Causes of death after emergency general surgical admission: population cohort study of mortality

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Abstract

Background: A substantial number of patients treated in emergency general surgery (EGS) services die within a year of discharge. The aim of this study was to analyse causes of death and their relationship to discharge diagnoses, in patients who died within 1 year of discharge from an EGS service in Scotland.

Methods: This was a population cohort study of all patients with an EGS admission in Scotland, UK, in the year before death. Patients admitted to EGS services between January 2008 and December 2017 were included. Data regarding patient admissions were obtained from the Information Services Division in Scotland, and cross-referenced to death certificate data, obtained from the National Records of Scotland.

Results: Of 507,308 patients admitted to EGS services, 7,917 died while in hospital, and 52,094 within 1 year of discharge. For the latter, the median survival time was 67 (IQR 21–168) days after EGS discharge. Malignancy accounted for 48 per cent of deaths and was the predominant cause of death in patients aged over 35 years. The cause of death was directly related to the discharge diagnosis in 56.5 per cent of patients. Symptom-based discharge diagnoses were often associated with a malignancy not diagnosed on admission.

Conclusion: When analysed by subsequent cause of death, EGS is a cancer-based specialty. Adequate follow-up and close links with oncology and palliative care services merit development.

Introduction

Emergency general surgery (EGS) comprises the unscheduled in-hospital treatment of patients under the care of a surgeon with training in gastrointestinal surgery, and an important part of the spectrum of care provided by general surgeons. At any one time, around half of general surgical beds in the UK are occupied by patients who were admitted as an emergency. Per annum, there are around 74,000 such admissions in Scotland and approximately 3 million in the USA. Patients in the EGS service, regardless of operative intervention, are at high risk of dying. The in-hospital mortality rate for such patients is approximately eight times that of patients admitted for elective general surgery. The mortality rate remains high after discharge, particularly among older patients, and those with co-morbidities. In Scotland, 35 per cent of patients aged 75 years and older, who were admitted as an emergency under the care of a general surgeon, died within 1 year of discharge, a figure that almost doubled when severe co-morbidities were present.

Conversely, managed patients are a large group, and these patients also have a high mortality risk, about double that of patients having surgery. Although previous analyses have highlighted poor long-term outcomes after EGS admission and demonstrated the significant influence of age and co-morbidity, causes of postdischarge mortality remain unclear. It is not known whether these patients die from conditions related to the EGS admission, or from entirely different causes. This has obvious implications for postdischarge care and follow-up. The aim of the present study was to analyse causes of death and their relationship with discharge diagnoses, in patients who died within 1 year of discharge from an EGS service in Scotland.

Methods

This was a population-based, cross-sectional study in Scotland, UK.

Data sources

The Information Services Division (ISD; https://www.isdscotland.org) of National Health Service (NHS) Scotland records data on all
interactions with the NHS. Patients are assigned a unique identifier (Community Health Index (CHI) number) on first contact with NHS Scotland services, which allows healthcare interactions to be tracked over time, regardless of provider. ISD data are linked to national death records, allowing mortality to be examined, irrespective of death as an inpatient or in the community.

The ISD uses a consistent coding strategy and data are abstracted by professional coders, with high accuracy and consistency. Data are coded locally within each health board, and stored centrally. Diagnoses are coded using ICD-10, and operative codes using OPCS-4. For the purpose of this study, individualized data for patients meeting the inclusion criteria were anonymized at source and transferred to the National Data Safeguard for analysis. Demographic details, diagnoses, dates of admission, co-morbidity status (according to the Charlson Co-morbidity Index (CCI), 10-year look back) and discharge information were obtained from the SMR01 national data set. Date and cause of death (also coded by ICD-10) were obtained from the National Records of Scotland. For comparison of discharge diagnoses and causes of death, both primary and secondary causes of death were included. Causes of death for the population of Scotland as a whole were obtained from the National Register of Scotland.

