# Innovating for Improvement

# Emergency Department Admission Prediction Tool

Nottingham University Hospitals NHS Trust





# About the project

# Project title:

Emergency Department Admission Prediction Tool

# Lead organisation:

Nottingham University Hospitals NHS Trust

# Project lead(s):

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#### Part 1: Abstract

On average, we see 550 patients a day in our Emergency Department (ED) at the Queens Medical Centre, Nottingham University Hospitals NHS Trust. The current wait for an admission versus discharge decision for a patient is around 2.5 hours, leaving just 1.5 hours before breach time (4 hours) to find an appropriate bed in the hospital. This is a figure we want to improve both for patient experience and to improve patient flow.

We adopted an admission prediction score which was produced by Glasgow Royal Infirmary (Cameron et al, 2014) and applied it to our patients. This was an innovative concept to our Trust which has never used a score to predict admission at the front door.

This report demonstrates not only that the score could reduce the decision to admit time, but also suggests other uses of the score to make improvements within ED and for patient flow.

Compliance and improving the predictive accuracy of the score when applied to NUH were the main challenges which are also discussed in this report. There remains further work on the accuracy of the score before it can be embedded into practise.

### Part 2: Progress and outcomes

The score is generated at the point of triage through information which is already gathered at this stage – a patient's age, their mode of arrival to hospital, whether they were referred by their GP, what their observations are, their triage score and finally whether they have had any admissions in the last year (Figure 1). This score represents a patient's likelihood of admission. Our aim was to introduce the score as an adjunct to clinical decision making.

# Figure 1

Variable	Points Awarded
Age	1 point / 10 years
	1 = 15
Triage	2 = 10
Category	3, 5, 6, 8 = 5
Referred by GP	10
	If arrived by self = 0
Arrival Type	If arrived by ambulance = 5
Admitted <1 year	5
NEWS score	1 point for every point on the NEWS score, e.g. if NEWS is 6 = 6 points

Glasgow suggested possible cut offs when using the score with a score of <8 indicating a high likelihood of discharge and a score of >25 a high likelihood of admission. These parameters were applied retrospectively to our patients collected over 6 months (August 2016 to January 2017) and whilst we found that cut offs of <10 and >27 were more specific at predicting discharge and admission respectively to our patient population (Figure 2), we continued to use the Glasgow suggested scores in order to maintain the generalisability and potential future spread of the tool.



The score was applied to all adult non-injury patients who attended ED from May to September 2017, giving us a sample size of 50,706 patients. The score was automatically calculated and displayed electronically by a programme created by our Trust ICT team. This ensured there was no error in calculating the score manually and also didn't increase the work load of the clinicians. However, we did face a few technical issues where the score was not generated over a combined period of 4 weeks.

The primary aim of the project was to reduce the time till a decision to admit (DTA) could be applied to a patient. By definition a DTA can only be applied once a clinician has made the decision to admit the patient (as discussed later). We therefore identified the time the score was generated and the time a real DTA was applied to a patient (Figure 3). This drastically shows that if the score was to be used as a decision to admit, it would achieve this decision, on average 150mins (2.5hrs) earlier than currently.



We wanted to see how improving the time until DTA would impact on our patients. Patients were interviewed through an online questionnaire displayed as a QR code on posters across the department and also through face to face interviews until data saturation was reached. When asked "If you were informed within the first 30 minutes of arriving in ED that you would need to stay in hospital, what difference would that make to you?", 63% of the responses were positive, 28.5% neutral and 8.5% negative. We received positive responses about being able to plan their day or family visiting and comments such as "better than being kept in the dark" and "I'd know if it was serious or not". Negative comments were commonly around anxiety – knowing they were likely to be admitted would make them more anxious as they don't like hospitals or they would worry what was wrong with them.

A secondary intended benefit was for the score to act as an adjunct to clinical decision making; in other words, a 'sense checker' for the junior doctors. For example, if their intention was to discharge a patient who had a high admission prediction score, they might re-think about the components contributing to the high score and also the chances of re-presentation to ED. This data was collected both through a 'yes'/no' question in their medical clerking documentation and secondly through questionnaires. When asked in the medical clerking documentation, 'Has the score changed your decision to admit/discharge?' out of 50,706 patients, only 16 answered 'yes'.

