

# USING DISCRIMINANT FUNCTION AND QUALITATIVE RESEARCH TO ANALYSIS UNCOMPENSATED CARE OF HOSPITAL FOR BAD DEBT PREVENTION

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Each year, most of hospitals will aggregated information on the level of uncompensated care delivered in hospital and evaluate the possible problems and obstacles. This fact sheet provides the sum of a hospital's 'bad debt' that have to face and solve. This study analyzed data of admission inpatients between July 1 2005, and May, 30, 2006 based on discriminant analysis and established a discriminant function. Qualitative research was conducted in the second phase of this study which further integrate and confirm discriminant function to be able to improve process to predict and prevent bad debt.

## 1. Introduction

### 1. 1. *Hospital and Uncompensated Care Costs*

Uncompensated care is an overall measure of hospital care provided for which no payment was received from the patient or insurer. It is the sum of hospital's 'bad debt' and the charity care it provides. Charity care is care for which hospitals never expected to be reimbursed. A hospital incurs bad debt when it cannot obtain reimbursement for care provided. This happens when patients are unable or unwilling to pay their bills. Uncompensated care excludes other voluntary or involuntary discounts or 'reductions in revenue', such as underpayment form other donation or discounts to private payers.

For the purpose of management, some charity or church hospitals combine the hospitals' bad debt and charity care costs to arrive at the hospitals' total burden of unreimbursed care provided to the medically indigent and underinsured. In terms of accounting, bad debt consists of services for which hospitals anticipated but did not received payment. Charity care, in contrast,

consists of services for which hospitals neither received, nor expected to receive, payment because they had determined the patient's inability to pay. In practice, however, hospitals have difficulty in distinguishing bad debt from charity care.

### **1. 2. *Charity Care of Hospital***

Hospitals provide varying levels of charity care, which must be budgeted for and financed by the hospital depending on the hospital's mission, financial condition, and other factors. Some hospitals use a formal process to identify who can and cannot afford to pay, in advance of billing, in order to anticipate whether the patient's care could be funded through an alternative source such as charity care fund. On the other hand, some hospitals use the billing and collection process to identify those patients who are unable to pay. Care delivered to patient may be classified as charity care by one hospital, but bad debt by another. This does not mean, however, that care classified as bad debt was provided to patients who can afford to pay. On the contrary, bad debt can be generated by people with limited resources, making the distinctions between the two categories virtually meaningless.

Adding to the fact that bad debt and charity care are not strictly comparable across facilities due to institutional practices, several studies suggest that health care bad debt is more often than not accounted for by care provided to people who cannot afford to pay their hospital bills [1], [2]. It is, therefore, reasonable to consider bad debt as a component of hospitals total burden of care to medically indigent and underinsured.

### **1. 3. *Calculating Uncompensated Care Costs***

Uncompensated care is calculated by hospital basis. Bad debt and charity care are reported as charges in the annual. These tow numbers are added together and then multiplied by the hospital's cost to charge ration, or the ration of total expenses to gross patient and other operating revenue:

- $\text{Bad Debt charges} + \text{charity care charges} = \text{uncompensated care charges}$
- $\text{Total expenses} / (\text{gross patient revenue} + \text{other operating revenue}) = \text{cost-to-charge ratio}$
- $\text{Uncompensated care charges} \times \text{cost-to-charge ration} = \text{uncompensated care costs}$

Combining bad debt and charity care to arrive at the hospital's total uncompensated care value allows for comparability across hospitals. Table 1 is the list of American national uncompensated care based on cost from 1980 to

2004 (in Billions) of American Hospital Association (AHA) registered community hospitals.

Table 1. America national uncompensated care based on cost: 1980-2004 (in billions) of AHA hospitals.

