

# ON HEALTHCARE REFORM - A SYSTEMS ENGINEERING APPROACH<sup>1</sup>

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## ABSTRACT

We discuss a systems engineering approach for comprehensive reform of the healthcare system of the United States. The goal is to improve both the quality and cost performance of the entire healthcare system when compared to other leading industrialized nations. We identify three main sources of variability impacting both the healthcare system performance and total costs, and propose how to address these sources of variability.

**Key words:** healthcare system, systems engineering, enterprise systems, lean

## INTRODUCTION

According to the United States Congressional Budget Office (CBO) [5] in 2009 about 45 million non-elderly people in the United States are uninsured. This corresponds to about 17% of the U.S. population. The recently passed *Patient Protection and Affordable Care Act*, March 23, 2010 [3]; and its amendment, the *Health Care and Education Reconciliation Act of 2010* (H.R. 4872), March 30, 2010 [33] will broaden access to health care services but will also add significantly to the total costs. These bills fail to address system level inefficiencies, “system” standardization and integration, and, thereby, fail to control total “system” costs.

This analysis focuses on the larger issue of the total health care “system,” “system costs” and “system performance” and takes a systems engineering- and enterprise systems approach. Within this article the “total healthcare system” is defined to consist of all components contributing to the total national healthcare expenditures, and, in addition, the regulatory framework, policies, incentives and standards directly or indirectly impacting those components. We identify three main sources of variability that affect both the healthcare system performance and total costs. We propose a strategic approach for significantly lowering total health care system costs per capita over the long-term, while at the same time broadening access to both uninsured and underinsured and improving the overall system performance in terms quality of healthcare outcomes. We believe, that the cumulative savings from the proposed approach could cover a significant portion, if not all, of the added cost of the “public option” without adding to the U.S. government debt burden or adding new taxes.

## TOTAL HEALTHCARE SYSTEM SPENDING IN THE UNITED STATES

Total healthcare spending in the U.S. is estimated by the CBO [5] to exceed USD 2,555 billion in 2009, or about 17% of the 2008 U.S. Gross Domestic Product (GDP). About one-third of this spending is federal government spending. Expenditures and categories are summarized above in Table 1. It can be observed in Table 1 that the category “*Administration*” with a total of USD 184 billion, or 7.2% exceeds “*Research*”, “*Public Health*”, “*Medical equipment*” and “*Dental*” respectively. It can also be observed, that “*Prescription drugs*” represents the third-highest category at USD 264 billion, or 10.3%.

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A further significant area contributing to healthcare costs, not separately identified in the CBO report [5], is tort. Many discussions and sources, including [17], focus on just one component of tort – medical malpractice litigated claims. Studies [27, 28] look at three cost components of tort: liability insurance cost, self insurance, and medical cost malpractice. These studies do not address tort related indirect impact on spending or revenues of individuals or organizations. Expenditures in 2004 in the three tort cost categories are summarized in Table 2 [27].

Table 1: National Health Care System Expenditures, 2009, adapted from CBO [5]

	Billions \$	Percent of Total
Hospital care	800	31.31%
Physician’s and clinical services	533	20.86%
Dental and other professional care	177	6.93%
Prescription drugs	264	10.33%
Home health and nursing home care	210	8.22%
Medical equipment and other personal care	146	5.71%
Public health activity	72	2.82%
Research, equipment and structures	169	6.61%
Administration and net cost of private insurance	184	7.20%
Total	2,555	100.00%

Table 2: Expenditures in 2004 in the Three Tort Cost Categories [27] (billions of USD):

Year	Liability Insured	Self Insured	Medical Malpractice	Total
2004	182.0	49.4	28.7	260.1
	70%	19%	11%	100%

While not all the above tort costs relate directly to national healthcare expenditures, it appears, because of, among other, the geographic variability in medical liability insurance and awards, the variability of tort laws from state to state, the liability insurance and awards relating to pharmaceutical companies and medical equipment manufacturers, that just including the “medical malpractice litigated claims” seriously underestimates and misrepresents the impact of tort on total healthcare costs.

