Economics in Medicine: A Physician's Perspective

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[1] This is to acknowledge that Catherine Chen, MD has disclosed that she does not have any financial interests or other relationships with commercial concerns related directly or indirectly to this program. Dr. Chen will not be discussing off-label uses in her presentation.

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Purpose and Overview

The purpose of this presentation is to summarize and discuss the factors contributing to healthcare expenditures nationally, interventions aimed at decreasing healthcare expenditures, and the barriers to implementation of these interventions. This presentation will include an overview of healthcare expenditures globally and nationally, diagnoses contributing to rising healthcare expenditures—particularly the roles of sepsis and respiratory failure resulting in mechanical ventilation, physician knowledge of healthcare costs, methods of healthcare cost reduction, and barriers to healthcare cost reduction.

Educational Objectives

At the conclusion of this lecture, the listener should be able to:

1. Describe the factors leading to increased healthcare expenditures in the United States.
2. Describe the role of sepsis in driving healthcare expenditures.
3. Describe the role of mechanical ventilation in driving healthcare expenditures.
4. Describe three barriers to healthcare cost reduction.

Summary

Healthcare expenditures have been steadily increasing in the United States over the past four decades, outpacing the growth in gross national income and gross domestic product. When compared to other similarly developed countries, healthcare expenditure in the United States is disproportionately high. The reasons for this rapid growth are multifactorial, but appear to be primarily driven by increased interaction with healthcare systems. A limited number of diagnoses comprise the bulk of healthcare costs, including sepsis and respiratory failure. Hospital admissions for sepsis and respiratory failure account for nearly 10% of national healthcare expenditure, and costs are anticipated to rise with the aging population. In addition, physician knowledge of the costs of healthcare is limited and incomplete, and efforts to clarify true costs of treatment are challenging. While interventions such as cost transparency measures and cost-effectiveness analyses have shown promise, barriers to reducing healthcare costs include wide geographical variability in care delivery, high fixed costs of healthcare, and difficulty predicting efficacious care delivery.

Healthcare Costs in the World and the United States

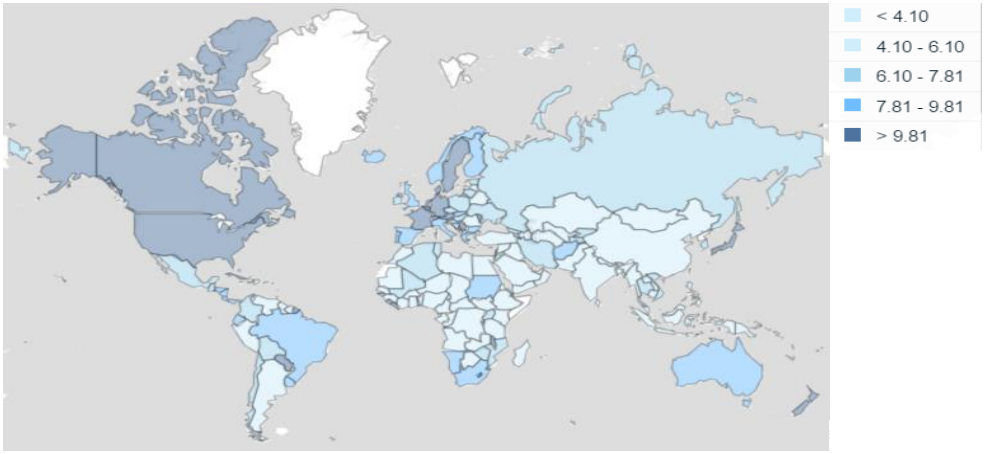


Figure 1. Healthcare expenditure as a percentage of gross domestic product. [1]

