Analytics for Hospitals Health-Care Data

INTRODUCTION

In 2009, the US government enacted the Health Information Technology for Economic and Clinical Health Act (HITECH) that includes an incentive program (around $27 billion) for the adoption and meaningful use of Electronic Health Records (EHRs).

Data analytics, in particular, forms a critical component of these computing technologies. The analytical solutions when applied to healthcare data have an immense potential to transform healthcare delivery from being reactive to more proactive.

Heterogeneity in the data collection and representation process leads to numerous challenges in both the processing and analysis of the underlying data. There is a wide diversity in the techniques that are required to analyze these different forms of data.

Researchers in the field of data analytics are particularly susceptible to becoming isolated from real domain-specific problems, and may often propose problem formulations with excellent technique but with no practical use.

Literature Review

[1] Chandan K. Reddy and Charu C. Aggarwal gave a brief introduction to the health care data analytics The various forms of patient data that is currently being collected in both clinical and non-clinical environments will be studied. The clinical data will have the structured electronic health records and biomedical images

Advanced Data Analytics for Healthcare:

Integrating heterogeneous data such as clinical and genomic data is essential for improving the predictive power of the data that will also be discussed. Information retrieval techniques that can enhance the quality of biomedical search will be presented. Data privacy is an extremely important concern in healthcare.

Applications and Practical Systems for Healthcare:

This part focuses on the practical applications of data analytics and the systems developed using data analytics for healthcare and clinical practice. Examples include applications of data analytics to pervasive healthcare, fraud detection, and drug discovery.

[2] Matthew Mitchell and Thomas Stratmann have proposed some information on bed shortage in that they have discussed about The requirements vary from state to state and cover a variety of services and procedures, ranging from hospitals and hospital beds to medical imaging devices and substance abuse facilities. First, need is subjective. It depends on the individually-defined value that particular consumers believe they will obtain from a service. Second, need is constantly changing as circumstances and tastes change. Researchers find that when health care providers are able to change their services without proving need to a regulator, they are more likely to adapt.

Third, need is contingent. A facility and its customers may benefit from a new hospital bed, but that may depend on other conditions such as the supply of medical professionals to staff the bed, the supply of beds in competing facilities, and the profitability of businesses in other sectors in the community. Fourth, the metrics that regulators use to assess need can be exploited by providers.

The COVID-19 pandemic only exacerbated these difficulties. From the outset, caregivers and public health officials were concerned about hospital capacity In the extreme case of running out of capacity, a hospital is unable to care for patients. However, even before it gets to that point, difficult decisions may have to be made by hospital staff and administrators. As the Delta variant swept through the nation in the summer of 2021, several states either enacted or considered enacting what is known as “crisis standards of care”. Certain patients deemed less likely to survive may not get a bed in the intensive care unit.

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Patients may have to be discharged from the hospital before they would normally go home, and some patients who would usually be admitted for hospital care might have to be denied We obtained hospital bed utilization data from the Federal Department of Health and Human Services (COVID-19 Reported Patient Impact and Hospital Capacity by State Time series (2021); COVID-19 Reported Patient Impact and Hospital Capacity by Facility (2021)).

That Department maintains a state-aggregated time series database on hospital bed utilization rates dating back to the beginning of the pandemic as well as a hospital level database dating back to July of 2020. Figure 1 shows national bed utilization over the course of the pandemic.2 In January of 2020, approximately 43 percent of all U.S. hospital beds were in use. By July 2020, nationwide bed utilization had jumped to 66 percent. It levelled off at approximately 70 percent until the summer of 2021, when utilization began to rise again.

