CAPITAL HEALTH

Hospitals

# A Data Driven Approach to Better Care


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# AGENDA

1. OVERVIEW
2. ANALYSES
3. FINDING AND INSIGHTS
4. RECOMMENDATIONS
5. USE OF AI
6. REFERENCES

KEY METRICS

# Important Variables

## Account No.

The primary key that makes everything else work

## Diag10

Tells why the patient was there

## Admit Dt/Disch Dt

Primary Variable for time analysis across different branches

# About the Data

- **Four files** — HPW Adult, HPW Peds, RMC, Deborah
- **Time period** — March 2021 to February 2022
- **Each row = one unique patient visit**
- **Capacity file** adds arrival and departure times
- **Deborah** — outpatient only, no overnight stays

# Data Cleaning

Missing Values

Summary Statistics

Code Translation

Visual Validation

# Data Cleaning

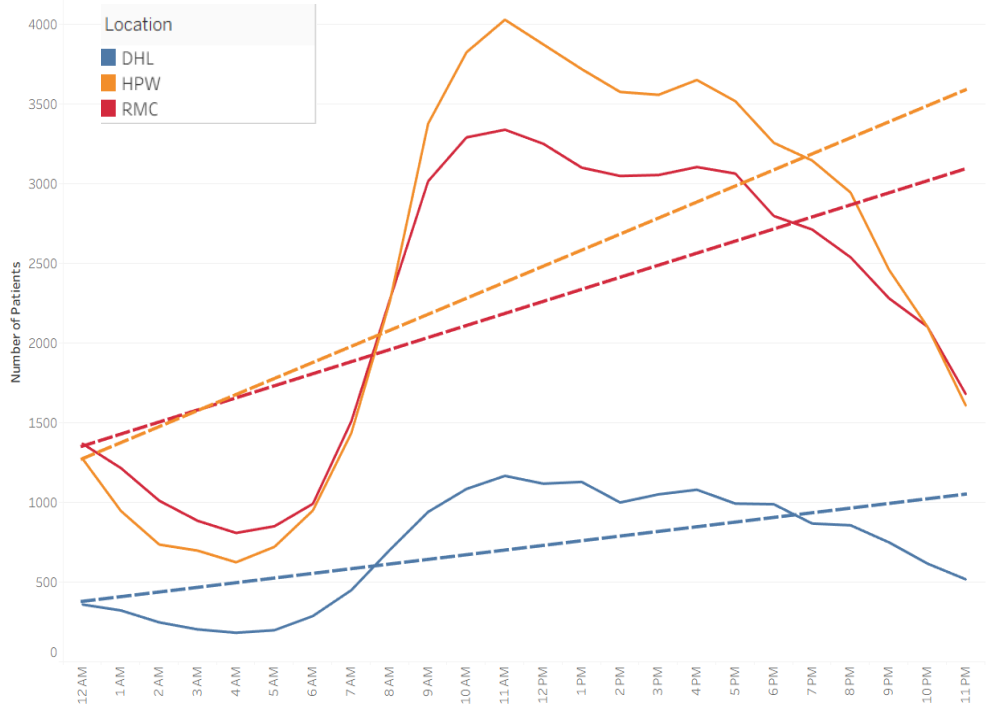
Formatting

Column Splitting

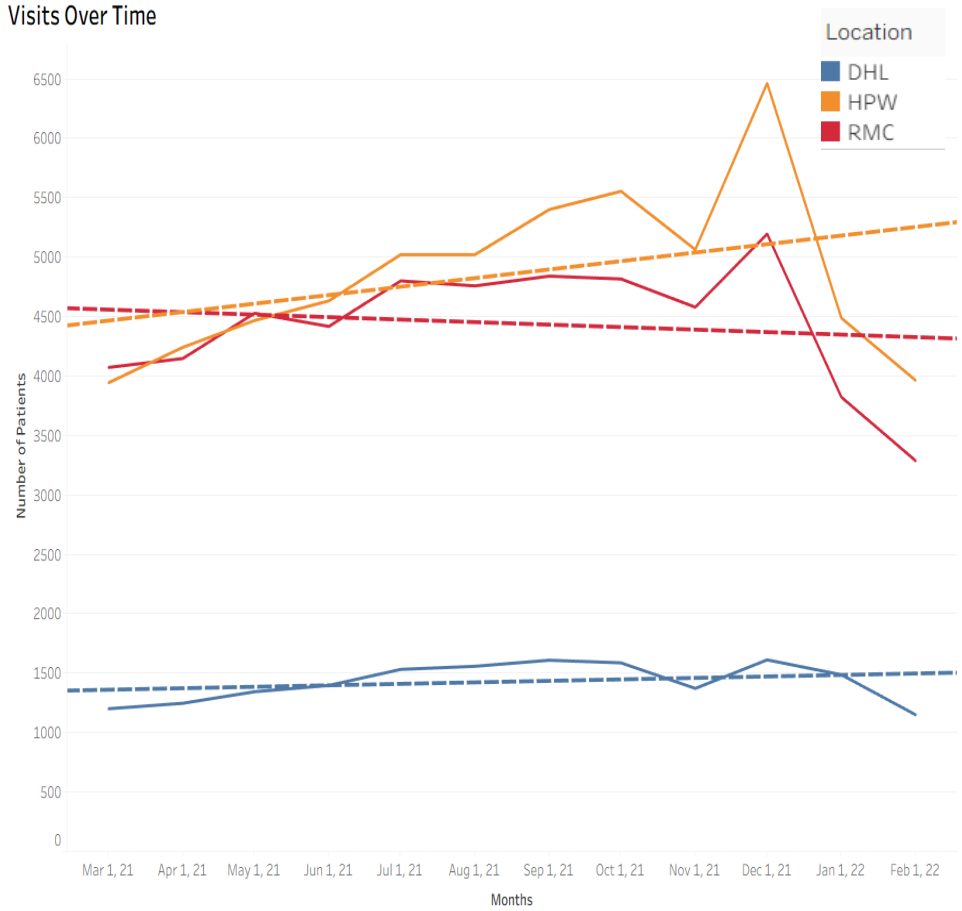
