Mortality and complications after emergency laparotomy in patients above 80 years

Elin K. Aakre1 | Atle Ulvik1 | Karl O. Hufthammer2 | Ib Jammer1

Emergency laparotomy (EL) is a high-risk procedure. However, available evidence regarding outcome after emergency surgery in very old patients is limited. The aim of this observational study was to investigate outcome following EL in patients ≥80 years of age.

Methods: This single-center retrospective study was undertaken at Haukeland University Hospital, Norway. Demographic data, pre-operative risk assessment, surgical procedures, intra-hospital logistics, complications, mortality, and discharge data were collected from the medical records. Primary outcome was 30-day mortality. Secondary outcomes were 90-day mortality, 1-year mortality, post-operative complications, and level of care at discharge.

Results: One hundred and six patients aged 80-96 years underwent EL between 2015 and 2016. Of these, 58% had cardiopulmonary disease, and 16% lived in a nursing home before surgery. Resection of colon was performed in 26 cases, adhesiolysis was performed in 24, and resection of small intestine in 18. Within 30 days, 28 patients died (26%), 15 during the first post-operative week. For 82% of the patients, at least one complication occurred, and medical complications were far more frequent than surgical. Post-operatively, pulmonary morbidity was found in 51 patients (48%) and delirium in 42 (40%). The number of inhospital deaths was 25 (24%). Among the 81 survivors, 53 were discharged to a nursing home (65%). One-year mortality was 47% (50/106).

Conclusions: Mortality after EL in octo- and nonagenarians is very high. Medical complications are more common than surgical, and functional decline is frequent. Future studies should focus on the effect of a care bundle including geriatric intervention in these patients.
1 | BACKGROUND

Emergency laparotomy is a high-risk procedure in old patients due to underlying comorbidity, frailty, and reduced physiological reserves.\(^1\) Previously, there has been little focus on emergency abdominal surgery patients, but this is changing, as the National Emergency Laparotomy Audit (NELA) is expanding in the United Kingdom.\(^2\) In Denmark, a national clinical database of emergency abdominal surgery is being established, collecting data regarding clinical outcome after surgery for bowel obstruction and perforated hollow viscus.\(^3\)

The first report from the NELA initiative\(^4\) revealed huge variations in standards of care after EL and thus several authors now advocate care bundles in emergency abdominal surgery.\(^5,6\) However, many Nordic hospitals have not implemented such standardized pathways yet.

Emergency laparotomy is performed more often in older than in younger patients.\(^6\) Nevertheless, available evidence regarding emergency surgery in octo- and nonagenarians is limited, and few studies have addressed outcome after EL in this group.\(^7-14\) The oldest age groups are now expanding rapidly, and the number of octogenarians in Norway is expected to double within 20 years.\(^15\)

Therefore, the aim of this study was to investigate mortality and morbidity in patients aged ≥80 years undergoing emergency laparotomy in a Norwegian university hospital without a standardized care bundle for emergency laparotomy.

2 | METHODS

This is a single-center retrospective cohort study. In April 2017, the electronic operation planning system at Haukeland University Hospital, Norway, was queried for patients ≥80 years old undergoing emergency laparotomy during the period January 2015 through December 2016. Exclusion criteria were pure palliative surgery and emergency vascular surgery. The primary outcome was 30-day mortality. 

Editorial Comment:
In this observational single-center study, findings of high morbidity, mortality and a substantial functional decline are reported after emergency laparotomy in patients above 80 years. Structural changes in the treatment program for these older patients are suggested.
mortality, and secondary outcomes were 90-day mortality, 1-year mortality, in-hospital complications, and level of care at discharge.

Data regarding age, sex, American Society of Anesthesiologists physical status classification (ASA), comorbidities, residential status, and number of daily medications were retrieved from the medical records. Daily medication was defined as any medication prescribed by a physician, also including vitamin substitution and herbal medication. The following parameters were recorded: duration from CT scan until start of surgery, the operative procedures performed, intraoperative findings, duration of surgery, length of stay in the Post-Anesthesia Care Unit (PACU) or Intensive Care Unit (ICU), and length of hospital stay. The post-operative complications and proportion of patients discharged to institutional care were registered. Mortality data were collected from the Norwegian National Registry, which records deaths for all Norwegian citizens.

Complications were defined by the European Perioperative Clinical Outcome (EPCO) definitions for all complications except delirium, and graded according to the Clavien-Dindo grading system. Complications with Clavien-Dindo grade ≥2 were included. To identify delirium, a chart-based method described by Inouye was used.

The project was approved by the Regional Ethics Committee, who waived informed consent (REK 2017/610).