### Postdischarge causes of death

**Tables 1 and 2** show causes of death for 13,700 patients who had an operation and 38,394 treated without surgery respectively. Overall, malignancies accounted for almost half of all deaths: 7280 (51.3 per cent) in the operative cohort and 17,735 (46.2 per cent) in the non-operative cohort (P < 0.001). Among patients who had surgery, cancer of the oesophagus was the most common cause of death, followed by cancers of the colon, pancreas, bronchus or lung, and stomach. The most common non-malignant causes of death were acute myocardial infarction (rank 7), chronic ischaemic heart disease, and chronic obstructive pulmonary disease (COPD). In patients who did not require an operation, colonic cancer was the most common cause of death, followed by malignancies in the bronchus or lung, pancreas, and oesophagus. Chronic ischaemic heart disease (rank 5), COPD, and acute myocardial infarction were the most common non-neoplastic causes of death.

The 50 most common causes of death (which accounted for 76.6 per cent of all deaths) for the 52,094 patients who died within 1 year of EGS admission are detailed in **Table S1**.

The ranking of causes of death varied with age (**Table 3**). Of the 619 patients who died aged 16–34 years, poisoning and substance abuse (18.3 per cent), alcoholic liver disease (6.1 per cent), and deliberate self-harm (4.4 per cent) were the most common causes. In those aged 35–54 years (4670 deaths), alcoholic liver disease (7.1 per cent) was the most common cause, followed by colonic, breast, pancreatic, oesophageal, and lung cancers. In 55–74 year olds, neoplastic conditions continued to predominate, whereas among patients aged 75 years and older, acute myocardial infarction, pneumonia, and COPD began to feature more heavily.

The causes of death after EGS admission also varied with comorbidity. In those without previous co-morbidity, the most common causes of death were myocardial infarction, followed by malignancy of the lung and then pneumonia. In those with moderate co-morbidity (CCI score 1–4), the most common causes of death were oesophageal cancer, COPD, and pancreatic cancer. In patients with high levels of co-morbidity (CCI score over 4), malignancy of the colon, pancreas and bronchus were the most common diagnoses at death (**Table 4**).

The rank order between patients treated in the EGS service and all deaths in Scotland over the same time period is shown in **Fig. 1**. Cancer represented a greater proportion of deaths in the EGS group (48 per cent) than in the Scottish population as a whole. Rates of death related to gastrointestinal pathologies were also higher in the EGS population (14 versus 5.8 per cent), whereas cardiovascular and respiratory diseases were less common in these patients.