Chronological Validation

Duplicate Check

Visits by Hour




| Campus | Peak hour | Peak Volume | Lowest Hour | Lowest Volume | Trend |
|---|---|---|---|---|---|
| RMC | 11 AM | ~3,300 | 4–5 AM | ~750 | Upward |
| HPW | 10–11 AM | ~4,050 | 4–5 AM | ~625 | Upward |
| DHL | 11AM – 12 PM | ~1,175 | 4:00 AM | ~125 | Slight upward |




| Campus | Peak Month | Peak Volume | Lowest Month | Lowest Volume | Trend |
|---|---|---|---|---|---|
| RMC | Dec-21 | ~5,200 | Feb-22 | ~3,300 | Declining |
| HPW | Dec-21 | ~6,500 | Mar-21 | ~3,950 | Upward |
| DHL | Jun–Aug 2021 | ~1,600 | Mar 2021 / Feb 2022 | ~1,175 | Flat / stable |

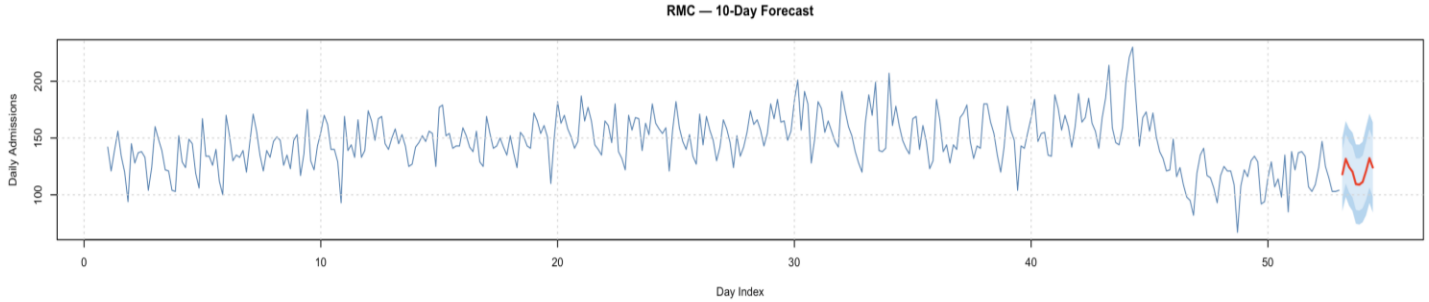
# ARIMA MODEL

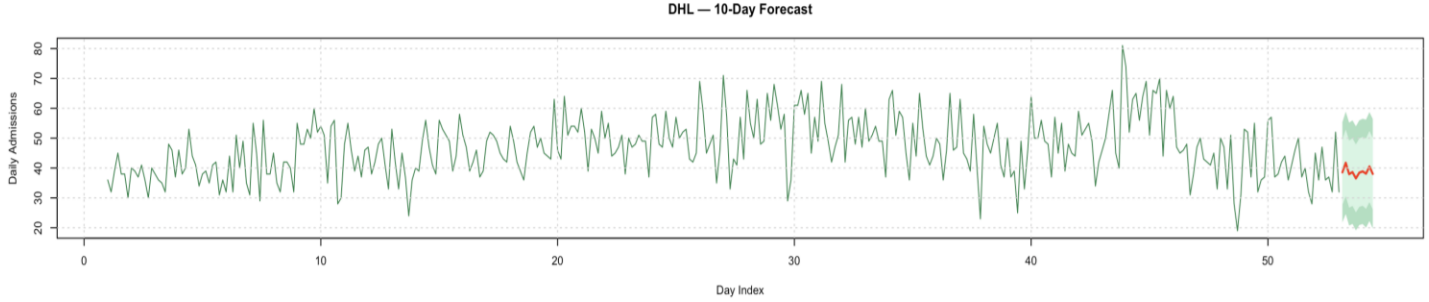
1. DHL → ARIMA(0,1,3): driven purely by past random shocks (noise only)

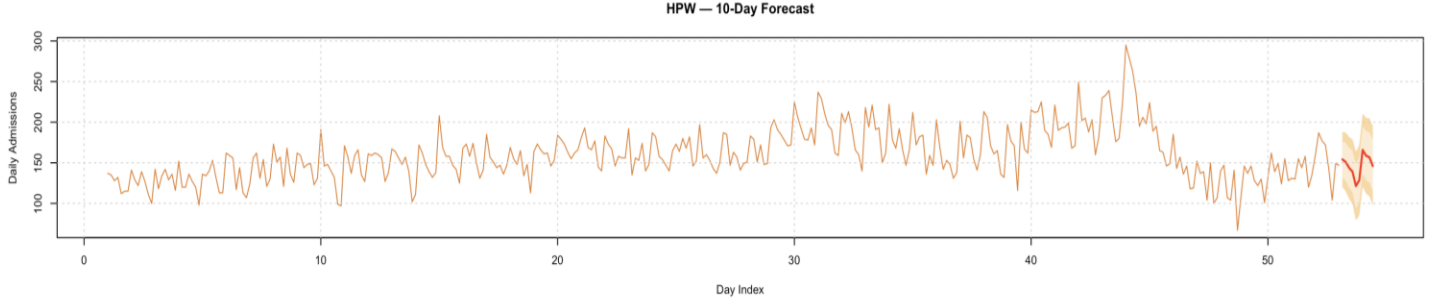
2. HPW → ARIMA(4,1,3): driven by both past admission patterns (signal) and random shocks (noise)