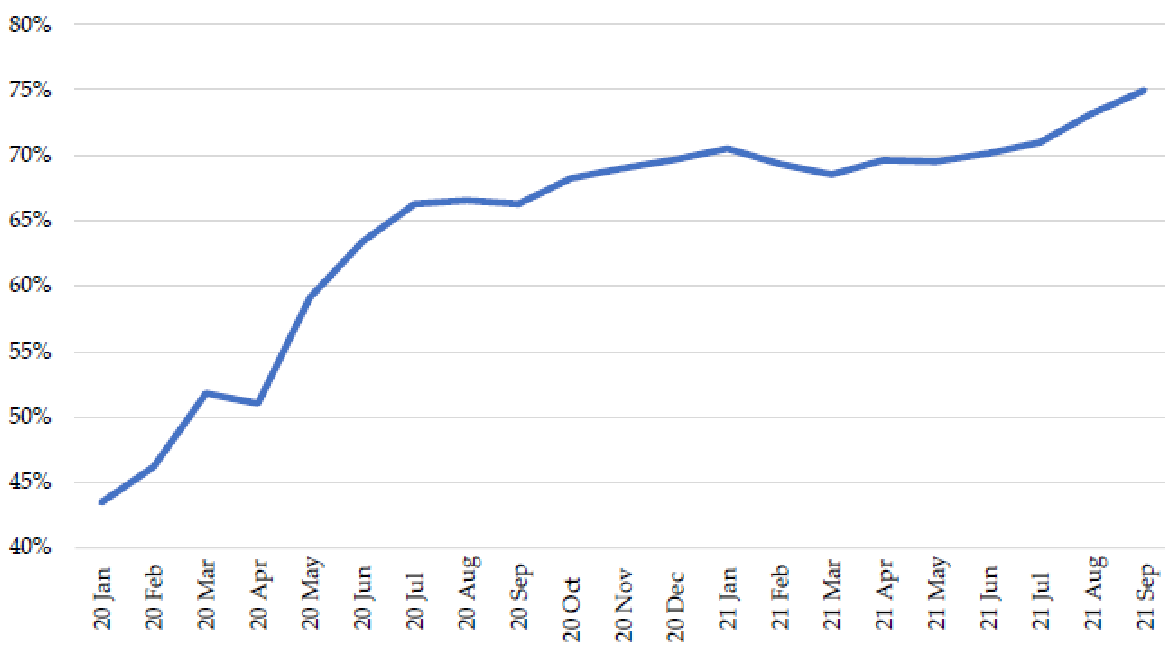

Figure 1. National Share of Beds in Use.
Source: (COVID-19 Reported Patient Impact and Hospital Capacity by State Timeseries 2021).

Figure 2 shows the number of days per month in which the average state was using 70 percent or more of its beds. As late as July 2020, the average state was experiencing 11 days with 70 percent or more of beds in use.

The situation continued to worsen, however, so that by September of 2021, the average state was experiencing nearly 24 days of 70 percent occupancy or more. Figure 3 shows bed utilization by state in September of 2021.
In that month, Rhode Island had the highest utilization rate, at 87 percent, while Wyoming had the lowest, at 51 percent.

We begin our analysis at the state level and then examine hospital-level data. We rely on two primary measures of statewide bed utilization: average bed utilization per state per month, and the number of days per state per month in which more than 70 percent of a state's beds are utilized (see Table 1 for a full list of descriptive statistics). These data cover 50 states over the course of 21 months.[3]

