# Supplementary Appendix

*Table A: Model development outcome measures and time horizons used in the 23 studies that used a prediction modelling approach to develop an early warning score.*

| Reference | Outcome measure | Prediction horizon |
|---|---|---|
| Alvarez 2013 [32] | Rescusitation / death composite | 24 hours |
| Badriyah 2014 [33] | Death / ICU / cardiac arrest composite | 24 hours |
| Churpek 2012 [8] | Cardiac arrest | In-hospital |
| Churpek 2014 [35] | Cardiac arrest / ICU composite | 24 hours |
| Churpek 2014 [36] | Cardiac arrest | 24 hours |
| Churpek 2016 [37] | Death | 24 hours |
| Duckitt 2007 [39] | Death | In-hospital |
| Dziadzko 2018 [40] | Death / medical ventilation composite | 48 hours |
| Escobar 2012 [41] | ICU admission | 12 hours |
| Faisal 2018 [42] | Death | In-hospital |
| Ghosh 2018 [43] | Death / ICU composite | In-hospital |
| Goldhill 2004 [44] | Death | 30 days |
| Kellett 2006 [47] | Death | 30 days |
| Kellett 2008 [48] | Death | 24 hours |
| Kipnis 2016 [49] | Death / ICU composite | 12 hours |
| Kirkland 2013 [50] | Death / ICU / rapid response trigger composite | 12 hours |
| Kwon 2018 [51] | Cardiac arrest | 24 hours |
| Luis 2018 [53] | Death / ICU composite | 24 hours |
| Moore 2017 [54] | Death | In-hospital |
| Nickel 2016 [55] | Death | 30 days |
| Perera 2011 [56] | Death / ICU / cardiac arrest composite | In-hospital |
| Silke 2010 [59] | Death | 5 days |
| Wheeler 2013 [62] | Death | 72 hours |

ICU: Intensive care unit

*Table B: Predictor variables considered as candidates and included in the final model, reported for the papers reporting the development of an early warning score.*

| Reference | Number of candidate predictors | Number of predictors in final model | Predictors included in the final model |
|---|---|---|---|
| Albert 2011 [31] | NA | 6 | SBP, RR, HR, temperature, oxygen therapy, urine output |
| Alvarez 2013 [32] | 45 | 13 | DBP, SpO2, age, temperature, pCO2, WBC, platelets, potassium, arterial blood gas order, ECG order, CT / MRI Order, floor assignment, MEWS |
| Badriyah 2014 [33] | 7 | 7 | SBP, RR, HR, SpO2, temperature, oxygen therapy, level of consciousness |
| Bleyer 2011 [34] | NA | 8 | SBP, DBP, RR, HR, SpO2, temperature, level of consciousness, mean arterial pressure |
| Churpek 2012 [8] | 16 | 4 | DBP, RR, HR, age |
| Churpek 2014 [35] | 22 | 15 | DBP, RR, HR, SpO2, temperature, age, oxygen therapy, level of consciousness, prior ICU admission, blood urea nitrogen, anion gap, hemoglobin, platelets, potassium, WBC |
| Churpek 2014 [36] | Missing | 27 | SBP, DBP, RR, HR, SpO2, temperature, age, level of consciousness, previous ICU admission, pulse pressure, sodium, potassium, bicarbonate, anion gap, BUN, creatinine, BUN-creatinine ratio, glucose, calcium, WBC, hemoglobin, platelets, protein, albumin, bilirubin, AST, alkaline phosphatase |
| Churpek 2016 [37] | 12 | 12 | SBP, DBP, RR, HR, SpO2, and trends of these vital signs |
| Cuthbertson 2010 [38] | NA | 3 | RR, HR, SpO2 |
| Douw 2016 [9] | NA | 10 | EWS, change in breathing, change in circulation, rigors, change in mentation, agitation, pain, unexpected trajectory, patient indicates, nurse observation |
| Duckitt 2007 [39] | 6 | 6 | SBP, RR, HR, SpO2, temperature, level of consciousness |
| Dziadzko 2018 [40] | 35 | 35 | SBP, DBP, RR, HR, temperature, age, sex, oxygen therapy, weight, BMI, pulse pressure, shock index, anion gap, arterial PaO2, arterial pH, BUN / Creatinine ratio, hematocrit, hemoglobin, lactate, serum albumin, serum anion gap, serum bicarbonate, serum blood gas nitrogen, serum calcium, serum chloride, serum creatinine, serum glucose, serum potassium, serum sodium, serum total |

| | | | |
|---|---|---|---|
| | | | bilirubin, white blood count, vasopressor use, oxygen delivery device, richmond agitation-sedation scale |
| Escobar 2012 [41] | 30 | 17 | SBP, DBP, RR, HR, SpO2, temperature, level of consciousness, directive status, LAPS, COPS, COPS missing, LOS, time of day, blood urea nitrogen , lactate, WBC |
| Faisal 2018 [42] | 19 | 19 | SBP, DBP, RR, HR, SpO2, temperature, age, sex, oxygen therapy, level of consciousness, NEWS, albumin, creatinine, haemoglobin, potassium, sodium, urea, white cell count, AKI |
| Ghosh 2018 [43] | 8 | 6 | SBP, RR, HR, SpO2, temperature, age |
| Goldhill 2004 [44] | 7 | 5 | SBP, RR, HR, age, level of consciousness |
| Harrison 2006 [45] | NA | 5 | SBP, RR, HR, temperature, level of consciousness |
| Jones 2012 [46] | NA | 7 | SBP, RR, HR, SpO2, temperature, oxygen therapy, level of consciousness |
| Kellett 2006 [47] | Missing | 15 | SBP, RR, HR, SpO2, temperature, age, breathless on presentation, abnormal ECG, diabetes, coma, altered mental status, stroke, lack on independence, nursing home resident, spends time in bed |
| Kellett 2008 [48] | 11 | 5 | SBP, SpO2, temperature, abnormal ECG, loss of independence |
| Kipnis 2016 [49] | 38 | 34 | SBP, DBP, RR, HR, SpO2, temperature, age, level of consciousness, admission category, anion gap, bicarbonate, SBP instability, care order, time of day, glucose, hematocrit, lactate, LAPS, BUN, COPS, creatinine, ELOS, ELOSO*LAPS, HR instability, SpO2 instability, worst SpO2, RR instability, troponin missing, lactate, worst RR, season, sodium, troponin, WBC |
| Kirkland 2013 [50] | 10 | 4 | SpO2, Braden scale, shock index (HR / SBP) |
| Kwon 2018 [51] | 4 | 4 | SBP, RR, HR, temperature |
| Kyriacos 2014 [52] | NA | 7 | SBP, RR, HR, SpO2, temperature, level of consciousness, urine |
| Luis 2018 [53] | 7 | 6 | SBP, RR, HR, SpO2, oxygen therapy, level of consciousness |
| Moore 2017 [54] | 13 | 7 | SBP, RR, HR, SpO2, temperature, level of consciousness, HIV status |

| | | | |
|---|---|---|---|
| Nickel 2016 [55] | 4 | 4 | NEWS, age, alternation in alertness, D-dimer |
| Perera 2011 [56] | 14 | 14 | SBP, RR, HR, Temperature, age, sex, level of consciousness, MEWS, albumin, CRP, CRP / albumin ratio, WBC, platelets, haemoglobin |
| Prytherch 2010 [57] | NA | 6 | RR, HR, SpO2, temperature, oxygen therapy, level of consciousness |
| Redfern 2018 [58] | NA | 14 | SBP, RR, HR, SpO2, temperature, oxygen therapy, level of consciousness, haemoglobin, WCC, urea, creatinine, sodium, potassium, albumin |
| Silke 2010 [59] | 11 | 9 | RR, HR, temperature, age, mean arterial pressure, potassium, urea, haematocrit, WCC |
| Tarassenko 2011 [60] | NA | 4 | SBP, RR, HR, SpO2 |
| Watkinson 2018 [61] | NA | 7 | SBP, RR, HR, SpO2, temperature, oxygen therapy, level of consciousness |
| Wheeler 2013 [62] | 12 | 5 | RR, SpO2, temperature, level of consciousness, loss of independence |