In 2011, $6.9 trillion was spent on healthcare globally, averaging approximately $1000 per person per year. The distribution of these expenditures is uneven, with 34 countries belonging to the Organization for Economic Cooperation and Development (OECD) utilizing 80% of healthcare resources but accounting for only 20% of the world's population. OECD countries spend an average of 12% of their gross domestic product (GDP) on healthcare expenditures, whereas other regions of the World Health Organization (WHO) spend half to one-third as much. [2]

The United States, in particular, spends a disproportionally large percentage of its GDP on healthcare (Figure 1). In 2015, 17.8% of the GDP was spent on healthcare, totaling $3.2 trillion. [3] In comparison, health spending as a percentage of GDP was 8.9% in 2013 in the OECD; behind the United States, healthcare expenditures in The Netherlands, Switzerland, Sweden, Germany, and France were each approximately 11%. [4] The rate of increase in healthcare expenditures per capita in the United States has outstripped the rise in gross national income, 5.8% [3] to 1.6% [5], respectively.

The increases in healthcare expenditures have been driven primarily by increased access to the health care system rather than increasing costs in any one facet of healthcare costs. Distributions of healthcare expenditures have not substantially changed since the 1960s. Between 2000 and 2015, hospital care

cost has remained between 30.3 and 32.6%, physician and clinical services between 19.7 and 21.1%, and medical equipment between 13.0 and 13.5% (Figure 2). [6]

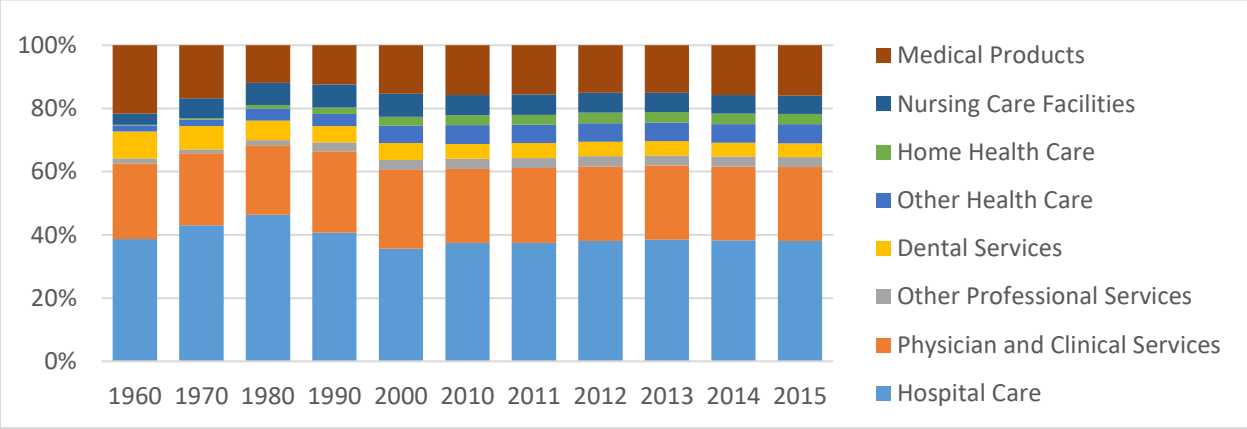


Figure 2. Percent distribution of national health care expenditures, 1960 – 2015. [6]

Costs of Hospital Care in the US

Comprising the largest proportion of health care expenditures, hospital costs have consistently remained approximately one-third of health care expenditures since the 1960s. According to the American Hospital Association, there are currently 4862 licensed community hospitals in the United States that account for 782,188 staffed beds, which accept 33.2 million admissions annually. [7] The average hospital length of stay in 2009 was 4.6 days according to the Healthcare Cost and Utilization Project. [8] Estimates of hospital health care expenditures range from $361.5 to $851.5 billion. [7] [8]