<b>Year</b>	<b>Hospitals</b>	<b>Uncompensated Care Cost</b>	<b>% of Total Expenses</b>
1980	5828	\$3.9	5.10%
1981	5812	\$4.7	5.20%
1982	5796	\$5.3	5.10%
1983	5782	\$6.1	5.30%
1984	5757	\$7.4	6%
1985	5729	\$7.6	5.80%
1986	5676	\$8.9	6.40%
1987	5597	\$9.5	6.20%
1988	5499	\$10.4	6.20%
1989	5448	\$11.1	6%
1990	5370	\$12.1	6%
1991	5329	\$13.4	6%
1992	5287	\$14.7	5.90%
1993	5252	\$16.0	6%
1994	5206	\$16.8	6.10%
1995	5166	\$17.5	6.10%
1996	5134	\$18.0	6.10%
1997	5057	\$18.5	6%
1998	5015	\$19.0	6%
1999	4956	\$20.7	6.20%

Year	Hospitals	Uncompensated Care Cost	% of Total Expenses
2000	4915	\$21.6	6%
2001	4908	\$21.5	5.60%
2002	4927	\$22.3	5.40%
2003	4895	\$24.9	5.50%
2004	4919	\$26.9	5.60%

#### 1. 4. *Limitations on the Placement of Tables, Equations and Figures*

Very large figures and tables should be placed on a page by themselves.

#### 2. **Elimination of Hospital Bad Debt**

In general, church hospitals and rural hospitals are at great risk for bad debt and are particularly vulnerable to budget cuts. Contributing to this vulnerability, a high proportion of rural residents, about one-quarter, have incomes less than 125 percent of the poverty line; 17 percent of rural residents under age 65 are uninsured in the United States [3]. At the same time, many church and rural hospitals are small in size and are unable to offer the more financially lucrative medical services and programs which could offset financial losses due to bad debt [4].

This study was conducted to developing a discriminant function by using statistical discriminant technique from large data record samples. Discriminant function is further combing with the study result of qualitative research to develop decision supporting method or system for prediction and prevention bad debt.

#### 3. **Methods**

##### 3. 1. *Design, Setting and Data Transformation*

This study was conducted in a teaching hospital near urban area. Due to the nature of the study, data of patients were not contacted directly and informed consent was not necessary. In the first phase of this study, 28741 patients records were selected from outpatients and admission patient data during a 15

month period. Selected patients data included those with any diagnosis regardless of their payment status. This study adopts discriminant analysis to establish the function and rules of normal payment patients and bad debt patients. The data sample of patients were obtained from Nosology (classification of diseases) subsystem of Health Information System database (HIS) in hospital. Patients with bad debt status were selected and transformed into metrics data while adding a bad debt status mark column by using a data transformation program developed by this study. This study analyzed a whole year data between July, 1, 2005 and May, 30, 2006 to avoid biasing the sample toward a specific timing.

There are certain risk factors that increase the possibility of bad debt. Those factors influencing bad debt include having an emergency department, adjusted discharges, and social status [5], [6]. Because no proper instruments exist for evaluating risk factors for bad debt patients, this study developed some decision rules for data transformation programs for data preparation shown as Table 2. These rules were based on the definition of financial data of definition of hospital and health system data items/terms from Iowa Hospital Association (IHA) and Noridian Administrative Services (NAS) bad debt clarification [7], [8].

Table 2. Rules for the data transformation programs (DTS).

No.	Rules	Descriptions
1	Non-reimbursed care	Patient care provided for which payment is not received including contractual adjustments, and charity care.
2	Uncompensated care	Services provided by hospitals for patients who are uninsured, are unable to pay, or fail to pay the costs of their care. The
3	Bad debt	The provision for actual or expected uncollectibles resulting from the extension of credit. Because bad debts are reported as an expense and not a deduction from revenue, the gross charges that result in bad debts will remain in net revenue.
4	Total expenses	Includes all payroll and non-payroll expenses (including bad debt) as well as any non-operating losses (including extraordinary losses).

No.	Rules	Descriptions
5	Bad debt period	A provider (patient) is expected to submit a bill to the hospital within 30 days. In total, the provider should be billing the hospital within 90 days of the date of discharge or death.
6	Patients with bad debt status	A provider (patient) should be billing the hospital within 90 days of the date of discharge or death within a year's budget.
7	Summation of a patient's bad debt	Identified same patient ID with different inpatient medical service number.

A pilot test for one month records (about 1000s records) was conducted to establish the utility of data transformation, determine the clarity of the data, and eliminate any mistakes. Pilot test result was reviewed by the discharge note digest coding expert, and rules were adjusted for the maxima accuracy.

