Prehospital triage of patients diagnosed with perforated peptic ulcer or peptic ulcer bleeding: an observational study of patients calling 1-1-2

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Abstract

Background: Triage systems are used in emergency medical services to systematically prioritize prehospital resources according to individual patient conditions. Previous studies have shown cases of preventable deaths in emergency medical services even when triage systems are used, indicating a potential undertriage among some conditions. The aim of this study was to investigate the triage level among patients diagnosed with perforated peptic ulcer (PPU) or peptic ulcer bleeding (PUB).

Methods: In a three-year period in Central Denmark Region, all patients hospitalized within 24 h after a 1-1-2 emergency call and who subsequently received either a PPU or a PUB (hereinafter combined and referred to as PPU/PUB) or a First Hour Quintet (FHQ: respiratory failure, stroke, cardiac chest pain, and cardiac arrest) diagnosis were investigated. A modified Poisson regression was used to estimate the relative risk of receiving the highest and lowest prehospital response level. Also, a linear regression analysis was used to estimate the relative risk of 30-day mortality.

Results: Of 8658 evaluated patients, 263 were diagnosed with PPU/PUB. After adjusting for relevant confounding variables, patients diagnosed with PPU/PUB were less likely to receive ambulance transportation compared to patients diagnosed with stroke, RR = 1.41 (CI: 1.28–1.56); trauma, RR = 1.28 (CI: 1.15–1.42); cardiac chest pain, RR = 1.47 (CI: 1.33–1.62); and cardiac arrest, RR = 1.44 (CI: 1.31–1.42). Among patients diagnosed with PPU/PUB, 6.5% (CI: 3.3–9.7) did not receive ambulance transportation. The proportion of patients not receiving ambulance transportation was higher among patients diagnosed with PPU/PUB compared to patients diagnosed with an FHQ diagnosis. The 30-day mortality rate among patients diagnosed with PPU/PUB was 7.8% (CI: 4.2–11.1). This was lower than the 30-day mortality rate among patients diagnosed with respiratory failure (P = 0.010), stroke (P = 0.001), and cardiac arrest (P < 0.001), but comparable to the 30-day mortality among patients diagnosed with cardiac chest pain (P = 0.080) and trauma (P = 0.281).

Conclusion: Among patients calling 1-1-2, fewer patients diagnosed with PPU/PUB received ambulance transportation than patients diagnosed with FHQ diagnoses, despite a high mortality among patients diagnosed with PPU/PUB.

Keywords: Perforated peptic ulcer, Peptic ulcer bleeding, Prehospital, Triage
Background
Triage systems are used in emergency medical services (EMS) for systematic prioritization of prehospital resources according to the presumed severity and urgency of the individual patient’s condition. Rapid diagnostics and treatment play a key role in severe time-critical conditions. Thus, avoiding undertriage is important. The criteria-based Danish Index for emergency care is used after all emergency calls (1-1-2) to an emergency medical communication center (EMCC) in Denmark. The Danish Index generally triages patients with the highest hospital admission risks and case fatality rates to the highest level of emergency [1]. A previous Danish study suggested cases of preventable deaths in EMS despite applying the Danish Index, thus indicating a potential undertriage among some conditions [2]. This has also been demonstrated in a Finnish EMS system [3]. The First Hour Quintet (FHQ) diagnoses (respiratory failure, stroke, trauma, cardiac chest pain, and cardiac arrest), are highly targeted in prehospital conditions [2]. This has also been demonstrated in a nationwide observational study that included all first time 1-1-2 calls within the study period. Exclusion criteria included: invalid civil personal register (CPR) number, if patients called more than one time in the study period, and non-existing symptom categories within the dispatch protocol. The cohort was identified via technical dispatch software in the EMCC, containing data on 1-1-2 calls, triage level, and prehospital time stamps. Vital status, gender, and age were retrieved from the Danish Civil Registration System [12], and data on previous diseases and present diagnoses, according to the 10th version of the International Classification of Disease (ICD-10), were retrieved from the National Patient Register [13]. Each Danish citizen has a unique CPR number that makes it possible to link Danish registers on an individual level. Patients were followed from hospital admission date to either death, emigration, or November 30, 2014 – whichever came first. The study was approved by the Danish Data Protection Agency (record number 12–16–02-207-15). Approval by the local ethics committee and collection of informed consent are not required for observational studies.

