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National Early Warning Score accurately discriminates the risk of serious adverse events in patients with liver disease

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TITLE PAGE**Title**

National Early Warning Score accurately discriminates the risk of serious adverse events in patients with liver disease

Short title (max 45 characters incl. spaces)

National Early Warning Score in liver disease

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List of abbreviations

ACLF: acute-on chronic liver failure

APACHE: Acute Physiology and Chronic Health Evaluation

ARLD: alcohol-related liver disease

AUROC: area under receiver operating characteristics curve

AVPU: Alert-Verbal-Painful-Unresponsive scale

CCS: Clinical Classifications Software

CI: confidence interval

CLD: chronic liver disease

CLIF-SOFA: Chronic Liver Failure Sequential Organ Failure Assessment

DNACPR: Do Not Attempt Cardiopulmonary Resuscitation

EWS: early warning score

FCE: finished consultant episode

ICD-10: International Classification of Diseases 10

ICU: intensive care unit

MELD: Model for End Stage Liver Disease

NCEPOD: National Confidential Enquiry into Patient Outcome and Death

NEWS: National Early Warning Score

PAS: Patient Administration System

SAPS: Simplified Acute Physiology Score

SHMI: Summary Hospital-level Mortality Indicator

SIH: Systemic Inflammation Hypothesis

SIRS: systemic inflammatory response syndrome

SOFA: Sequential Organ Failure Assessment

TIPSS: transjugular intrahepatic portosystemic shunt

UK: United Kingdom

UKELD: United Kingdom End Stage Liver Disease Score

US: United States

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Disclosures

VitalPAC™ is a collaborative development of The Learning Clinic Ltd (TLC) and Portsmouth Hospitals NHS Trust (PHT). At the time of the study PHT had a royalty agreement with TLC to pay for the use of PHT intellectual property within the VitalPAC™ product. Drs Schmidt, Aspinall and Meredith are employed by PHT. Professors Smith and Prytherch were employees of PHT until 31/03/2011 and 31/07/2016, respectively. Dr Schmidt, and the wives of Professors Smith and Prytherch were shareholders in TLC at the time of the study. Professors Smith and Prytherch, and Dr Schmidt, were unpaid research advisors to TLC until May 2016. Professors Smith and Prytherch have received reimbursement of travel expenses from TLC for attending symposia in the UK.

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T.Hydes: None to declare

Author Contributions

Theresa J Hydes: study concept and design, analysis and interpretation of data, drafting of the manuscript

Paul Meredith: study concept and design, analysis and interpretation of data, technical support

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Gary B Smith: study concept and design, analysis and interpretation of data, critical revision of the manuscript for important intellectual content

David R Prytherch: study concept and design, acquisition of data, analysis and interpretation of data, statistical analysis

Richard J Aspinall: study concept and design, analysis and interpretation of data, critical revision of the manuscript for important intellectual content

Abstract:

Background & Aims: The National Early Warning Score (NEWS) is used to identify deteriorating adult hospital inpatients. However, it includes physiological parameters frequently altered in patients with cirrhosis. We aimed to assess the performance of the NEWS in acute and chronic liver diseases.

Methods: We collected vital signs, recorded in real time, from completed consecutive admissions of patients 16 years or older to a large acute-care hospital in Southern England, from January 1, 2010 through October 31, 2014. Using ICD-10 codes, we categorized patients as having primary liver disease, secondary liver disease, or none. For patients with liver disease, 2 analysis groups were developed: the first based on clinical group (such as acute or chronic, alcohol-induced, or associated with portal hypertension) and the second based on summary liver-related hospital-level mortality indicator diagnoses. For each, we compared the abilities of the NEWS and 34 other early warning scores to discriminate 24-hr mortality, cardiac arrest, or unanticipated admission to the intensive care unit using area under the receiver operating characteristics (AUROC) curve and early warning score efficiency curve analyses.

Results: The NEWS identified patients with primary, non-primary, and no diagnoses of liver disease with AUROC values of 0.873 (95% CI, 0.860–0.886), 0.898 (95% CI, 0.891–0.905), and 0.879 (95% CI, 0.877–0.881), respectively. High AUROC values were also obtained for all clinical subgroups; the NEWS identified patients with alcohol-related liver disease with an AUROC value of 0.927 (95% CI, 0.912–0.941). The NEWS identified patients with liver diseases with higher AUROC values than other early warning scoring systems.

Conclusion: The NEWS accurately discriminates patients at risk of death, admission to the intensive care unit, or cardiac arrest within a 24-hr period for a range of liver-related diagnoses. Its widespread use provides a ready-made, easy to use option for identifying patients with liver disease who require early assessment and intervention, without the need to modify parameters, weightings or escalation criteria.

KEY WORDS: liver failure, sepsis, portal hypertension, cirrhosis, alcohol

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INTRODUCTION

Hospitalized patients with chronic liver disease (CLD) can rapidly deteriorate, particularly when acute decompensation is accompanied by extrahepatic organ dysfunction, a situation associated with high mortality.¹ Early recognition of clinical deterioration is vital if effective, goal-directed therapies are to be employed before complications develop.²

Clinical early warning scores (EWS) can identify patients at high risk of mortality³ and are deployed in many hospitals in the USA and Europe.⁴ Many different EWS are available (**Supplementary Table 1**) and to reduce variation in the United Kingdom (UK), a National EWS (NEWS) was launched by the Royal College of Physicians for use in all adults except pregnant women (**Supplementary Table 2**).⁵ NEWS allocates weighted points, based on derangement of vital signs from defined normal ranges. The sum of allocated points directs changes in the level of care e.g. more frequent monitoring, involvement of senior staff, calling a rapid response team.

NEWS is calculated using: pulse, respiratory rate, systolic blood pressure, AVPU (Alert-Verbal-Painful-Unresponsive) scale, temperature, peripheral oxygen saturations (S_pO_2) and use of supplemental oxygen. NEWS was validated in 35,585 unselected medical patients, achieving an area under the receiver operating characteristics (AUROC) curve [95% confidence interval (CI)] of 0.894 [0.887-0.902], 0.857 [0.847-0.868] and 0.722 [0.685-0.759] for discriminating risk of death, unanticipated intensive care unit (ICU) admission and cardiac arrest, within 24 hours, respectively.⁶

The introduction of NEWS was timely, coinciding with a National Confidential Enquiry into Patient Outcome and Death (NCEPOD) report on treating patients with alcohol-related liver disease (ARLD) in UK hospitals, which identified widespread deficiencies in management.⁷ These included poor recognition of deterioration and failure to escalate care. Opportunities were missed to manage sepsis, hypovolaemia, renal failure and variceal haemorrhage effectively. While current predictive models estimate medium and long-term prognosis in patients with liver disease, none are validated for short-term outcomes in a ward setting. There is an urgent need for tools to identify liver patients at risk of deterioration, which can be deployed outside the ICU.

However, a potential concern is that many patients with liver disease have chronic physiological derangements affecting NEWS parameters.⁸ Patients with cirrhosis often have low systemic vascular resistance, hypotension or resting tachycardia.^{9,10} Pyrexial response may be blunted in decompensated cirrhosis and respiratory rate increased in encephalopathy.²

These changes raise the possibility that NEWS may perform suboptimally in cirrhosis and other hepatic conditions. Indeed, no EWS has been specifically evaluated in liver patients. Therefore, the aims of our study were to determine whether NEWS accurately discriminates the risk of early in-hospital death, cardiac arrest or ICU admission in hospitalized patients with liver disease and to compare its performance against all other EWS.

PATIENTS AND METHODS

The Isle of Wight, Portsmouth and SE Hampshire research ethics committee approved our study (ref. 08/02/1394).

Setting

The study was performed in a large acute hospital in Southern England, serving 650,000 people.

Patient group

We analysed a database of electronically captured vital signs recorded in real-time from completed consecutive admissions (episodes) of patients aged ≥ 16 years between 01/01/2010 and 31/10/14. Electronic NEWS recordings were in hospital-wide use excluding the emergency department and ICU. Patients discharged before midnight on the day of admission and those admitted directly to ICU were excluded.

Identification and classification of patients with liver disease

Patient admissions were categorized according to International Classification of Diseases (ICD-10) codes for any finished consultant episode (FCE). Data were extracted from the hospital's Patient Administration System (PAS). If care was transferred to another consultant or specialty during the same admission, a new FCE and further set of ICD-10 codes were recorded. Groups included (1) patients with primary diagnosis of liver disease, (2) those with non-primary liver diagnosis (co-morbidity) and (3) patients not allocated any liver disease codes (control group). Where patients had more than one FCE during

admission, the final liver primary diagnosis or top-ranking liver secondary diagnosis (if no primary liver code) prior to discharge was used. Therefore each admission could only belong to one group.

ICD-10 codes were divided into four subgroups to examine NEWS performance according to whether liver disease was acute or chronic, alcohol-induced or associated with portal hypertension (**Supplementary Table 3**). Clinical subgroups included: (A) acute alcohol-induced liver injury, (B) other acute injury, (C) CLD without cirrhosis, (D) cirrhosis. Liver-related ICD-10 codes were identified separately using Summary Hospital-level Mortality Indicator (SHMI) definitions employed routinely in the UK's National Health Service.¹¹ Three previously defined SHMI groups were selected: (1) Alcohol-related liver disease (SHMI group 93), (2) Other liver disease (SHMI group 94), and (3) Hepatitis, viral infection, other infections (SHMI group 6, Clinical Classification System (CCS) group 6), which includes viral hepatitis, autoimmune and drug-induced liver disease (**Supplementary Table 4**).¹¹ Division between SHMI groups 93 and 94 may be relevant as ethanol can effect cardiovascular physiology independent of liver disease. Patients were defined as having no liver disease if none of their episodes of care during, or prior to this study, contained any liver ICD-10 codes (primary or secondary diagnosis) identified by the three SHMI groups or four clinical subgroups.

