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The contribution of sociodemographic and clinical factors to length of stay in hospitalized children

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BOSTON UNIVERSITY
SCHOOL OF MEDICINE

Thesis

**THE CONTRIBUTION OF SOCIODEMOGRAPHIC AND CLINICAL FACTORS
TO LENGTH OF STAY IN HOSPITALIZED CHILDREN**

by

FAREESA HASAN

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Approved by

First Reader

Jean L. Spencer, Ph.D.
Instructor of Biochemistry

Second Reader

Jay G. Berry, M.D., M.P.H.
Assistant Professor of Pediatrics
Boston Children's Hospital
Harvard Medical School

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ABSTRACT

Background. There is continued attention towards using patient demographic and clinical characteristics available in health administrative data when case mix adjusting the measurement of length of stay (LOS) for hospitalized children. However, little is known about what proportion of children's LOS is explained by these characteristics.

Objectives. The objectives of the study were to quantify the amount of variation in LOS within and across hospitals that is explained by demographic and clinical factors of hospitalized pediatric patients.

Methods. A retrospective cohort analysis was completed of 818,848 hospitalizations for any reason occurring from 1/1/2014 to 12/31/2014 in one of 44 freestanding children's hospitals in the Pediatric Health Information Systems (PHIS) dataset. A generalized linear model was derived to simultaneously regress demographic factors [age, race/ethnicity, payer, rural residence, health professional shortage area (HPSA) residence, income, and distance traveled], and clinical factors (severity of illness, type and number of chronic conditions) on LOS. The percentage of LOS attributable to each characteristic within each hospital was quantified using the covariance test of the hospital random effect.

Results. The factors with the greatest impact on LOS were severity of illness and chronic condition type and number, with a median (interquartile range) of 16.8% (IQR

15.0%-19.4%) and 4.0% (IQR 2.9%-4.5%) of LOS, respectively, explained by these characteristics across hospitals. LOS varied significantly ($p < 0.05$) with both severity of illness and chronic condition type and number for all 44 hospitals in the cohort. All patient demographic factors, (age, race/ethnicity, payer, rural residence, HSPA residence, income, and distance traveled) had minimal impact on LOS, with $< 0.1\%$ of LOS explained by each characteristic. Across hospitals, 78.3% (IQR 75.8-80.2%)] of LOS remained unexplained by the patient characteristics under study.

Conclusions. Patients' clinical characteristics ascertained from administrative data account for approximately one-fifth of LOS whereas their demographic characteristics account for a negligible amount. Efforts to optimize the efficiency of inpatient care for hospitalized children might benefit from uncovering how much of the vast amount of unexplained LOS is due to modifiable aspects of care quality.

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LIST OF ABBREVIATIONS

APR-DRG.....	All-Patient Refined Diagnosis Related Group
CHIP	Children’s Health Insurance Program
CI.....	Confidence Interval
CMS	Centers for Medicare and Medicaid Services
DSH.....	Disproportionate Share Hospital Payments
CRG	Clinical Risk Group
DRG	Diagnosis-Related Group
FPL.....	Federal poverty level
GDP.....	Gross domestic product
HPSA	Healthcare Professional Shortage Area
IOM.....	Institute of Medicine
IPPS.....	Inpatient Prospective Payment System
IRQ.....	Interquartile range
IVC.....	Inferior vena cava
LOS	Length of stay
MACPAC.....	Medicaid and CHIP Payment and Access Commission
MACRA.....	Medicare Access and CHIP Reauthorization Act
MIPS	Merit-Based Incentive Payment System
NP	Nurse practitioner
NQF.....	National Quality Forum
OECD.....	Organization for Economic Cooperation and Development

P4P Pay for Performance
PCP Primary care physician
PHIS Pediatric Hospital Information System
RSV Respiratory syncytial virus
RUCA Rural-urban commuting area

INTRODUCTION

Containing hospital resource use is a national priority for the U.S. healthcare system. Minimizing excessive hospital length of stay (LOS) is one approach to address this priority. LOS represents several aspects of the Institute of Medicine's (IOM) Six Aims for Healthcare Quality, including efficiency, effectiveness, safety, and timeliness. Measuring and reporting LOS is endorsed by the Centers for Medicare and Medicaid Services and Agency for Healthcare Research and Quality[1, 2]. In adult patients, LOS decreased dramatically, from weeks to days, over the last decades with systemic improvements in inpatient care adeptness and in use of post-discharge outpatient and community health services[3].

Several clinical and demographic factors are known to influence LOS in both pediatric and adult patients. Of course, hospitalized patients with a higher severity of illness or higher degree of underlying medical complexity (e.g., complex chronic conditions or multi-morbidities) require longer hospital stays for treatment and recovery. Social determinants of health, including race/ethnicity, type of insurance, and family income, also influence LOS. Most studies on the effect of clinical and demographic factors on LOS report findings of significance in each additional day in LOS associated with the factor. For example, low socioeconomic status has been associated with an additional 0.5 days (95% CI 0.1-0.9 days) in patients hospitalized with trauma[4].

Although reporting the statistical significance of factors influencing LOS is important, it does not convey information about the true impact or relevance of them. Most studies of these factors use large, administrative datasets that are sufficiently

powered to detect very small differences in LOS. Moreover, most studies do not quantify the influence of the factors in relation to each other. For example, it may be reported that severity of illness and race/ethnicity are significantly associated with LOS[5]. However, without additional information on how much LOS is explained by these factors, the importance of these factors will remain unknown. Quantifying this importance is critical for several reasons. There is on-going interest for the inclusion of social determinants of health when risk-adjusting hospitals' quality of care for public reporting. Moreover, many hospitals with substandard outcomes (e.g., hospitals with the longest LOS) often defend their performance by proclaiming that severity of illness and medical complexity are largely responsible for it.

Therefore, we undertook the present study to quantify (1) the amount of variation in LOS within and across hospitals that is explained by clinical and demographic characteristics of hospitalized patients; and (2) the amount of variation in LOS that is unexplained by these characteristics.

Background

The United States has long been spending the most amount of money on healthcare in the world, while exhibiting some of the most substandard health outcomes when compared with other wealthy nations. According to the Centers for Medicare and Medicaid Services (CMS), healthcare spending reached \$3.0 trillion in 2014, accounting for about 17.5% of the US Gross Domestic Product (GDP). This figure averages to about \$9,523 per capita[6]. Data from the Organization for Economic Cooperation and Development (OECD) allows comparative analyses between the US and other member

countries. In 2013, while US total healthcare per capita spending was \$9,086, the next highest was Switzerland at \$6,325, and the median for all 13 OECD countries was \$3,661.[7] Figure 1 shows that the share of GDP spent on healthcare in the US has been not only rising over the past two decades, but also rising faster than the share in other countries, resulting in a widening gap over time.

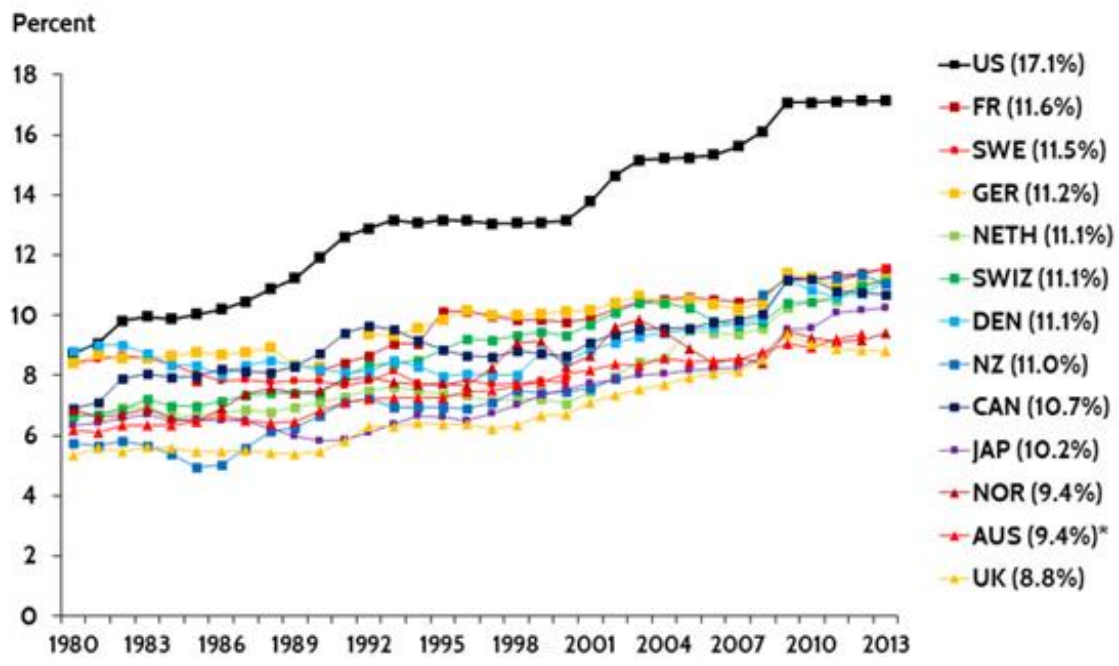


Figure 1: Healthcare spending as a percentage of GDP in 13 OECD countries. Spending trends are shown as a percentage of each country’s gross domestic product using data from OECD Health Data 2015, for years between 1980 and 2013. (Figure taken from Anderson, 2015)

Despite the United States’ aggressive financial investments in healthcare, there seems to be very little correlation between spending and the quality, accessibility, or efficacy of health services. Of the OECD nations, the US has the lowest life expectancy at birth even though it has the third lowest smoking rate. The US also has the highest

infant mortality rate, highest obesity rate, and highest proportion of seniors with multiple chronic diseases (Table 1)[7]. As such, there has been increasing urgency for the government as well as the healthcare community to find methods of containing costs and improving the quality of healthcare.