Methods
Study population and setting
This was a population-based observational study performed in the Central Denmark Region in a three-year period from December 1, 2011 to November 30, 2014. The Central Denmark Region covers an area of 13,007 km² urban, suburban, and rural land with 1.3 million inhabitants corresponding to 23% of the Danish population [11].

We included all first time 1-1-2 calls within the study period. Exclusion criteria included: invalid civil personal register (CPR) number, if patients called more than one time in the study period, and non-existing symptom categories within the dispatch protocol. The cohort was identified via technical dispatch software in the EMCC, containing data on 1-1-2 calls, triage level, and prehospital time stamps. Vital status, gender, and age were retrieved from the Danish Civil Registration System [12], and data on previous diseases and present diagnoses, according to the 10th version of the International Classification of Disease (ICD-10), were retrieved from the National Patient Register [13]. Each Danish citizen has a unique CPR number that makes it possible to link Danish registers on an individual level. Patients were followed from hospital admission date to either death, emigration, or November 30, 2014 – whichever came first. The study was approved by the Danish Data Protection Agency (record number 12–16–02-207-15). Approval by the local ethics committee and collection of informed consent are not required for observational studies.

Triage
The Danish health care system provides free and unconstrained access for all citizens to general practitioners, prehospital emergency medical services, and hospitals [14]. Thus, patients diagnosed with PPU/PUB or a FHQ diagnosis can gain access to acute medical help either via general practitioners, through the Danish national emergency number 1-1-2, or by appearance at a hospital (which is rare). When people dial 1-1-2, they are connected to a healthcare professional in the EMCC. In the Central Denmark Region, the EMCC is staffed by registered nurses and paramedics with six weeks’ additional training in communication and use of the dispatch protocol Danish Index [15]. This tool is designed to evaluate the severity and urgency of the patients’ conditions. It is divided into 37 symptom chapters (e.g. non-traumatic bleeding, stomach or back pain, traffic accident, etc.), each one subdivided into 5 levels of decreasing emergency (A–E).

PPU/PUB was defined according to specific ICD-10 diagnosis-codes listed by the Danish Clinical Register of Emergency Surgery [16]. Respiratory failure, stroke, cardiac chest pain, and cardiac arrest were defined according to specific ICD-10 diagnosis-codes listed by the European Emergency Data Project [17]. Trauma was defined as ICD-10 trauma diagnoses with an inhospital survival probability ≤0.941 based on pooled data from nearly 4 million injuries in seven industrialized countries, including Denmark, with similar emergency care setups [18, 19]. No validation of the trauma diagnoses has been conducted.
whereas all other diagnoses have been validated previously [20, 21]. The exact definition of each group is listed in the Appendix 3 (Table 5).

**Statistical analyses**

All statistical analyses were conducted in STATA version 14.1 (StataCorp, TX, USA). Categorical data were presented as number and percentage (%) with a 95% confidence interval (CI). Comparisons of categorical data were made by a chi-squared test. Continuous data were presented as means with a 95% CI for normally distributed data and as medians with interquartile ranges (IQR) for skewed data. Comparisons of continuous data were made using a student’s t test or a Mann-Whitney U test when appropriate.

A modified Poisson regression with a robust error-variance approach was used to estimate the relative risks (RR) of level A triage and level E triage [22]. PPU/PUB was used as a reference point and the following covariates were included in the adjusted analyses: age, sex, Charlson Comorbidity Index (CCI) score, and time of 1-1-2 call.

30-day mortality was used as proxy of disease severity. The initially intended use of a Cox proportional regression analysis was abandoned, as the data did not fulfill the proportional hazards assumption. Instead, a generalized linear regression of pseudo-observations was conducted to achieve relative risk estimates of mortality at specific time points. This kind of statistics does not require the fulfillment of the proportional hazards assumption and was therefore applicable [23]; the primary analysis was conducted on complete cases. In a sensitivity analysis, we repeated the regression analysis on triage level after imputing missing data by following two models: a multiple imputation model using chained equations and a bootstrapping model [24, 25].

