CMS Star Rating and Provider Analysis

Background – CMS Star Rating Methodology and Provider Analysis

CMS rates providers on a scale of 1 to 5. The objectives of the analysis are to:

- Understand the star rating methodology and identify the important variables affecting star ratings
- Recommend ways for Evanston Hospital to improve their current star rating of 3/5*

The analysis is divided into four parts:

- Data Understanding – Groups and Measures
- Identifying important measures affecting star ratings
- Predictive modelling of star ratings
- Provider analysis: Recommending ways for Evanston Hospital to improve their rating

* As of the July 2016 report published by CMS

- **Data Understanding – Groups and Measures**
- Identifying important measures affecting star ratings
- Predictive modelling of star ratings
- Provider analysis

Data Understanding – 7 Groups, 64 Measures

CMS included 64 measures (or variables) classified under 7 groups having a certain weightage as follows:

Groups

- Mortality, Readmission, Safety of Care, Patient Experience (22% weightage groups)
- Timeliness of care, Effectiveness of care, Medical Imaging Efficiency (4% weightage groups)

Measures (some examples)

- Positive measures: Patients given appropriate vaccines, Patients given timely treatment etc.
- Negative measures: All mortality measures, readmission measures, timeliness measures (avg. time taken to provide emergency care etc.)

Data Understanding – Quality Issues: Format, Standardisation and Missing Values

The three main data quality issues in the raw data provided by hospital compare are:

Data format

- The original data is in 'wide-format' in approx. 55 files which was converted into one 'long' master file such that each row represents a provider and each column a measure
- Each cell is a numeric score of a measure

Standardisation of Measures

- Measures need to be standardised such that 'higher value indicates better performance'

Missing values

- About 50% measures have a large number of missing values – they have been imputed as per the guidelines provided by CMS
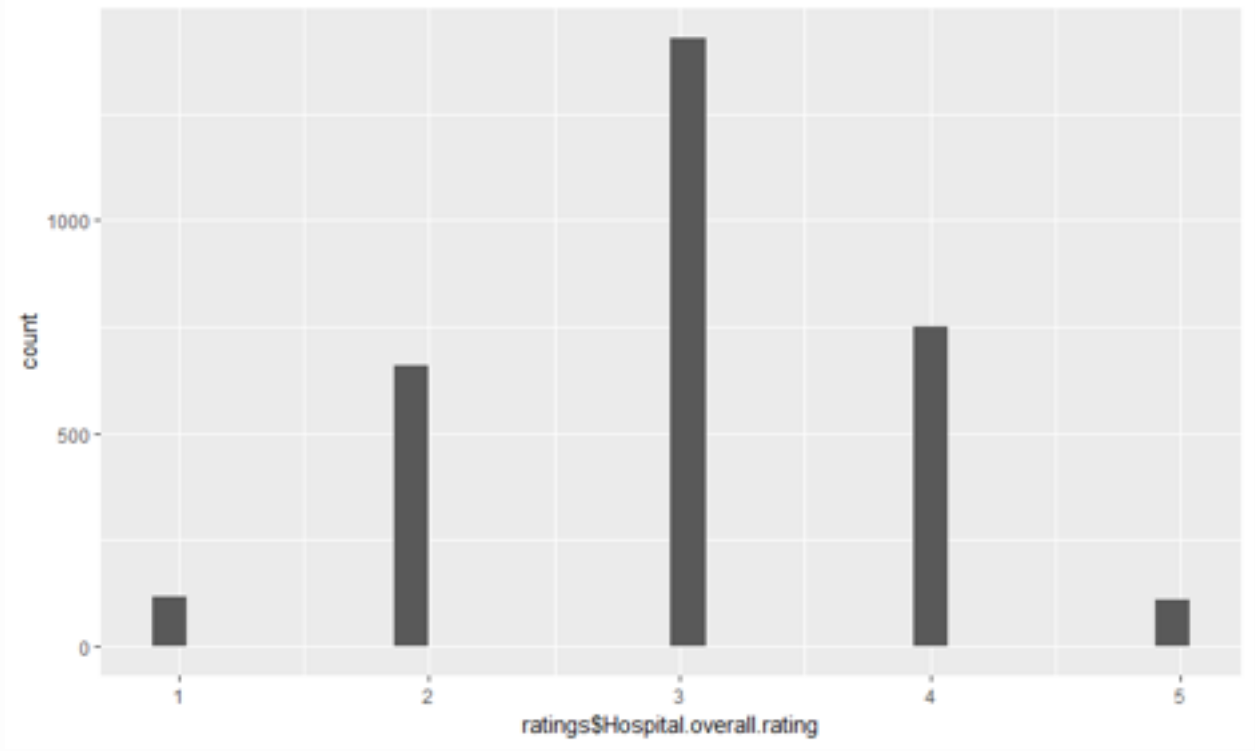
Data Understanding – Distribution of Star Ratings

