Describing EMS & Fire Data

In [101…
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import os
from dotenv import load_dotenv

load_dotenv()
```

Out[101… True

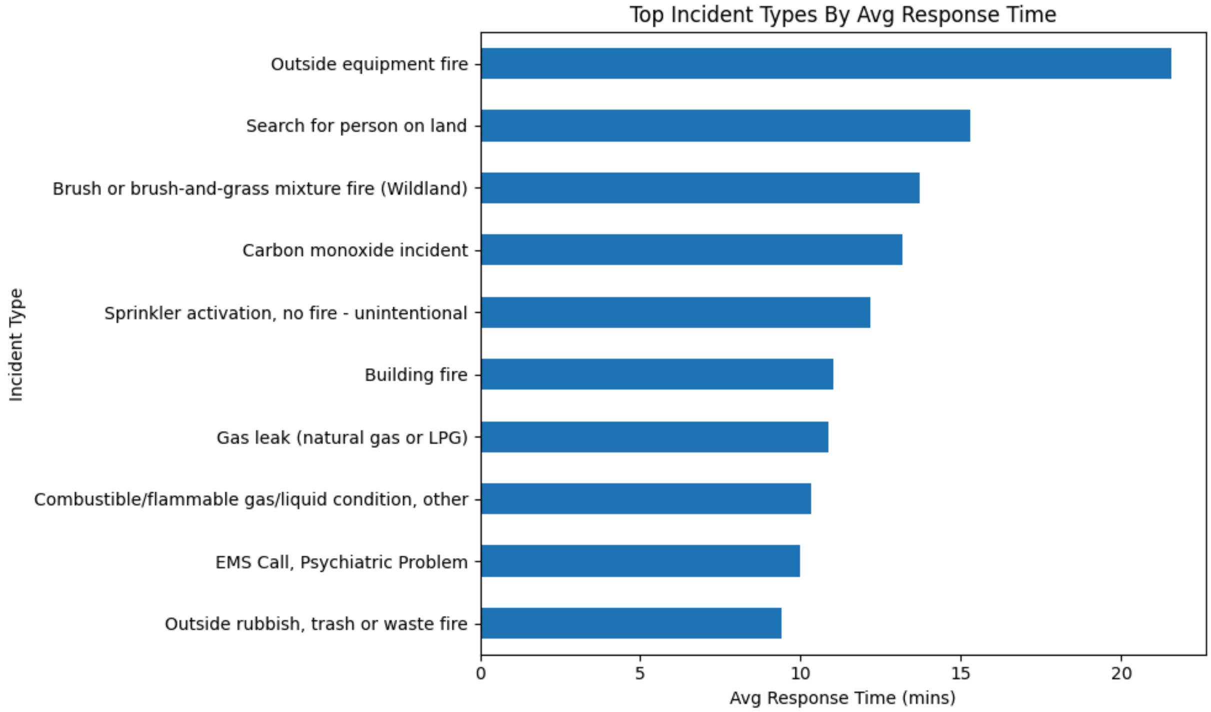
In [102…
```
ems_example_df = pd.read_csv(os.getenv('EMS_DATA_EXAMPLE_PATH'))
fire_example_df = pd.read_csv(os.getenv('FIRE_DATA_EXAMPLE_PATH'))


print("EMS DataFrame Shape:", ems_example_df.shape)
print("Fire DataFrame Shape:", fire_example_df.shape)
```

```
EMS DataFrame Shape: (2369, 11)
Fire DataFrame Shape: (6350, 28)
```

Average Response Time

In [103…
```
fire_example_df["dispatch_time"] = pd.to_datetime(fire_example_df["Apparatus
fire_example_df["arrive_time"] = pd.to_datetime(fire_example_df["Apparatus R

fire_example_df["resp_mins"] = (fire_example_df["arrive_time"] - fire_exampl

res = (
    fire_example_df.groupby("Basic Incident Type (FD1.21)")["resp_mins"]
    .mean()
    .sort_values(ascending=False)
    .dropna()
)

print("Top 5 Incident Types:")
print(res.head())

