Hospital Costs in the US – Is it ‘Costs’ or ‘Hospitals’ That Are out of Control?
An Analysis Using Six Sigma

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"Out-of-Control" Hospital Costs in the US

In May 2013, the Centers of Medicare and Medicaid Services (CMS) threw a cat among the pigeons by releasing 2011 Medicare data on what different hospitals (“providers”) in the United States were charging for and what they were getting for each of the 100 most frequently performed medical procedures. Healthcare costs in the US are high relative to other western countries by some measures, for instance, in 2010, the US spent 17.9% of GDP on healthcare versus, say 11.3% in neighboring Canada, 9.5% in Japan, 9.6% in the UK, 11.9% in France, 11.6% in Germany and 11.5% in Switzerland. And the Medicare data is pertinent because in the US, despite popular belief to the contrary, the government pays more than half (54% in 2010) of total healthcare.

In a situation where costs are high in the aggregate, variability across different hospitals attracts even more interest. Indeed, newspaper headlines in the US that followed the release of the data questioned why one hospital charges 40 times than another on average for the same procedure, without any obvious pattern in location-specific costs or even prestige: costs at the world-famous Mayo Clinic may be only a third or a fourth of those in some New York hospitals.1 According to Jonathan Blum, Medicare deputy administrator, the variations are too huge to be explained by obvious differences among hospitals, such as a more expensive regional economy, older or sicker patients, or the extra costs of running a teaching hospital. Indeed, a preceding study on the huge variance of appendicitis procedures and the resulting calls for transparency may well have set the stage of the CMS initiative of releasing the data.2

But how much is “too much” and how can we compare costs across thousands of hospitals and hundreds of procedure types, separating ‘normal’ differences – specific to

location or even patients and varying year from year – from ‘abnormal’ ones that are too egregious to be explained through normal variation?

The discipline of Six Sigma (and its derivative applied to pricing processes, Six Sigma Pricing) is one way to do that by looking at transaction prices in terms of number of standard deviations away from the average. We can use it to identify ‘defects’ which are procedures that have a cost that is, say, more than three standard deviations higher than the average. Indeed, the term ‘Six Sigma’ signifies three standard deviations below and three above the average for the bell-shaped normal distribution. Doing so would establish an initial set of transactions – in the Medicare data for procedures done in particular hospitals – that need more scrutiny. Further analysis obtains patterns in the incidence of these defects to hone in on specific procedures, hospitals, locations, etc. where the costs cannot be explained away as ‘normal’ variation.

We show here how to apply Six Sigma for the healthcare data and the results we obtain by way of patterns in the ‘defects’. This type of analysis is useful not only for the government and for health insurance providers, but also for hospitals in benchmarking themselves. In any case, the procedure is quite general: after all, if there were a company that does the quality check with its top 100 products being produced at 3000+ locations, how would it start focusing on its quality improvement initiatives? Six Sigma provides that focus by measuring every process in terms of standard deviations (‘sigmas’) from the average – those that are outside three standard deviation on either side are ‘defects’. Eventually, you start tightening the acceptable level of deviation for continuous improvement. The same can apply here.

We carried out the steps shown here in a spreadsheet using the data downloaded from the CMS website although for some graphics we used statistical software for convenience. The procedure does not involve any judgment calls on multipliers – the only parameter

we need is how many standard deviations to use to classify defects although 3 has a good statistical basis. But even if we had chosen 2 or 3.5 it would not have changed the results in this case. The biggest benefit is that ‘normal’ deviations (e.g., variations ones that can be explained using location-specific costs for instance) in procedure costs can be eliminated allowing focus on abnormal ones – in statistical terms, outliers – that cannot be easily explained. Our procedure is no different from what a company with many products and many plants would need to use to understand the pattern of manufacturing defects across products and plants.

**Cost per procedure** here is the total payment received by the hospital for carrying out that procedure, including payments made by the government and by the individual concerned. Using Six Sigma parlance, a ‘defect’ is a hospital-procedure with excessive total payments that is higher than the average across all hospitals by more than three standard deviations. Given the data, a hospital-procedure being thus labeled as a ‘defect’ only indicates the need for further scrutiny because it is ‘abnormally’ higher than the average cost.