AKI: Acute kidney injury, AST: Aspartate transaminase, BMI: Body mass index, BUN: Blood urea nitrogen, COPS: Comorbidity point score, CRP: C-reactive protein, CT: Computed tomography, DBP: Diastolic blood pressure, ECG: Electrocardiogram, ELOS: Elapsed length of stay, HIV: Human immunodeficiency virus, HR: Heart rate, ICU: Intensive care unit, LAPS: Laboratory-based Acute Physiology Score, LOS: Length of stay, MEWS: Modified early warning score, MRI: Magnetic resonance imaging, NA: Not applicable, NEWS: National early warning score, PaO2: Partial pressure of oxygen, pCO2: Partial pressure of carbon dioxide, RR: Respiratory rate, SBP: Systolic blood pressure, SpO2: Oxygen saturation, WBC: White blood cell

*Table C: Details of the methods used by the 29 studies that developed an early warning score using a statistical approach.*

| Reference | Modelling approach | Variable selection approach | Handling of continuous variables | Was missing data referred to | Missing data approach |
|---|---|---|---|---|---|
| Alvarez 2013 [32] | Logistic | All significant in univariable | Splines | Yes | Other (missing category used) |
| Badriyah 2014 [33] | Tree | All | Categorised / dictomised | No | NA |
| Bleyer 2011 [34] | NA (Critical vital signs identified according to those that lead to a 5/10/20% risk of mortality) | NA | NA | Yes | Use of complete cases |
| Churpek 2012 [8] | Logistic | Backward | Splines | Yes | Other (LOCF) |
| Churpek 2014 [35] | Multinomial logistic | Backward | Linear | No | NA |
| Churpek 2014 [36] | Cox | Backward | Splines | Yes | Other (LOCF) |
| Churpek 2016 [37] | Logistic | All | Splines | Yes | Other (LOCF) |
| Cuthbertson 2010 [38] | NA (discriminant analysis) | NA | NA | Yes | Use of complete cases |
| Duckitt 2007 [39] | Logistic | All | Splines | Yes | Use of complete cases |
| Dziadzko 2018 [40] | Random forest | Unclear | Other (Forest) | Yes | Other (random forest) |
| Escobar 2012 [41] | Logistic | Other | Linear | Yes | Unclear |
| Faisal 2018 [42] | Logistic | All | Other (Univariable transformations) | Yes | Use of complete cases |
| Ghosh 2018 [43] | Naïve Bayes / Logistic | Other | Other (Naïve Bayes Classification) | Yes | Unclear |

| | | | | | |
|---|---|---|---|---|---|
| Goldhill 2004 [44] | Logistic | Backward | Categorised / dictomised | Yes | No missing data |
| Kellett 2006 [47] | Logistic | All significant in univariable | Categorised / dictomised | Yes | Use of complete cases |
| Kellett 2008 [48] | Logistic | Backward | Categorised / dictomised | Yes | Use of complete cases |
| Kipnis 2016 [49] | Other - Discrete time logistic regression | Backward | Fractional polynomials | Yes | Unclear |
| Kirkland 2013 [50] | Logistic | Backward | Splines | Yes | Other (LOCF) |
| Kwon 2018 [51] | ANN | All | Other (Neural Network) | Yes | Other (LOCF) |
| Luis 2018 [53] | Logistic | All significant in univariable | Linear | Yes | Use of complete cases |
| Moore 2017 [54] | Tree | Backward | Categorised / dictomised | Yes | Single Imputation |
| Nickel 2016 [55] | Logistic | Other | Categorised / dictomised | No | NA |
| Perera 2011 [56] | Logistic | All | Linear | Yes | Use of complete cases |
| Prytherch 2010 [57] | NA (trial and error) | NA | NA | Yes | Unclear |
| Redfern 2018 [58] | NA (combines two published scores as a function of time) | NA | NA | Yes | Other (LOCF) |
| Silke 2010 [59] | Logistic | Other | Fractional polynomials | Yes | Use of complete cases |
| Tarassenko 2011 [60] | NA (centiles of vital sign distributions) | NA | NA | No | NA |
| Watkinson 2018 [61] | NA (centiles of vital sign distributions) | NA | NA | Yes | Other (population mean) |
| Wheeler 2013 [62] | Logistic | Backward | Categorised / dictomised | Yes | Use of complete cases |

*NA: Not applicable*

*Table D: Sample size reported in the 34 articles describing the development of an early warning scorer.*

| Reference | Multiple observations per patient | If single, which one | No. patients | No. observations | No. event patients | No. event observations | Events patients per variable | Event observations per variable |
|---|---|---|---|---|---|---|---|---|
| Alvarez 2013 [32] | Yes | NA | 3624 | 23127 | Missing | 298 | Missing | 7 |
| Badriyah 2014 [33] | Yes | NA | 35585 | 198755 | 3149 | Missing | 450 | Missing |
| Bleyer 2011 [34] | Yes | NA | 27722 | 191667 | 760 | Missing | Missing | Missing |
| Churpek 2012 [8] | No | Other (max/min) | 44607 | 44607 | 88 | 88 | 6 | 6 |
| Churpek 2014 [35] | Unclear | NA | 59301 | Missing | 2652 | Missing | 121 | Missing |
| Churpek 2014 [36] | Unclear | NA | 162068 | Missing | 264 | Missing | Missing | Missing |
| Churpek 2016 [37] | No | Other (most recent or summary stats) | 269999 | 269999 | 15452 | 15452 | 1288 | 1288 |
| Cuthbertson 2010 [38] | No | Other (summary stats) | 466 | 466 | 129 | 129 | NA | NA |
| Duckitt 2007 [39] | No | First | 3184 | 3184 | 270 | 270 | 45 | 45 |
| Dziadzko 2018 [40] | Yes | NA | 34387 | Missing | 958 | Missing | 27 | Missing |
| Escobar 2012 [41] | Yes | NA | 102422 | 1079062 | 3525 | 4036 | 118 | 135 |
| Faisal 2018 [42] | No | First | 30996 | 30996 | 1766 | 1766 | 93 | 93 |
| Ghosh 2018 [43] | No | Other (unclear) | 9265 | 9265 | 882 | 882 | 110 | 110 |
| Goldhill 2004 [44] | No | First | 433 | 433 | 26 | 26 | 4 | 4 |
| Kellett 2006 [47] | No | First | 6736 | 6736 | 316 | 316 | Missing | Missing |
| Kellett 2008 [48] | No | First | 6947 | 6947 | 40 | 40 | 4 | 4 |
| Kipnis 2016 [49] | Yes | NA | 649418 | 48723248 | 19153 | Missing | 504 | Missing |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Kirkland 2013 [50] | Yes | NA | 267 | Missing | 68 | Missing | 7 | Missing |
| Kwon 2018 [51] | Yes | NA | 46725 | 2769324 | 396 | 10772 | 99 | 2693 |
| Luis 2018 [53] | No | Other (highest EWS) | 330 | 330 | 34 | 34 | 5 | 5 |
| Moore 2017 [54] | Unclear | NA | 5573 | Missing | 966 | Missing | 74 | Missing |
| Nickel 2016 [55] | No | First | 1201 | 1201 | 69 | 69 | 17 | 17 |
| Perera 2011 [56] | No | First | 242 | 242 | 18 | 18 | 1 | 1 |
| Prytherch 2010 [57] | No | Last | 35585 | 198755 | 3133 | 1999 | NA | NA |
| Redfern 2018 [58] | Yes | NA | 97933 | 2490529 | NA | NA | NA | NA |
| Silke 2010 [59] | No | First | 10712 | 10712 | 648 | 648 | 59 | 59 |
| Tarassenko 2011 [60] | Yes | NA | 863 | 64622 | NA | NA | NA | NA |
| Watkinson 2018 [61] | Yes | NA | 12153 | 301644 | NA | NA | NA | NA |
| Wheeler 2013 [62] | No | First | 302 | 302 | 51 | 51 | 4 | 4 |

