



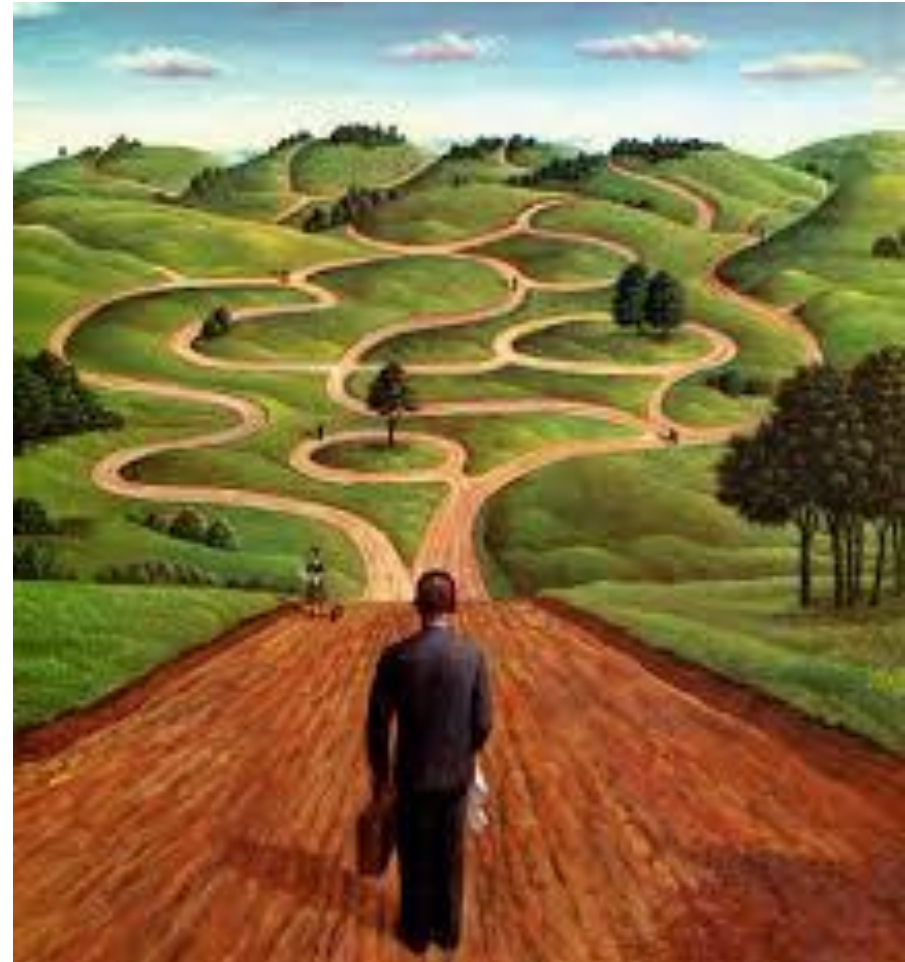
Australian
Clinical
Trials
Alliance

eMR Analytics Data Warehouse: Avenue to electronic clinical registries

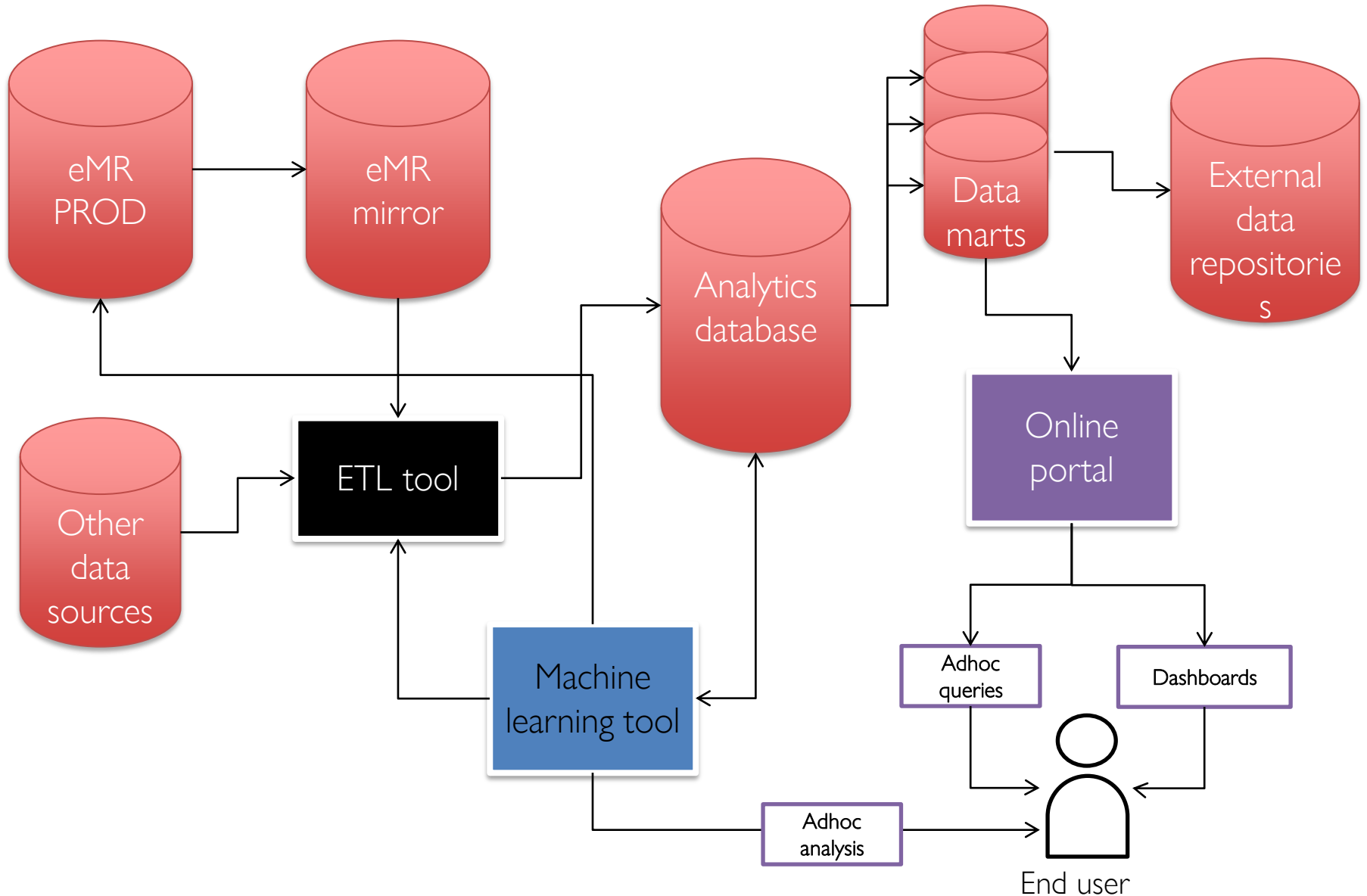
Jane Shrapnel
Data Scientist, Sydney Children's Hospital Network

Aim of the SCHN eMR data warehouse

Creation of an eMR analytics DWH to easily access clinical data to improve patient health outcomes and hospital efficiencies



End solution: Data workflow from eMR production to the other sources



Overview of SCHN hospitals

Hospital	ED presentations	Admissions	Outpatient services
Randwick	36,739	17,507	242,941
Westmead	61,433	35,985	765,653
Network	98,172	51,942	1,008,585



Data collected in the eMR

The screenshot displays an eMR interface for a patient named Jorgensen, Jill M. The interface is organized into several panels:

- Header:** Patient name, age (29y F), DOB (09/02/1982), MRN (12), PCP, and other identifiers.
- Summary Panel:** Overview of patient information, including visit details (06/28/2012 Rockcreek Ortho), notes, orders, charges, and rx counts.
- Vitals Panel:** A table showing vital signs for the last 2 years for all visits.
- Measurements Panel:** A table showing physical measurements (Height, Weight, BMI) for the last 2 years for all visits.
- My Favorite Orders Panel:** A list of medications and orders for the selected visit.
- Documents | Notes Panel:** A list of clinical notes and documents for the last 2 years for all visits.

