Supplementary Material

Model M0

$$Logit(Died) = -3.831 + 0.292 * \boldsymbol{NEWS}$$

Model M1

$$Logit(Died) = -7.884 + 0.192 * \boldsymbol{Male} + 0.053 * \boldsymbol{Age} + 0.283 * \boldsymbol{NEWS} + 0.569$$

Model M2

$$\begin{aligned} Logit(Died) = {} & 6.804 + 0.195 * \boldsymbol{Male} + 0.055 * \boldsymbol{Age} + 0.102 * \boldsymbol{NEWS} + 0.737 \\ & * \boldsymbol{log(Respiration\ Rate)} - 0.291 * \boldsymbol{Temperature} - 1.285 \\ & * \boldsymbol{log(Systoloic\ pressure)} - 0.258 * \boldsymbol{log(Diastolic\ pressure)} + 0.746 \\ & * \boldsymbol{log(Pulse\ rate)} - 0.021 * \boldsymbol{Oxygen\ Saturations} + 0.583 \\ & * \boldsymbol{Supplemntal\ oxygen} + 1.333 * \boldsymbol{Pain} + 0.809 * \boldsymbol{Voice} + 1.623 \\ & * \boldsymbol{Unconscious} \end{aligned}$$

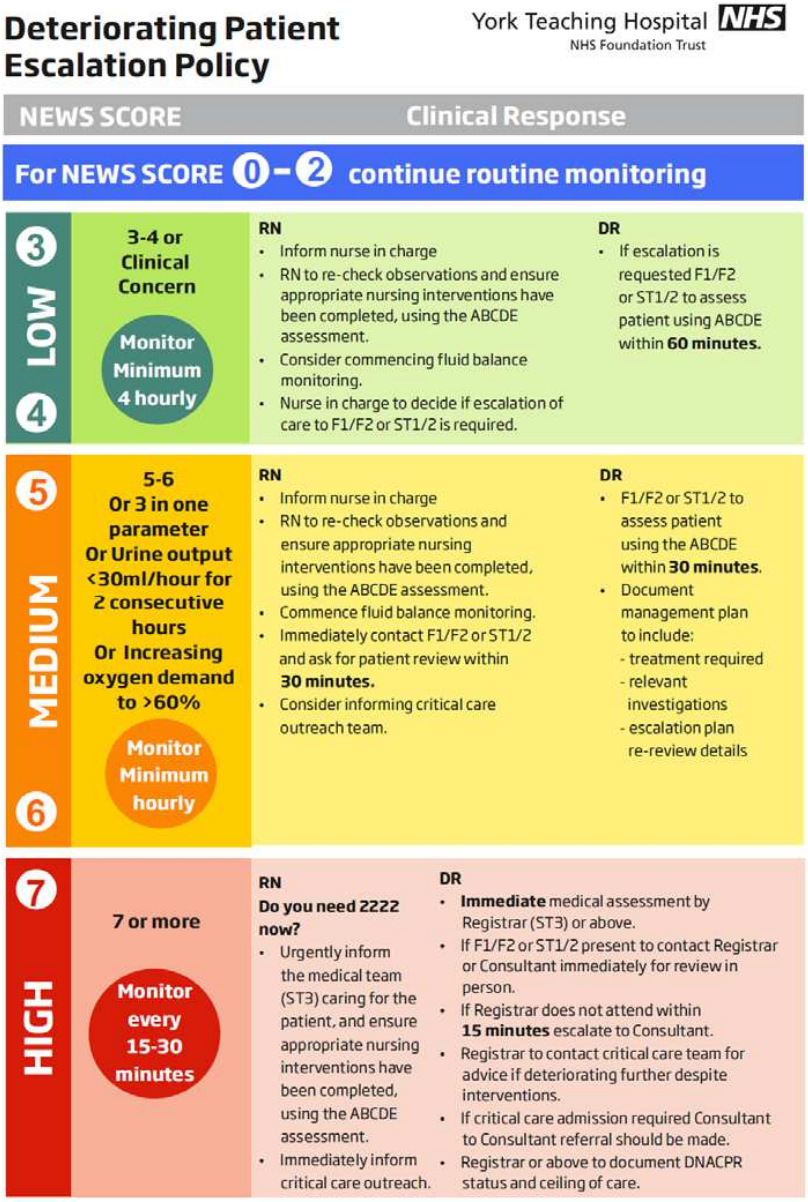
We accounted for baseline difference in risk of death in the external validation data by adding (M0: 0.11, M1:0.14, and M2:0.04) to the NEWS logit models using an iterative procedure described elsewhere[1]