### HEALTHCARE SPENDING IN INDUSTRIALIZED NATIONS VS. THE U.S.

The WHO in its World Health Report, 2008 [30], includes a comparison of healthcare expenditures as percentage of GDP in “*High-income countries without the United States vs. healthcare expenditures in the United States*” for 2005. The “*high-income*” countries include, among other, the European Union (EU), Canada and Japan.

Table 3: Percentage of GDP Used for Healthcare, 2005; The World Health Report, 2008, [30]

	High-income countries(w/o USA)	USA
Out-of-pocket expenditure	1.6%	2.0%
Other private expenditure	1.3%	6.3%
General government expenditure	6.7%	6.9%
TOTAL	9.6%	15.2%

The report [30] estimates, see Table 3 above, that in the U.S. the total healthcare expenditures amount to 15.2% of GDP, while for other “*high-income*” countries the percentage of GDP spent on total healthcare is 9.6%. Table 3 also reveals that expenditures in two categories, “*out-of-*

*pocket*”- and “*general government*” appear not to differ significantly in “*high-income countries*” and in the U.S., whereas the category “*other private expenditure*” is almost five-times higher in the U.S. than in the comparison group. The report [30] comments on the data, that in the U.S. the difference stems from “*its singularly high additional private expenditure*” and that there is “*persistent under-performance of the United States health sector across domains of health outcomes, quality, access, efficiency and equity...* ”.

In order to establish a feasible benchmark, let’s assume that the U.S. would have spent 9.6% of the GDP on healthcare like the other “*high-income*” countries. This would translate to total healthcare spending in 2009 of USD 1,614 billion by the U.S. vs. the current USD 2,555 billion. In other words, healthcare spending in the U.S. should have been USD 941 billion, or nearly 37%, lower to be comparable to other “*high-income*” countries. It should be noted that this benchmark cannot be considered to be a lower bound for expenditures, because there is no evidence that the high-income countries are operating at or near optimality. The actual “*system optimality*”, in terms of cost, for each country, respectively, is likely to be significantly lower.

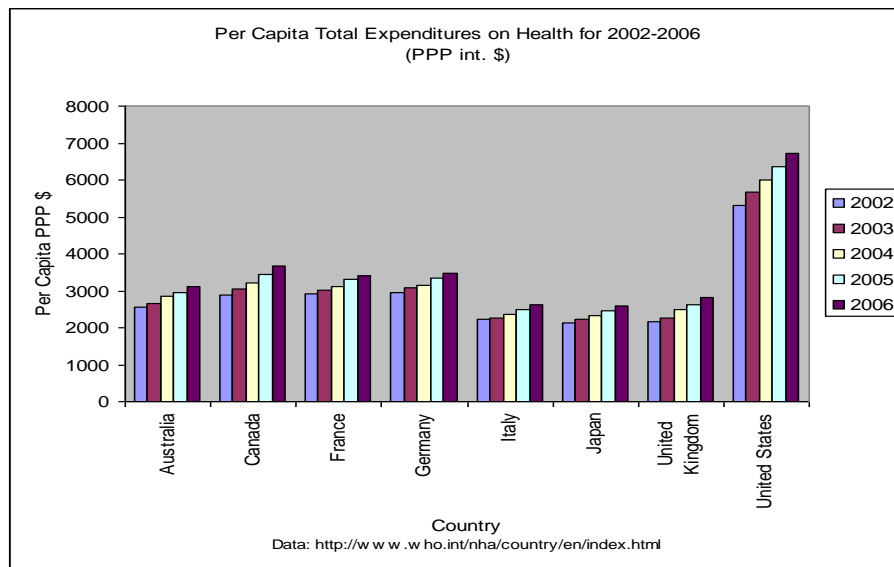


Figure 1: Per Capita Total Expenditures on Health for 2002-2006 (adjusted for PPP) for eight countries: Australia, Canada, France, Germany, Italy, Japan, United Kingdom and United States. Data from WHO [9].

