Smart Triage: A prediction-based facility quality improvement program for critically ill children

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BC Children's Hospital Foundation

Background

- 2016-4.9 million deaths in children aged < 5 years, most in LMICs
- Sepsis (pneumonia, diarrhea, or malaria) resulting in multiorgan dysfunction major cause of morbidity and mortality
- World Health Assembly (2017) resolved to prioritize prevention, recognition, and early treatment of sepsis

Chart 2. Triage of all sick children

Emergency signs:

If any sign is positive: call for help, assess and resuscitate, give treatment(s), draw blood for emergency laboratory investigations (glucose, malaria smear, Hb)

ASSESS		TREAT
		Do not move neck if you suspect cervical spine injury, but open the airway.
Coma/ convulsing ■ Coma *or* ■ Convulsing (now)	**IF COMA OR CONVULSION**	▶ Manage the airway (Chart 4) ▶ If convulsing, give diazepam rectally (Chart 9) ▶ Position the unconscious child (if head or neck trauma is suspected, stabilize the neck first) (Chart 6). ▶ Give IV glucose (Chart 10).
Severe dehydration *(only in a child with diarrhoea)* Diarrhoea plus any two of these signs: ■ Lethargy ■ Sunken eyes ■ Very slow skin pinch ■ Unable to drink or drinks poorly	**DIARRHOEA PLUS** ***two signs positive*** *Check for severe malnutrition*	▶ Make sure the child is warm. **If no severe malnutrition:** ▶ Insert an IV line and begin giving fluids rapidly following Chart 11 and diarrhoea treatment plan C in hospital (Chart 13, p. 131). **If severe malnutrition:** ▶ Do not insert an IV line. ▶ Proceed immediately to full assessment and treatment (see section 1.4, p. 19).

PRIORITY SIGNS

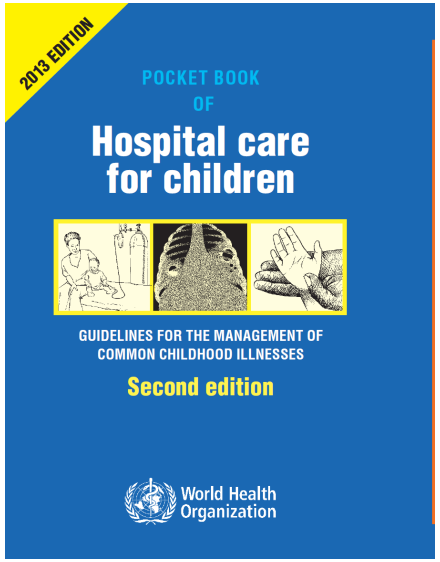
These children need prompt assessment and treatment

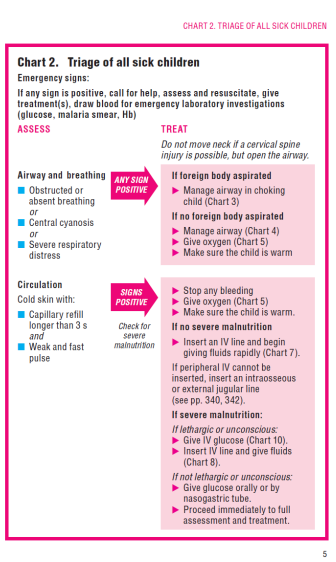
- Tiny infant (< 2 months)
- Temperature very high
- Trauma or other urgent surgical condition
- Pallor (severe)
- Poisoning (history of)
- Pain (severe)
- Respiratory distress
- Restless, continuously irritable, or lethargic
- Referral (urgent)
- Malnutrition: visible severe wasting
- Oedema of both feet or face
- Burns (major)

Note: If a child has trauma or other surgical problems, get surgical help or follow surgical guidelines.

NON-URGENT

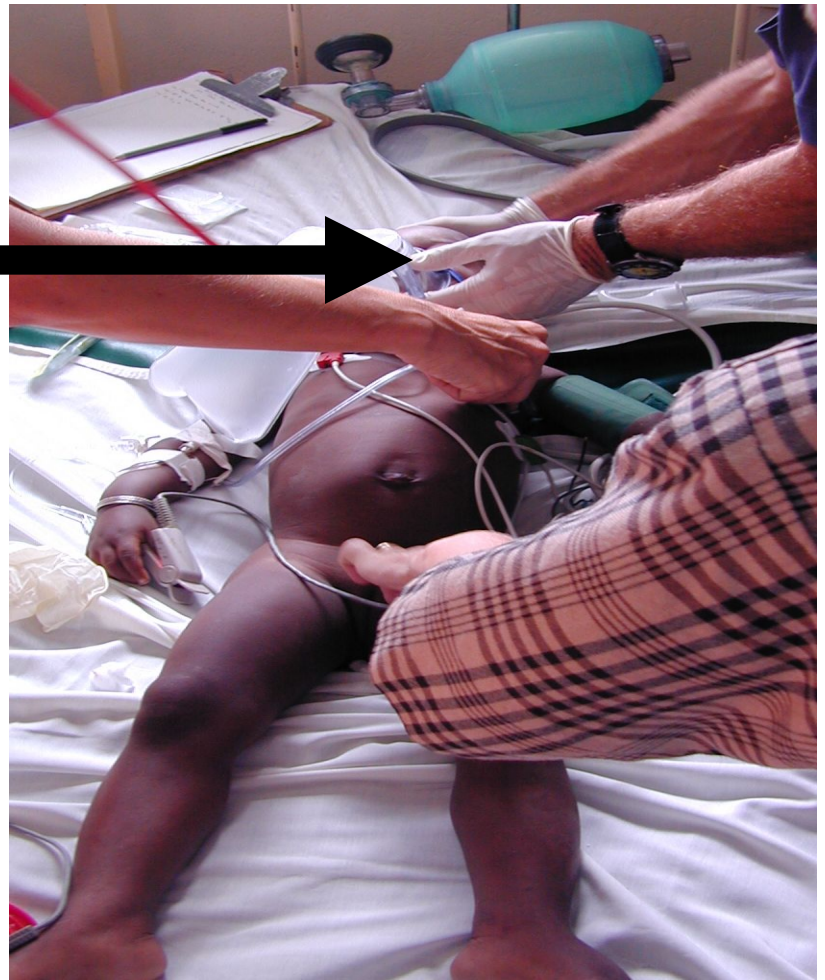
Proceed with assessment and further treatment according to the child's priority.





Hospital Care-Triage

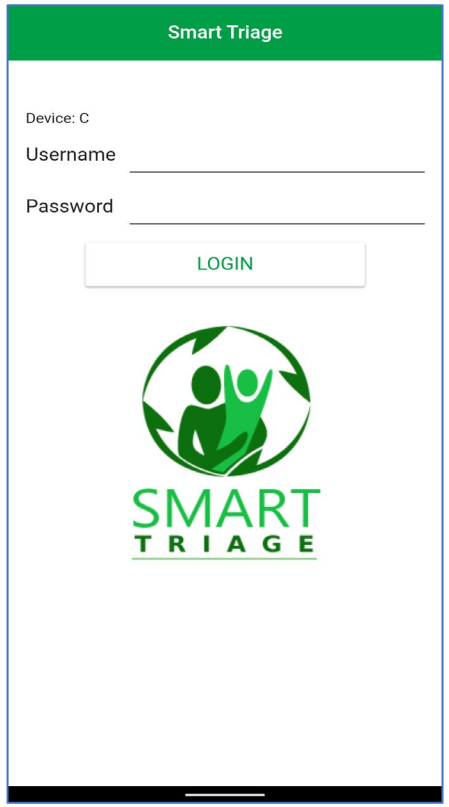
Reality



Crowded Triage/Emergency areas and
staff shortage resulting in missed triage

Is there a role for SMART Triage?