Outcomes

The primary outcome was any of the following events occurring within 24 hours of an observation set: in-hospital mortality, unanticipated ICU admission, or cardiac arrest.

Data collection

Nurses recorded data required for NEWS at the bedside using electronic devices running VitalPAC™ software.¹² Vital sign sets with implausible physiological values were excluded, as were events for which no observations were recorded within the preceding 24 hours. Reasons for this included end of life care or an outcome following admission to ICU. We excluded observations recorded after a primary outcome had occurred.

Comparison of NEWS with other EWS

To compare the performance of NEWS⁶ with 34 other published EWS in patients with liver disease, we applied each EWS to our data set.

Statistics

Data manipulation was performed using MicroSoft® Visual Fox-Pro 9.0. The ability of NEWS to discriminate outcomes was assessed using AUROC on IBM SPSSv22. Data were analysed regarding (a) percentage of observations that would trigger medical review if escalation occurred at or above a given NEWS value and (b) percentage of observations that were followed by death, cardiac arrest or ICU admission within 24 hours at, or above this value. EWS efficiency curves were constructed using this data.¹³ All observation sets were treated independently.

RESULTS

Study population

Categorising patient episodes using the four clinical subgroups, 773 patients (1197 episodes) were discharged with a primary diagnosis of liver disease and 2525 (3953 episodes) with non-primary (co-morbid) diagnosis. In the same period, if patient episodes were categorised using the three SHMI groups, 1216 patients (2016 episodes) were discharged with a primary diagnosis of liver disease and 4957 (6459 episodes) with a non-primary (co-morbid) diagnosis. After excluding episodes with no observations recorded 24 hours prior to an adverse event, the final dataset where episodes were categorised using the four clinical subgroups, comprised 722 patients (1112 episodes) with a primary liver diagnosis, and 2339 patients (3658 episodes) with a non-primary liver diagnosis (**Table 1**). Similarly, after the same exclusions, the final dataset where patient episodes were categorised using the three SHMI groups comprised 1136 patients (1894 episodes) with a primary liver diagnosis, and 4486 patients (5840 episodes) with a non-primary liver diagnosis (**Supplementary Table 5**).

From these datasets we examined NEWS' performance in liver disorders using over 3.5 million vital sign sets. As described in the Methods, we included all observations for analysis. We identified 39,619 sets from patients allocated a liver ICD-10 code as primary diagnosis and 105,092 from those with a non-primary liver diagnosis defined by the four clinical subgroups; in addition to 3,525,420 sets from those never allocated a liver ICD-10

code (control group) (**Table 1**). Of these 2.53% (1001 / 39,619), 1.94% (2035 / 105,092), and 0.87% (30,522 / 3,525,420) observations were followed by an adverse event within 24 hours respectively (**Table 1**). Using the SHMI classification, we identified 57,836 sets from patients allocated a liver primary diagnosis and 205,194 from those with a non-primary liver diagnosis (**Supplementary Table 5**). Overall 2.19% (1269 / 57,836) and 1.91% (3917 / 205,194) of these observations were followed by an event within 24 hours.

NEWS performance in primary and non-primary liver disease vs. patients without liver disease

NEWS performed equally well in patients with primary diagnoses of liver disease with AUROC values [CI] of 0.873 [0.860–0.886] compared to 0.879 [0.877–0.881] for patients without liver disease. NEWS achieved even higher levels of efficiency in patients with a non-primary diagnosis of liver disease, AUROC 0.898 [0.891–0.905] (**Table 2, Figure. 1**).

NEWS performance in four clinical subgroups of liver disease

NEWS performed as well in patients with non-alcohol related acute liver injury (AUROC [CI] 0.906 [0.879–0.933]) and CLD (AUROC [CI] 0.865 [0.835–0.894]) as it did in patients without liver disease (AUROC [CI] 0.879 [0.877–0.881]) (**Table 2**). Compared to those without liver disease, NEWS performed significantly higher in acute alcohol-induced liver injury (AUROC [CI] 0.927 [0.912–0.941]) and slightly lower in cirrhosis (AUROC [CI] 0.824 [0.797–0.850]) (**Table 2, Figure 2a**). In patients with non-primary diagnoses of liver disease, NEWS performed better for several groups (all liver diagnoses combined, AUROC

[CI] 0.898 [0.891–0.905]; acute alcohol-induced liver injury, AUROC [CI] 0.929 [0.909–0.949], and CLD, AUROC [CI] 0.905 [0.894–0.917]) than in patients without liver disease (**Table 2, Figure 2b**).

NEWS performance in subgroups of liver disease according to SHMI classification

NEWS performed equally well in patients with primary (AUROC [CI] 0.886 [0.875-0.896]) and non-primary (AUROC [CI] 0.880 [0.874-0.885]) liver disease defined using SHMI classification for all liver groups (**Table 3**). NEWS performed better in ARLD than other SHMI liver diagnoses, both as primary (AUROC [CI] 0.902 [0.889-0.916]) and non-primary diagnosis (AUROC [CI] 0.915 [0.903-0.928]) (**Figure 3a and 3b**). Admission numbers for SHMI group 6, CCS 6 were too small for meaningful interpretation.

Performance of other EWS in patients with and without a primary diagnosis of liver disease

NEWS performed better than the other 34 EWS evaluated for patients with a primary or non-primary liver diagnosis (**Supplementary Table 6**). On dividing patients into clinical subgroups, NEWS performed better than the 34 EWS for those with primary or secondary diagnosis of acute alcohol-related injury (group A) and patients with secondary diagnosis of CLD (group C) (**Supplemental Tables 7 and 8**). While NEWS also appeared to perform better in all other liver cohorts, there was no significant difference between NEWS and other high performing scores. NEWS performed better than the 34 EWS for alcohol and non-alcohol related liver disease groups according to the SHMI classification (**Supplemental Table 9**).

DISCUSSION

In the UK, the Royal College of Physicians recommended that NEWS is deployed to standardize assessment of acute-illness severity in hospitals. Our study was designed to test the hypothesis that NEWS might not accurately predict serious events in patients with liver disease due to pre-existing altered physiology associated with the underlying condition. This hypothesis was disproven and we were encouraged to find NEWS remained a highly accurate discriminator of adverse events in liver disorders, with its performance being highest in ARLD. Sensitivity and specificity was slightly reduced in patients with cirrhosis but remained clinically relevant. In a direct comparison with 34 other EWS systems, NEWS was the most discriminating in patients with primary or non-primary diagnostic codes for liver disease.

As described in the Systemic Inflammation Hypothesis (SIH), patients with advanced liver disease are imperiled by progressive interactions between circulatory disturbance and systemic inflammation.¹⁴ These can abruptly worsen, leading to acute-on-chronic liver failure (ACLF), multiple organ dysfunction and death.¹⁵ To allow effective interventions, physicians need to be promptly alerted to deterioration. Unfortunately many doctors fail to recognize deteriorating patients with liver disease.⁷

In our study, NEWS was validated as an accurate discriminator of short-term (< 24 hour) deterioration of inpatients with liver disease. The recent increase in hospital admissions secondary to cirrhosis in the UK¹⁶ and 43% increase in cirrhosis-associated deaths per year in the USA make these findings pertinent.¹⁷ NEWS' reliance on routine vital signs facilitates

serial monitoring, a potential advantage over many predictive scores. Its widespread adoption provides opportunities for standardization of care and the potential benefits.

The availability of other predictors of short-term mortality for ward-based patients with CLD is limited. Model for End Stage Liver Disease (MELD)^{18,19} and UK End Stage Liver Disease (UKELD) scores²⁰ are more accurate in predicting medium-term mortality. Child-Pugh score is limited by two subjective parameters and a ceiling effect.²¹ These scoring systems, along with the Glasgow alcoholic hepatitis score²² and Maddrey's discriminant function²³ are reliant on laboratory parameters and less easily applied at the bedside for frequent monitoring.

Clinical, hematological and biochemical criteria can predict short-term mortality using the Sequential Organ Failure Assessment (SOFA), Acute Physiology and Chronic Health Evaluation (APACHE) II and Simplified Acute Physiology (SAPS) II scores, but these have only been validated in ICU settings.²⁴ These prognostic models appear most accurate 48 hours after ICU admission and may not perform optimally on general wards.^{25,26} The adapted Chronic Liver Failure (CLIF)-SOFA score and CLIF-Consortium Organ Failure score for ACLF (CLIF-C ACLF) were validated as predictors of 28-day transplant-free mortality.^{1,27} Despite outperforming MELD and Child-Pugh, the predictive value of CLIF-C ACLF is lowest at day one of diagnosis and may not reveal the earliest point of deterioration.²⁷ Thus, none of the existing liver-specific scores have been validated as predictors of short-term (< 24 hour) mortality in a ward environment.

NEWS incorporates several parameters that can be deranged in the systemic inflammatory response syndrome (SIRS). This may be relevant to our finding that NEWS performs

especially well in ARLD patients, who are particularly susceptible to sepsis.²⁸ Alcohol misuse can lead to an altered intestinal microbiome, increased translocation of bacteria and elevated endotoxin levels.^{29,30} These events can worsen the liver injury itself, particularly alcoholic hepatitis.^{31,32}

A recent multi-centre study demonstrated strong associations between SIRS, multi-organ failure and death in patients with alcoholic hepatitis, independent of infection.³³ Furthermore, alcohol-related cirrhosis may be associated with higher portal pressures and a more hyperdynamic circulation.^{34,35} Similarly, low arterial pressures and increased intrahepatic resistance correlate with mortality in alcohol-related ACLF.³⁶

While the efficiency of NEWS was slightly reduced in cirrhosis compared to other subgroups, its ability to identify acute deterioration remained high. Importantly, AUROC values for NEWS in this group were higher than other EWS systems.