**Results**

In the three-year study period, 136,891 1-1-2 emergency calls were received by the EMCC in the Central Denmark Region. Figure 1 displays a flowchart of the patient inclusion. Of the 94,881 patients who fulfilled the inclusion criteria, 263 were diagnosed with PPU/PUB or a FHQ diagnosis. Patients diagnosed with PPU/PUB were older and had more comorbidities than the average FHQ patient. The variation of potential confounding variables between PPU/PUB and FHQ diagnoses is displayed in Table 1. Among the 8658 patients investigated, 263 were diagnosed with PPU/PUB. Of these, 63.4% (CI: 57.1–69.6) received a level A response. After adjusting for age, sex, CCI score, and time of 1-1-2 call, the study showed that patients diagnosed with PPU/PUB were less likely to receive a level A triage compared to patients diagnosed with stroke, RR = 1.41 (CI: 1.28–1.56); trauma, RR = 1.28 (CI: 1.15–1.42); cardiac chest pain, RR = 1.47 (CI: 1.33–1.62); and cardiac arrest, RR = 1.44 (CI: 1.31–1.42). On the contrary, the risk of level E triage was higher among patients diagnosed with PPU/PUB compared to patients diagnosed with a FHQ diagnosis except for patients diagnosed with respiratory failure, (RR = 0.60 (CI: 0.35–1.05) , Table 2). The association between diagnosis-groups and triage was not noticeably modified by age, sex, and CCI score (Table 3 in Appendix 1). After imputing missing data on triage level, patients diagnosed with PPU/PUB had a lower risk of receiving a level A triage compared to all FHQ diagnoses including respiratory failure. After imputation the results regarding level E triage remained robust, except in the bootstrapping model, where patients diagnosed with stroke had a comparable possibility of receiving a level E triage (see Table 4 in the Appendix 2).

The 30-day mortality rate among patients diagnosed with PPU/PUB was 7.8% (CI: 4.2–11.1). In the adjusted analysis, 30-day mortality was similar for patients with cardiac chest pain, RR = 0.64 (CI: 0.38–1.06) and patients diagnosed with trauma, RR = 1.33 (CI: 0.72–2.44), but higher for respiratory failure, RR = 1.67 (CI: 1.06–2.64); stroke, RR = 2.03 (CI: 1.27–3.24), and cardiac arrest, RR = 6.72 (CI: 4.21–10.73).

**Discussion**

In this large observational study, including 8658 patients hospitalized within 24 h from a 1-1-2 call and diagnosed with PPU/PUB or a FHQ diagnosis, we found that the 30-day mortality rate among PPU/PUB patients was comparable to two of the five FHQ groups but fewer patients with PPU/PUB received level A triage compared to the FHQ patients.

The main objective of the EMCC is to dispatch the correct level of triage to keep the degree of undertriage to a minimum, as undertriage is associated with increased mortality. Andersen et al. discovered 18 potentially preventable deaths same day as the 1-1-2 call in an 18-month period [2]. Kuisma et al. also discovered 29 potentially avoidable deaths and one definitely avoidable death in patients receiving the lower urgency triage categories in a three-year period [3] and other studies have shown similar results [26–29]. The possibility of reducing the number of potential cases of undertriage seems present according to previous studies. A Belgium study has shown that two training sessions can increase the sensitivity of sending a mobile critical care unit along with a basic life support ambulance from 36% to 60% without any change in specificity [30]. Another Belgium study suggested trends towards an increased ability to obtain information from emergency callers among the telephone responders after a training session [31]. An American study showed that appropriate performance feedback could increase dispatch protocol compliance from 76% to 95% [32].

Today, the telephone responders in the EMCC are offered continuous education on a regular basis. However, a more systematic approach might be beneficial. The high amount of level A triage among patients diagnosed with cardiac chest pain (primarily acute myocardial infarction and angina pectoris) seen in our study might be
an effect of previous research regarding patients diagnosed with ST-elevation myocardial infarction, causing a change in procedure for these patients. Today, ST-elevation myocardial infarction is diagnosed prehospital and the patients are field-triaged directly to an invasive center. This has resulted in reduced time consumption of reperfusion, a decrease in mortality, and a lower risk of congestive heart failure [33–36]. On the contrary, increased attention to patients presenting themselves with chest pain may potentially result in overtriage [37, 38].

The main strength of this study is its large-sized population-based cohort, which improves precision and external validity. The unique CPR numbers provide the possibility of record linkage of validated registers on an individual level [12, 39]. Another strength is the free access to health care for all patients mitigating the risk of selection bias. Other studies might have an underrepresentation of less critical illnesses due to treatment expenses. Furthermore, diagnoses are validated for most ICD-10 diagnoses and this ensures correct classification. The nearly complete data set of the included covariates is also a strength. On the
### Table 1: Baseline characteristics

