Teaching Case

Creating a Clear Vision for Rural Healthcare: A Data Analysis Exercise

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Hook

Data is a powerful tool for the healthcare industry to use for managing, analyzing, and reporting on critical events in the field. The analysis of broad, salient data files aids healthcare businesses in uncovering hidden patterns, market trends, and customer preferences; these details may then be used to improve the quality and delivery of care to patients in an organization's community. This case highlights the use of data analysis as a planning tool for a mid-sized rural hospital with limited resources.

Abstract

Data is a powerful tool for the healthcare industry to use for managing, analyzing, and reporting on critical events in the field. The analysis of broad, salient data files aids healthcare businesses in uncovering hidden patterns, market trends, and customer preferences; these details may then be used to improve the quality and delivery of care to patients in an organization's community. In this case, students use simple data mining procedures to investigate issues a healthcare organization faces regarding regional and national population patterns, directions for facility and service expansion, and prospective staffing changes. The exercise highlights the use of data analysis as a planning tool for a mid-sized rural hospital with limited resources and may be used in an undergraduate or graduate level management information systems or healthcare information systems course to illustrate data analysis and visualization concepts, reporting, and data driven strategy development.

Keywords: Teaching Case, Big Data Analytics, Healthcare

1. SEEING THE BIG PICTURE

Although approximately 60 million Americans live in rural areas, access to healthcare is challenging for individuals in these locations, and rural medical providers struggle financially (HHS, 2020). Nearly 50% of rural hospitals operate at a loss. They also face provider recruitment and retention challenges, revenue pressure, and patient groups with complex medical issues (HHS, 2020). Due to these factors, it is critical for small and mid-sized rural hospitals to possess a clear understanding of the needs within their patient populations.

Because their healthcare delivery has unique obstacles and issues, rural health providers are seeking methods for better analyzing their current and prospective patients' needs and requirements. A powerful tool to accomplish this objective is the use of big data, often characterized by: Volume (a large volume in many environments), Variety (wide variety of data types), and Velocity (velocity at which data is generated, collected, and processed) (Botelho & Bigelow, 2022), Veracity (accuracy in data sets), Value (relevant data), and Variability (variation in data sources). It is a common myth that the term big data just refers to a large amount of data; it is actually the ability of complex smart data to expand the understanding of the issue under examination that truly defines the term. Big data allows an organization to move beyond its immediate borders to capture the big picture of related factors, and therefore more effectively analyze and respond to an issue.

Data mining techniques are used to analyze big data and may include "quantitative analysis, database management, data visualization and intelligent computing (machine learning, pattern recognition and artificial intelligence) for the purpose of discovering patterns that are not previously known in the data" (Jafar, Anderson, & Abdullat, 2008). Data mining is being used in the healthcare environment to unearth new knowledge and trends for both clinical and administrative decision-making (Yoo et al., 2012).

Big data analysis is being used by healthcare businesses to identify patient outcomes, better organize staffing and operations, and strategize the addition of providers and services. The use of big data may also be applied to improve the diagnosis and treatment of illnesses, and lead to better prevention of disease and patient safety (Pastorino et al., 2019). Because of its breadth and source variety, big data is ideal for aiding rural healthcare institutions in addressing disparities in patient access or identifying allocation directions for scant resources. Big data collected during the height of the COVID-19 pandemic has been especially valuable in helping small and mid-sized hospitals with planning for future healthcare delivery (Kent, 2021) such as operational strategy, staffing, grant development, and service delivery.

2. THE NEED FOR CLARITY

Midwest Hospital operates as a not-for-profit 55-bed acute care facility in an area with a population of approximately 40,000 residents distributed across six rural counties in Missouri. The facility offers inpatient care including surgical and obstetric services, and outpatient surgical and cardiac rehabilitation. The hospital employs 225 staff and providers (compared to urban medical centers which employ on average 1500+) and has been operating its physical plant at its current location for 9½ years. Nearly 22% of patients seen at the hospital are 65 years or older. The number of patients seen at the hospital between the ages of 0 (birth) and 17 years is 25%. Approximately 15% of the area's populations served have income below the poverty level.

Rural hospitals such as Midwest continually encounter a challenging financial landscape with decreasing demand for inpatient services, revenue pressure, complex patient populations and the cost of attracting and retaining medical providers. Between 2010 and 2021, 138 rural hospitals in the U.S. closed their doors, further reducing the availability of services to their communities (NC Rural Health Research, 2022).

In order to help Midwest Hospital retain some of its service lines and develop additional programs, the organization received a grant in 2018 through the Health Resources & Services Administration to support its *Aging in Place* program. Due to the large population of older adults who would prefer to age in place (remain in their homes and communities for as long as possible) in its service area, the hospital has been seeking to provide enhanced medical care to senior citizens. Grant funds were directed toward increasing home health services, improving technology for telehealth, and increasing preventive care.