There were mixed opinions about the use of the score amongst the clinicians when asked in questionnaires (see Appendix 1) and examples of free text comments are as follows:

- "Worth a try but outflow needs to be sorted to allow the score to be of any use to improve flow".
- "Would be useful".
- "I worry about this taking precedent over clinical reasoning and skill".
- "Would be a helpful risk stratifying score and help junior staff in particular

when trying to make decisions about patient location".

- "I believe that the more junior decision makers take too long to make decisions and this affects the care of other patients in the department. The juniors also run every decision past senior staff again time consuming".
- "It could be useful for patients that are not an obvious admission or discharge".
- "The values are fairly wide between being admitted and being suitable for discharge".
- "We should be able to make a decision on admission or discharge based on clinical information without a prediction tool and I don't think we should be using it in that decision tree. But I think it has a place in predicting admissions before they are seen by a clinician, i.e. telling us how many beds we are going to need in 4 hours time".
- "Usually I am not aware of the prediction score until the end of the consultation/clerking by which point I have already decided to admit/discharge a patient".

Consultants were interviewed separately through face to face semi-structured interviews until data saturation was reached. Interviews were recorded with consent, typed up verbatim and coded thematically. A common theme that presented was a concern about the score increasing unnecessary admissions. The score has a 71.5% accuracy at predicting admission, meaning if the score was to be wholly relied on, almost 3 in 10 admissions would be unnecessary. This statistic understandably raised some scepticism amongst the Consultants and lack of trust in using the score alongside clinical decision making. There was a general consensus that the accuracy of the score in predicting admission needed improving. One Consultant identified a bias in the score against elderly patients. Despite reservations about the use of the score, surprising feedback was received and common themes identified were as follows:

- Using the score to bed manage, i.e. identify to site managers early on the potential number of admissions to allow them more time to manage the flow of patients from the receiving wards.
- Using the score to allocate workforce.
- Using the score to streamline patients, for example the frailty patients, who are well, don't require emergency care but need admission.

If the accuracy of the score was improved, the Consultants saw the potential for the score to reduce the amount of senior discussions – only for patients being admitted as the GMC dictates that all patients being discharged from the Emergency Department must have a senior discussion.

#### Part 3: Cost impact

We discussed our service improvement project with a Health Economist, but did not have a formal financial evaluation of our project. As the initial intention of adopting an admission prediction score was to use it to direct the low scoring patients to primary healthcare services (NEMS), it could be argued that there would be huge cost savings through a reduced amount of investigations and staff time (ECGs, bloods, assessment by triage nurse and then clinician) carried out on those patients. However, due to the change made by NHS England in front door streaming, these low scoring patients rarely enter our ED.

Hypothetically, you could argue that if a patient was streamlined to another speciality e.g. frailty, soon after they were identified as needing admission (according to the score), this would save x amount of hours in ED and therefore x hours of care within ED. As we have not yet achieved streamlining patients within our project time frame, we have not yet explored the associated cost saving.

# Part 4: Learning from your project

Our project aims and achievements for each have been broken down as follows:

1. Applying a DTA (decision to admit)

"The time of decision to admit is defined as the time a clinician decides and records a decision to admit, or the time when treatment that must be carried out in A&E before admission is complete; whichever is the latter" (NHS England 2014). As the score does not comply with this policy, we were unable to apply a real DTA to our patients and so resorted to creating a hypothetical DTA, i.e. argue that if the score was to be used to formulate a clinical decision, the DTA could be applied at the time the score was generated.

We trialled applying a proxy DTA, however we later discovered that our data analyst was unable to differentiate between the time the proxy DTA and real DTA were applied.

# 2. Score acting as a sense checker

We were anticipating the score to be used more as an adjunct to clinical decision making for the junior doctors. However, the data shows it had little to no impact on their decision making. We questioned whether the timing of the question was best placed. In practice, the junior doctors often have a senior discussion prior to their medical clerking documentation and so when asked "Has the score changed your decision to admit/discharge?" the most likely answer would be "no" as the senior discussion has resulted in a decision. Perhaps a more appropriate question to ask would be "prior to senior discussion, were you confident of your admit vs discharge decision"? Or, "have you used the score to confirm your decision of admission/discharge"?