### 3. 2. *Medical Data Analysis - Quantitative Analysis*

A whole year data was transferred into a data set. This data set consists of 52 different attributes (for example, patient number, sex, birthday, etc.) and was analyzed by discriminant analysis for all related attributes and try to find out the major risk factors for a bad debt status patient. Discriminant analysis technique is for classifying a set of observations into predefined classes. In the two group case, discriminant function analysis can be thought of multiple regression. The two group discriminant analysis is also called Fisher linear discriminant analysis after Fisher [9]. If we code the two groups in the analysis as 1 and 2, and use that variable as the dependent variable in a multiple regression analysis, then we would get results that are analogous to those we would obtain via Discriminant Analysis. In general, in the two group case we fit a linear equation of the type:

$$Group = a + b_1*x_1 + b_2*x_2 + \dots + b_m*x_m \quad (1)$$

where  $a$  is a constant and  $b_1$  through  $b_m$  are regression coefficients. The interpretation of the results of a two group problems is straightforward and closely follows the logic of multiple regression: Those variables with the largest regression coefficients are the ones that contribute most to the prediction of group membership.

Based on the data-set, a linear function was constructed by discriminant technique. This discriminant function can be used to predict the class of possible bad debt patients in the future. In the first run of discriminant analysis, we drop the attributes without the ability of discrimination according to

Univariate test ( $p > 0.05$ ). Table 3 is the Canonical Discriminant Analysis result of the second run.

Table 3. Major factors of bad debt patient \*

Factors (Attributes)	Total Canonical Structure Value	Factor Descriptions
AREA_CODE	-0.592224	The patient comes from which location.
INP_SOURCE	0.5114	Source of the patient (ER, outpatient, etc.)
DIS_KIND	0.173253	MBD: Discharge by the order of physician. AAD: Discharge without the order of physician. HAAD: Expired.
MAIN_CODE3	-0.237297	Diagnostics with 3 different diseases.
BABY_WT	0.741564	Infant weight.
DEATH_REASON	0.226855	Patient expired with main disease.

\* Total Canonical Structure of the DISCRIM procedure canonical discriminant analysis.

We can construct a discriminant function according the discriminant weight form Total-Sample Standardized Canonical Coefficients as follow:

$$\begin{aligned}
 \text{Group} = & -0.5793834 * \text{AREA\_CODE} - 0.0113790 * \text{INP\_SOURCE} + \\
 & 0.1809879 * \text{DIS\_KIND} - 0.1695139 * \text{MAIN\_CODE3} + 0.7390868 * \text{BABY\_WT} + \\
 & 0.2050119 * \text{DEATH\_REASON} \quad (2)
 \end{aligned}$$

### 3. 3. Interview with Representatives - Qualitative Analysis

In the second phase of this study the generated discriminant function is adopted to predict ... and possible hospital's responses to the elimination of bad debt reimbursement. This study interviewed three hospital representatives to gain a better understanding of current debt collection practices, the predicted impact, and possible hospital's responses to the elimination of bad debt reimbursement. Interviewees included hospital Chief Financial Officers (CFO), Chief Executive Officers (CEO), and a leader of cashier office.

#### **4. Financial Effect of Changes in Discriminant Bad Debt Function**

Respondents contacted for interviews raised similar issues and concerns regarding the potential elimination of bad debt. Most of the three respondents indicated that their hospitals have already begun considering ways to deal with the financial strain that could be caused by the elimination of bad debt payments. Among the responses noted were the following:

##### **4. 1. *Pay Attention to Specific Programs or Services***

Two respondents indicated that the programs most in jeopardy are those currently being subsidized by the hospitals; these include home health program, hospice care, mental health, drugs addition treatment, and specialty clinics.

##### **4. 2. *Reducing Charity Care***

Some interviewers indicated that they might attempt to reduce the amount of charity care they provide by making qualifying criteria more stringent. Although these respondents thought that lowering charity care expense would be ideal, most respondents also noted that, in practice, it would be difficult to implement, given that church hospital with large bad debt expenditures are located in high poverty areas; particularly in this study, in those communities where the hospital is the solve provider, it would not be possible to turn patients away. In fact, one respondent felt that his institution might make charity care qualifications less rigorous.

