Central Line Economics

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Introduction

In the pursuit of proving or disproving a null hypothesis it is not uncommon for another, perhaps more significant, insight to present itself. This paper presents a unique view of the economic landscape of health care in the United States caught in the pursuit of an entirely different question.

We set out to perform a simple study evaluating the cost effectiveness of ultrasound guidance for the placement of central venous access. As an emergency physician with ultrasound fellowship training and an economist with an interest in health care reform we admit we hoped to prove or at least support the belief that this method was in fact cost effective. We all strive to maintain the course of objectivity in our research but the curiosity that sparks our interest is often specific to our own goals and modes of practice. It is our honesty with both data and design that stays the course in our opinion. Besides, in the case of ultrasound guided central venous access, why would it not be cost effective when multiple meta-analyses, both native and foreign, have consistently shown a reduction in complication rate coupled with a faster time to line placement[1,2,3,4]? It would appear, by simple observation, to be a safer and more efficient method. The cost-effectiveness of this practice was studied and reported by the National Institute for Clinical Excellence in the United Kingdom in 2002[4]. Their meta-analysis suggested a 2000 pound sterling savings for every 1000 central lines placed. Based on their estimate of 200,000 central lines being placed in the United Kingdom each year this represents a 400,000 pound/yr savings (748,646.00 US$).

Our intent was to perform an economic analysis of ultrasound guided central venous access using data from the United States and the uniquely suited resource based relative value unit scale (RBRVUS). This scale was the product of research by William Hsiao and colleagues at Harvard's Department of Health Policy and Management. It was subsequently adopted by Medicare as a standardized ruler for the determination of medical reimbursement for medical procedures and processes associated with patient care[5,6]. It was developed to measure:

"1) the work expended on a particular service encompassing the time spent before, during, and after a service and the intensity with which that time is spent 2) practice costs; and 3) the opportunity costs of specialty training."

The RBRVUS scale is based on a cost per-procedure equation developed by Hsiao and his colleagues over several years after studying patterns of reimbursement in a variety of specialties and in multiple locations. It is therefore well suited to reflect the potential cost of a procedure to the Nation's various health care systems.

According to the scale, one relative value unit is equivalent to a set dollar amount, which is adjusted annually and modified according to geographic variations in practice and malpractice expense. Medicare utilizes this measure nationally therefore we begin by making the assumption that this unit of 'cost' can be applied to national statistics for our theoretical estimates as well. As a government tool it is also likely that the 'costs' estimated with this measure will err toward a conservative measurement, because one of the mandates of the RBRVUS program is to reduce costs to the government through Medicare, while maintaining quality of care. We also accept *a priori* that the listed cost and actual reimbursement are often not the same and therefore this theoretical analysis may introduce some skewness through accrual of a successive series of incorrect measurements through this initial error.

There are approximately three to five million central lines placed in the United States each year[7,8]. We asked the question: "what if all of these lines were placed with ultrasound guidance?" We compared the 'cost' in relative value units of performing these lines by the standard landmark and ultrasound guided

techniques. We chose to begin by looking at the definable costs associated with pneumothorax and its treatment.

Pneumothorax is reported to occur in 1.3-1.5% of land-marked guided central line placements[9,10,11]. The 'cost' of a pneumothorax was estimated as the cost of two and a half additional chest x-rays as well as the cost of placing a thoracostomy tube in 20% of patients. These numbers were taken from the Boland Study of Hickman line insertion. [13] The cost of 2.5 view radiograph of the chest (CPT code - 71020) was estimated at 90.75$ (2.5 * 36.30$/cxr) using a median geographical price cost index, which in 2006 was that of the state of Arizona (Geographical price index code - 83200)[12]. The cost of a thoracostomy tube (CPT code – 32020) in 20% of patients was 43.74$ (20% of 218.63$/tube) using the same locality. While many other costs are incurred with every pneumothorax our intent was to make a boldly and broadly conservative estimate, assuming that a reduction in complications would map directly into a reduction in cost. This total 'cost of a pneumothorax' is 134.49$ which is less than the number utilized by the National Institute for Clinical Excellence. The Boland study estimated a cost per pneumothorax of 316.02 pounds(598.19$). However, it should be noted that their calculation incorporated the cost of an overnight stay as they were evaluating an outpatient procedure. Also of note, the *only* 'cost' of arterial puncture, another complication of central venous access, was that of an overnight stay in their calculations. For patients in the ICU or emergency department this complication is probably not a factor in overall length of stay for patients who are requiring central access.

The complication rate above yields an annual pneumothorax rate affecting 39,000-75,000 patients each year. Given the assumptions above the cost of pneumothorax in the landmark technique was 5,245,110-10,086,750/yr.

39,000 * 134.49$ = 5,245,110$
75,000 * 134.49$ = 10,086,750$

Several meta-analysis of ultrasound guided central line placement have suggested a maximal risk reduction of 50%[3,4]. Factoring this into our equation, we estimated the cost of pneumothorax in ultrasound guided central lines to be 2,622,555-5,043,375.00$. In other words, there is roughly a 2 to 5 million-dollar annual savings as a direct result of performing central lines with ultrasound guidance.

