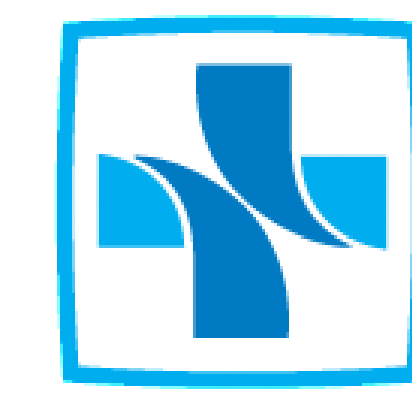


Reducing Outpatient MRI Appointment No-show Rate Through Artificial Intelligence Predictive Analytics



Singapore Healthcare Management 2021

Lisa Tham Mui Hiong, Lee Lee Lian, Foo Seck Guan, Tsai Koh Tzan, Chang Piek Chim, Chong Le Roy



Changi General Hospital SingHealth

Problem Statement / Background:

❑ Problem Identification: Outpatient MRI no-show rates have shown an increasing trend between 2016 to 2018 (Figure 1) leading to issues detailed in Figure 2.

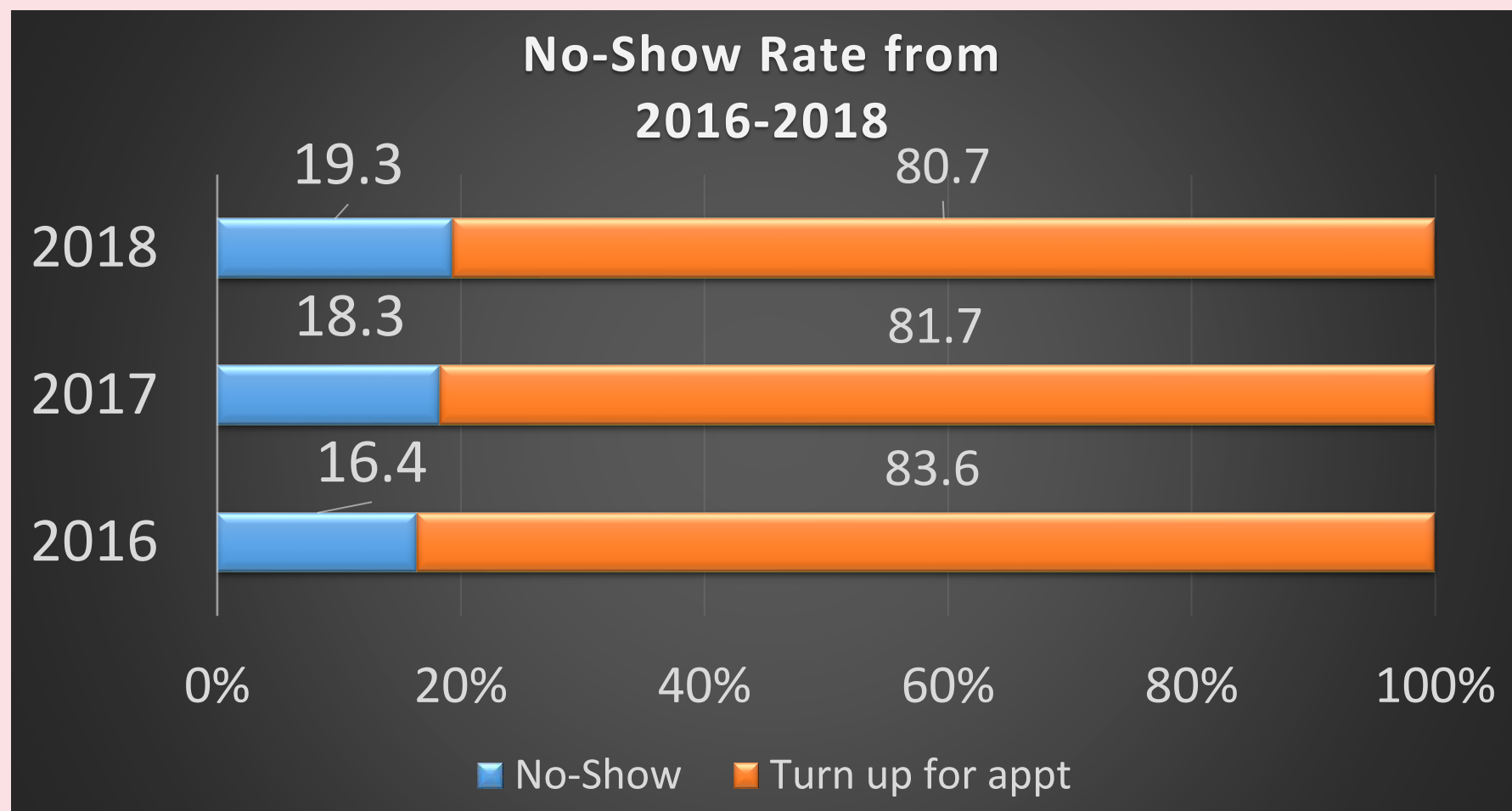
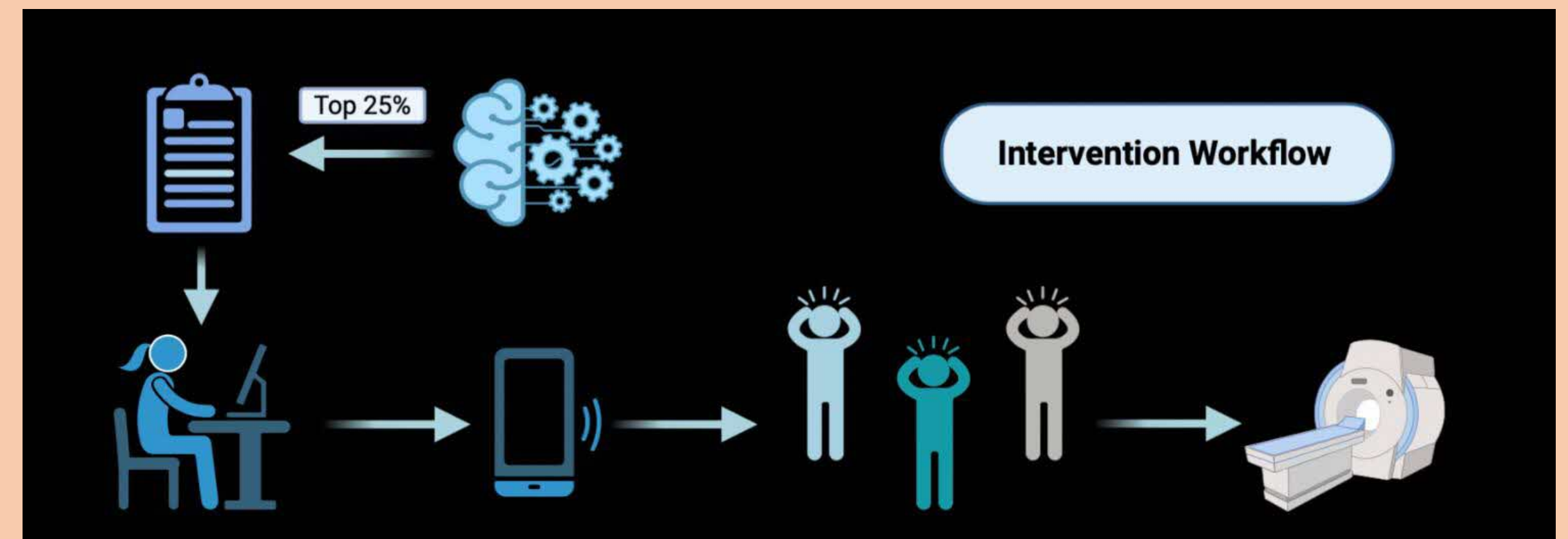


Figure 1. Increasing Trend in No-show Rates

❑ Retrospective data of **32,957** MRI outpatient appointments between 2016-2018 were extracted from RIS and OAS.

❑ Total no-shows of **5734 (17.4%)** with yearly increasing trend as shown in Figure 1.

Methodology & Results:



❖ Machine learning model (XGBoost) developed with features extracted from RIS and OAS from 2016-2018 appointments.

❖ Weekly list of outpatient MRI appointments with highest risks of no-show predicted by model generated.

❖ MRI Radiographers call top 25% of patients at highest risk of no-show one working day before appointments to confirm attendance.

- ❑ There was a significant absolute decrease in no-show rates of 3.4% over 6 months following implementation, with a relative decrease of 17.2% compared to the 12 months pre-intervention baseline no-show rate ($p < 0.0001$, Figure 4).
- ❑ Appointment no-show rates for contactable and non-contactable patients at high-risk of no-shows were 17.5% and 40.3% respectively ($p < 0.0001$).