##### **4. 3. *Staff and Salary Reductions***

Another way that hospital administrators discussed compensating for financial losses associated with elimination of the bad debt reimbursement is by reducing either staff size or pay decreases. CFO pointed out that if employees failed to receive cost of living increases or salaries were not competitive, it would not be possible to retain and attract qualified staff. On a related note, some respondents indicated that bad debt policy could force hospital to delay or entirely forego purchasing new equipment or expanding facilities as anticipated and necessary. Respondents expressed concern about their ability to maintain and improve standards of care. Moreover, respondents indicated that staff reductions would decrease the hospital's quality of care and that the access and that the access and quality of care available to all persons in the community.



#### 4. 4. *Renewed Emphasis on Bad Debt Collections*

Ongoing collection procedures range in degree of aggressiveness (for example, phone calls, letters, legal actions... etc.). Most hospital administrators revealed that they attempted to avoid harsh collection practices, such as the placement of property liens, and were amenable to flexible financial arrangements with patients. The interviewees also sought to qualify clients into financial assistance programs (for example, emergency assistance funds, national indigent care programs, and social assistance funds), benefiting both the hospital and the patients.

Hospital representative indicated that they might re-examine their debt collection strategies, particularly when the outstanding account balance is large. One hospital respondent thought that institutions facing greater financial strain might be forced to be more insistent or aggressive in their collection efforts. Even though most hospitals already attempt to refer eligible patients to public programs to determine their qualification for health and financial assistance, respondents indicated that they may need to step up efforts to ensure that individuals who qualify for these programs receive these benefits.

More aggressive collection efforts which could be employed include legal actions, such as liens. In general, hospital representatives that we spoke with indicated that although they currently try to avoid using such extreme measures to collect on unpaid accounts, harsher collection tactics may be necessary.

### 5. Findings and Conclusions

#### 5. 1. *Findings from Discriminant Analysis*

##### 5. 1. 1. *Demographics and Clinical Characteristics*

There are 293 medical records of patients with bad debt status from all 13613 sample records. Most of the patients were admitted from emergency (48%), with 35% of the patients being admitted from outpatient and 15% of neonate.

Demographic characteristics were evaluated to identify differences between the normal status and bad debt status groups (see Table 4).

Table 4. Demographics of bad debt and normal groups

Characteristic	Bad debt (n = 293)		Normal (n = 13320)	
	X	SD	X	SD
Age	27.19	21.62	33.07	29.03

Characteristic	Bad debt (n = 293)		Normal (n = 13320)	
	n	%	n	%
<b>Age</b>				
<=1	71	24%	2210	17%
02-16	25	9%	3028	23%
17-39	124	42%	2841	21%
40-59	52	18%	1938	15%
60-79	12	4%	2378	18%
80+	9	3%	883	6%
<b>Gender</b>				
Male	155	53%	6754	51%
Female	138	47%	6566	49%
<b>Marital Status</b>				
Single	144	49%	5988	45%
Married	144	49%	7005	53%
Divorced	2	1%	46	2%
Widowed	3	1%	236	1%
Unknown	0	0%	24	0.2%

Patients with bad debt status tended to be younger than normal status patients ( $p < 0.0001$ ) and no significant differences existed in relation to gender. There is not difference existed between normal and bad debt patients according to marital status. Of those bad debt patients, 49% are single compared to 45% of those normal patients.

This study further analysis clinical characteristic and bad debt factors. Patients with source from emergency room and infants were more likely to be bad debt status than those come from other sources ( $p < 0.0001$ ). Weight of neonatal under 2000 gm are 3 times of possibility to be bad debt status as table 5 shows.

Table 5. Factor of neonatal weight

Neonatal weight	Bad debt		Normal	
	n	%	n	%
<b>Weight under 2000 gm</b>	5	9%	32	3.30%

Neonatal weight	Bad debt		Normal	
Weight above 2000 gm	51	91%	931	96.70%

The area in which patients come from is also a very important discriminant factor to predict bad debt status. Among the patients who come from more far away from the hospital is more likely to be bad debt status ( $p < 0.0001$ ).