	Today within	Previous within	Previous within
BP	122/84 7 mins	122/80 22 hrs	120/80 4 mos
Temp	100.4 7 mins	100.2 22 hrs	102 4 mos
HR	60 7 mins	70 22 hrs	88 4 mos
Respiratory Rate	30 7 mins	24 22 hrs	17 4 mos
Oxygen Saturation	98 7 mins	99 22 hrs	99 4 mos

	Today within	Previous within	Change
Height	63 in 7 mins	63 in 22 hrs	0 in
Weight	133 lb 7 mins	133 lb 22 hrs	0 lb
Body Mass Index	23.56 kg/m2 7 mins	23.56 kg/m2 22 hrs	0.00 kg/m2

Meds	Labs	Imaging	Billing	Other
Advair Diskus 100 mcg-50 mcg inhalation powder				
albuterol-ipratropium inhalation aerosol with adapter				
amoxicillin 200 mg oral tablet				
amoxicillin 500 mg oral tablet				
Bactrim oral tablet				
cephalexin 500 mg oral tablet				
lisinopril 20 mg oral tablet				
loratadine 10 mg oral capsule				
Lotrimin AF 1% topical cream				
Motrin 400 mg oral tablet 1 tab(s) (400 mg), PO, q4hr, PRN: for pain, # 60 tab(s), 0				

	Author	Date/Time
General Clinic Note (Physician)	ZZEMRProvider nCode , Provider nCode	06/19/12 14:03
Prescription Management	ZZEMRProvider nCode , Provider nCode	06/19/12 13:53
General Clinic Note (Physician)	ZZEMRProvider nCode , Provider nCode	05/31/12 08:08
General Message	Demo , Cerner	05/30/12 08:56

How do we access eMR data?

Current state

- Requires specialised skills to access data
- Query directly to the production database potentially causing delays and outages
- Cannot easily create aggregate data flows or visualisations directly from database
- Is not real-time

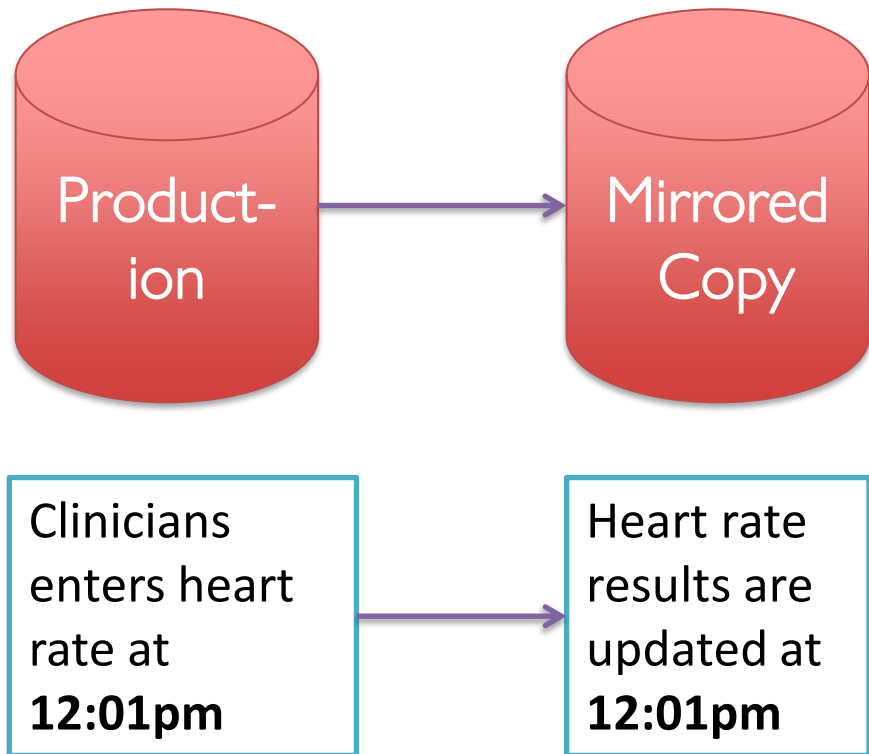


Future state

- Anyone with permissions can easily query data
- Automated complex data flows into national repositories
- Regular reports and dashboards will be automatically refreshed on a real-time basis, removing need for someone to run a query each time
- Advanced analytics integration and analysis will be able to inform real-time decision making for clinicians and administration staff