Debt incurred by healthcare expenditures are frequently cited as a common cause for bankruptcy in the United States. A study by Himmelstein et al interviewed over 1000 individuals who filed for bankruptcy in 2007; 62.1% of them cited medical debt or loss of wages due to illness as the primary reason for bankruptcy. Three-quarters of them had health insurance at the time of bankruptcy filings, although those filing due to medical debt were more likely to have had a lapse in coverage in the two years preceding bankruptcy filing. Forty-eight percent of those surveyed cited hospital bills as the largest out-of-pocket expense. [9]

Twenty diagnoses are responsible for almost half of all healthcare expenditures nationally (Table 1). Leading the list in cost is septicemia, accounting for $23.7 billion, 6.2% of all healthcare costs. Other diagnoses that commonly result in intensive care unit (ICU) admission are pneumonia, cardiac dysrhythmias, respiratory failure, and chronic obstructive pulmonary disease. [10]

Table 1. The 20 most expensive conditions treated in US hospitals, all payers, 2013. [10]

Rank	Diagnosis category	Aggregate hospital costs, $ millions	National costs, %	Number of hospital stays, thousands	Hospital stays, %
1	Septicemia	23,663	6.2	1297	3.6
2	Osteoarthritis	16,520	4.3	1023	2.9
3	Liveborn	13,287	3.5	3765	10.6
4	Complication of device, implant, or graft	12,431	3.3	632	1.8
5	Acute myocardial infarction	12,092	3.2	602	1.7
6	Congestive heart failure	10,218	2.7	882	2.5
7	Spondylosis, intervertebral disc disorders, other back problems	10,198	2.7	555	1.6
8	Pneumonia	9501	2.5	961	2.7
9	Coronary atherosclerosis	9003	2.4	458	1.3
10	Acute cerebrovascular disease	8840	2.3	585	1.6
11	Cardiac dysrhythmias	7178	1.9	710	2.0
12	Respiratory failure, insufficiency, arrest	7077	1.9	387	1.1
13	Complications of surgical procedures or medical care	6079	1.6	465	1.3
14	Rehabilitation care, fitting of prostheses, and adjustment of adevices	5373	1.4	390	1.1
15	Mood disorders	5246	1.4	836	2.3
16	Chronic obstructive pulmonary disease and bronchiectasis	5182	1.4	645	1.8
17	Heart valve disorders	5151	1.5	123	0.3
18	Diabetes mellitus with complications	5142	1.3	531	1.5
19	Fracture of neck of femur (hip)	4861	1.3	303	0.9
20	Biliary tract disease	4722	1.2	405	1.1
	Total for top 20 conditions	181,762	47.7	15,554	43.7
	Total for all stays	381,439	100.0	35,598	100.0

Costs of Sepsis

Sepsis is not only the most expensive condition treated in the United States, it is also one of the leading causes of death. Estimates for incidence vary between 850,000 to 3,000,000 cases per year, [11] and according to data derived from health insurance claims and other administrative data, the incidence has been steadily increasing for the past two decades. [12] While present in 6% of adult hospitalizations, it was present in 35% of all hospitalizations that resulted in death [13], although some estimate that it causes or contributes to half of all in-hospital deaths in the United States. [11]

A recent analysis performed by Rhee et al reported that half of patients with sepsis required ICU admission, with a median length of stay of 5 days. Median hospital length of stay was 10 days, and overall in-hospital mortality was 15.6%; an additional 6.2% were discharged from the hospital on hospice. [13] Prior studies by Lagu et al derived a cost of $17,048 for each case of sepsis; sepsis associated with organ dysfunction were reported to cost $41,631 per case. [12]

The cost of sepsis is particularly burdensome because the risk of readmission is high. All-cause readmission rates for sepsis has been reported as 20.4%, similar to readmission rates for congestive heart failure and acute myocardial infarction. Recurrent infection was the primary diagnosis for readmission in the majority of cases at all time-points examined. The high incidence of primary sepsis,

when coupled with the higher cost of readmission, resulted in higher total cost for the examined population. It is estimated that sepsis readmissions in California cost $500 million for the two-year period examined. [14]

