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**MD Anderson**  
**Cancer Center**  
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# **Predictive Modeling for Future CT Imaging Procedure Volume - Recovering from Harvey**

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## **Purpose:**

The prediction of imaging procedure volume is an important process to establish adequate technical and professional resources to ensure proper imaging and interpretation capacity. We describe an automated procedure prediction processes, based upon statistical analysis, which have enabled successful prediction of procedure volume beginning 90 days prior to date of service. Following Harvey, these processes were also valuable in assisting resource allocation as patients rescheduled from canceled appointments.

## **Materials/Methods Used:**

Beginning 100 days prior to a given date of service, future procedures schedules are retrieved from EMR (Epic, Verona, WI) and then stored in a SQL database schedule repository. Daily updated schedule tallies provide administrators insight into relative intensity of future days of service. Linear regression analysis based processes, informed by recent scheduling intensity patterns.

Schedules for weekday imaging for eight consecutive weeks beginning 10/9/2017 (excluding Thanksgiving week) were analyzed for the ability to predict heavily booked weeks defined as >725 out-patient CT procedures Mon-Wed, >560 on Thursday and >300 on Friday. Scheduling predictions for the month of September were excluded due to after effects of Harvey.

## **Results:**

During the study period, 11 days of heavy defined procedure volume occurred. Prediction accuracy: 90 Days – 87.5%; 60D – 100%; 30D – 97.5%; 15D – 97.5%

While September weeks were excluded from the analysis, the prediction system was heavily relied upon to determine recovery patterns. In real-time the prediction models observed focal increased intensity of schedule during the weeks of September following Harvey as patient rescheduled appointments. While 90 and 60 day predictions were disrupted, nonetheless the models accuracy detected rescheduling events.

## **Conclusions:**

Observation and analysis of imaging procedure volumes for future dates of service enables accurate predictive models beginning 90 days prior to date of service. During three years' experience, reproducible scheduling patterns have been identified which assist imaging resource scheduling and are likely to be reproducible in majority of imaging practices.

## **Disclosures:**

Kevin W. McEnery, MD, Philips Healthcare, Trusted Advisor  
Habib Tannir, MS, None