- Approx. 42% providers have 3 star rating
- Approx. 20% have 2 and 4 each; 3.5% have 1 and 5 each

Table - Provider Rating Distribution

| Rating	Number of providers
1	117 (3.4%)
2	659 (19.5%)
3	1426 (42.2%)
4	749 (22.1%)
5	110 (3.3%)
NA	321 (9.5%)

Plot - Provider Rating Distribution

- Data Understanding – Groups and Measures
- **Identifying important measures affecting star ratings**
- Predictive modelling of star ratings
- Provider analysis

Measure Importance – Correlated measures carry higher weightage

Within each group, measure **weights are proportional to the correlation** of the measure within the group.
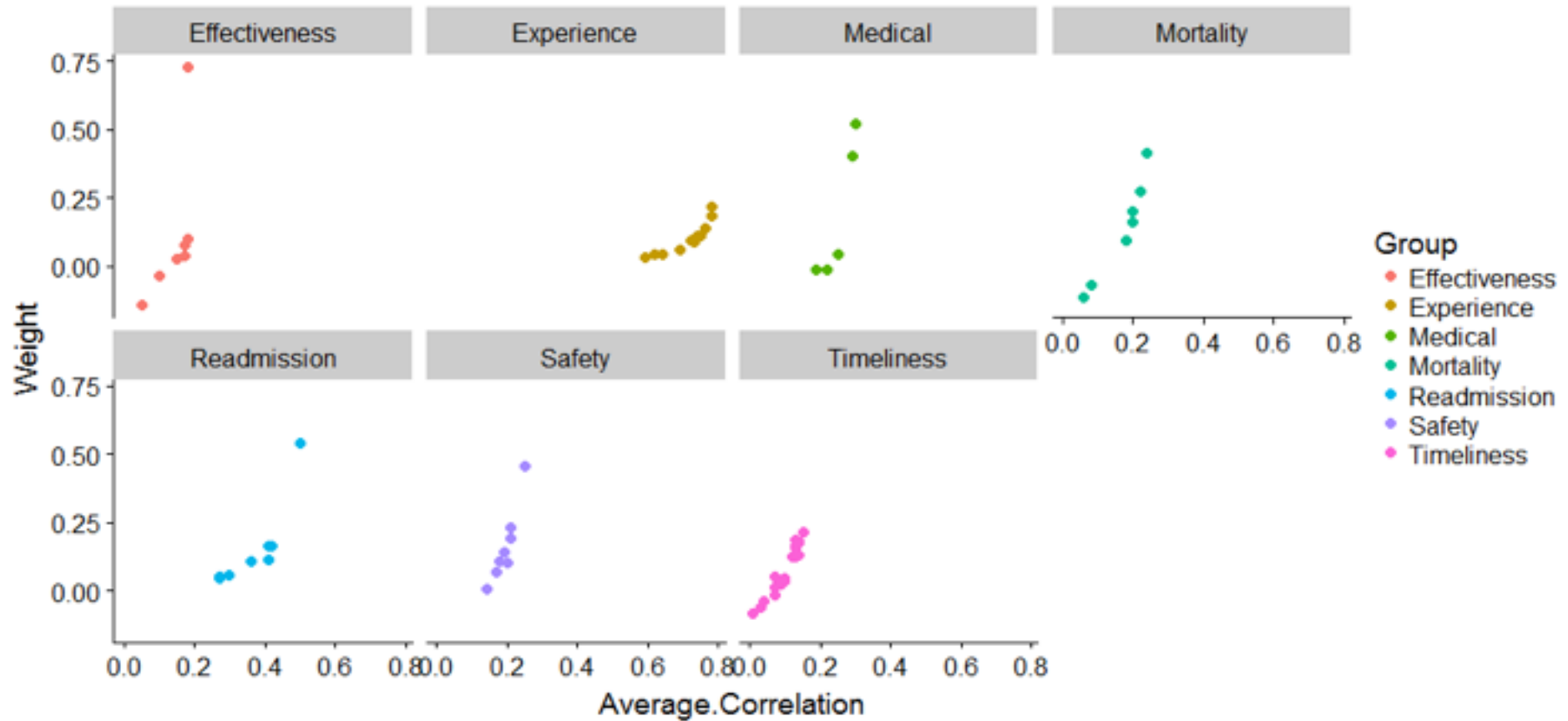
Measure Importance – Top 20 measures carry approx. 80% weight, Top 30 carry approx. 97%
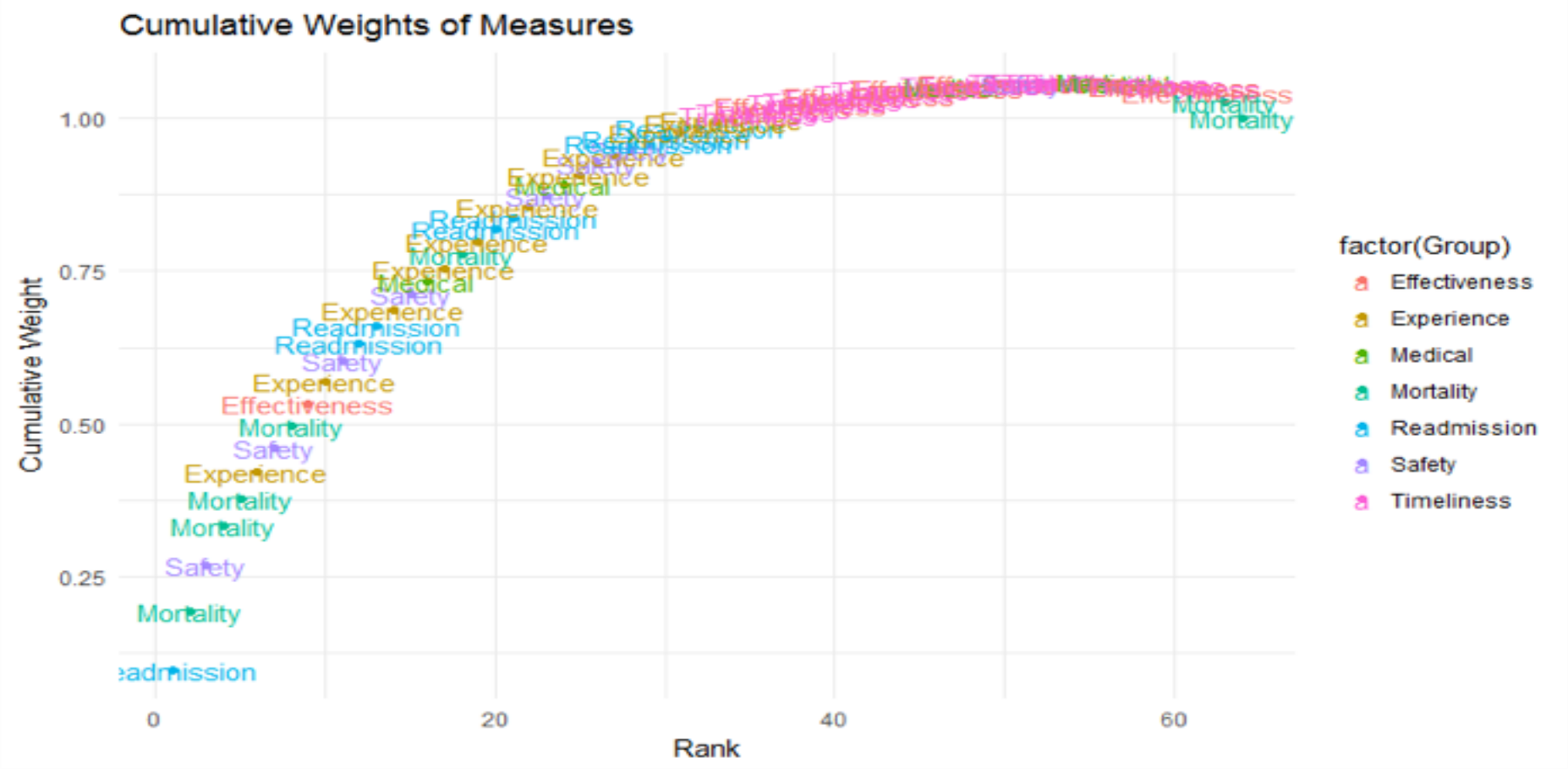
Top 20 Measures Weightage - Mortality (26%), Readmission and Safety (17% each), Experience(15%), Effectiveness (4%), Medical (2%)

