Do Nosocomial Infections Discriminate?

Proposal for Econ 699

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Problem Definition and Significance

Patients enter the hospital believing they will be treated for their health problem and then be discharged in better health than they were admitted in. However, in many cases this is not the reality. The CDC estimates that nearly two million patients each year will get an infection while in a United States hospital, and about 90,000 of them will die from the infection. (October 2002) In fact, deaths due to hospital acquired infections, otherwise known as nosocomial infections, is the fourth leading cause of death after heart disease, cancer, and strokes. (ABC News, 2003) While death and illness are of primary concern, there are also other consequences of this problem. The CDC estimated a $5 billion additional cost to US healthcare in 2000 due to hospital acquired infections (March 2000). These are costs that hospitals should take note of. In the 2000 CDC article, it was mentioned that in many cases "insurance companies and other payers, such as Medicaid, reimburse the hospital on the basis of the patient's original condition." This results in lost dollars to the hospital. The main cost involved is in extended days in the hospital. Extra days in the hospital range from days to weeks depending on the type of infection. Without a doubt, these costs will be passed on to consumers to add to the already burgeoning healthcare costs.

Problems related to nosocomial infections are not limited to US hospitals. The BBC News reports that infections are acquired by one in ten patients in the UK and cost about 1 billion pounds per year; patients spend 2.5 times longer in hospital; it costs 3,000 pounds more to treat them; and they often require additional treatment after they leave the hospital. Clearly, the problem of hospital acquired infections is widespread.

While costs to the hospitals and health care system are direct costs, the costs to patients and their families should not be forgotten. Extra days in the hospital and time spent going to the doctor for follow-up are indirect costs of the nosocomial infection for the patient and his family. Even when insurance covers the cost, there is still a cost to society even if not a personal cost. Another consequence, which is noted in the following literature review, includes increased resistance to antibiotics and "super-bugs." These consequences of the nosocomial infection can be considered negative externalities, while the nosocomial infection itself is a negative externality of being hospitalized. The most important economic impact is that resources used to treat these infections could be better utilized elsewhere.

Literature Review

Most of the literature on nosocomial infections concerns the seriousness of the problem, with only a few studies investigating the costs. An article in Drug Topics (Gebhart, 2002) gave details of hospitals in Florida that were in danger of the federal government revoking their Medicare certification due to very high nosocomial infection numbers. Patient complaints caused the Centers for Medicare & Medicaid Services to inspect the hospital and find such problems as dirty IV pumps and a "ventilation system that could circulate contaminated air into spaces that are supposed to be sterile." This article also addressed the problem with finding effective drugs to treat hospital-acquired infections, which are particularly "nasty."

An excellent article for nurses, "Diseases From Within Our Doors" (Tilton, 2002) gives three contributing factors to nosocomial infections: overuse of antimicrobials, which has led to resistant strains of "super-bugs," failure to follow infection control

procedures, and aging hospitals being renovated, releasing dust and spores into the air. A particularly astute point Tilton (2002) made is that the migration of many illnesses to outpatient centers has resulted in the very sickest patients being the ones in the hospital setting, and these are the patients most likely to acquire an infection.

Some articles emphasize infection reduction strategies that rely on educational components. OB GYN News (Boschert, 2002) and Internal Medicine News (Boschert, 2002) relate how simple reminders for hand washing reduced nosocomial infection rates. An article in Critical Care Alert (October 2003) found that educational intervention for medical personnel including doctors and nurses also reduced infection rates.

A study on costs, found in Clinical Infectious Diseases (Roberts, Scott, Cordell, Solomon, Steele, Kampe, Trick, Weinstein, June 2003) attempted to use economic modeling to determine the costs to hospitals of nosocomial infections. While controlling for severity of illness and intensive unit care, they associate an excess cost of $6767 to suspected infections and $15,275 for confirmed nosocomial infections. They believe hospitals can use these figures to justify costs for intervention strategies that could reduce nosocomial infections.

Hypotheses

Based on the literature review and research, it appears that nosocomial infections are a serious problem that might be addressed with more awareness. In an ABC *Primetime* television show (October 2003), Dr. Barry Farr, the head of infection control at the University of Virginia Medical Center, tested each patient on admission and isolated those with germs. He claimed to have eradicated a serious infection outbreak in

his hospital within a year and a half. This is an example of policy that could effectively reduce nosocomial infections.