plt.figure(figsize=(10,6))
res.head(10).plot(kind="barh")
plt.xlabel("Avg Response Time (mins)")
plt.ylabel("Incident Type")
plt.title("Top Incident Types By Avg Response Time")
plt.gca().invert_yaxis()
plt.tight_layout()
plt.show()
```

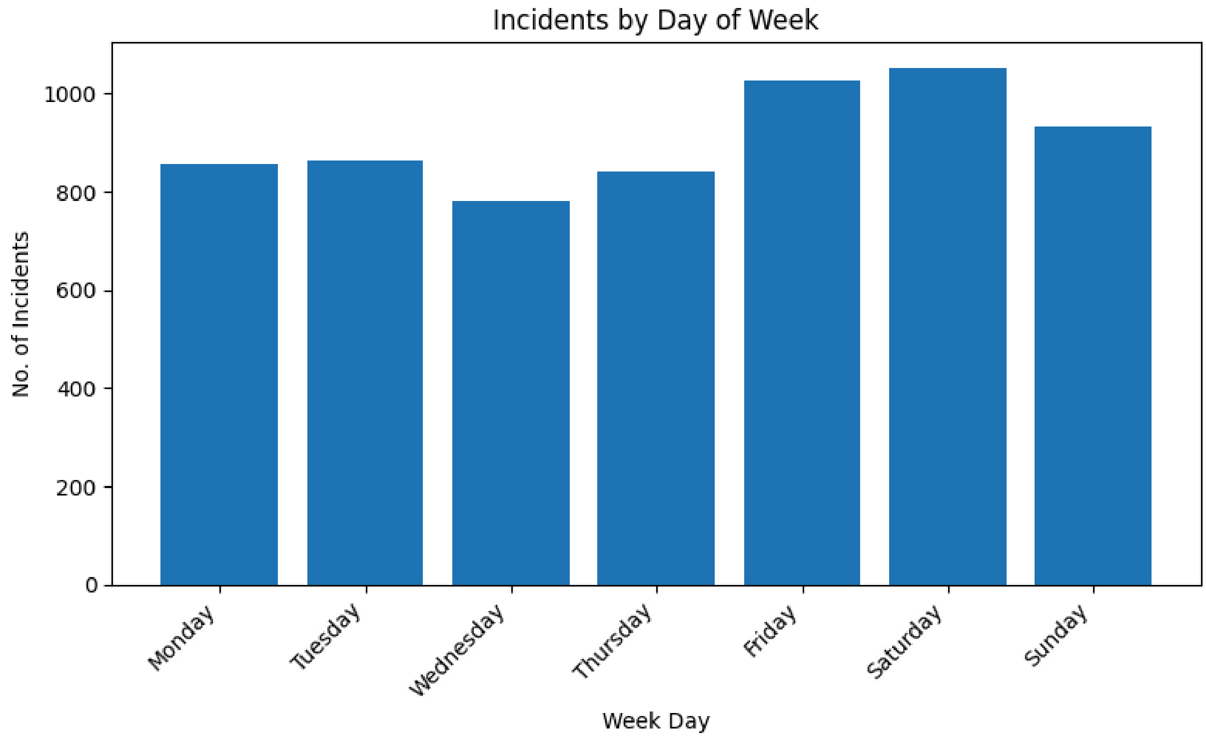
```
Top 5 Incident Types:
Basic Incident Type (FD1.21)
Outside equipment fire                                21.566667
Search for person on land                             15.296726
Brush or brush-and-grass mixture fire (Wildland)      13.733333
Carbon monoxide incident                              13.179365
Sprinkler activation, no fire - unintentional         12.191667
Name: resp_mins, dtype: float64
```



Incidents By Week

In [104…