Smart Triage Platform



1. Smart Triage Mobile App

2. Smart Spot

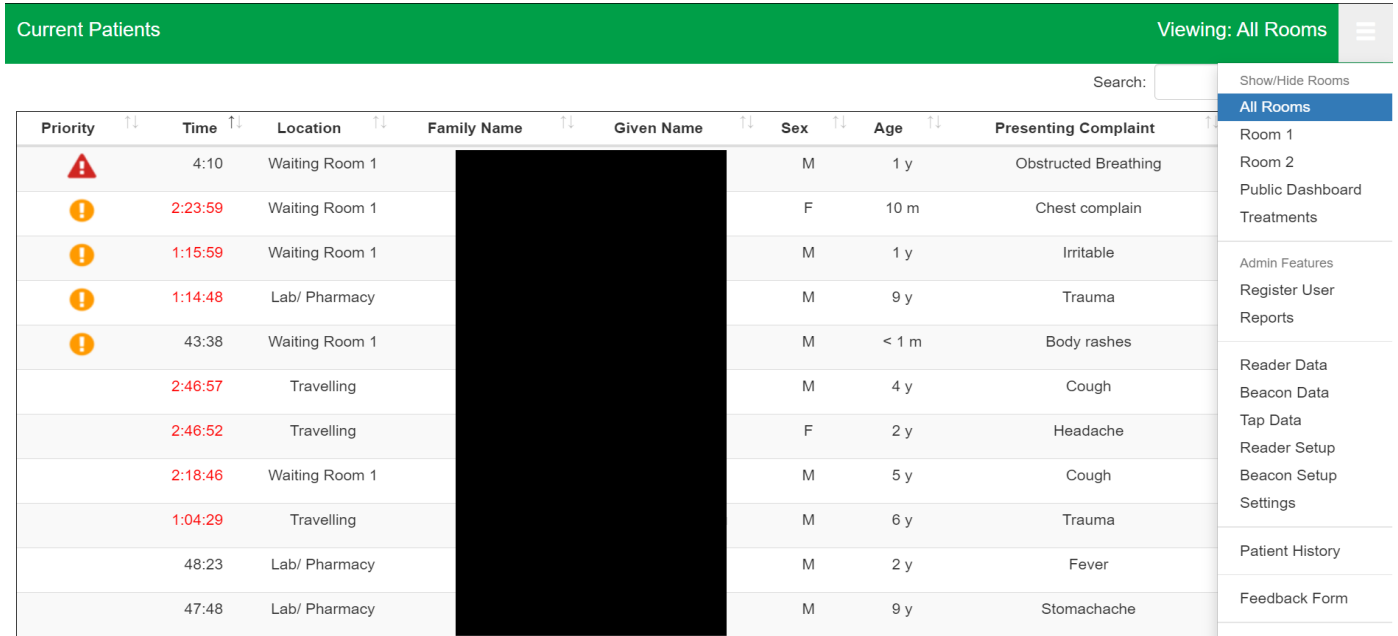
(Patient beacons)

(Treatment beacons)

Beacon Reader

Server box

3.Clinician Dashboard



Objectives of SMART Triage

To develop and clinically validate a digital triage tool for improving hospital waiting times to treatment administration in seriously ill children

To validate use of RFID method to track timing of interventions in children presenting to hospitals with serious illnesses

Study procedures

Phase I: Baseline data collection

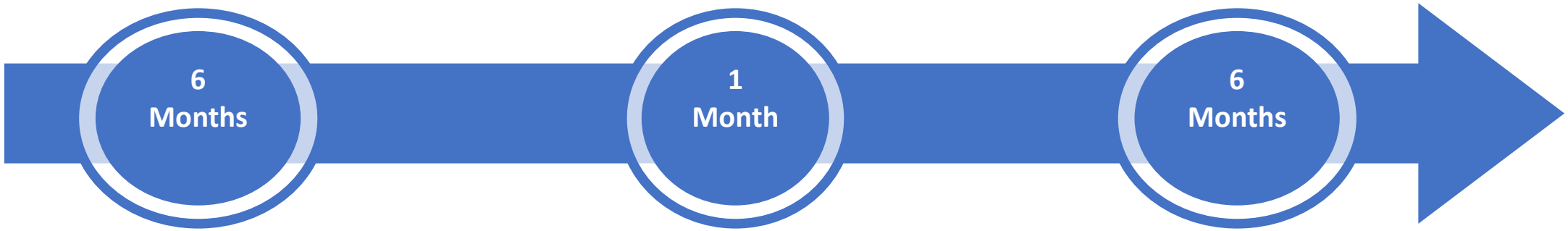
(Mbagathi & Kiambu)

Usability testing & Training Phase

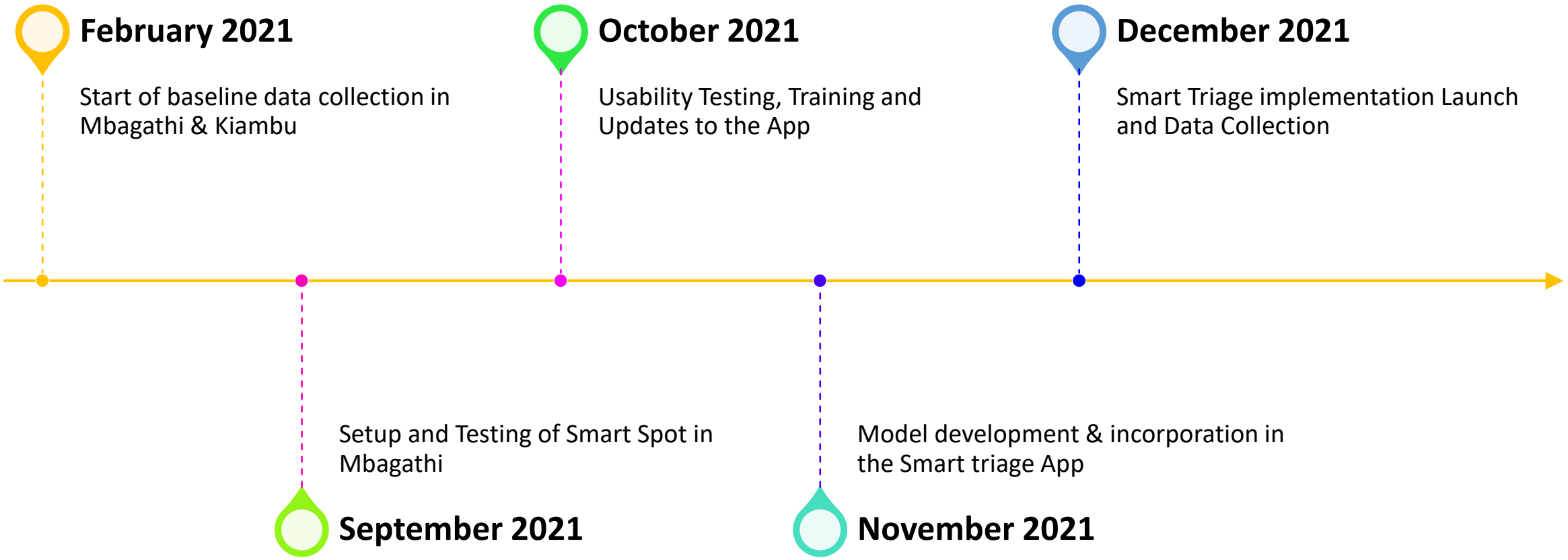
(Mbagathi)

Phase II: Intervention

(Mbagathi – Intervention site)
Kiambu – Control site



Timeline


February 2021
Start of baseline data collection in Mbagathi & Kiambu
September 2021
Setup and Testing of Smart Spot in Mbagathi
October 2021
Usability Testing, Training and Updates to the App
November 2021
Model development & incorporation in the Smart triage App
December 2021
Smart Triage implementation Launch and Data Collection