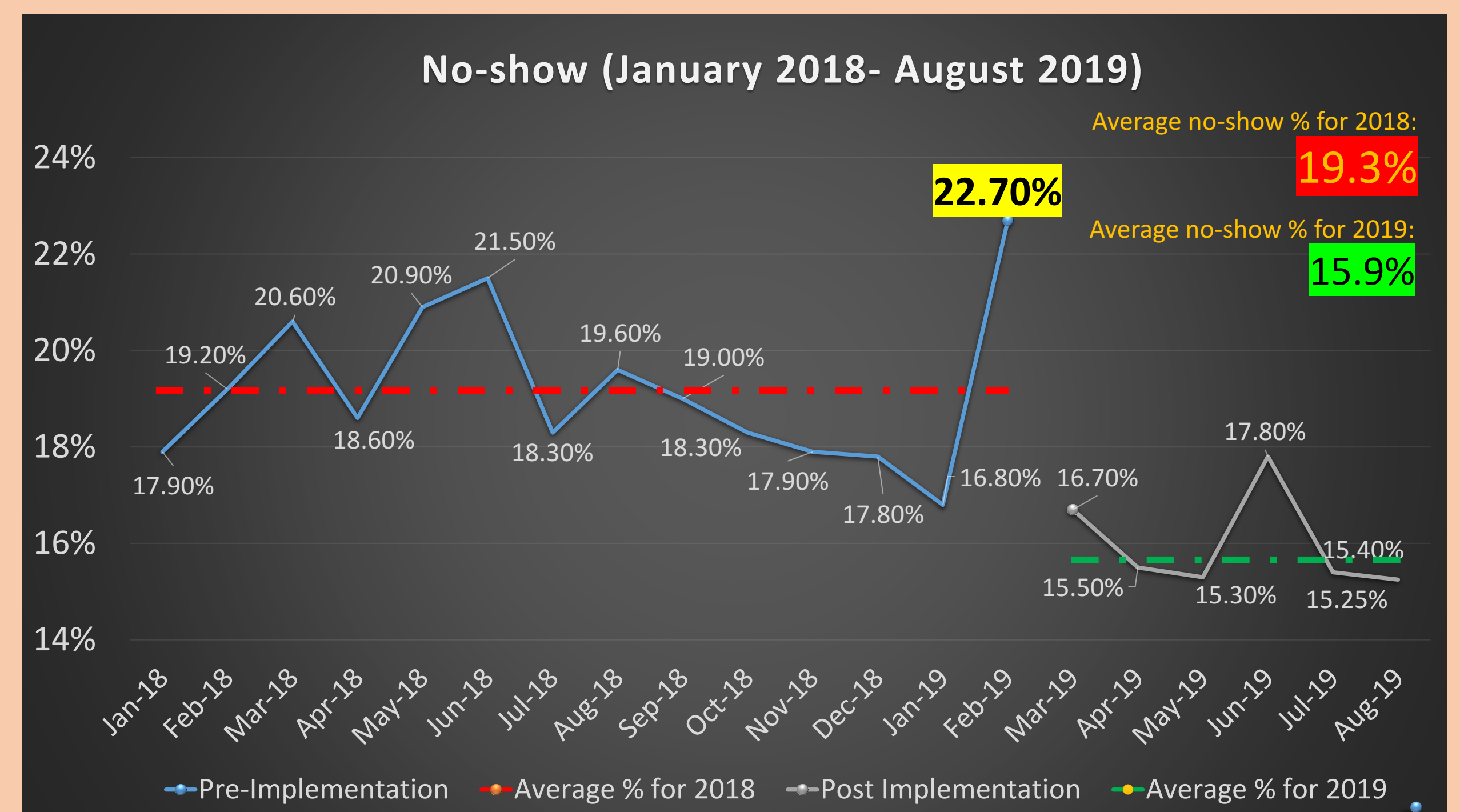


Figure 4. No-show rates 12-months preceding and 6 months after intervention measures.