```
days_of_week = ["Monday", "Tuesday", "Wednesday", "Thursday", "Friday", "Sat

day_stats = (fire_example_df["Basic Incident Day Name (FD1.3)"].value_counts

plt.figure(figsize=(8, 5))
plt.bar(day_stats.index, day_stats.values)
plt.xlabel("Week Day")
plt.ylabel("No. of Incidents")
plt.title("Incidents by Day of Week")
plt.xticks(rotation=45, ha="right")
plt.tight_layout()
plt.show()
```



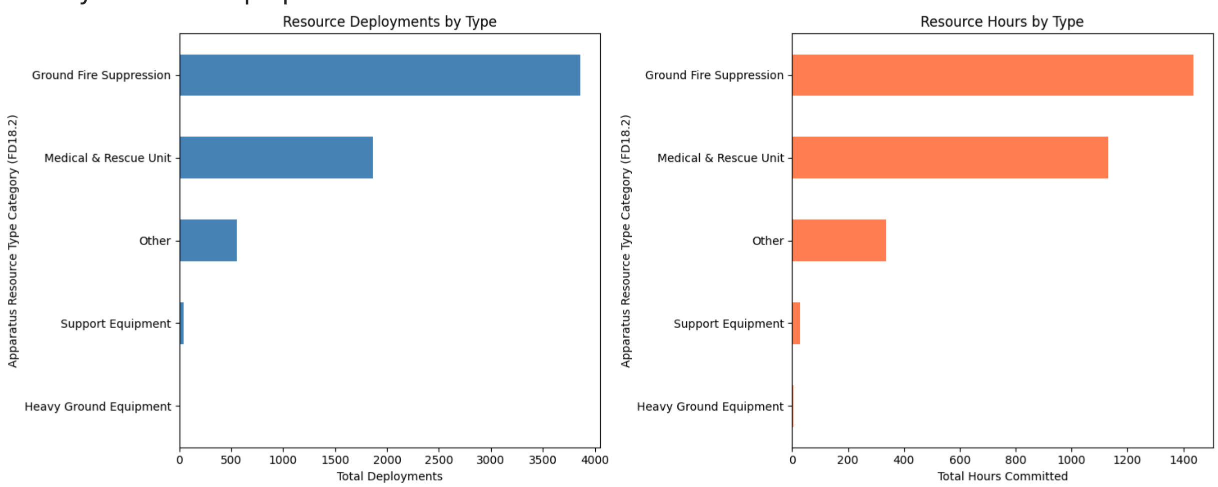
Resource Utilization

In [105…

```
fire_example_df["clear_time"] = pd.to_datetime(
    fire_example_df["Apparatus Resource Clear Date Time (FD18.5)"],
    errors="coerce"
)
fire_example_df["arrival_time"] = pd.to_datetime(
    fire_example_df["Apparatus Resource Arrival Date Time (FD18.4)"],
    errors="coerce"
)

fire_example_df["on_scene_time"] = (
    fire_example_df["clear_time"] - fire_example_df["arrival_time"]
).dt.total_seconds() / 60

resource_stats = (
    fire_example_df.groupby("Apparatus Resource Type Category (FD18.2)")
    .agg({
        "Apparatus Resource ID (FD18.1)": "count", "on_scene_time": "sum"
    })
    .rename(columns={"Apparatus Resource ID (FD18.1)": "deployment_total","c
)


resource_stats.dropna(inplace=True)
resource_stats["hours_total"] = resource_stats["hours_total"] / 60
resource_stats = resource_stats.sort_values("deployment_total", ascending=Fa

print("\nResource Utilization:")
print(resource_stats)

fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(15, 6))
```

```
resource_stats["deployment_total"].plot(kind="barh", ax=ax1, color="steelblu
ax1.set_xlabel("Total Deployments")
ax1.set_title("Resource Deployments by Type")
ax1.invert_yaxis()

resource_stats["hours_total"].plot(kind="barh", ax=ax2, color="coral")
ax2.set_xlabel("Total Hours Committed")
ax2.set_title("Resource Hours by Type")
ax2.invert_yaxis()

plt.tight_layout()
plt.show()
```

```
Resource Utilization:
                                           deployment_total  hours_total
Apparatus Resource Type Category (FD18.2)
Ground Fire Suppression                                3858  1435.302222
Medical & Rescue Unit                                  1866  1132.722222
Other                                                   558   335.326944
Support Equipment                                        45    28.299167
Heavy Ground Equipment                                    6     3.114722
```



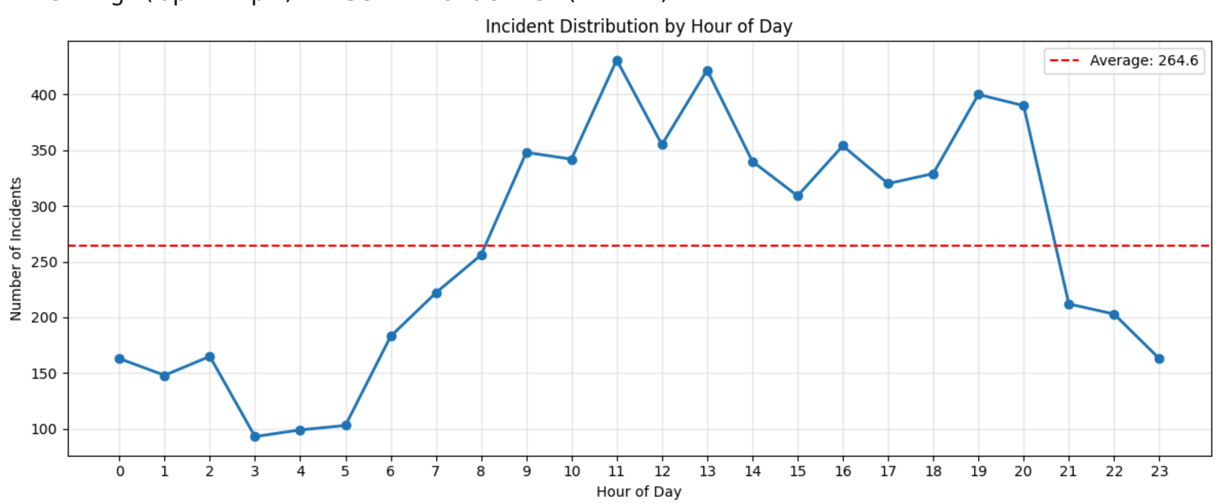
Peak Hour Analysis

In [106…