### Discharge diagnoses

**Tables 1, 2** and **Table S1** show the most common discharge diagnoses overall and by operative status. Non-specific symptoms and signs (ICD-10 R codes) represented the most common primary discharge diagnosis in 7.5 per cent of patients, followed by intestinal obstruction without hernia, colonic cancer, constipation, pancreatic cancer,
| Rank | ICD-10 code | Description | n       | Rank | ICD-10 code                        | Description                                                                 | n       |
|------|-------------|-------------|---------|------|-----------------------------------|-----------------------------------------------------------------------------|---------|
| 1    | C15         | Malignant neoplasm of oesophagus | 1040 (7.6) | 1    | C18                              | Malignant neoplasm of colon                                                | 944 (6.9) |
| 2    | C18         | Malignant neoplasm of colon       | 952 (6.9)  | 2    | K56                              | Paralytic ileus and intestinal obstruction without hernia                  | 929 (6.8) |
| 3    | C25         | Malignant neoplasm of pancreas    | 820 (6.0)  | 3    | C15                              | Malignant neoplasm of oesophagus                                           | 766 (5.6) |
| 4    | C34         | Malignant neoplasm of unspecified part of bronchus or lung | 470 (3.4)  | 4    | C25                              | Malignant neoplasm of pancreas                                             | 571 (4.2) |
| 5    | C16         | Malignant neoplasm of stomach     | 463 (3.4)  | 5    | C78                              | Secondary malignant neoplasm of respiratory and digestive organs           | 385 (2.8) |
| 6    | C22         | Malignant neoplasm of liver and intrahepatic bile ducts | 385 (2.8)  | 6    | C16                              | Malignant neoplasm of stomach                                              | 358 (2.6) |
| 7    | I21         | Acute myocardial infarction       | 376 (2.7)  | 7    | K57                              | Diverticular disease of intestine                                           | 349 (2.6) |
| 8    | I25         | Chronic ischaemic heart disease   | 362 (2.6)  | 8    | K80                              | Cholelithiasis                                                             | 334 (2.4) |
| 9    | G80         | Malignant neoplasm without specification of site | 318 (2.3)  | 9    | K55                              | Vascular disorders of intestine                                             | 300 (2.2) |
| 10   | J44         | Chronic obstructive pulmonary disease | 318 (2.3)  | 10   | R33                              | Retention of urine                                                         | 275 (2.0) |
| 11   | C20         | Malignant neoplasm of rectum      | 297 (2.2)  | 11   | T85                              | Complications of other internal prosthetic devices, implants, and grafts   | 272 (2.0) |
| 12   | C19         | Malignant neoplasm of rectosigmoid junction | 292 (2.1)  | 12   | C20                              | Malignant neoplasm of rectum                                               | 271 (2.0) |
| 13   | J18         | Pneumonia, unspecified organism   | 269 (2.0)  | 13   | K92                              | Haematemesis/melaena                                                        | 250 (1.8) |
| 14   | K56         | Paralytic ileus and intestinal obstruction without hernia | 255 (1.9)  | 14   | C22                              | Malignant neoplasm of liver and intrahepatic bile ducts                    | 234 (1.7) |
| 15   | K55         | Vascular disorders of intestine   | 228 (1.7)  | 15   | K62                              | Other diseases of anus and rectum                                          | 234 (1.7) |
| 16   | C26         | Malignant neoplasm of other and ill defined digestive organs | 220 (1.6)  | 16   | K63                              | Other diseases of intestine (including perforation)                         | 226 (1.7) |
| 17   | C56         | Malignant neoplasm of ovary       | 220 (1.6)  | 17   | R10                              | Abdominal and pelvic pain                                                  | 216 (1.6) |
| 18   | G61         | Malignant neoplasm of prostate    | 189 (1.4)  | 18   | L02                              | Cutaneous abscess, furuncle, and carbuncle                                  | 205 (1.5) |
| 19   | C50         | Malignant neoplasm of breast      | 187 (1.4)  | 19   | K40                              | Inguinal hernia                                                            | 197 (1.4) |
| 20   | G87         | Malignant neoplasm of bladder     | 179 (1.3)  | 20   | K26                              | Duodenal ulcer                                                             | 192 (1.4) |
| 21   | K57         | Diverticular disease of intestine  | 156 (1.1)  | 21   | C80                              | Malignant neoplasm without specification of site                           | 188 (1.4) |
| 22   | J64         | Stroke, unspecified               | 155 (1.1)  | 22   | K22                              | Other diseases of oesophagus                                               | 188 (1.4) |
| 23   | K70         | Alcoholic liver disease           | 155 (1.1)  | 23   | K59                              | Constipation                                                                | 184 (1.3) |
| 24   | J69         | Pneumonitis due to solids and liquids | 145 (1.1)  | 24   | K83                              | Other diseases of biliary tract                                             | 182 (1.3) |
| 25   | K63         | Other diseases of intestine (including perforation) | 133 (1.0)  | 25   | R13                              | Aphagia and dysphagia                                                      | 152 (1.1) |

Values in parentheses are percentages.
Table 2 Most common discharge diagnoses and causes of death for 38 394 patients who died within 1 year of emergency general surgery admission, and had non-operative treatment during the last admission.