3. RMC → ARIMA(2,1,2): driven by both signal and noise, with strong day-to-day persistence

```
Series: DHL
ARIMA(0,1,3)

Coefficients:
         ma1      ma2     ma3
      -0.786  -0.1793  0.1114
s.e.   0.052   0.0657  0.0530

sigma^2 = 76.62:  log likelihood = -1305.33
AIC=2618.67   AICc=2618.78   BIC=2634.26
> auto.arima.HPW <- auto.arima(HPW)
> auto.arima.HPW
Series: HPW
ARIMA(4,1,3)

Coefficients:
          ar1     ar2      ar3      ar4      ma1      ma2     ma3
      -0.0091  0.1224  -0.5138  -0.3531  -0.5910  -0.2669  0.5450
s.e.   0.1700  0.1687   0.0952   0.0636   0.1727   0.2745  0.1358

sigma^2 = 462.8:  log likelihood = -1630.79
AIC=3277.57   AICc=3277.98   BIC=3308.75
> auto.arima.RMC <- auto.arima(RMC)
> auto.arima.RMC
Series: RMC
ARIMA(2,1,2)

Coefficients:
         ar1      ar2      ma1     ma2
      0.8969  -0.4535  -1.4851  0.6310
s.e.  0.0811   0.0666   0.0714  0.0722

sigma^2 = 336.6:  log likelihood = -1574.18
AIC=3158.35   AICc=3158.52   BIC=3177.84
```


RMC — 10-Day Forecast
Daily Admissions
100
150
200
0
10
20
30
40
50
Day Index


DHL — 10-Day Forecast
Daily Admissions
20
30
40
50
60
70
80
0
10
20
30
40
50
Day Index


HPW — 10-Day Forecast
Daily Admissions
100
150
200
250
300
0
10
20
30
40
50
Day Index

# Sentimental Analysis Review

**1 — RMC (Negative)** ★★☆☆☆ "Waited over 4 hours in the ER and not a single nurse came to update me. When I finally got seen, the care was fine — but the wait was unacceptable. I left feeling like a number, not a patient."
— Patient review, Capital Health RMC, 2021

**2 — RMC (Negative)** ★★☆☆☆ "I received a $1,200 bill with no breakdown and no explanation. When I called billing, no one could tell me what I was charged for. The doctor was great but the experience around it was a nightmare."
— Patient review, Capital Health RMC, 2022

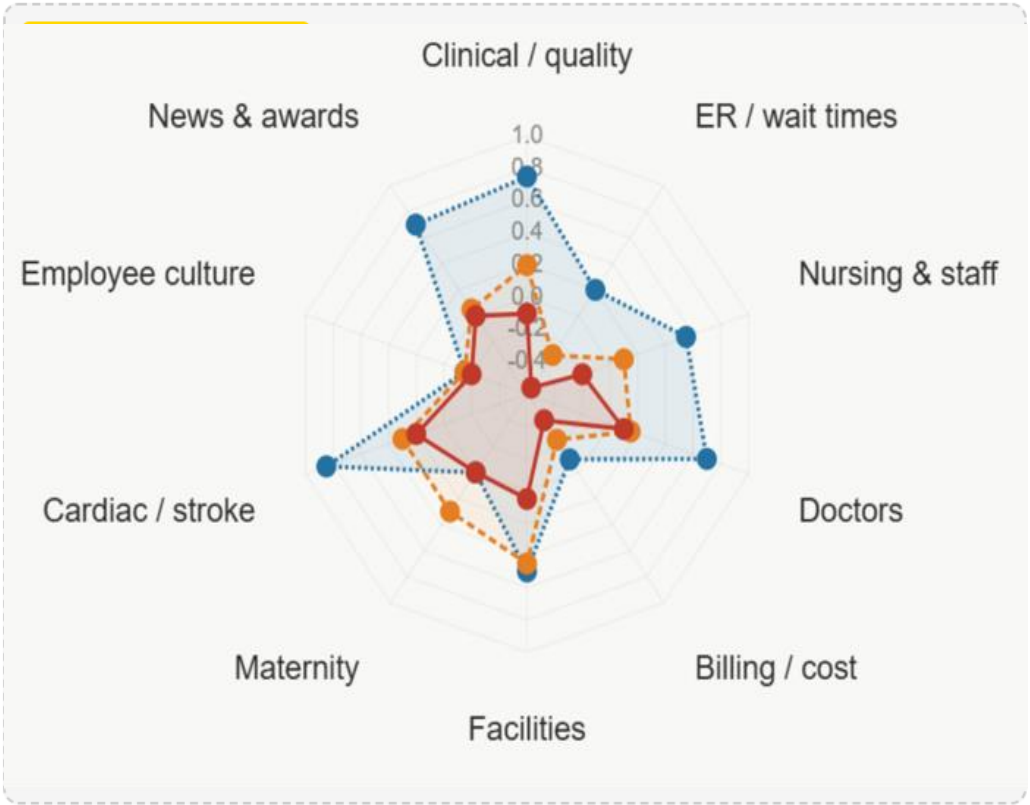
**3 — Hopewell (Mixed)** ★★★☆☆ "The facility was clean and the doctors were knowledgeable. The ER wait was long but manageable. Billing had a small error they fixed quickly. Overall decent, but room to improve."
— Patient review, Capital Health Hopewell, 2021

