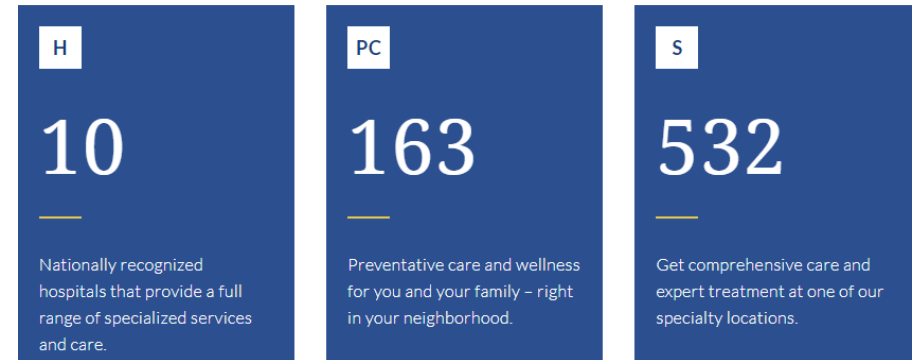# A Data-Driven Approach to *Exploring* and *Standardizing* Inpatient Diabetes Care across a Healthcare System

Shanza Ashraf
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Emory Healthcare | Office of Quality

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Emory Healthcare

- Most comprehensive academic health system in Georgia
- Affiliated with Emory University

H
10
Nationally recognized hospitals that provide a full range of specialized services and care.

PC
163
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S
532
Get comprehensive care and expert treatment at one of our specialty locations.

U.S. News & World Report 2019-2020 Best Hospitals

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#2 ATLANTA METRO

EMORY UNIVERSITY HOSPITAL MIDTOWN
#5 GEORGIA
#4 ATLANTA METRO

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Outline

- Background
  - Diabetes
  - Our Data Structure
- Quality Improvement (QI)
- Current Diabetes-Related Projects using R
- QI Case Study: Reducing Correctional Insulin (Sliding Scale Insulin) Administration Errors

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Background: Diabetes mellitus

- A chronic disease in which the body does not produce enough insulin or cannot effectively use the insulin it produces
  - Insulin is a vital hormone that regulates blood sugar (glucose)
- Diabetes is a large driver of quality-related metrics in inpatient settings

9%

Global burden of diabetes

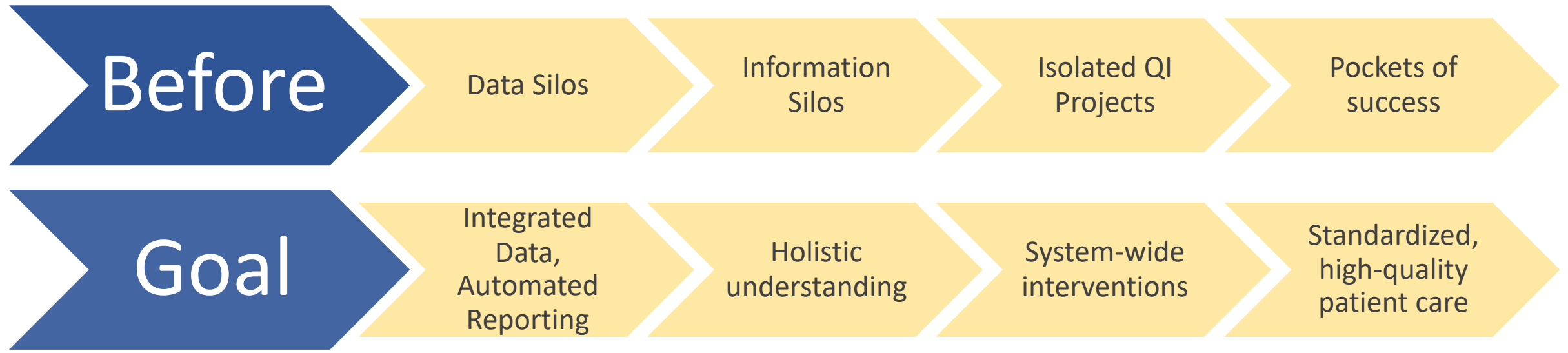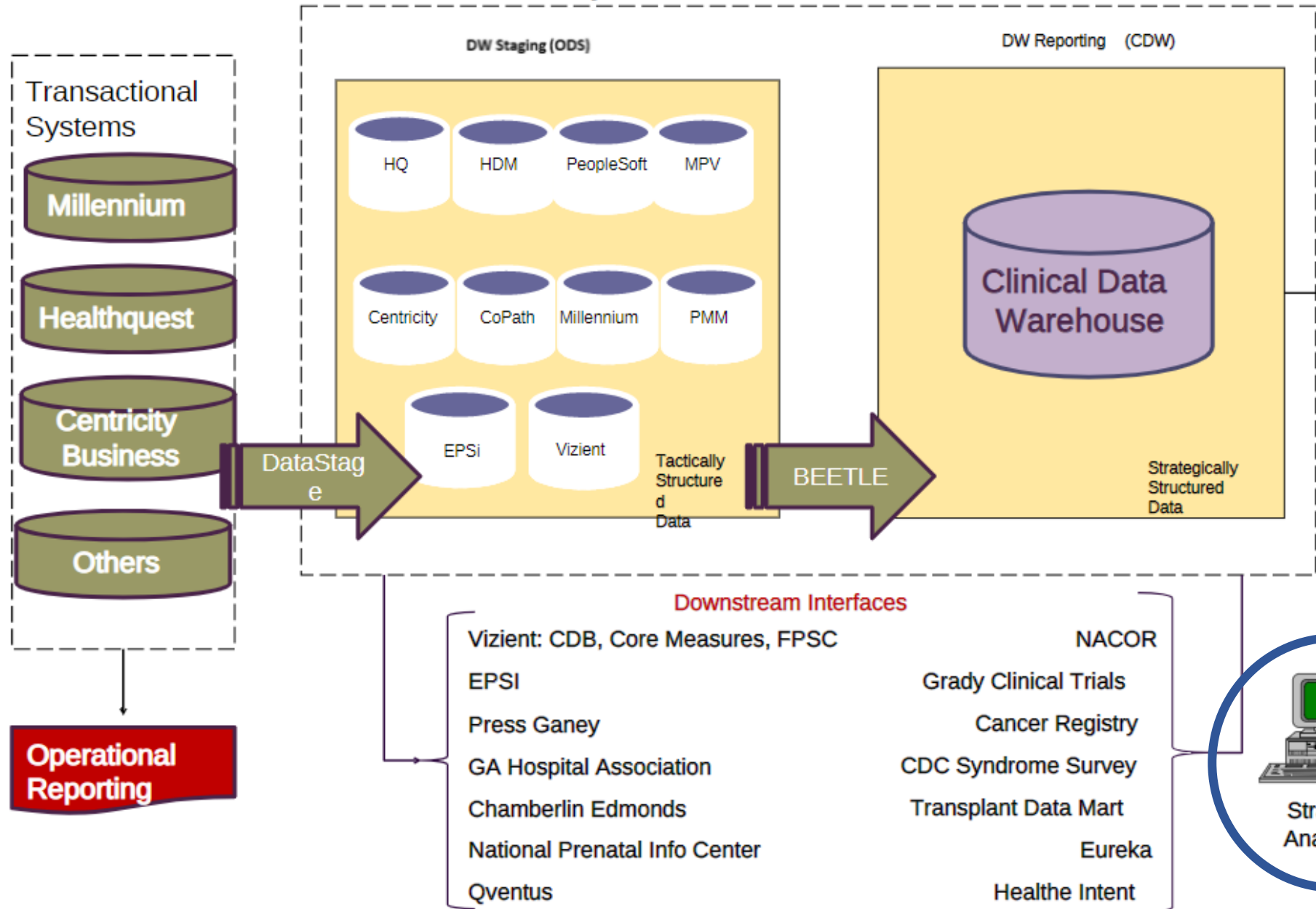| 20-30% EHC Inpatient admissions are diabetics | Higher in-hospital mortality | Higher readmission rates | More high-risk comorbidities |

Background: Our Data Approach

Before → Data Silos → Information Silos → Isolated QI Projects → Pockets of success

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Background: Our Data Approach

| Before | Data Silos | Information Silos | Isolated QI Projects | Pockets of success |

| Goal | Integrated Data, Automated Reporting | Holistic understanding | System-wide interventions | Standardized, high-quality patient care |

Clinical Data Warehouse Data Architecture

Emory Healthcare Data Warehouse

DW Staging (ODS)

HQ HDM PeopleSoft MPV

Centricity CoPath Millennium PMM

EPSi Vizient

Tactically Structured Data

DW Reporting (CDW)

