International Journal Of

Recent Scientific Research

ISSN: 0976-3031

Volume: 7(4) April -2016

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THE OFFICIAL PUBLICATION OF
INTERNATIONAL JOURNAL OF RECENT SCIENTIFIC RESEARCH (IJRSR)
http://www.recentscientific.com/ recentscientific@gmail.com

ISSN: 0976-3031

Available Online at http://www.recentscientific.com

International Journal of Recent Scientific Research
Vol. 7, Issue, 4, pp. 10272-10275, April, 2016

International Journal of Recent Scientific Research

Research Article

OPTIMAL ALLOCATION OF IN-PATENT IN ACUTE CARE HOSPITALS

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ARTICLE INFO

Article History:

Received 15th January, 2016
Received in revised form 21st February, 2016
Accepted 06th March, 2016
Published online 28th April, 2016

Keywords:

Potential Avoidability, True Acuity Algorithm, 0-1 Goal Programming.

ABSTRACT

A patient-day of service is classified as potentially avoidable if the unique facilities and manpower of an acute care hospital are not essential to providing the services received. From a practical standpoint, not all potentially avoidable days are truly avoidable. However, norms can be established, specific to diagnosis, surgery, sex, and age, which specify an acceptable range for the percentage of potentially avoidable days. A procedure is developed for efficiently assessing potential avoidability making if feasible to measure this concept for every patient on a daily basis. The resultant data base can then be used in utilization review screening to detect abnormal patterns of utilization by case, physician, or hospital.

INTRODUCTION

With the advent of pre-paid group medical plans and government sponsored health insurance, hospital in-patent utilization in India is coming under increasingly close scrutiny. These plans, in effect, eliminate most of the marginal cost to the patient of hospital admission and treatment. In the absence of economic incentives, some direct control mechanisms over in-patient utilization must be available to health care administrators [Joseph P and Taylor V]. Statistical measures which signal variances from desirable practice can provide the means for controlling utilization provided that their costs is not prohibitive and the behavioral consequence of their implementation is not disruptive to hospital operations.

Statistical summaries of hospital utilization are commonplace, perhaps, the most widely used being the Professional Activity Study. From this and other broad information bases, norms of practice for specific diagnoses and types of surgery have been developed [Paul Frijters *et al*.,]. However, the multiplicity of variables required characterizing a single case, a physician's practice, or a hospital's performance makes comprehensive abstracts difficult to use a control devices.

Perhaps, the most effective statistical control measure in use today. From a control standpoint, is the accumulated length-of-stay. The use of excessive length-of-stay, based on diagnosis-specific norms, as a signal for case review is a proven technique for influencing the utilization patterns of physicians. Data collection and processing is performed entirely within the hospital at low cost and without dependence on external information systems. Substantial shifts in utilization patterns are brought about by the mere existence of the control mechanism. Only occasionally is there need to resort to case review. When reviews are indicated, the records routinely stored by the hospital are sufficient to make judgments. More elaborate screening techniques have been suggested [Mclain John O] which, if implemented, would produce more accurate selection of cases but would entail considerable clerical effort on the part of medical records personnel.

This paper reports research which shows that the length-of-stay measure can be supplemented with an additional, high powerful measure to control in-patient utilization. The measure indicates the *potential avoidability* of acute bed utilization. Briefly, each day of a patient's hospital service is evaluated with respect to the degree to which the unique facilities and manpower of an acute care hospital are essential to providing that service. As with length-of-stay, potential avoidability can be measured daily with little additional clerical effort. Potential avoidability is closely related to the concept "level-of-care', which specifies the quantity of service inputs and states the

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severity of patient's condition. Studies attempting to measure level-of-care have been numerous and results have been applied to such problems as admissions scheduling, assignments of patient to wards, allocating nursing personal, and accounting cost allocation [Chorba R W] and [Jeroen Belien *et al*.,]. A valid assessment of level-of-care requires lengthly documentations of service inputs utilized and factors affecting care.