| Rank | ICD-10 code | Description | n     | Rank | ICD-10 code | Description | n     |
|------|-------------|-------------|-------|------|-------------|-------------|-------|
| 1    | C18         | Malignant neoplasm of colon | 1931 (5.0) | 1    | R10         | Abdominal and pelvic pain | 6397 (16.7) |
| 2    | C34         | Malignant neoplasm of unspecified part of bronchus or lung | 1824 (4.8) | 2    | K59         | Constipation | 1912 (5.0)  |
| 3    | C25         | Malignant neoplasm of pancreas | 1812 (4.7) | 3    | K56         | Paralytic ileus and intestinal obstruction without hernia | 1312 (3.4)  |
| 4    | C15         | Malignant neoplasm of oesophagus | 1309 (3.4) | 4    | C18         | Malignant neoplasm of colon | 1164 (3.0)  |
| 5    | I25         | Chronic ischaemic heart disease | 1255 (3.3) | 5    | C25         | Malignant neoplasm of pancreas | 1161 (3.0)  |
| 6    | J44         | Chronic obstructive pulmonary disease | 1210 (3.2) | 6    | K92         | Haematemesis | 1104 (2.9)  |
| 7    | I21         | Acute myocardial infarction | 1166 (3.0) | 7    | N39         | Urinary tract infection, site not specified | 906 (2.4) |
| 8    | C22         | Malignant neoplasm of liver and intrahepatic bile ducts | 959 (2.5) | 8    | K85         | Acute pancreatitis | 854 (2.2) |
| 9    | J18         | Pneumonia, unspecified organism | 946 (2.5) | 9    | K80         | Cholelithiasis | 826 (2.2) |
| 10   | C50         | Malignant neoplasm of breast | 827 (2.2) | 10   | C15         | Malignant neoplasm of oesophagus | 774 (2.0) |
| 11   | C16         | Malignant neoplasm of stomach | 816 (2.1) | 11   | K62         | Other diseases of anus and rectum | 750 (2.0) |
| 12   | C61         | Malignant neoplasm of prostate | 789 (2.1) | 12   | S09         | Other and unspecified injuries of head | 719 (1.9) |
| 13   | C67         | Malignant neoplasm of bladder | 723 (1.9) | 13   | K57         | Diverticular disease of intestine | 684 (1.8) |
| 14   | C20         | Malignant neoplasm of rectum | 697 (1.8) | 14   | C78         | Secondary malignant neoplasm of respiratory and digestive organs | 679 (1.8) |
| 15   | C80         | Malignant neoplasm without specification of site | 691 (1.8) | 15   | A41         | Sepsis | 663 (1.7) |
| 16   | C19         | Malignant neoplasm of rectosigmoid junction | 612 (1.6) | 16   | C34         | Malignant neoplasm of bronchus and lung | 515 (1.3) |
| 17   | C56         | Malignant neoplasm of ovary | 574 (1.5) | 17   | R11         | Nausea and vomiting | 505 (1.3) |
| 18   | F03         | Unspecified dementia | 554 (1.4) | 18   | C16         | Malignant neoplasm of stomach | 489 (1.3) |
| 19   | K70         | Alcoholic liver disease | 637 (1.4) | 19   | I73         | Other peripheral vascular diseases | 481 (1.3) |
| 20   | C26         | Malignant neoplasm of other and ill defined digestive organs | 490 (1.3) | 20   | S01         | Open wound of head | 480 (1.3) |
| 21   | I69         | Sequela of cerebrovascular disease | 468 (1.2) | 21   | C22         | Malignant neoplasm of liver and intrahepatic bile ducts | 460 (1.2) |
| 22   | I73         | Other peripheral vascular diseases | 454 (1.2) | 22   | J18         | Pneumonia, unspecified organism | 442 (1.2) |
| 23   | F01         | Vascular dementia | 463 (1.2) | 23   | K83         | Complications of genitourinary prosthetic devices, implants, and grafts | 416 (1.1) |
| 24   | K56         | Paralytic ileus and intestinal obstruction without hernia | 441 (1.2) | 24   | T81         | Complications of procedures, not elsewhere classified | 396 (1.0) |
| 25   | R68         | Other general symptoms and signs (including hyperthermia) | 428 (1.1) | 25   | K55         | Vascular disorders of intestine | 385 (1.0) |

Values in parentheses are percentages.
Overall, malignancies accounted for 26 per cent of discharge diagnoses. Abdominal pain was the most common cause of admission in the non-operative cohort, followed by constipation, paralytic ileus and intestinal obstruction without hernia, colonic cancer then pancreatic cancer. Colonic cancer was the most common admission diagnosis for the operative cohort, followed by paralytic ileus and intestinal obstruction without hernia, oesophageal cancer, and pancreatic cancer.