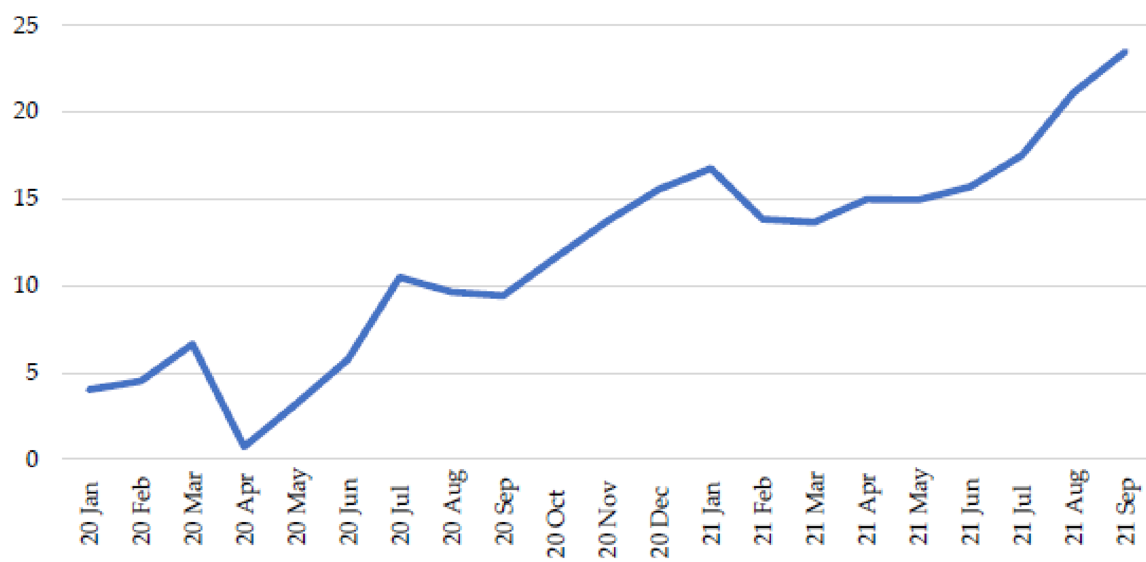

Figure 2 number of days per month in which more than 70 percent of a state's bed are in use averaged over 50 states.
Source: (COVID-19 Reported Patient Impact and Hospital Capacity by State Time series 2021).

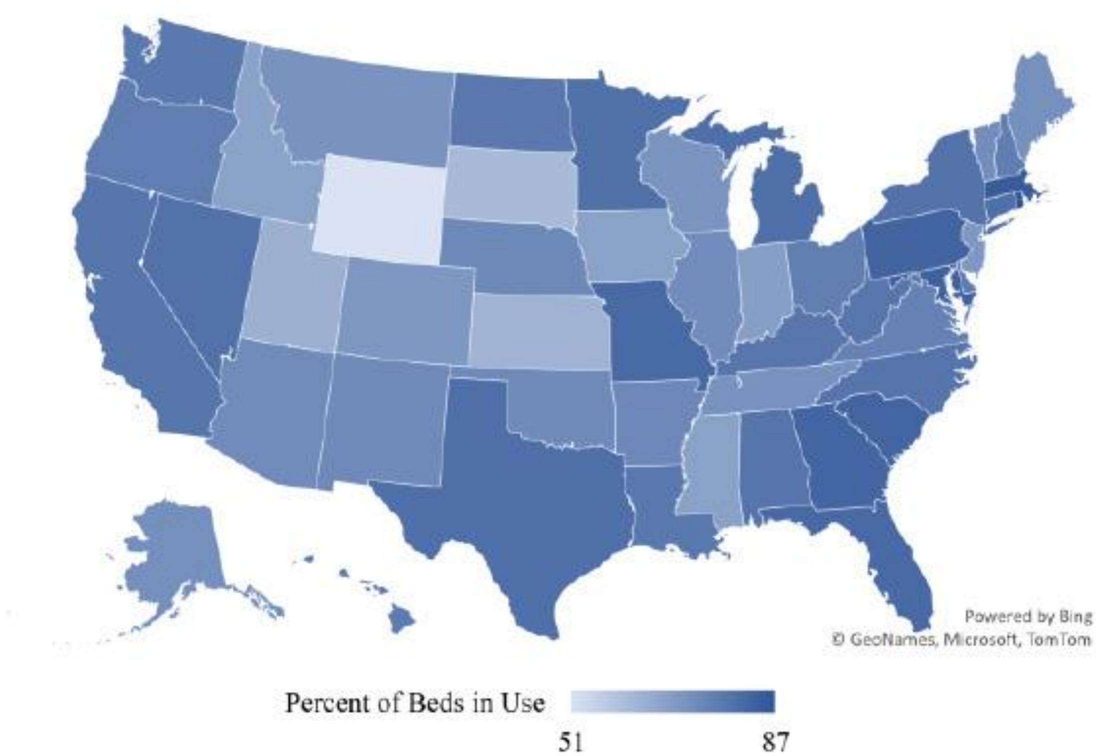

Figure 3. State wide Bed Utilization, September 2021. Source: (COVID-19 Reported Patient Impact and Hospital Capacity by State Time series 2021).

Another way to think about state wide bed utilization is to consider how many days in a month a state used 70 percent or more of its hospital beds. Figure 4 offers this perspective. It shows the frequency with which states fell into one of four categories, ranging from 0 to 8 days up to 25 to 31 days.

The modal range is 0–8 days. There were 474 times that a state had between 0 and 8 days of the month with more than 70 percent of its beds in use. At the other end of the spectrum, there were 289 times in which a state had between 25 and 31 days of the month with more than 70 percent of its beds in use.

Figure 4shows the status of hospital bed CON requirements during the pandemic.