PROJECT OBJECTIVES:

- ☑ To reduce no-show rate
- ☑ Reduce MRI appointment lead time
- ☑ Improve accessibility of MRI services
- ☑ Improve patient care / pathway

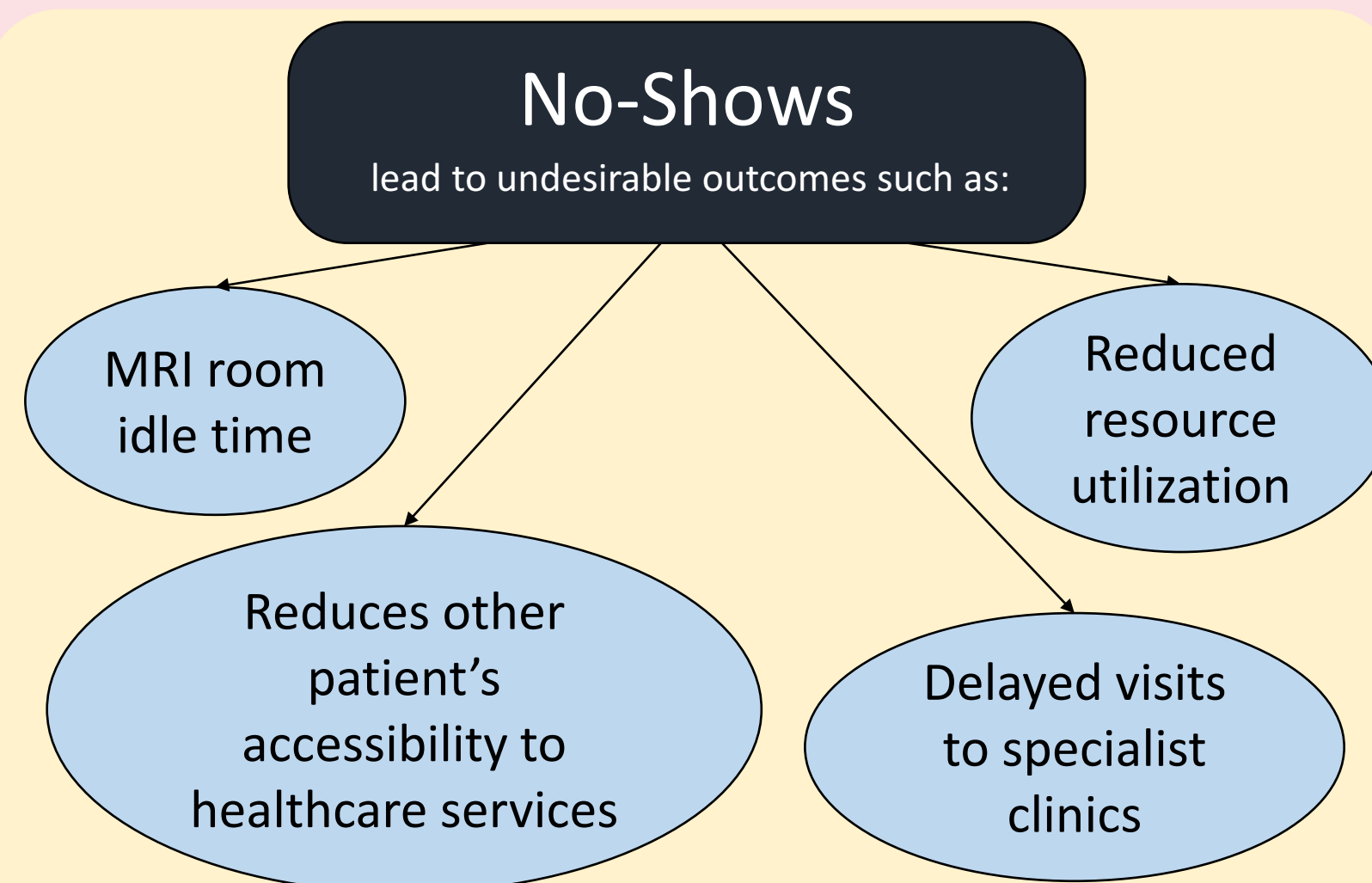


Figure 2. Undesirable Outcomes From Increasing No-show Rates.

Problem Analysis & Evaluation:

❑ Causes of appointment no-shows are complex, with multiple human and non-human factors potentially interacting in complex ways to influence appointment attendance.

Feature	Type	Values
Appointment Status	Categorical, Target	2 (show/no-show)
Age	Numeric	11-101 years
Appointment Duration	Numeric	30-150 minutes
Appointment Wait Days	Numeric	0-721 days
Appointment Reschedules	Numeric	0-5
Appointment Day	Categorical	6
Appointment Hour	Categorical	13
Appointment Location	Categorical	7
Appointment Month	Categorical	12
Appointment Session	Categorical	3
Appointment Timeslot	Categorical	31
Appointment Priority	Categorical	3
Gender	Categorical	2
Language	Categorical	8
Nationality	Categorical	47
Ordering Department	Categorical	45
Payment Class	Categorical	7
Postal District	Categorical	16
Race	Categorical	20
Referral Facility	Categorical	23
Scan Order	Categorical	93
Scan Region	Categorical	13

Table 1. Features extracted from RIS / OAS used for training of the model.