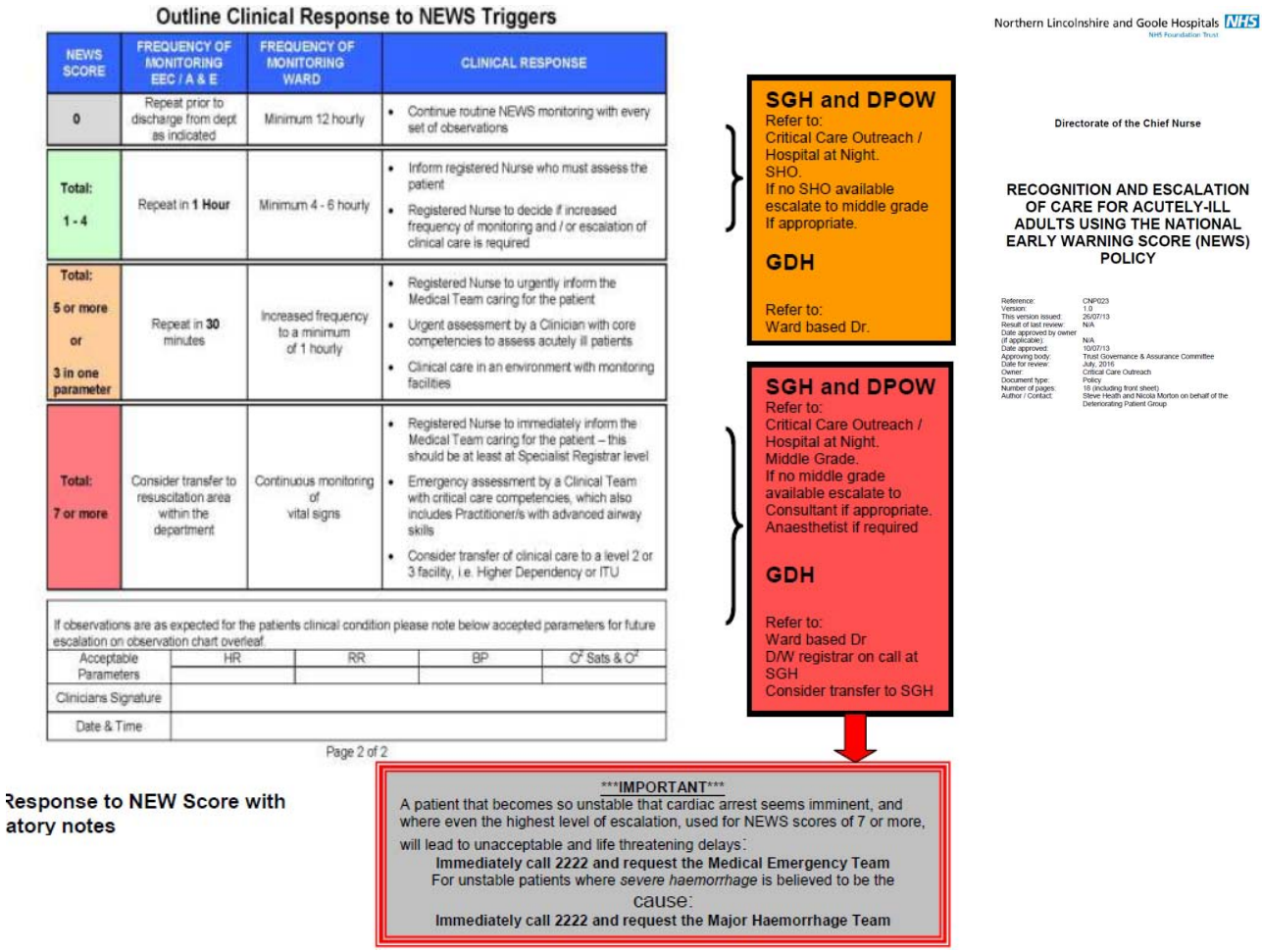
1. Faisal M, Howes R, Steyerberg EW, Richardson D, Mohammed MA. Using routine blood test results to predict the risk of death for emergency medical admissions to hospital: an external model validation study. QJM [Internet]. 2017 Jan 1 [cited 2017 Oct 2];110(1):27–31. Available from: https://academic.oup.com/qjmed/article-lookup/doi/10.1093/qjmed/hcw110

The NEWS [https://www.rcplondon.ac.uk/projects/outputs/national-early-warning-score-news] is based on a scoring system in which a score is allocated to vital signs physiological measurements already undertaken when patients present to, or are being monitored in hospital. Seven physiological parameters form the basis of the scoring system:

Physiological Parameters	3	2	1	0	1	2	3
Respiration Rate	≤8		9 - 11	12 - 20		21 - 24	≥25
Oxygen Saturations	≤91	92 - 93	94 - 95	≥96			
Any Supplemental Oxygen		Yes		No			
Temperature	≤35.0		35.1 - 36.0	36.1 - 38.0	38.1 - 39.0	≥39.1	
Systolic BP	≤90	91 - 100	101 - 110	111 - 219			≥220
Heart Rate	≤40		41 - 50	51-90	91 - 110	111 - 130	≥131
Level of Consciousness				Alert			Voice, Pain, or Unconscious

A score is allocated to each as they are measured, the magnitude of the score reflecting how extreme the parameter varies from the norm. This score is then aggregated and uplifted for people requiring oxygen.


Deteriorating Patient Escalation Policy
York Teaching Hospital NHS
NHS Foundation Trust
NEWS SCORE
Clinical Response
For NEWS SCORE 0 – 2 continue routine monitoring
3 LOW 4
3-4 or Clinical Concern
Monitor Minimum 4 hourly
RN
Inform nurse in charge
RN to re-check observations and ensure appropriate nursing interventions have been completed, using the ABCDE assessment.
Consider commencing fluid balance monitoring.
Nurse in charge to decide if escalation of care to F1/F2 or ST1/2 is required.
DR
If escalation is requested F1/F2 or ST1/2 to assess patient using ABCDE within 60 minutes.
5 MEDIUM 6
5-6 Or 3 in one parameter Or Urine output <30ml/hour for 2 consecutive hours Or Increasing oxygen demand to >60%
Monitor Minimum hourly
RN
Inform nurse in charge
RN to re-check observations and ensure appropriate nursing interventions have been completed, using the ABCDE assessment.
Commence fluid balance monitoring.
Immediately contact F1/F2 or ST1/2 and ask for patient review within 30 minutes.
Consider informing critical care outreach team.
DR
F1/F2 or ST1/2 to assess patient using the ABCDE within 30 minutes.
Document management plan to include:
- treatment required
- relevant investigations
- escalation plan re-review details
7 HIGH
7 or more
Monitor every 15-30 minutes
RN
Do you need 2222 now?
Urgently inform the medical team (ST3) caring for the patient, and ensure appropriate nursing interventions have been completed, using the ABCDE assessment.
Immediately inform critical care outreach.
DR
Immediate medical assessment by Registrar (ST3) or above.
If F1/F2 or ST1/2 present to contact Registrar or Consultant immediately for review in person.
If Registrar does not attend within 15 minutes escalate to Consultant.
Registrar to contact critical care team for advice if deteriorating further despite interventions.
If critical care admission required Consultant to Consultant referral should be made.
Registrar or above to document DNACPR status and ceiling of care.