Table: Top 20 measures

| Measure	Group	Cumulative Weight (%)
READM_30_HOSP_WIDE_score	Readmission	9.7
MORT_30_AMI_score	Mortality	19.2
HAI_2_SIR	Safety	26.9
MORT_30_PN_score	Mortality	33.2
MORT_30_CABG_score	Mortality	37.8
H_COMP_1_LINEAR_SCORE_mean	Experience	42.1
HAI_1_SIR	Safety	45.9
MORT_30_STK_score	Mortality	49.7
ED_1b_Score	Effectiveness	53.4
H_HSP_RATING_LINEAR_SCORE_mean	Experience	57.0
HAI_3_SIR	Safety	60.2
READM_30_HF_score	Readmission	63.1
READM_30_PN_score	Readmission	66.0
H_COMP_7_LINEAR_SCORE_mean	Experience	68.7
HAI_4_SIR	Safety	71.1
OP_10	Medical	73.4
H_COMP_3_LINEAR_SCORE_mean	Experience	75.5
PSI_4_SURG_COMP_Score	Mortality	77.7
H_COMP_4_LINEAR_SCORE_mean	Experience	79.9
READM_30_AMI_score	Readmission	81.8

Table: Weights distribution of top 20 measures

Group	Number of Measures	Total Weight
Mortality	5	0.26
Readmission	4	0.17
Safety	4	0.17
Experience	5	0.15
Effectiveness	1	0.04
Medical	1	0.02
Total	**20**	**0.82**

- Data Understanding – Groups and Measures
- Identifying important measures affecting star ratings
- **Predictive modelling of star ratings**
- Provider analysis

Predicting Star Ratings – Overall Accuracy of approx. 80% with Random Forest

Random Forest predicts star ratings with an overall accuracy of approx. 80%*:

- Accuracy is between 80-90% for classes 2, 3 and 4

- Accuracy is approx. 70% for ratings 1 and 5

- All provider ratings are predicted **within an error of +1 and -1 stars**

Random Forest Prediction Accuracy (Test Data - 1095 Providers)
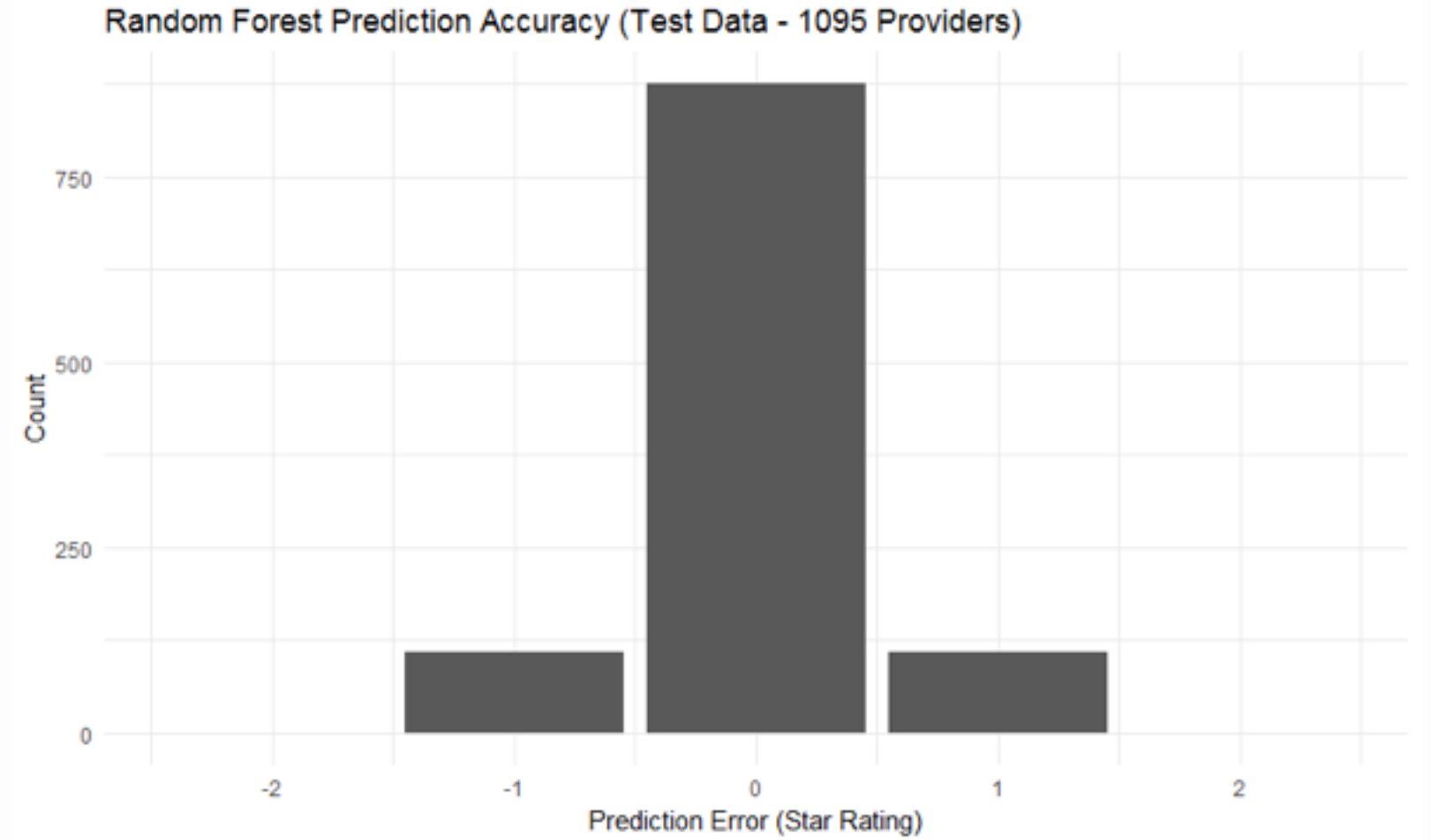
*Assuming CMS rating methodology, the list of measures and weights of groups stays the same