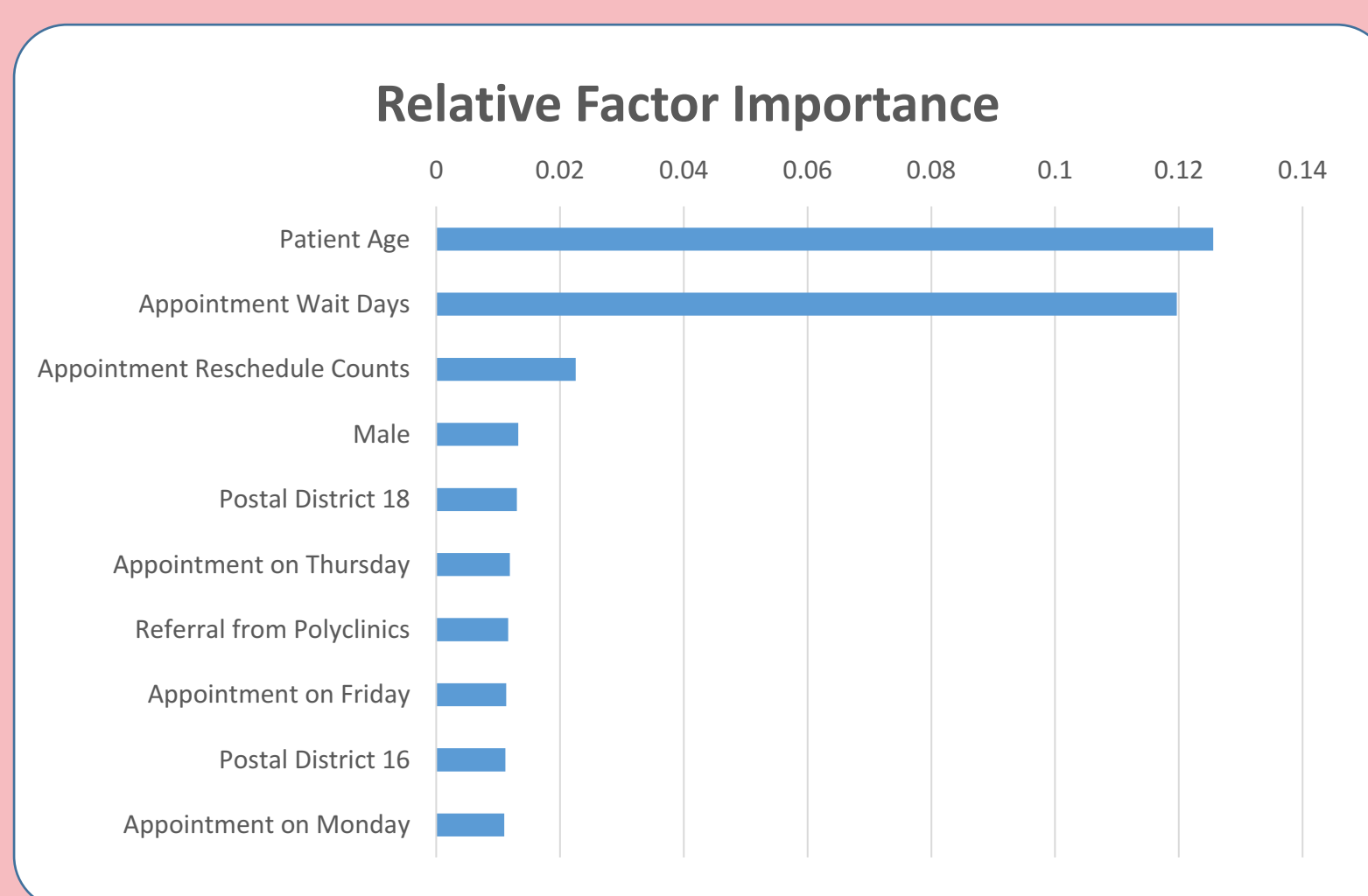


Figure 3. Relative importance of various features in predicting appointment no-show identified by the XGBoost model.