Using existing technology to create a mirrored server

eMR Data



Benefits:

- Large quantities of data can accessed any time as no impact of production performance
- In real-time
- Can apply complex queries on structured and unstructured data

So we can access the data, now what?

Issues

- Data lake – a lot of data without any meaning or structure to it
- We have no specific problems to address
- We have no idea about data quality, classifications and business rules that impact how data is entered

How we scoped

- Engaged with universities, research executives, executives and clinicians to ask what they thought were important
- Categorised these to understand how tables should be structured

Examples of categorisation of use cases



	Outcomes to measure	Measuring	Join across	Example use cases
Long-term patient outcomes	<ul style="list-style-type: none"> • LOS reduction • Fewer re-admissions • Higher survival rates • Greater use of outpatient services 	<ul style="list-style-type: none"> • Success of care plans/models over time for chronic patients 	<ul style="list-style-type: none"> • Months/Years • Pathology • Pharmacy • Diagnosis • Procedure • Cancer treatments 	Value of specific therapy over time, e.g. re-presentation of asthma looking for commonalities
Clinical operations	<ul style="list-style-type: none"> • LOS reduction • Fewer re-admissions • Care quality 	<ul style="list-style-type: none"> • What happens when the patient is at hospital (specific to diagnosis) 	<ul style="list-style-type: none"> • Minute/hour • Diagnosis • Pathology • Pharmacy • Treatments • Clinical results 	Can we reduce the LOS for febrile neutropenia patients by investigating patient treatment
Clinical variance	<ul style="list-style-type: none"> • LOS reduction • Fewer re-admissions • Lower use of tests • Lower use of meds 	<ul style="list-style-type: none"> • Variation in treatment of patients for similar medical condition 	<ul style="list-style-type: none"> • Minute/hour • Diagnosis • Pathology • Pharmacy • Treatments 	Drug ordering patterns and outcome observing clinical variation in medication use for common presentations
Population risk	<ul style="list-style-type: none"> • Better health outcomes for the population • Lower admission/ED rates 	<ul style="list-style-type: none"> • Preventable incidence or diseases 	<ul style="list-style-type: none"> • Hour/day • Re-admissions • LOS • ICU • Patient demographics 	Can we use the eMR for rapid surveillance and alerting of deteriorating conditions, such as sepsis

Process to deliver a eMR driven clinical analytics project

1. Engage a clinical team with an area
2. Select cohort of patients using eMR data (ICD 10 coding, vital signs, pathology results)
3. Develop an ideal data set
4. Source data set within eMR, using proxy's where needed
5. Set up data workflows to create data mart for immediate and long-term analysis
6. Conduct analysis
7. Develop digital tools to support clinicians in their decision-making when treating and caring for patients

Predicting low risk patients with febrile neutropenia

Question: Can we use the eMR to rapidly validate international clinical decision rules to risk stratify febrile neutropenia patients into high or low risk infection?

		PICNICC ¹	SPOC ²
Outcome	What the model is trying to predict	Risk of microbiological defined infection	Risk of adverse outcome ³
Model performance	Prediction rate of infection out of 10 patients		
	Number of countries data used to develop model	15	2
Time period to predict outcome	Predicted at admission	x	
	Predicted within 24 hours of admission		x
Clinical predictor	Clinical description 'severely unwell'	x	
Biomedical predictors	Total white cell count (G/L)	x	x
	Temperature (Celsius)	x	
	Haemoglobin (g/L)	x	x
	Absolute monocyte count (cells per mm ³)	x	
Cancer predictors	Platelet count (G/L)		x
	Cancer type	x	
	Preceding chemotherapy more intensive than acute lymphoblastic leukaemia (ALL) maintenance		x

