How does The **P**aediatric **A**dmission **G**uidance in the **E**mergency Department (**PAGE**) score compare with other scores and systems?

1. What is PAGE?

PAGE[1] is an assessment tool to aid discharge and admission decision making in relation to children aged under 16 years of age in hospital urgent and emergency care facilities. The PAGE score can assist clinicians to predict the need for admission from the emergency department. PAGE is intended as a one-off score to predict this need – it is not a track and trigger early warning score or system (**Figure 1**).

Figure 1: PAGE

Variable	Category	Point(s)
Age (months)	≥ 6	0
	2-5	1
	0-1	2
Heart rate (beats per minute)	≤ 125 (ie 0-125)	0
	>125 (ie 126 and above)	1
Respiratory rate (breaths per minute)	0-25	0
	26-60	2
	>60	3
Temperature (ºC)	<38	0
	38-39	1
	>39	2
Oxygen saturation (%)	>94	0
	90-94	4
	<90	5
Requires supplementary oxygen?	No	0
	Yes	2
Breathing	Normal	0
	Abnormal	2
Recession	No recession	0
	Any recession	1
Behaviour	Normal	0
	Agitated or Listless	1
	Floppy	2
Nurse judgement	No concern	0
	Low level concern	1
	High concern	3
Multi-morbidity? (ie any pre-existing condition?)	No	0
	Yes	2
Arrived by ambulance?	No	0
	Yes	3
Advised by medical professional to attend?	No	0
	Yes	2

[1] Rowland A, Cotterill S, Heal C, *et al*. Observational cohort study with internal and external validation of a predictive tool for identification of children in need of hospital admission from the emergency department: the **P**aediatric **A**dmission **G**uidance in the **E**mergency Department (PAGE) score. *BMJ Open* 2020; **10:**e043864. doi: 10.1136/bmjopen-2020-043864**.** Available from https://bmjopen.bmj.com/content/10/12/e043864.info

2. How good is PAGE at predicting admission?
The C-Index is a "goodness of fit" measure. In essence, the C-Index can range from 0 to 1 with 1 being a perfect predictor and 0 being no prediction whatsoever. Using a C-Index can help to compare how well early warning scores perform. If the outcome measure is "admission" from the emergency department, the nearer the C-Index is to 1, the better the tool is at predicting that outcome measure.

The C-Index for PAGE is **0.78** overall and there is reason to be 95% confident that the actual value (rather than this calculated value) lies between very narrow limits[2]. PAGE performs better at predicting admission of children from the emergency department than any other previously published similar tool[3].

3. How does PAGE compare to other scores?
Other scores are in use, for example the Manchester Children's Early Warning System (ManChEWS) and the Pennine Acute Trust Paediatric Observation Priority Score (PAT-POPS)[4]. Our earlier work has found that the equivalent for PAT-POPS is 0.72[5] and for ManChEWS is 0.68[6].

From the above data it is clear that the C-Index for PAGE is higher than that of both PAT-POPS and ManChEWS *and* the range of possible error in these scores is much smaller for PAGE. This means that PAGE is statistically better than the other two at predicting admission. Effectively, PAGE is an improvement to PAT-POPS in terms of diagnostic accuracy for predicting admission of children from the emergency department. For that reason, we propose that PAGE could replace PAT-POPS in children's emergency medicine.

Similar comparisons can take place with other early warning scores or early warning scoring systems, for example those in a paper by Seiger et al.

4. What cut-off point should we use to help guide an admission decision?
Cut-off points refer to the threshold at which a score should mandate admission. This needs to be adjusted to local circumstances taking into consideration things such as what community follow-up services are available, for example a children's community nursing team.

5. What do we need to consider if we are interested in moving to PAGE from our current early warning score or system in use in our emergency department?
Using PAT-POPS as one example, the emergency department at North Manchester General Hospital (NMGH) children's emergency department has PAT-POPS in use. **Figure 2** shows the associated decisions made at various cut-off points for PAT-POPS.

To determine how the above may translate to PAGE it is necessary to understand a little about sensitivity and specificity. The sensitivity of the tool is how well a particular score correctly identifies those children who need to be admitted. The specificity of the tool is how well a particular score correctly identifies those children who should be discharged. It is impossible to prioritise both at once. In order to ensure that every child who *should* be admitted *is* admitted, all of those who should have been discharged must also be admitted. This is not practicable or desirable and therefore a balanced risk of some error either in unnecessary admission or in incorrect discharge has to be accepted. This is why cut-off points require consideration. For PAT-POPS the sensitivities and specificities of scores 0-5 are shown in **Figure 3**.

