

# Emergency admissions' diagnoses and risk of in-hospital death according to the primary ICD-10 chapter assigned at discharge and the National Early Warning Score on admission

M Holland, A Dannatt, J Kellett & D Green

## Abstract

**Background:** The relationship between diagnosis, illness severity, and mortality risk for unselected emergency admissions is poorly defined.

**Aim:** To define primary ICD-10 diagnostic chapters at discharge, admission illness severity by the National Early Warning Score, and in-hospital mortality for all unselected emergency admissions.

**Method:** Retrospective, observational, cohort study of 122,259 unselected, adult emergency admissions to Salford Royal Hospital between 2014 and 2022.

**Results:** In-hospital mortality was 4.3% but most patients had an ICD-10 chapter associated with a lower risk of death. 60% of in-hospital deaths were in four chapters, infections, circulatory and respiratory diseases, or neoplasms. An admission NEWS  $\geq 3$  was associated with earlier mortality and an eight-fold increased risk of in-hospital mortality. 45% of all in-hospital deaths occurred in patients with an admission NEWS  $< 3$ .

**Conclusion:** Mortality in emergency hospital admissions is associated with illness severity and four diagnostic chapters. NEWS should not be the only arbiter of hospital admission, as for certain diagnostic chapters the risk of death is high even if vital signs on presentation are normal.

## Keywords

In-patient mortality, National Early Warning Score, ICD-10 chapters, Discharge diagnosis

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## Key Points

1. This paper starts to address the knowledge gap to understand the relationship between discharge diagnosis, admission illness severity, and mortality risk for unselected emergency admissions.
2. An admission NEWS  $\geq 3$  is associated with earlier mortality and an eight-fold increased risk of in-hospital death.
3. 60% of in-hospital deaths occurred in patients with one of the following four discharge diagnoses, infections, circulatory and respiratory diseases, or neoplasms.
4. 45% of all in-hospital deaths occurred in patients with a low admission NEWS of  $< 3$ .

## Introduction

The conditions that every physician working in an acute hospital setting needs to know how to diagnose and treat have never been explicitly defined. In 1976 Dever published a landmark epidemiological paper, which showed that 85% of deaths in the United States were caused by cardiovascular disease, neoplasms, accidents, strokes, lung infections or other respiratory diseases.<sup>1</sup> However, these may not be the same conditions as those encountered today in hospital practice. Moreover, a patient's risk of dying while in hospital may depend less on their diagnosis and more on the severity of their illness.<sup>2</sup>

The inexorable rise in both emergency hospital attendances and admissions is an important reason for acute physicians to understand the conditions they are likely to encounter, and the mortality risks associated with them.<sup>3</sup> In 2019 De Silva et al. highlighted the discrepancy between the top 20 most common patient presentations listed in the acute internal medicine curriculum and those patients presenting to their hospital.<sup>4</sup> Despite a study reported in 2007 on the frequency and outcome of acute medical conditions presenting to hospital,<sup>5</sup> there remains a paucity of data on the reason for admission and associated mortality risks of unselected acutely unwell patients admitted to hospital.

# *Emergency admissions' diagnoses and risk of in-hospital death according to the primary ICD-10 chapter assigned at discharge and the National Early Warning Score on admission*

The thousands of diagnoses contained in the 10<sup>th</sup> World Health Organisation's International Classification of Diseases (ICD-10) are categorised into 22 chapters.<sup>6</sup> Although patients may have several diagnoses coded at discharge, we postulated that the primary ICD-10 chapters assigned at discharge are probably the simplest way to capture the likely reasons for hospital admission in a large patient population. The National Early Warning Score (NEWS) is well validated and widely used in the UK.<sup>7</sup> Although its intended purpose is to identify patients who need immediate attention,<sup>8</sup> NEWS can also be used to measure illness severity as it uses aggregated weighted vital sign values to predict 24-hour mortality.

We hypothesised that a patient's risk of dying while in hospital depends both on their diagnosis and the severity of their illness. The aim of this study is to define the primary ICD-10 chapters recorded at discharge and severity of illness measured by NEWS on admission to a UK university teaching hospital, and their association with in-hospital mortality.

## Methods

### *Setting and methodology*

This is a retrospective observational cohort study of all emergency patients admitted between 1<sup>st</sup> April 2014 and 31<sup>st</sup> March 2022 to Salford Royal Hospital, part of the Northern Care Alliance NHS Trust hospitals. Salford Royal Hospital is a university teaching hospital, providing routine secondary care services and tertiary care services in neurology, neurosurgery, stroke medicine, renal medicine, dermatology, and intestinal failure. The hospital does not provide maternity care. The study conforms with STROBE guideline.<sup>9</sup>

### *Participants*

All emergency admissions, including readmissions, of patients aged 16 years and older.