# Future Schedule Volume Prediction

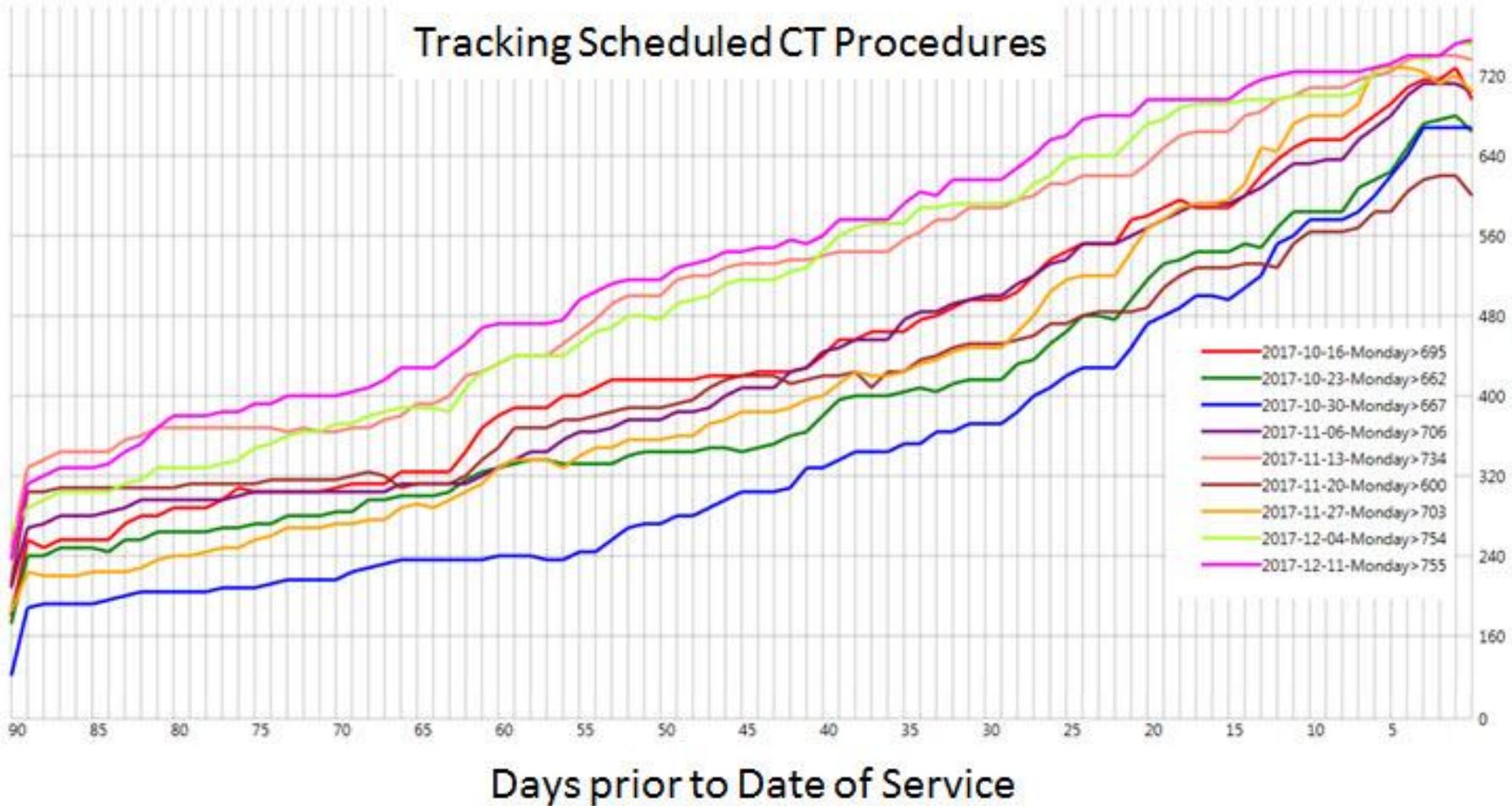
- While most procedure scheduling systems can readily provide information regarding the number of imaging procedure for a future date of service, the prediction of expected volume of procedures for future dates involves analysis which provides insight into the expected procedure volume weeks and yes months into the future.
- Insights regarding scheduling patterns, enable effective technologist and radiologist scheduling to manage expected procedure volumes.
- In the longer term, analysis of procedure scheduling patterns can inform planning decisions regarding the imaging resources required to match future anticipated procedure scheduling demand.

# Data Collection Process

- Each morning an automated process retrieves future schedule data (100 days into future) and stores information in a SQL data repository
  - Locally, this process is enabled by web service-based data retrieval.
  - However, it is also possible to obtain this information from data extracts of scheduling data
  - On a smaller scale manual data collection of data is possible but would require daily confirmation that data is collected.
- At MDACC this process, collects data from 16 CT scanner schedules and 17 MRI scanner schedules.
- The retrieved data is then converted into schedule plots as well as made available to managers of each procedure area formatted into detailed spreadsheets to concurrently enable precise scheduling of resources for the coming days.