```
fire_example_df["dispatch_dt"] = pd.to_datetime(
    fire_example_df["Apparatus Resource Dispatch Date Time (FD18.3)"],
    errors="coerce"
)
fire_example_df["hour"] = fire_example_df["dispatch_dt"].dt.hour

hourly_incidents = fire_example_df.groupby("hour").size()

print("\n Peak Hour Analysis \n")
print(f"Mean incidents per hour: {hourly_incidents.mean():.2f}")
print(f"Median incidents per hour: {hourly_incidents.median():.2f}")
print(f"Std deviation: {hourly_incidents.std():.2f}")
print(f"\nPeak hour: {hourly_incidents.idxmax()}:00 with {hourly_incidents.m
print(f"Lowest hour: {hourly_incidents.idxmin()}:00 with {hourly_incidents.m
```

```
print(f"\nTop 5 busiest hours:")

for hour, count in hourly_incidents.sort_values(ascending=False).head(5).ite
    print(f"  {hour}:00 - {count} incidents ({count/hourly_incidents.sum()*1


print(f"\nBottom 5 quietest hours:")
for hour, count in hourly_incidents.sort_values(ascending=True).head(5).item
    print(f"  {hour}:00 - {count} incidents ({count/hourly_incidents.sum()*1


morning_rush = hourly_incidents[6:10].sum() #6 to 10am
midday = hourly_incidents[10:14].sum() #10am to 2pm
afternoon_rush = hourly_incidents[14:18].sum() #2pm to 6pm
evening = hourly_incidents[18:23].sum() #6pm to 11pm
overnight = hourly_incidents[list(range(0,6)) + [23]].sum() #11pm to 6am

print(f"\n Time Period Distribution \n")
print(f"Overnight (11pm-6am): {overnight} incidents ({overnight/hourly_incic
print(f"Morning rush (6am-10am): {morning_rush} incidents ({morning_rush/hou
print(f"Midday (10am-2pm): {midday} incidents ({midday/hourly_incidents.sum(
print(f"Afternoon rush (2pm-6pm): {afternoon_rush} incidents ({afternoon_rus
print(f"Evening (6pm-11pm): {evening} incidents ({evening/hourly_incidents.s

plt.figure(figsize=(12, 5))
plt.plot(hourly_incidents.index, hourly_incidents.values, marker='o', linewi
plt.xlabel("Hour of Day")
plt.ylabel("Number of Incidents")
plt.title("Incident Distribution by Hour of Day")
plt.xticks(range(0, 24))
plt.grid(True, alpha=0.3)
plt.axhline(y=hourly_incidents.mean(), color='r', linestyle='--', label=f'Av
plt.legend()
plt.tight_layout()
plt.show()
```

```
 Peak Hour Analysis

Mean incidents per hour: 264.58
Median incidents per hour: 282.50
Std deviation: 108.90

Peak hour: 11:00 with 431 incidents
Lowest hour: 3:00 with 93 incidents

Top 5 busiest hours:
  11:00 - 431 incidents (6.8%)
  13:00 - 422 incidents (6.6%)
  19:00 - 400 incidents (6.3%)
  20:00 - 390 incidents (6.1%)
  12:00 - 355 incidents (5.6%)

Bottom 5 quietest hours:
  3:00 - 93 incidents (1.5%)
  4:00 - 99 incidents (1.6%)
  5:00 - 103 incidents (1.6%)
  1:00 - 148 incidents (2.3%)
  0:00 - 163 incidents (2.6%)