2.1 | Statistical analysis

We present categorical data as counts and percentages (with 95% confidence intervals), and continuous data as means, medians and/or ranges, as appropriate. Confidence intervals for percentages were calculated using the recommended Wilson (score) method. Survival up to 1 year is also shown as a Kaplan-Meier survival curve (Figure 1), with 95% pointwise confidence bands. The 30-day standardized mortality ratio (SMR) was calculated using age- and sex-matched mortality data for the general Norwegian population.

The amount of missing data was low (<5% for all variables), so for variables with missing data, we used complete-case analysis. All statistical analyses were done using SPSS 24 (Chicago IL USA) and/or R version 3.6.0.

3 | RESULTS

All eligible patients undergoing emergency laparotomy during the 2-year period were included, in total 106 patients. Demographic data regarding age, sex, ASA classification, and comorbidities are shown in Table 1. Comorbidity was present in 102 patients (96%), and 62 (58%) had cardiopulmonary disease, that is, COPD, emphysema, asthma, cardiac arrhythmia, ischemic heart disease, or congestive heart failure. Cancer other than gastrointestinal was present in 11 (10%) patients. The median number of daily prescriptions in the cohort was 5. A table demonstrating the 20 most common classes of medications taken by the patients is shown in “Supplementary material” (Table S1). Pre-operatively, 17 (16%) patients were nursing home residents, and 89 (84%) lived at home.

The operative procedures, intraoperative findings, and intra-hospital logistics are described in Table 2. Resection of colon was performed in 25%, followed by adhesiolysis, and resection of small intestine. Median time from CT-scan until surgery was 9.0 hours, median stay in PACU was 18 hours, and 12 patients (11%) were treated in the ICU post-operatively.

Post-operative complications are shown in Figure 2 and Table S2. Mortality and discharge data are shown in Table 3. For 82% of the patients, at least one complication occurred. Pulmonary complications (POPCs) were the most frequent complication (48%), followed by delirium (40%). Kidney failure and paralytic ileus were equally common (22%), and wound infection occurred in 17%. The number of intrahospital deaths was 25 (24%), and of the 81 surviving patients, 53 were discharged to a nursing home post-operatively. The median length of hospital stay was 9 days (range 0.6-50 days). The total 30-day, 90-day, and 1-year mortality were 26%, 34%, and 47%, respectively.

Of the 28 patients dying within 30 days, 15 (54%) died during the first week after surgery. The corresponding mortality rates

| TABLE 1 | Patient characteristics (n = 106) |
| Variable | Count or (median) | Percentage |
| Age (80-96) | (84) | – |
| Female | 63 | 59% |
| ASA-classification* | | |
| ASA 2 | 11 | 11% |
| ASA 3 | 59 | 58% |
| ASA 4 | 32 | 31% |
| Comorbidities | | |
| Hypertension | 54 | 51% |
| COPD, Emphysema or Asthma | 27 | 26% |
| Ischemic heart disease | 25 | 24% |
| Arrhythmia | 27 | 26% |
| Diabetes Mellitus | 18 | 17% |
| Cerebrovascular disease | 16 | 15% |
| Congestive heart failure | 14 | 13% |
| Kidney failure | 14 | 13% |
| Dementia or Cognitive failure | 13 | 12% |
| Peripheral vascular disease | 6 | 6% |
| Number of daily prescriptions | | |
| 0 | 10 | 9% |
| 1 | 3 | 3% |
| 2 | 6 | 6% |
| 3 | 5 | 5% |
| 4 | 16 | 15% |
| 5 | 14 | 13% |
| >5 | 52 | 49% |

*Four patients have missing information on ASA category.
among the 17 patients living in a nursing home before surgery were 29%, 53%, and 76%, respectively. A Kaplan–Meier survival curve for 1-year follow-up is shown in Figure 1. The expected number of deaths within a 30-day period for an age- and sex-matched general Norwegian population was 0.82, giving a standardized mortality ratio of 28/0.82 = 34 (95% CI: 23-49).

In the cohort, there were 82 patients without cancer, and their 1-year mortality rate was 44%. The 1-year mortality rate among the 24 patients with either previously known cancer (n = 10) or cancer diagnosed at surgery (n = 14) was 58%.

### DISCUSSION

This study demonstrates the unique problems in the elderly emergency surgical population. The subjects presenting for surgery were multimorbid and polypharmacy was widespread. Post-operative mortality was very high, and most of the patients experienced at least one complication. The risk of functional decline was obvious, as about 2/3 of the survivors were discharged to a nursing home.

In our study, mortality after 30 and 90 days was 26% and 34%, respectively. This is higher than for a UK cohort of 4 246 patients (aged 80-89), with corresponding mortality rates of 18% and 24%, respectively.