## Tracking Scheduled CT Procedures

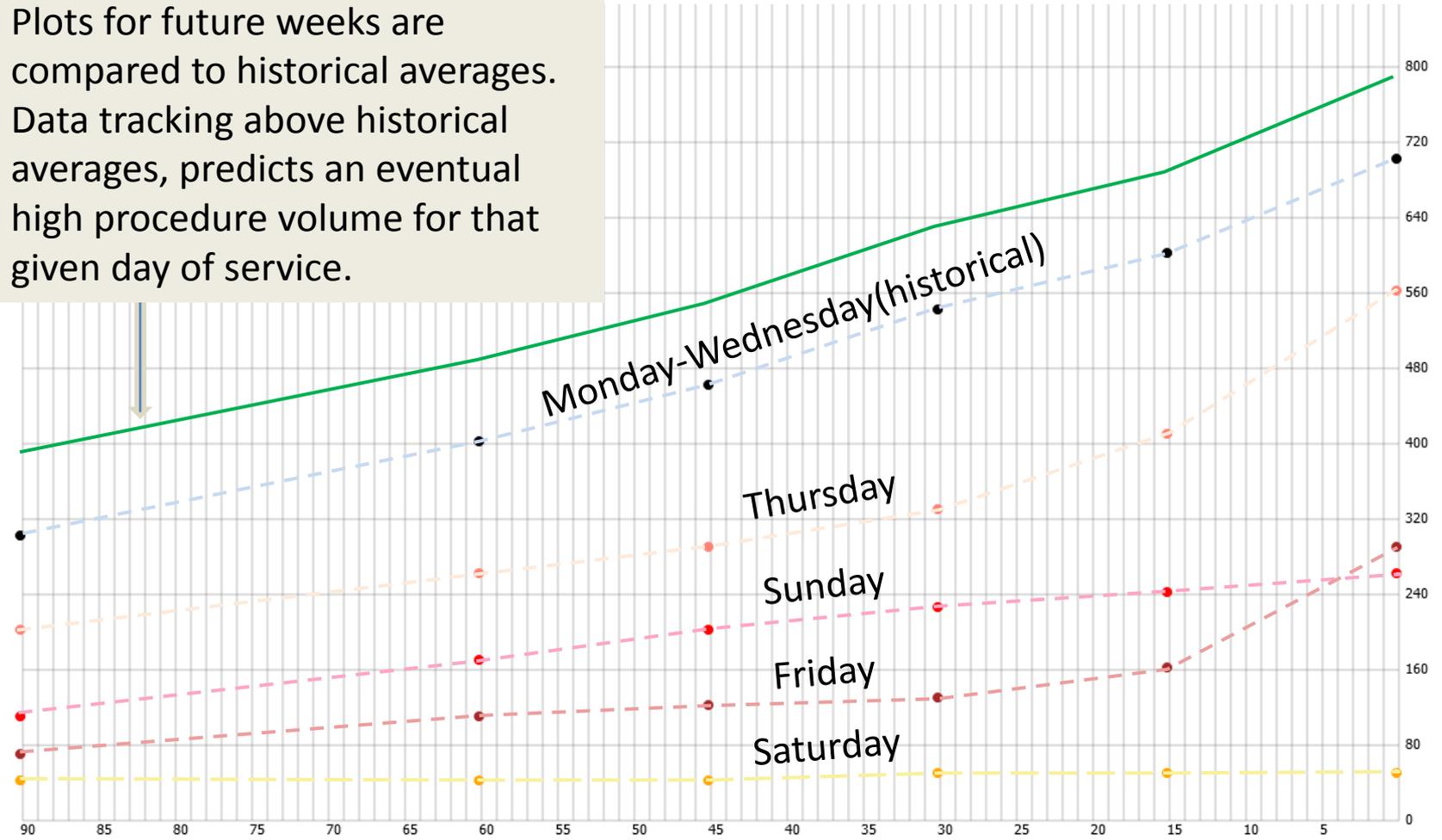
Scheduled Procedures



Historical data analysis enables prediction of future procedure volumes. Graph displays show the number of procedures scheduled for a single day of service starting 90 days before the date of service and 'Day 0' representing the tally of procedures actually performed on the day of service (collected on the morning after).