Clinical Data Warehouse

Strategically Structured Data

Transactional Systems

Millennium

Healthquest

Centricity Business

Others

DataStage

BEETLE

Operational Reporting

Downstream Interfaces

Vizient: CDB, Core Measures, FPSC

EPSI

Press Ganey

GA Hospital Association

Chamberlin Edmonds

National Prenatal Info Center

Qventus

NACOR

Grady Clinical Trials

Cancer Registry

CDC Syndrome Survey

Transplant Data Mart

Eureka

Healthe Intent

Strategic Analysis

R

Quality Improvement (QI)

- In healthcare, it is the framework we use to systematically and continuously improve the ways in which we provide care to patients
  - Evidence-based
  - Data-driven
  - Interdisciplinary
  - Establishes or improves standard of care
  - Meet/exceed regulatory requirements
- Donabedian model

Structures
*Infrastructure
Demographics
Equipment
Education
Staff*

→

Processes
*Diagnosis
Treatment
Interaction
Behaviors*

→

Outcomes
*Mortality
Morbidity
Readmission
Quality of life
Pt. satisfaction*

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Quality Improvement (QI)

- In healthcare, it is the framework we use to systematically and continuously improve the ways in which we provide care to patients
  - Evidence-based
  - Data-driven
  - Interdisciplinary
  - Establishes or improves standard of care
  - Meet/exceed regulatory requirements
- Donabedian model

Structures	**Processes**	**Outcomes**
Infrastructure	*Diagnosis*	*Mortality*
Demographics	*Treatment*	*Morbidity*
Equipment	*Interaction*	*Readmission*
Education	*Behaviors*	*Quality of life*
Staff		*Pt. satisfaction*

Current Projects

- An all-inclusive dashboard reviewing:
  - Demographics of our diabetic admissions
  - Outcome metrics: mortality, comorbidities, readmissions
  - Glucometrics (glycemic control)
  - Medication regimens
  - Medication errors (correctional insulin)
  - Inpatient diabetes education
  - Order set use
  - Provider ordering practices
  - Hospital Medicine/Endocrinology Consults
  - Outpatient referrals
- Automated weekly/monthly reports to physicians, nurses, pharmacists, diabetes educators, leaders

Current Projects

Setup as flexdashboard

```
---
title: "EHC Inpatient Diabetes Dashboard"
output:
    flexdashboard::flex_dashboard:
        theme: cerulean
        logo: S:/shares/OfficeOfQuality/data/Quality Analytics Dept/Shanza/logo.png
        output: html_document
        orientation: rows
---

Column {.sidebar}
======================================
**This report contains process and outcome metrics related to inpatient diabetes care.**

_To use, first select a metric of interest from the navigation bar at the top. Then review the
figures using the metric definitions document below._
```

Global sidebar with embedded definitions pdf

```
```{r echo = FALSE}

xfun::embed_file('S:/shares/OfficeOfQuality/data/Quality Analytics Dept/Diabetes/All-Inclusive
Diabetes Dashboard/EHC Inpatient Diabetes Dashboard Metric Definitions.pdf')

```
```

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EHC Inpatient Diabetes Dashboard | Diabetic Population | Glucometrics ▾ | Glucometrics_V2 ▾ | Diabetes Consults ▾ | Insulin Pens and Needles | Correctional Insulin ▾ | Metrics in Progress ▾

This report contains process and outcome metrics related to inpatient diabetes care.

Data Time Period January 2016 - April 2019

To use, first select a metric of interest from the navigation bar at the top. Then review the figures using the metric definitions document below.

Download EHC Inpatient Diabetes Dashboard Metric Definitions.pdf

EHC Diabetic Patients

Jan, 2016:
EHC: 27.5
EUH: 29
EUHM: 25.1
ESJH: 29.7
EJCH: 26.1

EHC Mortality in Diabetic vs. Non-Diabetic Patients

— % Mortality in Diabetic Patients
— % Mortality in Non-Diabetic Patients
⋯ % Mortality in All Patients

EUH Mortality in Diabetic vs. Non-Diabetic Patients

— % Mortality in Diabetic Patients
— % Mortality in Non-Diabetic Patients
⋯ % Mortality in All Patients

EUHM Mortality in Diabetic vs. Non-Diabetic

— % Mortality in Diabetic Patients
— % Mortality in Non-Diabetic Patients
⋯ % Mortality in All Patients

ESJH Mortality in Diabetic vs. Non-Diabetic

— % Mortality in Diabetic Patients
— % Mortality in Non-Diabetic Patients
⋯ % Mortality in All Patients