Predicting Star Ratings – Overall Accuracy of 57% using Factor Analysis and Clustering Model

Process

- Using the measure weights calculated using factor analysis, each group's score is calculated
- The group scores are multiplied by the weight of group (22% or 4%) to calculate the final score
- Based on the final score, 5 clusters are created

Results

Clustering model using factor analysis is able to predict star ratings with an overall accuracy of about 57%*:

- Class-wise accuracies are approx. 66%, 77%, 68%, 73%, 85% for ratings 1, 2, 3, 4, 5 respectively

*Assuming CMS methodology, the list of measures and weights of groups stays the same; results of clustering vary with software used

- Data Understanding – Groups and Measures
- Identifying important measures affecting star ratings
- Predictive modelling of star ratings
- **Provider analysis**

Provider Analysis – Final (Predicted) Provider Score is comparable to 4/5 rated hospitals
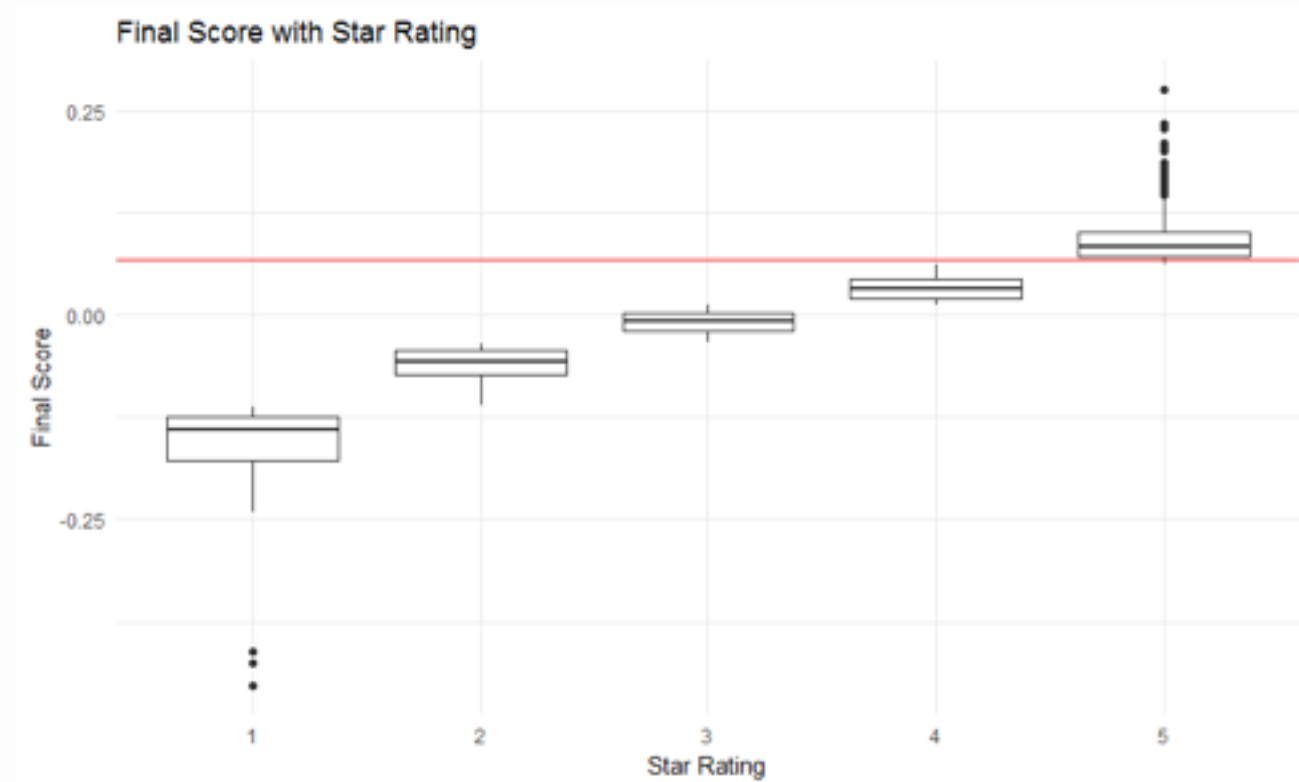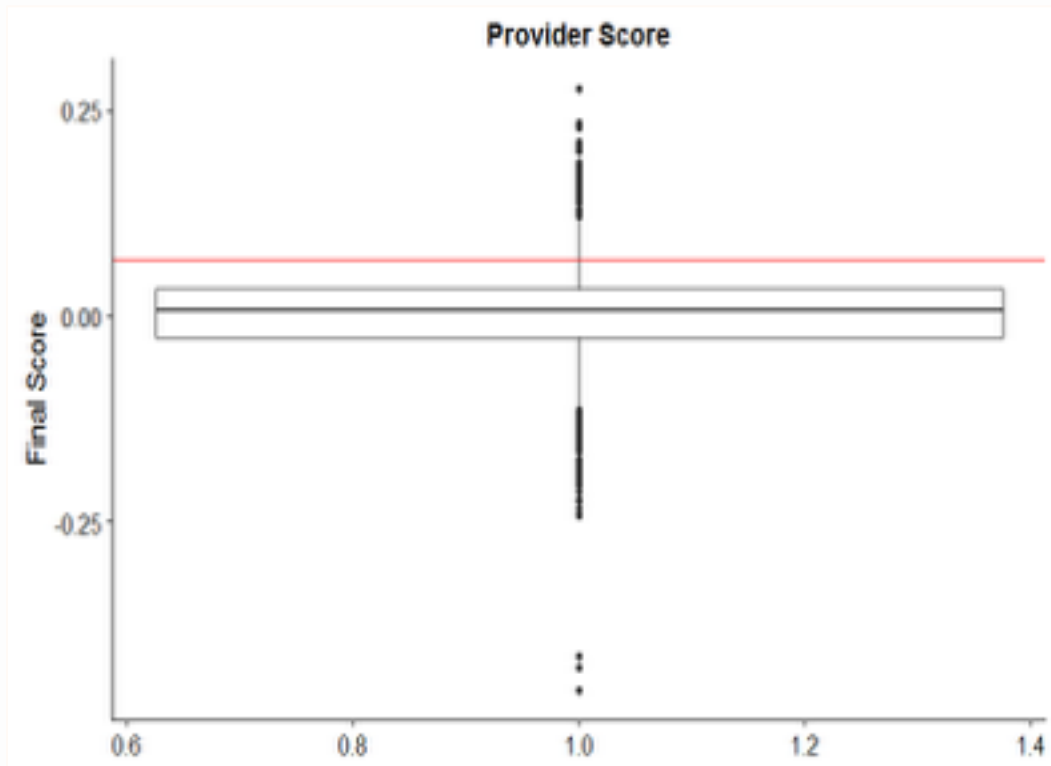
Provider Analysis – Safety and Patient Experience scores are lower than national average