Table 1. Select population health outcomes and risk factors in 13 OECD countries[7]. (Table amended from Anderson, 2015.)

	Life exp. at birth, 2013 ^a	Infant mortality, per 1,000 live births, 2013 ^a	Percent of pop. age 65+ with two or more chronic conditions, 2014 ^b	Obesity rate (BMI>30), 2013 ^{a,c}	Percent of pop. (age 15+) who are daily smokers, 2013 ^a	Percent of pop. age 65+
Australia	82.2	3.6	54	28.3 ^e	12.8	14.4
Canada	81.5 ^e	4.8 ^e	56	25.8	14.9	15.2
Denmark	80.4	3.5	–	14.2	17.0	17.8
France	82.3	3.6	43	14.5 ^d	24.1 ^d	17.7
Germany	80.9	3.3	49	23.6	20.9	21.1
Japan	83.4	2.1	–	3.7	19.3	25.1
Netherlands	81.4	3.8	46	11.8	18.5	16.8
New Zealand	81.4	5.2 ^e	37	30.6	15.5	14.2
Norway	81.8	2.4	43	10.0 ^d	15.0	15.6
Sweden	82.0	2.7	42	11.7	10.7	19.0
Switzerland	82.9	3.9	44	10.3 ^d	20.4 ^d	17.3
United Kingdom	81.1	3.8	33	24.9	20.0 ^d	17.1
United States	78.8	6.1^e	68	35.3^d	13.7	14.1
OECD median	81.2	3.5	–	28.3	18.9	17.0

One of the main targets of healthcare reform is payment methods to hospitals and physicians in the U.S. Traditional methods incentivize boosting patient volume through high patient turnover and ordering excessive tests and procedures. In the last decade there has been a shift towards alternative payment models including bundled payments, capitation, and pay-for-performance. In each of these payment structures, financial risk is shifted to hospitals and healthcare providers to ensure that they rein in costs. As quality

metrics are increasingly incorporated into payment methods, they hold hospitals and caregivers more accountable for the quality of care that they provide.

Reforming Healthcare

In 1974, Aday and Andersen constructed a framework to analyze the complexities of access to healthcare in the U.S. (Figure 2)[8]. Three decades later, this framework is still widely used and remains relevant. At the top, policy defines the characteristics of both the healthcare delivery system and the populations at risk via decisions about financing, education, manpower, and organization. This second tier in the framework describes characteristics at the aggregate, while the third tier describes individuals, such as hospitals, providers, and patients. Thus, the framework illustrates how hospitals and patients are affected by the various forces at the societal level (policy, system resources and organization, population characteristics), yet are not able to influence those forces directly[8].

In the Aday & Andersen Model, the population Predisposing characteristics are defined as the “propensity individuals to use services”[8]. This includes characteristics that are mutable (such as age) and immutable (such as race and sex). Enabling characteristics are those which describe “the means individuals have available to them for the use of services,” including income, insurance coverage, and residence in urban or rural areas. Finally, Need characteristics refers to levels of illness as perceived by the individual and evaluated by the delivery system. All of these characteristics affect both the utilization of health services in a community and the different facets of consumer satisfaction, which include quality of care[8].

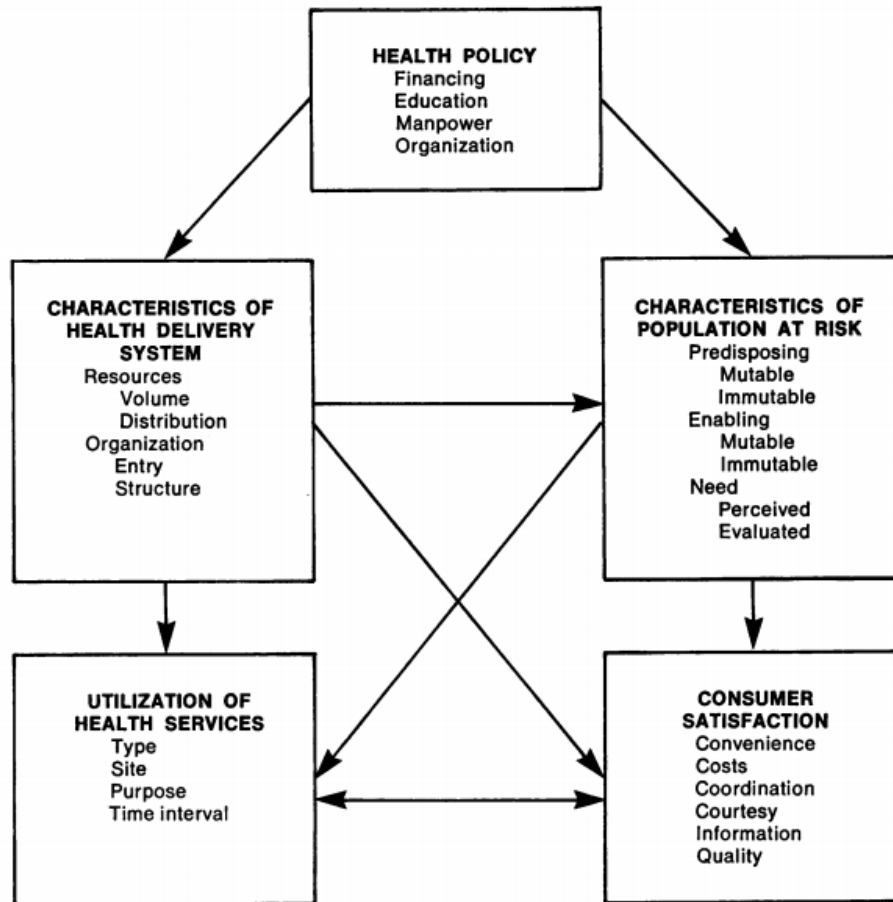


Figure 2. Aday & Andersen framework for the study of access to healthcare.
(Figure taken from Aday, 1974)

In 2001, the IOM published *Crossing the Quality Chasm: A New Health System for the 21st Century* to address the vast disparities in quality and access to healthcare in the U.S.[9]. The report asserted that all stakeholders in healthcare, from policymakers to providers, need to be united in the effort to redesign the system into one that will serve the needs of society. Thus, the IOM delineated the Six Aims for Quality Improvement to

serve as universal goals for healthcare reform. According to these aims, healthcare must be:

- Safe: Care provided for the patient's benefit should avoid inflicting harm
- Timely: Harmful delays in receiving and providing care should be reduced
- Effective: Evidence-based practices are used to achieve beneficial outcomes
- Efficient: Waste of resources (time, money, equipment, energy, etc) should be minimized
- Equitable: Care should be consistent across all demographics regardless of race, gender, socioeconomic status, location, age
- Patient-centered: Care is respectful and responsive to the patient's values and needs [9]

By keeping these aims in mind, the U.S. can carry out meaningful health care reform that will bring the country closer to achieving the desired outcomes of comparable nations.

Length of Stay as a Quality Metric

Length of stay is a common measure used to determine quality of care provided and responsible resource utilization by hospitals. It is easily measured, available in data, and comparable between hospitals and between diagnoses. In 2015 a study was done to analyze the usefulness of LOS as a quality metric in the context of radical nephrectomy with inferior vena cava (IVC) thrombectomy. The study found that LOS is predictive of 30-day readmission rates and 30-day mortality rates for patients[10].

Although it does not provide the entire story of inpatient quality of care, LOS in conjunction with other metrics can help determine if appropriate care is being provided in

an efficient and effective manner. If LOS is too short, patients may be sent home when they are not ready, and as a result readmitted to the hospital for preventable complications. If LOS is too long, the hospital has procedural issues that need to be resolved. These issues can include practices that lead to nosocomial infections that require patients to stay longer than was initially necessary. Inappropriately long LOS can also be a result of inefficiencies between services in which the patient is waiting extended periods of time for lab results or transfers, but receiving no care in the meantime (Figure 3).