Twenty-six states require providers to obtain a CON before adding—or in some cases even reallocating—hospital beds.[8] During the pandemic, however, twenty states moved to relax these rules, often through executive order.[9]

For example, Tennessee Governor Bill Lee signed an executive order on 19 March 2020 declaring state regulations to be :suspended to the extent necessary to allow hospitals that would otherwise be subject to certificate of need requirements to temporarily increase their number of licensed hospital beds at any location or temporarily establish hospital and diagnostic services at any location, if necessary for the treatment of COVID-19 patient (Lee 2020).

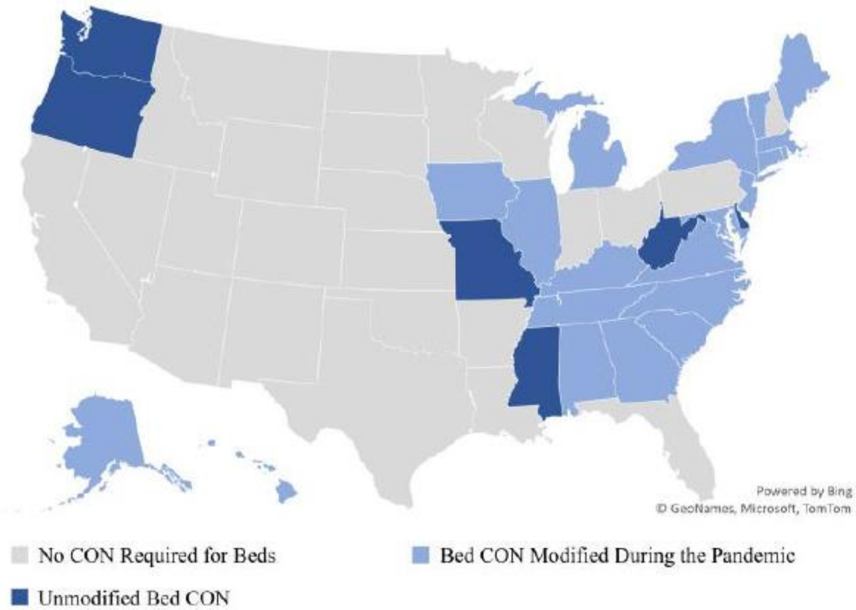

Figure 4. Bed CON Regulations during the Pandemic.
Source: State CON regulators.

We began our regression analysis at the state level, running a series of regressions to estimate the marginal effect of bed CON regulation and the effect of relaxing this regulation, while controlling for possibly confounding factors.

Equation (1) presents the main regression model. In the full specification, we estimated bed utilization in state s in month m as a function of bed CON regulation, relaxation of bed CON regulation, a vector of control variables, and a vector of month controls.

$$\text{Utilizations,m} = a + b(\text{BedCONs,m}) + g(\text{BedCONRelaxeds,m}) + (\mathbf{DemographicControlss,m})\mathbf{X} + \mathbf{G}\text{M}\square 1\mathbf{T} + \text{"s,m-}\rightarrow(1)$$

In our state-level analysis, we measure bed utilization in two ways. The first is the average share of beds used per state per month.

Risk Financial Manag. **2022**, 15, 10 10 of 18 month in which more than 70 percent of a state's beds were used. Our two primary variables of interest are BedCON and BedCONRelaxed. BedCON takes the value 1 if the state requires a CON for hospital beds and 0 otherwise. BedCONRelaxed takes the value 1 if the state requires a CON for beds and relaxed this requirement in the month in question and 0 otherwise.

Our control vector includes five variables designed to capture the economic and demographic variation between states that might explain demand for and supply of hospital beds: the percent of the population that is Black, the percent of the population that is Hispanic, per capita personal income in 2017, the percent of adults with diabetes, and new COVID cases per month as a share of the state's population.

10 We present summary statistics for each of these variables in Tables 1 and 2. We also include a vector of month controls to account for variation in demand for beds over time. Because BedCON is time-invariant, we cannot include state effects.

Previous studies have found that CON regulations are associated with fewer beds per capita (Joskow 1980; Harrington et al. 1997; Hellinger 2009; Eichmann and Santerre 2011; Stratmann and Russ 2014). In the spring of 2020 we examined the link between bed CONs J.
Risk Financial Manag. **2022**, 15, 10 7 of 18 and projected shortages during the pandemic with James Bailey (Mitchell et al. 2020). At that time, however, actual utilization data was not yet available and so we had to rely on projected shortages estimated by the Institute for Health Metrics and Evaluation at the University of Washington.