Based on discriminant analysis result, patients with more active health problems or comorbidities (the simultaneous presence of two chronic disease or conditions in a patient) were likely to be predictive of bad debt. Patients with 3 comorbidities (MAIN\_CODE3) tended to be more likely to be a bad debt patient ( $p = 0.0206$ ).

#### 5. 1. 2. *Factors and Model for Bad Debt Status Patients*

On average, bad debt status patients live more far than those normal, and this difference was significant. Infant with lighter body weight are begin likely to be bad debt, that is 9% of body weight under 2000 gm infant compared to 3.3% of normal status. Bad debt status also has significant relation with discharge without the order of physician and the patient expired in the hospital.

Bad debt status was not affected by by insurance or payment methods. Sex, age, marriage, medical department, surgery operation and readmission or not were not associated with the risk of readmission.

Figure 1 is the discriminant model of this study. The squares show different risk factors for prediction bad debt status patients. Different factors plays different weighting impact on bad debt possibilities. Weighting of factors is represented by the difference of line thickness.

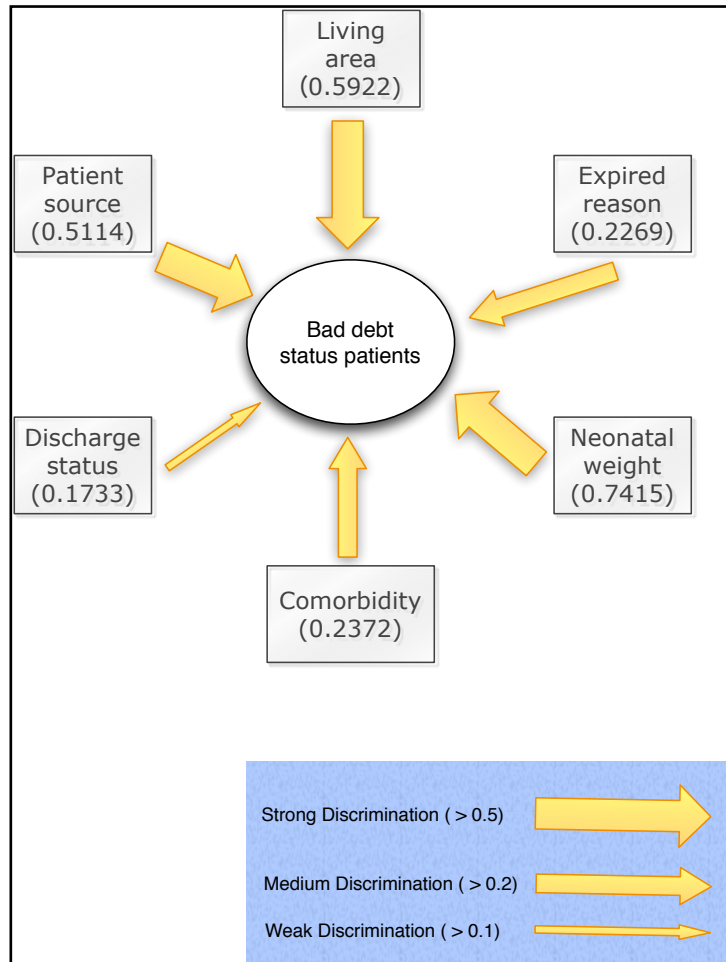


Figure 1. Discriminant model for the prediction of bad debt status patients.

## 5. 2. *Qualitative Research and the Application of Discriminant Function*

Findings from this study suggest that the discriminant function, which would phase-out bad debt to hospitals, by its prediction and prevention function. Depending on size, financial losses could be expected to different range. Rural and urban payer mixes differ, with rural hospital in this study relying more heavily on social financial support. Of particular concern is the fact that many rural hospitals are already financially constrained and the elimination of bad

debt could result in the improvement of essential health services and programs or a enlargement in the quality of care available to community residents.

Thus, we can use this bad debt discriminant function on the process of charge system of hospital and further predict and prevent bad debt event by the support of social or religious assist funding.

On of the important limitation of this study is the natural attribute of this case limit in rural area, case in the urban may need to develop in the further.

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