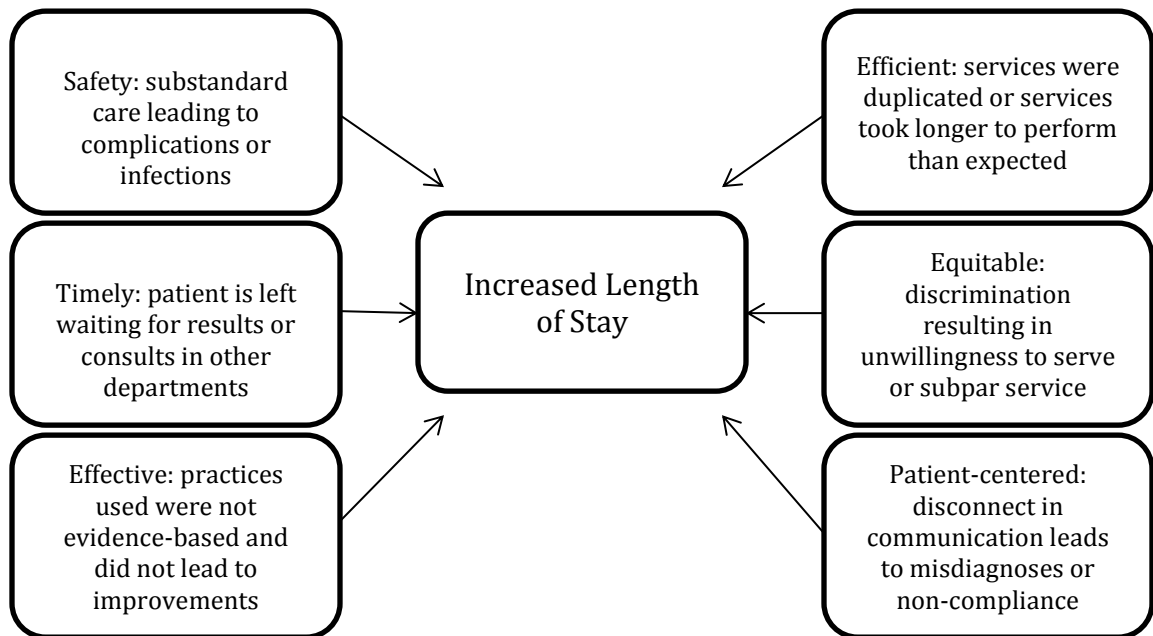


Figure 3. Length of Stay as a quality indicator applying the Institute of Medicine’s (IOM) six aims. Examples of how hospital practices can affect length of stay using the IOM’s six aims for quality improvement. Hospital practices can affect more than one aim.

Some payment structures for hospitals create budgets based on the expected LOS appropriate for different clinical profiles. For example, Medicare and Medicaid use the

acute inpatient prospective payment system (IPPS) to “cover the costs that reasonably efficient providers would incur in furnishing high quality care” through diagnosis-related groups (DRGs)[11]. DRG’s are used to cluster inpatients that are expected to have similar resource utilization. This system considers a combination of the primary diagnosis, any complications and comorbidities, and treatments who need to be done. Based on clinical guidelines and practice, an operating base payment rate is calculated to determine how much it would cost a hospital to treat a patient, which is then given a weight based on how much it would cost to treat a specific DRG given an expected LOS[11].

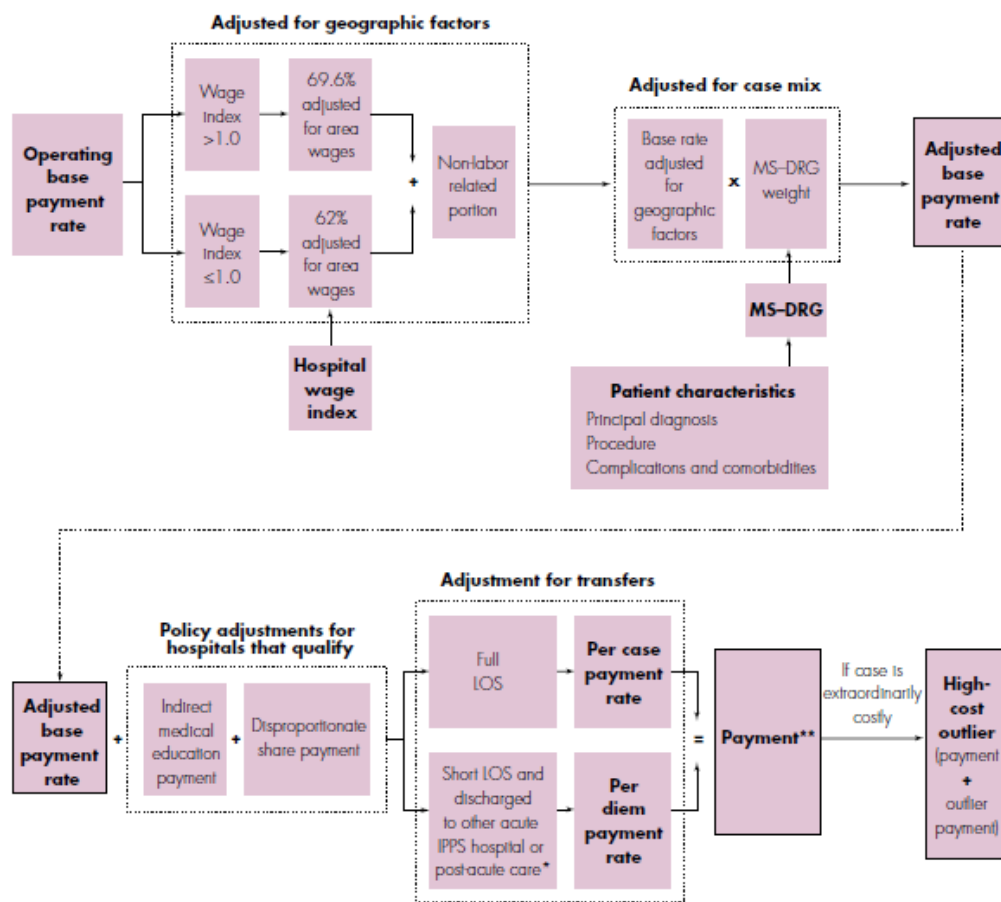


Figure 4: Flow Chart in Calculating DRGs. (Figure taken from “Hospital Acute Inpatient Services Payment System”, 2015)

After going through a series of adjustments as shown in Figure 4, the base operating cost evolves into a contractual budget for each DRG that varies for each hospital.

Adjustments are made to account for case mix, local markets, and special circumstances of the hospital. Currently, there are no adjustments made in the IPPS for sociodemographic risk factors such as race/ethnicity. DRGs are assigned and billed by the discharge. Because the monetary amount to be paid for each DRG is stipulated in advance, this is considered to be a prospective payment system. As such, hospitals bear financial risk in that they only have to use enough resources to treat a patient and still stay within the DRG budget. If a patient stays longer in the hospital than accounted for in the DRG cost, then more money is spent than the hospital will receive from CMS for that discharge, and the hospital is at a financial loss.

Discrepancies between DRG calculations and real-world costs make some DRGs profitable and others financial sinks[12]. Some hospitals may create policies that favor profitable DRGs. Meanwhile, hospitals can attempt to make non-profitable DRGs less financially harmful by cutting LOS for patients. This solution would cut costs, potentially at the expense of the patient's health, and would also free up a bed to increase patient volume and make up for losses. Some hospitals bypass the issue of non-profitable DRGs by simply not offering the services associated with those DRGs.

Currently there is a push towards newer payment models for physicians based on pay-for-performance (P4P) methods[13]. This is in direct opposition to the current prevailing model, fee-for-service, which incentivizes doctors to push for volume of care

provided rather than quality. In P4P, payments are awarded for reaching certain benchmarks that are considered structure, process, or outcome measures[14]. Structure measures are standards for the healthcare setting that would best facilitate the delivery of care to patients: for example, staffing patterns, facilities, and financial organization. Process measures are to ensure that healthcare providers are meeting minimum standards of care that are widely shown to be evidence-based and effective. An example would be to ensure that doctors provide aspirin to any patient with chest pain. Outcome measures are benchmarks regarding the patient's health after he or she receives care, such as reaching a target glycated hemoglobin level in diabetes patients, reducing 30-day readmission rates, or reducing LOS to appropriate lengths for inpatients[14].

CMS recently passed the Medicare Access and CHIP Reauthorization Act (MACRA) to streamline three of the biggest federal payment and incentive programs into one comprehensive Merit-Based Incentive Payment System (MIPS). In doing so, they plan to shift their payment method to a value-based system as well, using P4P. In the new program, MIPS will not only reward providers who perform well according to predetermined quality metrics, but also penalize providers and hospitals that perform in the lowest percentiles [15].

Many hospitals and caregivers claim that they serve more demanding demographics than payment calculations account for because sociodemographic risk factors are disregarded or underestimated. Because they serve higher risk populations, it is more difficult for them to meet quality standards than it is for other hospitals. Therefore, hospitals and providers that serve predominantly low-income, minority, and

rural populations are concerned that they will be systematically disadvantaged in the new payment system under MIPS. Large, wealthy hospitals that are already performing well will continue to receive significant federal funding, whereas smaller hospitals with fewer resources and more demanding patients will lose funding, setting them back in quality improvement. Many are calling for sociodemographic risk-adjustment as a way to “level the playing field” in reimbursement rates [16, 17].