The strength of this study lies in its access to a large electronic dataset of four years of hospital-wide vital signs captured at the point of care. Exclusion rate was small (~6%), reflecting a valid cross-section of inpatients. Potential weaknesses include reliance on ICD-10 coding which may limit the accurate placement of patients into clinical subgroups. In addition, this study was not designed to demonstrate whether introducing NEWS improved clinical care and saved lives in patients with liver diseases. This would be difficult to demonstrate, as NEWS is merely a clinical tool to identify patients at risk of deterioration.

NEWS forms only one part of the 'Chain of Prevention',³⁷ which requires staff education, timely vital signs monitoring, escalation of care and appropriate clinical responses. No EWS could be expected to improve outcomes if other components of the chain are not optimised. Additionally, metrics that might indicate NEWS-mediated improvements in care (e.g. microbiology cultures, fluid resuscitation, ICU outreach referrals) are affected by factors with no bearing on the performance of EWS. Furthermore, some metrics, e.g. number of

ICU outreach referrals, might be difficult to interpret. For instance, would a reduction in the number of critical care referrals be a good or bad indicator? One could argue that increased referral to ICU implies a more pre-emptive approach to critical illness, whereas another might argue that fewer calls result from improved ward care.

Other potential weaknesses of our study include its retrospective nature and the fact that we obtained date/time of death (or discharge) from the hospital's PAS computer system. Some events may have been recorded later than they occurred, potentially underestimating the number of observations followed by an event within 24 hours. For simplicity, we used all observations for analysis. It would have been possible to randomly choose one observation per episode, either by randomly choosing one, or to select a random time and take the nearest NEWS value. However, we have previously demonstrated that whichever of these approaches is taken, the ranking of competing early warning systems (EWSs) is essentially unchanged.³⁷ Our analysis aimed to rank performance of different EWSs and so we used the computationally simplest.

This work could be extended by identifying whether changes in NEWS over time are more accurate predictors of deterioration, particularly in patients judged to be activating NEWS despite appearing clinically stable. It might also be possible to combine bedside observations with laboratory markers to develop a scoring system with additional medium term predictive qualities.

Many clinicians would agree that shock or severe sepsis are easily recognized, yet many doctors fail to recognize deteriorating patients with liver disease and other conditions.^{7,38,39}

An assessment using NEWS is easily performed by inexperienced and experienced staff alike. It provides an aggregate score based upon the, sometimes subtle, physiologic disturbance of several vital signs and may permit earlier risk stratification than when detailed clinical examination and initial laboratory test results are required. However, this current study was not designed to determine if there was such a measurable benefit from using NEWS.

In conclusion, we have demonstrated that NEWS accurately discriminates risk of death, ICU admission or cardiac arrest within 24 hours in patients with liver-related diagnoses. Its widespread use in hospitals provides an easy-to-use assessment without needing to modify

parameters, weightings or escalation criteria. This could be particularly valuable for identifying patients with decompensated liver disease at risk of deterioration.

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TABLES

Table 1: Demographic, observation and event data regarding patient admissions with primary or non-primary diagnosis of liver disease defined by four clinical subgroups

Table 2: NEWS performance in liver disease according to four clinical subgroups

Table 3: NEWS performance in liver disease according to SHML classification

FIGURE LEGENDS

Figure 1. Calling efficiency curves of NEWS for combined outcome of cardiac arrest, unanticipated ICU admission or death occurring within 24 hours: comparison between patients with a primary or non-primary liver code vs. patients without liver disease

Figure 2. Calling efficiency curves of NEWS for combined outcome of cardiac arrest, unanticipated ICU admission or death occurring within 24 hours: comparison between ICD-10 defined clinical subgroups of liver disease assigned to **a)** primary diagnosis, and **b)** non-primary diagnosis

Figure 3. Calling efficiency curves of NEWS for combined outcome of cardiac arrest, unanticipated ICU admission or death occurring within 24 hours: comparison between SHMI defined subgroups of liver disease assigned to **a)** primary diagnosis, and **b)** non-primary diagnosis

Table 1: Demographic, observation and event data regarding patient admissions with a primary or non-primary diagnosis of liver disease defined by the four clinical subgroups

	<i>Primary diagnosis of liver disease</i>					<i>Non-primary diagnosis of liver disease</i>					
	Total	<i>Group A Acute liver injury (alcohol)</i>	<i>Group B Acute liver injury (other)</i>	<i>Group C Chronic liver disease</i>	<i>Group D Cirrhosis</i>	Total	<i>Group A Acute liver injury (alcohol)</i>	<i>Group B Acute liver injury (other)</i>	<i>Group C Chronic liver disease</i>	<i>Group D Cirrhosis</i>	<i>Patients without liver disease</i>
ADMISSIONS											
Number of admissions, n	1112	177	158	282	495	3658	275	292	1819	1272	172,022
Age of admissions, median (IQR)	57.2 (46.8-66.3)	48.5 (40.3-56.9)	60.3 (47.9-72.6)	57.0 (46.5-65.3)	59.6 (50.3-68.4)	59.4 (47.9-69.8)	47.5 (41.3-58.8)	58.8 (47.8-75.7)	58.9 (47.5-69.7)	62.1 (52.8-71.3)	65.83 (47.17-79.08)
Male, n (%)	682 (61.3)	96 (54.2)	87 (55.1)	174 (61.7)	325 (65.7)	2154 (58.9)	203 (73.8)	174 (59.6)	1020 (56.1)	757 (59.5)	80462 (46.77)
OBSERVATIONS											
Number of observations, n	39,619	6967	6185	8794	17,673	105,092	6147	12,391	49,261	37,293	3,525,420
Number of observations followed by an event, n	1001	257	166	219	359	2035	166	536	694	639	30,522
Number of observations followed by an event, %	2.53	3.69	2.68	2.49	2.03	1.94	2.70	4.33	1.41	1.71	0.87
Average NEWS value (SD)	2.17 (2.09)	2.48 (2.36)	1.76 (2.00)	2.13 (2.01)	2.20 (2.03)	2.06 (2.11)	2.11 (2.18)	2.44 (2.50)	1.93 (2.01)	2.09 (2.05)	1.76 (1.94)
EVENTS											
Number of events, n	146	29	23	33	61	323	21	78	115	109	5881
Rate of events, %	13.13	16.38	14.56	11.70	12.32	8.83	7.64	26.71	6.32	8.57	3.42
Number deaths, n	54 (4.86)	8 (4.52)	11 (6.96)	9 (3.19)	26 (5.25)	152 (4.16)	5 (1.82)	42 (14.39)	47 (2.58)	58 (4.56)	3673 (2.14)
Number cardiac arrests, n	16 (1.44)	0 (0)	1 (0.63)	5 (1.77)	10 (2.02)	22 (0.60)	2 (0.73)	1 (0.34)	9 (0.49)	10 (0.79)	756 (0.44)
Number unanticipated ICU admission, n	76 (6.83)	21 (11.86)	11 (6.96)	19 (6.74)	25 (5.05)	149 (4.07)	14 (5.09)	35 (11.99)	59 (3.24)	41 (3.22)	1452 (0.84)

Table 2: NEWS performance in liver disease according to the four clinical subgroups

	Primary diagnosis of liver disease		Non-primary diagnosis of liver disease		No primary or non-primary diagnosis of liver disease	
Liver group	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval
All combined	0.873 (0.007)	0.860 – 0.886	0.898 (0.004)	0.891 – 0.905	0.879 (0.001)	0.877 – 0.881
Acute liver injury (alcohol)	0.927 (0.007)	0.912 – 0.941	0.929 (0.010)	0.909 – 0.949		
Acute liver injury (other)	0.906 (0.014)	0.879 – 0.933	0.875 (0.008)	0.860 – 0.890		
Chronic liver disease	0.865 (0.015)	0.835 – 0.894	0.905 (0.006)	0.894 – 0.917		
Cirrhosis	0.824 (0.013)	0.797 – 0.850	0.888 (0.007)	0.874 – 0.903		

Table 3: NEWS performance in liver disease according to SHMI classification

	Primary diagnosis of liver disease		Non-primary diagnosis of liver disease		No primary or non-primary diagnosis of liver disease	
Liver group	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval
All combined	0.886 (0.005)	0.875 – 0.896	0.880 (0.003)	0.874 – 0.885	0.879 (0.001)	0.877 – 0.881
SHMI 93: Liver disease, alcohol related	0.902 (0.007)	0.889 – 0.916	0.915 (0.006)	0.903 – 0.928		
SHMI 94: Liver disease, other	0.874 (0.008)	0.858 – 0.890	0.872 (0.003)	0.866 – 0.878		
SHMI 6 (CCS Group 6): Hepatitis, viral infection, other infections, immunization and screening for infectious disease	0.824 (0.048)	0.731 – 0.918	0.921 (0.013)	0.895 – 0.946		

Figure 1

Figure shows the efficiency curves for patients with a primary liver code, a non-primary liver code and patients without either a primary or non-primary diagnosis of liver disease, as defined by the four clinical subgroups of liver disease. For each NEWS value the percentage of the total number of observations at, or above, that NEWS value is plotted against the percentage of the total number of observations that were followed by cardiac arrest, unanticipated ICU admission or death within 24 hours at, or above, a given NEWS.

Figure 2a

Figure shows the efficiency curves for patients allocated a primary diagnosis of acute liver injury due to alcohol, acute liver injury due to other causes, chronic liver disease, cirrhosis, any of the four clinical liver subgroups and patients without any primary or non-primary diagnosis of liver disease. For each NEWS value the percentage of the total number of observations at, or above, that NEWS value is plotted against the percentage of the total number of observations that were followed by cardiac arrest, unanticipated ICU admission or death within 24 hours at, or above, a given NEWS.

Figure 2b

Figure shows the efficiency curves for patients allocated a non-primary diagnosis of acute liver injury due to alcohol, acute liver injury due to other causes, chronic liver disease, cirrhosis, any of the four clinical liver subgroups and patients without any primary or non-primary diagnosis of liver disease. For each NEWS value the percentage of the total number of observations at, or above, that NEWS value is plotted against the percentage of the total number of observations that were followed by cardiac arrest, unanticipated ICU admission or death within 24 hours at, or above, a given NEWS.