Outline Clinical Response to NEWS Triggers

NEWS SCORE	FREQUENCY OF MONITORING EEC / A & E	FREQUENCY OF MONITORING WARD	CLINICAL RESPONSE
0	Repeat prior to discharge from dept as indicated	Minimum 12 hourly	• Continue routine NEWS monitoring with every set of observations
Total: 1 - 4	Repeat in **1 Hour**	Minimum 4 - 6 hourly	• Inform registered Nurse who must assess the patient • Registered Nurse to decide if increased frequency of monitoring and / or escalation of clinical care is required
Total: 5 or more or 3 in one parameter	Repeat in **30** minutes	Increased frequency to a minimum of 1 hourly	• Registered Nurse to urgently inform the Medical Team caring for the patient • Urgent assessment by a Clinician with core competencies to assess acutely ill patients • Clinical care in an environment with monitoring facilities
Total: 7 or more	Consider transfer to resuscitation area within the department	Continuous monitoring of vital signs	• Registered Nurse to immediately inform the Medical Team caring for the patient – this should be at least at Specialist Registrar level • Emergency assessment by a Clinical Team with critical care competencies, which also includes Practitioner/s with advanced airway skills • Consider transfer of clinical care to a level 2 or 3 facility, i.e. Higher Dependency or ITU

If observations are as expected for the patients clinical condition please note below accepted parameters for future escalation on observation chart overleaf

	HR	RR	BP	O^2 Sats & O^2
Acceptable Parameters				
Clinicians Signature				
Date & Time				

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SGH and DPOW
Refer to:
Critical Care Outreach / Hospital at Night.
SHO.
If no SHO available escalate to middle grade If appropriate.

GDH

Refer to:
Ward based Dr.

SGH and DPOW
Refer to:
Critical Care Outreach / Hospital at Night.
Middle Grade.
If no middle grade available escalate to Consultant if appropriate.
Anaesthetist if required

GDH

Refer to:
Ward based Dr
D/W registrar on call at SGH
Consider transfer to SGH

IMPORTANT
A patient that becomes so unstable that cardiac arrest seems imminent, and where even the highest level of escalation, used for NEWS scores of 7 or more, will lead to unacceptable and life threatening delays:
Immediately call 2222 and request the Medical Emergency Team
For unstable patients where *severe haemorrhage* is believed to be the cause:
Immediately call 2222 and request the Major Haemorrhage Team

Northern Lincolnshire and Goole Hospitals NHS
NHS Foundation Trust

Directorate of the Chief Nurse

RECOGNITION AND ESCALATION OF CARE FOR ACUTELY-ILL ADULTS USING THE NATIONAL EARLY WARNING SCORE (NEWS) POLICY

Reference:	CNP023
Version:	1.0
This version issued:	26/07/13
Result of last review:	N/A
Date approved by owner (if applicable):	N/A
Date approved:	10/07/13
Approving body:	Trust Governance & Assurance Committee
Date for review:	July, 2016
Owner:	Critical Care Outreach
Document type:	Policy
Number of pages:	18 (including front sheet)
Author / Contact:	Steve Heath and Nicola Morton on behalf of the Deteriorating Patient Group

Response to NEW Score with atory notes

Characteristic	YH N (%)	NH N (%)
Total emergency medical admissions	36751	37100
Excluded: No NEWS recorded (%)	772 (2.1)	1305 (3.5)
Excluded: First NEWS recorded after 24 hours of admission (%)	172 (0.5)	634 (1.7)
Total excluded (%)	944 (2.6)	1939 (5.2)
Total included (%)	35807 (98.4)	35161 (94.8)

Table S1 Number of emergency medical admissions included/excluded in the YH and NH hospitals

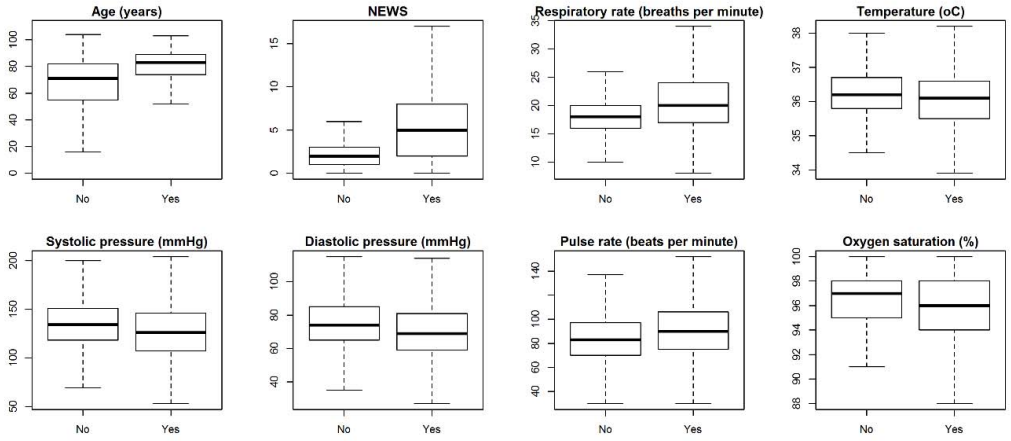

Figure S1 Boxplot without outliers for continuous covariates with respect to patient's discharge status (Alive/Died) for YH.