SMART TRIAGE MODEL

Variable	Estimate	P-value
(Intercept)	-34.918	<0.0001
Continuous Variables		
Heart Rate	0.015	<0.0001
Temperature	0.877	<0.0001
MUAC	-0.017	<0.001
Transformed SpO2	0.058	<0.001
Age	0.016	<0.0001
Categorical Variables		
Parent Concern *(caregiver thinks child should be admitted to the hospital)*	1.828	<0.0001
Difficulty breathing (reported or observed)	0.866	<0.0001
Oedema	2.039	<0.0001
Palmar Pallor	1.703	<0.0001

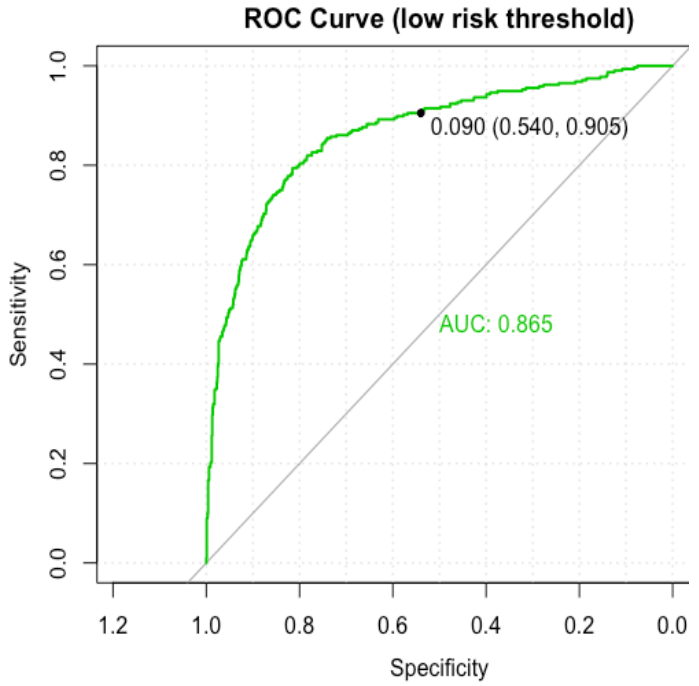


Figure 1a. Cross validated receiver operating characteristic curve of the final model in the study cohort (N=1333). The low risk threshold to classify non-urgent cases is labelled. AUC = Area under the curve.

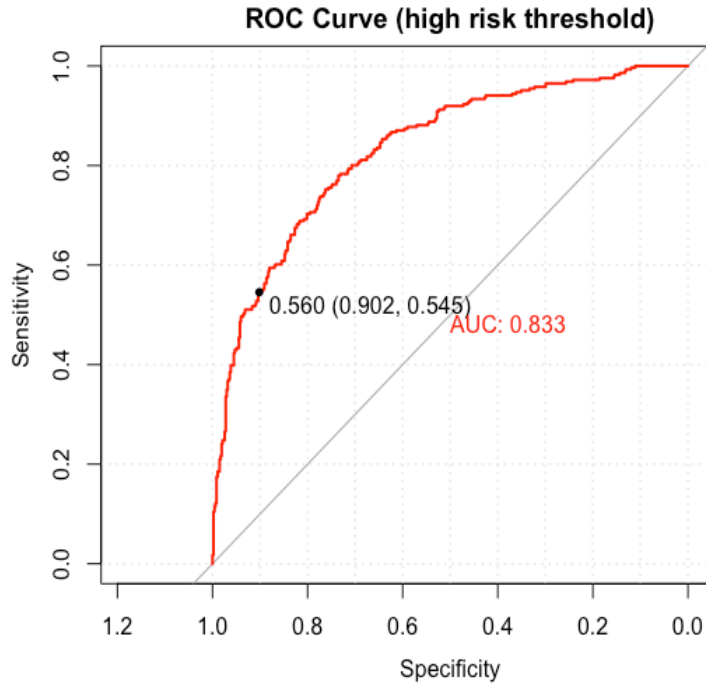
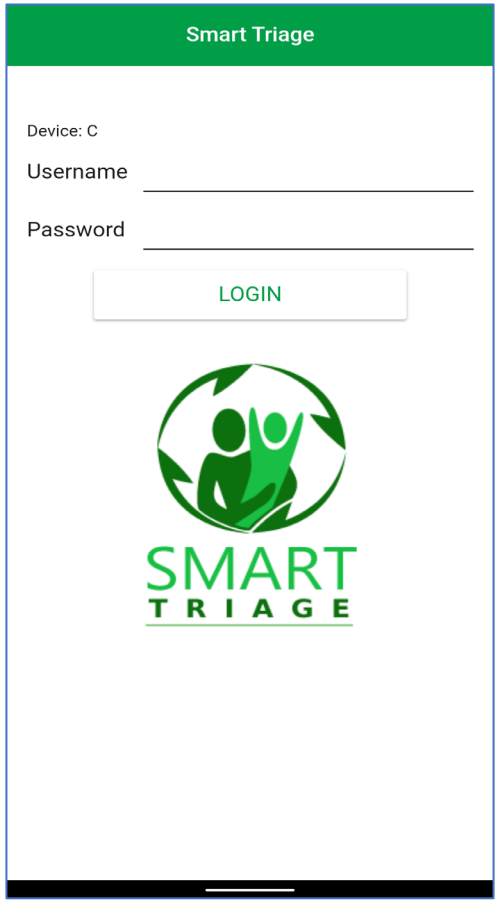
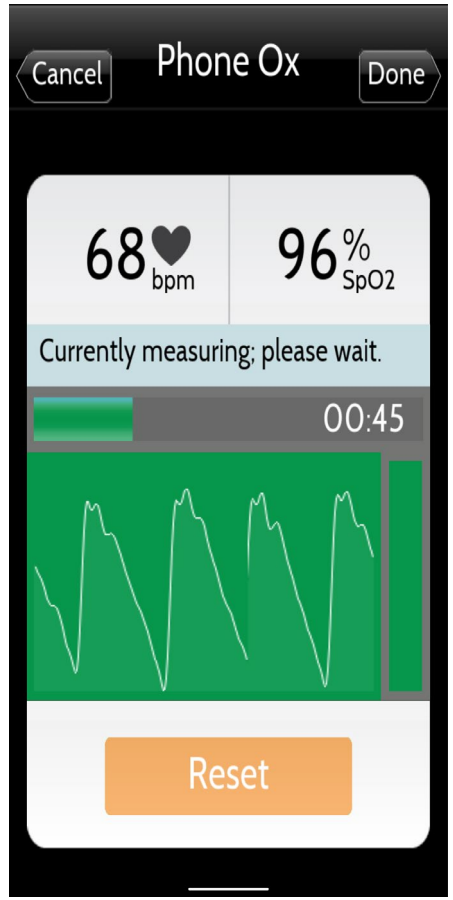


Figure 1b. Cross validated receiver operating characteristic curve of the final model in the study cohort classified as not non-urgent (N=754). The high risk threshold to classify emergency and priority cases is labelled. AUC = Area under the curve.

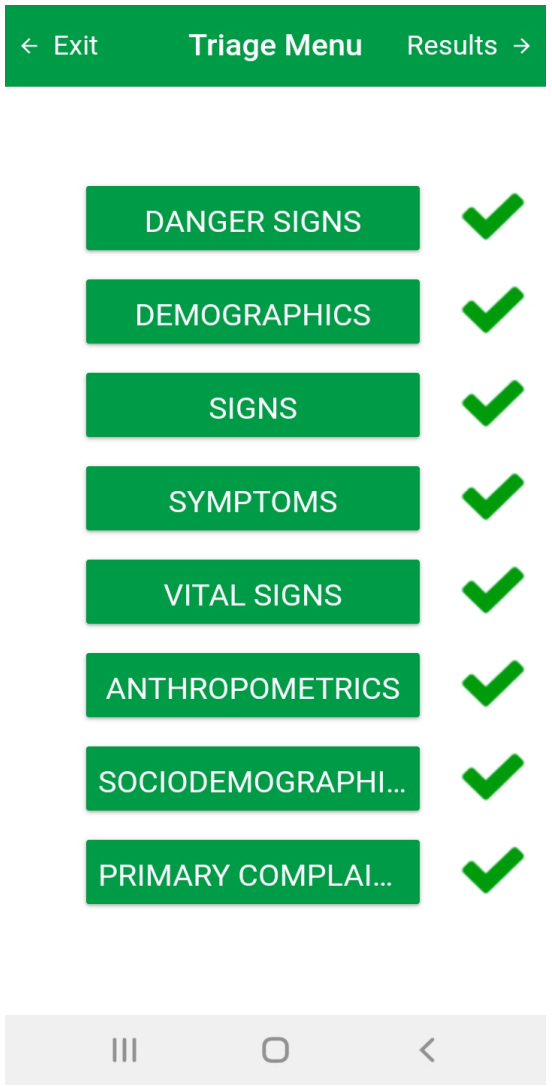
Smart triage App

- Used by nurses during triage to rapidly categorize patients as **non-urgent**, **priority**, or **emergency**
- Android app with attachable Masimo pulse oximeter
- Connects to local server box through WiFi
  - Authenticated with user database on server
  - Security certificate installed on each phone