### Association between diagnosis at discharge and cause of death

Fig. 2 shows the association between diagnosis at discharge (ranked in rows) and cause of death (ranked in columns). Given that both discharge diagnosis and causes of death are ranked, the overall trend is for numbers to decrease from the top left to bottom right. A comparison of rank order of cause of death and EGS discharge diagnosis in operative and non-operative cohorts is shown in Figs S1 and S2 respectively.

Cause of death was the same as the discharge diagnosis (same ICD-10 code) in 56.5 per cent of patients. Among patients who died from malignant diseases (ICD-10 C codes), the odds of the same malignancy having been known at the time of discharge were 3.10 (95 per cent c.i. 2.99 to 3.22). For patients who died from colonic cancer, the odds of having been discharged with this diagnosis in the past year were 2.42 (2.24 to 2.61); respective values were 3.69 (3.39 to 4.02) for pancreatic cancer, and 4.43 (4.03 to 4.85) for oesophageal cancer.

A symptom-based discharge diagnosis (R10, abdominal and pelvic pain; R11, nausea and vomiting; R13, aphagia and dysphagia) was associated with a wide range of causes of death. However, the odds of subsequent death from malignancy were 0.77 (0.72 to 0.82). Similarly, discharge diagnoses such as sepsis and oesophageal cancer. Overall, malignancies accounted for 26 per cent of discharge diagnoses. Abdominal pain was the most common cause of admission in the non-operative cohort, followed by constipation, paralytic ileus and intestinal obstruction without hernia, colonic cancer then pancreatic cancer. Colonic cancer was the most common admission diagnosis for the operative cohort, followed by paralytic ileus and intestinal obstruction without hernia, oesophageal cancer, and pancreatic cancer.

### Table 3 Most common cause of death by age group for patients who died within 1 year of emergency general surgery admission

| Rank | ICD-10 code | Description | n  |
|------|-------------|-------------|----|
| Age 16–34 years | | | |
| 1 | X42 | Accidental poisoning by and exposure to narcotics and psychodysleptics | 62 (10.0) |
| 2 | K70 | Alcoholic liver disease | 38 (6.1) |
| 3 | F19 | Other psychoactive substance dependence with intoxication with perceptual disturbance | 32 (5.2) |
| 4 | X70 | Intentional self harm | 27 (4.4) |
| 5 | C18 | Malignant neoplasm of colon | 22 (3.6) |
| 6 | C50 | Malignant neoplasm of breast | 19 (3.1) |
| 7 | Y12 | Poisoning by and exposure to narcotics and psychodysleptics | 19 (3.1) |
| 8 | C53 | Malignant neoplasm of cervix | 16 (2.6) |
| 9 | R85 | Acute pancreatitis | 13 (2.1) |
| 10 | C20 | Malignant neoplasm of rectum | 12 (1.9) |
| All deaths | | | 619 |
| Age 35–54 years | | | |
| 1 | K70 | Alcoholic liver disease | 333 (7.1) |
| 2 | C18 | Malignant neoplasm of colon | 246 (5.3) |
| 3 | C50 | Malignant neoplasm of breast | 242 (5.2) |
| 4 | C25 | Malignant neoplasm of pancreas | 230 (4.9) |
| 5 | C15 | Malignant neoplasm of oesophagus | 219 (4.7) |
| 6 | C34 | Malignant neoplasm of unspecified part of bronchus or lung | 155 (3.3) |
| 7 | X42 | Accidental poisoning by and exposure to narcotics and psychodysleptics | 119 (2.5) |
| 8 | C16 | Malignant neoplasm of stomach | 115 (2.5) |
| 9 | F10 | Alcohol abuse | 103 (2.2) |
| 10 | C19 | Malignant neoplasm of rectum | 100 (2.1) |
| All deaths | | | 4670 |
| Age 55–74 years | | | |
| 1 | C25 | Malignant neoplasm of pancreas | 1347 (7.1) |
| 2 | C15 | Malignant neoplasm of oesophagus | 1201 (6.3) |
| 3 | C34 | Malignant neoplasm of unspecified part of bronchus or lung | 1199 (6.3) |
| 4 | C18 | Malignant neoplasm of colon | 1143 (6.0) |
| 5 | C22 | Intrahepatic bile duct carcinoma | 673 (3.5) |
| 6 | J44 | Chronic obstructive pulmonary disease | 585 (3.1) |
| 7 | C16 | Malignant neoplasm of stomach | 541 (2.9) |
| 8 | C20 | Malignant neoplasm of rectum | 541 (2.9) |
| 9 | I21 | Acute myocardial infarction | 455 (2.4) |
| 10 | I25 | Chronic ischaemic heart disease | 454 (2.4) |
| All deaths | | | 18996 |
| Age ≥75 years | | | |
| 1 | C18 | Malignant neoplasm of colon | 1472 (5.3) |
| 2 | I25 | Chronic ischaemic heart disease | 1059 (3.8) |
| 3 | C25 | Malignant neoplasm of pancreas | 1052 (3.8) |
| 4 | I21 | Acute myocardial infarction | 1030 (3.7) |
| 5 | J18 | Pneumonia | 940 (3.4) |
| 6 | C34 | Malignant neoplasm of unspecified part of bronchus or lung | 938 (3.4) |
| 7 | C15 | Malignant neoplasm of oesophagus | 923 (3.3) |
| 8 | J44 | Chronic obstructive pulmonary disease | 905 (3.3) |
| 9 | G61 | Malignant neoplasm of prostate | 628 (2.3) |
| 10 | F03 | Unspecified dementia | 626 (2.3) |
| All deaths | | | 27808 |