Figure 3a

Figure shows the efficiency curves for patients allocated a primary diagnosis of alcohol related liver disease (SHMI 93), liver disease due to other causes (SHMI 94) and patients without any primary or non-primary diagnosis of liver disease. For each NEWS value the percentage of the total number of observations at, or above, that NEWS value is plotted against the percentage of the total number of observations that were followed by cardiac arrest, unanticipated ICU admission or death within 24 hours at, or above, a given NEWS.

Figure 3b

Figure shows the efficiency curves for patients allocated a non-primary diagnosis of alcohol related liver disease (SHMI 93), liver disease due to other causes (SHMI 94) and patients without any primary or non-primary diagnosis of liver disease. For each NEWS value the percentage of the total number of observations at, or above, that NEWS value is plotted against the percentage of the total number of observations that were followed by cardiac arrest, unanticipated ICU admission or death within 24 hours at, or above, a given NEWS.

Supplementary Table 1: Early warning scoring systems

System number	Reference
1	Morgan R et al. <i>Clin Intensive Care</i> 1997;8:100
2	Wright MM et al. <i>Anaesthesia</i> 2000;55:391-2.
3	Subbe CP et al. <i>QJM</i> 2001;94:521-6.
4	Subbe CP et al. <i>QJM</i> 2001;94:521-6.
5	Fox N et al. <i>Nurs Times</i> 2001;97:34-5.
6	Riley B et al. <i>BJA CEPD Rev</i> 2001;1:146-9.
7	Cooper N. <i>Clin Med</i> 2001;1:309-11.
8	Subbe C et al. <i>Intensive Care Med</i> 2002;28:21.
9	Wasson C et al. <i>Br J Anaesth</i> 2002;89:367.
10	Odell M et al. <i>Nurs Crit Care</i> 2002;7:132-5.
11	Carberry M. <i>Nurs Crit Care</i> 2002;7:220-6.
12	Rees JE. <i>Update Anaesth</i> 2003;17:30-3.
13	Rees JE et al. <i>Emerg Med J</i> 2004;21:698-9.
14	Priestley G et al. <i>Intensive Care Med</i> 2004;30:1398—404.
15	Ryan H et al. <i>Br J Nurs</i> 2004;13:1186-90.
16	Allen K. <i>Nurs Times</i> 2004;100:34-7.
17	Goldhill DR. <i>Br J Anaesth</i> 2005;95:88-94.
18	Chatterjee MT et al. <i>Postgrad Med J</i> 2005;81:663-6.
19	Heaps N et al. <i>Br J Nurs</i> 2005;14:1208-11.
20	Andrews T et al. <i>J Adv Nurs</i> 2005;52:473-81.
21	Bakir A et al. Poster presentation Intensive Care Society. 2005.
22	Smith GB et al. <i>Resuscitation</i> 2006;71:19-29.
23	Paterson R et al. <i>Clin Med</i> 2006;6:281-4.
24	Lam TS et al. <i>Hong Kong J Emerg Med</i> 2006;13:24-30.
25	Smith AF et al. <i>Anaesthesia</i> 2006;61:222-8.
26	Gardner-Thorpe J et al. <i>Ann R Coll Surg Engl</i> 2006;88:571-5.
27	Hancock HC et al. <i>Intensive Crit Care Nurs</i> 2007;23:104-14.
28	Duckitt RW et al. <i>Br J Anaesth</i> 2007;98:769-74.
29	Subbe CP et al. <i>Intensive Care Med</i> 2007;33:619-24.
30	Odell M et al. <i>Resuscitation</i> 2007;74:470-5.
31	Barlow G et al. <i>Thorax</i> 2007;62:253-9.
32	von Lilienfeld-Toal M et al. <i>Biol Blood Marrow Transplant</i> 2007;13:568-76.
33	von Lilienfeld-Toal M et al. <i>Biol Blood Marrow Transplant</i> 2007;13:568-76.
34	Tarassenko L et al. <i>Resuscitation</i> 2011;82:1013-1018
NEWS	Smith GB et al. <i>Resuscitation</i> 2013;84(4):465-70.

Supplementary Table 2: The National Early Warning Score (NEWS)

Physiological parameters	3	2	1	0	1	2	3
Respiration Rate (breaths per minute)	≤ 8		9 - 11	12 - 20		21 - 24	≥ 25
Oxygen Saturation percentage (S _p O ₂ %)	≤ 91	92 - 93	94 - 95	≥ 96			
Any supplemental oxygen?		Yes		No			
Temperature (°C)	≤ 35.0		35.1 - 36.0	36.1 - 38.0	38.1 - 39.0	≥ 39.1	
Systolic BP (mmHg)	≤ 90	91 - 100	101 - 110	111 - 219			≥ 220
Heart/pulse rate (beats per minute)	≤ 40		41 - 50	51 - 90	91 - 110	111 - 130	≥ 131
Level of consciousness using the AVPU system				A			V, P or U

Level of consciousness: A = Alert; V = Responds to voice; P = Responds to pain; U = Unresponsive

Modified from the National Early Warning Score (NEWS): Standardising the assessment of acute-illness severity in the NHS. Report of a working party. Royal College of Physicians, London, 2012 (2).

Supplementary Table 3: Liver ICD scores grouped according to clinical presentation

	Total number admissions, n				Total number admissions		
	Primary liver disease	Non-primary liver disease	Total		Primary liver disease	Non-primary liver disease	Total
Group A Acute liver injury (alcohol)	177	275	452	Group C Chronic liver disease continued			
K70.0 Alcoholic fatty liver				K71.3 Toxic liver disease with chronic persistent hepatitis			
K70.1 Alcoholic hepatitis				K71.4 Toxic liver disease chronic lobular hepatitis			
K70.4 Alcoholic hepatic failure				K71.5 Toxic liver disease with chronic active hepatitis			
Group B Acute liver injury (other)	158	292	450	K71.6 Toxic liver disease with hepatitis, not elsewhere classified			
B15.0 Hepatitis A with hepatic coma				K71.8 Toxic liver disease with other disorders of liver			
B15.9 Hepatitis A without hepatic coma				K71.9 Toxic liver disease, unspecified			
B16.0 Acute hepatitis B with delta-agent with hepatic coma				K73.0 Chronic persistent hepatitis, not classified elsewhere			
B16.1 Acute hepatitis B with delta-agent without hepatic coma				K73.1 Chronic lobular hepatitis, not classified elsewhere			
B16.2 Acute hepatitis B without delta-agent with hepatic coma				K73.2 Chronic active hepatitis, not classified elsewhere			
B16.9 Acute hepatitis B without delta-agent without hepatic coma				K73.8 Other chronic hepatitis, not classified elsewhere			
B17.0 Acute delta-(super) infection of hepatitis B carrier				K73.9 Chronic hepatitis, unspecified			
B17.1 Acute hepatitis C				K75.3 Granulomatous hepatitis, not elsewhere classified			
B17.2 Acute hepatitis E				K75.4 Autoimmune hepatitis			
B17.8 Other specified acute viral hepatitis				K75.8 Nonalcoholic steatohepatitis (NASH)			
B17.9 Acute viral hepatitis, unspecified				K75.9 Inflammatory liver disease, unspecified			
B19.0 Unspecified viral hepatitis with hepatic coma				K76.0 Fatty (change of) liver, no elsewhere classified			
B19.9 Unspecified viral hepatitis without hepatic coma				K76.1 Chronic passive congestion of liver			
B25.1 Cytomegaloviral hepatitis				K76.9 Liver disease, unspecified			
B58.1 Toxoplasma hepatitis				Group D Cirrhosis	495	1272	1767
K71.0 Toxic liver disease with cholestasis				I81.0 Portal vein thrombosis			
K71.1 Toxic liver disease with hepatic necrosis				I85.0 Oesophageal varices with bleeding			
K71.2 Toxic liver disease with acute hepatitis				I85.9 Oesophageal varices without bleeding			
K72.0 Acute & subacute hepatic failure				I86.4 Gastric varices			
K72.9 Hepatic failure, unspecified with coma				K70.2 Alcoholic fibrosis and sclerosis of liver			
K75.0 Abscess of liver				K70.3 Alcoholic cirrhosis of liver			
K75.2 Nonspecific reactive hepatitis				K71.7 Toxic liver disease with fibrosis and cirrhosis			
K76.2 Central haemorrhagic necrosis of liver				K72.1 Chronic hepatic failure			
K76.3 Infarction of liver				K74.0 Hepatic fibrosis			
Group C Chronic liver disease	282	1819	2101	K74.1 Hepatic sclerosis			
B18.0 Chronic viral hepatitis B with delta antigen				K74.2 Hepatic fibrosis with hepatic sclerosis			
B18.1 Chronic viral hepatitis B without delta antigen				K74.3 Primary biliary cirrhosis			
B18.2 Chronic viral hepatitis C				K74.4 Secondary biliary cirrhosis			
B18.8 Other chronic viral hepatitis				K74.5 Biliary cirrhosis, unspecified			
B18.9 Chronic viral hepatitis, unspecified				K74.6 Other and unspecified cirrhosis of liver			
B94.2 Sequelae of viral hepatitis				K76.5 Hepatic veno-occlusive disease			
E83.1 Haemochromatosis				K76.6 Portal hypertension			

182.0 Budd chiari syndrome				K76.7 Hepatorenal syndrome			
K70.9 Alcoholic liver disease, unspecified				R18.X. Ascites			

Supplementary Table 4: Liver SHMI scores grouped according to clinical presentation