The above Figure 1 shows per capita healthcare expenditures adjusted for purchasing power parity (PPP) for 2002-2006 for selected eight countries. It can be observed that expenditures per capita in the U.S. were not only the highest but increased at a faster rate from 2002 to 2006.

One area pointed out in the World Health Report [30] as a source for significant difference in total healthcare costs relates to pharmaceuticals. The report states that the “*per capita expenditure on drugs*” in the U.S. was in 2005 “*twice the level of Canada, Germany or the United Kingdom and 10 times that of Mexico*”. For simplicity, if we consider Canada, Germany and the UK as a representative sample, then one can estimate that half of the U.S. prescription drug expenditures, or about USD 132 billion, appears to explain a portion of the USD 941 billion difference. However, this would still leave USD 809 billion unexplained.

## HEALTHCARE ATTAINMENT AND SYSTEM PERFORMANCE

Ranking of health system attainment of 191 World Health Organization (WHO) member states was reported in the World Health Report 2000 [31].

Table 4: Health System Attainment and performance Ranking [adapted from 31]

World Health Report (WHO) [31, adapted from Table Annex 1] Member State (rank out of 191 members)	Health expenditure per capita; (rank)	Performance on level of health (rank)	Performance of overall health system (rank)
United States	1	72	37
Australia	17	39	32
Canada	10	35	30
France	4	4	1
Germany	3	41	25
Italy	11	3	2
Japan	13	9	10
United Kingdom	26	24	18

The above Table 4 summarizes health system attainment and performance rankings for the eight selected member countries. It can be noted that the U.S. ranks as the highest healthcare spender per capita of all 191 member states followed by Germany and France. However, when looking at “return on investment” (return for the per capita spending) the U.S. places 37<sup>th</sup> out of 191 with respect to the “performance of the overall health system,” and 72<sup>nd</sup> out of 191 in “performance on level of health,” or at the bottom in both categories among the selected eight countries. What causes the U.S. to rank so poorly? Would one not expect a strong positive correlation between performance of a “system” and related expenditures? It should be noted that the above it is broadly supported by other cost- and quality data comparisons [2, 18, 21, 25, 30, 31].

### CONTRIBUTING FACTORS TO THE GROWTH OF HEALTHCARE COSTS

#### Areas Contributing to the Level of Premiums and Growth

In [5] the CBO identifies areas contributing to the level of health insurance premiums in the U.S. These include: scope of benefits of coverage and cost sharing, health status of individuals, benefit management and administrative costs of insurers. The last two, “benefit management” and “administrative costs of insurers”, are “health system performance and efficiency” related.

The report [5] also lists areas which could affect the healthcare spending growth in the U.S.. Those include: advances in medical technology, aging of population, cost share, financing of health care services and rising healthcare problems. In addition, the report outlines “system” related causes to spending growth, including the individual- and regional-geographic variation, management of benefits and administrative costs.

With respect to the “system” related causes, the report [5] identifies regional differences, management of benefits and administrative costs as contributing factors. In the latter category (administrative costs) the report identifies customer service, claims processing, sales, marketing, etc., and finds that *“in general, however, substantial reductions in administrative costs would probably require the role of insurance agents and brokers in marketing and selling policies to be sharply curtailed and the services they provide to be rendered unnecessary.”*

The report suggests three possible approaches for reducing the number of uninsured: “*Subsidizing health insurance premiums, mandating health insurance coverage, or automatically enrolling individuals in health plans.*” These approaches do address the need for expanding healthcare coverage to uninsured and underinsured. However, the report and the suggested approaches do not recognize the areas of inefficiency and variability as “*key issues*” for “*major health insurance proposals*”.

### **Health Insurance Company Practices**

On June 24<sup>th</sup>, 2009, former CIGNA executive, Wendell Potter, gave a testimony in front of the U.S. Senate Committee of Commerce, Science and Transportation. He stated, among other, that “...look very closely at the role for-profit insurance companies play in making our health care system both the most expensive and one of the most dysfunctional in the world... insurers routinely dump policyholders who are less profitable or who get sick”([23]). Asked directly about this practice in the House Energy and Commerce Committee, executives of three of the nation's largest health insurers refused to end the practice of canceling policies for sick enrollees.