Following a reduction in COVID-19 hospital admissions, Midwest Hospital has again begun analyzing the availability of services and needs for its regional populations. Midwest's administration is contemplating whether to apply for another grant, this time to support children's

vision services. Midwest currently employs two optometrists. Family practitioners at the hospital and associated clinics also participate in the vision screening of children; and all providers have noticed an uptick in vision problems—especially myopia (nearsightedness)—in child visits beginning late 2020. (With myopia, objects that are close-up look clear but distant objects look blurry.) Both Midwest administrators and medical providers are interested in determining if this increase in vision problems is an anomaly or will be a continuing issue for the future. If a persistent problem, the hospital would need to consider hiring additional optometric staff and expanding screening services and facilities.

Expansion of vision services would additionally benefit the hospital's Aging in Place program. Age-related macular degeneration has also been noted as rising in incidence in older patients. This vision loss makes it difficult for individuals to drive, watch television, read, and complete household tasks such as cooking or cleaning (NEI, 2022). Midwest could also investigate the establishment of an ophthalmic telehealth program for the treatment of eye disease, which would benefit both adults and children.

The first order of business in preparing the grant application and planning for expanding vision services is to determine need. The hospital has logged a record number of myopia cases in children (aged 0-17 years) from the last quarter in 2020 through the first quarter of 2022. Working with an urban medical center librarian, Midwest Hospital providers uncovered a disturbing pattern in children's vision beginning in 2020. Midwest has asked their sole health data analyst to answer questions about this trend using data—from regional and national sources — while they research the literature.

3. WHAT IS SEEN IN THE LITERATURE

During their research, the providers found that myopia and associated vision loss has been recognized as a significant issue for some time. The World Health Organization estimated in 2015 that half of the world's population may be myopic by 2050 (Holden et al., 2015). The literature they reviewed demonstrated that myopia was rising even more rapidly than expected throughout the world.

A recent Chinese study of over 195,000 school-aged children noted a significant myopic shift in the year 2020 compared to previously recorded years (2015-2019). Specifically, the study found that the prevalence of myopia in the 2020 screenings was higher than the highest prevalence of myopia within 2015-2019 for children aged 6 (21.5% vs 5.7%), 7 (26.2% vs 16.2%), and 8 (37.2% vs 27.7%) years (Wang et al., 2021). Researchers theorized that the at-home confinement of children during the pandemic, combined with insufficient outside activities and increased screen time, were associated with the myopic changes. The medical center librarian located dozens of similar studies over the period 2020 through 2022, all suggesting that isolation due to COVID-19 was responsible for much of the observed increases in myopia cases.

Although myopia is generally regarded as a benign condition that is treatable with corrective lenses and other therapies, untreated cases are associated with an increased risk of blinding pathologies such as cataracts and glaucoma (Zhang et al., 2022). Early detection through screening is the key to prevention of these severe progressions, and also aids children with early correction so they have improved sight quality.

Midwest Hospital providers were both relieved and concerned by information they discovered. They were relieved in the knowledge that what they were experiencing in their small rural hospital population was not an isolated situation; yet concerned about the broader implications for their young patients. After receiving the librarian's report, Midwest administrators turned to their health informaticist to evaluate results of the data analysis.

4. THE BIG PICTURE IN NUMBERS

The data file references an actual children's vision and eye health surveillance study organized by the Maternal and Child Health Bureau of the U.S. Department of Health and Human Services. The data set contains demographic information that identifies the gender, race/ethnicity, and location of children being screened for vision impairment or issues. The records cover simulated surveillance results for the years 2016 through 2017 (pre-COVID-19 pandemic) with similar data for the years 2020 through 2021 (post the start of the COVID-19 pandemic). All the data represents individuals in the 0-17 age group in all 50 states. The data file for this exercise contains simulated records and should only be used for this exercise. The data file will be maintained at: https://drive.google.com/file/d/1Hx31CRh9oCJFMQcIx-fBt-8gXpNrBcOy/view?usp=sharing

Using the exercise data file and the data dictionary provided in Appendix A, the analyst is asked to see if they can answer the questions provided in Appendix B for the hospital's grant application through a comparison of the 2016-17 (1,968 records) and 2020-21 (2,400 records) sets of data).

After the analyst has examined the data, Midwest administration has asked that the results be reported in a table which may be sent to the grant-writer for further analysis and preparation of the grant application. A summarization of the analysis should be included with the table and charts effectively answering the questions posed in Appendix B. No conclusions or measures of significance have been requested on the part of the analyst at this time.

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Editor's Note:

This paper was selected for inclusion in the journal as an EDSIGCON 2022 Distinguished Case. The acceptance rate is typically 7% for this category of teaching cases based on blind reviews from six or more peers including three or more former best case authors who did not submit a paper in 2022.

