



Development of a Paediatric Advanced Warning Score (PAWS)



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Objectives

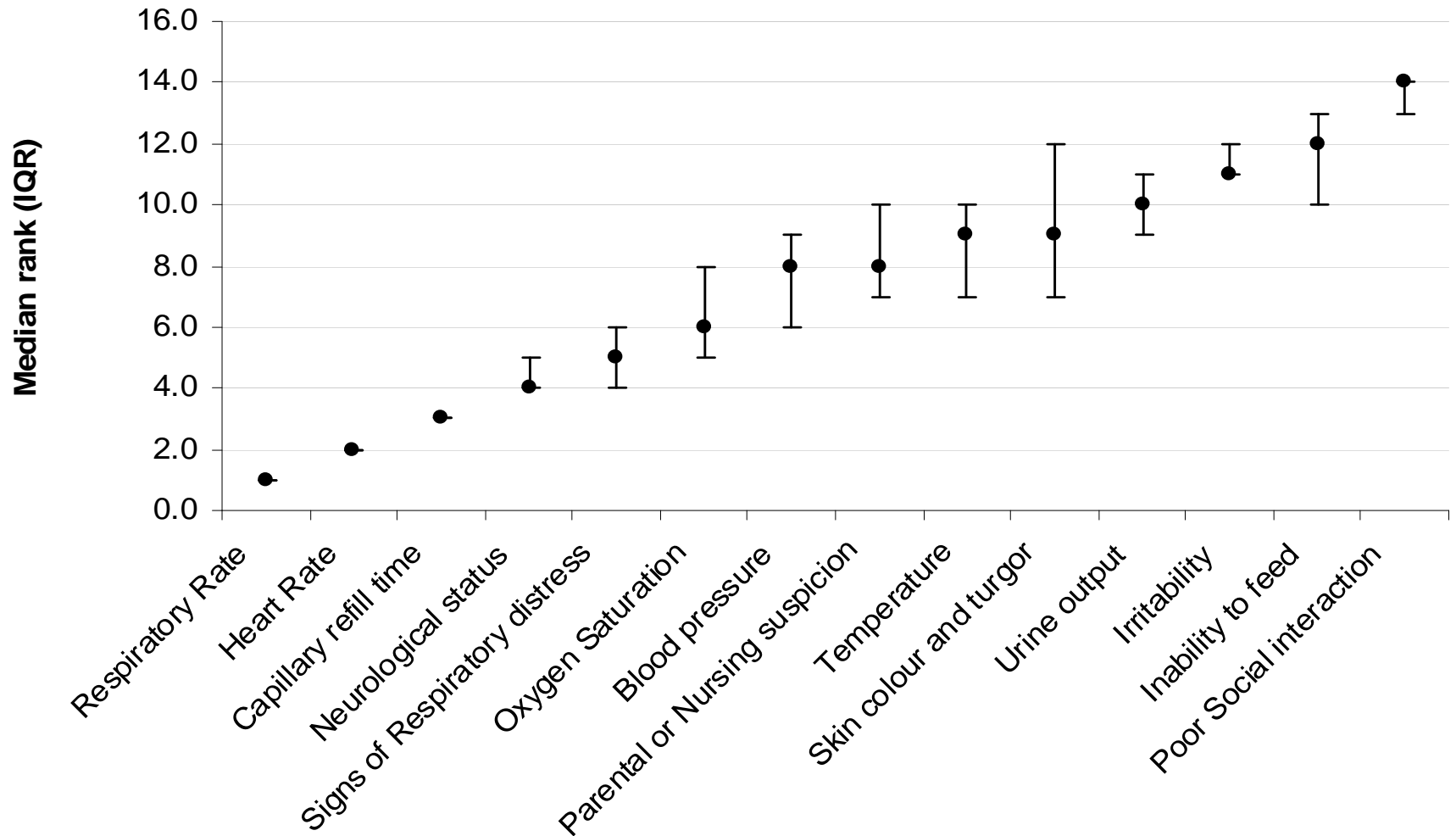
- Simple to use
- Support decision making by medical / nursing staff
- Applicable to patients 1 month – 16 years
- Sensitive enough to identify children with physiological disturbance at risk of developing critical illness
- Specific enough to exclude typical patient on ward
- Provide a graduated response

(touchy feely colours!!!)