| Variable                           | PPU/PUB (n = 263) | Respiratory Failure (n = 2589) | Stroke (n = 1688) | Trauma (n = 1219) | Cardiac Chest Pain (n = 1804) | Cardiac Arrest (n = 1095) | Total (n = 8658) |
|------------------------------------|-------------------|--------------------------------|-------------------|-------------------|------------------------------|--------------------------|------------------|
| Age, years (95% CI)                | 69.4 (67.6;71.2)  | 63.2 (62.3;64.1)               | 70.1 (69.4;70.8)  | 39.9 (38.7;41.1)  | 69.2 (68.5;69.8)             | 68.9 (68.0;69.0)       | 63.4 (63.0;63.9) |
| Sex, % (95% CI)                    |                   |                                |                   |                   |                              |                          |                  |
| Male                               | 58.9 (53.0;64.9)  | 55.2 (53.4;57.2)               | 55.6 (53.3;58.0)  | 61.6 (58.8;64.3)  | 66.6 (64.4;68.8)             | 65.6 (62.8;68.4)       | 60.0 (59.0;61.0) |
| Emergency calls a, % (95% CI)      |                   |                                |                   |                   |                              |                          |                  |
| 1                                  | 95.1 (92.4;97.7)  | 89.5 (88.3;90.6)               | 95.6 (94.6;96.6)  | 98.5 (97.8;99.2)  | 89.9 (88.5;91.3)             | 98.1 (97.3;98.9)       | 93.3 (92.8;93.8) |
| 2                                  | 49 (2.3;7.6)      | 74 (6.4;8.4)                   | 4.0 (3.1;5.0)     | 1.3 (0.7;2.0)     | 8.3 (7.0;9.5)                | 1.7 (1.0;2.5)          | 5.3 (4.8;5.7)    |
| 3                                  |                   | 1.7 (1.2;2.2)                  | 0.3 (0.0;0.6)     | 0.1 (0.0;0.2)     | 1.2 (0.7;1.7)                | 0.2 (0.0;0.4)          | 0.8 (0.6;1.0)    |
| 4+                                 |                   | 1.5 (1.0;1.9)                  | 0.1 (0.0;0.2)     | 0.1 (0.0;0.2)     | 0.7 (0.3;1.1)                |                          | 0.6 (0.4;0.8)    |
| CCI score, % (95% CI)              |                   |                                |                   |                   |                              |                          |                  |
| 0                                  | 0.8 (0.0;1.8)     | 157 (14.3;17.1)                | –                 | 77.1 (74.8;79.5)  | 9.2 (7.9;10.5)               | 31.5 (28.8;34.3)       | 21.5 (20.6;22.3) |
| 1                                  | 41.1 (35.1;47.0)  | 257 (24.0;27.4)                | 51.1 (48.8;53.5)  | 10.3 (8.5;12.0)   | 29.4 (27.3;31.5)             | 20.9 (18.5;23.3)       | 29.1 (28.2;30.1) |
| 2                                  | 167 (11.2;21.3)   | 152 (13.8;16.6)                | 14.6 (12.9;16.3)  | 5.2 (3.9;6.4)     | 18.5 (16.7;20.3)             | 15.4 (13.3;17.6)       | 14.4 (13.7;15.2) |
| 3+                                 | 41.4 (35.5;47.4)  | 43.4 (41.5;45.3)               | 34.2 (32.0;36.5)  | 7.4 (5.9;8.9)     | 43.0 (40.7;45.2)             | 32.1 (29.4;34.9)       | 35.0 (34.0;36.0) |
| Time of 1–1-2 call, % (95% CI)     |                   |                                |                   |                   |                              |                          |                  |
| 00:00–05:59                        | 183 (13.6;22.9)   | 217 (20.1;23.3)                | 6.9 (5.7;8.1)     | 9.7 (8.0;11.3)    | 18.0 (16.2;19.7)             | 12.3 (10.4;14.3)       | 15.0 (14.3;15.8) |
| 06:00–11:59                        | 304 (24.8;36.0)   | 321 (30.3;33.9)                | 36.0 (33.7;38.3)  | 27.2 (24.7;29.7)  | 29.8 (27.7;31.9)             | 37.5 (34.7;40.4)       | 32.3 (31.4;33.3) |
| 12:00–17:59                        | 319 (26.3;37.6)   | 222 (20.6;23.8)                | 35.2 (32.9;37.5)  | 40.0 (37.3;42.8)  | 28.3 (26.2;30.4)             | 28.8 (26.1;31.5)       | 29.6 (28.7;30.6) |
| 18:00–23:59                        | 194 (14.6;24.2)   | 240 (22.4;25.7)                | 21.9 (19.9;23.9)  | 23.0 (20.6;25.3)  | 24.0 (22.0;26.0)             | 21.4 (18.9;23.8)       | 23.0 (22.1;23.9) |