Potential avoidability does not require measurement of all inputs and care factors. Rather, it excludes all inputs and conditions which could be provided or treated outside of what is generally considered to be an acute care setting. By reporting a measure of potential avoidability for each patient on a daily basis, a non-economic motivation would exist to utilize lower cost environment for the delivery of healthcare. This does not mean that every patient-day of service rated as potentially avoidable is, in fact, truly avoidable. Typically, a patient progresses through a succession of stages during his stay, several days of which may be rated as potentially avoidable. It would often be impractical to suggest a shift in environmental from either a health or cost standpoint. Nevertheless, norms can be established specific to diagnosis, type of surgery, age, and sex. A significant variance from a normal proportion of potentially avoidable days for a specific case, a physician's practice, or a hospital could be subjected to detailed review.
A significant drawback to applying the concept of potential avoidability as a control device is the multiplicity of surrogate measures on might, a priori, conceive to be necessary in a valid instrument. In this research we have proposed and utilized such an instrument. However, our primary purpose was to develop a compact instrument with a minimum number of measures which accurately produced the same assessment as the more elaborated device.

Data of The Problem

Data for this study were derived from a survey of patient services delivered at three major hospitals of similar size wise Yashoda Hospitals, Global Hospitals and Care Hospital with a combined rated capacity of over 2,000beds. A unit of observation consisted of 24 hours of stay by a single patient. A nonproportionate stratified sample of patients was selected for observation each day over a 35 consecutive day period. The resultant sample size was slightly over 4,000 patient-days of service and represented approximately seven percent of all delivered in-patient services for the period. Exclusions from the survey consisted only of psychiatric patients and long-term care patients in one hospital where a separate facility existed.

The survey instrument consisted of a composite of several documents designed for level-of-care assessment and supplemented by suggestions from nursing direction and staff at the participating hospitals. There were 167 items on the instrument. Approximately 45 items identified the patient-day of service by hospital ward, patient demography, dragnosis, surgery and various important times, days, and dates. The remaining 122 items characterized and the service received and the patient's condition. Most of these service-condition items were then grouped into ten related categories.

A "true" acuity algorithm was specified, a prior, utilizing the service and condition item measurements to classify patients with respect to the potential for serving the patient in a nonacute environment. Details of this "true" algorithm are too lengthly to present here, but it's essential content can be summarized briefly. Each patient-day was scored unity or zero in each of the ten categories of service or condition, a unity score indicating the necessity of an acute care environment with respect to that service or condition. A count of the total number of unity-scored categories constituted an overall "true" measure of acuity. A patient-day scored as zero on this integer scale was considered to be potentially avoidable. The ten services / condition categories of concern and a crude description of their respective criteria are given below:

1. ***Self-Care Capability***. Scored zero if patient was able to move about, dress, bathe, feed himself and take medication with at most a moderate amount of assistance
2. ***Routine Recording***. Measurements of temperature, pulse, respiration, and blood pressure taken less than 12 times per day resulted in zero score.
3. ***Nonroutine Recording***. One of a variety of observations such as intake/output, level of consciousness, electro-cardiac monitoring etc. would result in a unity score.
4. ***Critical Patient Conditions***. One of a variety of severe conditions including an "other" category would yield a unity score.
5. ***Medications***. More than one injected medication would yield a unity score.
6. ***Drip Solutions***. Any form of drip solution would yield a unity score.
7. ***Patient Conditions Affecting Care Level***. Any of a variety of conditions such as isolation, tracheostomy, unconscious, vital signs instability, etc., would yield a unity score.
8. ***Nursing Procedures***. Any of a variety of nursing procedures such as drainage dialysis, irrigations, suction, oxygen, etc. would yield unity score.
9. ***Facilities***. Use of operating or recovery room labor and delivery, ECG, EEG, etc. would yield a unity score.
10. ***Diet***. Scored unity only if no oral feeding was permitted.