1 Phillips RS, Sung L, Amman, RA et al. (2016) Predicting microbiologically defined infection in febrile neutropenic episodes in children: global individual participants data multivariable meta-analysis. *British Journal of Cancer*

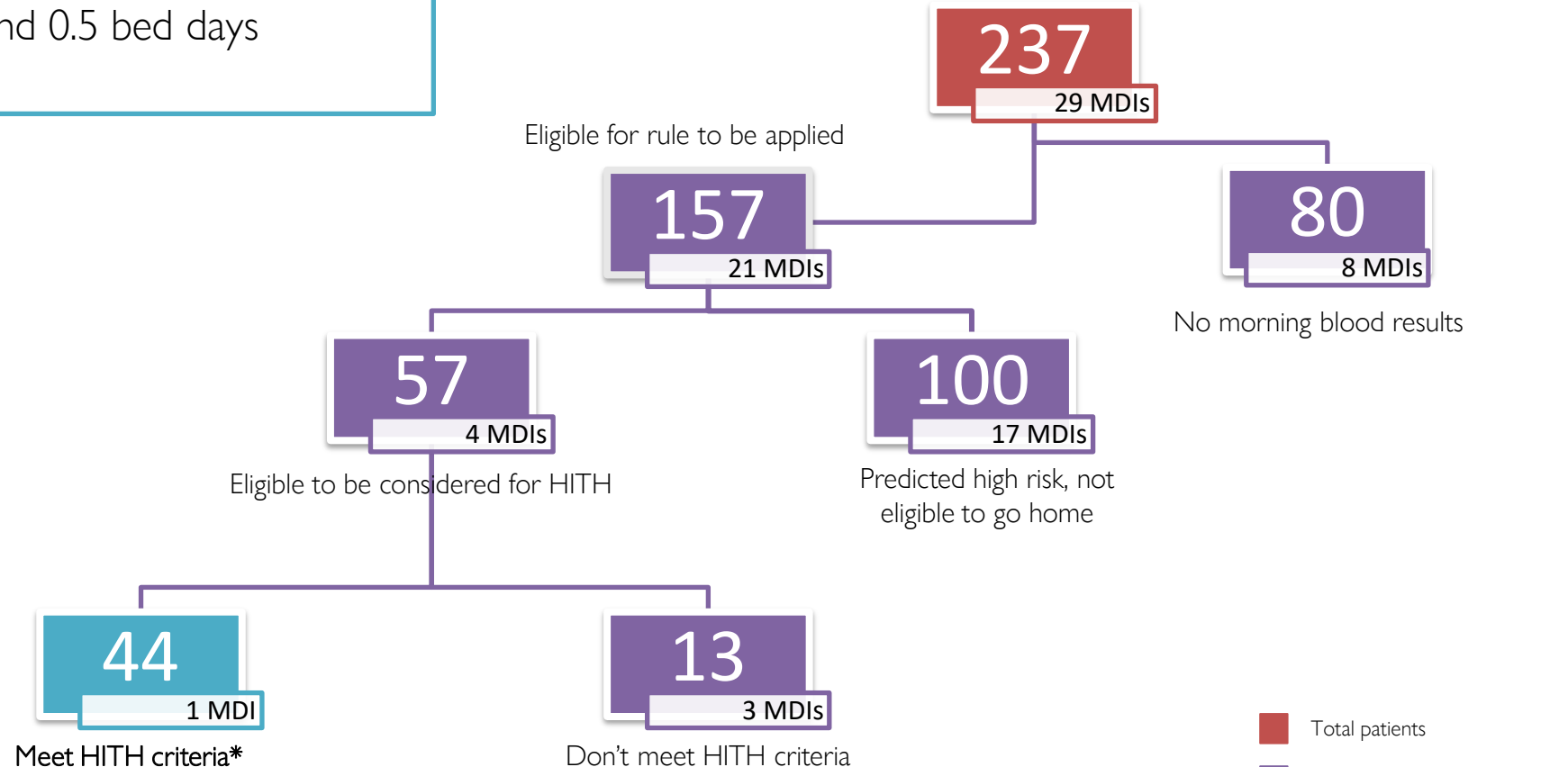
2 Ammann RA, Bodmer N, Hirt A et al. (2010) Predicting adverse events in children with fever and chemotherapy-induced neutropenia: the prospective multicentre SPOG 2003 FN study. *J Clin Oncol* **28**(12)