**4 — Hopewell (Positive)** ★★★★☆ "Had my baby here and the maternity team was wonderful — attentive, kind, and professional throughout. The postpartum nurses checked on me constantly. Would absolutely come back."
— Patient review, Capital Health Hopewell, 2022

**5 — Deborah (Positive)** ★★★★★ "The cardiac team at Deborah is in a league of their own. Every single nurse knew my chart. The doctors explained everything clearly. I never once felt rushed or ignored."
— Patient review, Deborah Heart & Lung Center, 2021

**6 — Deborah (Positive)** ★★★★★ "After two bad experiences at other hospitals, Deborah was a completely different world. Immaculate facility, zero wait, and a care team that genuinely felt invested in my recovery."
— Patient review, Deborah Heart & Lung Center, 2022

# Patient Sentiment Radar — 2021–2022




**BIGGEST WEAKNESS**

**ER wait times hit −0.55 at RMC**

Worst-scoring dimension across all campuses

**UNIVERSAL PAIN POINT**

**Billing is negative at every campus**

Only theme where even Deborah scores below zero

**DEBORAH'S STRENGTH**

**Cardiac care scores +0.85**

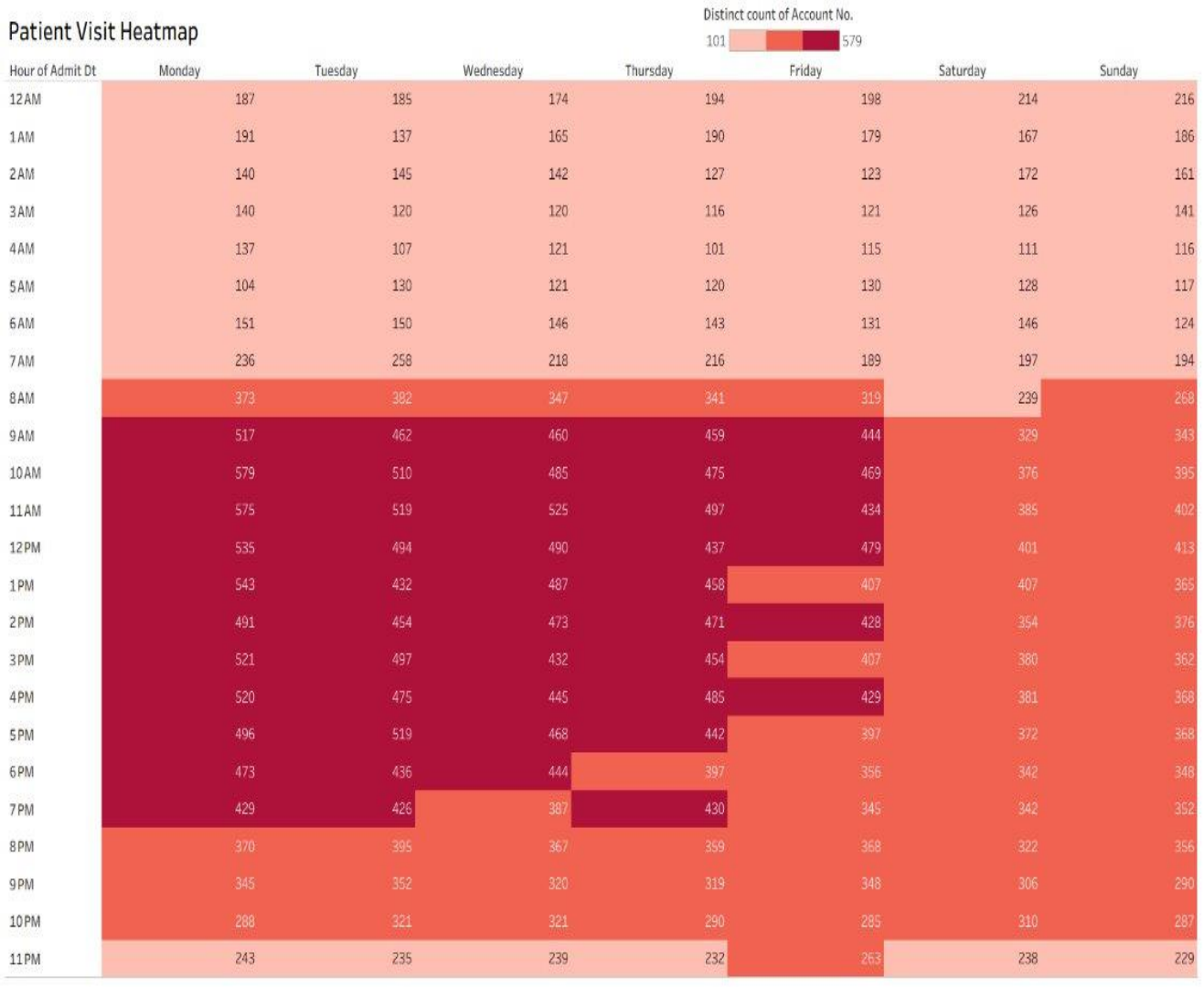
Far outperforms RMC & HPW on clinical dimensions