NA: Not applicable

*Table E: Presentation of model development by the 23 studies developing an early warning score using a prediction modelling approach.*

| Reference | Full regression formula shown | Predictor coefficients shown | Risk groups created | Simplified model created |
|---|---|---|---|---|
| Alvarez 2013 [32] | No | Yes | Yes | No |
| Badriyah 2014 [33] | No | No | No | Yes |
| Churpek 2012 [8] | No | Yes | No | No |
| Churpek 2014 [35] | No | Yes | No | No |
| Churpek 2014 [36] | No | Yes | No | No |
| Churpek 2016 [37] | No | No | No | No |
| Duckitt 2007 [39] | No | Yes | No | Yes |
| Dziadzko 2018 [40] | No | No | No | No |
| Escobar 2012 [41] | Yes | Yes | No | No |
| Faisal 2018 [42] | Yes | Yes | No | No |
| Ghosh 2018 [43] | No | No | No | No |
| Goldhill 2004 [44] | No | Yes | No | Yes |
| Kellett 2006 [47] | Yes | Yes | Yes | Yes |
| Kellett 2008 [48] | Yes | Yes | No | Yes |
| Kipnis 2016 [49] | Yes | No | No | No |
| Kirkland 2013 [50] | Yes | Yes | No | No |
| Kwon 2018 [51] | No | No | No | No |
| Luis 2018 [53] | Yes | Yes | No | Yes |
| Moore 2017 [54] | No | No | No | Yes |
| Nickel 2016 [55] | Yes | Yes | No | Yes |
| Perera 2011 [56] | No | Yes | No | Yes |
| Silke 2010 [59] | Yes | Yes | No | No |

| | | | | |
|---|---|---|---|---|
| Wheeler 2013 [62] | Yes | Yes | No | Yes |

*Table F: Assessment of apparent performance in the 34 studies developing an early warning score.*

| Reference | Apparent performance assessed | Discrimination assessed | Calibration assessed | ROC curve presented |
|---|---|---|---|---|
| Albert 2011 [31] | Yes | No | No | No |
| Alvarez 2013 [32] | Yes | Yes | Yes | No |
| Badriyah 2014 [33] | Yes | Yes | No | No |
| Bleyer 2011 [34] | Yes | Yes | No | Yes |
| Churpek 2012 [8] | Yes | Yes | No | Yes |
| Churpek 2014 [35] | No | NA | NA | NA |
| Churpek 2014 [36] | No | NA | NA | NA |
| Churpek 2016 [37] | No | NA | NA | NA |
| Cuthbertson 2010 [38] | Yes | Yes | No | No |
| Douw 2016 [9] | Yes | Yes | No | No |
| Duckitt 2007 [39] | Yes | Yes | Yes | Yes |
| Dziadzko 2018 [40] | Yes | No | No | No |
| Escobar 2012 [41] | Yes | Yes | Yes | No |
| Faisal 2018 [42] | Yes | Yes | Yes | Yes |
| Ghosh 2018 [43] | Yes | Yes | No | Yes |
| Goldhill 2004 [44] | Yes | No | No | No |
| Harrison 2006 [45] | Yes | No | No | No |
| Jones 2012 [46] | No | NA | NA | NA |
| Kellett 2006 [47] | Yes | Yes | No | Yes |
| Kellett 2008 [48] | Yes | Yes | No | No |
| Kipnis 2016 [49] | No | NA | NA | NA |
| Kirkland 2013 [50] | Yes | Yes | No | No |
| Kwon 2018 [51] | No | NA | NA | NA |
| Kyriacos 2014 [52] | No | NA | NA | NA |
| Luis 2018 [53] | Yes | Yes | Yes | Yes |
| Moore 2017 [54] | No | NA | NA | NA |
| Nickel 2016 [55] | Yes | Yes | Yes | No |
| Perera 2011 [56] | Yes | Yes | No | No |
| Prytherch 2010 [57] | No | NA | NA | NA |
| Redfern 2018 [58] | No | NA | NA | NA |
| Silke 2010 [59] | Yes | Yes | Yes | Yes |
| Tarassenko 2011 [60] | No | NA | NA | NA |
| Watkinson 2018 [61] | No | NA | NA | NA |

| | | | | |
|---|---|---|---|---|
| Wheeler 2013 [62] | Yes | Yes | Yes | No |

ROC: Receiver operating characteristic

*Table G: Reporting of internal validation in the 34 studies developing an early warning score.*

| Reference | Internal validation performed | Internal validation method | Discrimination assessed | Calibration assessed | ROC curve presented |
|---|---|---|---|---|---|
| Albert 2011 [31] | No | NA | NA | NA | NA |
| Alvarez 2013 [32] | Yes | Split sample | Yes | Yes | Yes |
| Badriyah 2014 [33] | No | NA | NA | NA | NA |
| Bleyer 2011 [34] | No | NA | NA | NA | NA |
| Churpek 2012 [8] | No | NA | NA | NA | NA |
| Churpek 2014 [35] | Yes | Cross-validation | Yes | No | No |
| Churpek 2014 [36] | Yes | Split sample | Yes | Yes | No |
| Churpek 2016 [37] | Yes | Split sample | Yes | No | No |
| Cuthbertson 2010 [38] | No | NA | NA | NA | NA |
| Douw 2016 [9] | No | NA | Na | NA | NA |
| Duckitt 2007 [39] | Yes | Other (additional sample combined with derivation) | Yes | No | No |
| Dziadzko 2018 [40] | Yes | Split sample | Yes | No | Yes |
| Escobar 2012 [41] | Yes | Split sample | Yes | No | No |
| Faisal 2018 [42] | Yes | Bootstrapping | Yes | Yes | No |
| Ghosh 2018 [43] | Yes | Split sample | Yes | No | Yes |
| Goldhill 2004 [44] | No | NA | NA | NA | NA |
| Harrison 2006 [45] | No | NA | NA | NA | NA |
| Jones 2012 [46] | No | NA | NA | NA | NA |
| Kellett 2006 [47] | Yes | Split sample | Yes | No | Yes |
| Kellett 2008 [48] | Yes | Split sample | Yes | Yes | No |

| | | | | | |
|---|---|---|---|---|---|
| Kipnis 2016 [49] | Yes | Split sample | Yes | No | Yes |
| Kirkland 2013 [50] | Yes | Split sample | Yes | No | Yes |
| Kwon 2018 [51] | Yes | Split sample | Yes | No | Yes |
| Kyriacos 2014 [52] | No | NA | NA | NA | NA |
| Luis 2018 [53] | No | NA | NA | NA | NA |
| Moore 2017 [54] | Yes | Cross-validation | Yes | No | No |
| Nickel 2016 [55] | No | NA | NA | NA | NA |
| Perera 2011 [56] | No | NA | NA | NA | NA |
| Prytherch 2010 [57] | Yes | Other (additional sample combined with derivation) | Yes | No | Yes |
| Redfern 2018 [58] | Yes | Split sample | Yes | No | Yes |
| Silke 2010 [59] | No | NA | NA | NA | NA |
| Tarassenko 2011 [60] | No | NA | NA | NA | NA |
| Watkinson 2018 [61] | Yes | Split samples | Yes | No | No |
| Wheeler 2013 [62] | Yes | Bootstrapping | Yes | No | No |