	Total number admissions, n				Total number admissions, n		
	Primary liver disease	Non-primary liver disease	Total		Primary liver disease	Non-primary liver disease	Total
Group 1: Liver disease, alcohol related (SHMI group 93)	632	1082	1714	<i>K76.8 Other specified diseases of the liver</i>			
K70.0 Alcoholic fatty liver				<i>K76.9 Liver disease, unspecified</i>			
K70.1 Alcoholic hepatitis				<i>K77.0 Liver disorders in infectious and parasitic diseases classified elsewhere</i>			
K70.2 Alcoholic fibrosis and sclerosis of liver				<i>K77.8 Liver disorders in other diseases classified elsewhere</i>			
K70.3 Alcoholic cirrhosis of liver				<i>R16.0 Hepatomegaly, not elsewhere classified</i>			
K70.4 Alcoholic hepatic failure				<i>R16.2 Hepatomegaly with splenomegaly, not elsewhere classified</i>			
K70.9 Alcoholic liver disease, unspecified				<i>R17.X Unspecified jaundice</i>			
Group 2: Liver disease, other (SHMI group 94)	1214	4461	5675	<i>R18.X Ascites</i>			
<i>A06.4 Amoebic liver abscess</i>				<i>R74.0 Elevation of levels of transaminase and lactic acid dehydrogenase</i>			
K71.0 Toxic liver disease with cholestasis				<i>R74.8 Abnormal levels of other serum enzymes</i>			
K71.1 Toxic liver disease with hepatic necrosis				<i>R74.9 Abnormal level of unspecified serum enzyme</i>			
K71.7 Toxic liver disease with fibrosis and cirrhosis				<i>R94.5 Abnormal results of liver function studies</i>			
K71.8 Toxic liver disease with other disorders of liver				Group 3: Hepatitis, Viral infection, Other infections, Immunisation and screening for infectious disease (SHMI group 6, CCS group 6)	48	297	345
K71.9 Toxic liver disease, unspecified				<i>B15.0 Hepatitis A with hepatic coma</i>			
K72.0 Acute & subacute hepatic failure				<i>B15.9 Hepatitis A without hepatic coma</i>			
K72.1 Chronic hepatic failure				<i>B16.0 Acute viral hepatitis B with delta antigen with hepatic coma</i>			
<i>K72.9 Hepatic failure, unspecified with coma</i>				<i>B16.1 Acute viral hepatitis B with delta antigen without hepatic coma</i>			
K74.0 Hepatic fibrosis				<i>B16.2 Acute viral hepatitis B without delta antigen with hepatic coma</i>			
K74.1 Hepatic sclerosis				<i>B16.9 Acute viral hepatitis B without delta antigen without hepatic coma</i>			
K74.2 Hepatic fibrosis with hepatic sclerosis				<i>B17.0 Acute delta-(super) infection of hepatitis B carrier</i>			
K74.3 Primary biliary cirrhosis				<i>B17.1 Acute hepatitis C</i>			
K74.4 Secondary biliary cirrhosis				<i>B17.2 Acute hepatitis E</i>			
K74.5 Biliary cirrhosis, unspecified				<i>B17.8 Other specified acute viral hepatitis</i>			
K74.6 Other and unspecified cirrhosis of liver				<i>B17.9 Acute viral hepatitis, unspecified</i>			
K75.0 Abscess of liver				<i>B18.0 Chronic viral hepatitis B with delta antigen</i>			
<i>K75.1 Phlebitis of the portal vein</i>				<i>B18.1 Chronic viral hepatitis B without delta antigen</i>			
K75.8 Nonalcoholic steatohepatitis (NASH)				<i>B18.2 Chronic viral hepatitis C</i>			
K75.9 Inflammatory liver disease, unspecified				<i>B18.8 Other chronic viral hepatitis</i>			
K76.0 Fatty (change of) liver, no elsewhere classified				<i>B18.9 Chronic viral hepatitis unspecified</i>			
K76.1 Chronic passive congestion of liver				<i>B19.0 Unspecified viral hepatitis with hepatic coma</i>			
K76.2 Central haemorrhagic necrosis of liver				<i>B19.9 Unspecified viral hepatitis without hepatic coma</i>			
K76.3 Infarction of liver				<i>B25.1 Cytomegaloviral Hepatitis</i>			
<i>K76.4 Peliosis hepatis</i>				<i>B58.1 Toxoplasma Hepatitis</i>			
K76.5 Hepatic veno-occlusive disease				<i>B94.2 Sequelae of viral hepatitis</i>			
K76.6 Portal hypertension							

K76.7 Hepatorenal syndrome				K71.2 Toxic liver disease with acute hepatitis			
K71.4 Toxic liver disease with chronic lobular hepatitis				K71.3 Toxic liver disease with chronic persistent hepatitis			
K71.5 Toxic liver disease with chronic active hepatitis				Codes Included in clinical subgroups of liver disease, not in SHMI liver groups 93, 94, 6 (CCS 6)			
K71.6 Toxic liver disease with hepatitis, not elsewhere classified				E83.1 Haemochromatosis			
K73.0 Chronic persistent hepatitis, not elsewhere classified				I8.1 Portal vein thrombosis			
K73.1 Chronic lobular hepatitis, not elsewhere classified				I82.0 Budd chiari syndrome			
K73.2 Chronic active hepatitis, not elsewhere classified				I85.0 Oesophageal varices with bleeding			
K73.8 Other chronic hepatitis, not elsewhere classified				I85.9 Oesophageal varices without bleeding			
K73.9 Chronic hepatitis, unspecified				I86.4 Gastric varices			
<i>K75.2 Nonspecific reactive hepatitis</i>							
K75.3 Granulomatous hepatitis, not elsewhere classified							
K75.4 Autoimmune hepatitis							
<i>P35.3 Congenital viral hepatitis</i>							

ICD-10 codes included in SHMI classification (groups 93, 94 and 6 (CCS6)) not included in clinical subgroups of liver disease defined by the study's organisers (supplementary table 2) are shown in italics. These ICD-10 diagnoses were excluded due to being non-applicable to adults (congenital disease), having a poor specificity for identifying patients with liver disease, or for denoting relatively benign disease which would be unlikely to influence physiology or lead to admission. A further 6 ICD-10 codes were included in the study's clinical subgroups which do not appear in either SHMI group 93, 94 or 6 (CCS 6). These include haemochromatosis (it was decided that to require hospital admission patients are likely to have a liver complication) and oesophageal and gastric varices (it was decided that these complications of portal hypertension are likely to be highly specific for liver disease).

Supplementary Table 5: Demographic, observation and event data regarding admissions of patients with a primary or non-primary diagnosis of liver disease defined by the SHMI classification

	<i>Primary diagnosis of liver disease</i>				<i>Non-primary diagnosis of liver disease</i>				
	Total	<i>Group 1 Liver disease, alcohol related (SHMI 93)</i>	<i>Group 2 Liver disease, other (SHMI 94)</i>	<i>Group 3 Hepatitis and viral infection (SHMI 6, CCS6)</i>	Total	<i>Group 1 Liver disease, alcohol related (SHMI 93)</i>	<i>Group 2 Liver disease, other (SHMI 94)</i>	<i>Group 3 Hepatitis and viral infection (SHMI 6, CCS6)</i>	<i>Patients without liver disease</i>
ADMISSIONS									
Number of admissions, n	1894	632	1214	48	5840	1082	4461	297	172,022
Age of admissions, median (IQR)	59.83 (48.75-68.54)	54.17 (45.50-61.42)	63.92 (54.29-72.92)	51.25 (37.17-61.33)	63.67 (50.58-76.75)	54.50 (45.42-63.50)	67.25 (53.46-79.33)	55.00 (43.33-66.67)	65.83 (47.17-79.08)
Male, n (%)	1050 (55.44)	399 (63.13)	625 (51.48)	26 (54.17)	3047 (52.17)	740 (68.39)	2123 (47.59)	184 (61.95)	80,462 (46.77)
OBSERVATIONS									
Number of observations, n	57,836	21,619	35,153	1064	205,194	27,268	169,925	8001	3,525,420
Number of observations followed by an event, n	1269	583	662	24	3917	550	3262	105	30,522
Number of observations followed by an event, %	2.19	2.70	1.88	2.26	1.91	2.02	1.92	1.31	0.87
Average NEWS value (SD)	2.09 (2.02)	2.26 (2.12)	2.01 (1.96)	1.32 (1.54)	2.09 (2.13)	2.09 (2.16)	2.11 (2.14)	1.79 (1.85)	1.76 (1.94)
EVENTS									
Number of events, n	189	79	105	5	666	81	571	14	5881
Rate of events, %	9.98	12.50	8.65	1.02	11.40	7.49	12.80	4.71	3.42
<i>Number deaths, n (rate, %)</i>	81 (4.28)	28 (4.43)	51 (4.20)	2 (4.17)	361 (6.18)	34 (3.14)	324 (7.26)	3 (1.01)	3673 (2.14)
<i>Number cardiac arrests, n</i>	21 (1.11)	7 (1.11)	13 (1.07)	1 (2.08)	53 (0.91)	9 (0.83)	43 (0.96)	1 (0.34)	756 (0.44)
<i>Number unanticipated ICU admission, n</i>	87 (4.59)	28 (6.96)	41 (3.38)	2 (4.17)	252 (4.32)	38 (3.51)	204 (4.57)	10 (3.37)	1452 (0.84)

Supplementary Table 6: Comparison of NEWS and 34 other early warning scoring systems for patients with a primary or non-primary diagnosis of liver disease defined by the four clinical subgroups