**HIDDEN RISK**

**Employee culture negative at all 3**

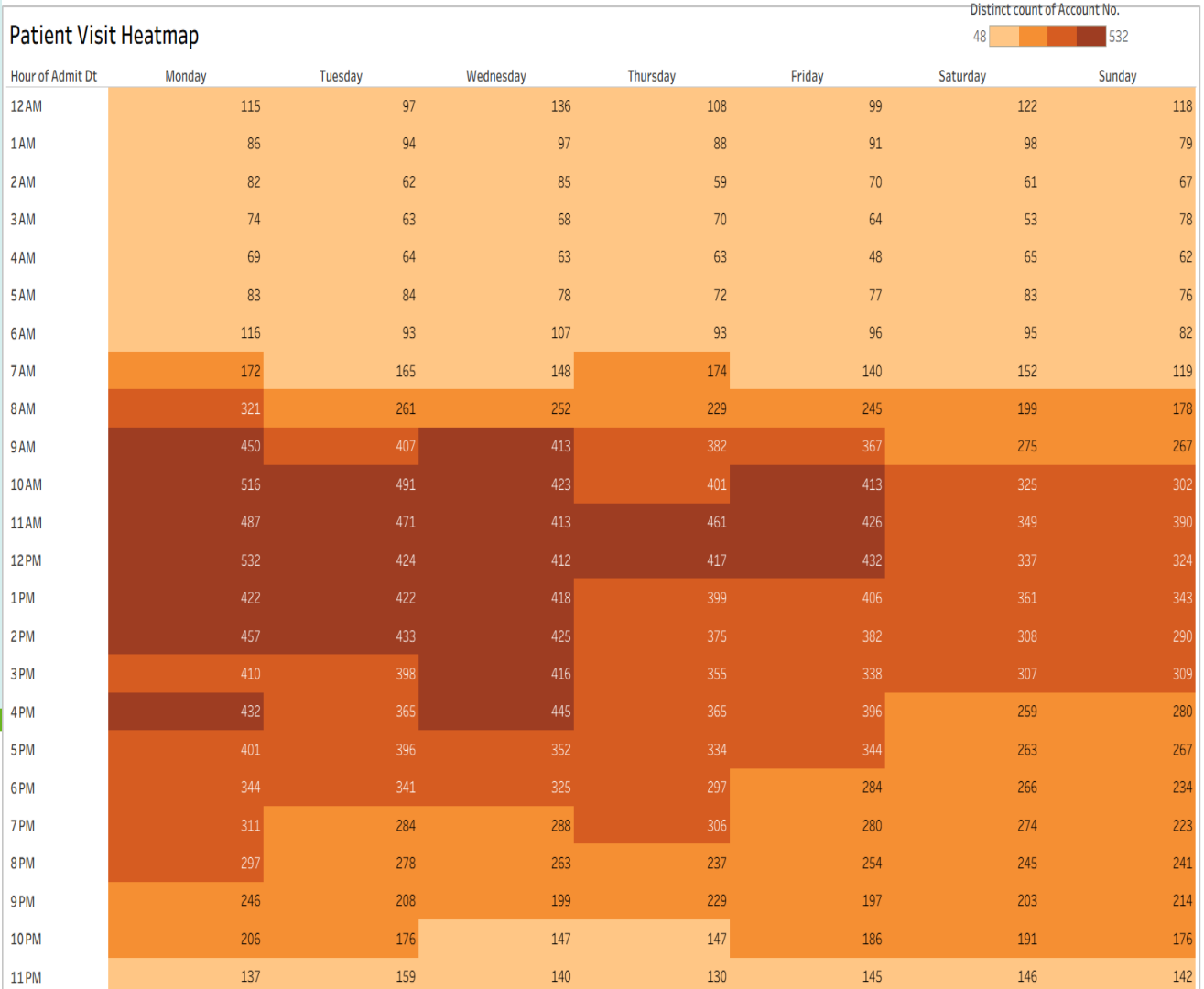
Staff dissatisfaction drives future patient experience decline

Composite scores — RMC: −0.30 · Hopewell: +0.05 · Deborah: +0.55 | Scale: −1.0 to +1.0 | Source: Patient reviews, CMS, Indeed 2021–22




# RMC

RMC sustains peak-level admissions from 9 AM through 6 PM daily — the heaviest and most prolonged demand of all three campuses. This sustained overload is the root cause of the −0.30 composite sentiment score, not clinical failure.




| Hour of Admit Dt | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 12 AM | 115 | 97 | 136 | 108 | 99 | 122 | 118 |
| 1 AM | 86 | 94 | 97 | 88 | 91 | 98 | 79 |
| 2 AM | 82 | 62 | 85 | 59 | 70 | 61 | 67 |
| 3 AM | 74 | 63 | 68 | 70 | 64 | 53 | 78 |
| 4 AM | 69 | 64 | 63 | 63 | 48 | 65 | 62 |
| 5 AM | 83 | 84 | 78 | 72 | 77 | 83 | 76 |
| 6 AM | 116 | 93 | 107 | 93 | 96 | 95 | 82 |
| 7 AM | 172 | 165 | 148 | 174 | 140 | 152 | 119 |
| 8 AM | 321 | 261 | 252 | 229 | 245 | 199 | 178 |
| 9 AM | 450 | 407 | 413 | 382 | 367 | 275 | 267 |
| 10 AM | 516 | 491 | 423 | 401 | 413 | 325 | 302 |
| 11 AM | 487 | 471 | 413 | 461 | 426 | 349 | 390 |
| 12 PM | 532 | 424 | 412 | 417 | 432 | 337 | 324 |
| 1 PM | 422 | 422 | 418 | 399 | 406 | 361 | 343 |
| 2 PM | 457 | 433 | 425 | 375 | 382 | 308 | 290 |
| 3 PM | 410 | 398 | 416 | 355 | 338 | 307 | 309 |
| 4 PM | 432 | 365 | 445 | 365 | 396 | 259 | 280 |
| 5 PM | 401 | 396 | 352 | 334 | 344 | 263 | 267 |
| 6 PM | 344 | 341 | 325 | 297 | 284 | 266 | 234 |
| 7 PM | 311 | 284 | 288 | 306 | 280 | 274 | 223 |
| 8 PM | 297 | 278 | 263 | 237 | 254 | 245 | 241 |
| 9 PM | 246 | 208 | 199 | 229 | 197 | 203 | 214 |
| 10 PM | 206 | 176 | 147 | 147 | 186 | 191 | 176 |
| 11 PM | 137 | 159 | 140 | 130 | 145 | 146 | 142 |