### *Outcome*

The primary outcome measure was in-patient mortality and length of stay a secondary outcome measure. Patients were categorised into two NEWS categories, <3 and ≥3<sup>10</sup>; therefore, all patients with a NEWS <3 were conscious and alert.

### *Data collection*

Non-identifiable patient data collected in routine clinical practice was extracted from 168,506 completed patient episodes held in the 'data warehouse' of the electronic patient record of all emergency admissions. The NEWS in this study is the first recorded score on admission to a ward. Data pertaining to age, sex, length of hospital stay, and in-hospital mortality were

also extracted and exported for analysis in a Microsoft Excel file.

The primary diagnosis was defined by the codes in ICD-10 version 2019,<sup>6</sup> and the codes were manually categorised into ICD-10 chapters in Microsoft Excel. One of the chapters is reserved for special purposes (U00-U85) and was never employed at Salford Royal Hospital prior to the COVID-19 pandemic. Therefore, all the patients in this study placed in Chapter U00-U85 had a primary diagnosis of COVID-19. Following data cleansing, the only patient exclusion criterium was missing data. Each patient's primary diagnosis was placed into its appropriate ICD-10 chapter.

### *Statistical analysis*

Excel was used to store and manipulate data, and to calculate odds ratios. IBM SPSS (version 28.0.0.0) was used for all other statistical analysis. Parametric and non-parametric data summary data are reported by means, with standard deviations, and medians, with interquartile ranges. The significance level was set at  $p < 0.05$ . Continuous numerical data was analysed using student's t test for parametric data and the Mann-Whitney U test for non-parametric data. Categorical data was analysed using the Chi square test. Odds ratios with 95 % confidence intervals were used to compare the risk of death within categories.

### *Ethics approval*

In keeping with Health Research Authority guidance, national ethics approval was not required for non-identifiable patient data collected in routine clinical practice. Permission was granted by the NCA's Research & Innovation (R&I 21HIP13) for access to non-identifiable patient level data collected in routine clinical practice.

## Results

During the study period 168,506 patients were admitted to hospital as emergencies, of which 46,247 (27.4%) were excluded because of missing NEWS data. Compared with the 122,259 patients with complete data, those with missing data were younger (57.8 SD 21.0 versus 65.1 SD 20.4 years,  $p < 0.0001$ ), less likely to die in hospital (2.6% versus 4.3%,  $p < 0.001$ ), and had a far shorter length of hospital stay (2.5 SD 8.5 versus 6.8 SD 14.7 days,  $p < 0.001$ ).

The 122,259 patients in the final study population had an in-hospital mortality of 4.3% and could be placed into one of 20 ICD10 chapters (Table 1). Patients who died were significantly older than survivors (78.3 SD 12.4 versus 64.5 SD 20.5 years,  $p < 0.001$ ). 'Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified R00-R99' accounted for more than 18% of all admissions and

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**Table 1.** Discharge ICD-10 chapters ranked according to number.

R00-R99 accounted for 18.08% of all admissions and had an in-hospital mortality of 1.4%. The seven next commonest chapters account for more than 64% of all admissions.