Sepsis is not only a common admission diagnosis, it is a common complication of hospitalization as well. Bloodstream infection is identified as the most common healthcare acquired complication in patients having at least one healthcare acquired complication, infectious or otherwise. Nineteen percent of hospital-acquired infections in the medical intensive care unit are bloodstream infections, the overwhelming majority of which are associated with central lines. It is estimated that 51% of hospital-acquired bloodstream infections occurred in intensive care units. [15]

Additionally, the organisms responsible for hospital-acquired infections are associated with a higher cost of treatment. Coagulase-negative *Staphylococcus*, *S. aureus*, *Enterococcus* species, and *Candida* species are the most commonly identified organisms causing bloodstream infections. [16] When compared to Gram-negative organisms, Gram-positive organisms have a risk-adjusted attributable hospital cost of $4473. The risk-adjusted attributable hospital cost for *Candida* species infection is $12,617. [17] Due to these and other factors such as increased length of stay, episodes of nosocomial sepsis are five time more expensive to treat. [15]

Costs of Respiratory Failure and Mechanical Ventilation

Respiratory failure requiring mechanical ventilation is the most common ICU admission diagnosis (Table 2), accounting for 30% of all ICU admissions [18] and almost one-quarter of total ICU charges. [19]

Table 2. Common conditions and procedures with the highest proportion of intensive care unit utilization in 29 States, 2011. [19]

Conditions and Procedures	Total stays, n	Total stays with ICU services, %	Mean total charges across all stays, $	Total charges attributed to ICU, %
Respiratory system diagnosis with ventilator support <96 hrs	78,233	93.3	57,200	24.4
Acute myocardial infarction, discharged alive with MCC*	59,727	70.3	45,000	30.3
Intracranial hemorrhage or cerebral infarction with MCC*	68,604	64.6	50,000	27.1
Percutaneous cardiovascular procedure with drug-eluting stent without MCC*	164,846	63.4	58,500	10.3
Septicemia or severe sepsis without mechanical ventilation 96+ hrs with MCC*	304,367	59.0	45,500	24.1
Poisoning and toxic effects of drugs without MCC*	102,005	57.6	15,100	29.4
Pulmonary edema and respiratory failure	101,064	54.1	29,600	25.8

*MCC: Major complication or comorbidity.

With an incidence of 2.8 per 1000 population, an estimated 700,000 patients receive mechanical ventilation each year in the United States. Incidence also increases with increasing age, and patients over the age of 65 are three to five times more likely undergo mechanical ventilation. In-hospital mortality for patients who receive mechanical ventilation is approximately 30 to 40%, and those who

survive to hospital discharge have higher rates of long-term morbidity and mortality, including frequent readmissions, debility resulting in dependence, long-term respiratory support, cognitive impairment, and reduced life expectancies. [18]

Estimates of hospital costs for adult patients undergoing mechanical ventilation vary from $34,000 [18] to $57,200 [19] per hospitalization. This results in an estimated $27 billion in healthcare costs, or 12% of all hospital costs. [18] Adjusted mean incremental daily costs of mechanical ventilation have been previously calculated at approximately $1500 per day, with the greatest cost differential incurred on day 1, and costs stabilizing after day 3. [20]

The cost-effectiveness of providing mechanical ventilation has also been studied. In an analysis of seriously ill patients with acute respiratory failure, patients were stratified based on estimated probability of surviving at least two months from the time of ventilatory support, and the incremental cost per quality-adjusted life-year (QALY) was calculated. As risk of mortality increased, the incremental cost per QALY similarly increased (Table 3), exceeding $100,000 in those with a ≤50% likelihood of survival. [21]

Table 3. Cost of index hospitalization and incremental cost per quality-adjusted life-year by estimated probability of surviving at least two months. [21]