EJCH Mortality in Diabetic vs. Non-Diabetic

— % Mortality in Diabetic Patients
— % Mortality in Non-Diabetic Patients
⋯ % Mortality in All Patients


```r
library(dygraphs)

#mortality comparison
dygraph((subset(FIGURE1, FIGURE1$`Discharging Unit`=="EHC"))[,5:7],
        main = "EHC Mortality in Diabetic vs. Non-Diabetic Patients",
        xlab = "Discharge Month") %>%
  dySeries("% Mortality in Diabetic Patients", strokeWidth = 2, color = "#7F7F7F") %>%
  dySeries("% Mortality in Non-Diabetic Patients", strokeWidth = 2, color = "#1874CD") %>%
  dySeries("% Mortality in All Patients", strokeWidth = 2, color = "#EEB422", strokePattern =
"dotted") %>%
  dyAxis("y", label = "Mortality, %",
         valueRange = c(0,10)) %>%
  dyOptions(fillGraph = FALSE,
            drawPoints = TRUE, pointSize = 2.5,
            strokeWidth = 2,
            drawGrid = FALSE) %>%
  dyHighlight(highlightCircleSize = 7,
              highlightSeriesBackgroundAlpha = 0.2,
              hideOnMouseOut = FALSE,
              highlightSeriesOpts = list(strokeWidth = 5)) %>%
  dyLegend(show = "always",
           labelsSeparateLines = TRUE,
           width = 300) %>%
  dyUnzoom() %>%
  dyCrosshair(direction = "vertical")
```
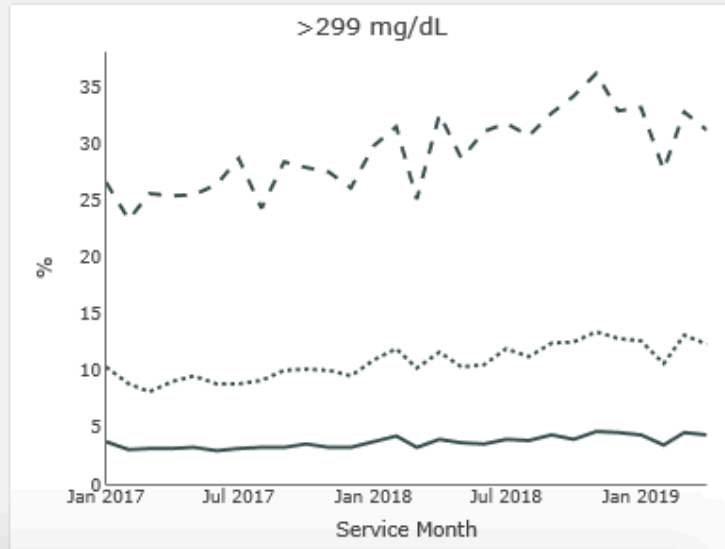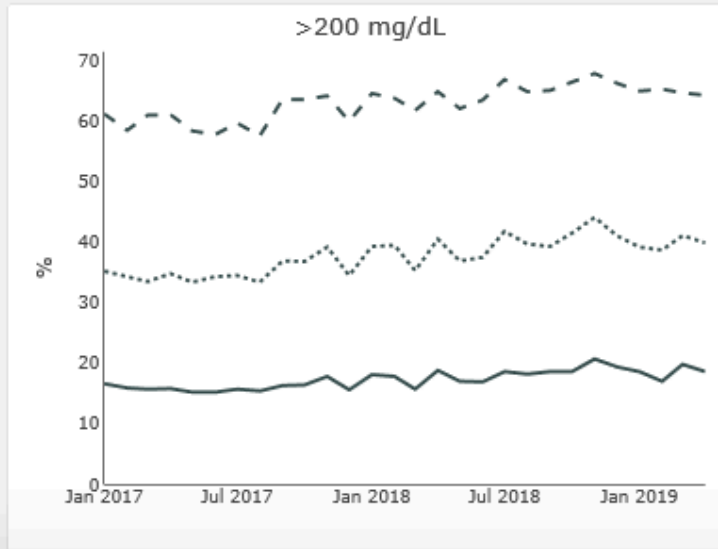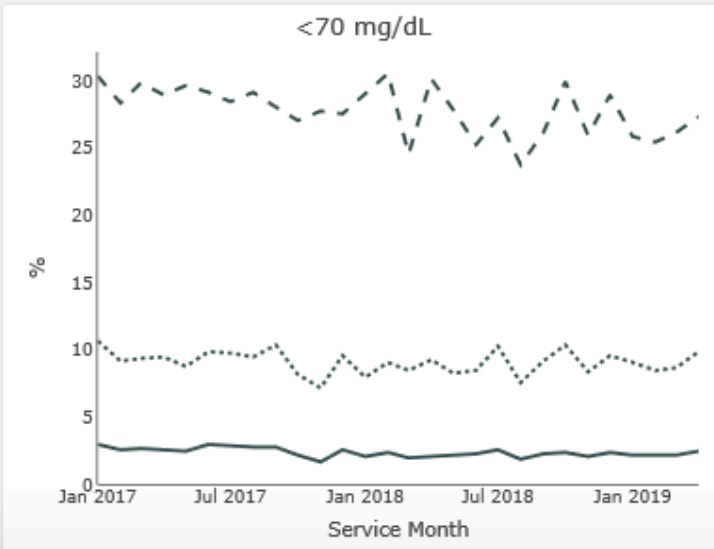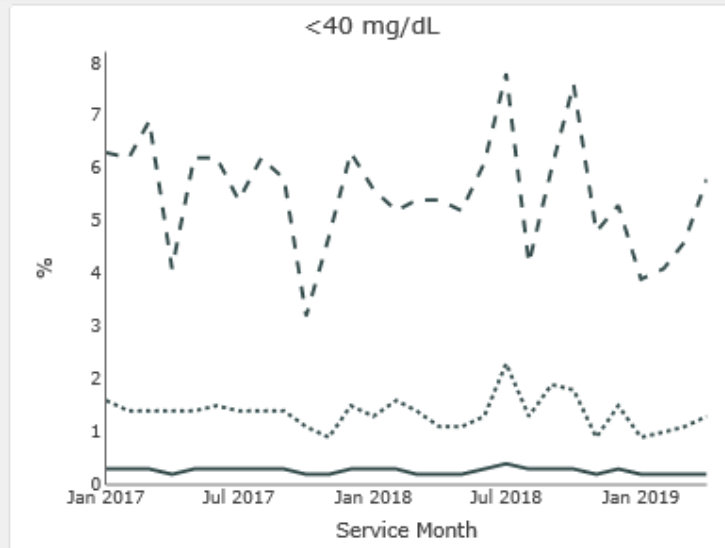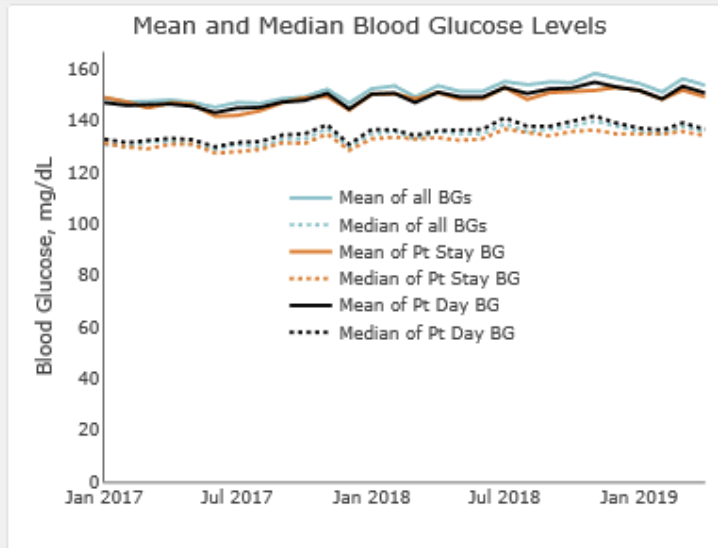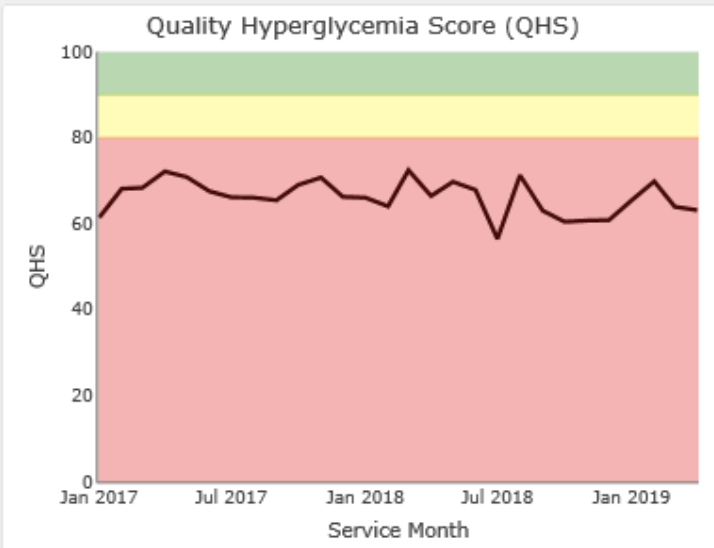
```r
library(crosstalk)
shared_together_qhs_EHC <- SharedData$new(qhs_data_EHC)
```

Column {.sidebar}

```{r}
library(crosstalk)
filter_select("Unit", "Select Unit", shared_together_EUH, ~Unit, multiple = FALSE)
```

