

A machine learning approach to predict Emergency Care 4hr Visit Time target breaches – The Torbay case study

Rob Radmore – Honorary HSMA

About me.....

- Information Analyst – Torbay and South Devon NHS Foundation Trust
- Working in the Information team since 2009
- Very little opportunity for external training
- I was looking to improve upon the skills that I have
- The HSMA course was recommended to me as a way to explore new methods of analysis and to get a better understanding of modelling which was pretty basic at this stage

My journey.....

- I successfully applied for the course with a project idea having met with our acute pathways redesign group
- This project idea went through a number of changes and I struggled to form a credible project and as a result my project was not accepted as a HSMA project but...
- I was asked to come through to the second phase of the HSMA as an “Honorary HSMA” – this meant that I would be able to attend the training sessions and experience the action learning sets so still a positive outcome for me

My journey.....

- Following a really interesting but mind blowing Machine Learning training session I was having a chat with Mike whilst we were sharing a train journey to Plymouth.
- Mike was telling me how machine learning worked best if you could provide the algorithm with a lot of data



My journey.....

- Finally an idea started to form.
- Access to data – ED snapshots, Inpatient snapshots
- ED crowding data
- I pulled together approximately 8000 x 2 hourly snapshots of data and Mike and I used this to see if we could predict whether a breaches would occur in the next 2 hours for each of these.
- Initial success – the Risk Score on our ED Dashboard was approximately 69% accurate at predicting a breach in the next timeslot but using the metrics that produced the risk score gave approximately 80% accuracy

The ED Dashboard – with crowding scores

Torbay Hospital - ED Dashboard As at: **29-Nov-2018 19:52** Torbay and South Devon  NHS Foundation Trust
Current Status

Performance* 81.9% **Current Risk Score** 7.8 **Patients in ED** 33 **Waiting Triage** 3 **Waiting Clinician** 13 **Waiting Bed** 11

Majors Perform.	76.3%
Minors Perform.	100.0%
Attendances*	166
Breaches*	30
ED Admissions	49
Patients in CDU	3
Patients in AMU	6
Beds Allocated	1/11
Ward Admissions	48
Ward Discharges	65
Waiting Decision Majors (>2.5hrs)	11
Waiting Decision Minors (>2.5 hrs)	0

* Excluding Planned Attendances (Calculated since midnight)

v1.2.0.1

Breakdown of Patients Currently in ED	Time in Department (In Hours)							Patients Waiting For:						
	Total	0-1	1-2	2-3	3-4	4-5	5+	Triage		Clinician		Bed		
Totals	33	9	10	7	3	2	2	<15m	>15m	<60m	>60m	<4hr	4-12hr	>12hr
ED Majors	7	2	3	2				1	2	7	6	11		
ED Paeds	2		1	1						2	1	1		
ENT	1				1						1			
Medical	9		2	2	2	1	2				1	8		
Mental Health Team	1		1								1			
Paediatric Team	2			2							1			
Surgical	3	1	1			1				1		2		
Trauma and Orthopaedic Team	1		1								1			
Unassigned Care Group	4	4						1	2	4				
Sub-Total of Majors	30	7	9	7	3	2	2	1	2	7	6	11	0	0
ED Minors	3	2	1											
Sub-Total of Minors	3	2	1	0	0	0	0	0	0	0	0	0	0	0

Historic Crowding Snapshots (for last 24 hours)	Oldest (Taken every 2 hours)													Newest Thu 19:52
	Wed 18:00	Wed 20:00	Wed 22:00	Thu 00:00	Thu 02:01	Thu 04:04	Thu 06:00	Thu 08:00	Thu 10:02	Thu 12:01	Thu 14:00	Thu 16:00	Thu 18:00	
Risk Score	9.6	11.1	14.3	11.8	7.0	4.0	3.7	3.4	7.9	9.8	12.3	12.1	8.4	7.8
01-Total Number of Patients in the Department	39	46	54	44	27	17	14	14	29	36	48	48	33	33
02-Number of Patients in Resus	3	3	4	2	2	1	0	0	2	4	3	4	1	1
03-Number of Patients Registered in Last 60 Minutes	12	8	12	8	2	2	6	4	12	15	19	16	11	10
04-Number of Patients Waiting Triage	4	9	6	4	0	0	1	0	3	2	9	5	4	3
05-Number of Patients Waiting to be Seen (ED)	14	10	14	10	6	3	2	1	4	8	14	9	7	3
06-Number of Patients Waiting to be Seen (Medical)	0	0	3	2	1	0	0	0	0	0	0	3	2	1
07-Number of Patients Waiting to be Seen (Surgery)	1	0	0	0	0	0	0	0	0	0	0	0	0	1
08-Number of Patients > 3 Hours	6	13	25	25	16	10	7	5	9	10	9	14	8	7
09-Number of Patients Waiting a Bed	7	11	11	11	9	3	3	7	12	13	9	10	10	11
10-Number of Patients Left Department in Last 60 Minutes	11	8	8	0	0	1	3	2	3	9	10	19	11	9