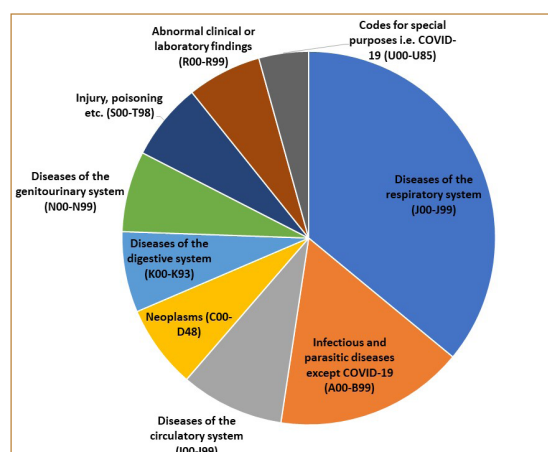
| ICD-10 chapter                                                                  | Number of patients | Age (years)         | In-hospital mortality | Proportion of admissions |            |
|---------------------------------------------------------------------------------|--------------------|---------------------|-----------------------|--------------------------|------------|
|                                                                                 |                    |                     |                       | %                        | Cumulative |
| Abnormal clinical or laboratory findings (R00-R99)                              | 22100              | 63.0 SD 20.8        | 1.4%                  | 18.08%                   | 18.08%     |
| Diseases of the respiratory system (J00-J99)                                    | 20932              | 70.2 SD 17.6        | 8.2%                  | 17.12%                   | 35.20%     |
| Injury, poisoning etc. (S00-T98)                                                | 15502              | 61.3 SD 23.8        | 2.1%                  | 12.68%                   | 47.88%     |
| Diseases of the circulatory system (I00-I99)                                    | 10318              | 72.5 SD 18.9        | 4.1%                  | 8.44%                    | 56.32%     |
| Diseases of the digestive system (K00-K93)                                      | 8295               | 61.9 SD 19.6        | 4.0%                  | 6.78%                    | 63.10%     |
| Musculoskeletal and connective tissue diseases (M00-M99)                        | 7805               | 63.3 SD 20.2        | 1.3%                  | 6.38%                    | 69.49%     |
| Infectious and parasitic diseases except COVID-19 (A00-B99)                     | 7669               | 67.3 SD 19.8        | 10.2%                 | 6.27%                    | 75.76%     |
| Diseases of the genitourinary system (N00-N99)                                  | 7317               | 69.4 SD 19.5        | 4.6%                  | 5.98%                    | 81.74%     |
| Mental and behavioural disorders (F00-F99)                                      | 4466               | 58.9 SD 21.7        | 1.8%                  | 3.65%                    | 85.40%     |
| Endocrine, nutritional, and metabolic diseases (E00-E90)                        | 4351               | 62.4 SD 20.5        | 3.1%                  | 3.56%                    | 88.95%     |
| Diseases of the nervous system (G00-G99)                                        | 3906               | 54.8 SD 20.5        | 1.3%                  | 3.19%                    | 92.15%     |
| Diseases of the skin and subcutaneous tissue (L00-L99)                          | 3475               | 63.7 SD 20.3        | 3.2%                  | 2.84%                    | 94.99%     |
| Neoplasms (C00-D48)                                                             | 2157               | 69.0 SD 13.6        | 16.0%                 | 1.76%                    | 96.76%     |
| Diseases of the blood and immune systems (D50-D89)                              | 1616               | 65.7 SD 20.2        | 2.3%                  | 1.32%                    | 98.08%     |
| Codes for special purposes i.e., COVID-19 (U00-U85)                             | 1196               | 63.8 SD 18.3        | 17.2%                 | 0.98%                    | 99.06%     |
| Diseases of the eye and adnexa (H00-H59)                                        | 428                | 60.8 SD 20.2        | 0.0%                  | 0.35%                    | 99.41%     |
| Pregnancy, childbirth, and the puerperium (O00-O99)                             | 350                | 33.3 SD 6.3         | 0.0%                  | 0.29%                    | 99.69%     |
| Factors influencing health status and contact with health services (Z00-Z99)    | 226                | 65.4 SD 21.6        | 0.4%                  | 0.18%                    | 99.88%     |
| Diseases of the ear and mastoid process (H60-H95)                               | 110                | 54.8 SD 20.3        | 0.0%                  | 0.09%                    | 99.97%     |
| Congenital malformations, deformations, and chromosomal abnormalities (Q00-Q99) | 40                 | 47.1 SD 16.2        | 2.5%                  | 0.03%                    | 100.00%    |
| <b>Total</b>                                                                    | <b>122,259</b>     | <b>65.1 SD 20.4</b> | <b>4.30%</b>          |                          |            |

had an in-hospital mortality of 1.4%. The seven next commonest chapters account for more than 64% of all admissions.

Nine chapters accounted for more than 90% of all in-hospital deaths (Table 2), and four accounted for more than 60% of them (Figure 1). There were no deaths in three of the chapters, and only one death in each of two more; these five chapters accounted for less than 1% of all patients and only 0.04% of all deaths. Four chapters had a significantly higher risk of death and accounted for 26.1% of all patients, three chapters (21.2% of all patients) had an average risk, nine chapters (51.9% of all patients) were low risk, and four chapters (0.8% of all patients) contained insufficient deaths for analysis (Figure 2). The chapters with lowest mean age of death were for 'Diseases of the digestive system K00-K93' (71.7 SD 16.3 years) and 'Neoplasms C00-D48' (71.8 SD 12.0 years); for all the other chapters the mean age of death was >76 years (Table 2).