### **Observation Relating to Medical Technology**

The category “advances in medical technology” appears, as suggested in the CBO report, to be a contributing factor to healthcare spending growth. This view is also supported by the World Health Report, 2008, [30]. However, according to the same report, in 2006 “*the United States, the European Union and Japan spent USD 287, USD 250 and USD 273 per capita, respectively, on medical equipment.*” If one assumes the cost of technology adoption and implementation are about equal for the U.S., EU and Japan, then there does not appear to be a statistically significant difference in this expenditure category. Therefore, also, this factor does not appear to explain the difference between total healthcare system expenditures in the U.S. and other nations.

### **Medical Malpractice Liability Litigation, Liability Insurance, Quality, Transparency**

A significant factor contributing to healthcare costs appears to be the geographic variability of medical malpractice liability litigation, caps on malpractice awards and the variability in liability insurance premiums. There continues to be discussion about whether there is a causal relationship between malpractice awards and insurance premiums. For example Baicker and Chandra in [1] investigated the relationship between malpractice awards and insurance premiums, and found no strong support for a causal relationship. However, the hypothesis posed should relate to “system” level variability, variability of awards between states and regions, variability of caps on awards between states and regions and their relationship to variability of premiums, instead of simply award amounts and premiums.

There has been a number of attempts to pass a medical liability insurance reform at the national level, including in 2002-2003 the effort to introduce a California Medical Injury Compensation Reform Act (MICRA) – style national reform bill (Feinstein). In a number of studies and reports (including [2], [4], [6], [18], [29]) California’s MICRA (1976) is referred to as a “possible model for a national malpractice reform”. The relatively broad support for MICRA may be attributable to the results that have been observed. The House of Representatives subsequently in 2002 passed a liability reform bill similar to MICRA, the H.R. 4600. However, the bill did not make it through the U.S. Senate. [7], [12], [29].

The U.S. Department of Health and Human Services (HHS) in [6] addresses a number of key issues of the medical liability system, including liability insurance premiums and defensive

medicine practiced by doctors who fear medical malpractice lawsuits. The report compares liability insurance premium increases for non-economic damages for 2000-2001 in states with caps to states without caps. The report also summarizes medical liability rates for three specialty groups of medical doctors in states with and without caps for non-economic damages. The average premium paid by doctors in states without a cap was 94% higher. While an independent analysis does not prove causality between premiums and caps on awards, it shows a statistically significant difference between average premiums in states with caps vs. states without caps, and further, shows a statistically significantly higher variance of premiums in states without caps.

The report [6] by HHS also summarizes results of a survey relating to defensive medicine practiced by doctors. According to the survey results, 79% of doctors ordered more tests, 74% referred patients to specialists, 51% recommended invasive procedures and 41% prescribed more medications than they believed was “medically necessary”. Also, 75% of the doctors reported malpractice litigation “*has hurt their ability to provide quality care to patients*”. According to the same report, doctors do not want to collect quality related data, and share it with others, because of fear that the information and data may be used “against them or their colleagues”.

It is estimated by Kessler and McClellan in [18] and also reported in [6] that “*limiting unreasonable awards for non-economic damages could reduce total health care costs by 5 to 9% without adversely affecting quality of care.*” This corresponds to USD 130 to USD 230 billion of the current total health expenditures of USD 2,555 billion. Further, it is estimated by Berwick in [2] and also reported in [6] that quality data could provide for “*significant improvements in patient health outcomes, but also reduce medical costs by as much as 30%.*”

From a systems engineering perspective any systematic variability will lead to unwanted performance-, quality- and cost-differences. In this case, variability in medical liability laws between regions or states appears to contribute not only to the significant difference in average liability insurance premiums, but also to the quantity and quality of care, as well as transparency.