In 2014, the National Quality Forum (NQF) conducted an assessment of potential factors that could be used in sociodemographic adjustment and their efficacy in reflecting health disparities in populations [18]. Among the factors recommended were household income, insurance status, and race/ethnicity. The assessment concluded that certain providers would benefit from sociodemographic adjustment for accountability applications such as pay-for-performance in order to mitigate health disparities. However, NQF did not make any sweeping policy changes. Instead, it requested healthcare organizations to submit recommendations of specific measures that should be risk adjusted for sociodemographic factors, so that they could be examined for an evidence-based decision. In 2015, when evaluating the metric of risk-adjusted average length of inpatient hospital stay based on data provided by Premier Inc., the NQF Board Executive Committee was unable to reach a consensus. Currently this metric is not endorsed by the NQF, but further studies could change this [19].

Severity of Illness, Chronicity, and Age

Ideally, clinical factors would be the only determinants of care provided in a hospital. Patients who have higher severity of illnesses, suffer more chronic conditions,

and/or are very young or very old, require more medical interventions and are more susceptible to complications. As such, any of these characteristics would require longer LOS, since patients might need advanced medical devices and professional supervision offered by the hospital. If a hospital serves a population with more severe illnesses and a higher number of chronic conditions, a “sicker” case mix, the hospital is likely to have longer LOS data overall, compared with a hospital that serves a generally healthier population.

Healthier populations usually are associated with being predominantly wealthier, non-Hispanic white, non-elderly adults[5, 20, 21]. Elderly patients are more likely to have multiple chronic conditions, recover slower, and be more prone to medical complications due to deteriorating immune systems. Younger children have developing immune systems, which make them highly susceptible to infections. Additionally, newborns that have to be hospitalized are likely to either be premature or have severe congenital disorders. Such neonates are generally treated aggressively, and may be on life-sustaining medical devices for long periods of time until they are stable enough to be transferred or taken home.

Severity of illness is defined as “extent of physiologic decompensation or organ system loss of function”[22]. For the purposes of this study, severity was measured by the All Patient Refined DRG (APR-DRG) designated to each hospital admission. APR-DRG’s are built upon the DRG calculations discussed earlier, but are adapted to include the pediatric population and account for severity of illness as well as risk of mortality. Four severity subclasses are added to each DRG: 1-minor, 2-moderate, 3-major, and 4-

extreme. Determining the severity subclass is a three-part process. In phase one, the severity of each secondary diagnosis is designated. In phase two, the severity of each secondary diagnosis is modified and then combined with all other secondary diagnoses into one base severity level. In phase three, the severity of the primary diagnosis and other factors (such as age and procedures done) are taken into account to calculate the final severity level [11]. Subdividing all classes into the severity classes results in 1,258 APR-DRG's [23].

The chronicity in this study was determined by the 3M™ Clinical Risk Groups (CRGs) associated with each patient, to estimate the number and type of chronic illnesses. CRG's are similar to DRG's in that they are each a measure of resource utilization for specific clinical cases. While DRG's are specific to a given hospital admission, CRG's are a measure of all healthcare utilization across inpatient and ambulatory settings for a patient, in a given amount of time[24] . All CRG's fall within one of nine health statuses:

- Healthy (no chronic health problems)
- History of significant acute disease (eg: chest pains)
- Single minor chronic disease (eg: migraine)
- Minor chronic diseases in multiple systems (eg: migraine and benign prostatic hyperplasia)
- Significant chronic disease (eg: diabetes mellitus)
- Significant chronic diseases in multiple organ systems (eg: diabetes mellitus and congestive heart failure)

- Dominant chronic disease in 3 or more organ systems (eg: diabetes mellitus, congestive heart failure, and chronic obstructive pulmonary disease)
- Dominant/Metastatic malignancy (eg: metastatic colon malignancy)
- Catastrophic (eg: history of major organ transplant)

After subdivision into the nine health statuses, there are a total of 1,080 CRGs [24].

HPSA, Distance Traveled, and Rurality

Primary care is defined as “first-contact, continuous, comprehensive, and coordinated care provided to populations undifferentiated by gender, disease, or organ system”[25]. In practice, family medicine, general internal medicine, pediatrics, and obstetrics/gynecology are the four medical fields categorized as primary care. Though the exact numbers are still being debated, many public health officials agree that the US is facing a physician shortage, particularly in the field of primary care. Although primary care constitutes one-third of the country’s physician workforce, in other developed countries primary care accounts for about one half or more. This imbalance between primary and specialized care may be one of the main factors contributing to poor health management and wasteful health spending in the US. Primary care is essential for screening, diagnoses, health maintenance, chronic care management, health education, and referrals for when specialized care is needed. Lack of proper primary care can lead to the development of serious, preventable conditions, or the exacerbation of conditions that remain undiagnosed and/or untreated. The Kaiser Family Foundation estimates that about 39.59% of healthcare need in the US remains unmet [26].

As of June 2014, the US Department of Health and Human Services has designated 6,100 primary care Health Professional Shortage Areas (HPSA's) in the US, and estimated that 8,200 primary care physicians would be required to eliminate the current shortage [27]. These areas are defined by a population in which there are more than 3,500 individuals for every one physician, and patients must travel more than 30 minutes to their nearest provider [27]. Public health officials have determined 1,000 patients for one physician to be the desired ratio in the US, while the OECD average is about 300 patients for one physician [28]. Many are concerned that this shortage will only continue to grow as the Affordable Care Act expands financial access to care, and the disproportionately large elderly population demands more care as they grow older and sicker.

Because of low population densities and tendencies for physicians to cluster in urban settings, rural areas are overwhelmingly designated as HPSA's. The U.S. 2010 Census Data found that 19.3% of the country's population resides in a rural area [29]. In order for a patient from a rural area or HPSA to be admitted to a free standing pediatric hospital, it is likely the individual travelled a significant distance to get there. As a result, it is possible that there are obstacles in coordination of care that would lead to longer LOS for patients that live far away, in an HPSA or in a rural area.

If the patient does not have a regular primary care giver (PCP), or has one that is in a remote location, it would be difficult for a hospital physician to find satisfactory medical history on the patient. The process of looking for and obtaining the pertinent medical history in itself could contribute to longer wait times, replication of services, or

more care provided than necessary. Also, in order to discharge a child from the hospital, physicians would want to ensure that further care would be provided at home, and that follow-up on the patient is possible. Navigating these issues without being able to coordinate with a local PCP for the patient would be difficult and could possibly delay discharge further.

Income and Payer

Currently, 22% of the United States' children are living in poverty, one of the highest rates among OECD countries[30]. This rate has been increasing over the years, disproportionately so in rural areas and among racial minority groups. It is generally accepted that low-income populations tend to have poorer health overall. With little political or financial leverage, they are more likely to endure hazardous living conditions. They have less access to adequate nutrition, primary and preventative care services, and education and health education. As a result, children in poverty are less likely to receive timely vaccines, and more likely to be exposed to environmental toxins, malnourishment, and chronic diseases such as asthma and obesity when compared with their more wealthy counterparts [31]. These factors make low-income patients likely to have more frequent and longer hospitalizations than children of higher socioeconomic status. Household income is often used as a proxy measure for factors such as education and environmental exposures that would have an effect on the patient's ability to self-manage health at home. Thus, some doctors are more likely to keep low-income children in the hospital longer than they typically would, since they know that the children's families are less able to provide adequate homecare after discharge. This option would allow more time

for the patient to heal under professional care. Furthermore, it is probable that families of low-income patients require more time for the discharge process. These families need more training in medical literacy to continue care at home, or alternative measures need to be found to navigate financial barriers if medical services or devices are required in the home.

To address the issue of childhood poverty, Congress established the Children's Health Insurance Program (CHIP) in 1997, to provide healthcare coverage for children who are ineligible for Medicaid, but still unable to afford private insurance [32]. The program includes not only coverage for medical health services typical of adult plans, but also developmental, dental, mental health, substance abuse, and special needs services, as well as annual eye and hearing exams. According to the most recent data reported by the Kaiser Family Foundation, about 37% of all children in the US are covered by either Medicaid or CHIP. Between these two programs, the uninsured rate among children has fallen to a historic low of 7% as of 2014, half of what it was at the inception of CHIP. This growth in coverage for children was continuous despite the economic downturn the country faced in recent years, when many non-elderly adults lost health insurance coverage[32].

The decline in the uninsured rate was most dramatic in the population below 200% of the federal poverty level and in the population of Hispanics, the ethnic group most likely to be uninsured. CHIP and Medicaid have helped to decrease disparities in financial access to healthcare by covering more than half of Hispanic and Black children (52% and 56% respectively) while covering only a quarter of White and Asian children.