	Cost of index hospitalization	**Incremental cost per QALY**
No ventilator support	$10,913	Reference
Low-risk, >70% estimated survival	$59,096	$29,000
Medium-risk, 51-70% estimated survival	$70,130	$44,000
High-risk, ≤50% estimated survival	$59,310	$110,000

An estimated 10% of critically ill patients require prolonged mechanical ventilation, defined as mechanical ventilation exceeding 21 days. Of those requiring more than two days of mechanical ventilation, 34% will require prolonged ventilatory support. Even excluding charges for long-term acute care facilities, skilled nursing facilities, and rehabilitation facilities, this subset of patients have an estimated annual hospital expenditure of $20 billion, the highest amount of charges per patient of all diagnosis groups. [22]

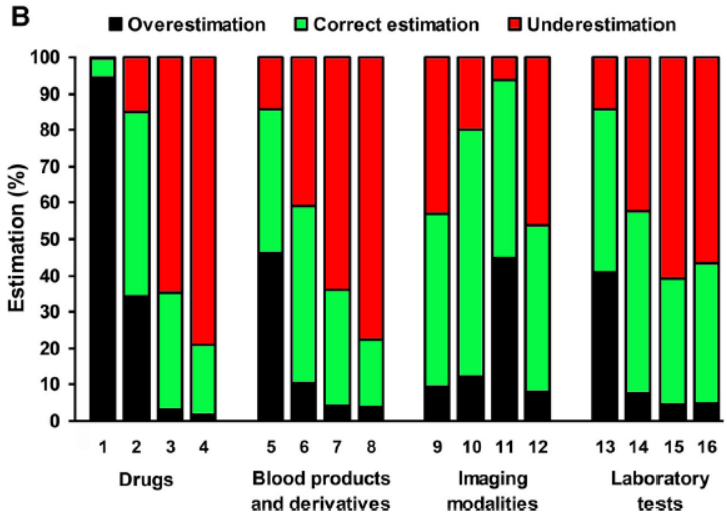
Despite high resource utilization, less than half of patients receiving prolonged mechanical ventilation survive longer than one year. In light of high economics costs and poor outcomes, a formal economic evaluation of prolonged mechanical ventilation was performed by Cox et al, stratifying patients based on age and calculating incremental cost per QALY gained by prolonged mechanical ventilation as compared to withdrawal of ventilatory support between seven and 21 days. Incremental cost per QALY ranged from $14,289 for a patient aged 18 years to >$206,000 for a patient aged 85 years. [22]

Almost as burdensome as nosocomial bloodstream infections is ventilator-associated pneumonia (VAP). It accounts for one-third of all healthcare-associated infections and is responsible for more than half of all ICU antibiotic utilization. Despite the introduction of VAP prevention bundles and adoption of some interventions such as silver-coated endotracheal tubes, incidence remains at two cases per 1000 mechanical ventilation days among patients in medical ICUs. [23] The Centers for Disease Control and Prevention estimates average attributable patient cost to be between $17,827 and $32,450. [24]

Physician Knowledge of Healthcare Costs and Charges

It is widely acknowledged among healthcare professions that the continually increasing cost of healthcare is not sustainable. Physicians play an integral role in strategies to control healthcare costs, as their prescribing habits drive a significant portion of cost. However, physicians and other healthcare providers are frequently unaware of the costs of medications, testing, and radiographic studies.

A survey of over 1000 French physicians demonstrated that only 29% of respondents were able to give estimates that were within 50% of true costs of 46 prescriptions, resulting in a 14,756 € underestimation of total costs (25,595 €). A clear trend in the overestimation of inexpensive prescriptions and underestimation of expensive ones was also observed (Figure 3). [25] A survey among Norwegian physicians for five commonly prescribed pharmaceuticals elicited similar results. [26]



Overestimation: >50% of true cost
Correct estimation: within 50% of true cost
Underestimation: <50% of true cost