#### 3. Accuracy of the score

As previously mentioned, the accuracy of the score at predicting admission raised a few concerns with regards to increasing admission rates. As a matter of urgency, we employed a principle analyst who looked at the statistical relevance of each variable and worked to improve the score's predictive ability. As can be read from his paper (appendix 2) he made a small gain of improving the accuracy by 1.6%. Unfortunately this was not substantial enough to get buy-in. We are continuing to add more variables to improve the predictive accuracy of the score.

Other challenges:

# 1. Data collection

Our data analyst who was responsible for quantitative data collection was very overstretched and so it was difficult to get data. At one point we considered employing an external data analyst, but they were not familiar with our Trust computer systems, meaning they would have needed to be trained.

A learning point would be to employ an in-house data analyst solely for the project, perhaps on a part time overtime basis.

### 2. Compliance

We approached clinicians within their staff group meetings, which we found to be more effective than trying to educate and disseminate information over work email and through publicity materials, though these were also done. We found that just getting a couple of clinicians on board with the project helped with enabling further staff buy-in.

Feedback from the clinicians was that opening the programme which displayed the score and then ticking a box within their medical clerking note was time consuming. They wanted the score to be auto populated into their clerking note. Our concern was that by auto populating the score, there would be no way of telling that the score had been looked at.

The lack of compliance with the score and willingness to trial a quality improvement project was surprising and disappointing. As the score was not always generated (most commonly due to missing observations), there was an option for the clinicians to select 'no obs' in the clerking note. However, this acted negatively as a get out clause and as can be seen by Figure 5, it was selected incorrectly.

As the majority of ED patients fell into the 8-25 bracket, assumptions were made and as a result we had incorrect scores being clicked on in the medical clerking note (Figure 6). On the back of this, adjustments were made so that the clinicians had to enter a numerical value as the admission prediction score rather than ticking a box. Unfortunately, this did not yield an increase in entering the correct score (Figure 7). From the raw data, on many occasions the value entered by the clinicians was 1 point off the correct score. With technical issues in accessing the score and from working alongside the doctors and witnessing them, it could be deduced that the clinicians were trying to manually calculate the score and were getting it wrong.



Adult non injury patien recorded in Clinical Not	ts with a calculā ing	ated score o	f <8 compa	red to value.	8	Adult non injury recorded in Clini	patients wil cal Noting	th a calculat	ed score of £	-25 compared	to values	Adult non injury , recorded in Clinic	oatients w	th a calculate	d score of >;	25 compared	to values
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10/04/2017	0	0	0	0	0	10/04/2017	0	0	0	0	0	10/04/2017	0	0	0	0	0
17/04/2017	0	0	0	0	0	17/04/2017	0	0	0	0	0	17/04/2017	0	0	0	0	0
24/04/2017	0	0	0	0	0	24/04/2017	0	0	0	0	0	24/04/2017	0	0	0	0	0
01/05/2017	1	0	0	0	1	01/05/2017	125	156	269	0	550	01/05/2017	6	151	99	0	226
08/05/2017	0	0	0	0	0	08/05/2017	114	104	418	0	636	08/05/2017	80	178	91	0	277
15/05/2017	1	0	0	0	7	15/05/2017	115	84	466	0	665	15/05/2017	6	146	128	0	283
22/05/2017	2	0	0	1	n	22/05/2017	92	30	498	53	673	22/05/2017	4	150	<u>98</u>	10	262
29/05/2017	0	0	2	0	2	29/05/2017	89	32	487	68	676	29/05/2017	4	127	105	33	269
05/06/2017	2	0	2	1	5	05/06/2017	99	52	492	87	697	05/06/2017	9	136	121	20	283
12/06/2017	ŝ	0	2	2	7	12/06/2017	<mark>91</mark>	20	489	68	698	12/06/2017	11	130	106	12	259
19/06/2017	1	1	ε	0	5	19/06/2017	85	32	483	62	662	19/06/2017	9	144	102	20	272
26/06/2017	1	0	1	7	εΩ	26/06/2017	82	31	486	69	668	26/06/2017	4	125	<del>66</del>	27	255
03/07/2017	2	0	1	0	n	03/07/2017	84	31	437	144	969	03/07/2017	ŝ	104	102	39	248
10/07/2017	ę	0	1	2	9	10/07/2017	109	46	498	94	747	10/07/2017	∞	84	133	23	248
17/07/2017	ŝ	0	0	0	n	17/07/2017	63	20	575	82	740	17/07/2017	4	106	133	16	259
24/07/2017	1	0	0	0	1	24/07/2017	84	24	570	34	712	24/07/2017	4	98	123	16	241
31/07/2017	2	0	1	1	4	31/07/2017	118	34	530	46	728	31/07/2017	9	100	141	15	262
07/08/2017	0	0	1	0		07/08/2017	87	32	519	40	678	07/08/2017	7	124	147	2	283
14/08/2017	0	0	1	0	7	14/08/2017	53	20	252	13	338	14/08/2017	4	43	60	2	109
21/08/2017	0	0	0	0	0	21/08/2017	0	0	0	0	0	21/08/2017	•	0	0	0	0
Grand Total	22	1	15	8	46	<b>Grand Total</b>	1462	677	7472	860	10573	<b>Grand Total</b>	97	1946	1757	238	4038
2																	