Although on admission 103,783 (84.9%) patients had a NEWS <3, 2379 (2.3%) of them died in hospital and these deaths accounted for

44.9% of all in-hospital deaths; the remaining 2915 deaths occurred in the 18,476 patients with an admission NEWS  $\geq 3$ , who had an in-hospital mortality of 15.8%. For patients with an admission NEWS  $\geq 3$ , men were more likely to die than women (17.6% versus 14.2%,  $p < 0.001$ ); for patients with



**Figure 1.** Nine ICD-10 chapters, which accounted for more than 90% of all in-hospital deaths.

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**Table 2.** Discharge ICD-10 chapters ranked by in-hospital deaths.

The top nine chapters accounted for 90.25% of all in-hospital deaths. Age redacted to protect patient anonymity.

| ICD-10 chapter                                                                  | Number of deaths | Age (years)         | In-hospital mortality |            |
|---------------------------------------------------------------------------------|------------------|---------------------|-----------------------|------------|
|                                                                                 |                  |                     | %                     | Cumulative |
| Diseases of the respiratory system (J00-J99)                                    | 1719             | 78.9 SD 11.6        | 8.21%                 | 32.47%     |
| Infectious and parasitic diseases except COVID-19 (A00-B99)                     | 784              | 79.1 SD 12.1        | 10.22%                | 47.28%     |
| Diseases of the circulatory system (I00-I99)                                    | 428              | 79.7 SD 12.1        | 4.15%                 | 55.36%     |
| Neoplasms (C00-D48)                                                             | 345              | 71.8 SD 12.0        | 15.99%                | 61.88%     |
| Diseases of the digestive system (K00-K93)                                      | 334              | 71.7 SD 16.3        | 4.03%                 | 68.19%     |
| Diseases of the genitourinary system (N00-N99)                                  | 334              | 78.6 SD 11.8        | 4.56%                 | 74.50%     |
| Injury, poisoning etc. (S00-T98)                                                | 320              | 82.8 SD 10.5        | 2.06%                 | 80.54%     |
| Abnormal clinical or laboratory findings (R00-R99)                              | 308              | 79.8 SD 11.7        | 1.39%                 | 86.36%     |
| Codes for special purposes i.e., COVID-19 (U00-U85)                             | 206              | 76.6 SD 11.1        | 17.22%                | 90.25%     |
| Endocrine, nutritional, and metabolic diseases (E00-E90)                        | 137              | 78.0 SD 13.0        | 3.15%                 | 92.84%     |
| Diseases of the skin and subcutaneous tissue (L00-L99)                          | 111              | 77.1 SD 13.3        | 3.19%                 | 94.94%     |
| Musculoskeletal and connective tissue diseases (M00-M99)                        | 98               | 80.2 SD 11.3        | 1.26%                 | 96.79%     |
| Mental and behavioural disorders (F00-F99)                                      | 80               | 83.1 SD 10.3        | 1.79%                 | 98.30%     |
| Diseases of the nervous system (G00-G99)                                        | 51               | 77.4 SD 12.0        | 1.31%                 | 99.26%     |
| Diseases of the blood and immune systems (D50-D89)                              | 37               | 78.2 SD 12.3        | 2.29%                 | 99.96%     |
| Factors influencing health status and contact with health services (Z00-Z99)    | 1                | Redacted            | 0.44%                 | 99.98%     |
| Congenital malformations, deformations, and chromosomal abnormalities (Q00-Q99) | 1                | Redacted            | 2.50%                 | 100.00%    |
| Diseases of the eye and adnexa (H00-H59)                                        | 0                | -                   | 0.00%                 | 100.00%    |
| Pregnancy, childbirth, and the puerperium (O00-O99)                             | 0                | -                   | 0.00%                 | 100.00%    |
| Diseases of the ear and mastoid process (H60-H95)                               | 0                | -                   | 0.00%                 | 100.00%    |
| <b>Total</b>                                                                    | <b>5294</b>      | <b>78.3 SD 12.4</b> |                       |            |