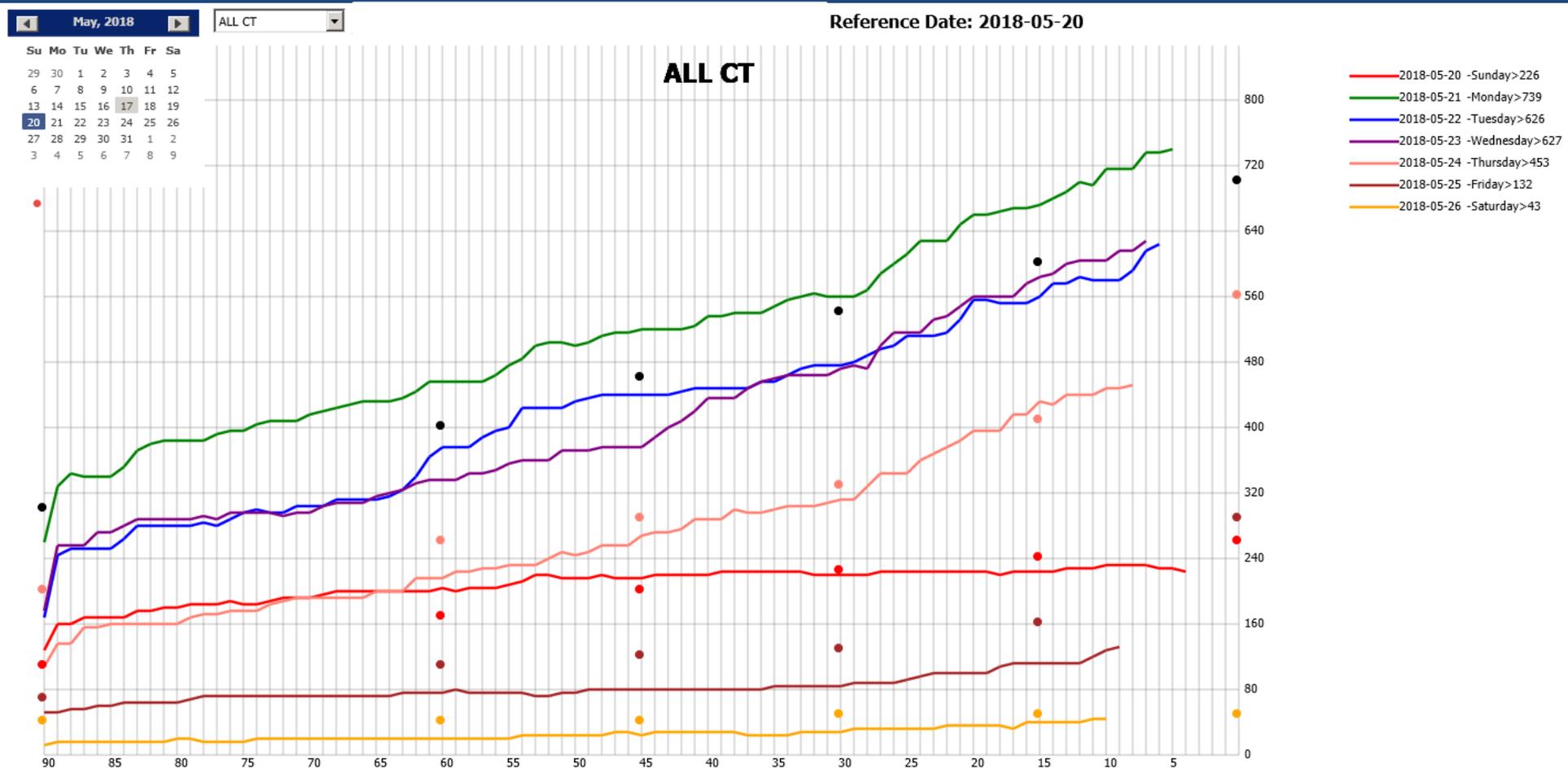
# Future Schedule Analysis

Plots for future weeks are compared to historical averages. Data tracking above historical averages, predicts an eventual high procedure volume for that given day of service.