Row {}

###
```{r}
shared_together_qhs_hospital_EUH %>%
plot_ly(
            x = ~`Service Month`,
         mode = "lines",
         hoverinfo = "text") %>%
       add_trace(y = ~QHS, name = "QHS",
                 line = list(width = 3, dash = "solid", color = "#000000"),
                 text = ~paste("QHS",
                               paste0(as.yearmon(`Service Month`, "%Y-%m-%d"), ": ", `QHS`),
                               sep = "<br>")) %>%
```
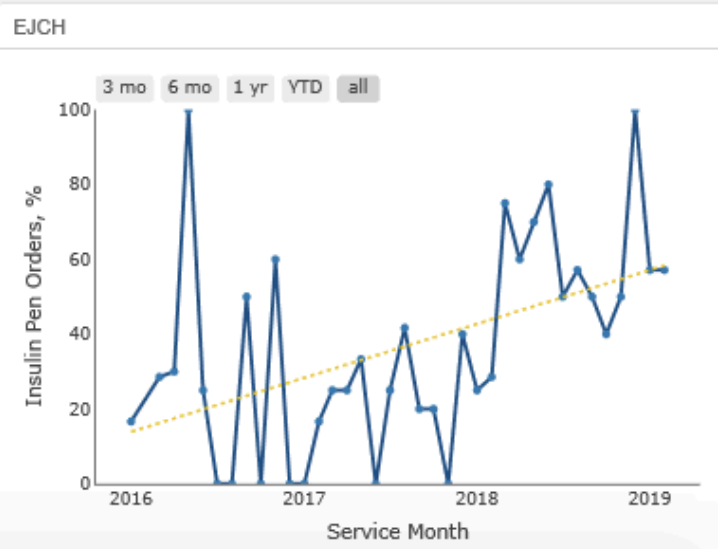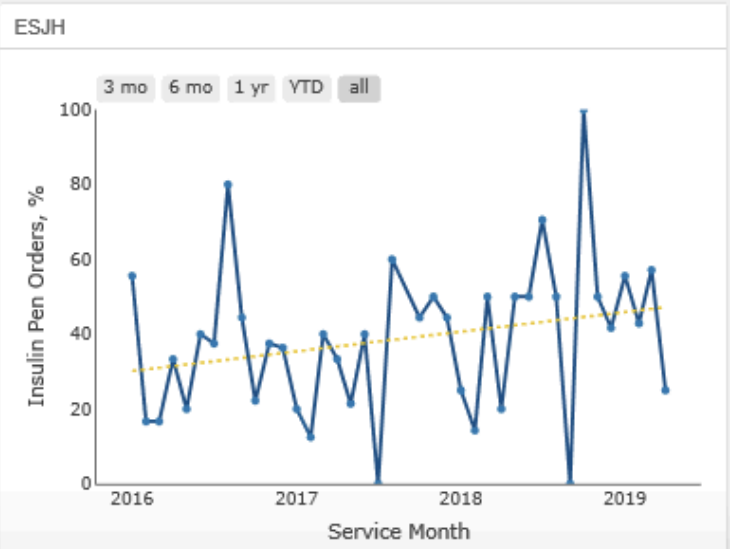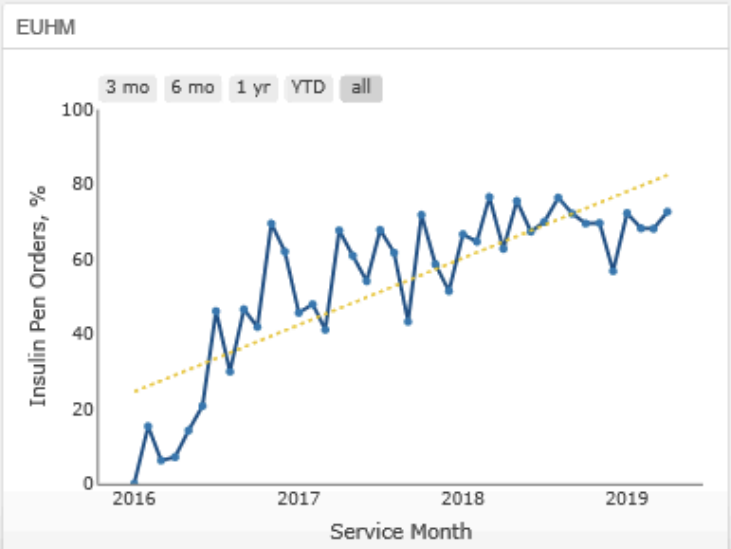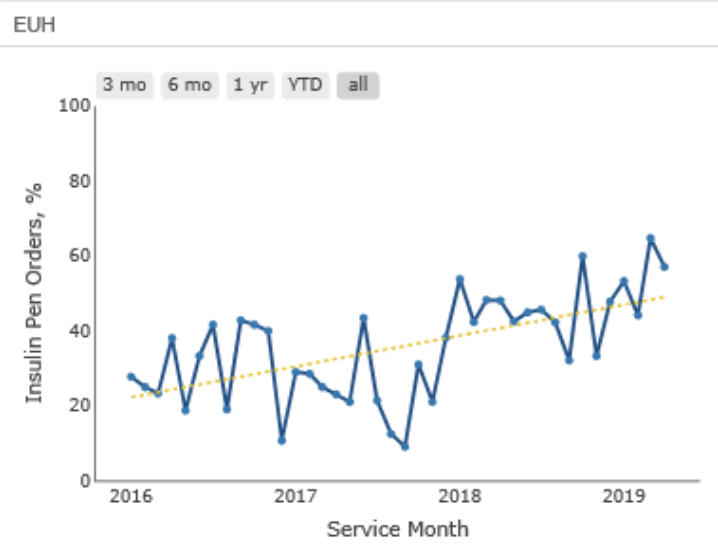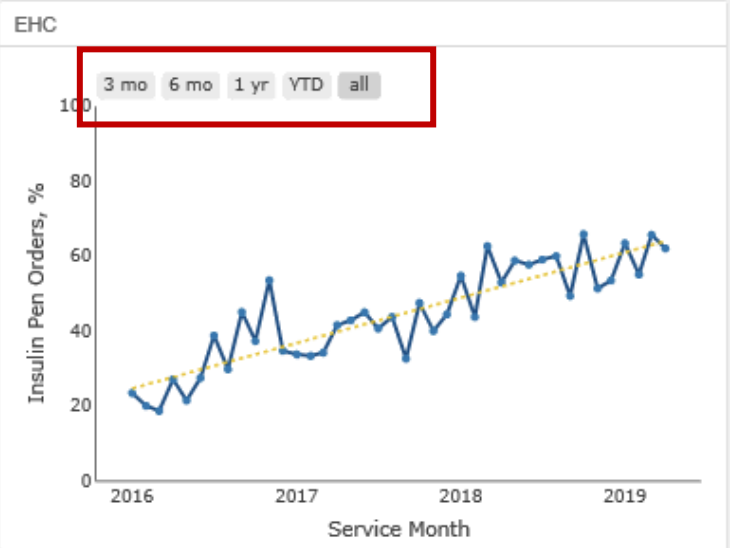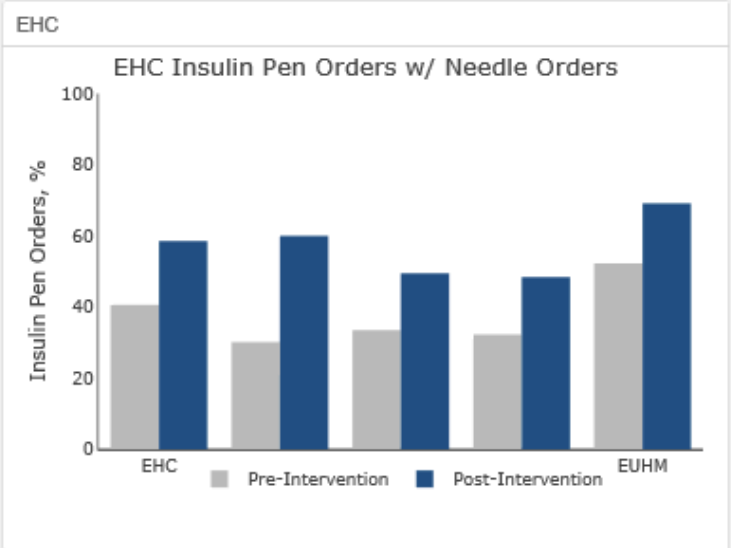
```
rangeselector = list(
  buttons = list(
    list(
      count = 3,
      label = "3 mo",
      step = "month",
      stepmode = "backward"),
    list(
      count = 6,
      label = "6 mo",
      step = "month",
      stepmode = "backward"),
    list(
      count = 1,
      label = "1 yr",
      step = "year",
      stepmode = "backward"),
    list(
      count = 1,
      label = "YTD",
      step = "year",
      stepmode = "todate"),
    list(step = "all")))),
```

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Case Study: Reducing Correctional Insulin (Sliding Scale Insulin) Administration Errors

- Correctional insulin is insulin dosing meant to correct or lower high blood sugar before meals.
  - Calculated using a "correction factor" determined by the ordering provider.
  - Nursing must interpret the order and administer the correct dose based on the last blood glucose result

- Example:
  - (BG-100)/40 = # units for BG ≥ 180 mg/dL, Subcutan AND round up to nearest whole unit

- Questions:
  - How often are correctional insulin doses accurate? How often are we underdosing? Overdosing?
  - Do we have a standard system of dosage calculation across the system?
  - Is our process in control?

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Data Import

Data Pull → Data Cleaning → Data Analysis → Data Visualization

00_Subreport
01_Insulin Orders
02_Insulin Admin
03_Blood Glucose

readr
www.rstudio.com

```
#set up working directory
setwd(filename)

#rename files
new.names<-c("sub", "ins_orders", "ins_admin", "bg")

#import all files in path
cd_data<-function(filename, pattern = ".csv$"){
    list1<-list.files(filename, pattern = ".csv$")
    list2<-list(length = length(list1))
    for (i in 1:length(list1)){
        list2[[i]]<-read_csv(list1[i], skip = 2)}
    names(list2)<-new.names
    list2
}

#list to data frames
list2env(list2, envir = .GlobalEnv)
```

Data Cleaning

Data Pull → **Data Cleaning** → Data Analysis → Data Visualization

tidyverse

| Patient | Correctional Insulin Order | Previous Blood Glucose | Insulin Dosage Administered | Correct Dose? |

Data Analysis: Statistical Process Control (SPC)/Shewhart Charts

- Line graphs showing measures over time
  - Center: mean
  - Control limits: natural variation limits inherent in the process (3σ limits)
    - Common cause variation

Process is in control!

```
library(qicharts2)
#EHC total (4 hospitals)
qic(`Service Month`, Correct, Total,
    data        = cd1,
    chart       = 'pp',
    y.percent   = T,
    title       = '% Correct Administrations at EHC',
    subtitle    = "Jan 2017 - Feb 25, 2019",
    ylab        = '% Administrations',
    xlab        = 'Service Month',
    x.format    = "%b %Y",
    print.summary = T)
```

```
 facet1 facet2 part n.obs n.useful longest.run longest.run.max n.crossings n.crossings.min
1      1      1    1    26       26           4               8          11               8
  runs.signal      aLCL        CL     aUCL sigma.signal
1           0 0.6532284 0.6868717 0.720515            0
```