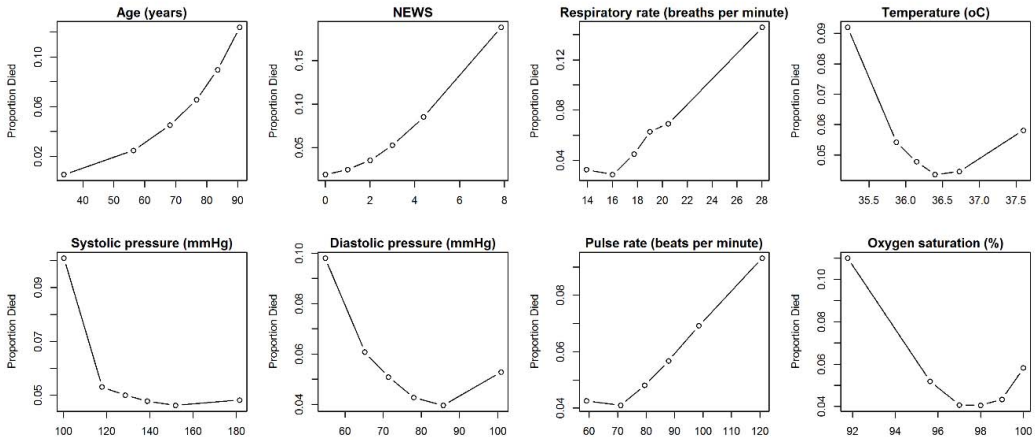

Figure S2 Scatter plots showing the observed risk of death with continuous covariates for YH.

NB: y-axis range changes in each plot.

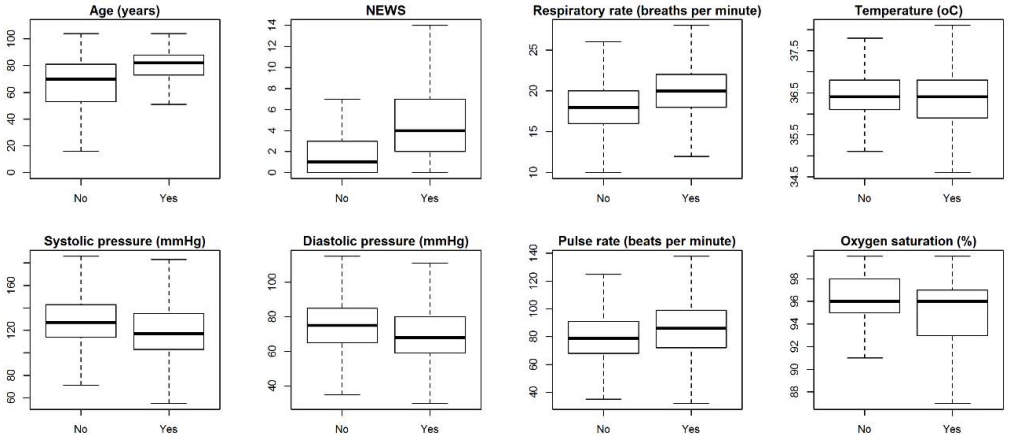

Figure S3 Boxplot without outliers for continuous covariates with respect to patient's discharge status (Alive/Died) for NH

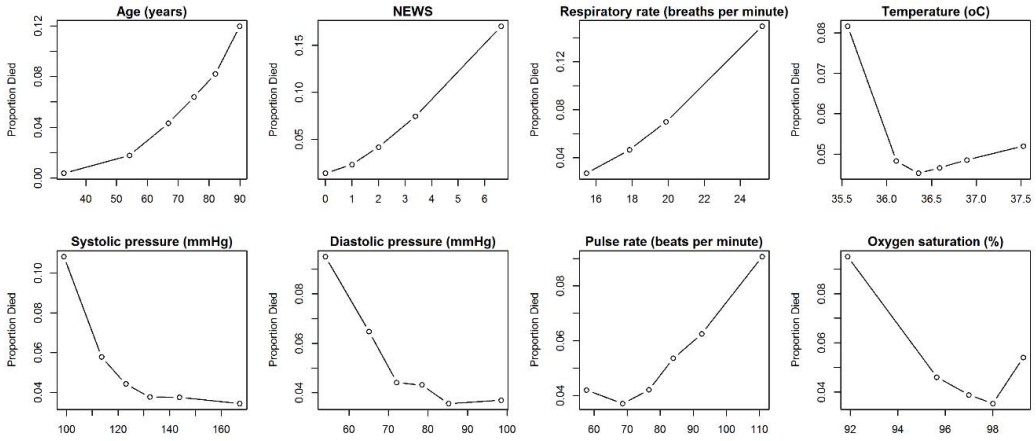

Figure S4 Scatter plots showing the observed risk of death with continuous covariates for NH

NB: y-axis range changes in each plot.

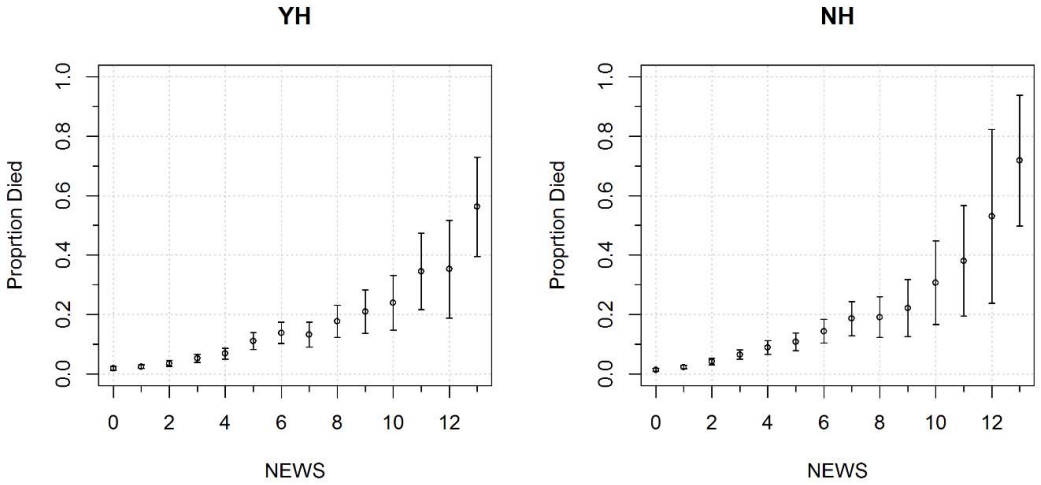

Figure S5: Observed in-hospital mortality versus index electronic NEWS in YH and NH hospitals. Vertical bars are exact binomial 95% confidence intervals.