Studies evaluating the efficacy of CHIP estimate that enrollment in the program reduces the rates of unmet healthcare need by 50% or more[32]. This is a result of the increased likelihood that low-income children have access to regular and continuous primary and dental care, and access to needed preventative care, pharmaceuticals, and hospital care when enrolled in CHIP compared with being uninsured.

Furthermore, the Medicaid and CHIP Payment and Access Commission (MACPAC) found that overall rates of access and use of regular health services among children enrolled in Medicaid and/or CHIP are comparable with those among privately-insured children[32] However, there are some studies that suggest that Medicaid/CHIP enrolled children are more likely to be denied appointments with specialists and face longer wait times than their privately-insured counterparts. One survey indicates that physicians are three times more likely to face difficulties in referring Medicaid/CHIP patients to specialists than privately insured ones [32].

Several studies have shown that reimbursement rates are the major driving force behind which patients providers serve, and Medicaid/CHIP reimbursement rates are consistently lower than those from private insurance[33]. Additionally, there are concerns about delays in payments, and more burdensome bureaucracy associated with Medicaid/CHIP patients. In evaluating the efficacy of expanding Medicaid and CHIP, states have found mixed results (either positive or no impact) in outcomes for pediatric patients when using metrics such as avoidable hospitalizations and child mortality[32] All of this suggests that the type of payer for each patient has an effect on the behavior of

caregivers and hospitals. This relationship has implications in both the long and the short term.

If a patient on Medicaid/CHIP is repeatedly denied or faces delays in receiving needed care, there is a greater risk of health conditions exacerbating into more serious stages. Obstacles to receiving care can also lead to patients becoming jaded towards the system, and eventually becoming less willing to seek needed care. When the patient is finally hospitalized, the effect described in relation to low-income patients can be expected, since Medicaid/CHIP patients are inherently low-income. Considering that these patients have fewer resources, physicians may decide to keep them in the hospital longer. Also, if there are more obstacles with processing or accepting Medicaid/CHIP patients, it is likely that there would be longer wait times for completing tasks for a patient, which would unintentionally extend LOS. Meanwhile, an opposing force could potentially be at play in which hospitals less willing to treat Medicaid/CHIP patients might attempt to push the patient out earlier than they would a patient with private insurance. Thus, LOS data between different payer types could reflect differences in hospital and caregiver behavior.

Race/Ethnicity

Race and ethnicity is an extremely complex and ambiguous factor that many studies have attempted to explain. The racial designations most commonly used in the US are based in social constructs that have been systemically enforced for so long that they may have led to physiological implications. Studies have found that lifetimes and generations of deprivation and discrimination faced by racial minorities have led to poor

health outcomes such as those associated with chronic stress[34]. Moreover, cultural aspects associated with race/ethnicity have long-term implications on health, such as diet and exercise habits, as well as views towards seeking Western medicine and ability to access healthcare due to differences in language or values. Differences in views, language, and values, or religious constraints can present obstacles to providing efficient and timely care, thus extending LOS.

Other studies have attempted to show that there are some inherent biological differences between different racial groups that can affect health outcomes. For example, a genomic study done on patients with childhood acute lymphoblastic leukemia found five gene loci associated with increased susceptibility to the disease, four of which were able to be associated with specific racial/ethnic groups[35]. However the same study acknowledged the unreliability in clinically applying these genetic associations given the vagueness of race/ethnicity designations. An individual who identifies as Hispanic may have a mixture of African and European genetic profiles. Therefore, the study concluded that when clinically relevant, genomic testing should be for decision-making rather than self-identification of race/ethnicity. If there are biological differences between races, there is potential that different races require different healing times or respond differently to different interventions, thus causing variation in LOS for the same illnesses. However, it may be difficult to associate biological factors with race/ethnicity given the limitations of self-identification of race in the US.

Specific Aims

We undertook the present study to further quantify the effects various clinical and sociodemographic factors could have on quality of care. Specifically, the aims of this study are as follows:

- (1) Inpatient data from 44 free standing pediatric hospitals in the United States will be pulled from the Pediatric Health Information Systems (PHIS)
- (2) Length of stay (LOS), and clinical and sociodemographic data at each hospital will be examined
- (3) Variance in LOS and contribution to LOS variance by clinical and sociodemographic data between hospitals will be analyzed

Through this study, we aim to examine on the impact of sociodemographic and clinical risk factors on health outcomes, specifically inpatient LOS, for patients between different pediatric hospitals.

METHODS

We conducted a retrospective cohort analysis of 818,848 hospitalizations of patients occurring from 1/1/2014 to 12/31/2014 in one of 44 freestanding children's hospitals from 24 states and the District of Columbia in the Pediatric Health Information Systems (PHIS) dataset. PHIS is a national comparative database that collects information from various healthcare settings on resource utilization, clinical information, and patient demographics. Among other things, the data are collected for the purposes of research, management, quality improvement, and financial contracting. All hospitals participating in PHIS are members of the Children's Hospital Association. Hospitalizations were excluded from analysis if they were associated with neonatal intensive care (7.5%, n=639,113), transfer in from another hospital (13.5%; n=110,339), transfer out to another hospital (0.6%, n=4984), transfer out to a rehabilitation facility (0.1%, n=828), or in-hospital mortality (0.3%, n=2,709). These exclusions were applied because they represent incomplete measurement of the patients' entire episode of hospital care (i.e., transfers) or atypical circumstances of LOS (i.e., neonatal intensive care or in-hospital mortality). The Boston Children's Hospital Institutional Review Board approved this study with a waiver for informed consent.

Main Outcome Measure. The main outcome measure was length of hospital stay (LOS) in days, including the days of admission and discharge.

Characteristics Associated with Persistent High Inpatient Cost

We assessed patients' demographic, clinical, and hospitalization characteristics that might be associated with LOS.

Demographic characteristics included age at admission, household income (\leq \$33,525; \$33,526-\$44,700; \$44,701-\$67,050; and \geq \$67,051), insurance (public, private, and other), race/ethnicity (Asian/Pacific islander, Hispanic, Non-Hispanic White, Non-Hispanic Black, and Other), and residence of home (distance from hospital, rurality, and health professional shortage area). We calculated the distance traveled to hospital as the miles between the geographic center of the hospitals' Zip code and the patient's home ZIP code. Rurality was determined by linking each patient's home ZIP code to their modified rural-urban commuting area (RUCA) categorization. We defined "rural" as residence in a large rural town or small rural town/isolated rural area. Health professional shortage area (HPSA) designation was applied when the patient's home residence was in an area where the ratio of population to primary care physician was \geq 3500:1.[36]

Clinical and hospitalization characteristics included severity of illness and the number and type of chronic conditions endured by the patients. These characteristics were identified with codes from the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. Severity of illness, defined as the extent of physiologic decompensation or organ system loss of functioning, was measured as minor, moderate, major, or extreme using 3MTM All Patient Refined Diagnosis Related Group Classification System. We also used the 3MTM Clinical Risk Groupings Software version 1.7, a risk adjustment method developed by 3M Health Information Systems and the National Association of Children's Hospitals and Related Institutions, to assign each individual pediatric patient to one of nine mutually exclusive hierarchical groups of type

and number of chronic conditions, according to type (e.g., episodic or lifelong) and severity (e.g., minor, major, or catastrophic).[37-40]

Statistical Analysis

In univariable analysis, we used a generalized linear model with a random effect for hospital, to assess the relationship between LOS and each individual patient characteristic. In multivariable analysis, we derived a generalized linear model to regress all of the demographic, clinical, and hospitalization characteristics simultaneously on LOS. Using the covariance test of the hospital random effect, we determined the percentage of total variation in LOS attributable to each characteristic within each hospital. To account for multiple comparisons, statistical significance was adjusted to $p < 0.001$. All analyses were implemented with SAS (Statistical Analysis Software) version 9.3 for Windows. Copyright© 2011 (SAS Institute, Cary, North Carolina, USA).

RESULTS

Demographic and Clinical Characteristics of Study Population

Across the 44 hospitals in this study, 818,848 hospitalizations of 638,285 distinct pediatric patients were analyzed. The five most common reasons for admission, designed by APR-DRG, were Asthma (5.6%, n=35,635), Seizure (5.0%, n=31,712), Bronchiolitis and RSV (respiratory syncytial virus) Pneumonia (4.0%, n=25305), Chemotherapy (3.1%, n=19,915), and Tonsil and Adenoid Procedures (2.9%, n=18,689).

Of these hospitalizations, 25.2% (n=160,680) were age \leq 1 year, 17.4% (n=111,227) were ages 2-4 years, 30.1% (n=192,081) were ages 5-12 years, and 27.3% (n=174,297) were ages 13-18 years (Table A1). About half of the study population (50.6%, n=323,138) identified as Non-Hispanic White, whereas Hispanic and Non-Hispanic Black each represented 20.1% (n=128,122) and 19.6% (n=125,147) of the population, respectively. Most patients had public insurance (56.3%, n=359,666) and resided in an urban area (88.3%, n=558,716), an area not designated as HPSA (94.4%, n=602,405), and in an area $<$ 60 miles away from the admitting hospital (85.4%, n=545,061) (Table A1).