3 Adverse outcomes include serious medical complication, microbiological defined infection, radiologically confirmed pneumonia

Applying a CDR on eMR can accurately risk stratify oncology patients at risk of infection

This algorithm will save the hospital \$700k a year and 0.5 bed days

Total febrile neutropenia episodes 1 April 2017 – 30 April 2018



*Some criteria cannot be verified easily by system
HITH criteria developed by Peter Mac and Royal Children's Hospital

Reducing variation to provide high value care



Situation

- Over 1,500 bronchiolitis patients present to ED each year, peaking over the winter period

Complication

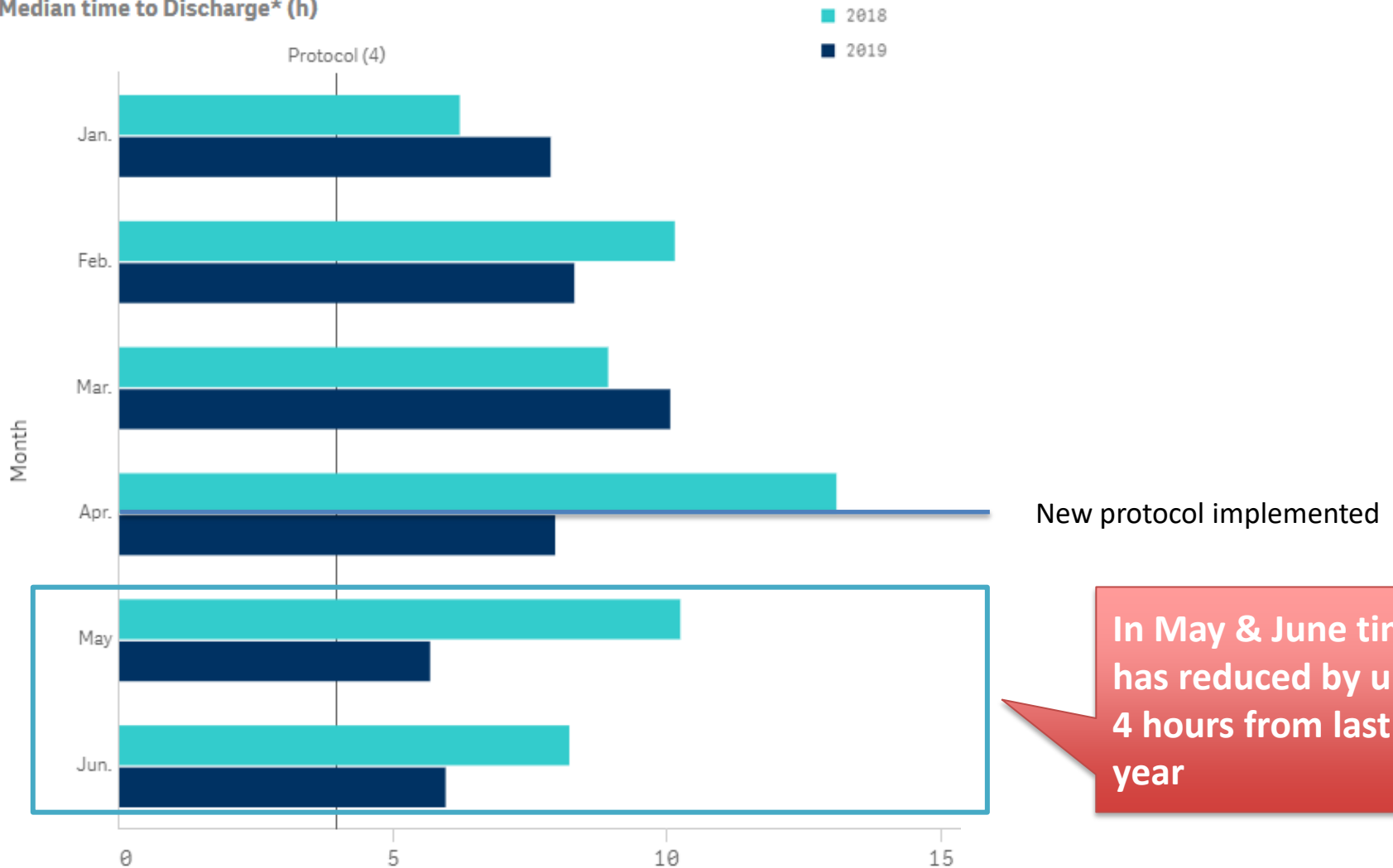
- Variation in care can occur for these patients due to the following factors:
- Patients presenting to the tertiary hospitals may have risk factors associated with moderate to severe bronchiolitis
- There is a lack of consensus in weaning and discharge from oxygen cessation.