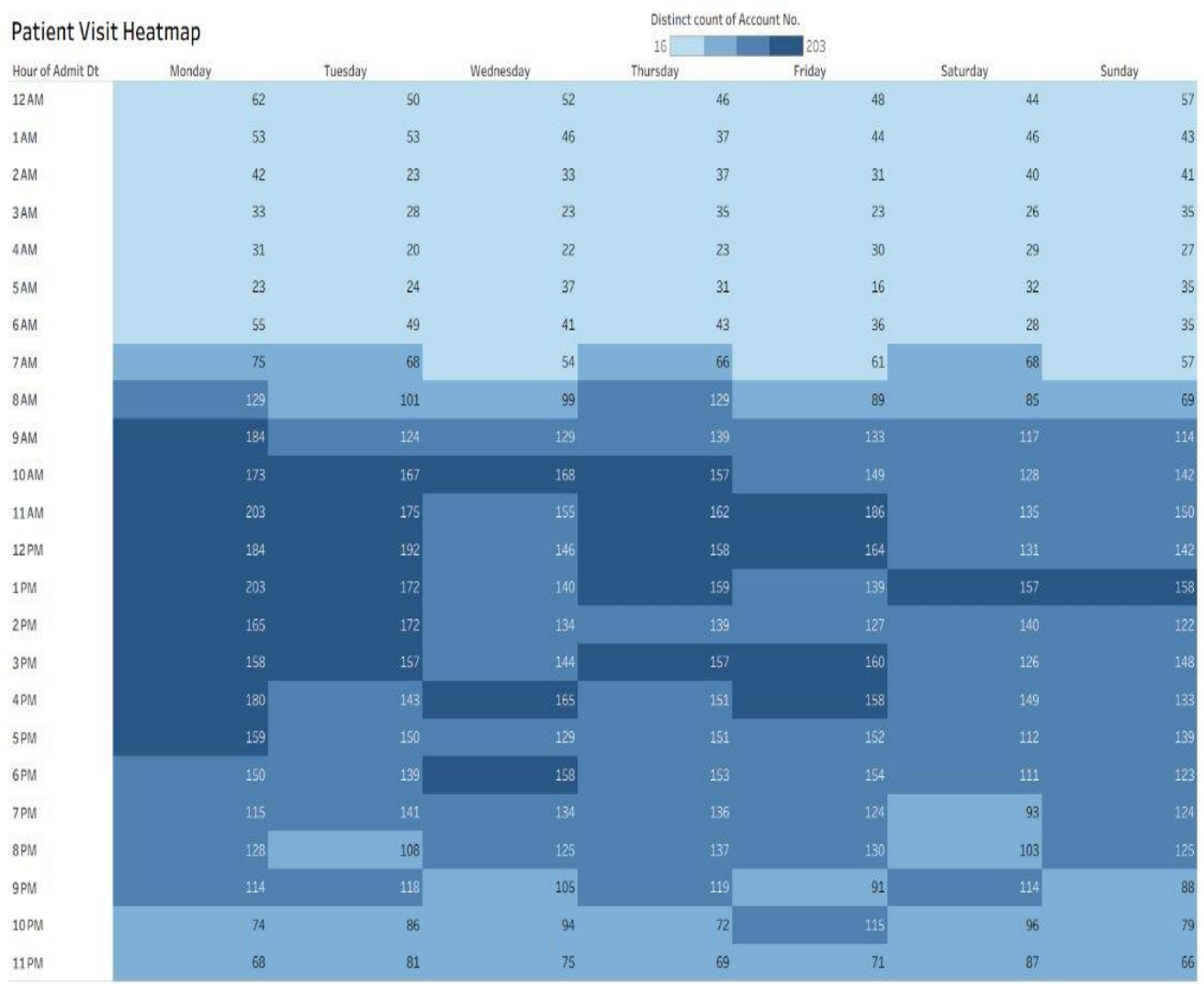
# HPW Adult

Hopewell Adult follows a similar weekday pattern but the volume is concentrated more in the morning — roughly 9 AM to 1 PM. Afternoons are lighter.


