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# The Role of Data Visualization in Healthcare Analytics

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**Author's full name: Roja Boina**

Designation: SESA

Name of the College or University: WID

**Author's full name: Alekhya Achanta**

Designation: DataOps Engineer

Name of the College or University: Continental Properties

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## Introduction

Healthcare organizations leverage data to make more informed decisions and improve patient outcomes. Advanced analytics provides ways to derive insights from complex healthcare data. However, a key challenge is presenting those insights in an intuitive way to diverse stakeholders. Data visualization is emerging as a solution to enable compelling yet comprehensible analysis reports. This paper examines how data visualization enhances healthcare analytics across various applications from patient health records to population health trends.

## Background

The healthcare sector generates vast amounts of data from sources like electronic medical records, insurance claims, clinical research and wearables. The total volume of healthcare data is estimated to reach 2.3 billion gigabytes by 2020 (Raghupathi & Raghupathi, 2014). However, raw data alone cannot provide value. Analytics methodologies are needed to analyze relationships, patterns and trends that support clinical and business objectives.

Analytics models can identify effective treatments, optimize resource allocation, minimize readmissions, improve patient satisfaction and more. But model outputs alone need to convey insights effectively. Stakeholders ranging from doctors to hospital administrators to patients require summarized data analysis presentations. This is where data visualization becomes critical in healthcare analytics.

Data visualization represents information graphically through charts, graphs, and other visual elements. It utilizes principles like statistics, design, psychology and computer science. Visualizations can present large amounts of complex data in efficient and meaningful ways (Brennan et al., 2015). Well-designed visuals leverage human visual processing capabilities to spot trends and patterns faster than looking at raw numbers or text. Data visualization makes healthcare analytics more consumable and impactful for diverse audiences.

## Benefits of Data Visualization in Healthcare

Make data analysis accessible to all stakeholders

A core benefit of data visualization is expanding accessibility to analytics insights beyond just technical experts. Doctors can better understand clinical dashboards to treat patients. Healthcare managers can track operational metrics more intuitively through data visualizations integrated into reports or systems. Patients also increasingly access their own health data, and visual presentation creates more engaging user experiences. Tailored visualizations can make analytics consumable for any stakeholder.

#### Faster and clearer insight identification

Visual elements like charts, graphs and maps allow stakeholders to discern key trends and relationships in data more quickly than alternate formats. Interactive capabilities further allow drilling down into details. Data visualization minimizes cognitive load for identifying relevant insights. For instance, a simple timeseries chart easily shows monthly trends in patient volumes as opposed to tables of numbers (Ghassemi et al., 2015). Intuitive recognition of patterns through visuals enhances productivity in analytics.

#### Present multidimensional perspectives

Healthcare data is often highly multidimensional, involving cost, clinical outcomes, resource utilization, and patient groups. Data visualization is adept at presenting such multifaceted perspectives through techniques like small multiples. For example, a single dashboard can simultaneously contain line charts showing cost and surgery outcomes trends for several procedure types. This enables consuming analytical evidence from different facets quickly.

#### Surface hidden insights through alternate visualizations

Applying different visual styles like pie charts, heat maps, scatter plots, tree maps or network diagrams to the same data can reveal unique insights. Healthcare analysts can apply an array of visualization techniques to extract fuller value from data. Novel visuals also improve recall of insights and engagement from audiences.

#### Make data more memorable and persuasive

The human brain is wired to better process and recall visual information. Representing analytics output visually improves knowledge retention and the persuasive appeal of identified trends. Interactive data visualization further heightens engagement and exploration by stakeholders. The combination makes data visualization an invaluable tool for converting healthcare analytics into impact through improved understanding, decision-making, and actions.

#### Data Visualization Methods for Healthcare

Some data visualization methods particularly applicable to healthcare analytics include:

- Time series & run charts to observe healthcare metrics over time e.g., effects of new drug treatment over months
- Scatter plots and heat maps to analyze bivariate relationships e.g. between cost and hospital quality
- Forest plots to compare multiple clinical trials or treatment effects
- Patient flow diagrams to visualize patient journeys through hospital departments

- Geographic maps to identify spatial patterns e.g., disease clusters or service accessibility gaps
- Network diagrams to reveal relationships and interconnections e.g. among symptoms, diagnoses, and medications
- Sparklines to plot multiple indicators concisely e.g., vital signs on patient records
- Small multiples to view performance on key metrics across multiple units like departments or hospitals

Careful design considerations are needed to tailor visualizations toward healthcare contexts. Factors like color conventions, terminology, and comparison group choices should fit the application area (West, Bdair, Galecki, & Janosky, 2015). Iterating through different visuals is also crucial to finding the most precise representations for the analytical goal.

### Real-World Examples

#### Study: Surgical site infection dashboard

A Veterans Health Administration hospital developed a visualization dashboard tracking surgical site infection rates over time and comparing performance across surgical specialties (Figure 1). By consolidating metrics into an intuitive interactive interface accessible to clinicians, the hospital reduced infections by 33% over two years (Schall et al., 2015).

#### Population health management platform

Health Catalyst's population health product enables care providers to visually analyze clinical, cost and utilization metrics across patient cohorts. Users can stratify and filter data across multiple variables to segment populations with specific risks and needs. The visualizations and drill-down capabilities surface key improvement opportunities (Figure 2).

Northwell Health uses the platform to optimize care management programs, reducing readmissions for one high-risk cohort by 44% (Health Catalyst, 2019).

#### Patient health records

Patient portals integrate data visualizations to allow patients to self-explore their health records. Visuals like line charts allow patients to observe trends in lab results, medications and symptoms over time. This enhances understanding of health status and engagement in care management. Figure 3 shows a sample blood pressure and blood sugar visualization for a diabetes patient on the Apple Health app.

### Challenges in Application

While data visualization offers significant value in surfacing insights from healthcare data, there remain barriers to application:

- Identifying the most insightful visualizations requires an iterative approach which can be time intensive. The analytics team needs data visualization literacy.
- Healthcare organizations need data management capabilities like data warehousing and ETL processing to aggregate data for analysis and visualization.
- User training is essential so executives, clinicians and patients can correctly interpret the visualizations. Misinterpretation due to perceptual biases is a risk.
- Careful design is required to avoid overwhelming users with overly complex visuals or distracting aesthetics. Constraints and defaults need to guide proper visual encodings.

## Conclusion

This paper demonstrates data visualization's vital role in deriving value from healthcare analytics. Tailored visuals enhance the interpretation of clinical and operational data patterns. They foster data-driven, collaborative decision-making across diverse stakeholder groups, ultimately driving better performance and patient outcomes. Further technical and design advances for data visualization in the healthcare domain can unleash more of its potential.

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