[2] 95% confidence interval 0.77 to 0.79

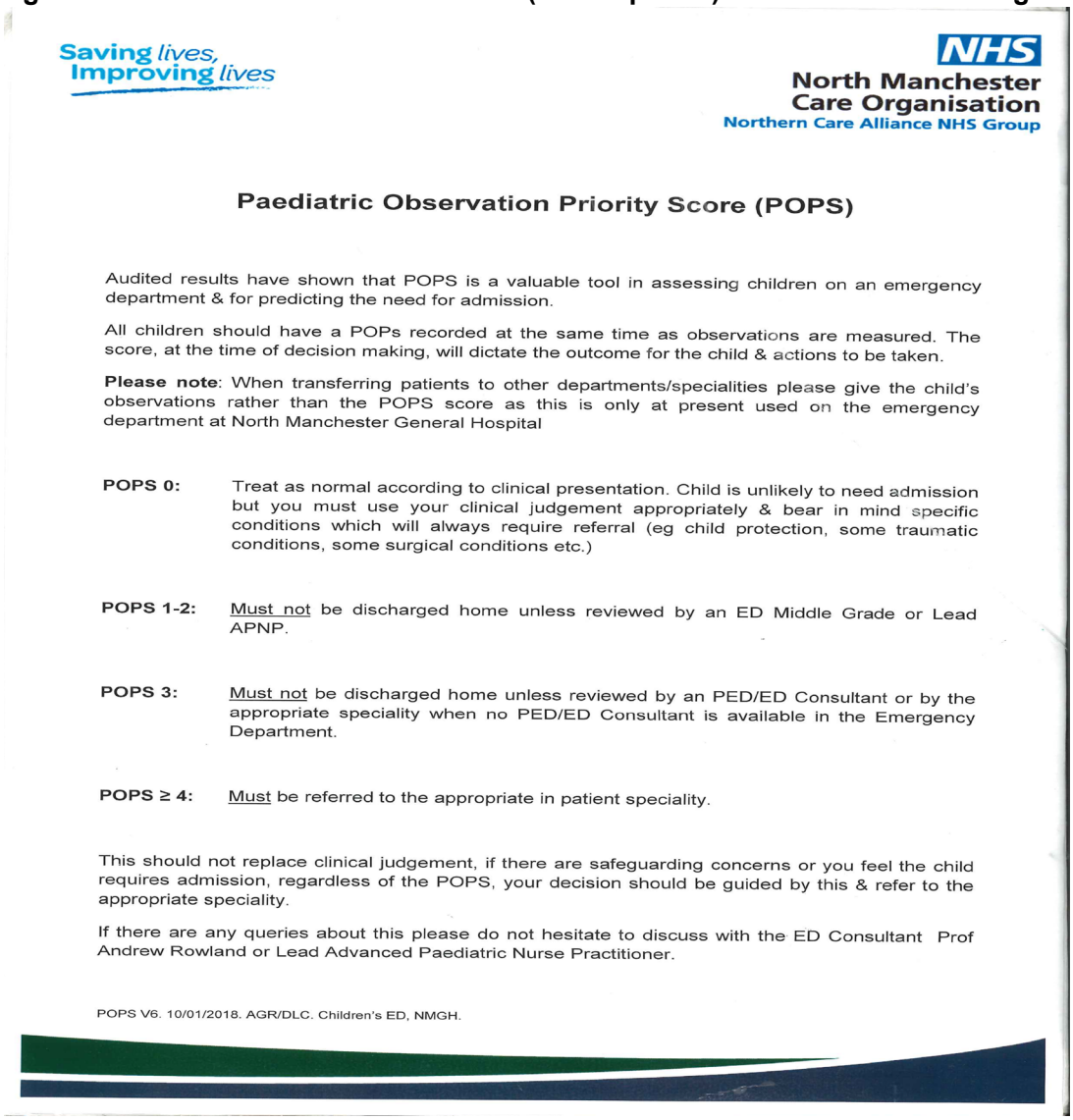
[3] Seiger N, Maconochie I, Oostenbrink R, et al. Validity of different pediatric early warning scores in the emergency department. Pediatrics 2013;132:e841–50

[4] Cotterill S, Rowland AG, Kelly J, *et al*. Diagnostic accuracy of PAT-POPS and ManChEWS for admissions of children from the emergency department. *Emergency Medicine Journal* 2016;33(11):756-62. Available from http://usir.salford.ac.uk/id/eprint/38927/

[5] 95% confidence interval 0.68 to 0.75

[6] 95% confidence interval 0.64 to 0.70

Figure 2: PAT-POPS actions to be taken (cut-off points) in the children's emergency department (NMGH)



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Paediatric Observation Priority Score (POPS)

Audited results have shown that POPS is a valuable tool in assessing children on an emergency department & for predicting the need for admission.

All children should have a POPs recorded at the same time as observations are measured. The score, at the time of decision making, will dictate the outcome for the child & actions to be taken.