Resolution

- Analysing the data on time to discharge showed it was safe to send children home after 4 hours instead of 6. This could save 2 hours a day in our short stay wards.

Changing practice has shown reduction in bed days

Median time to Discharge* (h)



ED digital pathway to assist in identifying sepsis

The aim is to design and implement digital alerts within the eMR to assist clinicians in the early identification and rapid treatment of suspected sepsis.

Alert timing and triggers

- 1 The triage nurse will be alerted based on presenting problem & BTF criteria if patient is missed being put in the sepsis pathway
- 2 The doctor will be alerted to order the appropriate tests, if they haven't, if patient is on the sepsis pathway
- 3 The doctor will be alerted to order antibiotics if they have ordered the appropriate tests and sepsis is suspected
- 4 The doctor will be alerted to order antibiotics if they have ordered the appropriate tests and severe sepsis or septic shock is suspected

Section in Pathway

- ☐ Two or more **YELLOW ZONE** observations
- ☐ OR additional criteria (SPOC)
- ☐ OR clinician concern

Patient may have SEPSIS
Conduct targeted history and clinical examination
Obtain blood
These are significant:
Lactate ≥ 2 mmol/L
BE ≤ -5.0
Procalcitonin (PCT) ≥ 0.5

Patient has SEVERE SEPSIS or SEPTIC SHOCK until proven otherwise

- ☐ Any **RED ZONE** observation
- ☐ OR additional criteria (SPOC)
- ☐ OR neonate with temp $\geq 38^{\circ}\text{C}$
- ☐ OR serious clinician concern

Defining suspected and confirmed sepsis groups

All ED

All emergency patients

Every patient under 18 who presented to ED across SCHN

Suspected sepsis

Those that had a suspected infection that could indicate sepsis

- ED diagnosis of sepsis or
- Order of full blood count, C-Reactive Protein, Procalcitonin, or any cultures or
- Lactate ≥ 2 mmol/L

High risk sepsis

This group is high risk of being septic and should've been treated immediately

- Suspected sepsis + pSOFA > 1 in ED or
- Suspected sepsis + admission in ICU within 24hrs
 - Blood culture positive

Confirmed sepsis

This group is confirmed sepsis and should've be treated immediately

- Hospital discharge diagnosis of sepsis
- Discharge diagnosis of infection + pSOFA > 1 in ED

SCHN
Cases
(n / %)