Having calculated our theoretical cost reductions we looked back at the *initial* cost of placing the central line. According to the average Medicare reimbursement, as determined by the relative value unit scale and the Arizona geographical cost index in 2006, the cost of placing a non-tunneled central venous catheter is roughly 130.26 dollars (CPT code - 36556). This is true with either technique. However, the use of ultrasound in a fee for service health care system also incurs a cost.

The CPT code used for ultrasound guided central venous access by Emergency Physicians prior to 2004 was 76942. This code, defined as being appropriate for "echo guide for biopsy" or "ultrasound guidance for needle placement," is the code still utilized for paracentesis, thoracentesis, and echo guidance of abscess drainage. The RVU assigned to this code for 2006 is 3.84 RVU's or 144.84$, given the same assumptions as above. This code was replaced in 2005 with a new code specific to ultrasound guidance of central venous access. This code, 76937, yields a markedly different RVU and dollar amount, .91 and 34.68$ respectively. A summary of the technical and professional components of these RVU's is presented in table 1:

	Technical (TC) RVU	Professional (26) RVU	Total RVU	'Cost' in 2006 (conversion factor 37.895$)
Central Access (76937)	.43	.48	.91	34.68$
Echo/Biopsy (76942)	.92	2.92	3.84	144.94$

Given that the complication rate of a paracentesis is similar if not less than that of central line placement, the time required for each procedure is roughly equivalent, and the procedure utilized for sterile preperation and ultrasound guidance of needle placement is almost identical for both procedures, how is it that the relative value of ultrasound guidance for central lines is only a fourth of that for paracentesis[14]? How is the relative value unit scale valid in this instance?

Regardless of this anomaly in reimbursement standards, we continued on with our estimation using the current relevant CPT codes. The derivation for the cost of ultrasound guided versus landmark guided central lines is outlined below:

Landmark technique:

3-5 million lines/yr x 130.26$ = 390,780,000 - 651,300,000$/yr

Ultrasound guided technique:

3-5 million lines/yr x (130.26$ + 34.68$) = 494,820,000 – 824,700,000$/yr

After subtracting the money saved in reducing the incidence of pneumothorax, this billable 'cost' of using ultrasound for central venous access is potentially 104 – 173 million dollars per year *above* that of performing the standard landmark technique.

Extra cost of ultrasound guidance - the money saved in reduction of pneumothoraces:

(104-173 million) – 5 million/yr = 99 – 168 million dollars/year

This simple calculation implies *if* pneumothorax were the only cost influential complication, *then* the cost per pneumothorax would need to be 1387- 2306$. Using the CPT code from 2004, that previously used for ultrasound guided central venous access, this value increases to an average of 14,800$/pneumothorax. This is the key result of our paper.

The National Health Service (NHS) in the United Kingdom is one of a majority of countries with a socialized health service. In their economic analysis they *save* 748,646$ each year **in complications avoided (nick, is this right?)** by mandating that all central lines must be placed with ultrasound guidance, while we *add* a potential 99-168 million dollar 'cost' to an already burdened health care environment in the United States by placing central lines this way, purely because of the way in which the procedure is valued at the governmental level. Of note, the NHS analysis *did* take into account the equipment costs, maintenance costs, and training costs involved with performing all central lines placed in the NHS under ultrasound guidance. The RVU is meant to reflect the same costs in its reimbursement valuation. Yet the large disparity in cost this paper reveals exists.

How is this possible?

*An alternative measure: valuation per capita per target group

(I'm not sure what the right nomenclature is, but I mean 'target group' to mean the age range of the cohort of the population most likely to get this procedure done to them, like our cholecystitis 50 year old fat women 50-65 year old group). I'm sure the most effected cohorts exist in the medical literature. US census data will give us the right population figures here, too.

UK valuation: 748,646USD/UK target pop
US valuation: 99m-168mUSD/US target pop.

What this measure does is tweak our measure to include demographics, so people can't simply say 'well, it's a smaller country' or whatever. Also, we'll have a comparable, unit-free number, which will be nice.

Alternative Conceptions of the Market for Healthcare make it possible

Textbook health care economics states that an increased demand for and/or higher quality of a homogenous product will result in a higher price being paid for that product through an increase in the (rational) consumer's willingness to pay[15]. Obviously health care provision is not the same as buying simple products like pencils and pens, but there are similarities. To take a simple example, like any durable good, our stock of health, however measured, depreciates over the time from birth to death. Were the market for health care a direct mapping from the production of healthcare to health, then, valuations of

these health care services would be much easier, one would simply choose the level of healthcare consumption, given one's income, to maximize one's satisfaction over one's expected lifetime[16]. As it is, high levels of government intervention, uncertainty and asymmetric information, as well as both positive and negative externalities characterize the healthcare market. Also, the outcome of a healthcare consumption through a treatment or therapy is dependent crucially on the disease a person has at the point in their life they begin to suffer from it, a contingent consumption framework generally ignored in the health economics literature, an issue we discuss in a separate work[17].