Please note: When transferring patients to other departments/specialities please give the child's observations rather than the POPS score as this is only at present used on the emergency department at North Manchester General Hospital

POPS 0: Treat as normal according to clinical presentation. Child is unlikely to need admission but you must use your clinical judgement appropriately & bear in mind specific conditions which will always require referral (eg child protection, some traumatic conditions, some surgical conditions etc.)

POPS 1-2: Must not be discharged home unless reviewed by an ED Middle Grade or Lead APNP.

POPS 3: Must not be discharged home unless reviewed by an PED/ED Consultant or by the appropriate speciality when no PED/ED Consultant is available in the Emergency Department.

POPS ≥ 4: Must be referred to the appropriate in patient speciality.

This should not replace clinical judgement, if there are safeguarding concerns or you feel the child requires admission, regardless of the POPS, your decision should be guided by this & refer to the appropriate speciality.

If there are any queries about this please do not hesitate to discuss with the ED Consultant Prof Andrew Rowland or Lead Advanced Paediatric Nurse Practitioner.

POPS V6. 10/01/2018. AGR/DLC. Children's ED, NMGH.

Figure 3: Sensitivity and specificity of PAT-POPS scores 0-5

PAT-POPS score	Sensitivity (correct admission)	Specificity (correct discharge)
≥ 0	100%	0%
≥ 1	66.97%	66.86%
≥ 2	49.54%	85.41%
≥ 3	36.09%	93.28%
≥ 4	23.24%	96.50%
≥ 5	17.74%	98.33%

Full sensitivity and specificity values, together with 95% confidence intervals are shown in the research paper in the Emergency Medicine Journal (EMJ).

This means, for example, if the cut-off point for requiring referral to paediatrics (an admission) is a PAT-POPS score of 4 (highlighted above) this will correctly identify 23.24% of admissions and 96.50% of discharges. The aim of the PAGE study was to improve on this level of sensitivity and specificity. For PAGE the sensitivities and specificities of scores are shown in **Figure 4**.

Figure 4: Sensitivity and specificity of PAGE scores 0-23

PAGE score	Sensitivity (correct admission)	Specificity (correct discharge)
≥ 0	100%	0%
≥ 1	96.83%	15.80%
≥ 2	91.13%	36.34%
≥ 3	87.70%	45.84%
≥ 4	78.87%	61.03%
≥ 5	68.61%	73.69%
≥ 6	59.47%	80.86%
≥ 7	48.56%	87.89%
≥ 8	38.88%	92.20%
≥ 9	29.84%	95.34%
≥ 10	22.11%	97.43%
≥ 11	16.36%	98.56%
≥ 12	12.03%	99.28%
≥ 13	8.33%	99.60%
≥ 14	5.49%	99.79%
≥ 15	3.25%	99.85%
≥ 16	2.14%	99.90%
≥ 17	1.12%	99.97%
≥ 18	0.65%	100%
≥ 19	0.34%	100%
≥ 20	0.12%	100%
≥ 21	0.04%	100%
≥ 22	0.02%	100%
≥ 23	0%	100%

95% confidence intervals are shown in the research paper in BMJ Open.

In our research we held a consensus group meeting with a number of children's emergency care clinicians from the North West of England. Based on the preferences of those at the consensus meeting the chosen cut-off for their organisations would be either 6 or 7 points. The consensus meeting attendees indicated a preference for giving more weight to higher specificity (ensuring the right children were discharged) than sensitivity (ensuring the right children were admitted).

Out of interest, the nearest PAGE score to a PAT-POPS of 4 (sensitivity 23.24%, specificity 96.50%) would be a PAGE score of 9 (sensitivity 29.84%, specificity 95.43%) which has better sensitivity and broadly comparable specificity to a PAT-POPS of 4; or a PAGE score of 10 (sensitivity 22.11%, specificity 97.43%) which has slightly lower sensitivity but slightly better specificity than a PAT-POPS of 4. A clinical governance decision therefore needs to be taken about which PAGE scores should be used to recommend or require:

1. Tier 2 (ST4+, middle grade doctor, or advanced paediatric nurse practitioner) review if discharge is being considered [currently PAT-POPS of 1 or 2]
2. Consultant or nurse consultant review if discharge is being considered [currently PAT-POPS of 3]
3. Referral to inpatient specialty (admission) [currently PAT-POPS of 4 or more]

6. Where can I find more information?

You can find more information about PAGE on our website (http://hub.salford.ac.uk/health-and-society-research/tag/emergency-care/), in BMJ Open[7], or by contacting: Professor Andrew Rowland, Honorary Professor (Paediatrics), Children's Emergency Department, North Manchester General Hospital, Delaunays Road, Manchester, M8 5RB, UK | A.Rowland@salford.ac.uk

[7] Cotterill S, Rowland AG, Kelly J, *et al*. Diagnostic accuracy of PAT-POPS and ManChEWS for admissions of children from the emergency department. *Emergency Medicine Journal* 2016;33(11):756-62. Available from http://usir.salford.ac.uk/id/eprint/38927/