NA: Not applicable

*Table H: Outcome measures and time horizons used in the 84 studies externally validating an early warning score.*

| Reference | Outcomes and time horizons |
|---|---|
| Abbott 2016 [63] | 48hr Composite death / ICU admission |
| Abbott 2015 [64] | 48hr Composite death / ICU admission; Length of stay |
| Alvarez 2013 [32] | 24hr Composite resuscitation event / death |
| Atmaca 2018 [65] | In-hospital ICU admission; 24hr, In-hospital death; Length of stay |
| Badriyah 2014 [33] | 24hr Composite death / ICU admission / cardiac arrest; 24hr Death; 24hr ICU admission; 24hr Cardiac arrest |
| Bartkowiak 2019 [66] | In-hospital composite cardiac arrest / ICU admission / death |
| Beane 2018 [67] | 24hr, In-hospital composite death / ICU admission / cardiac arrest / resuscitation |
| Bleyer 2011 [34] | In-hospital death |
| Brabrand 2017 [68] | 24hr, In-hospital death |
| Brabrand 2018 [69] | 30day death |
| Cei 2009 [70] | In-hospital death; In-hospital composite death / ICU admission; Length of stay |
| Churpek 2017 [71] | 48hr Composite death / ICU admission |
| Churpek 2017 [72] | In-hospital death; In-hospital composite death / ICU admission |
| Churpek 2013 [73] | In-hospital composite death / ICU admission / cardiac arrest; In-hospital death; In-hospital ICU admission; In-hospital cardiac arrest |
| Churpek 2014 [36] | 24hr Cardiac arrest; 24hr Composite death / ICU admission / cardiac arrest; 24hr Death; 24hr ICU admission |
| Churpek 2012 [74] | 24hr Cardiac arrest |
| Churpek 2012 [8] | In-hospital ICU admission |
| Churpek 2014 [35] | 24hr Cardiac arrest; 24hr ICU admission |
| Cooksley 2012 [75] | In-hospital ICU admission; In-hospital death |
| Cuthbertson 2010 [38] | 24hr ICU admission |
| De Meester 2013 [76] | 5day Composite death / ICU admission |
| DeVoe 2016 [77] | In-hospital death; Return of spontaneous circulation |

| | |
|---|---|
| Douw 2017 [78] | In-hospital composite ICU admission / death |
| Duckitt 2007 [39] | In-hospital death |
| Dziadzko 2018 [40] | 48hr composite death / mechanical ventilation |
| Eccles 2014 [79] | 30day Death |
| Escobar 2012 [41] | 12hr ICU admission |
| Fairclough 2009 [80] | In-hospital death |
| Faisal 2018 [42] | In-hospital death |
| Finlay 2014 [81] | 24hr Death |
| Forster 2018 [82] | 24hr Death |
| Garcea 2006 [83] | In-hospital composite death / ICU admission / surgery; In-hospital death; Severity of pancreatitis |
| Gardner 2006 [84] | In-hospital ICU admission; In-hospital death |
| Ghanem 2011 [85] | 24hr, 5day, 10day, 30day, 60day, In-hospital death |
| Ghosh 2018 [43] | In-hospital composite death / ICU admission |
| Green 2018 [86] | 24hr Composite death / ICU admission / cardiac arrest |
| Harrison 2006 [45] | In-hospital death |
| Hodgson 2017 [87] | In-hospital death |
| Hydes 2018 [88] | 24hr Composite death / ICU admission / cardiac arrest |
| Jo 2016 [89] | In-hospital death |
| Kellett 2012 [90] | 48hr, 5day, 10day, 20day, 30day Death |
| Kellett 2016 [91] | 24hr, 5day, 10day, 20day, 30day Death |
| Kim 2018 [92] | In-hospital composite death / ICU admission / RBC transfusion (>=5packs in 24hr); In-hospital death; In-hospital ICU admission; RBC transfusion (>=5packs in 24hrs) |
| Kim 2017 [93] | In-hospital ICU admission |
| Kipnis 2016 [49] | 12hr, 24hr Composite death / ICU admission |
| Kovacs 2016 [94] | 24hr Composite death / ICU admission / cardiac arrest; 24hr Death; 24hr ICU admission; 24hr Cardiac arrest |
| Kruisselbrink 2016 [95] | 7day Death |
| Kwon 2018 [51] | 24hr Cardiac arrest; 24hr Death |
| LeLagadec ~~2019~~ 2020[96] | 72hr Composite cardiac arrest / death / ICU admission / MET call |
| Lee 2018 [97] | In-hospital death |
| Liljehult 2016 [98] | 30day Death |

| | |
|---|---|
| Luis 2018 [53] | 24hr Composite death / ICU admission |
| Moore 2017 [54] | In-hospital death |
| Mulligan 2010 [99] | In-hospital composite death / ICU admission / DNAR |
| Ohman 2018 [100] | 5day, 7day Death |
| Opio 2013 [101] | 24hr Death |
| Opio 2013 [102] | 24hr Death |
| Pedersen 2018 [103] | 48hr Death; 48hr ICU admission |
| Perera 2011 [56] | In-hospital composite death / ICU admission / cardiac arrest |
| Pimentel 2019 [104] | 24hr Death; 24hr Cardiac arrest; 24hr ICU admission; 24hr Composite death / cardiac arrest / ICU admission |
| Plate 2018 [105] | 12hr, 24hr Death; 12hr, 24hr ICU admission; 12hr, 24hr Composite death / ICU admission |
| Prytherch 2010 [57] | 6, 12, 18, 24hr Death |
| Redfern 2018 [106] | 24hr, In-hospital death; 24hr, In-hospital composite ICU admission / death; In-hospital composite 3day long ICU admission / death |
| Redfern 2018 [58] | 24hr Composite death / ICU admission; 24hr Death; 24hr ICU admission |
| Roberts 2017 [107] | 30day Death |
| Romero 2017 [108] | 24hr Composite ICU admission / resuscitation call / RRT activation |
| Romero 2014 [109] | 3, 8, 12, 24, 36hr Composite ICU admission / resuscitation call / RRT activation |
| Rylance 2009 [110] | In-hospital death |
| Silke 2010 [59] | 5day, 7day Death |
| Smith 2008 [111] | In-hospital death |
| Smith 2013 [112] | 24hr Composite death / ICU admission / cardiac arrest; 24hr Death; 24hr ICU admission; 24hr Cardiac arrest |
| Smith 2016 [113] | 24hr Death; 24hr ICU admission; 24hr Cardiac arrest; 24hr Composite death / ICU admission / cardiac arrest |
| Smith 2016 [114] | In-hospital composite death / ICU admission / RRT activation / pulmonary thromboembolus (PTE) / postoperative sepsis / re-operation; Length of stay; 30day Readmission |
| Spagnolli 2017 [115] | 72hr, In-hospital death; 72hr, In-hospital ICU admission; 72hr, In-hospital composite death / ICU admission |
| Stark 2015 [116] | In-hospital death |
| Straede 2014 [117] | 24hr, 30day Death |

| | |
|---|---|
| Subbe 2001 [118] | 60day Death; In-hospital ICU admission |
| Suppiah 2014 [119] | In-hospital poor outcome |
| Tirkkonen 2014 [120] | 30day, 60day, 180day Death; Adverse Event |
| Tirotta 2017 [121] | In-hospital death |
| Vaughn 2018 [122] | In-hospital ICU admission; In-hospital death |
| VonLilienfeld-Toal 2007 [123] | In-hospital death |
| Watkinson 2018 [61] | 24hr Death; 24hr Cardiac arrest; 24hr ICU admission; 24hr Composite death / cardiac arrest / ICU admission |
| Wheeler 2013 [62] | 72hr Death |