Values in parentheses are percentages.
(A41), head injury (S00, S01, and S09), pneumonia (J18), superficial abscesses (L02), and infectious gastroenteritis and colitis (A01) were less obviously associated with specific causes of death.

Discussion

The present study demonstrated that nearly half of patients who died within a year of discharge following an EGS admission succumbed to neoplastic disease. The proportion of deaths caused by malignancies in patients treated in the EGS service was 17 per cent higher than that for the general population of Scotland, where cancer is the cause of death in 31 per cent.20 Other causes of death in the study cohort also differed from those in the general population. Diseases of the circulatory system were the second most common cause of death in both groups, but accounted for nearly one-third of deaths in the population as whole and only 16 per cent among the EGS cohort.20 This is likely to reflect the management of most cardiovascular pathologies by physicians rather than emergency general surgeons. Most of the findings were largely independent of whether patients underwent operation or not.

Previous publications21–24 have demonstrated the importance of the cancer workload associated with EGS, but most have focused on disease-specific or operation-dependent associations. The present findings highlight the importance of cancer care in this patient population. Although interactions between the specialties of oncology, palliative care, and general surgery are well established in the elective sphere, malignancies presenting as an emergency are more likely to be at more advanced stages25,26, and less likely to have been discussed in a multidisciplinary format before operation.27 Patients presenting to EGS services with malignancy may not have attended primary-care clinicians before admission.28 Optimizing links between the EGS service, multidisciplinary team, and community care seems important.

The present findings also confirm that patients discharged with non-specific diagnoses, such as abdominal and pelvic pain, nausea and vomiting, or aphagia and dysphagia often turn out to have underlying malignancies as the subsequent cause of death.29–31 Patients with recurring or persistent symptoms warrant further investigations. This might limit unplanned readmissions32 and further EGS admissions.

As expected, there were differences in causes of death between age cohorts. Self-harm, and drug and alcohol abuse were the most frequent causes of death in the younger cohort (aged 16–34 years). However, the absolute number of fatalities in this age group was very small, and therefore did not contribute markedly to the overall analysis. Increasing cohort age was associated with an increasing mortality rate. Previous work showed that the 1-year postdischarge mortality rate for patients aged over 75 years was very high at 35.6 per cent.3 In the present analysis,