| ICD-10 chapter                                                                  | Total  | In-hospital mortality | Odds ratio (95% CI) |
|---------------------------------------------------------------------------------|--------|-----------------------|---------------------|
| Codes for special purposes i.e., COVID-19 (U00-U85)                             | 1,196  | 17.22%                | 4.74 (4.06 5.54)    |
| Neoplasms (C00-D48)                                                             | 2,157  | 15.99%                | 4.43 (3.93 5.00)    |
| Infectious and parasitic diseases except COVID-19 (A00-B99)                     | 7,669  | 10.22%                | 2.78 (2.56 3.01)    |
| Diseases of the respiratory system (J00-J99)                                    | 20,932 | 8.21%                 | 2.45 (2.30 2.60)    |
| Diseases of the genitourinary system (N00-N99)                                  | 7,317  | 4.56%                 | 1.06 (0.95 1.19)    |
| Diseases of the circulatory system (I00-I99)                                    | 10,318 | 4.15%                 | 0.95 (0.86 1.05)    |
| Diseases of the digestive system (K00-K93)                                      | 8,295  | 4.03%                 | 0.92 (0.82 1.03)    |
| Diseases of the skin and subcutaneous tissue (L00-L99)                          | 3,475  | 3.19%                 | 0.72 (0.59 0.88)    |
| Endocrine, nutritional, and metabolic diseases (E00-E90)                        | 4,351  | 3.15%                 | 0.71 (0.60 0.85)    |
| Diseases of the blood and immune systems (D50-D89)                              | 1,616  | 2.29%                 | 0.51 (0.37 0.72)    |
| Injury, poisoning etc. (S00-T98)                                                | 15,502 | 2.06%                 | 0.43 (0.38 0.48)    |
| Mental and behavioural disorders (F00-F99)                                      | 4,466  | 1.79%                 | 0.39 (0.31 0.49)    |
| Diseases of the nervous system (G00-G99)                                        | 3,906  | 1.31%                 | 0.29 (0.21 0.38)    |
| Abnormal clinical or laboratory findings (R00-R99)                              | 22,100 | 1.39%                 | 0.27 (0.24 0.30)    |
| Musculoskeletal and connective tissue diseases (M00-M99)                        | 7,805  | 1.26%                 | 0.27 (0.22 0.33)    |
| Factors influencing health status and contact with health services (Z00-Z99)    | 226    | 0.44%                 | 0.1 (0.01 0.64)     |
| Congenital malformations, deformations, and chromosomal abnormalities (Q00-Q99) | 40     | 2.50%                 | 0.57 (0.03 3.82)    |
| Diseases of the eye and adnexa (H00-H59)                                        | 428    | 0.00%                 | 0 - -               |
| Pregnancy, childbirth, and the puerperium (O00-O99)                             | 350    | 0.00%                 | 0 - -               |
| Diseases of the ear and mastoid process (H60-H95)                               | 110    | 0.00%                 | 0 - -               |

**Figure 2.** ICD-10 chapters ranked according to in-hospital mortality and odds ratio of in-hospital compared with all other patients. Chapters in red had a significantly higher risk of death (26.1% of all patients), chapters in amber had an average risk (21.2% of all patients), and chapters in green a significantly lower risk of death (51.9% of all patients). Chapters with insufficient numbers of deaths for analysis (0.8% of all patients) are in grey.

# Emergency admissions' diagnoses and risk of in-hospital death according to the primary ICD-10 chapter assigned at discharge and the National Early Warning Score on admission

**Table 3.** Patients according to National Early Warning Score (NEWS) on admission, age, sex, hospital length of stay and in-hospital mortality.

|                                       | Alive at discharge |                | Died in hospital |               | All patients  |                |
|---------------------------------------|--------------------|----------------|------------------|---------------|---------------|----------------|
|                                       | NEWS $\geq 3$      | NEWS $< 3$     | NEWS $\geq 3$    | NEWS $< 3$    | NEWS $\geq 3$ | NEWS $< 3$     |
| <b>n</b>                              | 15,578             | 101,447        | 2,915            | 2,381         | 18,493        | 103,828        |
| <b>Male sex</b>                       | 7,080 (45.4%)      | 48,306 (47.6%) | 1,512 (51.9%)    | 1,228 (51.6%) | 8,592 (46.5%) | 49,534 (47.7%) |
| <b>Age (years)</b>                    | 68.1 SD 18.3       | 63.9 SD 20.8   | 77.6 SD 12.6     | 79.1 SD 12.2  | 69.6 SD 17.9  | 64.2 SD 20.8   |
| <b>Length of hospital stay (days)</b> | 10.1 SD 17.7       | 5.9 SD 13.8    | 10.1 SD 16.1     | 20.8 SD 22.2  | 10.1 SD 17.5  | 6.2 SD 14.2    |
| <b>(median)</b>                       | (5.6)              | (1.9)          | (5.5)            | (14.2)        | (5.6)         | (1.9)          |

**Table 4.** Leading causes of death for patients with an admission NEWS  $< 3$  compared with those with an admission NEWS  $\geq 3$ .