% Correct Administrations at EHC
Jan 2017 - Feb 25, 2019
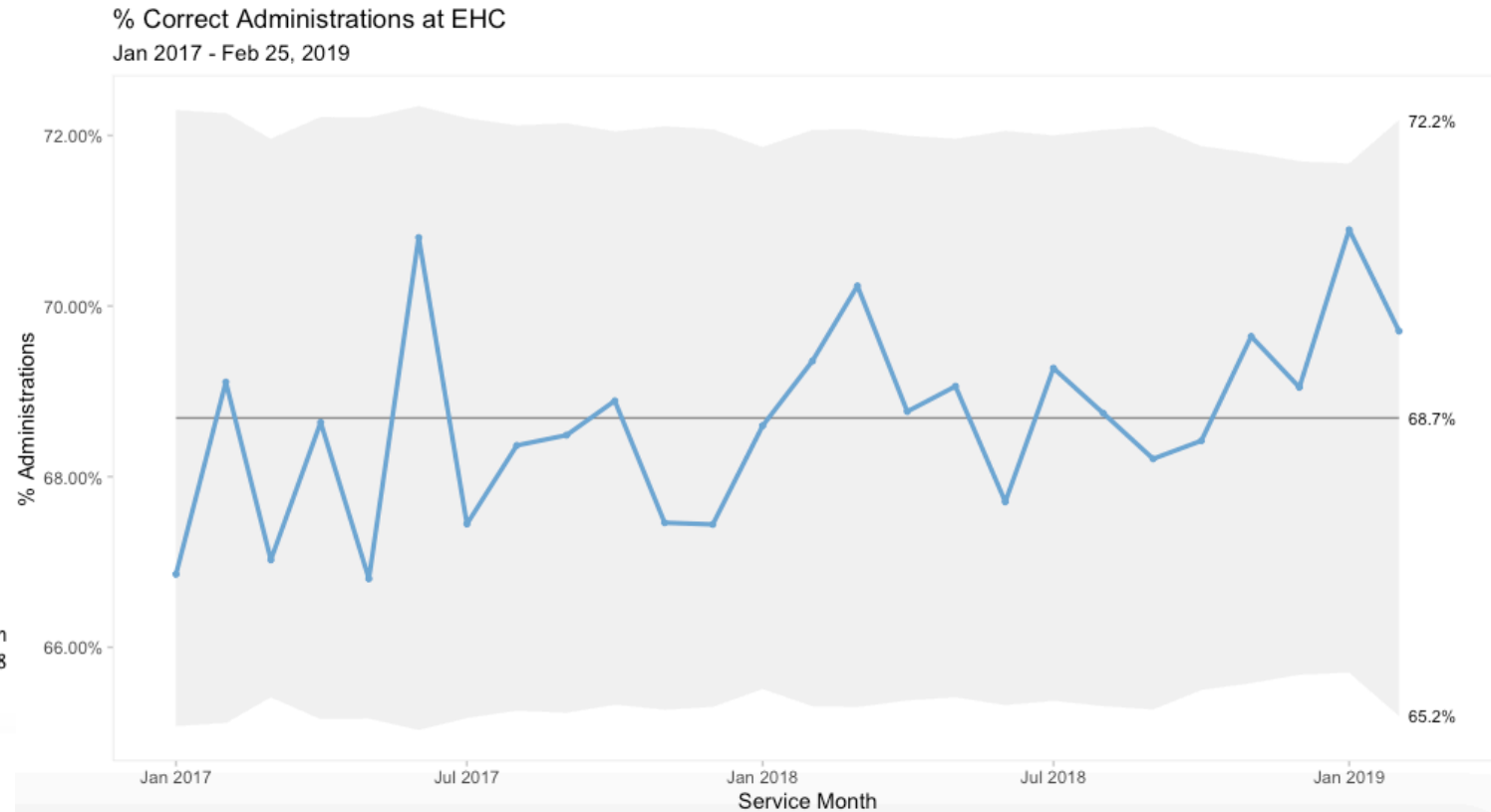
```
#by facility
qic(`Service Month`, Correct, Total,
    data       = cd1,
    facets     = ~ Facility,
    chart      = 'pp',
    y.percent = T,
    title      = '% Correct Administrations by Facility',
    subtitle = "Jan 2017 - Feb 25, 2019",
    ylab       = '% Administrations',
    xlab       = 'Service Month',
    x.format = "%b %Y",
    nrow = 1,
    print.summary = T)
```

	facet1	facet2	part	n.obs	n.useful	longest.run	longest.run.max	n.crossings	n.crossings.min
1	Hospital 1	1	1	26	26	10	8	9	8
2	Hospital 2	1	1	26	26	7	8	13	8
3	Hospital 3	1	1	26	26	8	8	7	8
4	Hospital 4	1	1	26	26	3	8	13	8

	runs.signal	aLCL	CL	aUCL	sigma.signal
1	1	0.8672278	0.9227914	0.9783550	1
2	0	0.8207258	0.8669745	0.9132233	0
3	1	0.5390817	0.5681902	0.5972987	0
4	0	0.6070543	0.6402780	0.6735016	0

% Correct Administrations by Facility
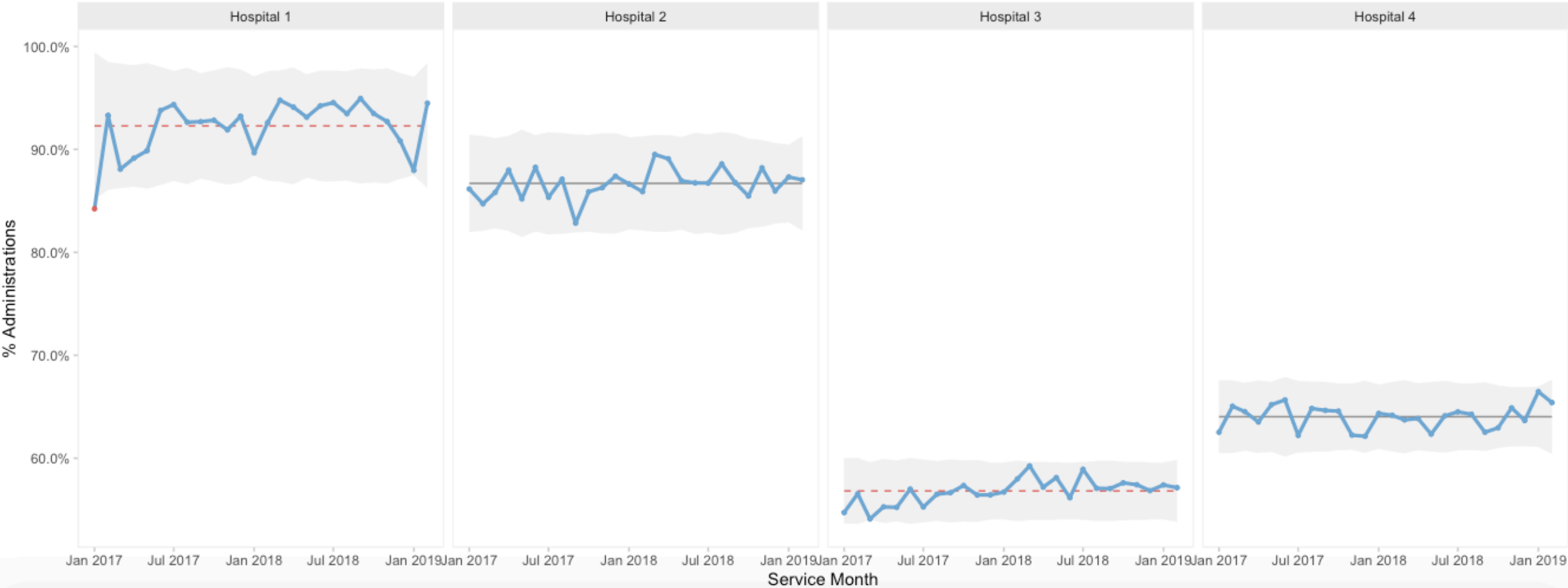
Jan 2017 - Feb 25, 2019

Table-based system   Formula-based system   Formula-based system   Formula-based system