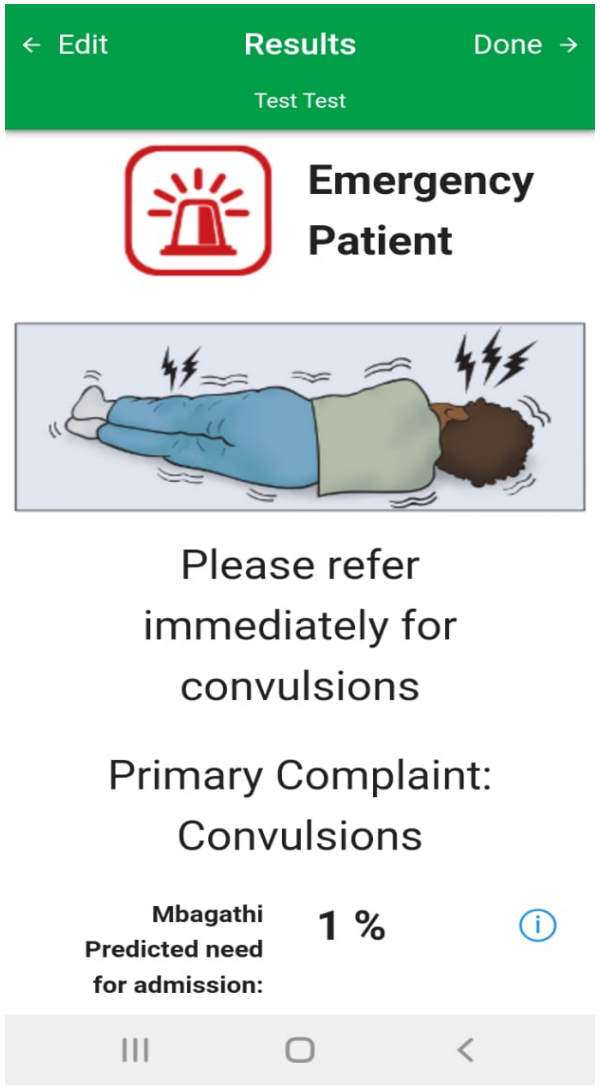




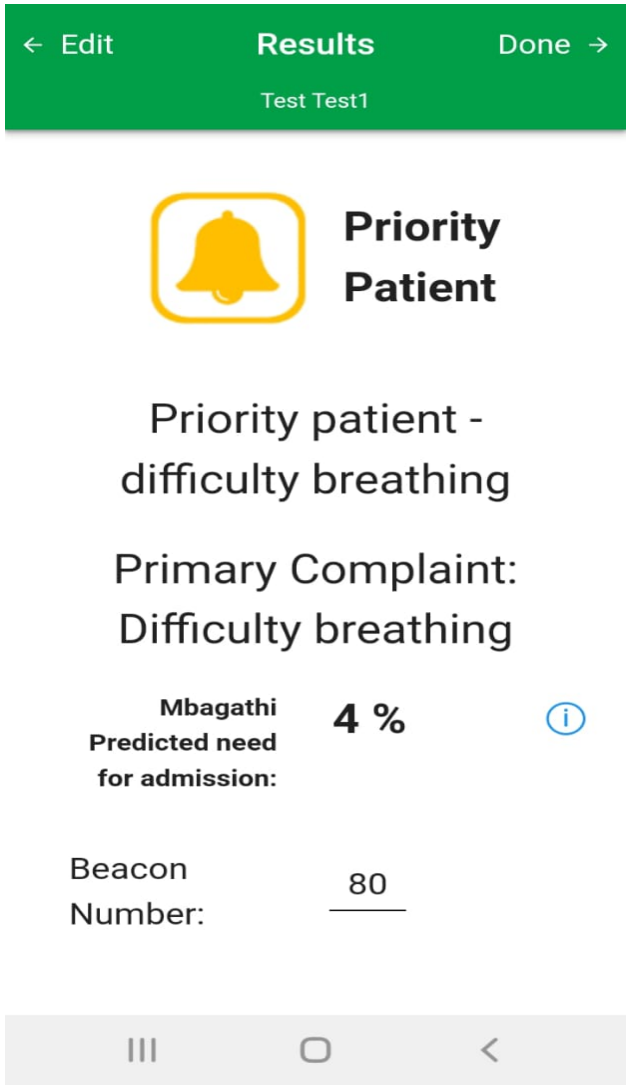
Triage menu



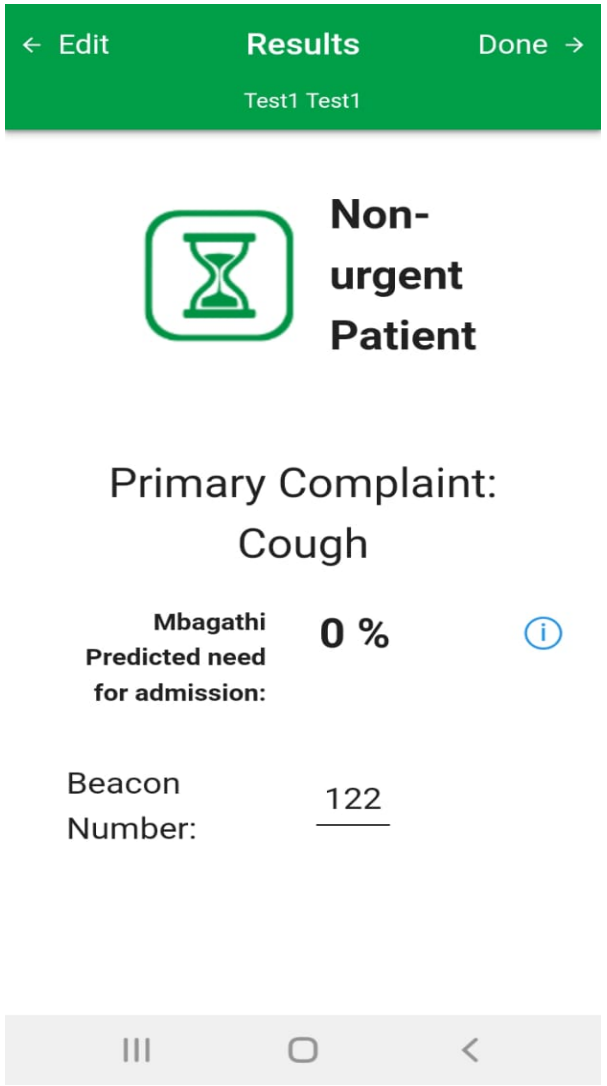
Emergency



Priority



Non-urgent



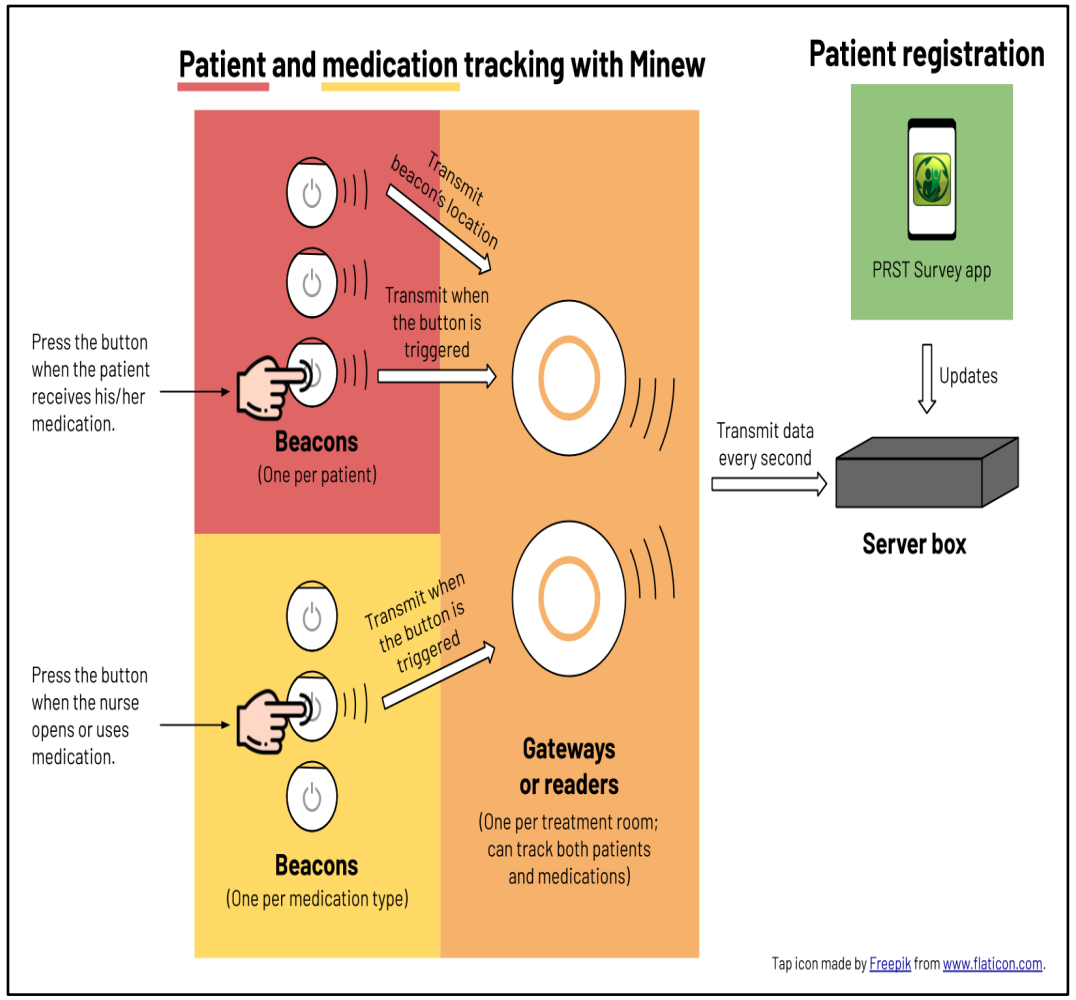
Smart Spot (Tracking system)

(Patient beacons)

(Treatment beacons)

Beacon Reader

Server box



Clinician dashboard

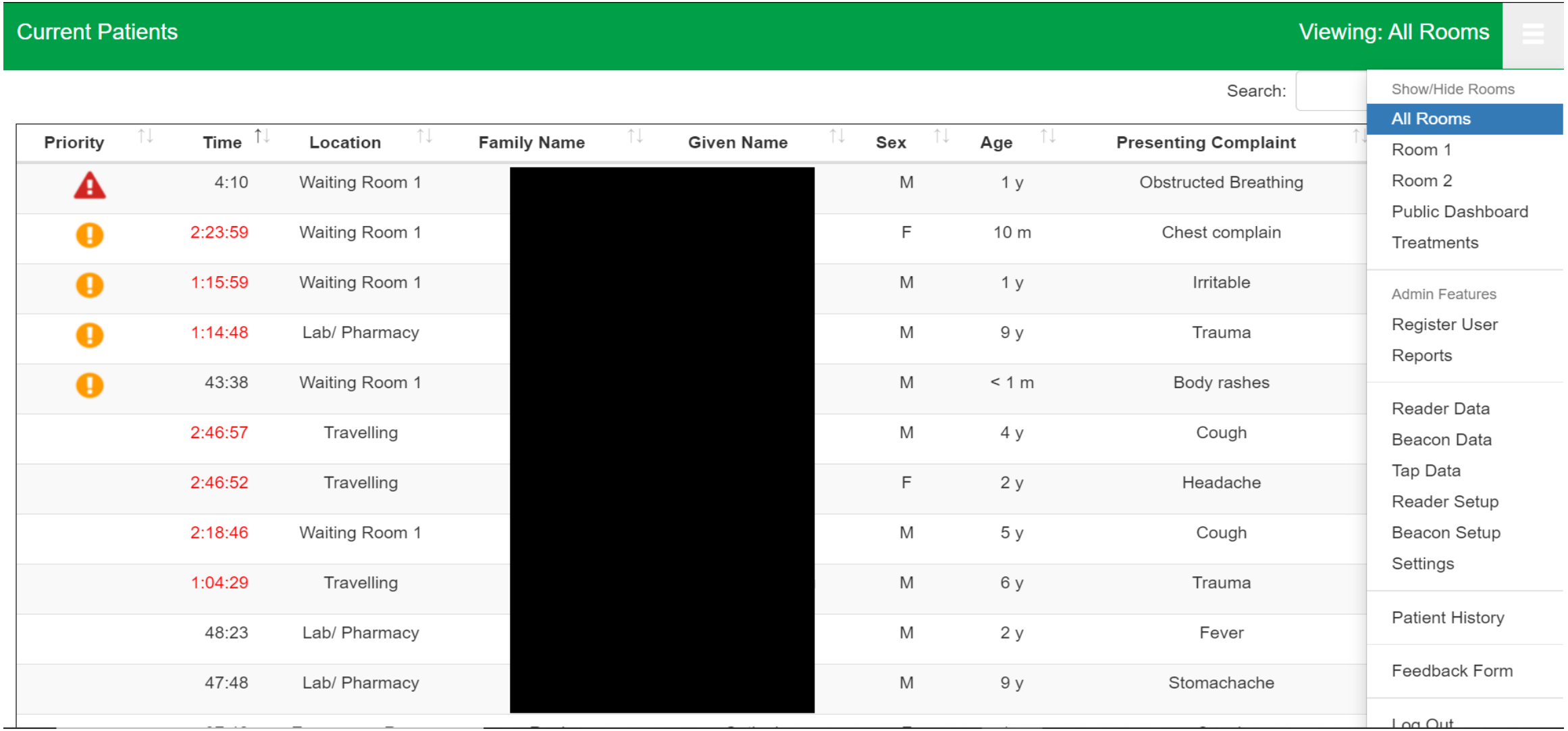
Current patients

Historical patient records

Live treatment data

Reports

Clinician dashboard



Historical patient records

All Patients From Last 24hrs

Search:

Date	Time Closed	Surname	First Name	Sex	Age	Presenting Complaint	Total Time	Final Status
2022-01-03	13:37:47	[redacted]		Female	3 y	Trauma	02:47:48	Discharged
2022-01-03	13:38:24			Male	2 y	Vomiting	02:42:34	Discharged
2022-01-03	13:38:05			Male	1 y	Rickets	02:24:13	Discharged
2022-01-03	13:37:56			Female	6 y	UTI	02:11:18	Discharged
2022-01-03	13:38:32			Male	4 y	Vomiting	02:05:31	Discharged
2022-01-03	13:38:16			Female	8 y	Headache	01:58:36	Discharged
2022-01-03	13:38:58			Female	3 y	Convulsion	01:52:45	Discharged
2022-01-03	13:01:42			Male	2 m	Extra digits	01:05:48	Discharged
2022-01-03	13:39:07			Male	1 y	Road accident	01:34:10	Discharged