While some studies try to assign a cost to the infection, I will look at the distributional effects of the nosocomial infections. Controlling for the severity of illness and using three specific nosocomial infections, I will test my hypothesis that patient characteristics affect whether the patient will acquire a hospital infection. The results can be used to identify targeted infection control procedures where dollars spent can have the most impact.

Discussion of the Data

The Nationwide Inpatient Sample (NIS) is a database of approximately 7 million inpatient discharge records from about 1,000 hospitals in 24 states, a sample representing all community hospitals in the U.S. Data elements include characteristics of the patient himself, such as race, sex and age; as well as the characteristics of their stay in the hospital, such as the diagnosis, procedures, charges, and payer. The NIS comes from the Healthcare Cost and Utilization Project (HCUP), which is sponsored by the Agency for Healthcare Research and Quality (AHRQ). The AHRQ also provides quality indicators that can be applied to the inpatient records. One quality indicator is the Patient Safety Indicators (PSI). By applying the PSI to the NIS I can extract inpatient records with the infections that I am interested in. The three infections I have chosen are selected infections due to medical care, postoperative sepsis, and decubitus ulcer. An advantage to the PSI is that patients identified as particularly susceptible to these infections are eliminated, removing them from my subset and eliminating that bias.

Empirical Model and Empirical Techniques

Using my data set created after using the PSI, I will run a regression using the usual model (in matrix notation) $\mathbf{y} = \mathbf{X\beta} + \mathbf{e}$

where, y is my dependent variable, a dichotomous variable with a value of 1 for the existence of the infection or 0 for no infection;

and, $\boldsymbol{\beta}$ is the vector of independent variables described below:

AGE – age is often taken as an indicator for recovery. Younger patients in general are better able to fight off infection.

BLOOD – this is the number of pints of blood furnished to a patient. It will be interesting to see if there is any effect. It might be an indicator of the degree of illness, but more "foreign" blood might affect the body's resistance to germs.

DaysBurnUnit, DaysCCU, DaysICU, DaysNICU, DaysPICU, DaysShockUnit – these are all special care units in the hospital. A variable will be created for the sum of all of the days combined in these units. Not only might it indicate the degree of illness, but also the degree of exposure to the sickest patients in the hospital.

DXn – diagnosis will most certainly affect the event. The more serious the problem, the more likely there may be some adverse effect. (Determining severity is actually a challenge that I have not yet worked out.)

FEMALE – gender might influence the event, possibly by their anatomy or family involvement in care. (A personal belief is that women are attentive to their loved ones care, while men normally are not.)

LOS – length of stay will be a factor in the amount of exposure.

NDX – the number of diagnoses (co morbidity) at discharge will have an effect on the degree of illness.

NPR – the number of procedures performed will be a factor also, not only as a degree of illness, but also as increased opportunities for an adverse event to happen.

PAY1 – the primary payer might have an effect. Will those with "better" insurance fare better than the uninsured?

RACE – race could be another interesting variable. The effect of race may be due to a disparity in the type of care received.

Because my dependent variable is a dichotomous variable, OLS is not an appropriate technique. In order to constrain my values to the 0-1 interval and correct for heteroskedasticity in the residuals, I will use a logit maximum likelihood procedure.

I will run two other regressions to obtain additional useful data.

Regression 2 – the dependent variable in this regression will be length of stay (LOS). The question being, how does the presence of the infection impact the length of stay in the hospital?

In this regression, the independent variables will be the same as described above, but the LOS will be removed and replaced with an infection flag. This is a dichotomous variable indicating whether the infection is present or not

Regression 3 – the dependent variable in this regression will be TOTCHG in order to see what impact the infection will have on the total charges for the hospital stay.

The independent variables will be the same as above, plus the infection flag. Again, this dichotomous variable indicates whether the event is present or not.

Again, OLS is not an appropriate technique. If including the infection as an explanatory variable, it will be endogenous to both LOS and TOTCHG. This results in a biased estimator and a covariance between the endogenous variable and error term not equal to 0. The remedy requires instrumental variables and a two stage least squares technique. Identifying the instrumental variable to "link" the dependent variable and endogenous explanatory variable is a problem, and one that I have not yet solved.

Discussion of Work Completed

The 7 million records have been reduced to approximately 1.4 million and the PSI program is ready to be applied. I have selected the three PSI that I am interested in. As mentioned earlier, selecting the instrumental variables is the current emphasis. Having determined the techniques for my analysis, the next step is to prepare the data for use. I will manipulate the dataset to include the variables I am interested in, so I can proceed

with the regressions. The final step will be analyzing the results and drawing conclusions from them.

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