51,621
100%

12,203
24%

2,222
4%

201
0.4%

Secondary focus group of alerts where we want to flag many cases

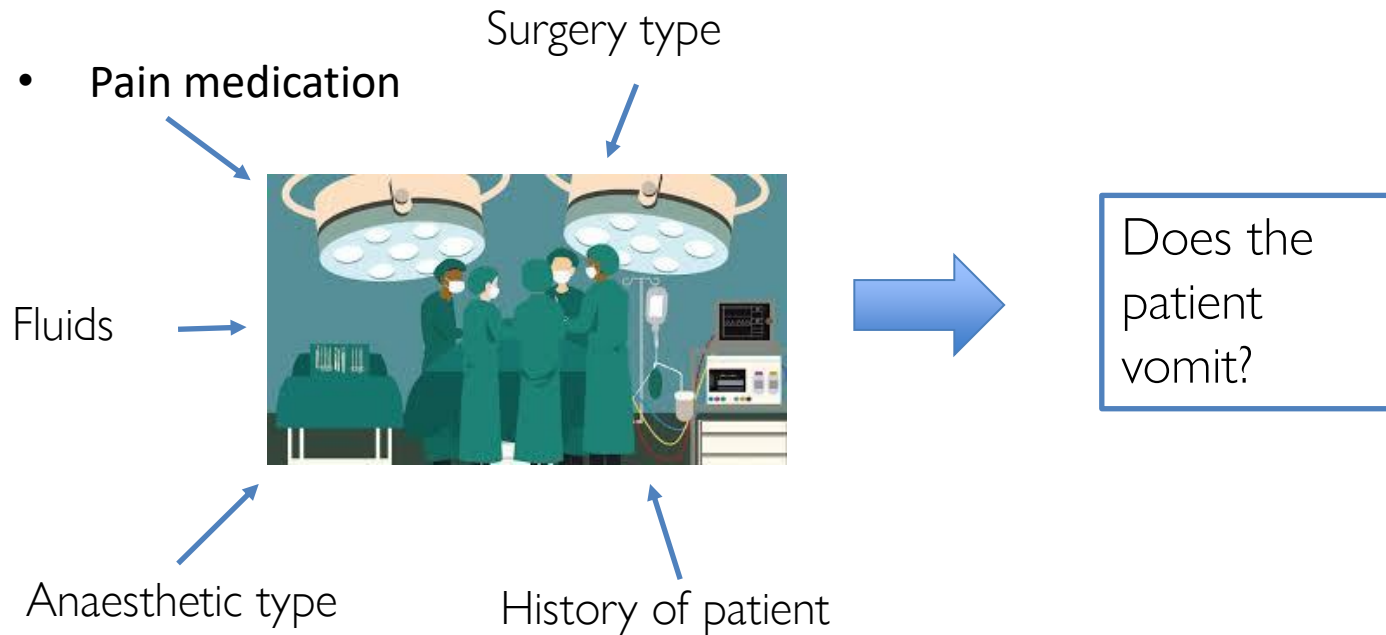
This will be our 'high risk/confirmed sepsis' (HRC sepsis) group where we want the alerts to flag all of these case. There are 4.1% of patient in the cohort (there are some patients in both groups)

Potential alerts and how they measure against the high risk/confirmed sepsis group

Condition	All encounters that met the condition	Encounters that met the condition and had HRC sepsis	% of encounters that met the condition and had HRC sepsis
Temperature and 28 days	1199	103	9%
Temperature and 90 days	5185	127	2%
Temperature and Central line	123	77	63%
Temperature and represent	661	22	3%
Tachycardia for 20 mins	1233	94	8%
Tachycardia for 60 mins	710	68	10%
Toxicity	2270	228	10%
NonBlanchingRash	621	39	6%

Determining appropriate use of antiemetic medication to prevent vomiting post-op

What are the **factors** determine if a patient should be given **antiemetic** medication?



Current progress and expansion of eMR DWH

Completed

- Patient details
 - Demographics
- Personnel details
 - Role/speciality
- Encounter details
 - Patient location
 - Patient journey across hospital
- Orders
 - Test, medication or treatment ordered
- Pathology
 - All results, include bloods and viruses
 - Easy identification of results out of normal range

Currently progressing

- Between the flags
 - Observations.
 - Easy identification of results out of normal range
- eMeds
 - Medication administration

To complete

- FirstNet
 - Clinical action in ED
 - Patient journey
- Surginet
 - IoT of surgery and anaesthesia
- eFluids
 - Intake and outake of fluids

Acknowledgements

- Paediatrico
- The University of Sydney's Centre for Translational Data Science
- Peter MacCallum Cancer Centre
- Western Sydney LHD