1. <10 € drugs
2. 10-100 € drugs
3. 100-1000 € drugs
4. >1000 € drugs
5. Plasma
6. Red cells
7. Platelets
8. Blood derivatives
9. Basic radiology
10. Echo-Doppler
11. CT/MRI
12. Specialized radiology
13. Hematology
14. Biochemistry
15. Toxicology
16. Microbiology

Figure 3. Cost estimations according to prescription subgroups. [25]

In the United States, determining true healthcare costs is particularly challenging due to the lack of transparent pricing. Private health insurance companies have considered health care prices, negotiated in secrecy between insurance companies and hospitals, trade secrets. Furthermore, the health care market is fragmented, and thus parties are unable to collectively negotiate for lower prices. As a consequence, federal health insurance programs have adapted to private-sector pricing, as beneficiaries lose access to care if government programs set reimbursements too far below private-sector prices. [27]

In fact, healthcare costs in the United States can only be estimated at best, using cost-to-charge ratios generated annually by the Centers for Medicare and Medicaid Services (CMS). These cost-to-charge ratios are derived from hospital accounting reports collected by CMS as well as total charges reported in the State Inpatient Databases, National Inpatient Sample, Kids' Inpatient Database, and Nationwide Readmissions Database, managed by the Agency for Healthcare Research and Quality. [28]

Methods of Healthcare Cost Reduction

There is some evidence that improving cost transparency can lead to reduced use. Interventions such as cost displays have been demonstrated to reduce laboratory testing among primary care physicians modestly, by 0.4 to 5.6 orders per 1000 visits per month. [29] A similarly modest decrease of 9.1% was seen among inpatient laboratory test ordering, a reduction of $3.79 per patient-day, when cost displays

were initiated at a large, tertiary-care academic hospital. [30] However, while cost displays have resulted in decreased laboratory testing, this has not necessarily translated to other diagnostic testing, such as imaging. [31]

Cost displays have also been demonstrated to reduce cost in antibiotic prescriptions. Deployment of decisional support tools that display cost categories for antibiotics reduced estimated average cost per unit of antibiotics from $11.13 to $7.65, a savings of 31.3%. This translated to a savings of $7.11 per patient, a total of $2211.21 for the 311 patients included in the post-intervention analysis. [32]

Cost disclosure has even been demonstrated to reduce surgical expenditures. Distribution of scorecards detailing case volume, case length, and direct supply cost per case to surgeons in a regional health care system was associated with a decrease of $269 in average supply cost per case for rotator cuff repair. This change in cost was driven primarily by the use of disposable and reusable equipment, such as gowns, gloves, tubing, drapes, retractors, slings, and immobilizers. Over the two-year study period, $39,831 was saved. [33]

Cost reductions may also be achieved with decreasing geographical variability in utilization of care. Currently, there is significant geographical variability in hospital use and intensive care use at the end of life (Figure 4). [34] ICU use in chronically ill patients varies between <20% to >40% depending on geographical location, and between 3 and 25% of Medicare enrollees spend more than seven days in an ICU in the six months preceding death. [35]