We downloaded the 2011 CMS data with information on nearly 6.7 million hospitals procedures condensed into about 163,000 ‘average’ hospital-procedures – all procedures of a certain type performed at a hospital have been averaged in the data. Each record provides the average charge as well as payments received of each procedure type along with the total number of procedures conducted at this hospital in 2011. The data is based on the top 100 procedure types based on number of times they were performed in 2011 at 3,200 hospitals (actually 3,348 ‘providers’ with some hospitals being listed as more than one provider). Excluded from the released data are hospital-procedures where the hospital performed 10 or fewer procedures for a particular procedure type.

**Exhibit 1** provides a list of the most frequently performed procedure types that were carried out more than 100,000 times in 2011. These twelve procedure types alone comprise more than half (56.8%) of the total 7 million procedures for which CMS has provided data. The top two procedure types alone account for more than a tenth of all
procedures: (1) “major joint replacement or reattachment of lower extremity without mcc” (6.1% of all procedures), and (2) “septicemia or severe sepsis w/o mv 96+ hours with mcc” (4.6%). We can look at their costs – Exhibit 2 provides the distributions of average total payments per procedure, across all hospitals. These distributions show the wide variation of actual transaction prices across the different hospitals – for the first one ranging from about $9,000 to about $39,000 and in the second case from about $7,500 to about $42,000.
Exhibit 1 – Procedure types (in ‘000s) with more than 100,000 procedures carried out in 2011 as a percentage of the 6.97 million hospital procedures in the CMS data

Exhibit 2 – Average total payments (US$) per procedure for top two procedure types by incidence
(a) Major joint replacement
(b) Digestion disorders
We could repeat such distributions for all the 100 procedure types in the data but that would not yield any obvious pattern or insight decision-makers will be looking for. Instead, we provide a systematic procedure to separate out cases that require scrutiny using Six Sigma:

1) Calculate the average total payment and the standard deviation across the different hospitals for each procedure type

2) For each hospital-procedure type in the data, calculate the difference between the cost and the average across all hospitals for this procedure, and divide the difference by the standard deviation of this cost across all the hospitals

3) If the resulting value is greater than three, label this hospital procedure ‘defective’ and count the number of ‘defects’ as the number of procedures of this type carried out at this hospital

4) Sum up the number of defects in different ways: across the different procedure types across each hospital, or across locations or even states

5) Find patterns in the defects.

By carrying out this procedure, we found that fewer than 2% out of 7 million procedures, 123,243 to be precise, were ‘defective’ in the sense that average payment received per procedure was more than three standard deviations higher than the average for the procedure across all hospitals. And these defects are highly concentrated – some hospitals in the New York City area alone contribute to nearly half of all ‘defects’ in the US – adding only a few other hospitals in Baltimore, San Francisco, Stanford, and Los Angeles would account for nearly 80% of all defects. The American Hospital Association says each patient's course of care is different. However, this analysis seems to suggest that these ‘different’ patients are coming only to a few hospitals across a variety of procedures. Exhibit 3 shows the providers where more than 1000 ‘defective’ hospital procedures occurred. Exhibit 4 shows the locations with more than 1000 such defects.

Exhibit 5 shows the US states that had more than 1000 defects (Minnesota had 983 but is included because it is still significantly higher than the state with the next highest number of defects).
Exhibit 3 – Hospitals with more than 1,000 ‘defects’ listed by their percentage contribution to the total number of ‘defects’ across the US

Exhibit 4 – Locations with more than 1,000 ‘defects’ reflecting the percentage this location contributes to all defects in the US
So what is the economic significance of these defects? We can compute ‘excess’ revenues as a result of the defects using the payments received for a procedure by a hospital in excess of the average cost for that procedure across all hospitals. Exhibit 6 lists 32 hospitals, fewer than 1% of all the hospitals in the data, which are responsible for more than a quarter of $5.6 billion in ‘excess’ healthcare revenues in the US.

In sum, before fretting about healthcare cost levels in general, the US government would be well advised to focus on only a few hospitals at the outset to reduce the extreme variance. Doing simple analysis using Six Sigma can be a start to doing so systematically to try and bring some level of control to ‘out-of-control’ costs.
Exhibit 6 – “Excess revenues” by hospitals where the total exceeds 25% of all excess revenues in the US in 2011