 Time Period Distribution

Overnight (11pm-6am): 934 incidents (14.7%)
Morning rush (6am-10am): 1009 incidents (15.9%)
Midday (10am-2pm): 1550 incidents (24.4%)
Afternoon rush (2pm-6pm): 1323 incidents (20.8%)
Evening (6pm-11pm): 1534 incidents (24.2%)
```



Response By Postal Code Analysis

In [107…

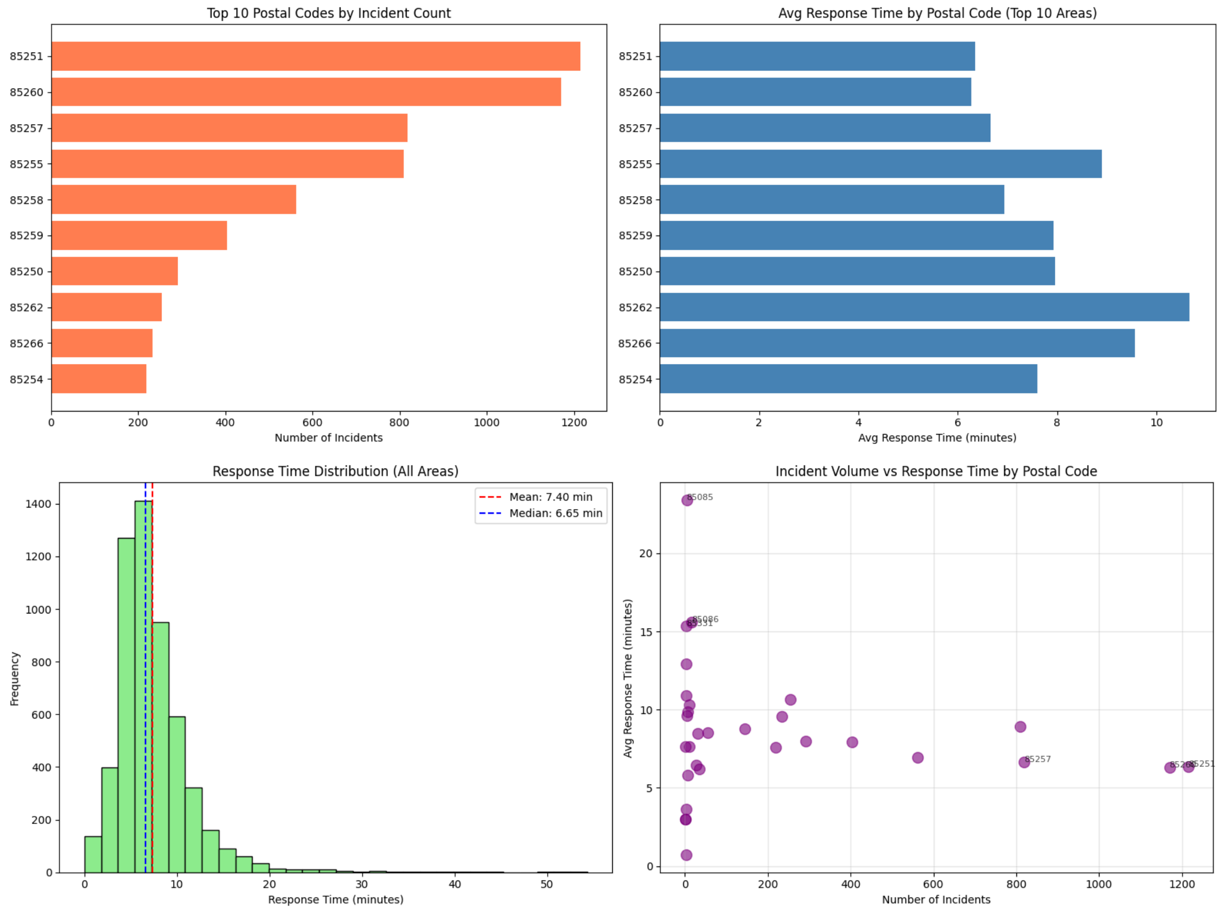
```
geo_analysis = fire_example_df[
    fire_example_df['Basic Incident Postal Code (FD1.19)'].notna() &
    (fire_example_df['Basic Incident Postal Code (FD1.19)'] != '')
].copy()

geo_analysis['dispatch_time'] = pd.to_datetime(
    geo_analysis['Apparatus Resource Dispatch Date Time (FD18.3)'],
    errors='coerce'
```