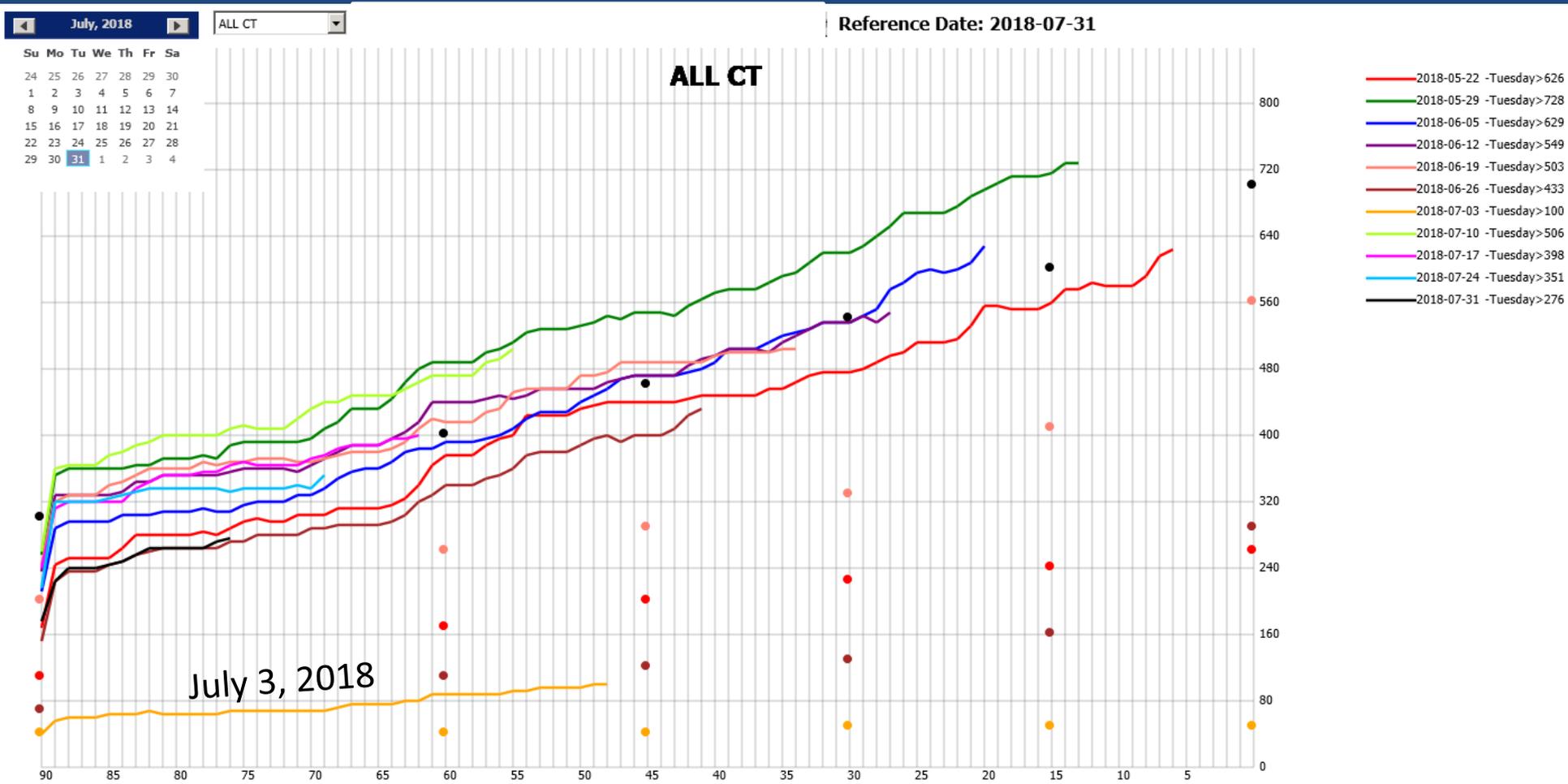
In analyzing the prior 12 weeks of scheduling data, regression analysis is utilized to determine an expected average volume 90, 60, 30 and 15 days prior to the date of service. Small colored circles, note tracking milestones. From past experience, Monday, Tuesday and Wednesday patterns are similar and therefore follow same trending prediction.

# Future CT Schedules: Week 5/20/18



The plot display is updated each morning with current data and enables managers and schedulers to readily observe projected future volumes, Example, for Monday 5/21, volume is projecting at approximately 800 procedures, while Tuesday 5/22 and Wednesday 5/23 are projecting slightly below 720 procedures.