| ICD-10 chapter                                                | Number of deaths | Age (years)    | In-hospital mortality |            |
|---------------------------------------------------------------|------------------|----------------|-----------------------|------------|
|                                                               |                  |                | %                     | Cumulative |
| 10 ICD chapters of patients with NEWS <3 with the most deaths | Death NEWS <3    |                |                       |            |
| Diseases of the respiratory system (J00-J99)                  | 508              | 80.8 SD 11.2 * | 3.72%                 | 21.35%     |
| Infectious and parasitic diseases except COVID-19 (A00-B99)   | 284              | 80.2 SD 11.0 * | 4.86%                 | 33.29%     |
| Abnormal clinical or laboratory findings (R00-R99)            | 214              | 79.5 SD 11.8   | 1.03%                 | 42.29%     |
| Diseases of the genitourinary system (N00-N99)                | 214              | 79.6 SD 11.3 * | 3.32%                 | 51.28%     |
| Injury, poisoning etc. (S00-T98)                              | 199              | 83.5 SD 9.7    | 1.41%                 | 59.65%     |
| Neoplasms (C00-D48)                                           | 197              | 72.1 SD 12.3   | 11.42%                | 67.93%     |
| Diseases of the digestive system (K00-K93)                    | 186              | 72.9 SD 15.8   | 2.51%                 | 75.75%     |
| Diseases of the circulatory system (I00-I99)                  | 172              | 79.7 SD 12.5   | 2.00%                 | 82.98%     |
| Endocrine, nutritional, and metabolic diseases (E00-E90)      | 89               | 78.9 SD 12.8   | 2.29%                 | 86.72%     |
| Musculoskeletal and connective tissue diseases (M00-M99)      | 74               | 79.3 SD 11.3   | 1.00%                 | 89.83%     |
| 10 ICD chapters of patients with NEWS ≥3 with the most deaths | Deaths NEWS ≥3   |                |                       |            |
| Diseases of the respiratory system (J00-J99)                  | 1211             | 78.1 SD 11.2 * | 16.62%                | 41.54%     |
| Infectious and parasitic diseases except COVID-19 (A00-B99)   | 500              | 78.4 SD 12.7 * | 27.34%                | 58.70%     |
| Diseases of the circulatory system (I00-I99)                  | 256              | 79.7 SD 11.8   | 14.76%                | 67.48%     |
| Codes for special purposes i.e. COVID-19 (U00-U85)            | 152              | 75.4 SD 11.5   | 27.49%                | 72.69%     |
| Diseases of the digestive system (K00-K93)                    | 148              | 70.1 SD 17.0   | 16.63%                | 77.77%     |
| Neoplasms (C00-D48)                                           | 148              | 71.4 SD 11.6   | 34.26%                | 82.85%     |
| Injury, poisoning etc. (S00-T98)                              | 121              | 81.3 SD 11.7   | 8.86%                 | 87.00%     |
| Diseases of the genitourinary system (N00-N99)                | 120              | 76.8 SD 12.7 * | 13.78%                | 91.11%     |
| Abnormal clinical or laboratory findings (R00-R99)            | 94               | 80.5 SD 11.5   | 6.85%                 | 94.34%     |
| Endocrine, nutritional, and metabolic diseases (E00-E90)      | 48               | 76.2 SD 13.4   | 10.48%                | 95.99%     |

\*indicated patients with an admission NEWS  $< 3$  who died were significantly older than patients who died with same ICD10 chapter and an admission NEWS  $\geq 3$ .

an admission NEWS  $< 3$  there was no difference in mortality between men and women (2.5% versus 2.6%). Patients who were discharged from hospital alive were younger than those who died, regardless of the value of their NEWS on admission, but those with an admission NEWS  $\geq 3$  were older and had a longer length of hospital stay than those with a NEWS  $< 3$ . However, while survivors and decedents with a NEWS  $\geq 3$  had the same length of hospital stay, survivors with a NEWS  $< 3$  had a far shorter length of stay compared with those who died (Table 3).