### **A SUCCESSFUL HEALTHCARE “SYSTEM” EXAMPLE**

There are successful examples that can serve as models for improving the healthcare system in the United States. One of them is Kaiser Permanente, which is an “integrated healthcare delivery system providing healthcare services to over eight million people” [19]. As Kaiser Permanente is both a healthcare provider and healthcare insurer, they influence and have direct interest in both the healthcare insurance- and provider side. On July 17, 2009 George Halvorson, Chairman and CEO of Kaiser Permanente, testified [13] before the Senate Finance Committee, and discussed “structural system inefficiencies“. Mr. Halvorson’s testimony included broad concepts and results about healthcare information system integration and standardization and advances made at Kaiser Permanente. Compare to the NIST programs designed to help organizational level improvements [15], [8].

### **FOCUS ON AREAS OF GREATEST POTENTIAL**

Based on our analysis the cost- and performance difference between the U.S. healthcare system and other countries appears to be attributable primarily to the following three sources:

1. Geographic- and individual variability of actions by healthcare insurers.

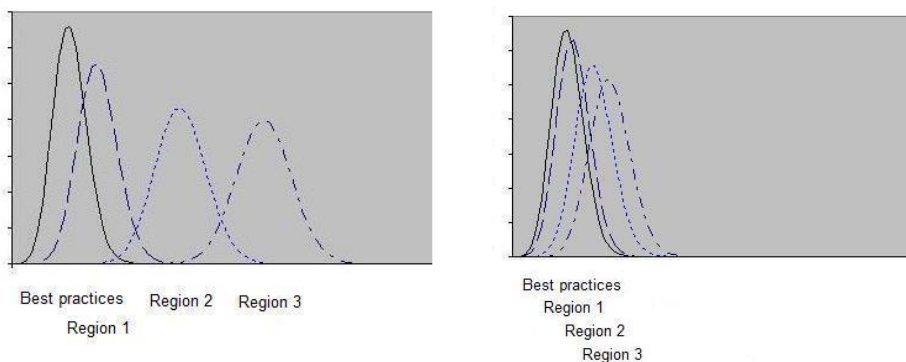
2. Geographic variability of tort laws, impact of that variability on liability insurance premiums, quality- and quantity of services, transparency and sharing of best practices.
3. Geographic- and individual variability of healthcare treatment processes and levels of treatment (including defensive medicine and consumption of prescription drugs).

These three sources of variability are interdependent, and therefore a proposed set of solutions should address all areas to achieve the best outcome with respect to cost and performance.

### A SYSTEMS LEVEL PERSPECTIVE

According to TQM-, Six Sigma-, and Lean literature, including [10], [11], [22], [26], [24], about 85% of process variability can be attributed to the “system,” while the remaining 15% is random variation. It is also known that only a few causes have major effects on total variation (the Pareto principle), and that when variability increases costs increase (the Taguchi principle). Support for a comprehensive systems approach is also suggested by Nightingale in [32]. It is reported that under the MIT’s Lean Advancement Initiative enterprise system approaches have been successfully applied to complex healthcare systems for the past three years in the Boston area.

#### Why reduction in variability improves costs and performance



**Figure 3:** Left side - before standardization and system integration; Right side – after standardization and system integration (for illustrative purpose only).

The above Figure 3, divided into two graphs, illustrates how the concept works. The solid distribution line represents “best-practices” distribution of costs for a given set of services at a given level of quality, the dashed and dotted lines represent cost distributions for regions 1, 2 and 3 (for example states) respectively. In Figure 3, left side, Region 1 is closest to “best practices” and shows the least amount of variance (narrowest shape of the distribution) when compared to Regions 2 and 3. Region 3 is farthest away from best practices, and shows the largest cost variance for the same level of services. The farther to the right the distribution is the higher the regional system costs. After standardization (see Figure 3, right side), information system integration, information and best practice transparency, and “system learning” regional variability will decrease resulting into improvements in costs at the system-, regional- and individual levels. In Figure 3 system variability reduction is shown by distributions moving closer to each other and closer to the best practices distribution (reduction of total system variability and cost). Within the region variability reduction is shown by the distributions’ narrower shape (measured by the variance).