System number	Primary diagnosis of liver disease		Non-primary diagnosis of liver disease	
	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval
NEWS	0.873 (0.007)	0.860 - 0.886	0.898 (0.004)	0.891 - 0.905
17	0.843 (0.007)	0.829 - 0.857	0.862 (0.005)	0.853 - 0.871
28	0.840 (0.007)	0.826 - 0.855	0.844 (0.005)	0.835 - 0.854
33	0.839 (0.007)	0.825 - 0.853	0.860 (0.005)	0.851 - 0.869
23	0.836 (0.007)	0.822 - 0.851	0.860 (0.005)	0.851 - 0.870
31	0.836 (0.007)	0.822 - 0.851	0.860 (0.005)	0.851 - 0.869
19	0.833 (0.007)	0.818 - 0.847	0.863 (0.005)	0.854 - 0.872
18	0.825 (0.008)	0.810 - 0.840	0.843 (0.005)	0.833 - 0.852
20	0.820 (0.008)	0.805 - 0.835	0.855 (0.005)	0.845 - 0.864
24	0.819 (0.008)	0.804 - 0.834	0.855 (0.005)	0.845 - 0.864
22	0.819 (0.008)	0.804 - 0.834	0.854 (0.005)	0.845 - 0.864
26	0.819 (0.008)	0.804 - 0.834	0.854 (0.005)	0.845 - 0.864
15	0.818 (0.008)	0.803 - 0.834	0.848 (0.005)	0.839 - 0.858
27	0.818 (0.008)	0.803 - 0.833	0.851 (0.005)	0.841 - 0.861
5	0.818 (0.008)	0.803 - 0.833	0.849 (0.005)	0.839 - 0.859
9	0.818 (0.008)	0.803 - 0.833	0.853 (0.005)	0.843 - 0.863
1	0.814 (0.008)	0.799 - 0.830	0.845 (0.005)	0.835 - 0.854
7	0.810 (0.008)	0.794 - 0.825	0.846 (0.005)	0.836 - 0.856
2	0.806 (0.008)	0.790 - 0.821	0.843 (0.005)	0.833 - 0.853
6	0.804 (0.008)	0.789 - 0.820	0.840 (0.005)	0.830 - 0.850
11	0.804 (0.008)	0.788 - 0.820	0.842 (0.005)	0.832 - 0.852
32	0.804 (0.008)	0.788 - 0.819	0.842 (0.005)	0.831 - 0.852
25	0.804 (0.008)	0.788 - 0.819	0.842 (0.005)	0.832 - 0.852
3	0.803 (0.008)	0.788 - 0.819	0.841 (0.005)	0.831 - 0.851
12	0.803 (0.008)	0.787 - 0.819	0.841 (0.005)	0.831 - 0.851
10	0.798 (0.008)	0.782 - 0.814	0.836 (0.005)	0.826 - 0.847
14	0.798 (0.008)	0.782 - 0.814	0.836 (0.005)	0.826 - 0.847
30	0.798 (0.008)	0.782 - 0.814	0.836 (0.005)	0.826 - 0.847
13	0.797 (0.008)	0.781 - 0.813	0.835 (0.005)	0.825 - 0.846
16	0.787 (0.008)	0.770 - 0.803	0.824 (0.005)	0.813 - 0.835
29	0.757 (0.009)	0.740 - 0.774	0.797 (0.006)	0.786 - 0.808
4	0.748 (0.009)	0.730 - 0.766	0.793 (0.006)	0.781 - 0.804
34	0.748 (0.009)	0.730 - 0.765	0.782 (0.006)	0.770 - 0.793
8	0.748 (0.009)	0.730 - 0.765	0.792 (0.006)	0.781 - 0.803
21	0.696 (0.009)	0.679 - 0.712	0.689 (0.006)	0.676 - 0.702

Early warning scoring systems ranked according to AUROCs for primary diagnosis of liver disease

Supplementary Table 7: Comparison of NEWS and 34 other early warning scoring systems for patients with a primary diagnosis of liver disease according to division by clinical liver subgroups

System number	Group A: Acute Liver Injury (alcohol)		Group B: Acute Liver Injury (other)		Group C: Chronic Liver Disease		Groups D: Cirrhosis	
	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval
NEWS	0.927 (0.007)	0.912 - 0.941	0.906 (0.014)	0.879 - 0.933	0.865 (0.015)	0.835 - 0.894	0.824 (0.013)	0.797 - 0.850
17	0.886 (0.011)	0.865 - 0.907	0.866 (0.017)	0.834 - 0.899	0.846 (0.015)	0.816 - 0.875	0.798 (0.014)	0.771 - 0.824
33	0.883 (0.011)	0.862 - 0.904	0.858 (0.017)	0.826 - 0.891	0.842 (0.015)	0.813 - 0.872	0.794 (0.014)	0.767 - 0.821
28	0.878 (0.010)	0.857 - 0.898	0.871 (0.016)	0.839 - 0.904	0.844 (0.015)	0.815 - 0.873	0.795 (0.014)	0.767 - 0.822
18	0.868 (0.012)	0.845 - 0.892	0.842 (0.019)	0.805 - 0.878	0.835 (0.015)	0.805 - 0.865	0.778 (0.015)	0.749 - 0.806
23	0.863 (0.013)	0.837 - 0.888	0.859 (0.017)	0.826 - 0.892	0.843 (0.015)	0.813 - 0.874	0.802 (0.013)	0.775 - 0.828
31	0.862 (0.013)	0.837 - 0.888	0.859 (0.017)	0.826 - 0.892	0.843 (0.015)	0.813 - 0.873	0.801 (0.013)	0.775 - 0.827
19	0.860 (0.013)	0.835 - 0.886	0.864 (0.017)	0.831 - 0.898	0.832 (0.016)	0.801 - 0.863	0.795 (0.014)	0.768 - 0.821
1	0.852 (0.013)	0.826 - 0.879	0.845 (0.019)	0.807 - 0.882	0.806 (0.016)	0.775 - 0.837	0.776 (0.014)	0.749 - 0.803
7	0.851 (0.013)	0.825 - 0.876	0.847 (0.019)	0.810 - 0.883	0.792 (0.017)	0.759 - 0.826	0.770 (0.014)	0.742 - 0.798
9	0.848 (0.014)	0.821 - 0.875	0.850 (0.018)	0.814 - 0.886	0.806 (0.017)	0.772 - 0.840	0.785 (0.014)	0.758 - 0.812
24	0.848 (0.014)	0.821 - 0.875	0.852 (0.018)	0.816 - 0.888	0.811 (0.017)	0.778 - 0.844	0.785 (0.014)	0.758 - 0.811
22	0.848 (0.014)	0.821 - 0.875	0.852 (0.018)	0.816 - 0.888	0.811 (0.017)	0.778 - 0.844	0.785 (0.014)	0.758 - 0.811
26	0.847 (0.014)	0.820 - 0.874	0.852 (0.018)	0.816 - 0.888	0.811 (0.017)	0.778 - 0.844	0.784 (0.014)	0.758 - 0.811
20	0.847 (0.014)	0.820 - 0.874	0.851 (0.018)	0.815 - 0.888	0.811 (0.017)	0.778 - 0.844	0.788 (0.014)	0.761 - 0.814
27	0.846 (0.014)	0.819 - 0.873	0.853 (0.018)	0.818 - 0.888	0.811 (0.017)	0.778 - 0.843	0.783 (0.014)	0.757 - 0.810
2	0.844 (0.014)	0.817 - 0.871	0.844 (0.019)	0.807 - 0.882	0.792 (0.018)	0.757 - 0.826	0.765 (0.015)	0.737 - 0.794
15	0.843 (0.014)	0.816 - 0.871	0.847 (0.019)	0.810 - 0.883	0.816 (0.016)	0.784 - 0.848	0.786 (0.014)	0.759 - 0.812
5	0.843 (0.014)	0.816 - 0.870	0.850 (0.018)	0.814 - 0.885	0.815 (0.017)	0.783 - 0.848	0.784 (0.014)	0.757 - 0.811
12	0.843 (0.014)	0.816 - 0.869	0.845 (0.019)	0.809 - 0.881	0.783 (0.018)	0.748 - 0.818	0.764 (0.015)	0.735 - 0.792
11	0.842 (0.014)	0.815 - 0.869	0.847 (0.019)	0.809 - 0.884	0.789 (0.018)	0.754 - 0.823	0.764 (0.015)	0.735 - 0.792
32	0.841 (0.014)	0.814 - 0.869	0.845 (0.019)	0.808 - 0.882	0.788 (0.018)	0.754 - 0.823	0.763 (0.015)	0.734 - 0.792
3	0.841 (0.014)	0.814 - 0.868	0.845 (0.019)	0.808 - 0.882	0.788 (0.018)	0.754 - 0.823	0.763 (0.015)	0.734 - 0.792
6	0.840 (0.014)	0.813 - 0.867	0.843 (0.019)	0.807 - 0.879	0.794 (0.017)	0.760 - 0.828	0.765 (0.014)	0.737 - 0.793
25	0.839 (0.014)	0.812 - 0.867	0.846 (0.019)	0.809 - 0.883	0.789 (0.018)	0.754 - 0.823	0.763 (0.015)	0.735 - 0.792
10	0.838 (0.014)	0.811 - 0.866	0.845 (0.019)	0.807 - 0.883	0.781 (0.018)	0.746 - 0.816	0.756 (0.015)	0.727 - 0.784
14	0.838 (0.014)	0.811 - 0.866	0.845 (0.019)	0.807 - 0.883	0.781 (0.018)	0.746 - 0.816	0.756 (0.015)	0.727 - 0.784
30	0.838 (0.014)	0.811 - 0.866	0.845 (0.019)	0.807 - 0.883	0.781 (0.018)	0.746 - 0.816	0.756 (0.015)	0.727 - 0.784
13	0.837 (0.014)	0.809 - 0.865	0.844 (0.019)	0.806 - 0.882	0.778 (0.018)	0.743 - 0.813	0.755 (0.015)	0.726 - 0.783
16	0.819 (0.016)	0.788 - 0.849	0.841 (0.018)	0.807 - 0.876	0.772 (0.018)	0.738 - 0.807	0.746 (0.015)	0.716 - 0.775
4	0.812 (0.015)	0.784 - 0.841	0.787 (0.021)	0.746 - 0.829	0.715 (0.021)	0.675 - 0.756	0.717 (0.016)	0.686 - 0.748