Live treatment dashboard

Treatments of Active Patients — **Viewing: All Treatments**

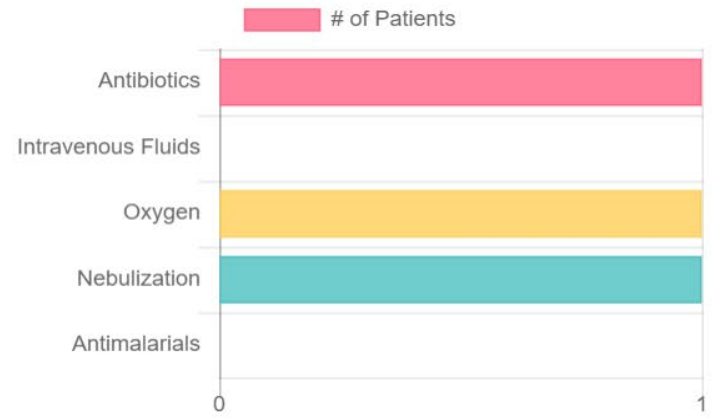
Recently Tapped: Antibiotics - Emergency Room (10:26:03), 12 (10:26:03)

Search:

Triage ID	Family Name	Given Name	Treatment	Time Given
1432	Provia	Sharika	Antibiotics	10:26:03
1404	Namuddu	Dembe	Antimalarials	10:08:57
1373	Mukwaya	Akello	Antimalarials	09:32:39
1329	Apio	Kaikara	Antibiotics	09:00:55
1329	Apio	Kaikara	Oxygen	08:37:14

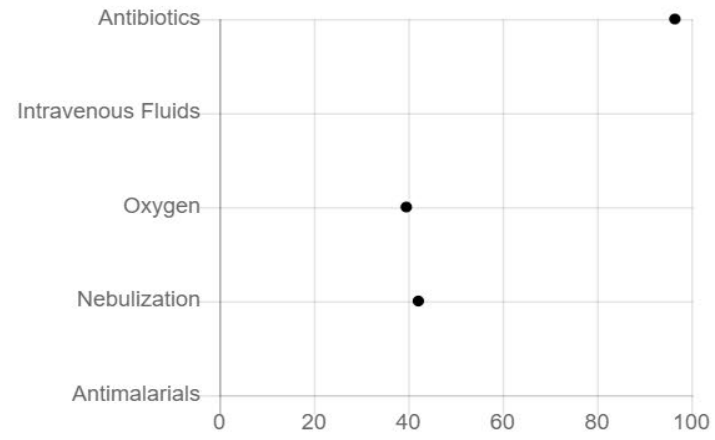
Dashboard reports

TREATMENTS



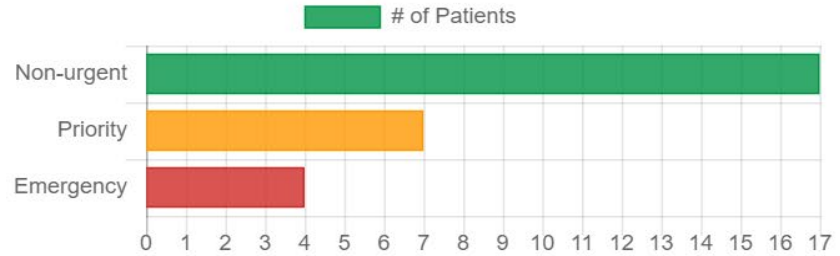
TREATMENT WAITS

Triage start to treatment (mins)