Note: for visualisation purposes, we capped NEWS to 13.

Type	Model	YH				NH				Calibration Slope AUC (95%CI)
		Mean Risk (Alive)	Mean Risk (Dead)	ARD	AUC (95%CI)	Mean Risk (Alive)	Mean Risk (Dead)	ARD	AUC (95%CI)	
In-Hospital Mortality (%)	M0	0.054	0.130	0.076	0.742 (0.73 to 0.754)	0.051	0.116	0.065	0.756 (0.744 to 0.767)	1.16 (1.11 to 1.21)
In-Hospital Mortality (%)	M1	0.052	0.162	0.11	0.808 (0.799 to 0.817)	0.049	0.149	0.100	0.815 (0.806 to 0.824)	1.10 (1.05 to 1.15)
In-Hospital Mortality (%)	M2	0.050	0.182	0.132	0.821 (0.813 to 0.83)	0.048	0.165	0.117	0.826 (0.817 to 0.834)	1.05 (1.00 to 1.10)
Mortality with-in 24 hours (%)	M0	0.057	0.234	0.177	0.893 (0.871 to 0.914)	0.053	0.218	0.165	0.864 (0.835 to 0.894)	-
Mortality with-in 24 hours (%)	M1	0.057	0.270	0.213	0.893 (0.872 to 0.914)	0.053	0.252	0.199	0.885 (0.86 to 0.911)	-
Mortality with-in 24 hours (%)	M2	0.056	0.321	0.265	0.905 (0.885 to 0.925)	0.053	0.290	0.237	0.891 (0.866 to 0.916)	-
Mortality with-in 48 hours (%)	M0	0.056	0.207	0.151	0.862 (0.842 to 0.882)	0.053	0.185	0.132	0.85 (0.829 to 0.871)	-
Mortality with-in 48 hours (%)	M1	0.056	0.236	0.18	0.87 (0.853 to 0.888)	0.052	0.219	0.167	0.864 (0.845 to 0.883)	-
Mortality with-in 48 hours (%)	M2	0.056	0.278	0.222	0.882 (0.864 to 0.899)	0.052	0.249	0.197	0.873 (0.854 to 0.892)	-
Mortality with-in 72 hours (%)	M0	0.056	0.198	0.142	0.846 (0.827 to 0.864)	0.052	0.173	0.121	0.844 (0.827 to 0.862)	-
Mortality with-in 72 hours (%)	M1	0.055	0.229	0.174	0.864 (0.849 to 0.88)	0.052	0.209	0.157	0.861 (0.844 to 0.877)	-
Mortality with-in 72 hours (%)	M2	0.055	0.269	0.214	0.876 (0.861 to 0.891)	0.051	0.235	0.184	0.868 (0.852 to 0.884)	-

Table S2 Performance of three NEWS models in predicting the risk of in-hospital mortality, mortality within 24 hours, 48 hours, and 72 hours in the YH and NH hospitals.

Note: We developed models in YH and externally validated them in NH using in-hospital mortality as the outcome of interest. We applied these validated models to determine accuracy for other mortality outcomes.
ARD = absolute risk difference

Model	With Age			Without Age		
	YH AUC (95%CI)	NH AUC (95%CI)	Calibration Slope AUC (95%CI)	YH AUC (95%CI)	NH AUC (95%CI)	Calibration Slope AUC (95%CI)
M0	–	–	–	0.742 (0.73 to 0.754)	0.756 (0.744 to 0.767)	1.16 (1.11 to 1.21)
M1	0.808 (0.799 to 0.817)	0.815 (0.806 to 0.824)	1.10 (1.05 to 1.15)	0.744 (0.732 to 0.755)	0.756 (0.745 to 0.768)	1.16 (1.11 to 1.21)
M2	0.821 (0.813 to 0.83)	0.826 (0.817 to 0.834)	1.05 (1.00 to 1.10)	0.763 (0.752 to 0.774)	0.772 (0.761 to 0.783)	1.12 (1.06 to 1.16)

Table S3 Discrimination and calibration of four NEWS models in predicting the risk of in-hospital mortality with/without age included as a predictor in the YH and NH hospitals.

Note: We developed models in YH and externally validated them in NH using in-hospital mortality as the outcome of interest.