29	0.810 (0.015)	0.780 - 0.840	0.787 (0.022)	0.744 - 0.830	0.738 (0.019)	0.700 - 0.776	0.724 (0.015)	0.694 - 0.755
8	0.800 (0.015)	0.770 - 0.829	0.767 (0.022)	0.724 - 0.810	0.732 (0.019)	0.694 - 0.769	0.719 (0.015)	0.689 - 0.749
34	0.787 (0.016)	0.755 - 0.819	0.721 (0.023)	0.677 - 0.766	0.764 (0.018)	0.728 - 0.799	0.724 (0.015)	0.694 - 0.754
21	0.761 (0.016)	0.730 - 0.791	0.705 (0.022)	0.662 - 0.748	0.681 (0.018)	0.645 - 0.716	0.689 (0.014)	0.661 - 0.716

Early warning scoring systems ranked according to AUROCs for group A: acute liver injury (alcohol)

Supplementary Table 8: Comparison of NEWS and 34 other early warning scoring systems for patients with a non-primary diagnosis of liver disease according to division by clinical liver subgroups

System number	Group A: Acute Liver Injury (alcohol)		Group B: Acute Liver Injury (other)		Group C: Chronic Liver Disease		Groups D: Cirrhosis	
	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval
NEWS	0.929 (0.010)	0.909 - 0.949	0.875 (0.008)	0.860 - 0.890	0.905 (0.006)	0.894 - 0.917	0.888 (0.007)	0.874 - 0.903
28	0.863 (0.015)	0.834 - 0.892	0.815 (0.010)	0.796 - 0.834	0.849 (0.008)	0.833 - 0.864	0.847 (0.008)	0.830 - 0.864
19	0.843 (0.017)	0.810 - 0.875	0.851 (0.009)	0.834 - 0.868	0.873 (0.008)	0.857 - 0.889	0.854 (0.009)	0.837 - 0.871
18	0.840 (0.017)	0.807 - 0.873	0.803 (0.011)	0.782 - 0.823	0.864 (0.008)	0.849 - 0.880	0.844 (0.009)	0.827 - 0.861
33	0.839 (0.017)	0.806 - 0.872	0.835 (0.009)	0.817 - 0.853	0.874 (0.008)	0.858 - 0.889	0.860 (0.008)	0.844 - 0.876
17	0.838 (0.017)	0.805 - 0.872	0.839 (0.009)	0.820 - 0.857	0.874 (0.008)	0.859 - 0.890	0.862 (0.008)	0.847 - 0.878
23	0.838 (0.016)	0.806 - 0.870	0.838 (0.010)	0.819 - 0.857	0.872 (0.008)	0.856 - 0.888	0.859 (0.008)	0.843 - 0.876
31	0.837 (0.016)	0.805 - 0.869	0.837 (0.010)	0.819 - 0.856	0.872 (0.008)	0.856 - 0.888	0.859 (0.008)	0.843 - 0.875
5	0.824 (0.018)	0.788 - 0.859	0.832 (0.010)	0.812 - 0.851	0.862 (0.008)	0.845 - 0.878	0.842 (0.009)	0.825 - 0.860
9	0.823 (0.018)	0.788 - 0.857	0.836 (0.010)	0.817 - 0.855	0.865 (0.008)	0.849 - 0.882	0.849 (0.009)	0.832 - 0.867
20	0.820 (0.018)	0.785 - 0.855	0.840 (0.009)	0.822 - 0.859	0.867 (0.008)	0.850 - 0.883	0.850 (0.009)	0.832 - 0.867
27	0.818 (0.018)	0.782 - 0.853	0.835 (0.010)	0.817 - 0.854	0.865 (0.008)	0.848 - 0.881	0.845 (0.009)	0.828 - 0.863
24	0.817 (0.018)	0.782 - 0.852	0.841 (0.009)	0.823 - 0.860	0.866 (0.008)	0.850 - 0.883	0.850 (0.009)	0.832 - 0.867
22	0.817 (0.018)	0.782 - 0.852	0.841 (0.009)	0.823 - 0.859	0.866 (0.008)	0.850 - 0.883	0.849 (0.009)	0.832 - 0.867
26	0.817 (0.018)	0.781 - 0.852	0.841 (0.009)	0.823 - 0.859	0.866 (0.008)	0.850 - 0.883	0.850 (0.009)	0.832 - 0.867
7	0.814 (0.017)	0.781 - 0.848	0.824 (0.010)	0.804 - 0.844	0.865 (0.008)	0.849 - 0.881	0.840 (0.009)	0.822 - 0.857
15	0.811 (0.018)	0.775 - 0.847	0.834 (0.010)	0.815 - 0.853	0.863 (0.008)	0.847 - 0.880	0.842 (0.009)	0.824 - 0.860
10	0.810 (0.018)	0.774 - 0.846	0.818 (0.011)	0.797 - 0.838	0.855 (0.009)	0.838 - 0.872	0.828 (0.010)	0.809 - 0.847
14	0.810 (0.018)	0.774 - 0.846	0.818 (0.011)	0.797 - 0.839	0.855 (0.009)	0.838 - 0.872	0.828 (0.010)	0.809 - 0.847
30	0.810 (0.018)	0.774 - 0.846	0.818 (0.011)	0.797 - 0.839	0.855 (0.009)	0.838 - 0.872	0.828 (0.010)	0.809 - 0.847
2	0.810 (0.018)	0.774 - 0.845	0.826 (0.010)	0.806 - 0.846	0.859 (0.009)	0.843 - 0.876	0.836 (0.009)	0.818 - 0.854
12	0.809 (0.018)	0.774 - 0.845	0.822 (0.010)	0.802 - 0.842	0.859 (0.009)	0.842 - 0.875	0.835 (0.009)	0.817 - 0.853
6	0.809 (0.018)	0.773 - 0.845	0.824 (0.010)	0.804 - 0.844	0.857 (0.009)	0.840 - 0.874	0.829 (0.009)	0.811 - 0.848
25	0.809 (0.018)	0.773 - 0.845	0.827 (0.010)	0.807 - 0.847	0.860 (0.009)	0.843 - 0.877	0.833 (0.009)	0.815 - 0.852
11	0.809 (0.018)	0.772 - 0.845	0.827 (0.010)	0.807 - 0.847	0.860 (0.009)	0.843 - 0.877	0.834 (0.009)	0.815 - 0.852
32	0.807 (0.018)	0.771 - 0.843	0.826 (0.010)	0.806 - 0.846	0.859 (0.009)	0.842 - 0.876	0.833 (0.009)	0.814 - 0.851
3	0.807 (0.018)	0.771 - 0.843	0.826 (0.010)	0.806 - 0.846	0.859 (0.009)	0.842 - 0.876	0.833 (0.009)	0.814 - 0.851
13	0.807 (0.018)	0.771 - 0.843	0.817 (0.011)	0.796 - 0.837	0.855 (0.009)	0.838 - 0.872	0.827 (0.010)	0.808 - 0.845
1	0.807 (0.019)	0.771 - 0.843	0.832 (0.010)	0.813 - 0.851	0.860 (0.008)	0.844 - 0.877	0.836 (0.009)	0.818 - 0.853
16	0.794 (0.020)	0.756 - 0.833	0.814 (0.010)	0.794 - 0.834	0.836 (0.009)	0.818 - 0.855	0.814 (0.010)	0.795 - 0.833
34	0.790 (0.019)	0.752 - 0.827	0.747 (0.012)	0.723 - 0.770	0.796 (0.010)	0.777 - 0.815	0.780 (0.010)	0.760 - 0.800

29	0.762 (0.022)	0.718 - 0.805	0.773 (0.011)	0.752 - 0.795	0.808 (0.010)	0.789 - 0.827	0.798 (0.010)	0.778 - 0.817
8	0.760 (0.022)	0.717 - 0.804	0.768 (0.011)	0.746 - 0.789	0.803 (0.010)	0.783 - 0.822	0.792 (0.010)	0.772 - 0.811
4	0.699 (0.022)	0.655 - 0.743	0.783 (0.011)	0.763 - 0.804	0.823 (0.010)	0.804 - 0.842	0.783 (0.011)	0.762 - 0.805
21	0.694 (0.022)	0.651 - 0.736	0.640 (0.013)	0.615 - 0.665	0.697 (0.011)	0.675 - 0.718	0.710 (0.012)	0.687 - 0.733

Early warning scoring systems ranked according to AUROCs for group A: acute liver injury (alcohol)

Supplementary Table 9: Comparison of NEWS and 34 other early warning scoring systems for patients with a primary or non-primary diagnosis of liver disease according to division by SHMI liver groups