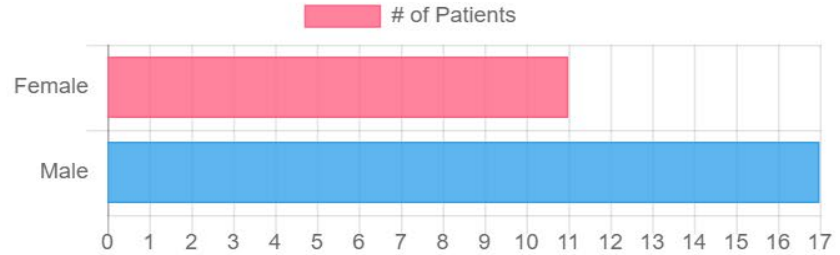


Triages Done: 28

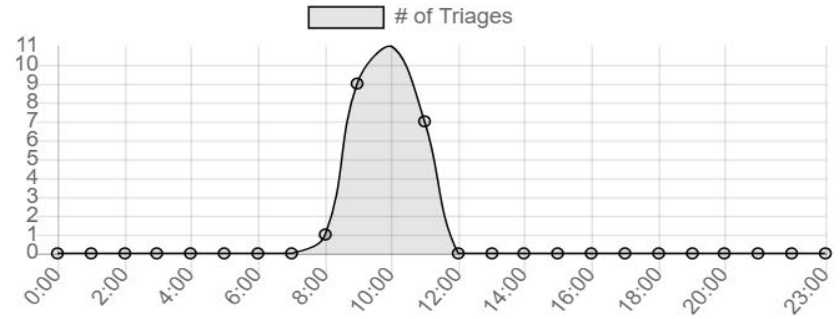
TRIAGE CATEGORY



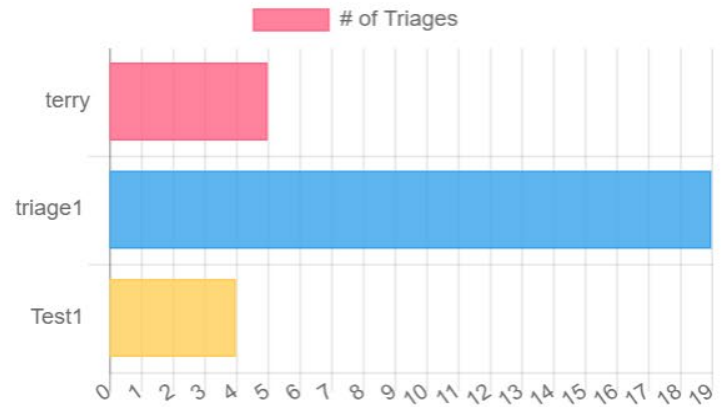
GENDER



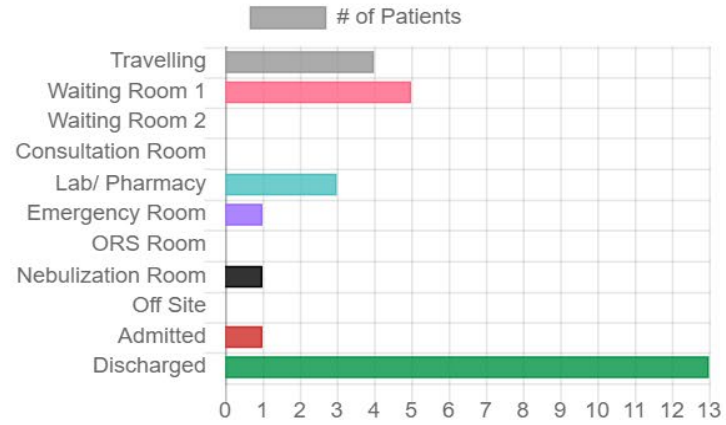
TRIAGES PER HOUR



TRIAGES PER USER



PATIENT LOCATIONS

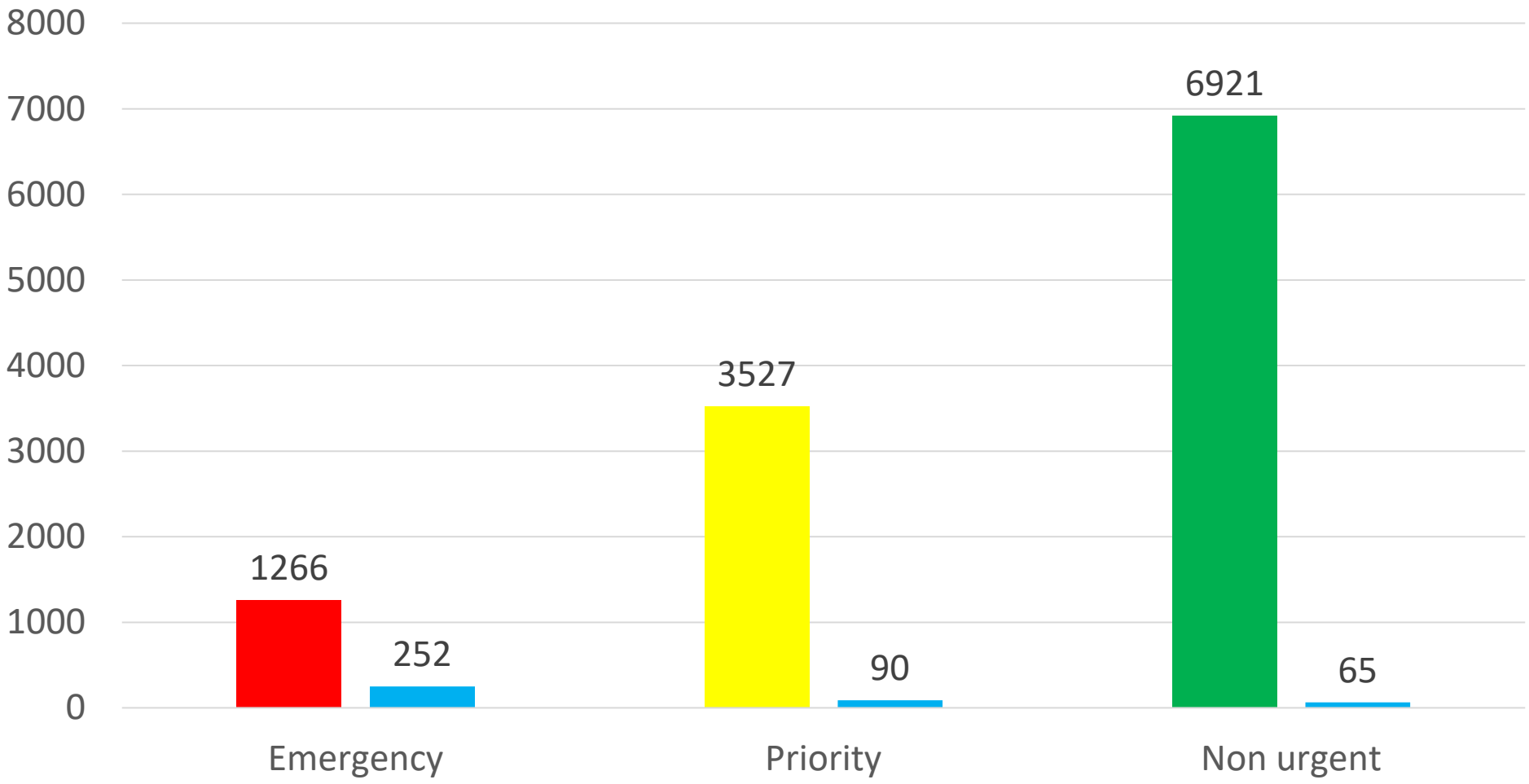


SMART TRIAGE SUMMARY

Month	Triages	Admissions	Anthropometrics	Pulse oximetry
December	680	19 (2.8%)	636 (93.5%)	668 (98.2%)
January	1053	34 (3.2%)	993 (94.3%)	1032 (98.0%)
February	1434	53 (3.7%)	1343 (93.7%)	1399 (97.6%)
March	1713	60 (3.5%)	1590 (92.8%)	1670 (97.5%)
April	1157	47 (4.1%)	1115 (96.4%)	1116 (96.4%)
May	1146	38 (3.3%)	1063 (92.8%)	1110 (96.8%)
June	1431	52 (3.6%)	1356 (94.8%)	1380 (96.4%)
July	1033	40 (3.9%)	913 (88.4%)	1008 (97.5%)
August	831	27 (3.2%)	771 (92.8%)	813 (97.8%)
September	1236	37 (3.0)	1155 (93.4%)	1207 (97.5%)