## **Proposed Approach**

The proposed solution to address the sources of variability consists of the following three parts:

- a) Introduce national level standards and incentives for the creation of an integrated healthcare information system for the United States. This addresses variability from all three sources listed above.
- b) Standardize external operating conditions. Pass a national medical malpractice liability bill using as the model the observed best practices. In addition, pass comprehensive national tort reform to provide a standardized framework of liability for businesses including pharmaceutical and medical technology companies. This addresses variability from source 2.
- c) Introduce competition for the current form of health insurance. We propose a novel approach for providing competition for the current form of health insurance in form of a virtual Health Coverage Transaction Facilitator – Enterprise Resource Planning solution, (HCTF - ERP). We outline this concept next. This addresses variability from sources 1 and 3 above.

## **A Reengineered Model for Providing Health Coverage**

To create more competition, reduce regional and individual treatment variability, and to address the “administrative cost” category, we propose the creation of a virtual not-for-profit corporation, a non-governmental health coverage transaction facilitator (HCTF) based on an Enterprise Resource Planning (ERP) solution. In the proposed model, the doctor, healthcare provider and patient assume complete responsibility as decision makers, away from the health insurance company. The primary role of the HCTF-ERP is to serve as a facilitator for premium and claims transactions (like NASDAQ as an automated facilitator of investment transactions). The proposed solution would essentially replace the healthcare insurance company function as it currently exists.

The HCTF-ERP has the following main characteristics:

- A virtual organization consisting of a fully-integrated, standardized and automated Internet based Enterprise Resource Planning (ERP) system for healthcare management. The role of the virtual organization is to serve as a transaction facilitator and enabler between healthcare providers, doctors and consumers.
- Decision makers are the patient and provider/doctor, with the insurer’s role reduced to transaction facilitation (HCTF-ERP).
- Role of the Management is to work with healthcare providers to advance adoption and sharing of standardized- and best practices across healthcare domains.
- Coverage criteria and premiums will be driven by actual cumulative pool expenditures. All subscribers are considered one pool with access to healthcare without discrimination.
- Secure personal accounts and level of authorized access are provided for each user. Each user (healthcare provider, doctor, consumer) has a “personal” secure account with preset levels and authorization for access.
- Completely standardized and automated claims processing.
- Fraud detection and system abuse using a fraud detection program checking statistics against best practices for frequency of services, number and type of prescriptions and unusual treatment patterns.
- Potential benefits at the “system” level include significantly reduced administrative costs and overhead due to reduced administrative structure, automated and standardized claims processing and reduced need for physical infrastructure. Additional benefits would include a



significant reduction in insurance company case management, claims processing, marketing, sales, enrollment processing, underwriting and “pool” pricing.

- Potential benefits to healthcare consumers and healthcare providers include improvements in healthcare quality and reduction in per patient health care expenditures, because of standardization, transparency and automation of records and reporting, integration of information systems, sharing of best practices and thereby reduction of individual- and geographic treatment quality- and cost variability.
- Requirements for success include regulatory and policy changes, national level standardization, policy support, incentives as well as an initial investment to support development, testing and launch of such a HCTF – ERP solution. It should be noted, that, for efficiency, such a system should not necessarily be one large system for the entire U.S., but rather an integrated network of state- or regional-level HCTF-ERP systems.

### CONCLUDING REMARKS

We recognize the complexity of the entire healthcare system, and recognize efforts at individual health service organizations and hospital systems. However, we believe, that the cumulative improvements resulting from these to-date efforts will not achieve maximum potential for the U.S. healthcare system in terms of total cost and quality unless these efforts are supported by a comprehensive and coordinated national level legislative and standardization effort and mandate. While we did not find a comprehensive study that addressed all the listed cost categories, there are reliable studies, discussed and referenced here by the WHO, CBO, HHS and recognized researchers, pointing to the same direction. No study was found suggesting that by making any of the proposed changes would result into cost increases and lower quality.

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