For patients with an admission NEWS  $\geq 3$  the in-hospital mortality was higher than the overall mortality of 4.3% for all ICD10 chapters, whereas for patients with an admission NEWS  $< 3$  the only chapters with a higher mortality were neoplasms and 'Certain infectious and parasitic diseases A00-B99'. The ten leading causes of death accounted for 90% of all deaths for patients with an admission NEWS  $< 3$ , and 96% of all deaths for those with an admission NEWS  $\geq 3$ . The causes of death for patients with an admission NEWS  $\geq 3$  were dominated by 'Diseases of

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**Table 5.** Discharge ICD-10 chapters ranked according to odds ratio of in-hospital mortality of admission NEWS  $\geq 3$  to admission NEWS  $< 3$ .

| ICD-10 chapter                                                                  | Number of patients | Mortality if NEWS $< 3$ | Proportion NEWS $\geq 3$ | Odds ratio (95% CI) |                    |
|---------------------------------------------------------------------------------|--------------------|-------------------------|--------------------------|---------------------|--------------------|
| Diseases of the nervous system (G00-G99)                                        | 3906               | 0.73%                   | 8.27%                    | 11.5                | (6.5 - 20.1)       |
| Diseases of the circulatory system (I00-I99)                                    | 10318              | 2.00%                   | 16.81%                   | 8.5                 | (6.9 - 10.4)       |
| <b>All patients</b>                                                             | <b>122259</b>      | <b>2.29%</b>            | <b>15.11%</b>            | <b>8.0</b>          | <b>(7.5 - 8.5)</b> |
| Infectious and parasitic diseases except COVID-19 (A00-B99)                     | 7669               | 4.86%                   | 23.85%                   | 7.4                 | (6.3 - 8.6)        |
| Abnormal clinical or laboratory findings (R00-R99)                              | 22100              | 1.03%                   | 6.21%                    | 7.1                 | (5.5 - 9.0)        |
| Injury, poisoning etc. (S00-T98)                                                | 15502              | 1.41%                   | 8.81%                    | 6.8                 | (5.4 - 8.6)        |
| Musculoskeletal and connective tissue diseases (M00-M99)                        | 7805               | 1.00%                   | 5.27%                    | 6.1                 | (3.8 - 9.8)        |
| Diseases of the skin and subcutaneous tissue (L00-L99)                          | 3475               | 2.23%                   | 9.70%                    | 6.1                 | (4.1 - 9.1)        |
| Diseases of the blood and immune systems (D50-D89)                              | 1616               | 1.70%                   | 8.91%                    | 5.3                 | (2.6 - 10.7)       |
| Diseases of the respiratory system (J00-J99)                                    | 20932              | 3.72%                   | 34.81%                   | 5.2                 | (4.6 - 5.7)        |
| Endocrine, nutritional, and metabolic diseases (E00-E90)                        | 4351               | 2.29%                   | 10.53%                   | 5.0                 | (3.5 - 7.2)        |
| Diseases of the genitourinary system (N00-N99)                                  | 7317               | 3.32%                   | 11.90%                   | 4.7                 | (3.7 - 5.9)        |
| Codes for special purposes (U00-U85)                                            | 1196               | 8.40%                   | 46.24%                   | 4.1                 | (3.0 - 5.8)        |
| Neoplasms (C00-D48)                                                             | 2157               | 11.42%                  | 20.03%                   | 4.0                 | (3.2 - 5.2)        |
| Mental and behavioural disorders (F00-F99)                                      | 4466               | 1.62%                   | 9.05%                    | 2.2                 | (1.2 - 3.9)        |
| Diseases of the eye and adnexa (H00-H59)                                        | 428                | 0.00%                   | 2.80%                    | -                   | -                  |
| Pregnancy, childbirth, and the puerperium (O00-O99)                             | 350                | 0.00%                   | 7.14%                    | -                   | -                  |
| Factors influencing health status and contact with health services (Z00-Z99)    | 226                | 0.48%                   | 7.96%                    | -                   | -                  |
| Diseases of the ear and mastoid process (H60-H95)                               | 110                | 0.00%                   | 4.55%                    | -                   | -                  |
| Congenital malformations, deformations, and chromosomal abnormalities (Q00-Q99) | 40                 | 0.00%                   | 15.00%                   | -                   | -                  |

the respiratory system J00-J99', infections, and 'Diseases of the circulatory system I00-I99', which accounted for 73% of all deaths. For patients with an admission NEWS  $< 3$ , respiratory disease and infections only accounted for 33% of deaths, and only died 7.2% from cardiovascular disease (Table 4).

Overall, an admission NEWS  $\geq 3$  increases the risk of in-hospital death eight-fold. However, the increase in mortality associated with an admission NEWS  $\geq 3$  varied according to ICD chapter. Patients with neurological diseases were more than 11 times more likely to die, compared to those with 'Mental and behavioural disorders F00-F99' who were only twice as likely to die if the admission NEWS  $\geq 3$ ; for five chapters the number of patients and deaths were too small for analysis (Table 5).