```
)
geo_analysis['arrival_time'] = pd.to_datetime(
    geo_analysis['Apparatus Resource Arrival Date Time (FD18.4)'],
    errors='coerce'
)
geo_analysis['response_minutes'] = (
    geo_analysis['arrival_time'] - geo_analysis['dispatch_time']
).dt.total_seconds() / 60

postal_stats = geo_analysis.groupby('Basic Incident Postal Code (FD1.19)').a
    'Basic Incident Number (FD1)': 'count',
    'response_minutes': 'mean'
}).rename(columns={
    'Basic Incident Number (FD1)': 'incident_count',
    'response_minutes': 'avg_response_time'
}).sort_values('incident_count', ascending=False)

postal_stats = postal_stats[postal_stats['avg_response_time'].notna()]




print("\n Geographic Response Analysis by Postal Code \n")
postal_display = postal_stats.head(15).copy()
postal_display['avg_response_time'] = postal_display['avg_response_time'].ro
postal_display.columns = ['Incidents', 'Avg Response (min)']
print(postal_display)




fig1, axes1 = plt.subplots(1, 2, figsize=(16, 6))

top_postal_codes = postal_stats.head(10)
axes1[0].barh(range(len(top_postal_codes)), top_postal_codes['incident_count
axes1[0].set_yticks(range(len(top_postal_codes)))
axes1[0].set_yticklabels(top_postal_codes.index)
axes1[0].set_xlabel("Number of Incidents")
axes1[0].set_title("Top 10 Postal Codes by Incident Count")
axes1[0].invert_yaxis()

axes1[1].barh(range(len(top_postal_codes)), top_postal_codes['avg_response_t
axes1[1].set_yticks(range(len(top_postal_codes)))
axes1[1].set_yticklabels(top_postal_codes.index)
axes1[1].set_xlabel("Avg Response Time (minutes)")
axes1[1].set_title("Avg Response Time by Postal Code (Top 10 Areas)")
axes1[1].invert_yaxis()

plt.tight_layout()
plt.show()

fig2, axes2 = plt.subplots(1, 2, figsize=(16, 6))

response_times_valid = geo_analysis['response_minutes'].dropna()
response_times_valid = response_times_valid[
    (response_times_valid > 0) & (response_times_valid < 60)
```

```
]



axes2[0].hist(response_times_valid, bins=30, color='lightgreen', edgecolor='
axes2[0].axvline(response_times_valid.mean(), color='red', linestyle='--',
                label=f'Mean: {response_times_valid.mean():.2f} min')
axes2[0].axvline(response_times_valid.median(), color='blue', linestyle='--'
                label=f'Median: {response_times_valid.median():.2f} min')
axes2[0].set_xlabel("Response Time (minutes)")
axes2[0].set_ylabel("Frequency")
axes2[0].set_title("Response Time Distribution (All Areas)")
axes2[0].legend()

axes2[1].scatter(postal_stats['incident_count'],
               postal_stats['avg_response_time'],
               alpha=0.6, s=100, color='purple')
axes2[1].set_xlabel("Number of Incidents")
axes2[1].set_ylabel("Avg Response Time (minutes)")
axes2[1].set_title("Incident Volume vs Response Time by Postal Code")
axes2[1].grid(True, alpha=0.3)

for idx, row in postal_stats.iterrows():
    if row['incident_count'] > postal_stats['incident_count'].quantile(0.9)
       row['avg_response_time'] > postal_stats['avg_response_time'].quantile
        axes2[1].annotate(idx,
                         (row['incident_count'], row['avg_response_time'])
                         fontsize=8, alpha=0.7)

plt.tight_layout()
plt.show()

print(f"\n Geographic Response Summary \n")
summary_data = {
    'Metric': [
        'Total unique postal codes served',
        'Overall average response time (min)',
        'Fastest avg response (min)',
        'Fastest response postal code',
        'Slowest avg response (min)',
        'Slowest response postal code'
    ],
    'Value': [
        len(postal_stats),
        round(postal_stats['avg_response_time'].mean(), 2),
        round(postal_stats['avg_response_time'].min(), 2),
        postal_stats['avg_response_time'].idxmin(),
        round(postal_stats['avg_response_time'].max(), 2),
        postal_stats['avg_response_time'].idxmax()
    ]
}
summary_df = pd.DataFrame(summary_data)
print(summary_df.to_string(index=False))
```

Geographic Response Analysis by Postal Code

Basic Incident Postal Code (FD1.19)	Incidents	Avg Response (min)
85251	1215	6.35
85260	1170	6.28
85257	819	6.66
85255	810	8.90
85258	562	6.94
85259	404	7.92
85250	292	7.96
85262	254	10.66
85266	233	9.56
85254	219	7.60
85253	144	8.77
85018	55	8.55
85288	35	6.18
85054	31	8.47
85008	28	6.44



Geographic Response Summary

Metric	Value
Total unique postal codes served	30.00
Overall average response time (min)	8.55
Fastest avg response (min)	0.73
Fastest response postal code	85031.00
Slowest avg response (min)	23.39
Slowest response postal code	85085.00

Additional EMS Stats

In [108…

