, anastomotic leak 12, bleeding 4, intestinal obstruction (bezoar/FB) 5, non-malignant intestinal obstruction 5, gallstone ileus 3 |
| Chua et al./2020/Singapore [20] | 170 | 60.5 (mean) | 98:72 | All consecutive cases of emergency laparotomies | Gastric perforation 11, small intestinal perforation 19, large intestinal perforation, intestinal obstruction 70, ischaemic bowel, anastomotic complications 15, intra-abdominal sepsis 21, haemorrhage 7 |
| Aakre et al./2020/Norway [19] | 106 | 84 (median) (80–96) | 43:63 | Mortality and morbidity in patients aged > 80 years undergoing emergency laparotomy without a standardized care bundle for emergency laparotomy | Resection of colon 26, Adhesiolysis 24, Resection of Small bowel 18, Laparotomy (paralytic ileus, trauma, fascia dehiscence) 15, Gastro/duodeno/enterorrhaphy 11, Appendicectomy 6, incarcerated hernia 4, gastrectomy 2 |
| Moller et al./2020/Denmark [25] | 11,962 | 65.7(mean) | 5254:6708 | All patients aged > 18 years who had undergone emergency laparotomy | Bowel resection 10,104, Drainage 518, Ostomy 4682 |

**Table 3** continued

| Author/Year/Country | No. of patients | Age | Sex (Male:Female) | Type of surgery | Operation or pathology (n or %) |
|---|---|---|---|---|---|
| Barazanchi et al./2020/New Zealand [12] | 758 | 62 (median) (18–96) | 378:380 | Inclusion criteria similar to the UK NELA | Colectomy (total or subtotal)/ hemicolectomy(right or left) 161, adhesiolysis, 158, small bowel resection/repair/anastomosis 136, Hartmann's procedure/reversal 93, Washout/drainage of collection 44, repair of bowel perforation 30, Stoma formation/revision 27, gastric surgery, 23, anterior rectal resection 21, enterotomy/removal of foreign body 8, sigmoid colon resection 8, reduction of volvulus 4, abdominal wall closure 3, intestinal bypass 3, haemostasis 2, other 6 |
| Vilches-Moraga et al./2020/UK [27] | 113 | 81.9 (mean) | 53:60 | All patients aged 75 years old or older undergoing emergency laparotomy | Bowel obstruction and perforation (46%), liver/biliary conditions 6.2%, Hernias 22.1%, Peritonitis 5.3%, Miscellaneous 5.3%, gastrointestinal ulcers 0.9%, diverticulitis 2.7%, bowel ischemia 3.5%, cancer (curative intent) 6.2%, cancer (progression) 1.8% |
| Hajibandeh et al./2021/UK [26] | 523 | 84.3 (mean) | 236:287 | All consecutive patients aged over 80 who underwent an emergency laparotomy due to an acute abdominal pathology | Colon perforation 72, small bowel perforation 39, peptic ulcer perforation 33, large bowel obstruction 92, small bowel obstruction 208, intestinal ischaemia 49, anastomotic leak 12, intra-abdominal bleeding 5, intraabdominal abscess 4, intestinal fistula 4, bleeding peptic ulcer 3, colitis 2 |
| Alder et al./2021/UK [24] | 153 | 79 (median) | 57:96 | All patients over the age of 70 years who underwent emergency laparotomy | – |
| Maghami et al. / 2021/ Sweden [28] | 192 | 76 (mean) | 97:95 | All geriatric patients ($\geq$ 65 years) who underwent an emergency laparotomy | Obstruction 114, perforation 44, ischemia 18, bleeding 6, other 10 |

of being treated with an EL appears to increase with age as with the risk of certain pathologies such as diverticular disease [33], bowel obstruction either from adhesions or malignancy [34]. These risk assessment scores may not fit into every age group or pathology. The focus will need to be shifted to the post-operative care. Although the reason was not detailed in the Singaporean study, we postulate that a significant effort has been placed into post-operative rehabilitative care where 20% of patients were discharged to a community hospital. The incorporation of geriatric/peri-operative care into the patient's management can have a positive impact on reduction of mortality, readmissions, and return to residence [35].

The current study does not focus on the correlation of outcomes with the subspecialty expertise offered for the pathology indicated for EL. However, the type of hospital setting may play a vital role in the long-term outcomes. In a tertiary university hospital, it is expected that full 24-h access to services for radiology, emergency surgery, anaesthesia, intensive care unit and subspecialty service such as geriatrics or palliative care are readily available. This is in contrast in this review that some studies are based in non-tertiary hospital setting which may have its limitation on the care provided [36].