| Rank | ICD-10 | Description | n |
|------|--------|-------------|---|
| 1    | I21    | Acute myocardial infarction | 275 (4.8) |
| 2    | C34    | Malignant neoplasm of bronchus and lung | 205 (3.6) |
| 3    | J18    | Pneumonia, unspecified organism | 192 (3.4) |
| 4    | I25    | Chronic ischaemic heart disease | 185 (3.2) |
| 5    | C25    | Malignant neoplasm of pancreas | 180 (3.2) |
| 6    | K85    | Acute pancreatitis | 160 (2.8) |
| 7    | K56    | Paralytic ileus and intestinal obstruction without hernia | 118 (2.1) |
| 8    | R68    | Other general symptoms and signs (including hypothermia) | 112 (2.0) |
| 9    | C80    | Malignant neoplasm without specification of site | 110 (1.9) |
| 10   | X42    | Accidental poisoning by and exposure to narcotics and psychodeltics | 109 (1.9) |

All deaths

| Rank | ICD-10 | Description | n |
|------|--------|-------------|---|
| 1    | C15    | Malignant neoplasm of oesophagus | 1247 (4.8) |
| 2    | J44    | Chronic obstructive pulmonary disease | 1149 (4.4) |
| 3    | C25    | Malignant neoplasm of pancreas | 1110 (4.2) |
| 4    | I25    | Chronic ischaemic heart disease | 989 (3.8) |
| 5    | C34    | Malignant neoplasm of bronchus and lung | 942 (3.6) |
| 6    | I21    | Acute myocardial infarction | 908 (3.5) |
| 7    | J18    | Pneumonia, unspecified organism | 794 (3.0) |
| 8    | C18    | Malignant neoplasm of colon | 771 (2.9) |
| 9    | C22    | Malignant neoplasm of liver and bile ducts | 631 (2.4) |
| 10   | C16    | Malignant neoplasm of stomach | 547 (2.1) |

All deaths

| Rank | ICD-10 | Description | n |
|------|--------|-------------|---|
| 1    | C18    | Malignant neoplasm of colon | 2020 (10.0) |
| 2    | C25    | Malignant neoplasm of pancreas | 1342 (6.6) |
| 3    | C34    | Malignant neoplasm of bronchus and lung | 1147 (5.7) |
| 4    | C15    | Malignant neoplasm of oesophagus | 1063 (5.3) |
| 5    | C50    | Malignant neoplasm of breast | 830 (4.1) |
| 6    | C19    | Malignant neoplasm of rectosigmoid junction | 695 (3.4) |
| 7    | C80    | Malignant neoplasm without specification of site | 693 (3.4) |
| 8    | C16    | Malignant neoplasm of stomach | 691 (3.4) |
| 9    | C61    | Malignant neoplasm of prostate | 682 (3.4) |
| 10   | C22    | Malignant neoplasm of liver and bile ducts | 626 (3.1) |

All deaths

Values in parentheses are percentages. CCI, Charlson Co-morbidity Index.
malignancies, dementia, and pathologies of the lung and heart all became more prevalent in the elderly. Frailty33,34, and co-morbidities35 are known to increase mortality rates in general surgery. The present work confirmed this finding, suggesting that the elderly patients treated in EGS services represent a high-risk group who may benefit from medical optimization, with greater input from specialists in geriatric medicine34,36.

The present study has limitations. Although this type of study has a risk of coding errors37, the ISD has professional coders who work to strict standards. Consistency is monitored, and the quality of Scottish health data is thought to be high37,38. The accuracy of death certificates, in contrast, may be more variable, as these certificates are completed by clinicians. Although the findings may be specific to Scotland, they may still be broadly generalizable to other healthcare settings, where an increasing proportion of the population is elderly.

This study has identified that medium-term mortality following EGS admission in Scotland, regardless of whether patients undergo operation or not, is largely driven by cancer diagnoses. Around half of these diagnoses will be known at the time of discharge from inpatient care. Service integration in the

**Fig. 1 Causes of death in the emergency general surgery service and general population of Scotland over 10 years**

*a* Emergency general surgery and *b* general population of Scotland.
hospital and community should be optimized, and surgeons providing EGS should ensure adequate follow-up, particularly for patients without a clear diagnosis on discharge because of the risk of undiagnosed malignancy.

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Supplementary material
Supplementary material is available at BJS online.

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