Group	Score Compared to National Average
Mortality (22%)	Above
Safety (22%)	Below
Readmission (22%)	Above
Experience (22%)	Below
Effectiveness (4%)	Above
Timeliness (4%)	Same
Medical (4%)	Above
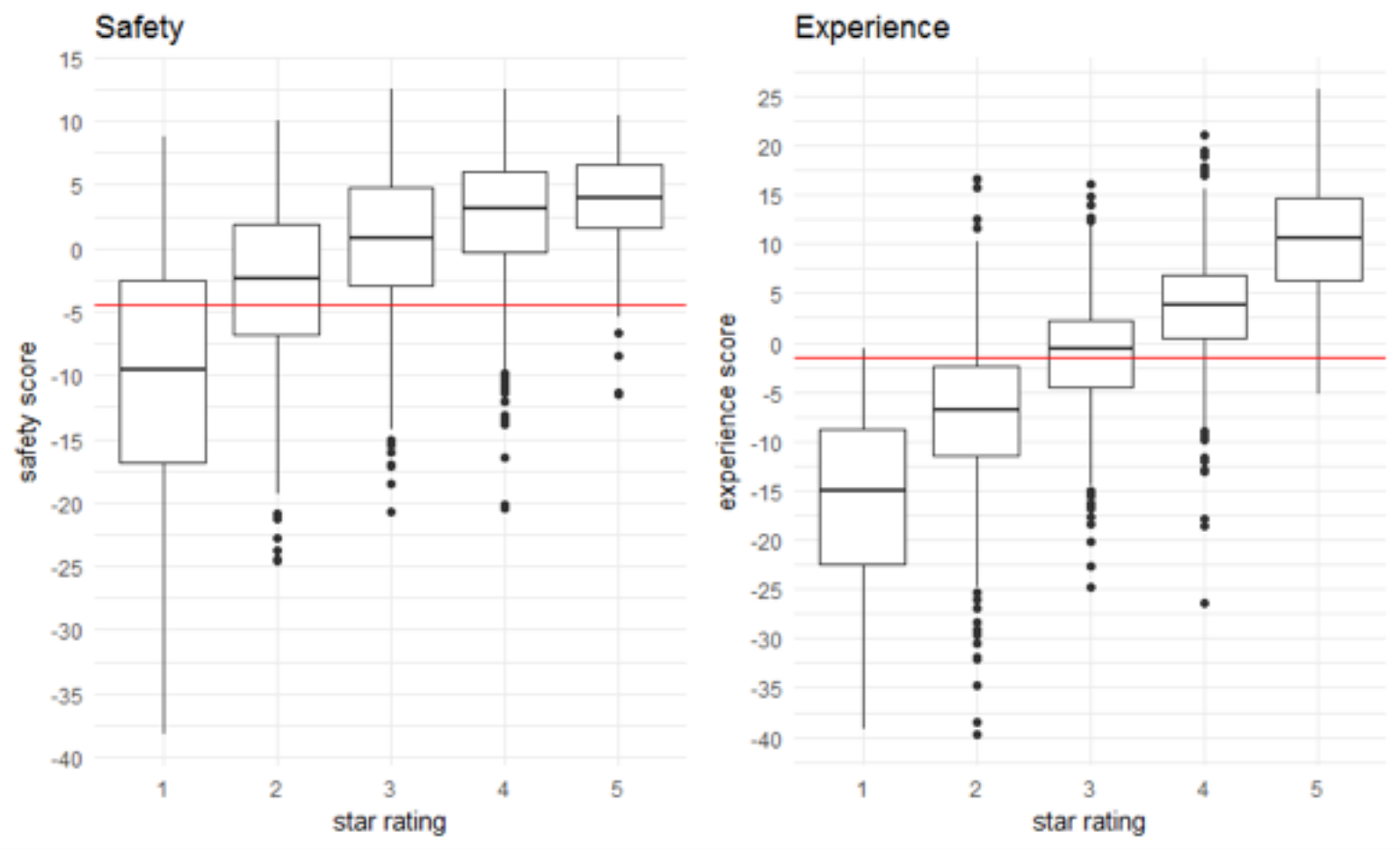
Provider Analysis – Surgical Site and MRSA Infections and Overall Patient Experience are key areas of improvement in Safety and Experience

**In Safety, HAI_4 and HAI_5 scores are lower than average:**

- HAI_4: Surgical Site Infection from abdominal hysterectomy (SSI: Hysterectomy)
- HAI_5: Methicillin-resistant Staphylococcus Aureus (MRSA) Blood Laboratory-identified Events (Bloodstream infections)

In Experience, and H_HSP_RATING_LINEAR_SCORE, H_RECMND_LINEAR_SCORE and H_CLEAN_LINEAR_SCORE are lower than average:

- H_HSP_RATING_LINEAR_SCORE: Patients who gave their hospital a rating of 9 or 10
- H_RECMND_LINEAR_SCORE: Patients who reported they would recommend the hospital
- H_CLEAN_LINEAR_SCORE: Patients who reported that their room and bathroom were "Always" clean

Provider Analysis – Reducing Readmission rates is also a key improvement area

- **Readmission** scores are comparable to the national average, but the group carries **extremely high weight**