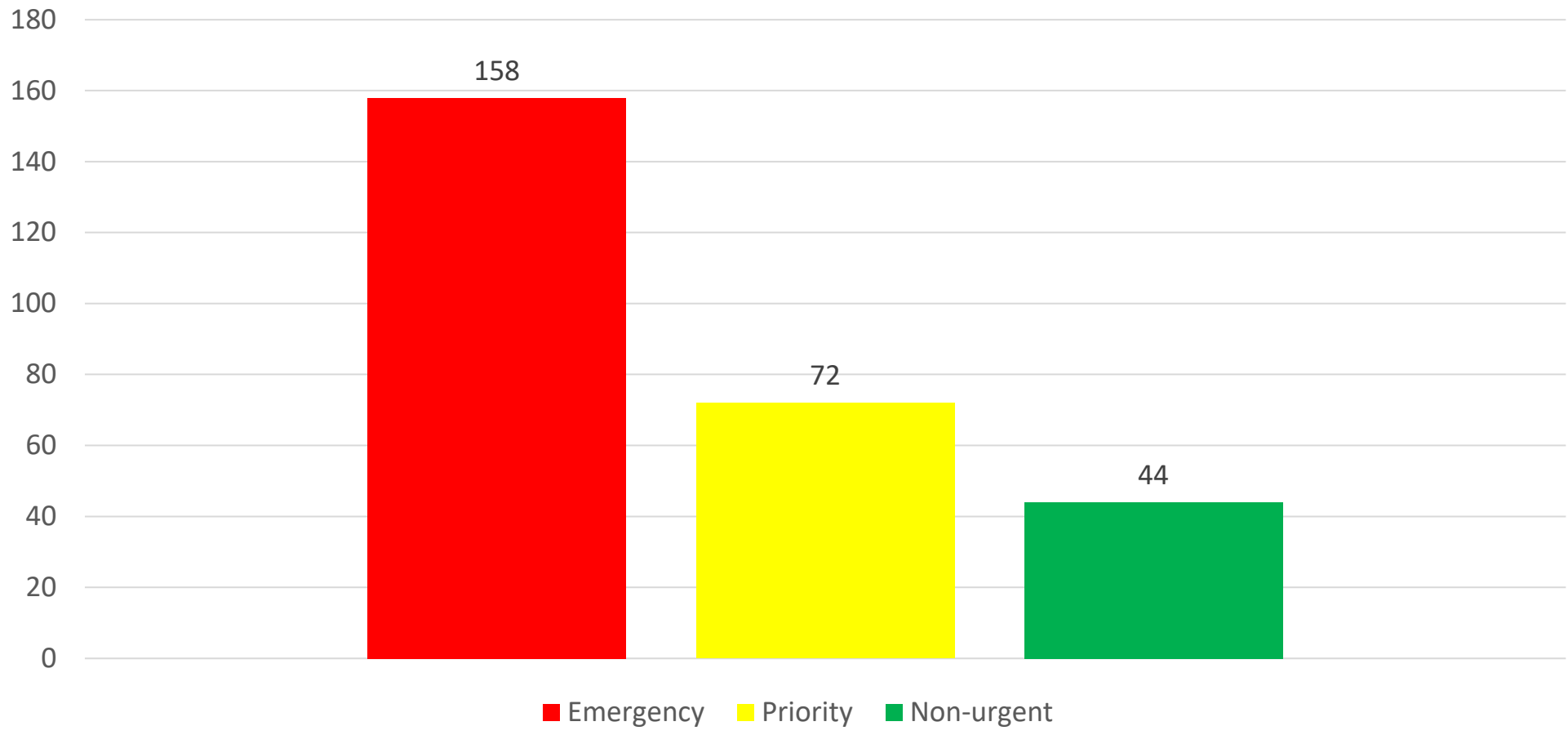
SMART TRIAGE

TRIAGE CATEGORIES

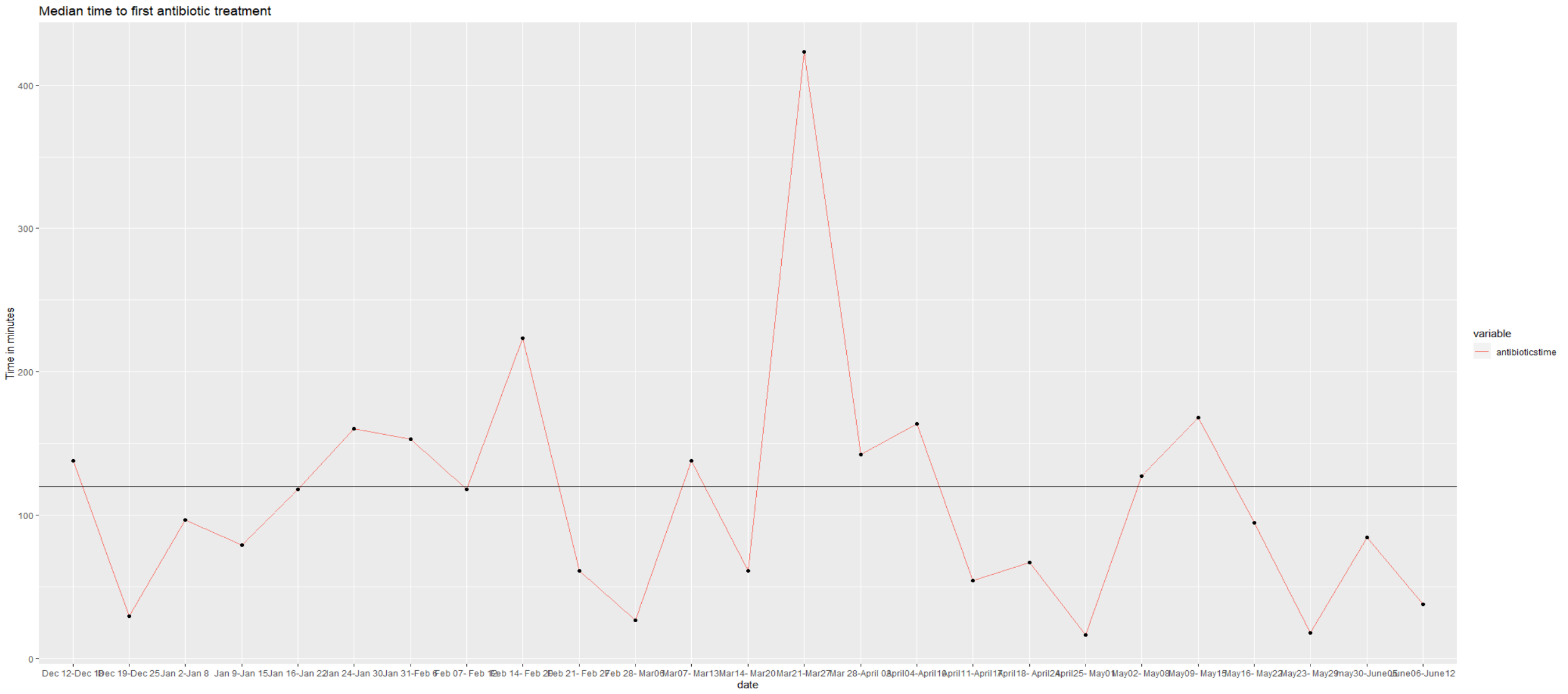


SMART TRIAGE

Admission per triage category



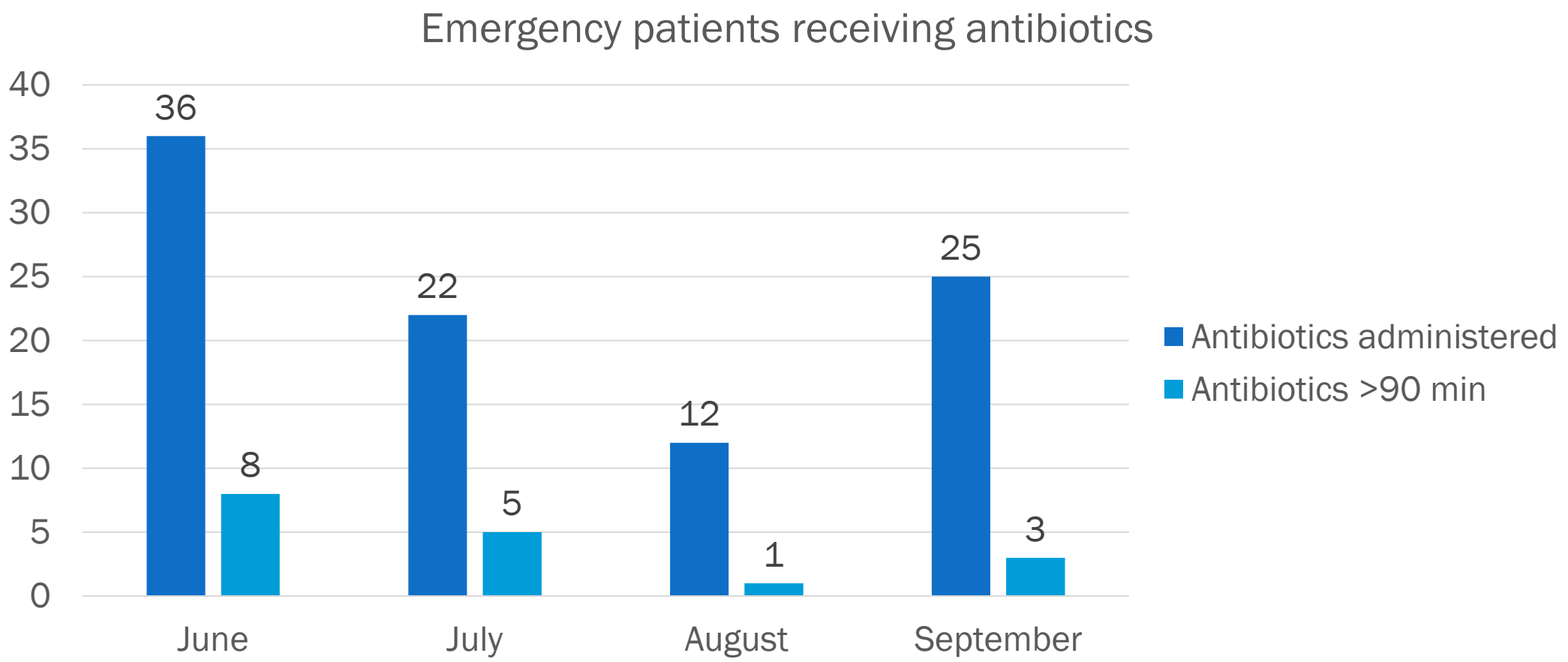
Median time to antibiotics



QI GOALS

All triaged children to receive treatment within 90 minutes from the time of triage.

TIME TO ADMINISTRATION OF ANTIBIOTICS



Success

Adoption of Smart Triage in Mbagathi County Hospital

Improved patient flow at the OPD

Prioritization of critically ill children.

Tracking of treatment administered in the acute room

Beacon loss

Breakdown of pulse oximeters

Triaging on weekends

Smart Triage Potential Applications

Improve risk assessment and prioritization of critically ill children at triage.

Increase the proportion of critically ill children receiving treatment within 1 hour of arrival.

Improve effectiveness and efficiency of patient flow and resource allocation.

**Integration with existing electronic health records (EHRs) in hospitals*

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https://doi.org/10.1186/s12913-020-05344-w

BMC Health Services Research

STUDY PROTOCOL Open Access

Smart triage: triage and management of sepsis in children using the point-of-care Pediatric Rapid Sepsis Trigger (PRST) tool

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PARTICIPANTS AND THEIR FAMILIES

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