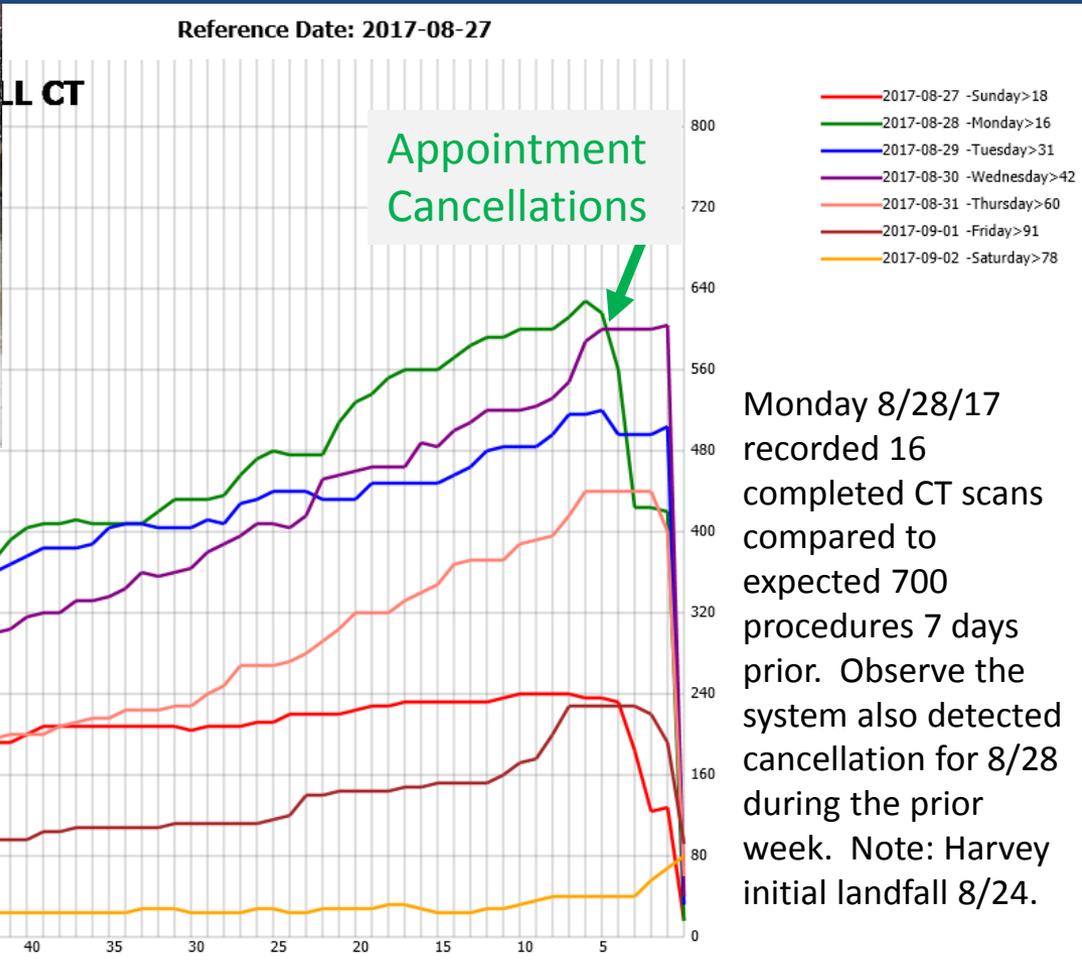
# Future CT Schedules: Summer 2018



Future “Day of Week” plots provide insight to relative intensity of volume of a given week of service. For example, managers could believe that July 4<sup>th</sup> week volume would be light with the prediction model currently projects volume of 200 procedures. However, procedure volume over the coming 12 weeks is otherwise slightly above 720/day average.