% Correct Administrations by Facility
Jan 2017 - Feb 25, 2019
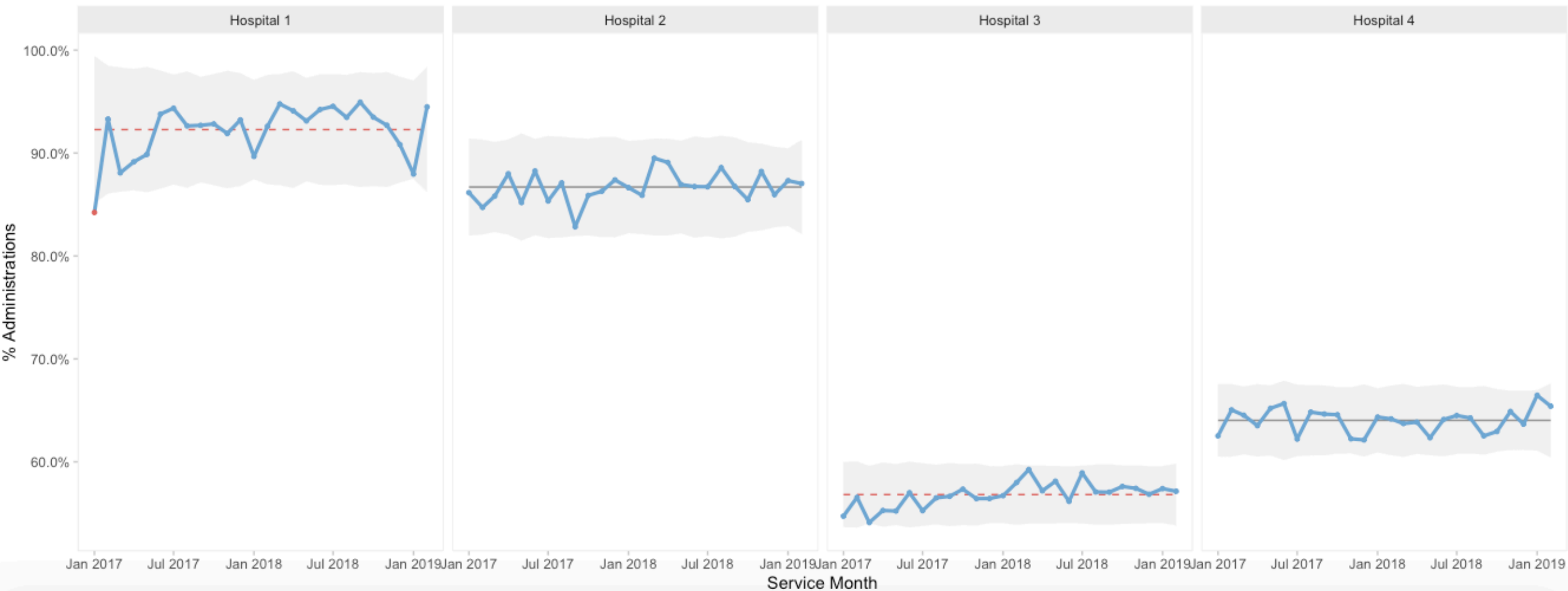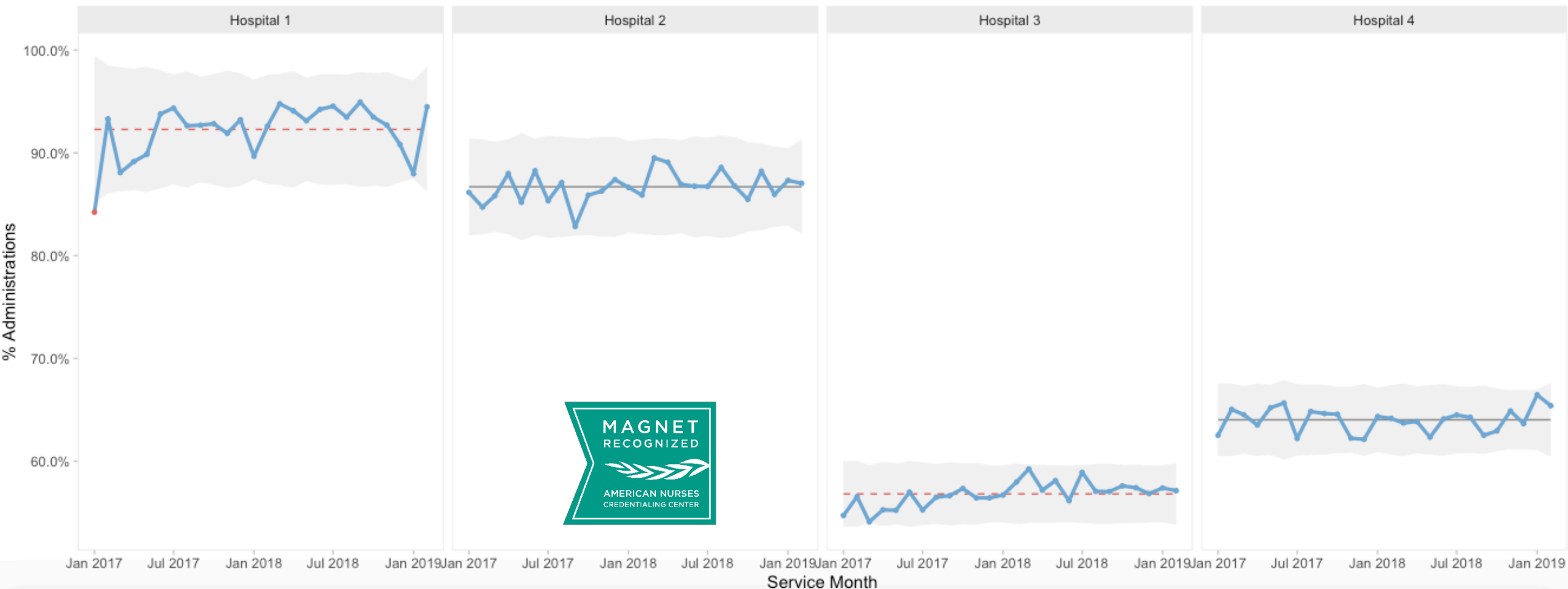
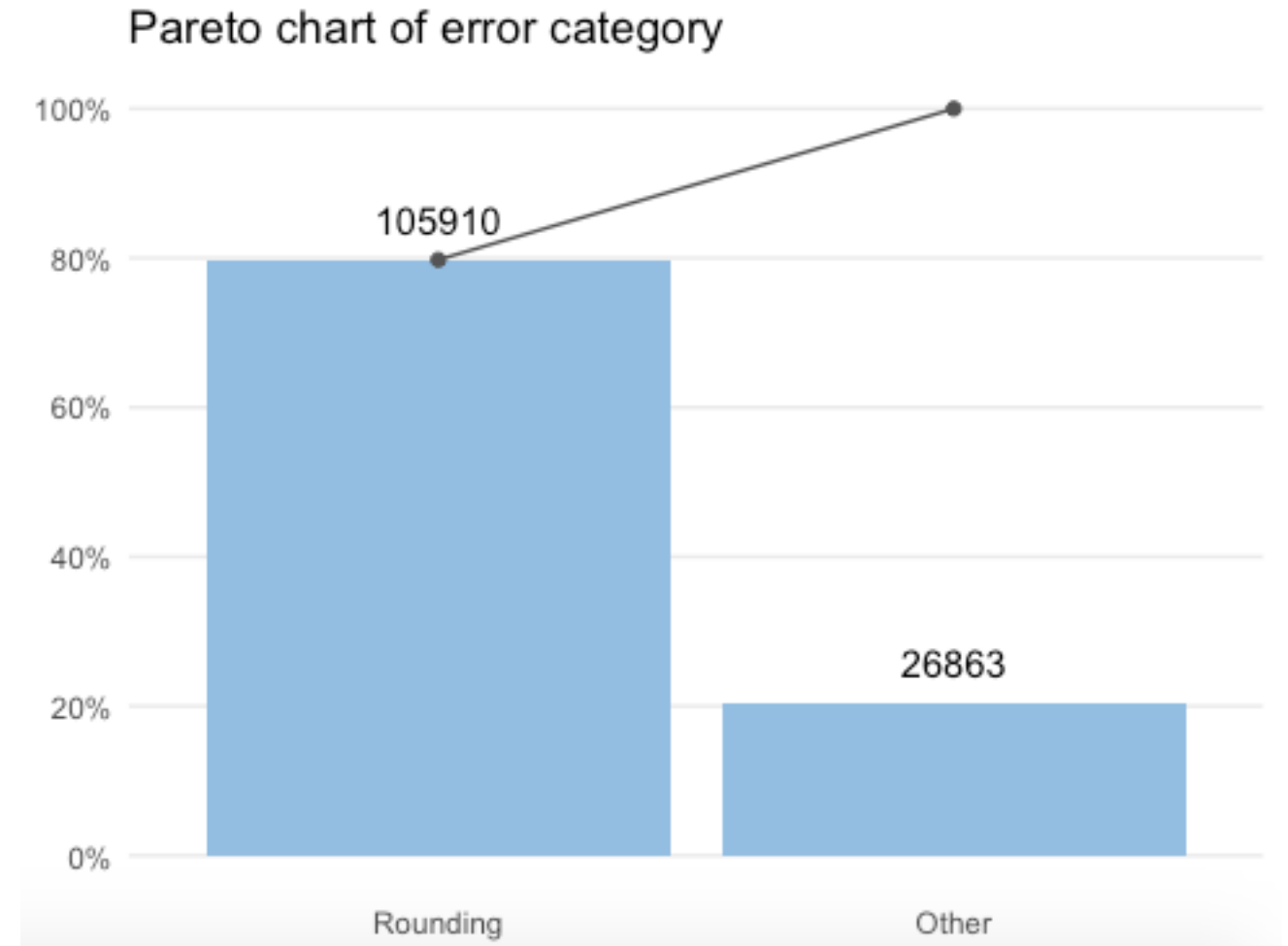Table-based system   Formula-based system   Formula-based system   Formula-based system

% Correct Administrations by Facility
Jan 2017 - Feb 25, 2019

Data Analysis: Pareto Chart

```
paretochart(cd$`Reason for Error`,
            title = 'Pareto chart of error category')
```


Pareto chart of error category

Process Change

- Using this data, we got buy-in from leadership to change a process that had been around for decades

In God we trust, all others bring data.