Problems with the Dashboard

- Risk score is not weighted – the first 9 metrics are added up and divided by 9 to provide an average score
- This means that large numbers influence the score that is calculated
- The dashboard can show a lot of red warnings but doesn't really show trends very well

What is Machine Learning?

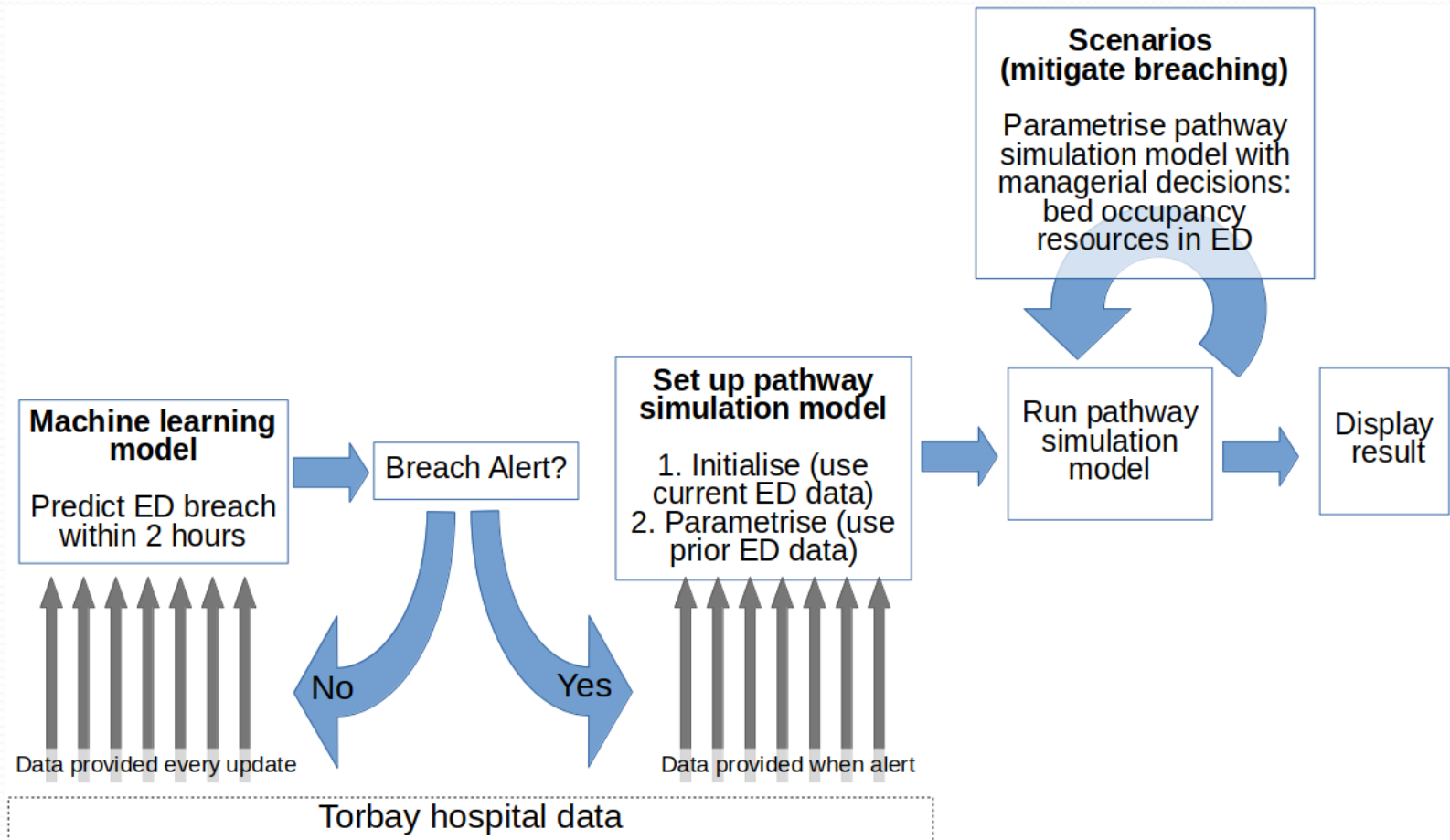
- Machine Learning - methods that have a framework that automatically adjusts (corrects) with new results. Performance may be initially poor but improves over time.
- Two main types of machine learning
 - ‘Classical’ methods such as logistic regression, support vector machines and random forests often work well with relatively simple structured data (most hospital data) and have high levels of explainability (understanding of the model overall) and interpretability (why one individual answer was given).
 - It is usually easy to understand why a particular result is given.
 - ‘Deep learning’ (neural networks) can work on simple structured data or complex unstructured data (e.g., free text, speech, photo, video). Deep learning can work where no other methods will work, or may improve on accuracy of classical methods in some cases. Deep learning methods, though often having better accuracy, are hard to explain and interpret (and so may make simple errors without easily understanding why).