## Discussion

### Main findings

Although overall in-hospital mortality was 4.3%, most patients had an ICD-10 chapter associated with a lower risk of death. More than 60% of in-hospital deaths were associated with ICD-10 chapters for infections, circulatory and respiratory diseases, or neoplasia, and there was an eight-fold increased risk

of death with an admission NEWS  $\geq 3$ . Nevertheless, 45% of all in-hospital deaths occurred in patients with an admission NEWS  $< 3$ . Apart from mental and behavioural disorders, all the 'low-risk' (i.e., in-hospital mortality  $< 4.3\%$ ) chapters became 'high risk' if the admission NEWS was  $\geq 3$ , whereas the admission NEWS value had far less impact on 'high-risk' chapters, such as those for neoplasms, respiratory disease, and COVID-19 infection.

### Interpretation

The purpose of this study was to define the relationship between in-hospital mortality and ICD-10 diagnostic chapters at discharge and illness severity on admission measured by NEWS. All emergency admissions were included, as on presentation the distinction between medical from non-medical patients may not be clear.

Our results should be interpreted with caution as ICD-10 chapters are very broad and introduce potential anomalies, such as pneumonia being classified as a respiratory disease as opposed to an infection. Furthermore, the chapters may group together conditions with disparate outcomes; for example, for operational reasons COVID-19 was coded in a separate chapter to other infections and had a strikingly higher mortality rate.

# Emergency admissions' diagnoses and risk of in-hospital death according to the primary ICD-10 chapter assigned at discharge and the National Early Warning Score on admission

## Clinical significance

Our study found that in-hospital mortality was dominated by infections, circulatory, respiratory diseases and neoplasia, and the risk of death was increased by age and NEWS  $\geq 3$ . Higher age was associated with an admission NEWS  $\geq 3$ , with those ICD10 Chapters with high mortality rates, and with overall mortality. Male sex was associated with mortality only for patients with an admission NEWS  $\geq 3$ .

For many ICD-10 chapters, the risk of in-hospital mortality is very low if the admission NEWS  $< 3$  but increases substantially if NEWS is elevated. However, this increased risk of mortality varies considerably between different ICD-10 chapters. Moreover, infections and neoplasia had an in-hospital mortality well above the overall average of 4.3%, even if the NEWS on admission was  $< 3$ . The commonest ICD10 chapter was not of defined diagnoses but of 'Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified R00-R99', which accounted for nearly one fifth of all admissions; 94% of these patients had an admission NEWS  $< 3$ , and only 1% of them died in hospital, but this increased seven-fold if the admission NEWS  $\geq 3$ .

We found half of all patients admitted with a NEWS  $< 3$  were discharged within 1.9 days. Nevertheless, patients with a NEWS  $< 3$  accounted for 45% of all in-hospital deaths and these patients died two to three weeks after admission, whereas patients with an admission NEWS  $\geq 3$  died within a few days. This finding highlights the need for ongoing monitoring of all patients while in hospital, and that NEWS values should not be the only arbiter of hospital admission, as for certain diagnostic categories the risk of death is high even if vital signs on presentation are normal.

## Limitations

This simple analysis only gives a broad overview of the common conditions admitted to a single UK university teaching hospital, the risk of death associated with these conditions and their severity of illness on admission. It was performed between 2014 and 2022 and, therefore, included data collected before and during the COVID-19 pandemic. It is possible that Salford Royal Hospital is not representative of hospitals elsewhere. While there are limitations to using ICD-10 in practice, such as accuracy of the primary diagnosis entered by non-clinicians, the codes are recognisable by clinicians and can be easily extracted from hospital electronic patients records.<sup>11</sup> This study did not explore other factors associated with mortality, such as comorbidity and functional status.<sup>2</sup>

## Conclusion

Most patients admitted to hospital had an ICD-10 chapter associated with a low risk of death. Sixty per cent of in-hospital deaths are associated with chapters for infections, circulatory and respiratory diseases, or neoplasia. Overall, an admission NEWS  $\geq 3$  was associated with an eight-fold increased risk of in-hospital death. Nevertheless, 45% of all in-hospital deaths occurred in patients with an admission NEWS  $< 3$ . These results highlight that the mortality of acute hospital admissions is associated with severity of illness and five diagnostic chapters, and that NEWS values should not be the only arbiter of hospital admission, as for certain diagnostic categories the risk of death is high even if vital signs on admission are normal.

## Conflicts of Interest

Nothing to declare

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