–William E. Deming

Emory Insulin Correction Chart

Standard Correctional Scale (BS – 100) / 40
FOR BLOOD SUGAR OVER 140 MG/DL
140 – 179 = 1 units
180 – 219 = 2 units
220 – 259 = 3 units
260 – 299 = 4 units
300 – 339 = 5 units
340 – 379 = 6 units
380 – 419 = 7 units
> 420 = 8 units, call MD

For HS (and 3AM if ordered)
for Blood Sugar Over 200 MG/DL:
200 – 259 = 1 units
260 – 339 = 2 units
340 – 419 = 3 units
> 420 = 4 units, call MD

Sensitive Correctional Scale (BS – 100) / 50
FOR BLOOD SUGAR OVER 140 MG/DL
140 – 149 = 0 units
150 – 199 = 1 units
200 – 249 = 2 units
250 – 299 = 3 units
300 – 349 = 4 units
350 – 399 = 5 units
> 400 = 6 units, call MD

For HS (and 3AM if ordered)
for Blood Sugar Over 200 MG/DL:
200 – 299 = 1 units
300 – 399 = 2 units
> 400 = 3 units, call MD

Resistant Correctional Scale (BS – 100) / 30
FOR BLOOD SUGAR OVER 140 MG/DL
140 – 159 = 1 units
160 – 189 = 2 units
190 – 219 = 3 units
220 – 249 = 4 units
250 – 279 = 5 units
280 – 309 = 6 units
310 – 339 = 7 units
340 – 369 = 8 units
370 – 399 = 9 units
> 400 = 10 units, call MD

For HS (and 3AM if ordered)
for Blood Sugar Over 200 MG/DL:
200 – 219 = 1 units
220 – 279 = 2 units
280 – 339 = 3 units
340 – 399 = 4 units
> 400 = 5 units, call MD

Highly Resistant Correctional Scale (BS – 100) / 20
FOR BLOOD SUGAR OVER 140 MG/DL
140 – 159 = 2 units
160 – 179 = 3 units
180 – 199 = 4 units
200 – 219 = 5 units
220 – 239 = 6 units
240 – 259 = 7 units
260 – 279 = 8 units
280 – 299 = 9 units
300 – 319 = 10 units
320 – 339 = 11 units
340 – 359 = 12 units
360 – 379 = 13 units
380 – 399 = 14 units
> 400 = 15 units, call MD

For HS (and 3AM if ordered)
for Blood Sugar Over 200 MG/DL:
200 – 219 = 2 units
220 – 259 = 3 units
260 – 299 = 4 units
300 – 339 = 5 units
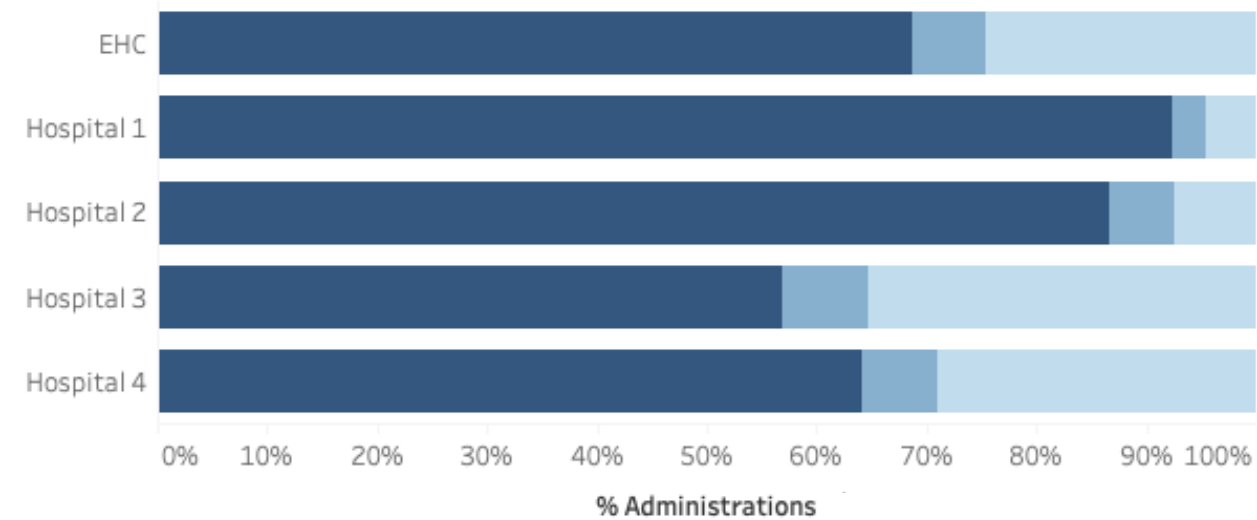340 – 379 = 6 units
> 380 = 7 units, call MD

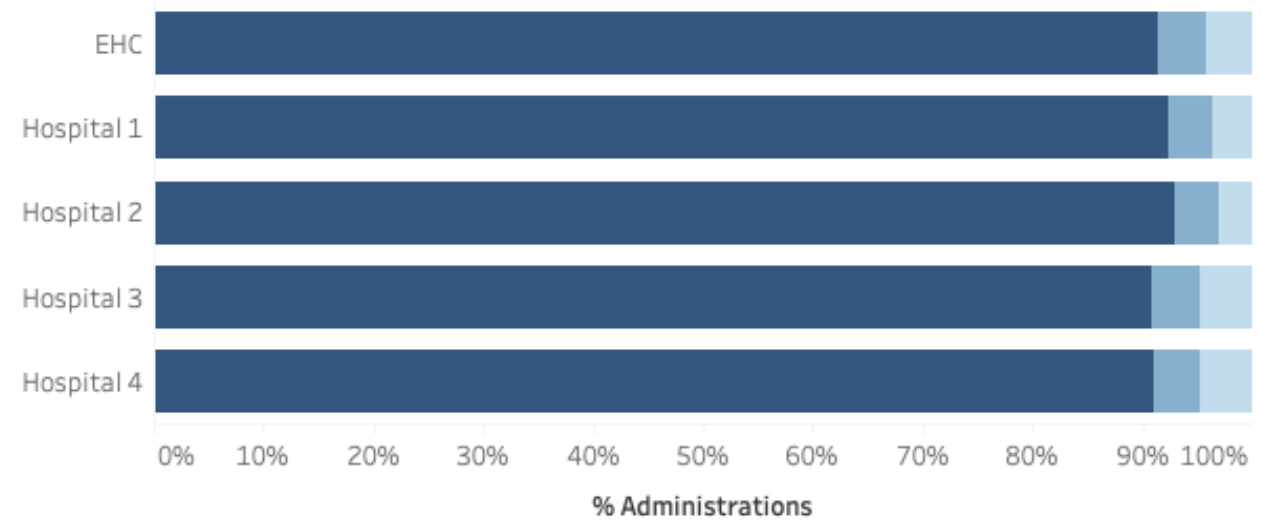EMORY HEALTHCARE

EHC Insulin Administration Accuracy
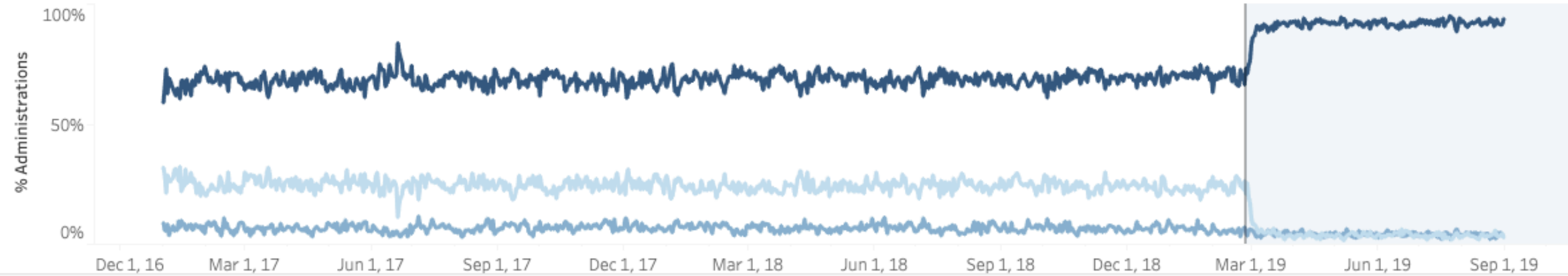
Pre-Intervention
Jan 2017 – Feb 24, 2019