ICU: Intensive care unit, MET: Medical emergency team, RRT: Rapid response team

*Table I: Reported sample size used in the 84 studies externally validating an early warning score.*

| Reference | Multiple observations per patient | If single, which one | No. patients | No. observations | No. event patients | No. event observations |
|---|---|---|---|---|---|---|
| Abbott 2016 [63] | No | First | 322 | 322 | 15 | 15 |
| Abbott 2015 [64] | No | First | 453 | 453 | 16 | 16 |
| Alvarez 2013 [32] | Yes | NA | 3792 | 23847 | 287 | Missing |
| Atmaca 2018 [65] | No | Other (cross-section in time) | 104 | 104 | 21 | 21 |
| Badriyah 2014 [33] | Yes | NA | 35585 | 198755 | 3149 | Missing |
| Bartkowiak 2019 [66] | No | Other (max EWS) | 32537 | 32537 | 1243 | 1243 |
| Beane 2018 [67] | No | Other (max EWS) | 16386 | 16386 | 502 | 502 |
| Bleyer 2011 [34] | Yes | NA | 27722 | 191667 | 760 | |
| Brabrand 2017 [68] | No | First | 5784 | 5784 | 32 | 32 |
| Brabrand 2018 [69] | No | First | 570 | 570 | 66 | 66 |
| Cei 2009 [70] | No | First | 1107 | 1107 | 141 | 141 |
| Churpek 2017 [71] | No | Other (max EWS) | 53849 | 53849 | 10527 | 10527 |
| Churpek 2017 [72] | No | Other (max EWS) | 12154 | 12154 | 729 | 729 |
| Churpek 2013 [73] | Yes | NA | 59643 | Missing | 3055 | Missing |
| Churpek 2014 [36] | Unclear | NA | 107911 | Missing | 160 | Missing |
| Churpek 2012 [74] | No | First | 440 | 440 | 88 | 88 |
| Churpek 2012 [8] | No | Other (max EWS) | 47339 | 47339 | 2820 | 2820 |
| Churpek 2014 [35] | Unclear | NA | 59301 | Missing | 2652 | Missing |
| Cooksley 2012 [75] | No | First | 840 | 840 | 157 | 157 |
| Cuthbertson 2010 [38] | No | Other (summary stats) | 466 | 466 | 129 | 129 |

| | | | | | | |
|---|---|---|---|---|---|---|
| De Meester 2013 [76] | No | First | 509 | 509 | 18 | 18 |
| DeVoe 2016 [77] | No | First | 417 | 417 | 86 | 86 |
| Douw 2017 [78] | No | First | 3522 | 3522 | 97 | 97 |
| Duckitt 2007 [39] | No | First | 3184 | 3184 | 270 | 270 |
| Dziadzko 2018 [40] | Yes | | 2258 | Missing | 35 | Missing |
| Eccles 2014 [79] | No | First | 196 | 196 | 23 | 23 |
| Escobar 2012 [41] | Yes | NA | 102422 | 1079062 | 3525 | Missing |
| Fairclough 2009 [80] | No | First | 300 | 300 | Missing | Missing |
| Faisal 2018 [42] | No | First | 26247 | 26247 | 1703 | 1703 |
| Finlay 2014 [81] | Yes | NA | 32472 | 1794910 | 617 | Missing |
| Forster 2018 [82] | Yes | NA | 8263 | 263840 | 467 | Missing |
| Garcea 2006 [83] | No | First | 110 | 110 | 21 | 21 |
| Gardner 2006 [84] | No | First | 334 | 334 | 16 | 16 |
| Ghanem 2011 [85] | No | First | 1072 | 1072 | 43 | 43 |
| Ghosh 2018 [43] | No | Other (unclear) | 9265 | 9265 | 882 | 882 |
| Green 2018 [86] | Yes | NA | 107868 | Missing | 5485 | Missing |
| Harrison 2006 [45] | No | First | 3160 | 3160 | 27 | 27 |
| Hodgson 2017 [87] | No | First | 942 | 942 | 123 | 123 |
| Hydes 2018 [88] | Yes | NA | 1112 | 39619 | 146 | 1001 |
| Jo 2016 [89] | No | First | 553 | 553 | 60 | 60 |
| Kellett 2012 [90] | No | First | 75419 | 75419 | 308 | 308 |
| Kellett 2016 [91] | No | First | 65417 | 65417 | 205 | 205 |
| Kim 2018 [92] | No | First | 530 | 530 | 59 | 59 |
| Kim 2017 [93] | No | First | 1219 | 1219 | 468 | 468 |
| Kipnis 2016 [49] | Yes | NA | 649418 | 48723248 | 19153 | Missing |
| Kovacs 2016 [94] | Yes | NA | 20626 | 517324 | 709 | Missing |
| Kruisselbrink 2016 [95] | No | First | 452 | 452 | 25 | 25 |
| Kwon 2018 [51] | Yes | NA | 5406 | 213369 | 23 | 1247 |
| LeLagadec ~~2019~~ 2020 [96] | Yes | NA | 331 | 5556 | 159 | Missing |

| | | | | | | |
|---|---|---|---|---|---|---|
| Lee 2018 [97] | No | First | 1300 | 1300 | 43 | 43 |
| Liljehult 2016 [98] | No | First | 274 | 274 | 24 | 24 |
| Luis 2018 [53] | No | Other (highest EWS) | 330 | 330 | 34 | 34 |
| Moore 2017 [54] | Unclear | NA | 5573 | Missing | 966 | Missing |
| Mulligan 2010 [99] | No | Other (max EWS) | 71 | 71 | 17 | 17 |
| Ohman 2018 [100] | No | First | 3904 | 3904 | 67 | 67 |
| Opio 2013 [101] | No | First | 844 | 844 | 66 | 66 |
| Opio 2013 [102] | Unclear | NA | 2935 | 14591 | 40 | Missing |
| Pedersen 2018 [103] | Yes | NA | 11266 | 404093 | 1138 | Missing |
| Perera 2011 [56] | No | First | 242 | 242 | 18 | 18 |
| Pimentel 2019 [104] | Yes | NA | 251266 | 6229740 | 6871 | Missing |
| Plate 2018 [105] | Yes | NA | 1782 | 9113 | Missing | 272 |
| Prytherch 2010 [57] | No | Last | 35585 | 198755 | 3133 | 3133 |
| Redfern 2018 [106] | No | Random | 241966 | 5435344 | 6798 | Missing |
| Redfern 2018 [58] | Yes | NA | 16309 | 395404 | Missing | Missing |
| Roberts 2017 [107] | No | First | 358 | 358 | 249 | 249 |
| Romero 2017 [108] | Yes | NA | 34898 | 16780669 | 3332 | Missing |
| Romero 2014 [109] | Yes | NA | 34898 | Missing | 4747 | Missing |
| Rylance 2009 [110] | No | First | 709 | 709 | 77 | 77 |
| Silke 2010 [59] | No | First | 3597 | 3597 | 171 | 171 |
| Smith 2008 [111] | No | First | 9987 | 9987 | 835 | 835 |
| Smith 2013 [112] | Yes | NA | 35585 | 198755 | | 1999 |
| Smith 2016 [113] | Yes | NA | 103998 | 2245778 | 2351 | 10767 |
| Smith 2016 [114] | No | First | 411 | 411 | 25 | 25 |
| Spagnolli 2017 [115] | No | First | 2677 | 2677 | 62 | 62 |
| Stark 2015 [116] | No | First | 62 | 62 | 35 | 35 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Straede 2014 [117] | No | First | 3046 | 3046 | 26 | 26 |
| Subbe 2001 [118] | No | First | 673 | 673 | 75 | 75 |
| Suppiah 2014 [119] | No | Other (max/mean EWS) | 142 | 142 | 22 | 22 |
| Tirkkonen 2014 [120] | No | Random | 615 | 615 | 26 | 26 |
| Tirotta 2017 [121] | No | First | 526 | 526 | 78 | 78 |
| Vaughn 2018 [122] | Unclear | NA | 504 | Missing | 49 | Missing |
| VonLilienfeld-Toal 2007 [123] | No | Other (max EWS) | 43 | 43 | 6 | 6 |
| Watkinson 2018 [61] | Yes | NA | 53385 | 1459422 | 3507 | Missing |
| Wheeler 2013 [62] | No | First | 302 | 302 | 51 | 51 |