```
ems_example_df['left_scene_time'] = pd.to_datetime(
    ems_example_df['Incident Unit Left Scene Date Time (eTimes.09)'],
    errors='coerce'
)
ems_example_df['hospital_arrival_time'] = pd.to_datetime(
    ems_example_df['Incident Patient Arrived At Destination Date Time (eTime
    errors='coerce'
)

ems_example_df['transport_time'] = (
    ems_example_df['hospital_arrival_time'] - ems_example_df['left_scene_tim
).dt.total_seconds() / 60
ems_example_df['was_transported'] = ems_example_df['hospital_arrival_time'].


unit_stats = ems_example_df.groupby('Response EMS Unit Call Sign (eResponse.
    'Response Incident Number (eResponse.03)': 'count',
    'was_transported': 'sum',
    'transport_time': 'mean'
}).rename(columns={
    'Response Incident Number (eResponse.03)': 'Total Calls',
    'was_transported': 'Transported',
    'transport_time': 'Avg Transport Time (min)'
}).sort_values('Total Calls', ascending=False).head(10)
unit_stats['Transport Rate (%)'] = (unit_stats['Transported'] / unit_stats['
unit_stats['Avg Transport Time (min)'] = unit_stats['Avg Transport Time (mir




print("EMS Unit Analysis (Top 10)")
print(unit_stats[['Total Calls', 'Transported', 'Transport Rate (%)', 'Avg T

fig1, ax1 = plt.subplots(figsize=(12, 6))
ax1.bar(unit_stats.index, unit_stats['Transport Rate (%)'], color='steelblue
ax1.set_xlabel('EMS Unit', fontsize=12)
ax1.set_ylabel('Transport Rate (%)', fontsize=12)
ax1.set_title('Hospital Transport Rate by Unit', fontsize=14)
ax1.tick_params(axis='x', rotation=45)
ax1.grid(axis='y', alpha=0.3)
plt.tight_layout()
plt.show()

fig2, (ax2, ax3) = plt.subplots(1, 2, figsize=(14, 5))



top_units = unit_stats.head(10)
ax2.barh(range(len(top_units)), top_units['Total Calls'].values, color='red'
ax2.set_yticks(range(len(top_units)))
ax2.set_yticklabels(top_units.index)
ax2.set_xlabel('Number of Calls', fontsize=12)
```

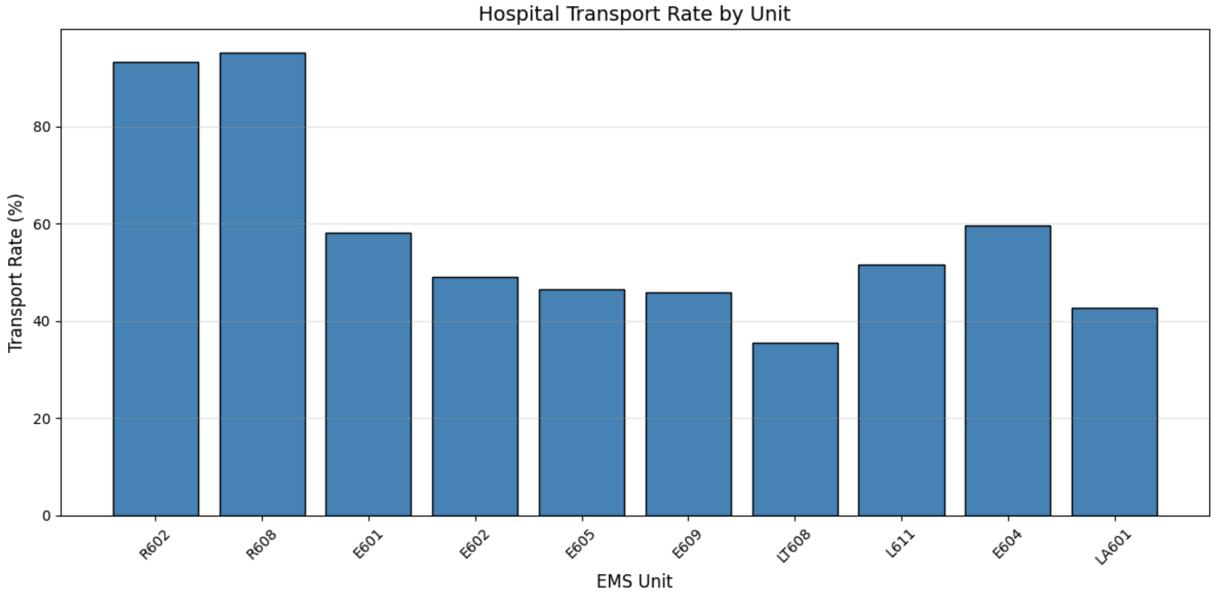
```
ax2.set_title('Top 10 Units by Call Volume', fontsize=12)
ax2.invert_yaxis()
ax2.grid(axis='x', alpha=0.3)