Severity of illness, as defined by APR-DRG methods, was fairly equally distributed among the five scoring categories: one (20.4%, n=129,947), two (20.1%, n=128,231), three (19.9%, n=127,220), four (19.7%, n=125,707), and five (19.9%, n=127,180) (Table A1). Types of chronic condition were more varied, with 30.8% of patients designated as Critical (n=196,329), 29.4% as Not Chronic (n=187,685), 25.0% as

Episodic Chronic (n=159,498), 9.0% as Lifelong Chronic/Catastrophic (n=57,634), and 5.8% as Malignancy (n=37,139) (Table A1).

Length of Stay by Demographic and Clinical Characteristics

The data showed that median LOS across all 44 hospitals for each category within factors was relatively stable. For most categories, median LOS was about 2 or 3 days, with an interquartile range (IQR) from 1 to 3 or 4 days (Table A1). Illness Severity deviated from this, such that lower levels were associated with a lower median of 1 day (IQR 1-2 days) while the highest severity level had a higher median of 4 days (IQR 2 -8 days) (Table A1).

Length of Stay Contribution and Variation by Demographic and Clinical Characteristics

Severity of Illness and Chronic Conditions.

Of the demographic and clinical characteristics analyzed, severity of illness had the greatest impact on length of stay (LOS) across hospitals; a median 16.8% (IQR 15.0%-19.4%) of the LOS variance was explained by illness Severity (Figure 5). Chronic condition had the second greatest impact on LOS; a median 4.0% (IQR 2.9%-4.5%) of the LOS variance was explained by Chronic Condition Type and Number (Figure 5). LOS varied significantly ($p < 0.05$) with both Illness Severity and Chronic Condition Type and Number for all 44 hospitals in the cohort (Figure 6).

Age, Race/Ethnicity, and Payer.

The contributions to the LOS variance by the demographic factors of age, race, and ethnicity, and payer type were found to be fairly low, with a median 0.08% (IQR 0.01%-0.39%) for Age at Admission, 0.07% (IQR 0.04-0.11%) for Race and Ethnicity, and 0.05% (IQR 0.01-0.1%) for Payer type (Figure 5). LOS differed significantly by Age at Admission in 70.5% of hospitals (n=31), by Race/ Ethnicity in 65.9% of hospitals (n=29), and by payer in 60.5% of hospitals (n=26) (Figure 6).

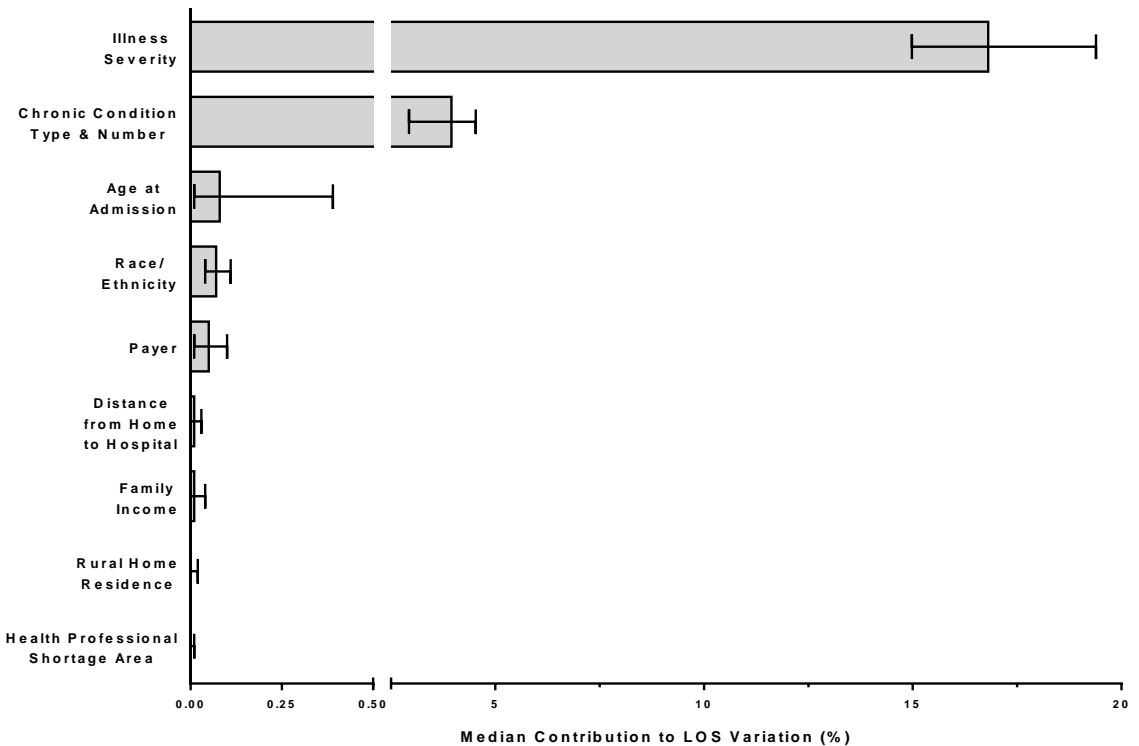


Figure 5. Contribution of demographic and clinical factors to LOS variation. The median percentage contributions to length of stay (LOS) variation are shown for each demographic and clinical factor, with the interquartile range defined by error bars. The clinical factors include Illness Severity of primary diagnosis and Chronic Condition Type and Number. The demographic factors are Age at Admission, Race/Ethnicity, the Payer type, Distance from Home to Hospital, Family Income of the patient, Rural home residence, and residence in a Health Professional Shortage Area.

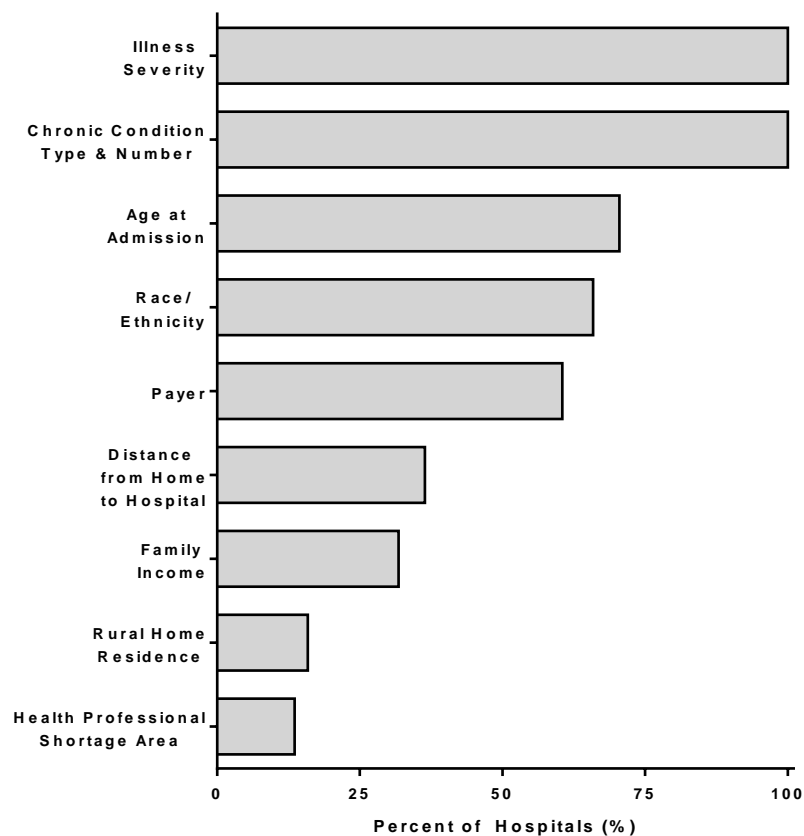


Figure 6. Portion of hospitals in which each demographic or clinical factor was significant. The number of hospitals in which each factor that contributed to total length of stay (LOS) variance was considered statistically significant is presented as a percentage of the total number of hospitals for which the data were available. All 44 hospitals reported data for the following factors: Illness Severity of primary diagnosis, Chronic Condition Type and Number, Age at Admission, Race/Ethnicity, Distance from Home to Hospital, Family Income, Rural Home Residence, and residence in a Health Professional Shortage Area. One hospital did not report data for Payer type. Significance level $p < 0.05$.

Area of Patient Residence: Distance from Hospital, Family Income, Rurality, and Health Professional Shortage Area.

The data indicated that demographic factors regarding the location of the patient's residence had almost no impact on the LOS variance between hospitals in this cohort.

The factor Distance from Home to Hospital explained a median 0.01% of LOS variance

(IQR 0.0%-0.03%). Family Income (Median Household Income) also contributed a median of 0.01% to LOS variance (IQR 0.00%-0.04%). There was a median 0.0% contribution to the LOS variance by each Rural Home Residence (RUCA categorization) (IQR 0.0-0.02) and each residence in a Health Professional Shortage Area (HPSA designation) (IQR 0.0%-0.01%) (Figure 5). Still, these factors were associated with significant LOS variance in several hospitals in the cohort. LOS varied significantly by Distance from Home to Hospital in 36.4% of hospitals (n=16), by RUCA categorization in 15.9% of hospitals (n=7) and by HPSA designation in 13.6% of hospitals (n=6) (Figure 6).