A few retrospective single-center studies from France, Japan, the UK, and the US have reported 30-day mortality after EL in octo- and nonagenarians. Their rates varied between 15% and 40%.

An unexpected finding was the high 1-year mortality of >40% in the 82 patients without cancer. This is markedly higher compared to the average 6% risk of dying within a year in the general Norwegian population aged 80-85, and also higher than the mortality after surgery for fractured neck of femur. In 2017, Norwegian patients with hip fracture had a 30-day and 1-year mortality rate of 8% and 24%, respectively.

Due to lack of follow-up of patients after hospital discharge, the causes of death between 30 days and 1 year after EL were not investigated in this study. The problems elderly patients face after EL have not yet been comprehensively studied, and there has been little focus on perioperative care of this group. A recent report from the NELA demonstrated that only 3% of UK hospitals met the recommended standard for perioperative care of elderly emergency abdominal surgery patients, even though almost half of the patients were elderly.

At 30 days, we found that about one in four had died, with more than half of the deaths occurring during the first post-operative week. This finding raises the question whether some of the procedures were futile and if surgery should have been avoided in the first place. According to an American paper, 30-day mortality after EL was 90% in patients aged >90 years with dependent functional status presenting with septic shock.

Until recently, there has been no standardized definition of post-operative complications, and this probably explains why complications after EL are reported in the range of 29.5%-71%. A few retrospective single-center studies from France, Japan, the UK, and the US have reported 30-day mortality after EL in octo- and nonagenarians. Their rates varied between 15% and 40%.

### TABLE 2 Operative procedures and intrahospital logistics (n = 106)

| Variable                              | Count | Percentage | Range         | Mean | Median |
|---------------------------------------|-------|------------|---------------|------|--------|
| Operative Procedure                   |       |            |               |      |        |
| Resection of colon                    | 26    | 25%        |               |      |        |
| Adhesiolysis                          | 24    | 23%        |               |      |        |
| Resection of small bowel              | 18    | 17%        |               |      |        |
| Laparotomy, other*                    | 15    | 14%        |               |      |        |
| Gastro/duodeno/enterorrhaphy          | 11    | 10%        |               |      |        |
| Appendectomy                          | 6     | 6%         |               |      |        |
| Incarcerated hernia                   | 4     | 4%         |               |      |        |
| Gastrectomy                           | 2     | 2%         |               |      |        |
| Intraoperative findings               |       |            |               |      |        |
| Malignancy                            | 14    | 13%        |               |      |        |
| Contamination/pus                     | 14    | 13%        |               |      |        |
| Intrahospital logistics               |       |            |               |      |        |
| Transfer to ICU                       | 12    | 11%        |               |      |        |
| Time from CT scan to surgery (hours)  | 0.5-156 | 19           | 9             |      |        |
| Duration of surgery (min)             | 30-332 | 114          | 99            |      |        |
| Stay in PACU (hours)                  | 3-83  | 22         | 18            |      |        |
| Time in ICU (days)                    | 1-8   | 4          | 4             |      |        |

*paralytic ileus, trauma, fascial dehiscence
medical morbidities were far more frequent than surgical, and almost half of the patients developed a pulmonary complication. Similar findings are commonly reported after abdominal surgery in the elderly, and up to a threefold increase in pulmonary complications has been reported in patients ≥85 years. \(^2^8\)

The second most common morbidity was delirium, which was observed in 40% of the patients. According to the formal definition,\(^1^7\) this complication should only be registered when based on strict criteria. Use of a delirium score is not common practice in Norwegian surgical wards. Hence, we used a chart-based method for evaluating delirium in the hospitalized patients retrospectively.\(^2^9\)

The frequency of delirium is probably underestimated, as hypoactive delirium is difficult to recognize, and some of the cognitive problems could represent post-operative cognitive dysfunction. A high prevalence of cognitive dysfunction has also been reported in other studies in patients hospitalized with acute surgical morbidity. One study found delirium in 2/3 of elderly patients admitted for general surgical conditions,\(^2^9\) while a retrospective study reported a 33% incidence of post-operative delirium after elective major surgery.\(^3^0\)

The evidence regarding functional decline or discharge to institution after emergency laparotomy is scarce.\(^1^2-1^4\) However, in one study, 60% of the patients needed assistance with ADL,\(^1^3\) and in another paper, 55% of patients were discharged to long-time care.\(^1^2\) Both results are similar to our findings.

The majority of our patients were vulnerable, as only four patients were admitted without any previous comorbidity. This is comparable to data from other studies,\(^7-1^4\) where comorbidities were present in 75%-90% of the patients.