| Hour of Admit Dt | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 12 AM | 66 | 63 | 66 | 74 | 71 | 57 | 82 |
| 1 AM | 53 | 42 | 37 | 34 | 45 | 43 | 59 |
| 2 AM | 31 | 30 | 42 | 39 | 27 | 34 | 46 |
| 3 AM | 29 | 29 | 38 | 28 | 37 | 29 | 37 |
| 4 AM | 28 | 30 | 18 | 32 | 21 | 29 | 32 |
| 5 AM | 25 | 22 | 26 | 21 | 21 | 26 | 27 |
| 6 AM | 33 | 33 | 35 | 36 | 40 | 40 | 50 |
| 7 AM | 56 | 57 | 56 | 54 | 42 | 39 | 60 |
| 8 AM | 88 | 93 | 82 | 68 | 93 | 63 | 84 |
| 9 AM | 130 | 134 | 127 | 137 | 104 | 100 | 82 |
| 10 AM | 156 | 135 | 141 | 124 | 138 | 119 | 138 |
| 11 AM | 179 | 149 | 138 | 135 | 133 | 143 | 153 |
| 12 PM | 180 | 147 | 141 | 121 | 120 | 131 | 153 |
| 1 PM | 149 | 129 | 144 | 97 | 131 | 142 | 154 |
| 2 PM | 136 | 129 | 122 | 129 | 118 | 131 | 139 |
| 3 PM | 176 | 158 | 151 | 141 | 135 | 124 | 136 |
| 4 PM | 198 | 158 | 164 | 166 | 138 | 135 | 148 |
| 5 PM | 229 | 168 | 174 | 165 | 174 | 109 | 138 |
| 6 PM | 172 | 198 | 188 | 183 | 148 | 132 | 143 |
| 7 PM | 187 | 180 | 150 | 185 | 154 | 157 | 165 |
| 8 PM | 168 | 180 | 177 | 187 | 150 | 133 | 133 |
| 9 PM | 170 | 165 | 130 | 117 | 137 | 113 | 131 |
| 10 PM | 125 | 133 | 131 | 117 | 134 | 115 | 117 |
| 11 PM | 86 | 74 | 78 | 92 | 90 | 114 | 73 |

# HPW Peds

Pediatric visits peak later — 11 AM through 5 PM — and stay elevated on Mondays and Thursdays. Evening staffing is critical for this unit, unlike adult admissions.




# DHL

Deborah's volume is lower and spread evenly across the day with no extreme spikes. This steady flow allows staff to provide consistent, attentive care — directly reflected in its nursing score of +0.55 and clinical quality of +0.75.