Unexplained Variance.

A large portion [78.3% (IQR 75.8-80.2%)] of the LOS variance between hospitals was unexplained by the demographic and clinical factors of this study (Figure 5).

Population Demographics by Factor.

When demographics were compared by factor between hospitals that did and those that did not show significant LOS variation by each factor, there was no significant difference between populations ($p < 0.05$) (Table 2). The median age in hospitals that show significance in LOS variation by age was 6.61 years, while in remaining hospitals it was 6.23 years. Median distance between patient residence and the hospital was 13.1 miles for hospitals that found significant LOS variation by Distance, and 14.6 miles for those that did not. Median Family Income was \$39,258 in hospitals significant by income, but \$42,171 in the remaining ones. The median proportion of public payers was

59.5% at hospitals with significance in LOS variation by payer, and 52.8% at hospitals with no significance.

Table 2. Population demographics by factor between hospitals with and without significance.

Factor	Hospitals without Significant Factor*	Hospitals with Significant Factor*	p-value
Median Age (years)	6.23 [5.76, 6.58]	6.61 [5.90, 7.68]	0.177
Median Distance (miles)	14.6 [12.8, 19.0]	13.1 [11.7, 18.7]	0.267
Median Family Income (\$)	42171 [38009, 47556]	39258 [35438, 42616]	0.325
% Non-Hispanic White	51.7 [30.3, 69.5]	59.1 [40.3, 65.6]	0.747
% Public Payer	52.8 [50.5, 61.6]	59.5 [48.5, 66.3]	0.405
% Rural Residence	9.4 [4.2, 19.0]	11.6 [6.5, 24.7]	0.335

*data given as median [interquartile range]

^significance level $p < 0.05$

Demographics with Longest Length of Stay

Patients with public insurance were more likely to have the longest length of stay compared with those with private or other types in 14 of the 26 hospitals (53.85%) that showed significant variance in LOS by Payer type (Figure 7). Patients who identified as either Asian or Other were equally more likely to have the longest length of stay compared with patients who identified as Non-Hispanic Black, Non-Hispanic White, or Hispanic, in hospitals associated with significant variance in LOS by Race/Ethnicity. Of these 29 hospitals, 9 (31.0%) showed that Asians received the longest LOS and another 9 (31.0%) showed that Other received the longest LOS (Figure 7).

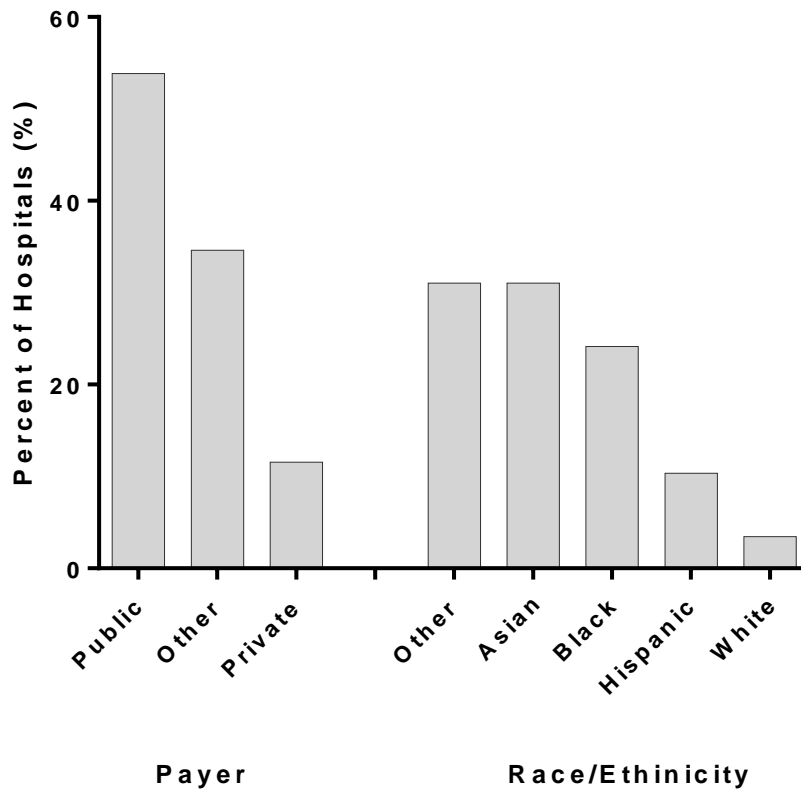


Figure 7. Portion of hospitals in which each attribute was associated with the longest LOS. The number of hospitals in which a given attribute for the factors Payer type and Race/Ethnicity was associated with the longest length of stay (LOS), is presented as a percentage of the number of hospitals that showed statistical significance in LOS variance for that factor. The payer attributes of Public, Other, and Private are shown as percentages of 26 hospitals. The Race/Ethnicity attributes of Other, Asian, non-Hispanic Black, Hispanic, and non-Hispanic White are shown as percentages of 29 hospitals. Significance level: $p < 0.05$

DISCUSSION

In 100% of the hospitals that were evaluated in the study, severity and chronicity of the patient's condition were the greatest significant factors in contributing to the variance in LOS between hospitals. This was expected given that decisions surrounding discharge of a patient are most directly based on these clinical factors. However, the study also shows that the actual contribution to total LOS variance by clinical factors is only about 21%. With each of the other factors contributing less than 1%, the remaining 78% of LOS variance is left unexplained by the factors considered in this study. This suggests that the vast majority of LOS variance is due to practices at individual hospitals, not risk factors relating to the patients.

In all likelihood, the health disparities regarding race, age, rurality and income all manifested in differences in severity and chronicity of illness. It is well supported in the literature that Black and Hispanic populations tend to have lower income in the US, that they have worse health outcomes, and that lower income populations in general have worse health outcomes [41, 42]. However, when these factors are taken in isolation of each other, there is very little effect from any inherent mechanisms that result in large differences in LOS. Furthermore, a more in-depth statistical analysis will be required to draw meaningful conclusions about the effect income has on LOS. A simple overview of the data suggests that while there was not a significant difference in median incomes between hospitals that found significant LOS variance by income and those that did not, the overall distributions of income at hospitals in each group are very different.

The patient living in an area designated as an HPSA showed very little effect on length of stay. This can be due to several reasons. First, the data came from large, free standing pediatric hospitals, which means that by definition they are not located in HPSA's. Any patients that they did receive from HPSA's had to have traveled a significant distance to receive hospital care. Thus, there may be a selection bias in that the people who were able to make that journey had more resources and support than most of their peers in the HPSA. Second, HPSA's are determined based on patient access to primary care physicians, but they do not account for other caregivers such as nurse practitioners (NPs). There are 19 states in the U.S. in which NPs are given full autonomy to their scope of practice allowing them to run rural and community clinics in underserved areas in the absence of physicians[36]. This benefits the clinics because an NP is less costly to hire than a physician for most of the same services. Therefore, a patient residing in an HPSA does not necessarily mean that the individual is not receiving adequate primary care. A similar argument can be made for patients who live in rural areas or traveled a great distance.

The fact that patients with public payers were more likely to have longer LOS in hospitals where payer mix was significant is consistent with the expectations discussed earlier regarding physician behavior and obstacles associated with accepting Medicaid/CHIP payments. Though there was some difference in LOS seen between types of payer, the overall contribution to LOS variation was still very small. This may be indicative of other programs that supplement public payer money being effective. One such program is the Medicaid Disproportionate Share Hospital (DSH) Payments[43].

This is additional federal funding given to qualifying hospitals that serve a disproportionately large number of Medicaid and uninsured individuals. If DSH is the reason that payer mix has such a small effect on LOS variance, it may mitigate any financial discrepancies that could potentially influence caregiver behavior.

Results for racial demographics with the longest LOS in hospitals where race was significant are somewhat surprising. Patients who identified as Other tied for first place in likelihood of having the longest LOS with patients who identified as Asian. The fact that The Other is one of the groups with longest LOS implies that the racial designations commonly used in the US are inadequate, and probably not meaningful in clinical terms. The Other group usually includes individuals who have either unknown or multiple ancestral origins. It is also possible that patients from other countries, who do not identify with US designations chose Other. Many individuals from regions such as the Caribbean, Central America, and South America do not associate with the term Black, though an American might have categorized them as such. There is additional confusion created for these populations given that the term Hispanic relates to cultural and linguistic association, while White and Black are generally associated with physical attributes and American history.