APPENDIX A
Data Dictionary for Vision and Eye Health Surveillance Data File

Fields / (Field Values)	Description for Fields and Some Field Values	Data Type
YearStart	Starting Year for year range	number
YearEnd	Ending Year for year range, same as starting year if single year used in evaluation	number
LocationAbbr	State Abbreviation	plain text
LocationDesc	State Name	plain text
DataSource	Abbreviation of Data Source	plain text
Topic	Topic Description (Values defined below)	plain text
(BLND)	Blind or severe difficulty seeing	
(DGLAS)	Difficulty seeing with glasses	
(MYOPIA)	Near-sightedness (MYOPIA)	
(HPYEROPIA)	Far-sightedness (HYPEROPIA)	
Category	Category Description	plain text
Question	Question Description	plain text
Age	Stratification value for age group e.g. 0-17yrs	plain text
Gender	Stratification value for gender e.g. Male, Female	plain text
RaceEthnicity	Stratification value for race e.g. White, non-Hispanic	plain text
RiskFactor	Stratification value for major risk factor e.g. diabetes	plain text
Insurance	Type of Insurance (Values defined below)	plain text
(Ins_D)	Medicare + Medicaid Dual Eligible	
(Ins_E)	Medicaid	
(Ins_S)	Medicare Fee for Service	
(Ins_C)	Medicare Managed	
(Ins_Y)	Military	
(Ins_G)	Other Government	
(Ins_P)	Private	
(Ins_U)	No payment listed	
(Ins_All)	All payers	
Designation	Metropolitan Statistics Area Designation (Values defined below)	plain text
(URBN)	Urban: within a principal city of a MSA	
(SUBN)	Suburban: w/in a MSA but not w/in a principal city of the MSA	
(RURL)	Rural: outside of an MSA	
Diagnosis ID	Diagnosis of vision issue (Values defined below)	plain text
(BLND)	Blind or severe difficulty seeing - (Visual function)	
(DGLAS)	Difficulty seeing with glasses - (Visual function)	
(MYOPIA)	Near-sightedness (MYOPIA) - (Visual function)	
(HPYEROPIA)	Far-sightedness (HYPEROPIA) - (Visual function)	

(CMYOPIA)	Refractive correction for Myopia- (Corrective procedure)	
(CHYPEROPIA)	Refractive correction for Hyperopia - (Corrective procedure)	
(COTHER)	Refractive correction for Other - (Corrective procedure)	
(CATARACT)	Cataract surgery - (Corrective procedure)	
GeoLocation	Geographic location	plain text

APPENDIX B
Data Analysis Questions

1. What was the overall change in the following *Visual Function* categories in participants aged 0-17: Blind or Difficulty Seeing (BLND); Difficulty seeing with glasses (DGLAS); Near-sightedness (MYOPIA); and /or Far-sightedness (HYPEROPIA)?
2. What was the overall change in the following *Visual Function* categories in participants aged 0-17 by gender: Blind or Difficulty Seeing (BLND); Difficulty seeing with glasses (DGLAS); Near-sightedness (MYOPIA); and /or Far-sightedness (HYPEROPIA)?
3. What was the overall change in the following *Visual Function* categories in participants aged 0-17 by race/ethnicity: Blind or Difficulty Seeing (BLND); Difficulty seeing with glasses (DGLAS); Near-sightedness (MYOPIA); and /or Far-sightedness (HYPEROPIA)?
4. What was the overall change in the following *Service Utilization* categories in participants aged 0-17: Refractive correction for Myopia (CMYOPIA); Refractive correction for Hyperopia (CHYPEROPIA); Refractive correction for Other (COTHER); and/or Cataract surgery (CATARACT)?
5. What was the overall change in the following *Service Utilization* categories in participants aged 0-17 by gender: Refractive correction for Myopia (CMYOPIA); Refractive correction for Hyperopia (CHYPEROPIA); Refractive correction for Other (COTHER); and/or Cataract surgery (CATARACT)?
6. What was the overall change in the following *Service Utilization* categories in participants aged 0-17 by race/ethnicity: Refractive correction for Myopia (CMYOPIA); Refractive correction for Hyperopia (CHYPEROPIA); Refractive correction for Other (COTHER); and/or Cataract surgery (CATARACT)?
7. What was the overall change in the following *Visual Function* categories in participants aged 0-17: Blind or Difficulty Seeing (BLND); Difficulty seeing with glasses (DGLAS); Near-sightedness (MYOPIA); and /or Far-sightedness (HYPEROPIA) in these states: Missouri? Kansas? Illinois? Arkansas?
8. What was the overall change in the following *Service Utilization* categories in participants aged 0-17: Refractive correction for Myopia (CMYOPIA); Refractive correction for Hyperopia (CHYPEROPIA); Refractive correction for Other (COTHER); and/or Cataract surgery (CATARACT) in these states: Missouri? Kansas? Illinois? Arkansas?
9. Of participants aged 0-17, what was the overall change in the combined *Visual Function* category Near-sightedness (MYOPIA) and the *Service Utilization* category Refractive correction for Myopia (CMYOPIA)?
10. How many participants aged 0-17 in the combined *Visual Function* category Near-sightedness (MYOPIA) and in the *Service Utilization* category Refractive correction for Myopia (CMYOPIA) lived in rural communities?
11. Of participants aged 0-17, what was the overall change in the combined *Visual Function* category Near-sightedness (MYOPIA) and the *Service Utilization* category Refractive correction for Myopia (CMYOPIA) in these states: Missouri? Kansas? Illinois? Arkansas?
12. How many participants aged 0-17 in the survey were insured by Medicaid? How many were uninsured? How many had private insurance?
13. How many rural participants aged 0-17 in the survey were insured by Medicaid? How many were uninsured? How many had private insurance?