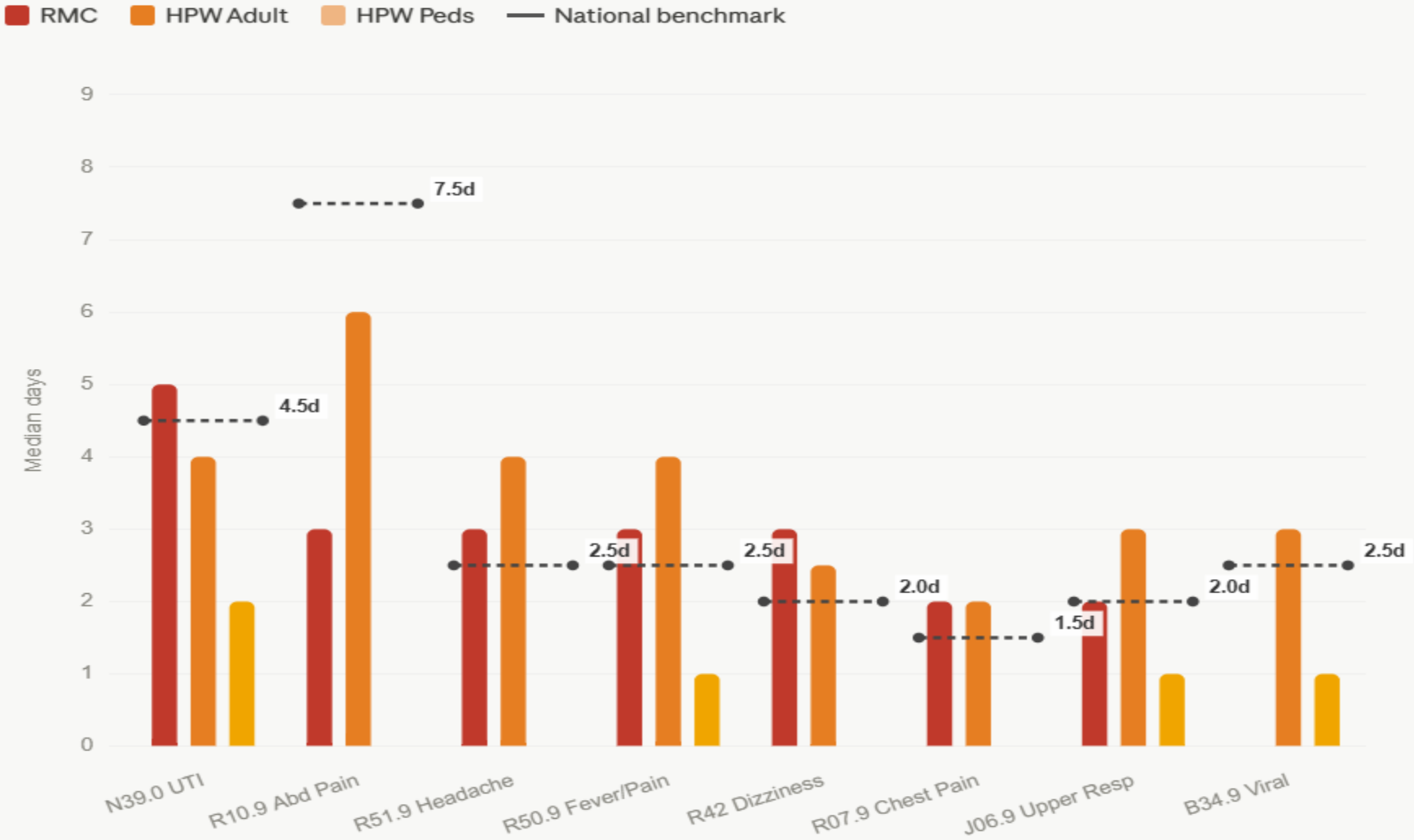
# Sentimental Analysis

✓ Accepted ✗ Not listed ~ Select plans only

| Insurance plan | NJ enrollment | Cap Health RMC | Cap Health HPW | Deborah H&L |
|---|---|---|---|---|
| **Medicare**<br>Traditional + Medicare Advantage | 1.7M | ✓ | ✓ | ✓ |
| **Horizon BCBS NJ**<br>PPO, HMO, Horizon NJ Health | 1.6M | ✓ | ✓ | ✓ |
| **Medicaid / NJ FamilyCare**<br>State Medicaid managed care | 1.5M | ✓ | ✓ | ✓ |
| **UnitedHealthcare (Medicaid)**<br>coverage gap<br>UHC Community & State, NJ | 345K | ✗ | ✗ | ✓ |
| **Aetna**<br>Commercial + Medicare Advantage | 291K | ✓ | ✓ | ✓ |
| **UnitedHealthcare (Commercial)**<br>coverage gap<br>Choice Plus, Choice, Select | 215K | ✗ | ✗ | ✓ |
| **Cigna**<br>Open Access Plus, LocalPlus | 198K | ✓ | ✓ | ✓ |
| **Amerigroup NJ** coverage gap<br>Medicaid managed care | 182K | ✗ | ✗ | ✗ |
| **Oxford Health Plans**<br>(UHC subsidiary) | ~130K | ✗ | ✗ | ✓ |

Coverage gap: ~872,000 NJ residents affected

Capital Health (RMC + HPW) does not accept UnitedHealthcare, Oxford, or Amerigroup — plans held by an estimated 872,000 New Jerseyans. Deborah accepts UHC and Oxford, giving it a significant access advantage. This gap is a likely structural driver of lower patient satisfaction scores at Capital Health facilities in 2021–2022.


RMC
HPW Adult
HPW Peds
National benchmark
Median days
9
8
7
6
5
4
3
2
1
0
7.5d
4.5d
2.5d
2.5d
2.0d
1.5d
2.0d
2.5d
N39.0 UTI
R10.9 Abd Pain
R51.9 Headache
R50.9 Fever/Pain
R42 Dizziness
R07.9 Chest Pain
J06.9 Upper Resp
B34.9 Viral

# Recommendations

- **Expand RMC Staffing Hours** — Increase staff coverage between 9 AM–6 PM to address sustained peak demand and improve patient wait time satisfaction scores.
- **Overhaul Billing Transparency** — Implement itemized billing statements and dedicated billing support staff to address the system-wide negative billing sentiment across all three campuses.
- **Extend HPW Pediatric Evening Coverage** — Schedule additional nursing staff through 5–6 PM on Mondays and Thursdays when pediatric volume remains elevated.
- **Invest in Employee Culture** — Launch staff satisfaction initiatives across all campuses, as negative employee sentiment poses a long-term risk to patient experience quality.
- **Negotiate New Insurance Contracts** — Pursue contracts with UnitedHealthcare, Oxford, and Amerigroup to close the coverage gap affecting an estimated 872,000 NJ residents.
- **Redistribute Patient Load Using ARIMA Forecasts** — Use the predictive admission models built for RMC, HPW, and DHL to proactively schedule resources and redirect non-urgent cases during peak periods

HOW IT WORKS

# How we used AI

1

## Data Cleaning & Presentation

Used AI to clean, organize, and structure large datasets for analysis.

2

## Coding & Tools Assistance

Used AI to improve and write code in R, Excel, and other tools used in the project

3

## Data Analysis Support

Used AI to help understand patterns, trends, and apply the right analysis methods.

4

## Insights & Presentation

Used AI to create clear visuals and improve explanations for better storytelling.

# References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# Thank You

## Question 1: RMC has the most patients and the longest average stay. What does that tell us about RMC's role in the Capital Health system?

Yes, RMC clearly is the busiest and most demanding facility in the system. In RMC patients stay longer which means they are coming in with more serious conditions that take more time to treat. Looking at the types of diagnoses at RMC, things like heart and circulatory problems show up frequently, and they clearly need more treatment time. So RMC is not just busy in terms of number of patients, it is busy with harder cases. Through which we can interpret that RMC needs more staff, more resources, and more specialist coverage compared to the other three facilities.

## Question 2: Deborah is part of the Capital Health system, so patients with those plans can still access care within our network. Why is this still a concern?

That's true, and it's an important clarification, however the concern is really about the volume, we're talking about an estimated 872,000 New Jersey residents whose plans aren't accepted at RMC or HPW specifically. Even within the same system, if patients are being funneled to one campus because of insurance limitations, that creates capacity and access imbalances. And it's also worth noting that Deborah specializes in heart and lung care, so a patient with UnitedHealthcare who needs something like an abdominal workup or a UTI treated isn't really being served by having access only to Deborah. They need RMC or HPW, and right now their insurance is a barrier to that.

## Question 3: HPW Adult ED and Hopewell Pediatrics are under the same Hopewell branch. Can we manage them together with the same budget and staffing plan?

No, that would cause more problems. Even though they fall under the same branch name, these two clinics are for very different purpose of treatment. HPW Adult ED sees a large number of patients with serious, long-term conditions that require significant time and resources. Whereas, Hopewell Peds see children with shorter, more basic diagnosis causes. If we try to apply one staffing plan to both, we will either have too many staff at the pediatric clinic or not enough at the adult ED. It's the same for budgeting, combining their finances could increase the problem as the adult ED needs more money and resources. The right approach is to run each clinic based on what it actually needs.