- **Mortality** rates are already much better than the average

- The other three groups carry only 4% weightage each, thus can be deprioritised
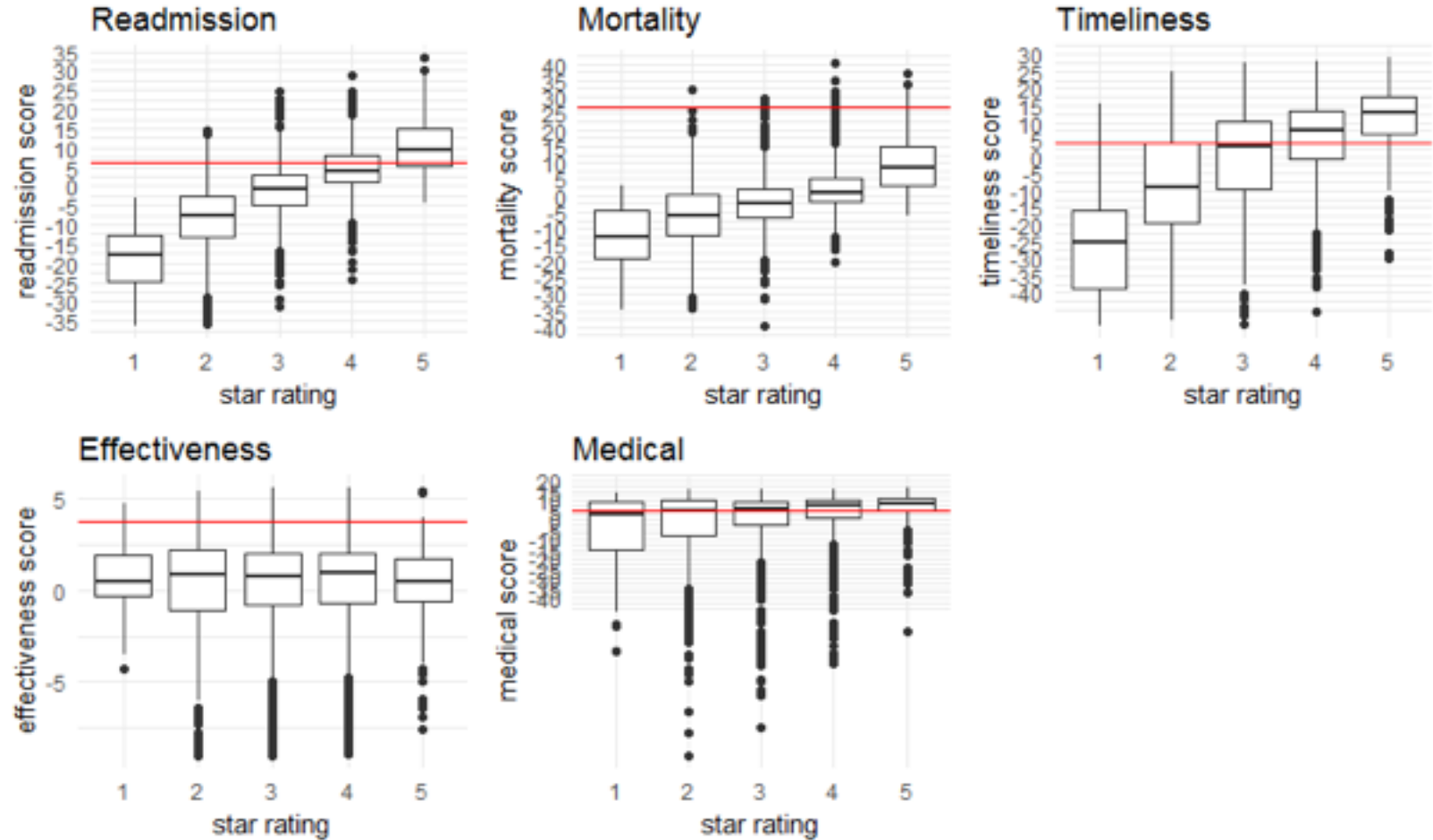
Provider Analysis – 11 low scoring measures in 3 groups carry approx. 30% weight

Low scoring measures:

- Readmission measures comprise about 20% weight

- Experience measures comprise about 6% weight

- Safety measures comprise about 4% weight

Table: Low score measures in Readmission, Safety and Experience groups

Measure Name	Group	Effective Measure Weight
READM_30_HOSP_WIDE_score	Readmission	0.097
H_HSP_RATING_LINEAR_SCORE_mean	Experience	0.036
READM_30_HF_score	Readmission	0.029
READM_30_PN_score	Readmission	0.029
HAI_4_SIR	Safety	0.024
READM_30_AMI_score	Readmission	0.020
READM_30_COPD_score	Readmission	0.019
H_RECMND_LINEAR_SCORE_mean	Experience	0.018
HAI_5_SIR	Safety	0.018
READM_30_HIP_KNEE_score	Readmission	0.009
H_CLEAN_LINEAR_SCORE_mean	Experience	0.009
Total		**0.307**

Recommendations

The key measures of improvement are:

- **Readmission (~20%):** Hospital-wide readmissions, readmission due to heart failure, pneumonia, heart attack, COPD, and hip-knee surgery

- **Patient Experience (~6%):** Hospitality (recommendations, patient-friendliness) and cleanliness

- **Safety (~4%) :** SSI and MRSA