Dose Correct?
Correct Too much Too little

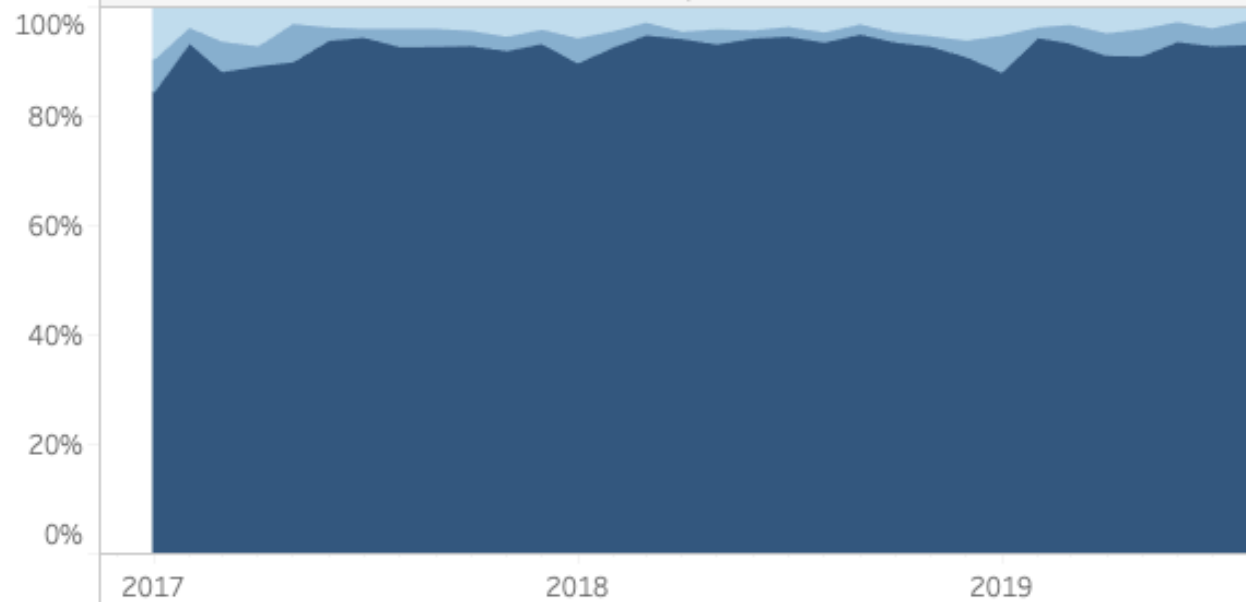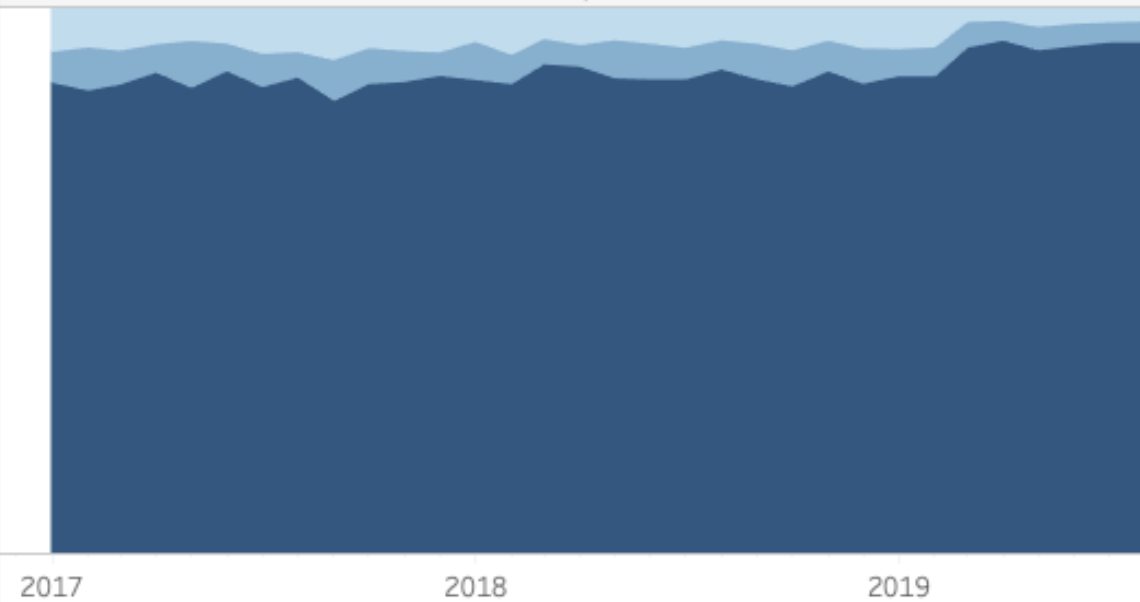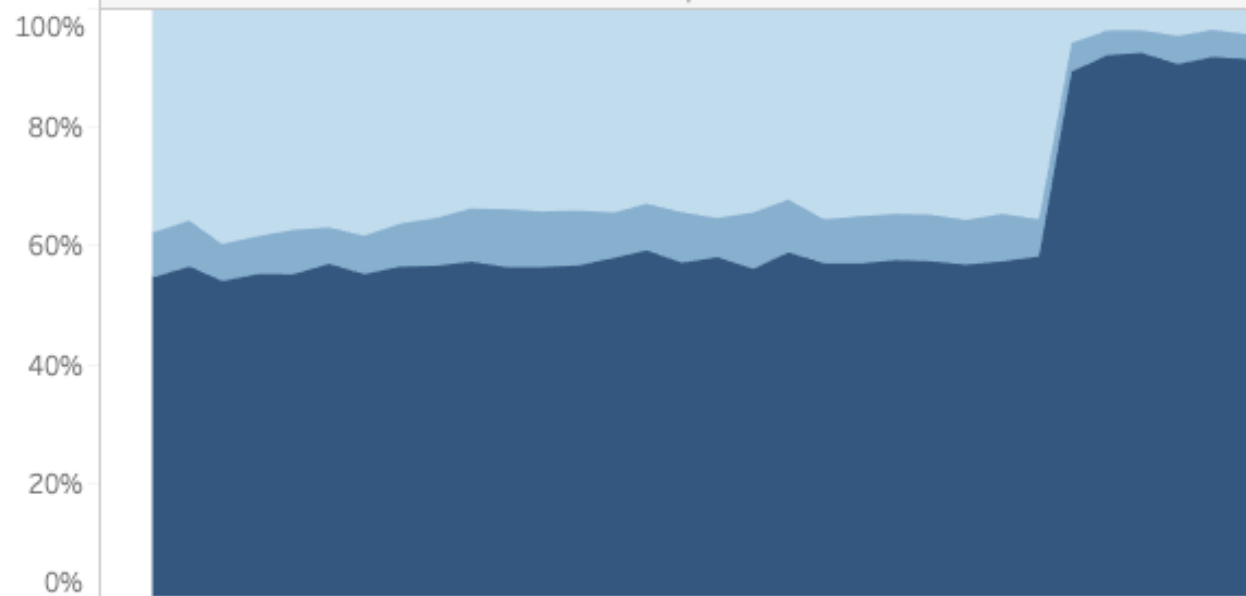**Post-Intervention**
Feb 26, 2019 – August, 2019

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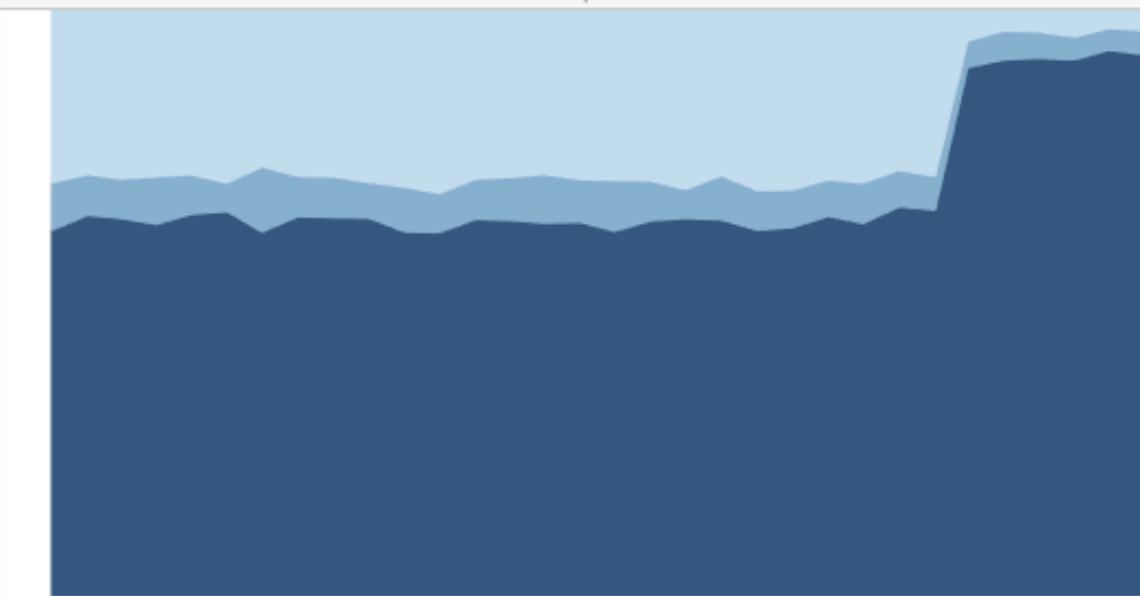
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Thank you!

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