Models	Outcome (Mortality)	YH							NH						
		N	Sensitivity%	Specificity%	PPV	NPV	LR+	LR-	N	Sensitivity%	Specificity%	PPV	NPV	LR+	LR-
M0	In-hospital	6591	52.5 (50.4 to 54.7)	83.7 (83.3 to 84.1)	16.6 (15.7 to 17.5)	96.6 (96.4 to 96.8)	3.2 (3.1 to 3.4)	0.6 (0.5 to 0.6)	4971	44.5 (42.3 to 46.8)	87.6 (87.2 to 88)	17 (16 to 18.1)	96.5 (96.3 to 96.7)	3.6 (3.4 to 3.8)	0.6 (0.6 to 0.7)
M1	In-hospital	6624	58.1 (55.9 to 60.2)	83.9 (83.5 to 84.3)	18.2 (17.3 to 19.2)	97 (96.8 to 97.2)	3.6 (3.5 to 3.8)	0.5 (0.5 to 0.5)	5327	52.6 (50.3 to 54.8)	87 (86.6 to 87.3)	18.8 (17.7 to 19.8)	97 (96.8 to 97.2)	4 (3.8 to 4.3)	0.5 (0.5 to 0.6)
M2	In-hospital	6459	60 (57.9 to 62.1)	84.5 (84.2 to 84.9)	19.3 (18.4 to 20.3)	97.2 (97 to 97.4)	3.9 (3.7 to 4.1)	0.5 (0.4 to 0.5)	5426	56.1 (53.8 to 58.4)	86.9 (86.5 to 87.3)	19.6 (18.6 to 20.7)	97.2 (97 to 97.4)	4.3 (4.1 to 4.5)	0.5 (0.5 to 0.5)
M0	Within 24 hours	6591	82.9 (77.3 to 87.6)	82 (81.6 to 82.4)	2.8 (2.4 to 3.2)	99.9 (99.8 to 99.9)	4.6 (4.3 to 4.9)	0.2 (0.2 to 0.3)	4971	71.2 (64.1 to 77.6)	86.2 (85.8 to 86.5)	2.6 (2.2 to 3.1)	99.8 (99.8 to 99.9)	5.1 (4.7 to 5.7)	0.3 (0.3 to 0.4)
M1	Within 24 hours	6624	82.0 (76.3 to 86.8)	81.9 (81.5 to 82.3)	2.7 (2.4 to 3.2)	99.9 (99.8 to 99.9)	4.5 (4.2 to 4.8)	0.2 (0.2 to 0.3)	5327	75 (68.1 to 81.1)	85.2 (84.8 to 85.5)	2.6 (2.2 to 3.1)	99.8 (99.8 to 99.9)	5.1 (4.6 to 5.5)	0.3 (0.2 to 0.4)
M2	Within 24 hours	6459	84.2 (78.8 to 88.8)	82.4 (82 to 82.8)	2.9 (2.5 to 3.3)	99.9 (99.8 to 99.9)	4.8 (4.5 to 5.1)	0.2 (0.1 to 0.3)	5426	80.4 (74 to 85.9)	84.9 (84.5 to 85.3)	2.7 (2.3 to 3.2)	99.9 (99.8 to 99.9)	5.3 (4.9 to 5.7)	0.2 (0.2 to 0.3)
M0	Within 48 hours	6591	76.5 (71.9 to 80.6)	82.2 (81.8 to 82.6)	4.5 (4 to 5)	99.7 (99.6 to 99.7)	4.3 (4.1 to 4.6)	0.3 (0.2 to 0.3)	4971	66.3 (61.2 to 71.2)	86.4 (86 to 86.8)	4.8 (4.2 to 5.5)	99.6 (99.5 to 99.7)	4.9 (4.5 to 5.3)	0.4 (0.3 to 0.5)
M1	Within 48 hours	6624	77.3 (72.8 to 81.3)	82.1 (81.7 to 82.5)	4.5 (4 to 5)	99.7 (99.6 to 99.8)	4.3 (4.1 to 4.6)	0.3 (0.2 to 0.3)	5327	68.2 (63.2 to 73)	85.4 (85 to 85.8)	4.6 (4.1 to 5.2)	99.6 (99.5 to 99.7)	4.7 (4.3 to 5)	0.4 (0.3 to 0.4)
M2	Within 48 hours	6459	78.8 (74.4 to 82.8)	82.6 (82.2 to 83)	4.7 (4.2 to 5.3)	99.7 (99.7 to 99.8)	4.5 (4.3 to 4.8)	0.3 (0.2 to 0.3)	5426	75.1 (70.4 to 79.5)	85.2 (84.8 to 85.6)	5 (4.4 to 5.6)	99.7 (99.6 to 99.8)	5.1 (4.8 to 5.4)	0.3 (0.2 to 0.3)
M0	Within 72 hours	6591	74.6 (70.8 to 78.2)	82.5 (82.1 to 82.9)	6.3 (5.7 to 6.9)	99.5 (99.4 to 99.6)	4.3 (4 to 4.5)	0.3 (0.3 to 0.4)	4971	66.1 (61.8 to 70.2)	86.6 (86.3 to 87)	6.8 (6.1 to 7.5)	99.4 (99.3 to 99.5)	4.9 (4.6 to 5.3)	0.4 (0.3 to 0.4)
M1	Within 72 hours	6624	75.7 (71.9 to 79.2)	82.4 (82 to 82.8)	6.3 (5.7 to 6.9)	99.5 (99.5 to 99.6)	4.3 (4.1 to 4.5)	0.3 (0.3 to 0.3)	5327	67.8 (63.6 to 71.9)	85.6 (85.3 to 86)	6.5 (5.8 to 7.2)	99.5 (99.4 to 99.5)	4.7 (4.4 to 5)	0.4 (0.3 to 0.4)
M2	Within 72 hours	6459	77.4 (73.6 to 80.8)	82.9 (82.5 to 83.3)	6.6 (6 to 7.2)	99.6 (99.5 to 99.6)	4.5 (4.3 to 4.8)	0.3 (0.2 to 0.3)	5426	72.9 (68.9 to 76.8)	85.4 (85 to 85.8)	6.9 (6.2 to 7.6)	99.5 (99.5 to 99.6)	5 (4.7 to 5.3)	0.3 (0.3 to 0.4)

Table S4 Sensitivity analysis of three NEWS models (M0, M1, M2) to predict the risk in-hospital mortality, mortality within 24 hours, 48 hours, and 72 hours at NEWS≥5 in the YH and NH hospitals. PPV=Positive Predictive Value; NPV= Negative Predictive Value; LR+=Positive Likelihood Ratio; LR-=Negative Likelihood Ratio).