Prototype PAWS Score

			Other Risk Factors Present	
			No	YES
			↓	↓
Physiological risk factors	Normal physiology Low risk	→	LOW OVERALL WARNING LEVEL	INTERMEDIATE OVERALL WARNING LEVEL
	Moderately deranged physiology Intermediate risk	→	INTERMEDIATE OVERALL WARNING LEVEL	INTERMEDIATE OVERALL WARNING LEVEL
	Highly deranged physiology high risk	→	HIGH OVERALL RISK LEVEL	HIGH OVERALL RISK LEVEL

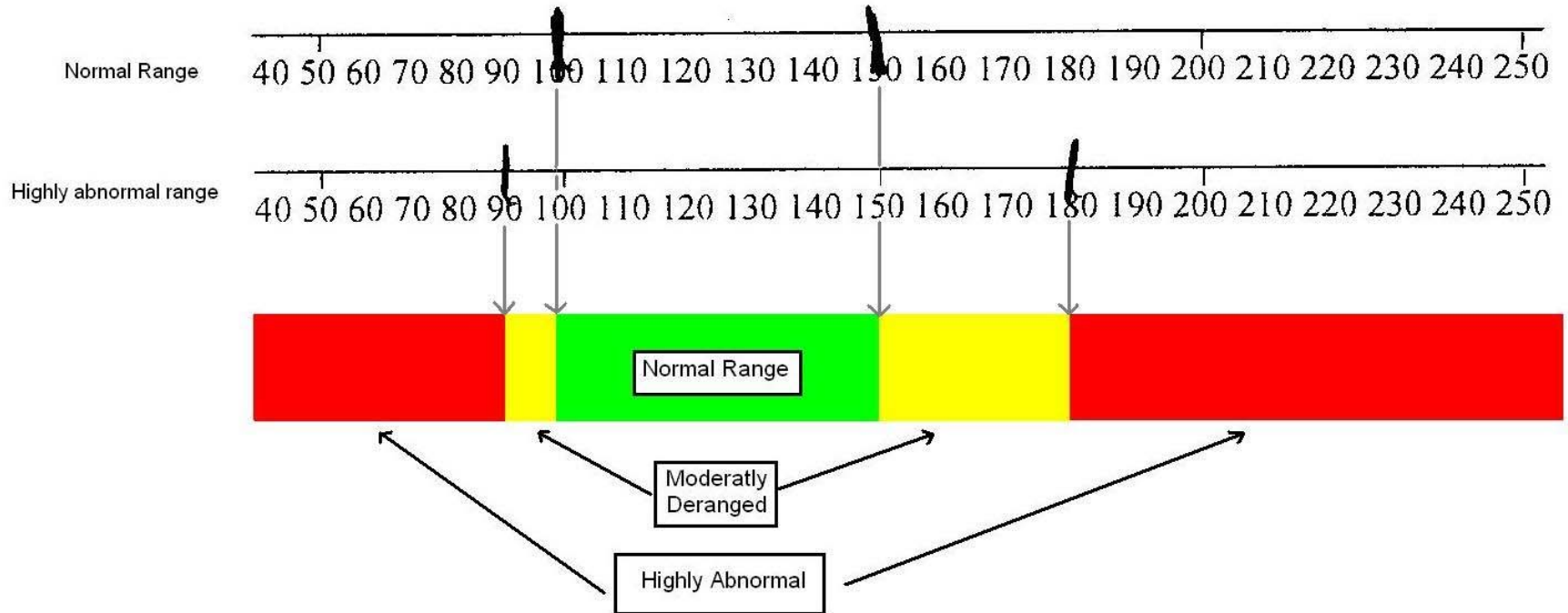
Clinical Risk Factors



Key elements

- Temperature
- Heart Rate
- Respiratory Rate
- Sao₂
- Evidence of respiratory distress
- Neurological status
- Capillary refill time
- Within 48 hours admission
- Cardiac disease
- Oncological / Haematological disease
- Neutropenia /Immune suppression
- Prematurity
- Indwelling central venous catheter

Physiological variables





PAWS

The Paediatric Advanced Warning Score



Instructions for use.

- Read measured variables against tables (1) and determine if any risk factors are present (2)
- Combine the two and read response off action area (3)

1

Read observations against age.

2

Are any risk factors present?