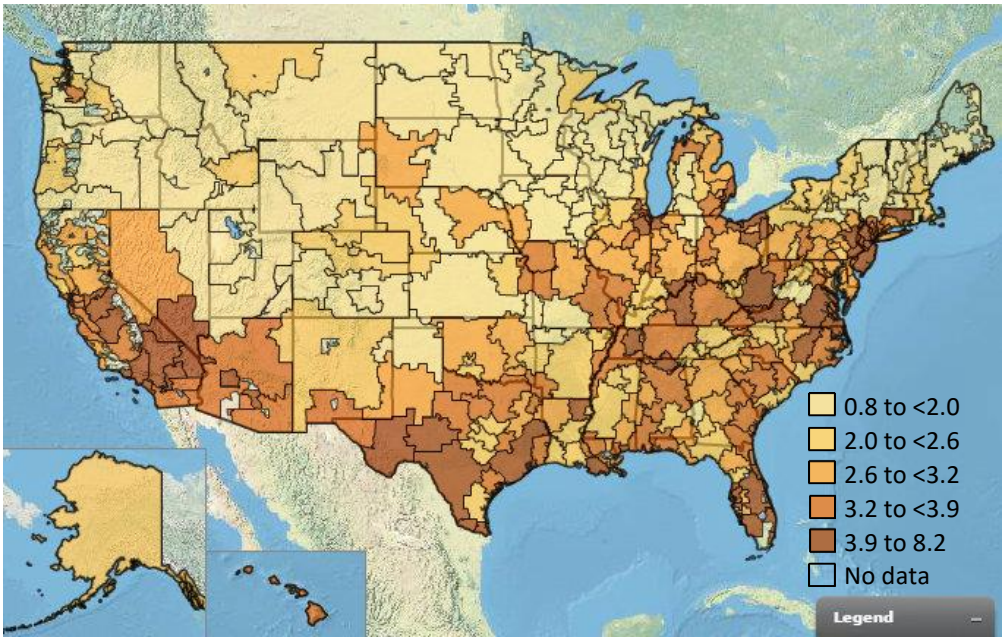


Figure 4. Average number of days spent in intensive care per decedent during the last six months of life based on hospital referral regions, 2014. [34]

In some countries, cost-effectiveness analyses are performed to distribute healthcare resources more efficiently. In the United Kingdom, an intervention costing between <£30,000 per QALY is usually considered to be cost effective by the National Institute for Health and Clinical Excellence. Similarly, the Australian Pharmaceutical Benefits Advisory Committee is unlikely to give a positive recommendation for a drug if the cost per QALY exceeds AU$76,000. [36]

In the United States, the threshold of $50,000 to $100,000 per QALY gained has frequently been cited, although it is unclear that these figures are based on scientific evidence. [36] That threshold has been used to judge the cost-effectiveness of interventions such as mechanical ventilation [21] [35], tissue plasminogen activator therapy for myocardial infarction [37], and early goal directed therapy [38].

Barriers to Cost Reduction

Although efforts at improving physician education regarding cost management are promising, there are several barriers to cost reduction. Many of the interventions to reduce healthcare costs focus on physician ordering behavior, a variable cost. However, an estimated 80% of hospital costs are fixed. These include capital expenditures, employee salaries and benefits, building maintenance, and utilities. The most substantial cost savings would come at the expense of smaller hospitals, fewer hospital beds, and fewer medical personnel. [35]

Resource-poor countries manage healthcare costs in this fashion. Whereas there is a median of 2.77 ICU beds per 10,000 population in the United States [39], the ratio of ICU beds in South Africa ranges from 1 in 20,000 to 1 in 80,000. [40] In comparison to Parkland Hospital, an urban tertiary-care academic hospital located in Dallas, TX, USA, with 35 medical ICU beds for 862 licensed beds, Chris Hani Baragwanath Hospital in Johannesburg, South Africa, has 18 multidisciplinary ICU beds in a hospital of 3000 beds. As a result of the very limited numbers of ICU beds, strict exclusion criteria are applied, including presence of AIDS, neurologic devastation, and end-stage cardiac or renal disease. [41]

Although early cost transparency measures have shown some benefit in cost reduction, changing prescribing behavior requires a multifaceted approach. Despite initiatives like the Choosing Wisely® campaign to reduce unnecessary testing and treatment, studies have demonstrated that emergency medicine, internal medicine, and primary care physicians continue to perform low-value services, driven by patient or family expectations, concern for malpractice, and desire for reassurance. [42] [43] While familiarity with the Choosing Wisely® guidelines was associated with increased cost-consciousness, it was not independently associated with decrease in use of low-value services. [44]