Figure 7



Secondly, achieving buy-in from the consultants who are a strong influence on our junior clinicians was a challenge. As can be seen from the qualitative interviews, there was a high level of scepticism and trust in the score.

# Part 5: Sustainability and spread

As there is no cost to the maintenance of the score being produced or the method of data collection (in that it can be pulled electronically and retrospectively), there is no barrier to its continuation. However, with the score's current level of accuracy, there needs to be vast improvement before the score can be adopted and spread.

Towards the end of the project, we received some interest from the East Midlands Academic Science Network. They not only supported us with an extra data analyst to assist with the data collection but also are exploring the adoption and spread of the admission prediction tool across nearby Trusts.

We have shared our trial and experiences with not only Glasgow who we adopted the prediction score from, but also other Trusts such as Torbay and South Devon NHS Foundation Trust, Addenbrook's Hospital in Cambridge and Royal Free London NHS Foundation Trust.

We hope this project will be published and intend to approach the BMJ Open Quality and Nursing Times.

#### Accuracy improvements

Funding was extended to allow Ben time to work with our data analysts to try and improve accuracy of the score. This is because the model suggested by Glasgow only has an accuracy of 71.5% when applied to our population. Changes to the model initially concentrated on altering cut off values of the original Glasgow model. The aim was to keep the model to enable easier spread amongst Emergency Departments as the Glasgow model is extremely simple to implement. The one downside of the model aside from the 71.5% accuracy is that it relies on NEWS, which isn't universally adopted amongst UK EDs.

It quickly became apparent that we would not be able to improve accuracy whilst aligning ourselves to the Glasgow model. We looked at a number of variables that were not included in the Glasgow model including:

- Presenting complaint.
- Pre-hospital observations.
- Patient's location within ED.
- Patient's residential status (are they from out of area).
- Patients registered with GP?
- Waiting time to be seen.
- Clinician review in the Initial Assessment Unit.
- Number of patients in the department.
- Intoxicated vs non intoxicated presentation
- Day and time of presentation

In total, 49 separate models were trialled. Of these, an accuracy of 92.3% was the highest achieved, however, this could only be achieved by looking solely at patients that were already highly likely to be admitted and so the sample size was reduced to just 975 from 22,271 meaning that the resulting tool would have been all but useless

as it only applied to a very limited number of patients.

The model with best fit to include all relevant patients has an accuracy of 76.2%. this is a significant increase on the Glasgow model, but still a relatively low accuracy. The benefit of this model is that it can be presented to a trust in the form of a data file. This file will look at all the raw data from a trust and calculate a score that is relevant to that trust and its population. It removes the need for a scoring tool per se and will give an output of a binary yes/no answer as to whether the patient is likely to need admission. As this is related to the trusts historical data, it would also take into account local techniques for managing patients away from the department (eg co located chest pain units, stroke units etc).