In contrast to comorbidity and serious abdominal pathology, intrahospital care plans are factors amenable to optimization. Huge variation in standards of care for EL patients have been documented,

\[\text{FIGURE 2} \quad \text{Postoperative complications after emergency laparotomy, with 95\% confidence intervals (n = 106) [Colour figure can be viewed at wileyonlinelibrary.com]}\]

\[\text{TABLE 3} \quad \text{Mortality (n = 106) and discharge data (n = 81)}\]

| Variable                                | Count | Percentage |
|-----------------------------------------|-------|------------|
| Mortality (n = 106)                     |       |            |
| 30 days                                 | 28    | 26%        |
| 90 days                                 | 36    | 34%        |
| 1 year                                  | 50    | 47%        |
| Mortality, nursing home residents (n =17)|       |            |
| 30 days                                 | 5     | 29%        |
| 90 days                                 | 9     | 53%        |
| 1 year                                  | 13    | 76%        |
| Discharge data (n = 81)                 |       |            |
| Discharge to home                       | 27    | 33%        |
| Discharge to nursing home facility      | 53    | 65%        |
| Discharge destination not recorded      | 1     | 1%         |
and this contributes to high morbidity and mortality. Our study demonstrated a wide range in duration between CT scan and surgery (0.5-156 hours). The delay could be due to the fact that CT scans sometimes are inconclusive, indicating a chance that the patient might recover spontaneously. In such case, a strategy of “watch and wait” is appropriate. However, long interval between diagnose and treatment could also reflect scarce capacity or low priority in the OR. During waiting hours, patients were often observed in the ordinary ward with limited surveillance and limited opportunities for optimizing fluid balance, electrolyte disturbances, etc. After surgery, patients spent a median of 18 hours in our PACU, which is comparable to a high-dependency unit, followed by discharge to the ward. At the ward, an “Enhanced Recovery After Surgery” (ERAS) program had not yet been implemented, possibly resulting in less focus on mobilization and nutrition after surgery. Although most of the patients were multimorbid and taking several medications daily, geriatric competence was never sought, as our hospital does not offer such service.

There is evidence that standardizing patient flow for emergency general surgery patients leads to better outcome. In Denmark, a multidisciplinary care bundle has shown a significant reduction in 30-day mortality from 21.8% to 15.5%. This bundle consists of evidence-based elements like early evaluation of patients by experienced surgeons and anesthetists, a short interval between decision to operate and surgery, and post-operative intermediate care. A similar “bundle” approach has resulted in favorable outcome in the UK. However, a care bundle addressing the specific problems in the elderly population has not yet been studied.

The strengths of this study are the use of a pre-specified classification of complications, and the robust long-term outcome easily retrieved from the Norwegian National Registry. We have also achieved a comprehensive description of this elderly cohort, the prevalence and nature of the post-operative complications, and the frequent functional deterioration after surgery.

The study has several limitations. It is a retrospective single-center study, limiting external generalization of the data, and with a small number of patients included. However, our results are in accordance with reports from larger populations.

Due to lack of information, we did not score frailty retrospectively. The modified frailty index (MFI) has been used in large studies, but this score measures comorbidity rather than frailty. We suspect, however, that a large proportion of our patients were frail, as frailty is reported in 28%-79.9% of elderly emergency surgery patients. The number of patients deemed unfit and thus rejected for surgery in this 2-year period is unknown, but suspected to be very low, as offering surgery when indicated, even if the patient is very fragile, has been common practice in our hospital.

In conclusion, our study demonstrates that poor outcome after emergency laparotomy in octo- and nonagenarians is common, with high mortality and morbidity, and hence a high risk of functional decline. Our findings call for a structural change in the treatment of older patients undergoing emergency laparotomy. The effect of a standardized pathway designed for elderly patients, consisting of evidence-based interventions like early involvement by competent physicians, rapid surgical response when indicated, perioperative resuscitation, and post-operative rehabilitation, should be investigated. Importantly, the bundle should also address ceiling of care—decisions to avoid futile treatment, with an offer of palliation instead. A bundle designed for elderly patients undergoing EL is currently being launched at our hospital (Clinical Trials.gov ID: NCT04293653). Lastly, future research should study the impact of post-operative geriatric service in old patients undergoing emergency abdominal surgery.

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CONFLICT OF INTEREST
All authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTION
Elin Kismul Aakre performed the literature search and wrote the first draft of this manuscript. Karl Ove Hufthammer performed the statistical analysis, prepared the figures, and contributed significantly to the writing of the manuscript. Ib Jammer and Atle Ulvik both contributed significantly to the writing of the manuscript.

ORCID
Elin K. Aakre https://orcid.org/0000-0002-3131-8914
Karl O. Hufthammer https://orcid.org/0000-0003-3170-9496
Ib Jammer https://orcid.org/0000-0001-6759-3929

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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