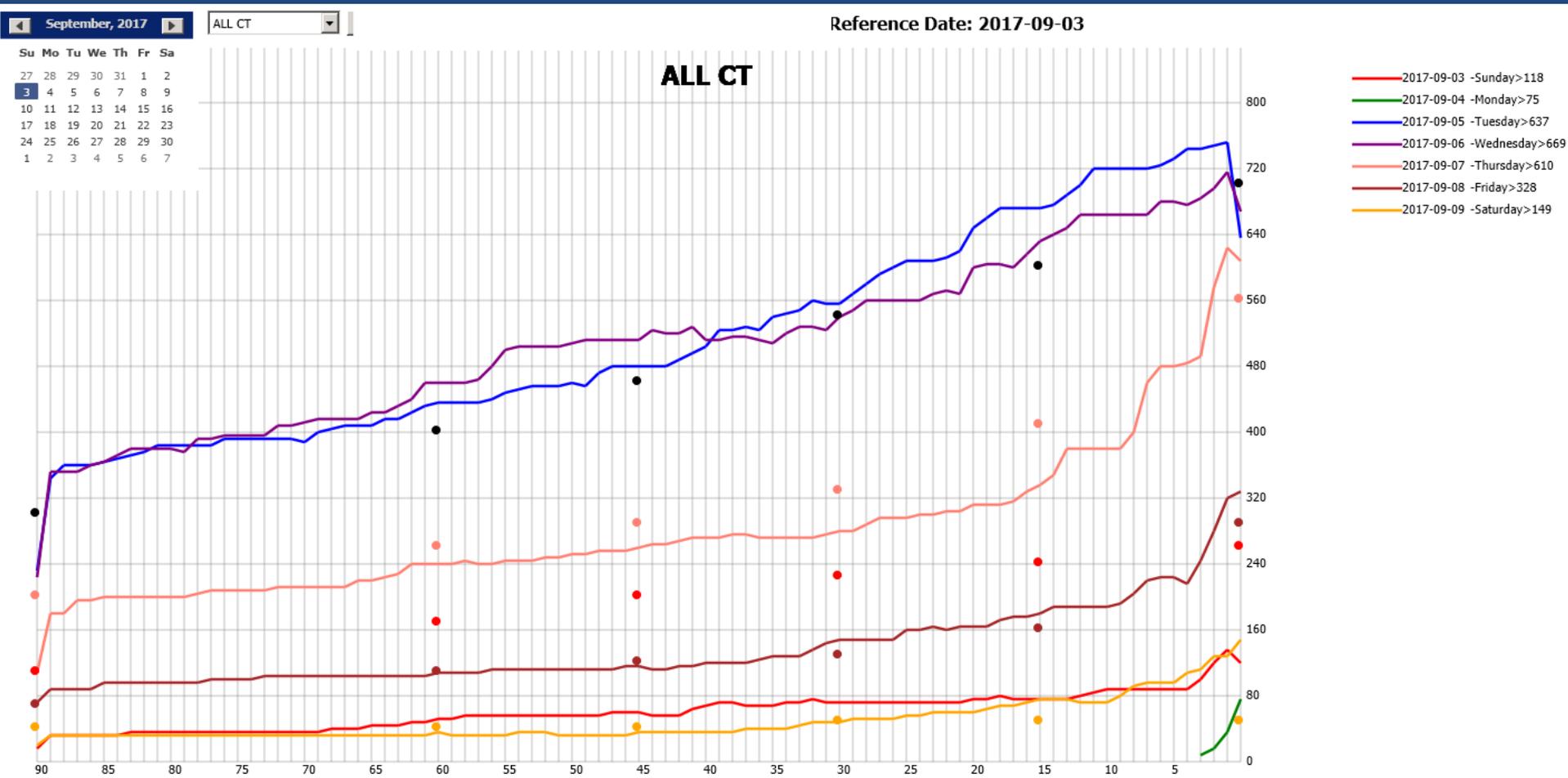
# Schedule Prediction: Harvey Impact

August, 2017						
Su	Mo	Tu	We	Th	Fr	Sa
30	31	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9