Abbreviations: PPU perforated peptic ulcer, PUB peptic ulcer bleeding, n number of patients, CI confidence interval, CCI Charlson Comorbidity Index

*Number of emergency calls per patient
other hand, the weaknesses of this study relate to its register-based observational design. First of all, the proportion of patients with invalid CPR contributes to potential selection bias. However, missing data on emergency patients making a 1-1-2 call is difficult to avoid, as seen in other similar observational prehospital studies [1, 4, 40–42]. Compared to the final cohort, patients with invalid CPR had a higher proportion of level E triage and tended to call more frequently in the evening and at night. Further information on these patients was unobtainable, thus it remains unanswered whether these patients differed from the final cohort in other ways. Second, missing outcome data on triage level, especially among patients diagnosed with trauma, may eventually lead to bias. In order to address this issue, a sensitivity analysis with imputed triage level was conducted using two different imputation models, and no major estimate changes were observed. Last, although adjusted for several potential confounders, unobserved confounding would still be able to affect our estimates, and residual confounding cannot be ruled out.

Based on the current study, undertriage seems present among PPU/PUB patients. This study suggests that undertriage is present among patients diagnosed with PPU/PUB.

### Conclusion
Among patients calling 1-1-2, patients diagnosed with PPU/PUB had a lower proportion of highest level of triage and a higher proportion of lowest level of triage than FHQ patients. The 30-day mortality among patients diagnosed with PPU/PUB was comparable to the 30-day mortality among patients diagnosed with cardiac chest pain and trauma. This study suggests that undertriage is present among patients diagnosed with PPU/PUB.

| Group               | Frequency, % (95% CI) Unadjusted, RR (95% CI) Adjusted, RR (95% CI) | p-value |
|---------------------|--------------------------------------------------|---------|
| A-triage (n = 7538) |                                   |         |
| PPU/PUB             | 63.26 (57.12–69.61)                      | 1 (ref) |         |
| Respiratory Failure | 69.73 (67.85–71.62)                      | 1.10 (0.99–1.22) | 1.09 (0.98–1.20) | 0.105 |
| Stroke              | 89.22 (87.67–90.78)                      | 1.41 (1.27–1.56) | 1.41 (1.28–1.56) | < 0.001 |
| Trauma              | 83.81 (81.46–86.16)                      | 1.32 (1.19–1.46) | 1.28 (1.15–1.42) | < 0.001 |
| Cardiac Chest Pain  | 93.22 (91.99–94.45)                      | 1.47 (1.33–1.62) | 1.46 (1.33–1.62) | < 0.001 |
| Cardiac Arrest      | 92.23 (90.52–93.95)                      | 1.46 (1.32–1.61) | 1.44 (1.30–1.59) | < 0.001 |
| E-triage (n = 7538) |                                   |         |
| PPU/PUB             | 6.47 (3.28–9.65)                         | 1 (ref) |         |
| Respiratory Failure | 3.79 (3.01–4.58)                         | 0.59 (0.35–1.00) | 0.60 (0.35–1.05) | 0.073 |
| Stroke              | 2.56 (1.77–3.36)                         | 0.40 (0.22–0.71) | 0.41 (0.23–0.73) | 0.002 |
| Trauma              | 0.74 (0.19–1.29)                         | 0.11 (0.05–0.28) | 0.13 (0.05–0.36) | < 0.001 |
| Cardiac Chest Pain  | 1.62 (1.00–2.24)                         | 0.25 (0.13–0.47) | 0.25 (0.13–0.47) | < 0.001 |
| Cardiac Arrest      | 1.17 (0.50–1.86)                         | 0.18 (0.08–0.39) | 0.18 (0.08–0.40) | < 0.001 |

30-day mortality (n = 7538) | PPU/PUB 7.83 (4.52–11.13) | 1 (ref) |         |
| Respiratory Failure | 12.16 (10.87–13.44)                      | 1.55 (1.01–2.39) | 1.67 (1.06–2.64) | 0.028 |
| Stroke              | 16.83 (15.01–18.66)                      | 2.15 (1.39–3.32) | 2.03 (1.27–3.24) | 0.003 |
| Trauma              | 3.16 (2.16–4.17)                         | 0.40 (0.24–0.68) | 0.33 (0.17–0.64) | 0.001 |
| Cardiac Chest Pain  | 4.45 (3.49–5.42)                         | 0.57 (0.35–0.91) | 0.64 (0.38–1.06) | 0.080 |
| Cardiac Arrest      | 47.34 (40.67–54.00)                      | 6.05 (3.89–9.41) | 6.72 (4.21–10.73) | < 0.001 |