[3] Hoyt,RE, Yoshihashi, A,Edsin 2014, have shared some information about health care data analytics ,In the meantime, there has also seen substantial growth in other kinds of health-related data, most notably through efforts to sequence genomes and other biological structures and functions.4 The analysis of this data is usually called analytics (or data analytics). Adams and Klein have authored a primer on analytics in healthcare that defined different levels and their attributes of the application of analytics. They noted three levels of analytics, each with increasing functionality and value:

• Descriptive – standard types of reporting that describe current situations and problems

• Predictive – simulation and modeling techniques that identify trends and portend outcomes of actions taken

• Prescriptive – optimizing clinical, financial, and other outcomes.Another close but more recent term in the vernacular is big data, which describes large and ever-increasing volumes of data that adhere to the following attributes:11

• Volume – ever-increasing amounts

• Velocity – quickly generated

• Variety – many different types

• Veracity – from trustable sources

Another source of large amounts of data is the world's growing base of scientific literature and its underlying data that is increasingly published in journals and other articles (see Chapter on online medical resources).

One approach to this problem that has generated attention is the IBM Watson project ,which started as a generic question-answering system that was made famous by winning at the TV game show Jeopardy!14 IBM has since focused Watson in the healthcare domain.

The growing quantity of data requires that its users have a good understanding of its provenance, which is where the data originated and how trustworthy it is for large-scale processing and analysis.17 A number of researchers and thought leaders have started to specify the path that will be required for big data to be applied in healthcare and biomedicine.

One of the major motivators for data analytics comes from new models of healthcare delivery, such as accountable care organizations (ACOs), where reimbursement for conditions and episodes is bundled in a variety of ways, providing incentive move to deliver high-quality care in cost-efficient ways. ACOs require a focused IT infrastructure that provides data that can be used to predict and quickly act on excess costs.

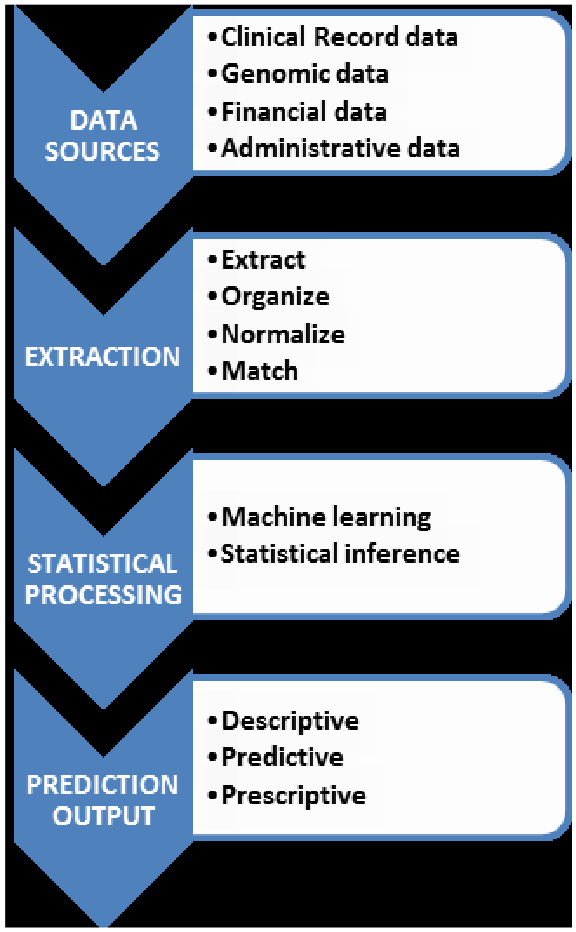

Figure 5 The Analytics Pipeline

Another approach used more novel methods. Denny and colleagues have developed methods for carrying out genome-wide association studies (GWAS) that associate specific findings from the EHR (the "phenotype") with the growing amount of genomic and related data (the "genotype") in the Electronic Medical Records and Genomics (eMERGE) Network. eMERGE has demonstrated the ability to validate existing research results and generate new findings,69 being able to identify genomic variants, among others, associated with atrio ventricular conduction abnormalities,70 red blood cell traits,71 white blood cell count abnormalities,72 and thyroid disorders.73 More recent work has "inverted" the paradigm to carry out phenome-wide association studies (PheWAS) that associated multiple phenotypes with varying genotypes.