CCS Disease Group	YH	NH	CCI Disease Group	YH	NH
Aspiration pneumonitis	41.4 (79/191)	30.2 (77/255)	Metastatic Cancer	17.2 (255/1483)	16.4 (220/1338)
Respiratory failure	29.4 (15/51)	26 (13/50)	Moderate/Severe LD (Liver)	15.9 (46/290)	15.1 (48/318)
Intracranial injury	26.9 (21/78)	-	Congestive Heart	15.2 (494/3259)	13.1 (447/3414)
Cancer of bronchus	25.5 (47/184)	21.8 (38/174)	Cancer	13.3 (325/2438)	8.9 (258/2895)
Septicemia (except in labor)	22.4 (131/585)	20.4 (107/525)	Peripheral Vascular	11.8 (148/1259)	10.8 (183/1688)
Liver disease	21.4 (22/103)	17.4 (24/138)	RD (Renal)	11.7 (579/4947)	11.2 (409/3648)
Pneumonia	18.8 (543/2888)	17.3 (467/2698)	Dementia	10.4 (328/3163)	11.9 (298/2497)
Secondary malignancies	12.6 (36/285)	15.9 (32/201)	Hemiplegia/Paraplegia	10.3 (70/679)	15.8 (55/348)
Acute renal failure	8.3 (20/242)	15.8 (96/609)	Cerebrovascular	9.4 (106/1130)	9.5 (391/4135)
Congestive heart failure	12.6 (46/364)	13.4 (24/179)	Mild LD (Liver)	8.5 (83/982)	6 (43/720)
Acute cerebrovascular disease	14.3 (187/1305)	12 (115/956)	Peptic Ulcer	7.7 (20/259)	15.3 (20/131)
Biliary tract disease	7.9 (21/267)	-	Acute Myocardial Infarction	7.4 (419/5679)	10.4 (283/2713)
Gastrointestinal hemorrhage	7.7 (31/402)	7 (35/497)	Rheumatoid Disease	7.2 (81/1132)	6.9 (73/1051)
Acute myocardial infarction	5.9 (30/506)	6.2 (21/340)	COPD	6.9 (520/7500)	8.4 (505/6025)
lower respiratory disease	6.2 (20/321)	6 (17/282)	Diabetes	6.3 (428/6804)	6.8 (434/6424)
Urinary tract infections	5.1 (53/1036)	4.9 (88/1795)	Diabetes+Complications	4.7 (24/506)	7.4 (20/269)
Fluid and electrolyte disorders	-	4.8 (19/393)			
Chronic obstructive pulmonary	4.4 (56/1273)	4.1 (86/2076)			
Skin infections	-	3.4 (21/611)			

Table S5: Risk of death by CCS and CCI disease groups in each hospital

CCS disease group	YH: M0	YH: M1	YH: M2	NH: M0	NH: M1	NH: M2
Aspiration pneumonitis	0.488 (0.403 to 0.573)	0.611 (0.531 to 0.69)	0.629 (0.55 to 0.708)	0.632 (0.553 to 0.711)	0.709 (0.64 to 0.779)	0.724 (0.655 to 0.792)
Respiratory failure	0.542 (0.357 to 0.727)	0.646 (0.48 to 0.813)	0.626 (0.442 to 0.81)	0.604 (0.412 to 0.796)	0.678 (0.485 to 0.87)	0.642 (0.431 to 0.854)
Intracranial injury	0.662 (0.5 to 0.824)	0.805 (0.707 to 0.904)	0.846 (0.761 to 0.932)	-	-	-
Cancer of bronchus	0.615 (0.522 to 0.707)	0.628 (0.531 to 0.725)	0.622 (0.52 to 0.724)	0.699 (0.606 to 0.793)	0.638 (0.538 to 0.738)	0.634 (0.532 to 0.735)
Septicemia (except in labor)	0.647 (0.59 to 0.704)	0.705 (0.654 to 0.756)	0.743 (0.697 to 0.789)	0.704 (0.647 to 0.761)	0.751 (0.702 to 0.799)	0.757 (0.707 to 0.806)
Liver disease	0.645 (0.49 to 0.799)	0.724 (0.607 to 0.84)	0.739 (0.621 to 0.857)	0.651 (0.519 to 0.783)	0.739 (0.633 to 0.845)	0.744 (0.634 to 0.854)
Pneumonia	0.651 (0.625 to 0.678)	0.732 (0.71 to 0.754)	0.759 (0.738 to 0.78)	0.663 (0.636 to 0.691)	0.733 (0.709 to 0.756)	0.747 (0.724 to 0.771)
Secondary malignancies	0.784 (0.745 to 0.823)	0.802 (0.765 to 0.839)	0.8 (0.762 to 0.837)	0.72 (0.629 to 0.811)	0.686 (0.59 to 0.782)	0.691 (0.594 to 0.789)
Acute renal failure	0.652 (0.565 to 0.738)	0.71 (0.636 to 0.783)	0.73 (0.657 to 0.803)	0.723 (0.672 to 0.775)	0.732 (0.677 to 0.788)	0.747 (0.693 to 0.801)
Congestive heart failure	0.588 (0.484 to 0.693)	0.578 (0.482 to 0.675)	0.593 (0.499 to 0.686)	0.692 (0.581 to 0.803)	0.729 (0.619 to 0.839)	0.725 (0.614 to 0.836)
Acute cerebrovascular disease	0.744 (0.623 to 0.865)	0.837 (0.747 to 0.927)	0.823 (0.733 to 0.914)	0.774 (0.73 to 0.818)	0.819 (0.777 to 0.861)	0.807 (0.766 to 0.849)
Biliary tract disease	0.685 (0.554 to 0.816)	0.782 (0.691 to 0.874)	0.831 (0.761 to 0.901)	-	-	-