- ❑ A machine learning model trained with an extreme gradient boosting algorithm (XGBoost) was developed to predict outpatient MRI appointment no-shows.
- ❑ Table 1 shows a list of features extracted from RIS and OAS used for model training.
- ❑ Figure 3 shows the relative importance of these features as identified by the XGBoost machine learning model in predicting no-shows.
- ❑ The ROC-AUC of the model was 0.746, sensitivity of 85.2%, positive predictive value of 60.6% and overall accuracy of 65.4%.

Evaluation of solutioning involves consideration on the following aspects:

Sustainability **Manpower** **Cost Effective** **Time Effective**

Main advantage of using AI predictive model → Computer generated list of patients with high probability of no-shows (Data supported selection)

Positive Outcomes & Conclusion:

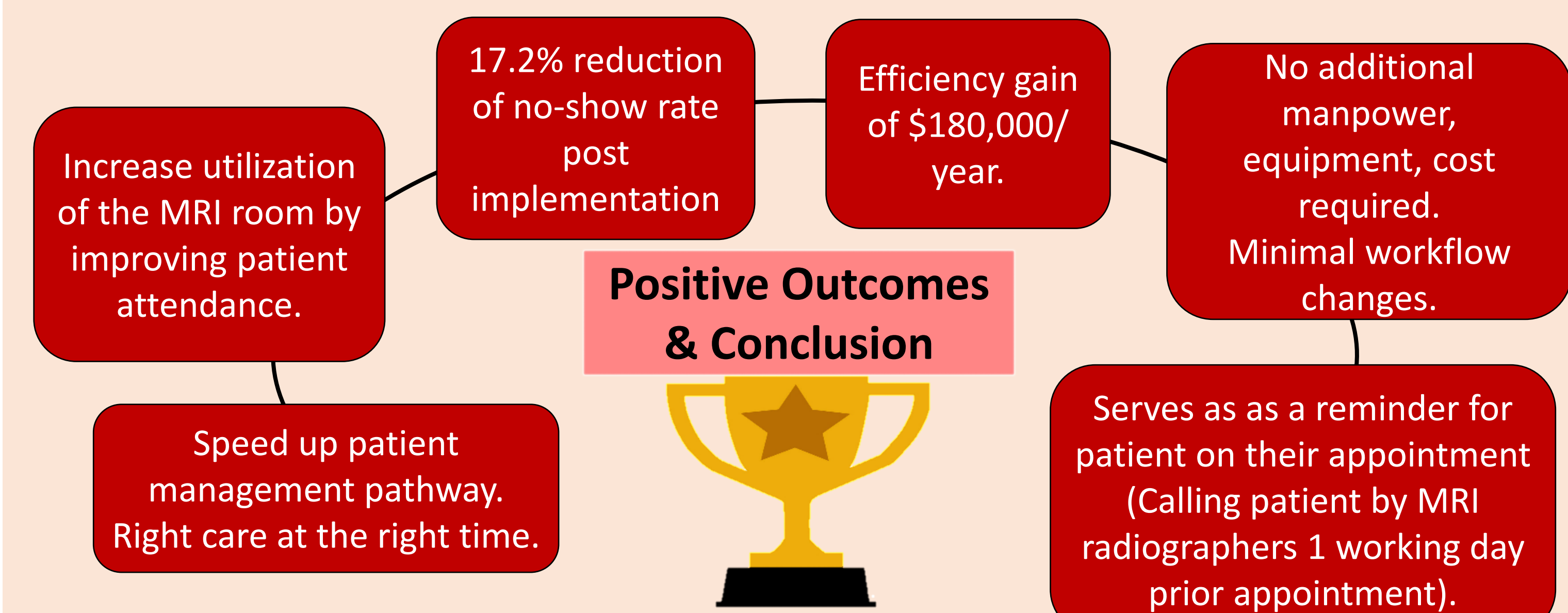


Diagram 3. Post-implementation positive outcomes & conclusion.

Subsequent Implementation & Improvement:

- The project objectives are met and post-intervention measures producing promising results. The department has since the onset of the COVID-19 pandemic adopted to call **all MRI outpatients** instead of the top 25% of patients generated from the predictive model.
- By calling all MRI outpatients, the monthly tabulated data (2020-early 2021) showed **further decreased no-show rates ranging between 8%-13%**. Nevertheless, the data may be affected by COVID-19 surge and measures.
- In the future, this predictive model can be readily adaptable to other diagnostic imaging modalities such as CT or US to manage patient scan appointment attendance.