Cardiac Disease
Neutropenia
Immunosuppression
Prematurity/Ex-Prem

Oncological Disease
Haematological disease
Central venous access
New admission (<48hrs)

NO

YES

Heart Rate

AGE	1 month - 1 year	40	45	50	55	60	65	70	75	80	85	90	95	100	110	120	130	140	145	150	160	165	170	175	180	185	190
	1 year - 5 year	40	45	50	55	60	65	70	75	80	85	90	95	100	110	120	130	140	145	150	160	165	170	175	180	185	190
	5 year - 12 year	40	45	50	55	60	65	70	75	80	85	90	95	100	110	120	130	140	145	150	160	165	170	175	180	185	190
	> 12 year	40	45	50	55	60	65	70	75	80	85	90	95	100	110	120	130	140	145	150	160	165	170	175	180	185	190

Respiratory Rate

AGE	1 month - 1 year	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56
	1 year - 5 year	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56
	5 year - 12 year	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56
	> 12 year	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56

If signs of respiratory distress (unable to complete sentences, use of accessory muscles, subcostal recession, SaO2<90%) CONSIDER SCORE RED

Capillary Refill Time

0	1	2	3	4	5	6
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Neurological Status

Alert	Responsive to vocal stimuli	Responsive to painful stimuli	Unresponsive
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Temperature (°C)

<35.6	35.6 to 36.0	36.1 to 37.5	37.6 to 37.9	>38
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All Scores Green

Any Amber Scores

Any Red Scores

Continue with current care

Patient Needs Review by medical staff.

Patient Needs Urgent Review by Senior Medical staff. Consider discussion with PICU

Patient Needs Urgent Review by senior medical staff. Consider discussion with PICU

Urgent Review by PICU

ACTION REQUIRED

3

Pilot study

- Data from regional study of high dependency
- Physiological data / outcomes
 - Increasing level of care
 - Review by senior level of staff
 - Change in treatment
 - Admission to PICU
 - Death
- 1970 observation / 445 children
- PAWS category for each observation calculated
- Descriptive statistics / logistic regression

Calibration

- Data collected 24 general / specialist wards
 - 11/ 13 Hospitals from 'Yorkshire region'
 - Physiological parameters
 - Outcomes
-
- Data returned to Paediatric Epidemiology group Leeds
 - Variables analysed individually / multi-variable model using logistic regression.

Outcomes

Please tick which interventions were relevant on each occasion
No change in therapy / frequency of observations
Change of treatment whilst on the ward
• Increased frequency of observations
• Increased monitoring: SaO ₂ / ECG / Blood Pressure
• New or increase in O ₂ therapy or nebuliser
• Commenced inotropes / vasopressors
• Commenced IV fluids / fluid bolus / increased infusion rate
• Ventilatory support
• CPR instigated
Change in nursing level:
• 'Specialised' on ward / Transfer to HDU
• Transfer to PICU
• Death of patient

Calibration Data

- Approx 6000 admissions study period
- 8766 observations / 2126 children
 - 1/3 admissions captured
 - 2011 (22%) lacked outcome (intervention) data
 - 75% had 4 or fewer observations
 - No single observation set complete
- All individual variables showed increased odd ratio for change in treatment
 - Respiratory rate red, OR: 5.87 (95% CI: 4.7 – 7.4)
- Multivariate analysis attenuated odds ratio

Calibration 1

CHANGE IN NURSING LEVEL

	All Green	Any Amber	Multi Amber	Multi Red	Total
No Change	3664	1988	689	275	6616
Change	49	39	28	15	131
Total	3713	2027	717	290	6747

ODDS RATIOS FROM LOGISTIC REGRESSION:

Amber: 1.47
Multi Amber: 3.04
Multi-red 4.08

Going in the right direction but too many children with 'multi-red' getting no increased level of care.....

Calibration 2

CHANGE IN TREATMENT

	All Green	Any Amber	Multi Amber	Multi Red	Total
No Change	3476	1854	556	152	6038
Change	237	173	161	138	709
Total	3713	2027	717	290	6747

ODDS RATIOS FROM LOGISTIC REGRESSION:

Amber: 1.37
Multi Amber: 4.25
Multi-red 13.31

Better but still too many children with 'multi-red' no change in treatment recorded



PAWS

Paediatric Advanced Warning Score



Instructions:

- 1 Reading from the chart, note which colour category the observations fall into
- 2 Allocate a score from the right hand side of the tool
- 3 Note suggested action
- 4 Complete Data Collection Form 2

PAWS score and suggested action

Temperature (°C)

Less than 36

36 - 37.8

More than 37.8

Heart Rate (bpm)

	3-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	101-105	106-110	111-115	116-120	121-125	126-130	131-135	136-140	141-145	146-150	151-155	156-160	161-165	166-170	171-175	176-180	181-185+	
1 - 11 months	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
1 - 2 years	Red	Red	Red	Red	Red	Red	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
3 - 4 years	Red	Red	Red	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
5 - 11 years	Red	Red	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
12 + years	Red	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	

Respiratory Rate (per minute)

	3-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36	37-38	39-40	41-42	43-44	45-46	47-48	49-50	51-52	53-54	55-56	57-58	59-60	61-62+	
1 - 11 months	Red	Red	Red	Red	Red	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
1 - 2 years	Red	Red	Red	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
3 - 4 years	Red	Red	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
5 - 11 years	Red	Red	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
12 + years	Red	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red