Gastrointestinal hemorrhage	0.749 (0.654 to 0.843)	0.807 (0.733 to 0.881)	0.821 (0.751 to 0.891)	0.765 (0.68 to 0.851)	0.799 (0.715 to 0.883)	0.826 (0.75 to 0.901)
Acute myocardial infarction	0.821 (0.746 to 0.896)	0.852 (0.79 to 0.914)	0.847 (0.769 to 0.926)	0.702 (0.58 to 0.823)	0.791 (0.712 to 0.87)	0.836 (0.767 to 0.906)
lower respiratory disease	0.788 (0.694 to 0.882)	0.843 (0.783 to 0.903)	0.85 (0.786 to 0.914)	0.79 (0.692 to 0.887)	0.746 (0.629 to 0.862)	0.771 (0.666 to 0.876)
Urinary tract infections	0.68 (0.602 to 0.757)	0.751 (0.684 to 0.817)	0.782 (0.719 to 0.845)	0.715 (0.655 to 0.775)	0.728 (0.67 to 0.785)	0.733 (0.674 to 0.792)
Fluid and electrolyte disorders	-	-	-	0.719 (0.583 to 0.855)	0.779 (0.681 to 0.877)	0.768 (0.651 to 0.884)
Chronic obstructive pulmonary	0.674 (0.604 to 0.744)	0.708 (0.643 to 0.773)	0.758 (0.699 to 0.818)	0.689 (0.629 to 0.748)	0.752 (0.697 to 0.806)	0.744 (0.687 to 0.801)
Skin infections	-	-	-	0.73 (0.62 to 0.84)	0.844 (0.774 to 0.914)	0.879 (0.824 to 0.935)

Table S6: The c-statistics (95% CI) for CCS disease groups for all four models (M0, M1, and M2) in each hospital

CCI Disease group	YH: M0	YH: M1	YH: M2	NH: M0	NH: M1	NH: M2
Metastatic Cancer	0.68 (0.641 to 0.72)	0.673 (0.634 to 0.713)	0.678 (0.637 to 0.718)	0.691 (0.655 to 0.726)	0.673 (0.637 to 0.709)	0.684 (0.649 to 0.719)
Moderate/Severe LD (Liver)	0.628 (0.529 to 0.726)	0.709 (0.63 to 0.788)	0.697 (0.618 to 0.775)	0.688 (0.598 to 0.778)	0.769 (0.693 to 0.846)	0.789 (0.719 to 0.859)
Congestive Heart	0.672 (0.645 to 0.699)	0.699 (0.673 to 0.724)	0.714 (0.688 to 0.739)	0.674 (0.649 to 0.699)	0.703 (0.678 to 0.727)	0.715 (0.691 to 0.739)
Cancer	0.7 (0.665 to 0.734)	0.729 (0.697 to 0.76)	0.75 (0.72 to 0.781)	0.693 (0.662 to 0.724)	0.701 (0.671 to 0.731)	0.722 (0.692 to 0.751)
Peripheral Vascular	0.675 (0.632 to 0.718)	0.714 (0.674 to 0.753)	0.748 (0.712 to 0.785)	0.668 (0.622 to 0.714)	0.708 (0.665 to 0.75)	0.725 (0.682 to 0.768)
RD (Renal)	0.703 (0.676 to 0.731)	0.744 (0.719 to 0.768)	0.768 (0.744 to 0.791)	0.705 (0.682 to 0.728)	0.724 (0.702 to 0.746)	0.737 (0.715 to 0.759)
Dementia	0.722 (0.69 to 0.754)	0.731 (0.7 to 0.762)	0.747 (0.718 to 0.777)	0.735 (0.705 to 0.764)	0.734 (0.704 to 0.765)	0.739 (0.709 to 0.769)
Hemiplegia/Paraplegia	0.696 (0.622 to 0.77)	0.74 (0.674 to 0.806)	0.74 (0.673 to 0.808)	0.766 (0.706 to 0.826)	0.776 (0.721 to 0.83)	0.762 (0.706 to 0.817)
Cerebrovascular	0.723 (0.695 to 0.75)	0.751 (0.724 to 0.778)	0.764 (0.737 to 0.79)	0.7 (0.646 to 0.754)	0.723 (0.671 to 0.775)	0.722 (0.669 to 0.774)
Mild LD (Liver)	0.675 (0.581 to 0.768)	0.746 (0.674 to 0.818)	0.754 (0.686 to 0.822)	0.633 (0.566 to 0.7)	0.787 (0.739 to 0.835)	0.799 (0.752 to 0.846)
Peptic Ulcer	0.612 (0.461 to 0.762)	0.721 (0.61 to 0.832)	0.756 (0.654 to 0.858)	0.791 (0.695 to 0.887)	0.836 (0.761 to 0.911)	0.869 (0.808 to 0.931)
Acute Myocardial Infarction	0.735 (0.702 to 0.767)	0.781 (0.753 to 0.809)	0.795 (0.768 to 0.821)	0.733 (0.709 to 0.757)	0.776 (0.754 to 0.797)	0.787 (0.766 to 0.808)
Rheumatoid Disease	0.746 (0.68 to 0.811)	0.788 (0.731 to 0.845)	0.806 (0.752 to 0.859)	0.789 (0.741 to 0.837)	0.82 (0.773 to 0.866)	0.814 (0.768 to 0.86)
COPD	0.752 (0.73 to 0.774)	0.797 (0.778 to 0.816)	0.81 (0.792 to 0.829)	0.753 (0.732 to 0.774)	0.796 (0.778 to 0.814)	0.809 (0.792 to 0.827)
Diabetes	0.734 (0.709 to 0.76)	0.771 (0.749 to 0.794)	0.79 (0.768 to 0.813)	0.723 (0.697 to 0.748)	0.778 (0.757 to 0.8)	0.791 (0.77 to 0.812)
Diabetes+Complications	0.656 (0.527 to 0.785)	0.85 (0.765 to 0.935)	0.879 (0.807 to 0.951)	0.648 (0.538 to 0.757)	0.776 (0.689 to 0.863)	0.785 (0.701 to 0.868)

Table S7: The c-statistics (95% CI) for CCI disease groups for all four models (M0, M1, and M2) in each hospital