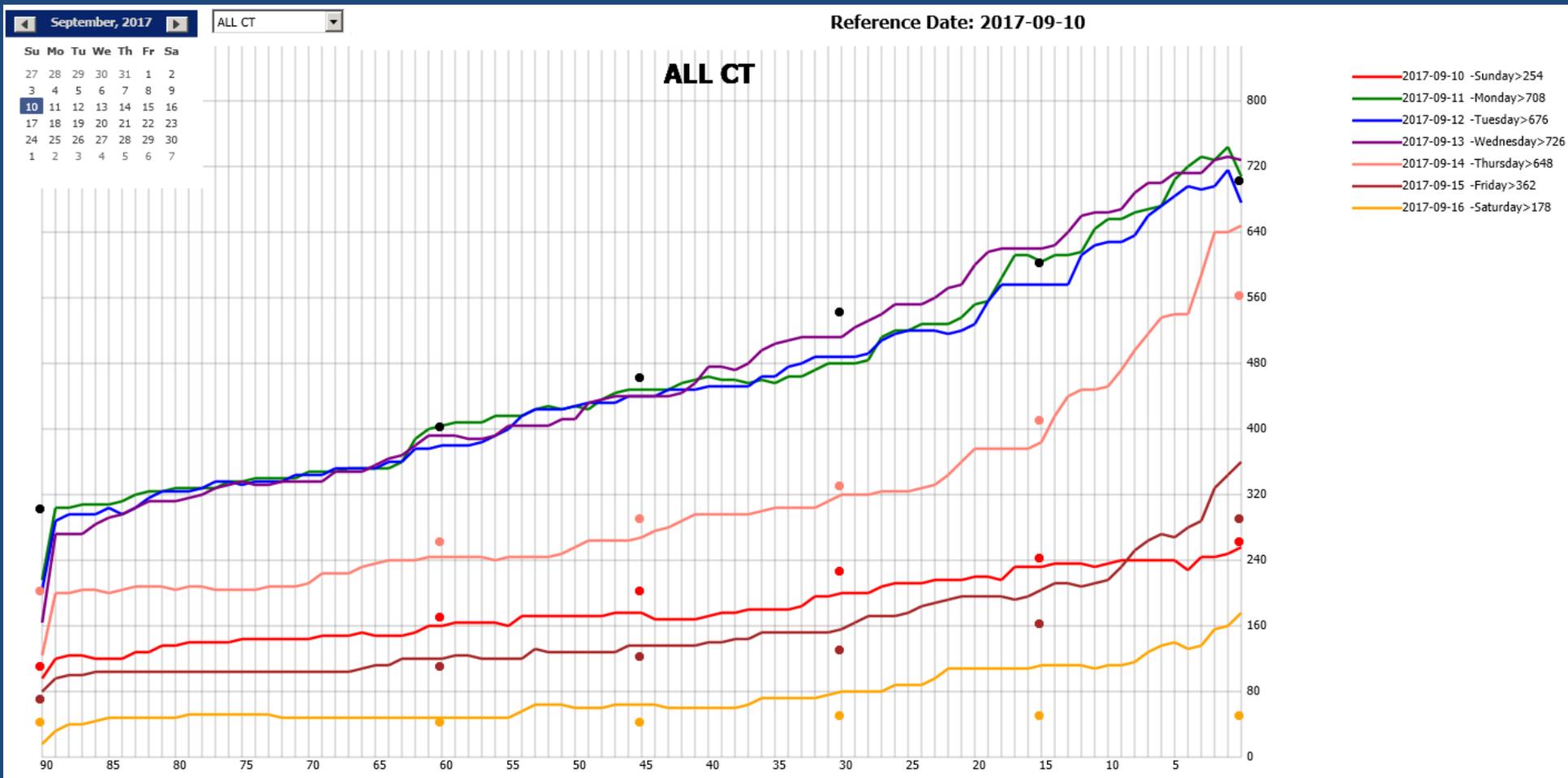
Within the Houston area, the major active rain impact of the storm occurred on 8/26 and 8/27. While there was major street flooding (image), the Texas Medical Center's flood protection worked as designed. Very little imaging activity occurred during the week following the weekend storm – essentially imaging was limited to in-patient evaluation as well as a skeleton staff for essential out-patient imaging procedures.

# Post-Harvey: Week One



On Tuesday 9/5, MDACC fully re-opened. Graphs readily identified two distinct trends; an increased, but not catastrophic no-show rate on Tuesday 9/5 and Wednesday 9/6, and secondly an atypical pattern of more scheduled procedures on Thursday 9/6 and Friday 9/7 – capturing the active rescheduling of previously missed patient appointments.

# Post-Harvey: Week Two



Week two following Harvey: the scheduling and procedure volume normalized albeit still with slightly higher than normal no-show rate Monday and Tuesday and continued strong procedure scheduling on Thursday. This information was utilized in real-time by Diagnostic Imaging as well as hospital and clinic leadership to proactively gain insight into institution impacts while the Houston-area recovery was in progress.

# Conclusions

- Prospective collection of future scheduling intensity enables proactive insights into future procedure volume.
- The system has proven reliable and enables proactive resource management for technologist and radiologist scheduling
- While Hurricane Harvey temporarily disrupted the schedule prediction process, it proved valuable providing real-time understanding of the recovery process, including appointment rescheduling, during the return to normal operations.