Oxygen Saturation

Less than 90% in air or 84% in any oxygen

Respiratory Effort

If signs of respiratory distress or poor respiratory effort

Neurological Status (AVPU)

Alert (A)	Responds to verbal stimuli (V)	Responds to painful stimuli (P)	Unresponsive (U)
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Capillary Refill Time (seconds)

Less than 2

2-3

4+

This tool is being assessed. Your clinical judgment is paramount. If you are in any doubt, refer the patient for further assessment

Contact: Diana Morgan / Roger Parslow 0113 343 4858 or Simon Whiteley 0113 206 7154

All 5 scores Green

Any Amber Scores

Any Red Scores

Score = 1
Continue current care

Score = 2
Increase frequency of observations + medical review

Score = 3
Immediate medical review + consider crash call

Validation exercise

- Released PAWS
 - Education
 - Lead time
- Data collected 28 wards / 13 participating hospitals
- Physiological observations
- Calculate PAWS score
- Recorded outcomes
 - None
 - Increased observation
 - Change therapy
 - Urgent medical review / crash call

Validation Data

- 10,800 admissions during study period
- 13,262 observations / 3852 children
 - 1,211 (9%) missing outcome / intervention data
 - 44% had 4 or fewer observations
- ‘Aberrant’ results
 - apparently normal physiology receiving urgent treatment
 - highly abnormal physiology receiving no intervention

5 – 12 year old (Non cardiac patient)

Temp	Resp Rate	Resp Distress	Heart Rate	Neuro.
41.2°C	60	Yes	200 BPM	‘V’

Weighting

- Numeric score may provide better discrimination
- Randomly assigned value 1-5 (amber) 2- 10 (red)
- Component scores added together – logistic regression
- 100,000 simulations
- Consistent weights in best fit models for
 - Heart rate
 - Respiratory rate
 - Capillary refill time
 - SaO₂
 - Temperature

Weightings

Variable	Green	Amber	Red
Temperature	0	5	10
CRT	0	5	10
Respiratory Rate	0	1	3
Heart Rate	0	2	3
Neurological status	0	1	10
Oxygen saturation	0	2	3
Respiratory distress	Removed from score		



1. Score each observation



2. Add cumulative score

3. Suggested Action

Temperature (°C)	Less than 35	35 - 37.8	More than 37.8
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Respiratory Rate (per minute)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
0-11 months	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1-2 years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
3-4 years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
5-11 years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

Capillary Refill Time (seconds)	Less than 2	2-3	4+
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Respiratory Effort (per minute)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
0-11 months	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1-2 years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
3-4 years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
5-11 years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

Respiratory Rate (per minute)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
0-11 months	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1-2 years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
3-4 years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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Either:

Oxygen saturation in air (See notes below)	≥95% in Air	<95%	<90%	<85%
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Or:

Oxygen saturation in 100% Oxygen (See notes below)	≥95% in 100% O ₂	<95%	<90%	<85%
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Neurological Status (GCS)	Alert (15)	Responds to verbal stimuli (5)	Responds to painful stimuli (4)	Unresponsive (3)
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- NOTES:
- Oxygen saturations refer to patients without known cardiac/lung disease.
 - Record oxygen saturation in Air or in oxygen as appropriate.
 - Do not stop oxygen therapy to record oxygen saturation in Air.
 - If oxygen saturation < 95% increase oxygen flow.

Total:

Score 0-2
Continue current care.

Score 3-5
Increase frequency of observations
Seek medical review

Score 6-8
Cardiac/respiratory monitoring required
Seek urgent medical review

Score 9 or greater
PRELIMINARY SITUATION
CONSIDER CRASH CALL

Your clinical judgment is paramount. If you are in any doubt, seek senior support / medical review

Logistic regression model

- Score against need for urgent medical review / crash call
- 11.924 observation

PAW Score	Odds Ratio	95% CI	P >
2-5	13.3	8.1 - 21.8	0.000
5-9	47.2	28.7 - 79.0	0.000
10 or greater	88.1	52.9 - 146.8	0.000

- **Area under ROC curve 0.8694**

Summary

- Significant delays
- Problems with data quality
- Inconsistent practice relating to standards of observation
- Traffic light system too sensitive / lacked specificity
- Numerical weighted scoring more promising

- Currently implementing system across region
- Evaluate in clinical use

Acknowledgments

- Harvey Livingston
- Diana Morgan Research Nurse
- Staff participating hospitals

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