A noticeable limitation of the current study was the heterogeneity of pathologies included. In a few studies,

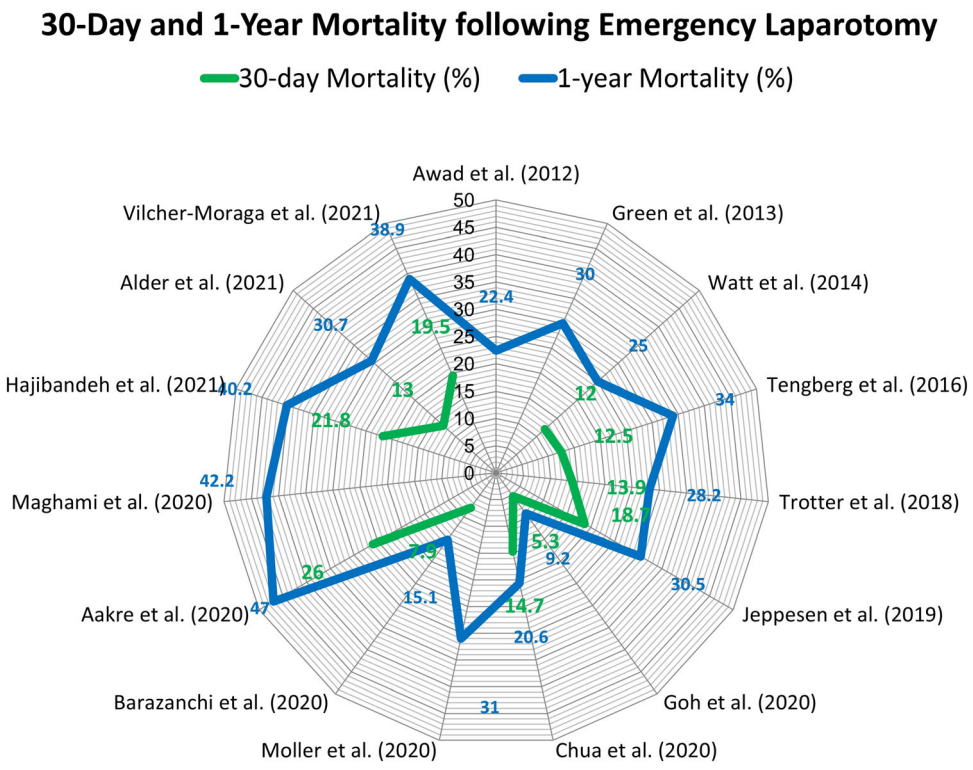


**Fig. 2** 30-day and 1-year mortality rates following emergency laparotomy

malignancy was a risk factor for poor prognosis if performed for EL [24, 26]. Naturally, the long-term mortality rate is likely to be higher. Furthermore, studies variably included different age cohorts, with some only focusing on the elderly [21, 22, 24, 26–28]. Similarly, when the studies included trauma or vascular-related EL, the outcomes are further clouded. For future research efforts, we suggest an urgent need to standardize definitions and include sufficient granularity regarding pathologies, such that improved comparison between hospitals and cohorts may be possible.

The stark one-year range of mortality reported in this systematic review challenges the clinician to engage in a meaningful and truthful GOC discussion with a patient before obtaining consent for an EL. Hatchimonji et al. rightfully asked the question "Do we know our patients' goals?" [37]. However, the concept of GOC is still evolving and encapsulates broadly the prognosis/diagnosis, illness/injury trajectory and goals/desired outcomes [38]. Furthermore, the mortality rate should not be the sole determinant of outcome measure. Unfortunately, the late morbidity data appears similarly lacking.

Current specialist training curricula for surgeons includes little formal training for GOC discussions, and methods for appropriate counselling of these patients and their families [39]. A recent study found that surgeons struggle to decide when there is unclear prognosis in the case and often continue with aggressive intervention, fearing that the patient and/or family may believe the surgeons were giving up [40]. While communication on prognoses, cardiopulmonary resuscitation and intubation have improved, long-term prognoses such as regarding tracheostomy, prolonged enteral feeding, decline in functional baseline will need further effort. Quality of life following EL is hard to quantify and should be individualized. Returning to pre-surgery level of functioning is usually a key indicator. Sadly, a study from Norway found that 65% of patients over the age of 80 years were discharged to a nursing home facility compared with 16% pre-surgery [21]. A study also showed that discharge disposition to a nursing home is an independent risk factor of death within 30-day post-surgery (OR 2.07; 95% CI 1.65–2.61) [41].

The current systematic review is limited by the small number of publications focusing on long-term outcomes following EL. Furthermore, the discussion is complicated by the heterogeneity in various study inclusion and exclusion criteria. The definitions of EL also varied. The definition of geriatric was not universal where certain studies evaluated the outcomes on patients $\geq$ 65 years of age [28], some above the age of 70 [24, 27] and some studies focussed only on patients $\geq$ 80 years of age [21, 22, 26] which might have influenced the subgroup analysis of geriatric population. Unfortunately, most studies also did not report the method of follow-up; this is likely to have further under-reported the already alarming mortality rate.

## Conclusion

The long-term mortality rate following EL appears substantial and is considerably greater than at one month or in-hospital. The range of 1-year mortality of up to 47% seen in the studies included in this systematic review, prompts the need for further investigation of these late outcomes. Furthermore, it prompts surgeons to communicate with patients needing EL to achieve a shared decision where the long-term outcome might indicate potentially a futile surgery. Future study designs should have uniformity in classification and definition systems for reporting.

**Author's contribution** ZQN contributed to study design, data collection and analysis and drafting of manuscript. DW contributed to co-design study, data collection and analysis and critical review of manuscript. All authors approved the final version of manuscript for submission and publication.

**Declarations**

**Conflict of interest** The authors have no conflict of interest or financial ties to declare.

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