(Source: Mike Allen, PenChord)

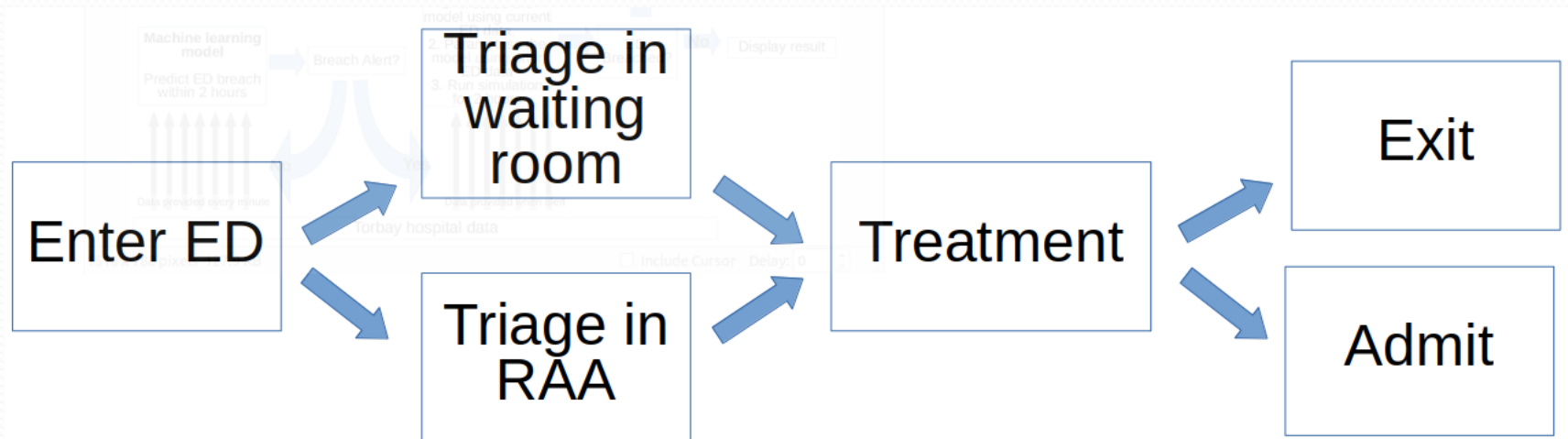
Aims of the project

- To be able to accurately predict as far ahead as possible the likelihood of breaching
- Using a simple simulation model and live data to show any constraints within the ED system to identify if changes can be made to staffing levels to fix the problem within ED
- Identify what factors are causing the flow issues internal or external to ED
- To enable more informed decision making

Whole Model



Simulation Model



What has been achieved to date?

- Initial analysis as a proof of concept
- A stakeholder group has been identified at Torbay Hospital
- Stakeholders brought together for a meeting to review the proposed project idea – positively received
- Started a debate about
 - What we want the model to show
 - Do we just want the right answer but in a way that is not explainable versus compromised performance but more understandable

Next actions

- Organise a stakeholder meeting to try to define all of the likely metrics that could be important and the type of Machine Learning model we use
 - Investigate if they are available
 - If not can we get them
- Project team to commence work in January 19 with an approximate end date of March 19
- Deliver an automated model that uses historic and current data to predict future breaches
- A simulation model to identify constraints within the ED



Thank you for listening!

- Any questions?