*NA: Not applicable*

*Table J: Approach to missing data reported by the 84 that externally validated an early warning score.*

| Reference | Missing data referred to | Missing data approach |
|---|---|---|
| Abbott 2016 [63] | Yes | Use of complete cases |
| Abbott 2015 [64] | Yes | Use of complete cases |
| Alvarez 2013 [32] | Yes | Other (missing category used) |
| Atmaca 2018 [65] | No | NA |
| Badriyah 2014 [33] | No | NA |
| Bartkowiak 2019 [66] | Yes | Other (LOCF) |
| Beane 2018 [67] | Yes | Single imputation |
| Bleyer 2011 [34] | Yes | Use of complete cases |
| Brabrand 2017 [68] | Yes | Use of complete cases |
| Brabrand 2018 [69] | Yes | Single imputation |
| Cei 2009 [70] | No | NA |
| Churpek 2017 [71] | No | NA |
| Churpek 2017 [72] | Yes | Other (LOCF) |
| Churpek 2013 [73] | Yes | Other (LOCF) |
| Churpek 2014 [36] | Yes | Other (LOCF) |
| Churpek 2012 [74] | Yes | Unclear |
| Churpek 2012 [8] | Yes | Other (LOCF) |
| Churpek 2014 [35] | No | NA |
| Cooksley 2012 [75] | Yes | Use of complete cases |
| Cuthbertson 2010 [38] | Yes | Use of complete cases |
| De Meester 2013 [76] | Yes | Use of complete cases |
| DeVoe 2016 [77] | Yes | Use of complete cases |
| Douw 2017 [78] | Yes | Other (LOCF) |
| Duckitt 2007 [39] | Yes | Use of complete cases |
| Dziadzko 2018 [40] | Yes | Other (LOCF) |
| Eccles 2014 [79] | No | NA |
| Escobar 2012 [41] | Yes | Unclear |
| Fairclough 2009 [80] | No | NA |
| Faisal 2018 [42] | Yes | Use of complete cases |
| Finlay 2014 [81] | No | NA |
| Forster 2018 [82] | Yes | Use of complete cases |
| Garcea 2006 [83] | No | NA |
| Gardner 2006 [84] | No | NA |
| Ghanem 2011 [85] | Yes | Unclear |
| Ghosh 2018 [43] | Yes | Unclear |
| Green 2018 [86] | Yes | Unclear |
| Harrison 2006 [45] | No | NA |

| | | |
|---|---|---|
| Hodgson 2017 [87] | Yes | No missing data |
| Hydes 2018 [88] | No | NA |
| Jo 2016 [89] | Yes | Use of complete cases |
| Kellett 2012 [90] | Yes | Use of complete cases |
| Kellett 2016 [91] | Yes | Use of complete cases |
| Kim 2018 [92] | Yes | Use of complete cases |
| Kim 2017 [93] | No | NA |
| Kipnis 2016 [49] | Yes | Unclear |
| Kovacs 2016 [94] | Yes | Use of complete cases |
| Kruisselbrink 2016 [95] | Yes | Use of complete cases |
| Kwon 2018 [51] | Yes | LOCF |
| LeLagadec ~~2019~~ 2020 [96] | Yes | Other (assumed normal) |
| Lee 2018 [97] | Yes | Use of complete cases |
| Liljehult 2016 [98] | Yes | Use of complete cases |
| Luis 2018 [53] | Yes | Use of complete cases |
| Moore 2017 [54] | Yes | Single imputation |
| Mulligan 2010 [99] | Yes | Other (assumed normal) |
| Ohman 2018 [100] | Yes | Use of complete cases |
| Opio 2013 [101] | Yes | Use of complete cases |
| Opio 2013 [102] | No | NA |
| Pedersen 2018 [103] | Yes | Use of complete cases |
| Perera 2011 [56] | Yes | Use of complete cases |
| Pimentel 2019 [104] | Yes | Multiple imputation |
| Plate 2018 [105] | Yes | Use of complete cases |
| Prytherch 2010 [57] | Yes | Unclear |
| Redfern 2018 [106] | Yes | Use of complete cases |
| Redfern 2018 [58] | Yes | Other (LOCF) |
| Roberts 2017 [107] | Yes | Other (assumed normal) |
| Romero 2017 [108] | No | NA |
| Romero 2014 [109] | No | NA |
| Rylance 2009 [110] | Yes | Use of complete cases |
| Silke 2010 [59] | Yes | Use of complete cases |
| Smith 2008 [111] | No | NA |
| Smith 2013 [112] | No | NA |
| Smith 2016 [113] | Yes | Use of complete cases |
| Smith 2016 [114] | No | NA |
| Spagnolli 2017 [115] | Yes | No missing data |
| Stark 2015 [116] | No | NA |
| Straede 2014 [117] | Yes | Use of complete cases |
| Subbe 2001 [118] | Yes | Use of complete cases |

| | | |
|---|---|---|
| Suppiah 2014 [119] | Yes | Use of complete cases |
| Tirkkonen 2014 [120] | Yes | Use of complete cases |
| Tirotta 2017 [121] | No | NA |
| Vaughn 2018 [122] | Yes | Use of complete cases |
| VonLilienfeld-Toal 2007 [123] | Yes | Other (assumed normal) |
| Watkinson 2018 [61] | Yes | Use of complete cases |
| Wheeler 2013 [62] | Yes | Use of complete cases |

*NA: Not applicable*

*Table K: Model performance reported by the 84 studies externally validating an early warning score.*

| Reference | Discrimination assessed | Calibration assessed | ROC curve presented |
|---|---|---|---|
| Abbott 2016 [63] | Yes | No | No |
| Abbott 2015 [64] | No | No | No |
| Alvarez 2013 [32] | Yes | No | Yes |
| Atmaca 2018 [65] | No | No | No |
| Badriyah 2014 [33] | Yes | No | No |
| Bartkowiak 2019 [66] | Yes | No | No |
| Beane 2018 [67] | Yes | No | No |
| Bleyer 2011 [34] | Yes | No | Yes |
| Brabrand 2017 [68] | Yes | No | Yes |
| Brabrand 2018 [69] | Yes | Yes | Yes |
| Cei 2009 [70] | No | No | No |
| Churpek 2017 [71] | Yes | No | No |
| Churpek 2017 [72] | Yes | No | No |
| Churpek 2013 [73] | Yes | No | No |
| Churpek 2014 [36] | Yes | Yes | No |
| Churpek 2012 [74] | Yes | No | No |
| Churpek 2012 [8] | Yes | No | Yes |
| Churpek 2014 [35] | Yes | No | No |
| Cooksley 2012 [75] | Yes | No | Yes |
| Cuthbertson 2010 [38] | Yes | No | No |
| De Meester 2013 [76] | Yes | No | No |
| DeVoe 2016 [77] | No | No | No |
| Douw 2017 [78] | Yes | No | No |
| Duckitt 2007 [39] | Yes | No | Yes |
| Dziadzko 2018 [40] | Yes | No | Yes |
| Eccles 2014 [79] | Yes | No | No |
| Escobar 2012 [41] | Yes | No | No |
| Fairclough 2009 [80] | No | No | No |
| Faisal 2018 [42] | Yes | Yes | Yes |
| Finlay 2014 [81] | Yes | No | Yes |
| Forster 2018 [82] | No | No | No |
| Garcea 2006 [83] | Yes | No | No |
| Gardner 2006 [84] | Yes | Yes | No |
| Ghanem 2011 [85] | Yes | Yes | Yes |
| Ghosh 2018 [43] | Yes | No | Yes |
| Green 2018 [86] | Yes | No | No |
| Harrison 2006 [45] | No | No | No |