transport_times = ems_example_df['transport_time'].dropna()
transport_times = transport_times[(transport_times > 0) & (transport_times <
ax3.hist(transport_times, bins=25, color='coral')
ax3.axvline(transport_times.mean(), color='red', linestyle='--', label=f'Mea
ax3.axvline(transport_times.median(), color='blue', linestyle='--', label=f'
ax3.set_xlabel('Transport Time (minutes)', fontsize=12)
ax3.set_ylabel('Frequency', fontsize=12)
ax3.set_title('Transport Time Distribution', fontsize=12)
ax3.legend()
ax3.grid(axis='y', alpha=0.3)

plt.tight_layout()
plt.show()

total = len(ems_example_df)
transported = ems_example_df['was_transported'].sum()
transport_rate = transported / total * 100
busiest_unit = unit_stats.index[0]
busiest_unit_calls = unit_stats['Total Calls'].values[0]
busiest_unit_pct = busiest_unit_calls / total * 100

print("Additional Insights")
print(f"Transport Rate")
print(f"{transported:,} of {total:,} calls transported ({transport_rate:.1f}

print(f"Busiest Unit")
print(f"{busiest_unit}: {busiest_unit_calls:,} calls ({busiest_unit_pct:.1f}
```

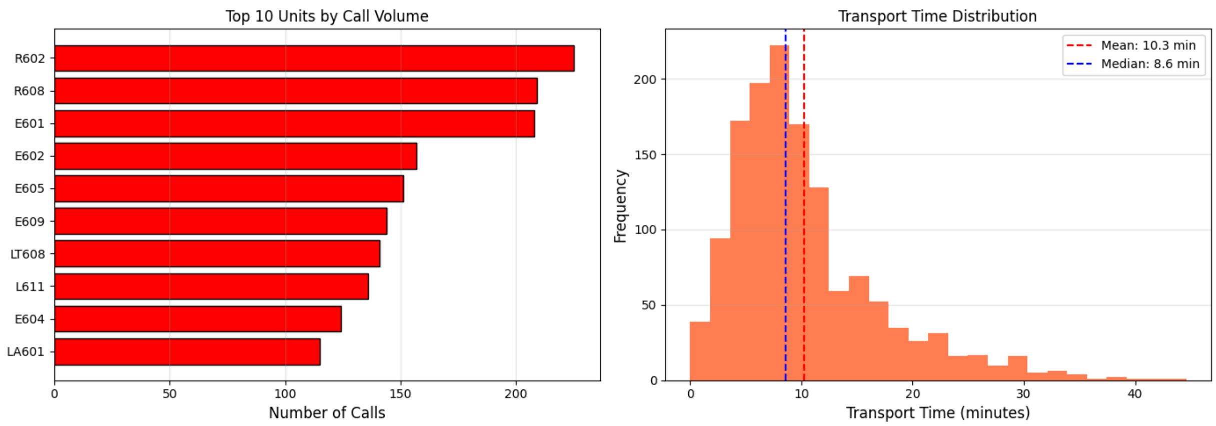
EMS Unit Analysis (Top 10)

Response EMS Unit Call Sign (eResponse.14)	Total Calls	Transported \
R602	225	210
R608	209	199
E601	208	121
E602	157	77
E605	151	70
E609	144	66
LT608	141	50
L611	136	70
E604	124	74
LA601	115	49

Response EMS Unit Call Sign (eResponse.14)	Transport Rate (%) \
R602	93.3
R608	95.2
E601	58.2
E602	49.0
E605	46.4
E609	45.8
LT608	35.5
L611	51.5
E604	59.7
LA601	42.6

Response EMS Unit Call Sign (eResponse.14)	Avg Transport Time (min)
R602	7.84
R608	10.76
E601	10.46
E602	6.01
E605	10.42
E609	10.93
LT608	9.78
L611	10.30
E604	8.22
LA601	7.31






```
Additional Insights
Transport Rate
1,375 of 2,369 calls transported (58.0%)

Busiest Unit
R602: 225 calls (9.5% of total)
```