In this paper, we ignored these aspects to infer a more direct, and therefore more imperfect, cost estimate from the RBRVUS reimbursement schema, in effect a case of monopoly pricing, where the physician, as individual seller, confronts a demand curve that is flat (they receive a constant price for their product), in the sense that if they tried to raise their price above the price set by the RVU committee (find out the proper title). This is how we in America have modeled and continue to legislate the structure of our health care system, on the premise of fully privatized health care in the presence of the government intervention; uncertainty and asymmetric information alluded to above. Were the healthcare market not characterized by these market imperfections, ultrasound guided central lines should cost more and the (rational) patient, or consumer, should be willing to pay for it. But health care cannot be driven by this premise, as it is ethically and practically impossible to implement.

Practitioners cannot use ultrasound only in those cases where they will be reimbursed and yet the current health care structure would suggest that they should. What company would survive if it were forced to provide services or products to anyone who cannot pay for them? We may refuse to accept it, but the health care system in the United States is one system of interdependent facilities and providers which, at it's root, has a collective goal of citizen health and a common pool of private and public funding. The 99--168 million dollars/yr in deadweight, i.e., economically useless, cost estimated for one procedure above either decreases the funding available for other care or increases the cost of health care for those who pay for it. Evidence based practice should not come at such a steep price to our health care system but in the case of central venous access it appears from our work that it does.

Here is where it would appear this article does a great disservice to our colleagues. An easy and myopic solution to this dilemma would be to say that all ultrasound-guided lines should be placed without additional cost. This is a typical short-sighted approach to a problem, to remove the leaf and ignore the root. There is a unique perspective provided by this conundrum. Devaluing a skill or service was not the intent of the authors. In fact, it appears this skill has already been devalued in the transition from the 2004 CPT code to the current one. Our goal was to highlight the value of this service both medically and economically. It is at the unexpected divergence of these two interests that we must focus. The naivety of our current healthcare system is the assumption that the cost of non-reimbursed care that is provided (ethically and legally must be provided) somehow occurs in isolation to all other health care costs, when of course the opposite is true. Outside of those few individuals with the funds to purchase health care directly, most insured patients in the United States pay inflated premiums to cover the costs of those patients who choose not to be insured or are unable to afford insurance, the textbook example of adverse selection[15], where insurers load their premia to buffer the extra risk they assume by insuring large amounts of the population, some of whom will be in poor health, and hence a bad insurance risk. Medicare, as the State-sponsored medical insurance system, faces this problem most acutely. This is, in fact, an inefficient form of socialized health care. Decreasing the reimbursement Medicare provides for ultrasound guided central venous access ignores the crux of this problem, that of divergent interests in the business and practice of medicine affecting the supply of healthcare services to those least able to pay for them.

To decrease the reimbursement for ultrasound studies, in the United States, either implies a decrease in the quality of the ultrasound procedure as measured by remuneration of physician effort in relative value units or a measure of the devaluation of this procedure in the eyes of the panels of physicians setting the reimbursement rate annually. Because of increases in the medical efficacy of the technology, ultrasound is only growing in utility and the use of ultrasound in this setting has proven benefit, as evidenced above. Perhaps instead of standardizing the cost of individual procedures and services thereby leaving providers and facilities to harvest what they will, we must focus on the standardization of *compensation* for health care providers based on hours worked, outcomes achieved and difficulty of the work provided. While radical at first glance, taking the RVU to the next level (or in actuality returning to it's origins), that of determining the geographically and specialty specific fair annual total reimbursement taking into consideration both experience and performance, might actually allow practitioners to focus on

the provision of care and unbridle the application of evidence based practice.

Summary and Further Work

This analysis was designed to evaluate the economic benefit of ultrasound guided central lines in terms of risk reduction of pneumothorax. We did this only partially and conservatively in light of the 99-168 million US dollar difference in techniques that was found in stark contrast to the findings of the UK's National Institute for Clinical Excellence analysis. It is obvious that many elements of morbidity associated with a procedure are difficult to quantify, and the benefit of using ultrasound guidance for central line placement argues for this practice *regardless of cost*. The intention of the authors is to highlight the perspective offered by this analysis in light of the economic issues faced by our collective Health care environment in order to stimulate informed debate on the subject.

Further work in this area will assess the following questions in a variety of treatments:

1. Where does the inverse relationship between Medicare reimbursement and procedure uptake not apply?
2. What valuation do other countries, apart from the UK, place upon ultrasound guided central line access?
3. Is a cost-effectiveness analysis of this study, emphasizing cross-comparability of results, possible?
4. Is there a more administratively effective and patient-welfare enhancing alternative to medical procedure reimbursement than the RVU system presently employed?

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Notes

CPT codes, RVU's, the 2006 RVU conversion factor and Geographical price indexes were obtained from the CMS website, http://www.cms.hhs.gov/apps/pfslookup