Asian was the other racial group with the greatest likelihood of having the longest LOS. This could be a reflection of a lack of cultural competency in healthcare. Again, there is inadequacy in the designation given that it refers to a wide range of ethnicities from the largest continent in the world. There are hundreds of languages, religions, and belief systems in Asia, and much of the Asian population in the U.S. has immigrated to

the country within the last few generations. In the case of the Hispanic population, while it is the largest minority population, it is unified in one language[44]. As a result, it is increasingly common for health care providers to know Spanish, have access to Spanish interpreters, or supply print materials in Spanish. The same level of access for foreign language-speaking patients is not available for the populations that identify as Asian. Lack of adequate communication between doctors and patient families would be a significant reason for longer LOS in Asian populations. This is an important issue to address considering that the Asian population has the second largest growth-rate (after the population identifying as Two or More Races), according to the U.S. Census Bureau[44].

The greatest limitation of this study is the small sample size. With only 44 free-standing hospitals participating in PHIS, statistical power in this study is low. Further work should be done to collect similar data in other pediatric healthcare settings. The next step for this type of analysis is to be applied to metrics such as 30-day readmission rates for patients. This is a more complex metric to consider, given that it is more directly under the influence of factors outside of the hospital's control. Yet this metric has been given increasingly more weight in discussion about P4P, and may become more ubiquitous in use than LOS.

In addition, other risk factors to consider in future studies include education levels of the patient, primary language spoken by the patient, and social support after discharge. Although these data may be more difficult to obtain, they would be valuable in providing insight into how well patients are able to care for their health outside of the hospital and

follow physician instructions. These factors affect the patient's ability to maintain health, and proper self-management can significantly decrease 30-day readmission rates.

CONCLUSION

The results of this study suggest that it is not meaningful to conduct sociodemographic risk adjustment for age, race/ethnicity, payer mix, family income, HPSA/rural residence, or distance traveled on LOS metrics for performance evaluation of hospitals. However, adjustments for severity and chronicity should be made. The majority of LOS variance is likely due to differences in practice and management at each hospital, suggesting that LOS is actually indicative of relative performance or efficiency between hospitals. This is not to say that sociodemographic risk adjustment should not be done at all. Adjustments may have more of an impact on metrics such as 30-day readmission rates, and pharmaceutical drug compliance. These types of outcome metrics affect the evaluation of hospitals and doctors, yet they result from the combination of caregiver performance and patient behaviors and circumstances.

APPENDIX

Table A1. Clinical and demographic characteristics of the study population.

Characteristic	N(%)*	Median LOS(IQR)^
Age at Admission (in years)		
0-1	160680 (25.2)	2 [1, 3]
2-4	111227 (17.4)	1 [1, 3]
5-12	192081 (30.1)	2 [1, 3]
13-18	174297 (27.3)	2 [1, 4]
Race/ethnicity		
Non-Hisp White	323138 (50.6)	2 [1, 3]
Non-Hisp Black	125147 (19.6)	2 [1, 3]
Hispanic	128122 (20.1)	2 [1, 3]
Asian	16889 (2.6)	2 [1, 4]
Other	44989 (7)	2 [1, 3]
Payer		
Government	359666 (56.3)	2 [1, 3]
Private	262132 (41.1)	2 [1, 3]
Other	16487 (2.6)	2 [1, 3]
Severity of Illness		
1 (lowest)	129947 (20.4)	1 [1, 2]
2	128231 (20.1)	1 [1, 2]
3	127220 (19.9)	2 [1, 3]
4	125707 (19.7)	2 [1, 4]
5 (highest)	127180 (19.9)	4 [2, 8]
Chronic Condition Classification		
Not chronic (1-2)	187685 (29.4)	1 [1, 2]
Episodic Chronic	159498 (25)	1 [1, 3]
Lifelong/Catastrophic Chronic	57634 (9)	2 [1, 3]
Critical (6,7,9)	196329 (30.8)	3 [1, 5]
Malignancy (8)	37139 (5.8)	3 [1, 5]
Family Income		
Q1	163915 (26.2)	2 [1, 3]
Q2	147007 (23.5)	2 [1, 3]
Q3	155592 (24.8)	2 [1, 3]
Q4	159798 (25.5)	2 [1, 4]
Health Professional Shortage Area		
No	602405 (94.4)	2 [1, 3]
Yes	35880 (5.6)	2 [1, 3]

Distance Traveled from Home Residence to Hospital		
<60 miles	545061 (85.4)	2 [1, 3]
60+ miles	93224 (14.6)	2 [1, 4]
Rurality of Home Residence		
Rural	74268 (11.7)	2 [1, 4]
Urban	558716 (88.3)	2 [1, 3]

* n (%) = number of pediatric patients (percentage of total population of 638,285 pediatric patients).

^LOS = length of stay in days.

IQR = interquartile range = [first quartile, third quartile].

LIST OF JOURNAL ABBREVIATIONS

Acad Pediatr	Academic Pediatrics
Am Econ Rev	American Economic Review
BMC Health Serv Res	BMC Health Services Research
Can Urol Assoc J	Canadian Urological Association Journal
Health Serv Manage Res	Health Services Management Research
Health Serv Res	Health Services Research
Issues Ment Health Nurs	Issues in Mental Health Nursing
J Ambul Care Manage	Journal of Ambulatory Care Management
J Arthroplasty	Journal of Arthroplasty
Med Care	Medical Care
Spine J	Spine Journal

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CURRICULUM VITAE

Fareesa Hasan

Year of Birth: 1992

farhsn@bu.edu | (571) 309-2111

EDUCATION AND TRAINING

Boston University, BA, Biology, 2014

Boston University Graduate Medical Sciences MS, Medical Sciences, 2016

Boston University School of Public Health MPH, Health Policy and Management, 2016

SKILLS

- Microsoft Office: Word, Excel, Powerpoint, Outlook
- Coding: Python, SQL, SAS
- Conversational Bengali

EXPERIENCE

Research Assistant, General Pediatrics, Boston Children's Hospital, Fall 2015-Present

- Organize, synthesize, and analyze data regarding healthcare costs and quality metrics from national data sets such as PHIS and Medicare claims
- Transcribe conversations regarding discharge information for complex chronic care patients

Administrative Assistant, Graduate Program for Neuroscience, BUSM-GMS, 2013-2015

- Started the NeuroDome project which integrates the neuroscience community at BU across the graduate and undergraduate campuses, and between departments
- Built database for all contact information of students, staff and faculty, as well as created a calendar for all seminars, conferences, and workshops related to neuroscience
- Effectively communicate upcoming events, seminars, student projects, and workshops, updating database and calendar, and coordinating with graduate student organizations

Volunteer, Outreach Van Program, BU School of Medicine, Summer 2015

- Distributed food (hot and preserved), clothing, and personal hygiene supplies weekly at a regular site in East Boston
- Assisted and observed physician and social worker/Spanish translator from Boston Healthcare for the Homeless provide street medicine and resources for housing and career development

Neurologist Shadowing, INOVA Fair Oaks Hospital, Herndon Neurology Clinic, Summer 2014

- Shadowed a neurologist in a private clinic
- Occasionally observed in a hospital

Research Assistant for Marine Biology Genomics Lab, BU Dept of Biology, 2012- 2014

- Carried out *in situ* hybridization in *Edwardsiella lineata*. Main procedures include PCR, gel electrophoresis, RNA isolation, and transcription reactions

- Organized and analyzed quantitative data collected on parasite growth and development
- Provided basic animal care for sea anemones used in lab
- Trained new members joining the lab

Volunteer, Helping Hands for the Homeless, BU, 2010-2012

- Volunteered at the Harvard Square Homeless Shelter Dinner Service, food pantries at local churches and Boston Food Pantry

Intern, American Sleep Apnea Association (ASAA), Washington, DC Summer 2011

- Wrote for and maintained the advocacy page of the non-profit's website allowing supporters to contact Members of Congress
- Wrote the draft of a pamphlet providing information about sleep apnea and delineating guidelines on how it should be addressed in the workplace
- Organized membership applications and put together new member informational packages
- Created and updated existing databases using Microsoft Excel
- Sat in on meetings and attended a public health conference

Volunteer, INOVA Fair Oaks Hospital, Emergency Department Triage, Fairfax, VA Summer 2011

- Greeted and assisted patients and visitors in filling out pre-registration forms, providing directions, obtaining wheelchairs, and other services needed in the ER waiting room
- Kept up communication and ran errands between the front desk, the triage EMTs, and the emergency nurses

AWARDS

Undergraduate Research Opportunity Program (UROP)

- Received UROP grant from Boston University to work as a research assistant
- Student Research Award (2013)
- Funded Research Opportunity Grant (2014)

LEADERSHIP

Bangladeshi Student Association, BU, Fall 2010-2014

- President, Treasurer
- Coordinated with student offices, other student organizations, and other executive board members to organize various cultural events that strengthened community
- Maintained organization's budget, and put together and presented funding proposals for the BU Allocations Board, which were granted in full

BU International Affairs Association, BU, 2010-2014

- Held various leadership positions including those of Chairperson in the Model United Nations Conferences hosted twice a year by BU, and Logistics Director of the annual event Global Village
- In above positions, wrote international affairs research papers, moderated debate, supervised high school and college students, coordinated with student offices on obtaining necessary resources and organized schedules of programs