There are also barriers to cost transparency measures. While clinicians want cost information, some are concerned with displaying such information at the point of order entry, particularly in safety net hospitals. Physicians often feel that their prescribing practices are already limited to clinically necessary tests, and prioritize responsibility to patients above responsibility to the healthcare system. [45] In fact, most physicians disagree that costly but beneficial services should be denied to individual patients in order to redistribute resources to needier patients. [46]

In addition, maximizing the delivery of cost-effective care is more challenging than anticipated. While death in the ICU and ICU length of stay are known predictive factors in costlier care, one major predictor of cost is an outcome different from what is clinically expected. In one trial, 68% of patients who had prolonged ICU courses and received the most expensive care had predicted survival probabilities between 40 and 80%. Neither clinicians nor predictive modeling such as the Acute Physiology and Chronic Health Evaluation model are particularly accurate at predicting patient outcomes, with median predicted chance of survival for two months of 0.51 in the week prior to actual death, and 0.17 on the day prior to actual death. [35]

Finally, some economic analyses challenge the concept that changing length of stay will lead to substantial cost savings. Kahn et al analyzed all patients receiving mechanical ventilation for >48 hours and calculated direct-variable costs—the supply costs for providing a specific service—for each hospital day. They determined that while total costs declined significantly between the last ICU day and the first non-ICU day, decreases in direct-variable costs were far more modest, on the order of $118 (Figure 5). Their analysis demonstrated that an intervention that reduced ICU and hospital length of stay by one day for all ICU survivors would save 0.2% of total hospital costs for one fiscal year. [47]

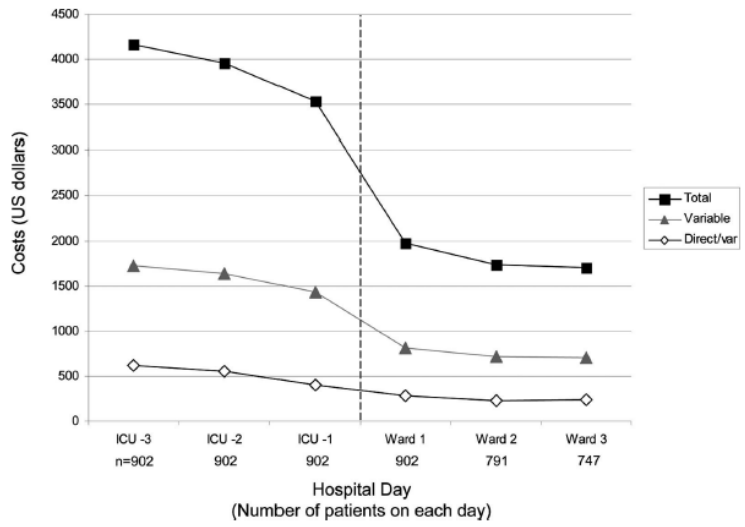


Figure 5. Mean costs for the last three days of ICU admission and first days of ward admission. Values represent the mean total, variable, and direct-variable costs for survivors with ICU lengths of stay of more than 3 days (n=902). [47]

Conclusions

Healthcare expenditures have rapidly increased in the past several decades, now accounting for nearly 18% of the gross domestic product of the United States. This growth has outstripped the growth in gross national income, placing ever increasing financial burdens on the American family. The primary driver for this increase in expenditures appears to be increased interaction with the healthcare system rather than increases in costs in one particular arena. A limited number of diagnoses, including sepsis and respiratory failure, are responsible for nearly 50% of healthcare expenditures in the United States, and the proportion spent on those diagnoses will likely continue to increase as the population ages and disease incidence also rises.

Although it is widely acknowledged that expanding healthcare costs are a burden, physicians and other providers have a poor understanding of the costs of the interventions performed or recommended, due in most part to the opaque nature of pricing in the healthcare field in the United States. Efforts at cost transparency have demonstrated some improvement, but numerous barriers to reducing healthcare costs remain, including a high proportion of fixed costs, responsibility to the patient above the healthcare system, and challenges in accurately predicting patient outcomes to maximize cost-effective care delivery.

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