**Abbreviations:** PPU perforated peptic ulcer, PUB peptic ulcer bleeding, CI confidence interval, RR relative risk, n number, ref. reference, CCI Charlson Comorbidity Index

*Triage adjusted for age, sex, CCI score, and time of 1-1-2 call
**30-day mortality adjusted for age, sex, CCI score, and time of 1-1-2 call – an interaction term between exposure and sex was included.
## Appendix 1

### Table 3 Stratification of adjusted relative risk on triage and mortality

| Group       | Adjusted, RR (95% CI) | Adjusted for age, CCI, and time of 1–2 call |
|-------------|------------------------|----------------------------------------------|
|             | Sex\(^a\)              | Age\(^b\)                                   |
|             | Male                   | Female                                      | < 54 | 54–67 | 68–79 | > 80 | 0–1  | 2+  |
| A-triage    | PPU/PUB                | 1 (ref)                                     | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) |
| Respiratory Failure | 1.12 (0.98–1.29) | 1.05 (0.90–1.21) | 1.38 (0.97–1.96) | 1.08 (0.90–1.31) | 1.00 (0.85–1.19) | 1.10 (0.91–1.34) | 1.10 (0.93–1.30) | 1.08 (0.96–1.23) |
| Stroke      | 1.46 (1.28–1.67) | 1.34 (1.16–1.55) | 1.81 (1.27–2.56) | 1.41 (1.18–1.68) | 1.29 (1.10–1.52) | 1.41 (1.16–1.70) | 1.50 (1.27–1.77) | 1.34 (1.19–1.52) |
| Cardiac Chest Pain | 1.52 (1.33–1.73) | 1.40 (1.21–1.62) | 1.87 (1.32–2.65) | 1.45 (1.21–1.73) | 1.35 (1.15–1.59) | 1.47 (1.21–1.77) | 1.58 (1.34–1.86) | 1.40 (1.24–1.58) |
| Cardiac Arrest | 1.49 (1.30–1.70) | 1.38 (1.19–1.59) | 1.85 (1.31–2.63) | 1.41 (1.18–1.70) | 1.34 (1.14–1.58) | 1.44 (1.19–1.74) | 1.53 (1.30–1.81) | 1.40 (1.24–1.58) |
| Trauma      | 1.27 (1.10–1.47) | 1.30 (1.11–1.52) | 1.69 (1.19–2.39) | 1.23 (1.01–1.50) | 1.10 (0.89–1.39) | 1.10 (0.85–1.44) | 1.37 (1.15–1.62) | 1.17 (1.00–1.36) |
| E-triage    | PPU/PUB                | 1 (ref)                                     | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) |
| Respiratory Failure | 0.60 (0.29–1.22) | 0.53 (0.23–1.24) | 0.31 (0.11–0.90) | 0.74 (0.28–1.98) | 0.64 (0.22–1.86) | 0.75 (0.23–2.44) | 0.77 (0.30–2.02) | 0.53 (0.28–1.03) |
| Stroke      | 0.39 (0.18–0.82) | 0.40 (0.16–0.98) | 0.21 (0.06–0.71) | 0.24 (0.07–0.82) | 0.59 (0.21–1.70) | 0.62 (0.18–2.15) | 0.48 (0.18–1.28) | 0.37 (0.18–0.77) |
| Cardiac Chest Pain | 0.27 (0.13–0.59) | 0.19 (0.06–0.56) | 0.10 (0.02–0.46) | 0.29 (0.09–0.90) | 0.33 (0.10–1.00) | 0.31 (0.08–1.20) | 0.32 (0.11–0.64) | 0.21 (0.10–0.46) |
| Cardiac Arrest | 0.13 (0.04–0.38) | 0.31 (0.10–0.94) | 0.12 (0.02–0.75) | 0.24 (0.06–1.00) | 0.14 (0.03–0.72) | 0.17 (0.03–0.99) | 0.17 (0.05–0.64) | 0.18 (0.07–0.50) |
| Trauma      | 0.16 (0.05–0.53) | 0.08 (0.01–0.48) | 0.06 (0.01–0.29) | 0.17 (0.03–1.02) | – | 0.04 (0.04–0.07) | 0.13 (0.04–0.06) | 0.20 (0.04–0.03) |
| 30-day mortality | PPU/PUB | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) |
| Respiratory Failure | 3.31 (1.34–8.14) | 1.16 (0.67–2.00) | 3.16 (0.26–38.41) | 0.88 (0.36–2.20) | 1.70 (0.76–3.81) | 1.89 (0.90–3.94) | 1.40 (0.64–3.10) | 1.86 (1.02–3.39) |
| Stroke      | 3.54 (1.46–8.57) | 1.53 (0.86–2.71) | 14.81 (0.90–242.86) | 1.28 (0.52–3.18) | 1.84 (0.84–4.04) | 2.41 (1.11–5.22) | 1.93 (0.88–4.27) | 2.20 (1.20–4.04) |
| Cardiac Chest Pain | 1.23 (0.49–3.10) | 0.42 (0.22–0.82) | 1.25 (0.07–22.99) | 0.10 (0.03–0.38) | 0.45 (0.19–1.09) | 1.01 (0.46–2.21) | 0.35 (0.14–0.88) | 0.77 (0.40–1.47) |
| Cardiac Arrest | 12.39 (5.06–30.09) | 5.34 (3.00–9.52) | 33.26 (2.01–550.89) | 4.65 (2.04–10.61) | 7.29 (3.26–16.30) | 7.40 (3.49–15.68) | 6.75 (3.08–14.80) | 6.73 (3.63–12.46) |
| Trauma      | 3.13 (1.14–8.58) | 0.65 (0.27–1.59) | 2.43 (0.12–50.59) | 0.55 (0.18–1.65) | 0.93 (0.29–2.96) | 2.37 (0.99–5.68) | 1.21 (0.49–2.99) | 1.31 (0.58–2.92) |