System number	Primary diagnosis of liver disease						Non-primary diagnosis of liver disease					
	SHMI Group 1: Alcohol related liver disease (SHMI 93)		SHMI Group 2: Other liver disease (SHMI 94)		SHMI Group 3: Hepatitis, Viral Infection (SHMI 6, CCS6)		SHMI Group 1: Alcohol related liver disease (SHMI 93)		SHMI Group 2: Other liver disease (SHMI 94)		SHMI Group 3: Hepatitis, Viral Infection (SHMI 6, CCS6)	
	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval	AUROC (Standard Error)	95% Confidence Interval
NEWS	0.902 (0.007)	0.889 - 0.916	0.874 (0.008)	0.858 - 0.890	0.824 (0.048)	0.731 - 0.918	0.915 (0.006)	0.903 - 0.928	0.872 (0.003)	0.866 - 0.878	0.921 (0.013)	0.895 - 0.946
17	0.868 (0.008)	0.853 - 0.884	0.836 (0.009)	0.818 - 0.854	0.820 (0.053)	0.716 - 0.925	0.884 (0.008)	0.869 - 0.900	0.822 (0.004)	0.814 - 0.830	0.885 (0.021)	0.844 - 0.927
28	0.868 (0.008)	0.853 - 0.884	0.831 (0.009)	0.812 - 0.849	0.807 (0.054)	0.701 - 0.912	0.874 (0.008)	0.858 - 0.890	0.816 (0.004)	0.808 - 0.824	0.798 (0.023)	0.753 - 0.842
33	0.865 (0.008)	0.849 - 0.880	0.833 (0.009)	0.814 - 0.851	0.821 (0.053)	0.716 - 0.925	0.885 (0.008)	0.870 - 0.900	0.820 (0.004)	0.812 - 0.828	0.883 (0.021)	0.841 - 0.925
23	0.860 (0.008)	0.844 - 0.877	0.835 (0.009)	0.816 - 0.853	0.751 (0.063)	0.628 - 0.875	0.882 (0.008)	0.866 - 0.898	0.823 (0.004)	0.815 - 0.831	0.892 (0.020)	0.852 - 0.932
31	0.860 (0.008)	0.843 - 0.876	0.834 (0.009)	0.816 - 0.853	0.751 (0.063)	0.628 - 0.874	0.881 (0.008)	0.865 - 0.897	0.822 (0.004)	0.814 - 0.830	0.892 (0.020)	0.851 - 0.932
19	0.854 (0.009)	0.837 - 0.871	0.837 (0.009)	0.819 - 0.855	0.758 (0.063)	0.635 - 0.881	0.879 (0.008)	0.863 - 0.896	0.820 (0.004)	0.812 - 0.829	0.906 (0.018)	0.870 - 0.942
18	0.852 (0.009)	0.835 - 0.869	0.817 (0.010)	0.797 - 0.836	0.867 (0.046)	0.776 - 0.958	0.873 (0.008)	0.857 - 0.890	0.803 (0.004)	0.795 - 0.812	0.862 (0.021)	0.821 - 0.902
5	0.844 (0.009)	0.827 - 0.862	0.816 (0.010)	0.797 - 0.835	0.786 (0.058)	0.673 - 0.899	0.865 (0.009)	0.848 - 0.883	0.809 (0.004)	0.800 - 0.817	0.887 (0.020)	0.848 - 0.925
9	0.844 (0.009)	0.826 - 0.861	0.822 (0.010)	0.803 - 0.841	0.714 (0.063)	0.591 - 0.837	0.867 (0.009)	0.849 - 0.885	0.813 (0.004)	0.804 - 0.821	0.893 (0.020)	0.854 - 0.932
20	0.843 (0.009)	0.825 - 0.860	0.826 (0.010)	0.807 - 0.845	0.725 (0.062)	0.603 - 0.846	0.868 (0.009)	0.850 - 0.885	0.814 (0.004)	0.806 - 0.823	0.895 (0.020)	0.856 - 0.933
24	0.841 (0.009)	0.823 - 0.859	0.826 (0.010)	0.807 - 0.844	0.724 (0.062)	0.603 - 0.846	0.866 (0.009)	0.848 - 0.884	0.814 (0.004)	0.806 - 0.823	0.896 (0.020)	0.857 - 0.934
22	0.841 (0.009)	0.823 - 0.859	0.825 (0.010)	0.807 - 0.844	0.724 (0.062)	0.603 - 0.846	0.866 (0.009)	0.848 - 0.884	0.814 (0.004)	0.806 - 0.823	0.896 (0.020)	0.857 - 0.934
26	0.841 (0.009)	0.823 - 0.859	0.826 (0.010)	0.807 - 0.844	0.725 (0.062)	0.603 - 0.846	0.866 (0.009)	0.848 - 0.884	0.814 (0.004)	0.806 - 0.823	0.896 (0.020)	0.857 - 0.934
27	0.839 (0.009)	0.821 - 0.856	0.822 (0.010)	0.803 - 0.841	0.792 (0.056)	0.682 - 0.901	0.866 (0.009)	0.848 - 0.884	0.807 (0.004)	0.799 - 0.816	0.898 (0.019)	0.860 - 0.935
15	0.838 (0.009)	0.821 - 0.856	0.820 (0.010)	0.801 - 0.839	0.807 (0.050)	0.709 - 0.904	0.864 (0.009)	0.846 - 0.882	0.803 (0.004)	0.794 - 0.811	0.896 (0.019)	0.859 - 0.933
1	0.837 (0.009)	0.819 - 0.854	0.816 (0.010)	0.797 - 0.835	0.790 (0.049)	0.693 - 0.887	0.859 (0.009)	0.841 - 0.877	0.808 (0.004)	0.800 - 0.817	0.884 (0.021)	0.843 - 0.925
6	0.835 (0.009)	0.817 - 0.853	0.805 (0.010)	0.786 - 0.824	0.713 (0.062)	0.591 - 0.834	0.851 (0.010)	0.833 - 0.870	0.807 (0.004)	0.798 - 0.816	0.891 (0.019)	0.853 - 0.929
7	0.833 (0.009)	0.815 - 0.852	0.816 (0.009)	0.798 - 0.835	0.734 (0.057)	0.622 - 0.846	0.859 (0.009)	0.842 - 0.877	0.807 (0.004)	0.798 - 0.815	0.894 (0.019)	0.858 - 0.931
2	0.833 (0.009)	0.814 - 0.851	0.809 (0.010)	0.790 - 0.829	0.718 (0.062)	0.596 - 0.840	0.855 (0.009)	0.837 - 0.873	0.806 (0.004)	0.797 - 0.814	0.896 (0.019)	0.858 - 0.934
11	0.830 (0.010)	0.812 - 0.849	0.808 (0.010)	0.789 - 0.828	0.719 (0.062)	0.596 - 0.841	0.853 (0.010)	0.835 - 0.872	0.806 (0.004)	0.797 - 0.815	0.895 (0.019)	0.857 - 0.933
12	0.830 (0.009)	0.812 - 0.848	0.807 (0.010)	0.788 - 0.827	0.713 (0.063)	0.591 - 0.836	0.855 (0.009)	0.837 - 0.873	0.804 (0.004)	0.795 - 0.812	0.898 (0.019)	0.860 - 0.936
32	0.830 (0.010)	0.811 - 0.849	0.808 (0.010)	0.788 - 0.827	0.718 (0.062)	0.596 - 0.841	0.852 (0.010)	0.834 - 0.871	0.805 (0.004)	0.797 - 0.814	0.896 (0.019)	0.858 - 0.934
3	0.830 (0.010)	0.811 - 0.848	0.808 (0.010)	0.788 - 0.827	0.718 (0.062)	0.596 - 0.841	0.852 (0.010)	0.833 - 0.871	0.805 (0.004)	0.796 - 0.814	0.896 (0.019)	0.858 - 0.934
25	0.829 (0.010)	0.811 - 0.848	0.808 (0.010)	0.789 - 0.827	0.719 (0.062)	0.596 - 0.841	0.853 (0.010)	0.834 - 0.872	0.805 (0.004)	0.796 - 0.814	0.897 (0.019)	0.859 - 0.935
10	0.823 (0.010)	0.804 - 0.842	0.805 (0.010)	0.786 - 0.825	0.720 (0.062)	0.597 - 0.842	0.849 (0.010)	0.830 - 0.868	0.802 (0.004)	0.793 - 0.810	0.888 (0.020)	0.849 - 0.927
14	0.823 (0.010)	0.804 - 0.842	0.805 (0.010)	0.786 - 0.825	0.720 (0.062)	0.597 - 0.842	0.849 (0.010)	0.830 - 0.868	0.802 (0.004)	0.793 - 0.810	0.888 (0.020)	0.849 - 0.927
30	0.823 (0.010)	0.804 - 0.842	0.805 (0.010)	0.786 - 0.825	0.720 (0.062)	0.597 - 0.842	0.849 (0.010)	0.830 - 0.868	0.802 (0.004)	0.793 - 0.810	0.888 (0.020)	0.849 - 0.927
13	0.821 (0.010)	0.802 - 0.840	0.804 (0.010)	0.784 - 0.823	0.720 (0.062)	0.597 - 0.842	0.849 (0.010)	0.830 - 0.868	0.801 (0.004)	0.792 - 0.809	0.886 (0.020)	0.848 - 0.925
16	0.808 (0.010)	0.788 - 0.828	0.786 (0.010)	0.765 - 0.806	0.653 (0.069)	0.517 - 0.789	0.840 (0.010)	0.820 - 0.859	0.790 (0.005)	0.781 - 0.799	0.890 (0.020)	0.850 - 0.930
29	0.795 (0.011)	0.775 - 0.816	0.728 (0.012)	0.705 - 0.750	0.626 (0.070)	0.489 - 0.764	0.820 (0.010)	0.800 - 0.840	0.767 (0.005)	0.758 - 0.777	0.800 (0.022)	0.757 - 0.843
34	0.792 (0.011)	0.772 - 0.813	0.732 (0.011)	0.711 - 0.754	0.745 (0.062)	0.624 - 0.866	0.817 (0.010)	0.798 - 0.837	0.749 (0.005)	0.740 - 0.759	0.771 (0.025)	0.722 - 0.819

8	0.787 (0.010)	0.766 - 0.807	0.721 (0.012)	0.698 - 0.744	0.627 (0.070)	0.489 - 0.764	0.815 (0.010)	0.795 - 0.836	0.764 (0.005)	0.754 - 0.773	0.787 (0.022)	0.744 - 0.830
4	0.778 (0.011)	0.756 - 0.799	0.724 (0.012)	0.700 - 0.748	0.792 (0.044)	0.706 - 0.877	0.800 (0.011)	0.779 - 0.821	0.787 (0.005)	0.778 - 0.796	0.738 (0.030)	0.680 - 0.796
21	0.743 (0.010)	0.723 - 0.764	0.636 (0.012)	0.612 - 0.660	0.810 (0.040)	0.730 - 0.889	0.737 (0.012)	0.714 - 0.760	0.695 (0.005)	0.686 - 0.705	0.441 (0.027)	0.388 - 0.494

Early warning scoring systems ranked according to AUROCs for SHMI Group 1: Alcohol related liver disease (SHMI 93)