| | | | |
|---|---|---|---|
| Hodgson 2017 [87] | Yes | Yes | Yes |
| Hydes 2018 [88] | Yes | No | No |
| Jo 2016 [89] | Yes | Yes | Yes |
| Kellett 2012 [90] | Yes | No | No |
| Kellett 2016 [91] | Yes | No | No |
| Kim 2018 [92] | Yes | Yes | Yes |
| Kim 2017 [93] | Yes | No | Yes |
| Kipnis 2016 [49] | Yes | No | Yes |
| Kovacs 2016 [94] | Yes | No | No |
| Kruisselbrink 2016 [95] | Yes | No | No |
| Kwon 2018 [51] | Yes | No | Yes |
| LeLagadec ~~2019~~ 2020 [96] | Yes | No | No |
| Lee 2018 [97] | Yes | No | No |
| Liljehult 2016 [98] | Yes | No | Yes |
| Luis 2018 [53] | Yes | No | Yes |
| Moore 2017 [54] | Yes | No | No |
| Mulligan 2010 [99] | Yes | No | Yes |
| Ohman 2018 [100] | Yes | Yes | Yes |
| Opio 2013 [101] | Yes | No | No |
| Opio 2013 [102] | Yes | No | No |
| Pedersen 2018 [103] | Yes | No | No |
| Perera 2011 [56] | Yes | No | No |
| Pimentel 2019 [104] | Yes | No | Yes |
| Plate 2018 [105] | Yes | Yes | No |
| Prytherch 2010 [57] | Yes | No | Yes |
| Redfern 2018 [106] | Yes | No | No |
| Redfern 2018 [58] | Yes | No | Yes |
| Roberts 2017 [107] | No | No | No |
| Romero 2017 [108] | No | No | No |
| Romero 2014 [109] | No | No | Yes |
| Rylance 2009 [110] | No | No | Yes |
| Silke 2010 [59] | Yes | Yes | Yes |
| Smith 2008 [111] | Yes | No | Yes |
| Smith 2013 [112] | Yes | No | No |
| Smith 2016 [113] | Yes | No | Yes |
| Smith 2016 [114] | Yes | No | Yes |
| Spagnolli 2017 [115] | No | No | No |
| Stark 2015 [116] | No | No | No |
| Straede 2014 [117] | Yes | Yes | Yes |
| Subbe 2001 [118] | Yes | No | Yes |

| | | | |
|---|---|---|---|
| Suppiah 2014 [119] | Yes | No | Yes |
| Tirkkonen 2014 [120] | No | No | No |
| Tirotta 2017 [121] | Yes | No | Yes |
| Vaughn 2018 [122] | Yes | No | No |
| VonLilienfeld-Toal 2007 [123] | No | No | Yes |
| Watkinson 2018 [61] | Yes | No | No |
| Wheeler 2013 [62] | Yes | Yes | Yes |

ROC: Receiver operating characteristic

## EMBASE search strategy

Database & Platform: Embase (OVID) 1974 to 2017 Week 35

Search date: 30 August 2017

1. ((National or VitalPAC or Modified or Centile or standard$) adj1 Early adj1 Warning adj1 Scor$).ti,ab.

2. (Reading adj1 Modified adj1 Early adj1 Warning adj1 Score).ti,ab.

3. (Cardiac adj1 Arrest adj1 Risk adj1 Triage).ti,ab.

4. (Assessment adj1 Score adj2 Sick adj1 patient adj1 Identification adj2 Step-up adj2 Treatment).ti,ab.

5. (Targeted adj1 Real adj1 Time adj1 Early adj1 Warning adj1 Score).ti,ab.

6. (Dutch adj1 Early adj1 Nurse adj1 Worry adj1 Indicator adj1 Score).ti,ab.

7. (Decision adj1 Tree adj1 Early adj1 Warning adj1 Score).ti,ab.

8. (Advanced adj1 Alert adj1 Monitor).ti,ab.

9. (Chronic adj1 Respiratory adj1 Early adj1 Warning adj1 Score).ti,ab.

10. (early adj1 warning adj1 (scor$ or system$)).ti,ab.

11. (track adj2 trigger adj2 (scor$ or system$)).ti,ab.

12. (physiological adj1 scoring adj1 system$).ti,ab.

13. (worry adj1 indicator adj1 scor$).ti,ab.

14. (physiological adj1 observation adj1 track adj2 trigger adj1 (scor$ or system$)).ti,ab.

15. (patient adj2 risk adj2 scoring adj1 system$).ti,ab.

16. (patient adj2 risk adj1 trigger adj1 scoring adj1 system).ti,ab.

17. (early adj1 detection adj2 patients adj2 risk).ti,ab.

18. Early Warning Score.kw.

19. Early Warning Scores.kw.

20. Early warning system.kw.

21. Early warning systems.kw.

22. Track-and-Trigger.kw.

23. "track and trigger".kw.

24. Early Warning Score/

25. Early Warning Scores/

26. National Early Warning Score/

27. Modified Early Warning Score/

28. "Track and Trigger System"/

29. OR/1-28

30. Vital Sign/

31. Scoring System/

32. Physiologic Monitoring/

33. (NEWS or ViEWS or CART or SEWS or CREWS or PAR or PART or PSS or AAM).ti,ab.

34. OR/30-33

35. ((early or risk or warn$ or alert$ or track$ or trigger) adj2 (scor$ or system or systems)).ti,ab.

36. 34 AND 35

37. (MEWS or R-MEWS or eCART or CEWS or TREWScore or DENWIS or DTEWS or DMEWS or POTTS or PAR-T or ViEWS-L).ti,ab.

38. (develop$ or design$ or creat$ or build$ or contruct$ or validat$).ti,ab.

39. Validation Study/

40. 38 or 39

41. 36 and 40

42. 37 and 40

43. 41 or 42

44. 29 or 43

45. ((child OR infant OR pediatrics) NOT adult).sh.

46. 44 NOT 45

# CINAHL search strategy

Database & Platform: CINAHL (via EbscoHost)

Search date: 30 August 2017

1. TI ((National or VitalPAC or Modified or Centile or standard*) N1 Early N1 Warning N1 Scor*) OR AB ((National or VitalPAC or Modified or Centile or standard*) N1 Early N1 Warning N1 Scor*) OR IN ((National or VitalPAC or Modified or Centile or standard*) N1 Early N1 warning N1 Scor*)

2. TI (Reading N1 Modified N1 Early N1 Warning N1 Score) OR AB (Reading N1 Modified N1 Early N1 Warning N1 Score) OR IN (Reading N1 Modified N1 Early N1 Warning N1 Score)

3. TI (Cardiac N1 Arrest N1 Risk N1 Triage) OR AB (Cardiac N1 Arrest N1 Risk N1 Triage) OR IN (Cardiac N1 Arrest N1 Risk N1 Triage)

4. TI (Assessment N1 Score N2 Sick N1 patient N1 Identification N2 Step-up N2 Treatment) OR AB (Assessment N1 Score N2 Sick N1 patient N1 Identification N2 Step-up N2 Treatment) OR IN (Assessment N1 Score N2 Sick N1 patient N1 Identification N2 Step-up N2 Treatment)

5. TI (Targeted N1 Real N1 Time N1 Early N1 Warning N1 Score) OR AB (Targeted N1 Real N1 Time N1 Early N1 Warning N1 Score) OR IN (Targeted N1 Real N1 Time N1 Early N1 Warning N1 Score)

6. TI (Dutch N1 Early N1 Nurse N1 Worry N1 Indicator N1 Score) OR AB (Dutch N1 Early N1 Nurse N1 Worry N1 Indicator N1 Score) OR IN (Dutch N1 Early N1 Nurse N1 Worry N1 Indicator N1 Score)

7. TI (Decision N1 Tree N1 Early N1 Warning N1 Score) OR AB (Decision N1 Tree N1 Early N1 Warning N1 Score) OR IN (Decision N1 Tree N1 Early N1 Warning N1 Score)

8. TI (Advanced N1 Alert N1 Monitor) OR AB (Advanced N1 Alert N1 Monitor) OR IN (Advanced N1 Alert N1 Monitor)

9. TI (Chronic N1 Respiratory N1 Early N1 Warning N1 Score) OR AB (Chronic N1 Respiratory N1 Early N1 Warning N1 Score) OR IN (Chronic N1 Respiratory N1 Early N1 Warning N1 Score)

10. TI (early N1 warning N1 (scor* or system*)) OR AB (early N1 warning N1 (scor* or system*))

11. TI (track N2 trigger N2 (scor* or system*)) OR AB (track N2 trigger N2 (scor* or system*))

12. TI (physiological N1 scoring N1 system*) OR AB (physiological N1 scoring N1 system*)

13. TI (worry N1 indicator N1 scor*) OR AB (worry N1 indicator N1 scor*)

14. TI (physiological N1 observation N1 track N2 trigger N1 (scor* or system*)) OR AB (physiological N1 observation N1 track N2 trigger N1 (scor* or system*))