**Abbreviations:** PPU perforated peptic ulcer, PUB peptic ulcer bleeding, RR relative risk, CI confidence interval, CCI Charlson Comorbidity Index, ref. reference

\(^a\)Adjusted for age, CCI, and time of 1–2 call

\(^b\)Adjusted for sex, CCI, and time of 1–2 call
## Appendix 2

### Table 4 Imputation on missing data on triage level

| Group                      | Unadjusted, RR (95% CI) | Unadjusted, RR (95% CI) | Unadjusted, RR (95% CI) |
|----------------------------|--------------------------|--------------------------|--------------------------|
|                            | Complete Cases           | Multiple imputation      | Bootstrapping            |
| A-triage (n = 7538)        |                          |                          |                          |
| PPU/PUB                    | 1 (ref)                  | 1.22 (0.99–1.49)         | 1.18 (1.06–1.39)         |
| Respiratory Failure        | 1.10 (0.99–1.22)         | 1.50 (1.21–1.87)         | 1.46 (1.29–1.67)         |
| Stroke                     | 1.41 (1.27–1.56)         | 1.42 (1.16–1.76)         | 1.40 (1.25–1.59)         |
| Trauma                     | 1.32 (1.19–1.46)         | 1.58 (1.27–1.96)         | 1.53 (1.37–1.75)         |
| Cardiac Chest Pain         | 1.47 (1.33–1.62)         | 1.56 (1.25–1.95)         | 1.53 (1.33–1.73)         |
| Cardiac Arrest             | 1.46 (1.32–1.61)         | 0.57 (0.31–1.05)         | 0.65 (0.37–1.48)         |
| E-triage (n = 7538)        |                          |                          |                          |
| PPU/PUB                    | 1 (ref)                  | 0.52 (0.28–0.95)         | 0.59 (0.33–1.33)         |
| Respiratory Failure        | 0.59 (0.35–1.00)         | 0.15 (0.06–0.36)         | 0.16 (0.08–0.40)         |
| Stroke                     | 0.40 (0.22–0.71)         | 0.26 (0.12–0.56)         | 0.33 (0.12–0.85)         |
| Trauma                     | 0.11 (0.05–0.28)         | 0.18 (0.07–0.45)         | 0.20 (0.12–0.30)         |
| Cardiac Chest Pain         | 0.25 (0.13–0.47)         | 0.18 (0.08–0.39)         | 0.18 (0.08–0.39)         |
| Cardiac Arrest             | 0.18 (0.08–0.39)         | 0.17 (0.07–0.43)         | 0.19 (0.12–0.29)         |