15. TI (patient N2 risk N2 scoring N1 system*) OR AB (patient N2 risk N2 scoring N1 system*)

16. TI (patient N2 risk N1 trigger N1 scoring N1 system) OR AB (patient N2 risk N1 trigger N1 scoring N1 system)

17. TI (early N1 detection N2 patients N2 risk) OR AB (early N1 detection N2 patients N2 risk)

18. IN "early warning"

19. IN "trigger"

20. S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19

21. MH "Early intervention"

22. MH "Predictive Value of Tests"

23. MH "Monitoring, Physiologic"

24. MH "Nursing Assessment"

25. MH "Severity of Illness Indices" OR MJ "Severity of illness"

26. MH "Instrument validation"

27. MH "Vital signs"

28. TI (NEWS or ViEWS or CART or SEWS or CREWS or PAR or PART or PSS or AAM) OR AB (NEWS or ViEWS or CART or SEWS or CREWS or PAR or PART or PSS or AAM)

29. S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28

30. TI ((early or risk or warn* or alert* or track* or trigger) N2 (scor* or system or systems)) OR AB ((early or risk or warn* or alert* or track* or trigger) N2 (scor* or system or systems))

31. S29 AND S30

32. TI (MEWS or R-MEWS or eCART or CEWS or TREWScore or DENWIS or DTEWS or DMEWS or POTTS or PAR-T or ViEWS-L) OR AB (MEWS or R-MEWS or eCART or CEWS or TREWScore or DENWIS or DTEWS or DMEWS or POTTS or PAR-T or ViEWS-L)

33. TI (develop* or design* or creat* or build* or contruct* or validat*) OR AB (develop* or design* or creat* or build* or contruct* or validat*)

34. MH "Validation Studies"

35. S33 OR S34

36. S31 AND S35

37. S32 AND S35

38. S36 OR S37

39. S20 OR S38

40. (MH (Child OR Infant OR Pediatrics) OR DH (Child OR Infant OR Pediatrics) NOT MH Adult)

41. S39 NOT S40

# PsycINFO search strategy

Database & Platform: PsycINFO (OVID) 1967 to August Week 3 2017

Search date: 30 August 2017

1. ((National or VitalPAC or Modified or Centile or standard$) adj1 Early adj1 Warning adj1 Scor$).ti,ab,id.

2. (Reading adj1 Modified adj1 Early adj1 Warning adj1 Score).ti,ab,id.

3. (Cardiac adj1 Arrest adj1 Risk adj1 Triage).ti,ab,id.

4. (Assessment adj1 Score adj2 Sick adj1 patient adj1 Identification adj2 Step-up adj2 Treatment).ti,ab,id.

5. (Targeted adj1 Real adj1 Time adj1 Early adj1 Warning adj1 Score).ti,ab,id.

6. (Dutch adj1 Early adj1 Nurse adj1 Worry adj1 Indicator adj1 Score).ti,ab,id.

7. (Decision adj1 Tree adj1 Early adj1 Warning adj1 score).ti,ab,id.

8. (Advanced adj1 Alert adj1 Monitor).ti,ab,id.

9. (Chronic adj1 Respiratory adj1 Early adj1 Warning adj1 Score).ti,ab,id.

10. (early adj1 warning adj1 (scor$ or system$)).ti,ab,id.

11. (track adj2 trigger adj2 (scor$ or system$)).ti,ab.

12. (physiological adj1 scoring adj1 system$).ti,ab.

13. (worry adj1 indicator adj1 scor$).ti,ab.

14. (physiological adj1 observation adj1 track adj2 trigger adj1 (scor$ or system$)).ti,ab.

15. (patient adj2 risk adj2 scoring adj1 system$).ti,ab.

16. (patient adj2 risk adj1 trigger adj1 scoring adj1 system).ti,ab.

17. (early adj1 detection adj2 patients adj2 risk).ti,ab.

18. "early warning".id.

19. "track and trigger".id.

20. "trigger scor$".id.

21. OR/1-20

22. Warnings/

23. Monitoring, Physiologic.mh.

24. Nursing Assessment.mh.

25. Vital Signs.mh.

26. Severity of Illness Index.mh.

27. Monitoring/

28. "Scoring (Testing)"/

29. "vital Signs".id.

30. "severity of illness".id.

31. (NEWS or ViEWS or CART or SEWS or CREWS or PAR or PART or PSS or AAM).ti,ab.

32. OR/22-31

33. ((early or risk or warn$ or alert$ or track$ or trigger) adj2 (scor$ or system or systems)).ti,ab.

34. 32 AND 33

35. (MEWS or R-MEWS or eCART or CEWS or TREWScore or DENWIS or DTEWS or DMEWS or POTTS or PAR-T or ViEWS-L).ti,ab.

36. (develop$ or design$ or creat$ or build$ or contruct$ or validat$).ti,ab.

37. 34 and 36

38. 35 and 36

39. 37 OR 38

40. 21 or 39

41. ((child OR infant OR pediatrics) NOT adult).mh,sh.

42. 40 NOT 41

# MEDLINE search strategy

Database and Platform: Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to Present

Search date: 30 August 2017

1. ((National or VitalPAC or Modified or Centile or standard$) adj1 Early adj1 Warning adj1 Scor$).ti,ab.

2. (Reading adj1 Modified adj1 Early adj1 Warning adj1 Score).ti,ab.

3. (Cardiac adj1 Arrest adj1 Risk adj1 Triage).ti,ab.

4. (Assessment adj1 Score adj2 Sick adj1 patient adj1 Identification adj2 Step-up adj2 Treatment).ti,ab.

5. (Targeted adj1 Real adj1 Time adj1 Early adj1 Warning adj1 Score).ti,ab.

6. (Dutch adj1 Early adj1 Nurse adj1 Worry adj1 Indicator adj1 Score).ti,ab.

7. (Decision adj1 Tree adj1 Early adj1 Warning adj1 Score).ti,ab.

8. (Advanced adj1 Alert adj1 Monitor).ti,ab.

9. (Chronic adj1 Respiratory adj1 Early adj1 Warning adj1 Score).ti,ab.

10. (early adj1 warning adj1 (scor$ or system$)).ti,ab.

11. (track adj2 trigger adj2 (scor$ or system$)).ti,ab.

12. (physiological adj1 scoring adj1 system$).ti,ab.

13. (worry adj1 indicator adj1 scor$).ti,ab.

14. (physiological adj1 observation adj1 track adj2 trigger adj1 (scor$ or system$)).ti,ab.

15. (patient adj2 risk adj2 scoring adj1 system$).ti,ab.

16. (patient adj2 risk adj1 trigger adj1 scoring adj1 system).ti,ab.

17. (early adj1 detection adj2 patients adj2 risk).ti,ab.

18. Early Warning Score.kw.

19. Early Warning Scores.kw.

20. Early Warning System.kw.

21. Early Warning Systems.kw.

22. Track-and-Trigger.kw.

23. "track and trigger".kw.

24. or/1-23

25. Predictive Value of Tests/

26. Monitoring, Physiologic/

27. Nursing Assessment/mt [Methods]

28. Nursing Assessment/st

29. Nursing Assessment/sn

30. Severity of Illness Index/

31. Health Status Indicators/

32. Point-of-Care-Systems/

33. (NEWS or ViEWS or CART or SEWS or CREWS or PAR or PART or PSS or AAM).ti,ab.

34. OR/25-33

35. ((early or risk or warn$ or alert$ or track$ or trigger) adj2 (scor$ or system or systems)).ti,ab.

36. 34 AND 35

37. (MEWS or R-MEWS or eCART or CEWS or TREWScore or DENWIS or DTEWS or DMEWS or POTTS or PAR-T or ViEWS-L).ti,ab.

38. (develop$ or design$ or creat$ or build$ or contruct$ or validat$).ti,ab.

39. Validation Studies.pt.

40. 38 OR 39

41. 36 AND 40

42. 37 AND 40

43. 41 OR 42

44. 24 OR 43

45. ((child OR infant OR pediatrics) NOT adult).sh.

46. 44 NOT 45