*A-triage adjusted for age, sex, CCI score, and time of 1-1-2 call*
Appendix 3

Table 5 ICD-10 definitions

| Diagnose                              | ICD-10 codes                                                                 | Frequency, n (%) |
|---------------------------------------|-------------------------------------------------------------------------------|------------------|
| PPU/PUB                               | Perforated peptic ulcer                                                      | 216 (2.49)       |
|                                       | DK251x, DK252x, DK255x, DK256x, DK261x, DK262x, DK265x, DK266x, DK271x, DK272x, DK275x, DK276x |                 |
|                                       | Peptic ulcer bleeding                                                        | 47 (0.54)        |
|                                       | DK250x, DK254x, DK260x, DK264x, DK270x, DK274x                                |                 |
| Respiratory Failure                   | Pulmonary embolism                                                           | 208 (2.40)       |
|                                       | DI26x                                                                         |                 |
|                                       | Heart failure                                                                | 407 (4.70)       |
|                                       | DI50.0, DI50.1, DI50.9                                                       |                 |
|                                       | Infection                                                                    | 616 (7.11)       |
|                                       | DJ05x, DJ15x, DJ21x, DJ12.9, DJ40.9, DJ42x                                    |                 |
|                                       | Asthma                                                                        | 228 (2.63)       |
|                                       | DJ45x                                                                         |                 |
|                                       | Pulmonary edema                                                              | 49 (0.57)        |
|                                       | DJ819                                                                         |                 |
|                                       | Pneumothorax                                                                  | 84 (0.97)        |
|                                       | DJ93x                                                                         |                 |
|                                       | Respiratory failure                                                          | 658 (7.60)       |
|                                       | DJ96.0, DJ96.1, DJ96.9, DR09.2                                                |                 |
|                                       | Dyspnea                                                                       | 339 (3.92)       |
|                                       | DR06.0                                                                        |                 |
| Stroke                                | Hemorrhage                                                                   | 363 (4.19)       |
|                                       | Di60x, Di61x, Di62.1, Di62.9                                                  |                 |
|                                       | Cerebral infarction                                                          | 720 (8.32)       |
|                                       | Di63x                                                                         |                 |
|                                       | Transient cerebral ischemic attacks and related syndromes                     | 605 (6.99)       |
|                                       | DG45x                                                                         |                 |
| Cardiac Chest Pain                    | Angina pectoris                                                              | 670 (7.74)       |
|                                       | Di20.0, Di20.1, Di20.8, Di20.9                                               |                 |
|                                       | Acute myocardial infarction                                                   | 1121 (12.95)     |
|                                       | Di21x                                                                        |                 |
|                                       | Other                                                                         | 13 (0.15)        |
|                                       | Di23x, Di24.9                                                                |                 |
| Cardiac Arrest                        | Cardiac arrest                                                                | 1083 (12.51)     |
|                                       | Di46.0, Di46.1, Di46.9                                                       |                 |
|                                       | Ventricular fibrillation                                                      | 12 (0.14)        |
|                                       | Di490                                                                         |                 |
| Trauma                                | Cranio-cerebral trauma                                                       | 203 (2.34)       |
|                                       | DS021x, DS061, DS062x, DS063x, DS064x, DS065x, DS066x, DS067x, DS068x, DS071x |                 |
|                                       | Thoracic injury                                                               | 2 (0.02)         |
|                                       | DS273x, DS274x, DS277x                                                       |                 |
|                                       | Abdominal injury                                                              | 12 (0.14)        |
|                                       | DS352x, DS367x, DS368x, DS369x                                                |                 |
|                                       | Spine fracture                                                                | 22 (0.25)        |
|                                       | DS120x, DS127x                                                                |                 |
|                                       | Poly-trauma                                                                  | 959 (11.08)      |
|                                       | DS097x, DS383, DS757x, DT025x, DT029x, DT068x                                 |                 |
|                                       | Burns                                                                         | 20 (0.23)        |
|                                       | DT203x, DT213x, DT290x, DT293x, DT312x, DT317x, DT318x                      |                 |

Abbreviations: PPU perforated peptic ulcer, PUB peptic ulcer bleeding, ICD-10 International Classification of Diseases 10th edition, n number

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KB participated in the design of the study, conceived the study, carried out the statistical calculations, and drafted the manuscript. KDF participated in the design of the study, the statistical calculations, and the draft of the manuscript. MTB helped to draft the manuscript. LN participated in the design of the study and the draft of the manuscript. All authors read and approved the final manuscript.

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Consent for publication
Approval by the local ethics committee and collection of informed consent are not required for observational studies.

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