Many items, not included in the above categories were recorded but were not considered as being, by themselves, determinates of acuity. These were social and educational needs, radiology, laboratory, respiratory therapy, physical medicine and rehabilitation.
To establish the validity of our "true" algorithm we must first rely heavily on the comprehensiveness of the instruments which contributed to our hybrid collection of items. Theses instruments have been used in various level-of-care studies. Secondly, we have examined the detailed item measurements on all 610 cases in one hospital rated as potentially avoidable by the "true" algorithm to assure ourselves that such a conclusion is not erroneous in the light of the objective evidence we have available.

The "true" acuity algorithm described above is much too costly and cumbersome to implement for control purpose. A simple model using a few item measurements as possible was desired, and our success in finding such a model hinged on the kind of interdependencies which existed between the items recorded in

the survey. Both linear discriminant analysis and liner regression analysis were employed to find a small subset of measurements which, when introduced into a linear model, would accurately and precisely estimate the acuity measure given by the more complex, "true" algorithm. Discriminant analysis falied us dismally, but liner regression yield greater success than we could have hoped.

Only the data from Yashoda hospitals were used in the formulation. Of course, the variables measured did not satisfy the necessary assumptions required for proper interpretation of the statistics usually associated with regression analysis. The resultant "best fit" utilizing a limited number of independent variables were accepted hypothetically and tested against data from Global hospitals. patient-days were assessed by both the "true" algorithm and the approximating linear model. Errors of misclassification were examined in detail, and some modifications in the model were required to correct systematic errors. Finally we were prepared to state, a compact linear approximation to the "true" acuity algorithm.

RESULT AND ANALYSIS

The regression study shows that twelve binomial measurements or variables is the maximum number necessary in a liner model to produce an excellent approximation to the "true" acuity algorithm. As few as seven variables give satisfactory results. Three alternative linear models **[Table 1]** were tested against the "true" acuity algorithm in Care hospital using from seven to twelve variables.

Table 1 Linear Models To Approximate Acuity, Derived From Yashoda And Global Hospitals

Variables (Yes =1, No = 0)	Parameter Values		
	Model 1	Model 2	Model 3
Intake / Output recording	1.21	1.22	1.27
Drip solutions	1.36	1.40	1.62
Ambulation assistance required	0.91	0.90	1.04
Injected medications-more than 1	1.06	1.06	1.16
Cannot administer own medications	0.93	0.92	0.96
Vital signs instability or elevation	1.06	1.08	1.35
Drainage	1.14	1.18	1.17
Oxygen therapy	1.10	1.09	-
Use of operating room / recovery room	0.83	0.95	-
ECG	0.88	0.85	-
Wound (sterile) technique	0.83	-	-
Surgical preparation	0.88	-	-
Constant term	0.17	0.22	0.26

Table 2 Goodness-Of-Fit Tests For Approximate Models, Independent Variable = True Measure Of Acuity Of Care Hospital

	Model 1	Model 2	Model 3
Sample size	1,515	1.515	1,515
Slope	1.026	1044	1.031
Intercept	-0.019	-0.045	-0.032
Coefficient of correlation	0.948	0.939	0.922
Coefficient of determination	0.899	0.881	0.850
Standard of error estimate	0.610	0.656	0.742

Two separate performance tests were applied. First, minimum squared error goodness-of-fit tests were applied with the "true" score given by the acuity algorithm as the independent variable and the score given by the linear model as the dependent variable. **Table 2** shows the result of these tests.

Table 3 Potential Availability Classification Tests For Approximate Acuity Models Of Care Hospital

Approximate Models	True Model	
Model 1(12 vars) Mode 2 (10 vars) Model 3 (7 vars)	P.A (=0)	Not P.A (1, 2, 3…)
P.A. (<0.5)	610	56 (3.7%)
	610	54 (5.5%)
	610	143 (9.4%)
Not P.A (>0.5)	0	849
	0	821
	0	762

A second and more important test of the linear models is their capacity to classify cases as potentially avoidable. Using the integer-valued "true" algorithm, a score of zero was considered to be potentially avoidable. With the continuous-valued linear models, a score of less than 0.5 was taken to be potentially avoidable. Comparative classifications are shown in **Table 3.**

It is incidental, though not altogether surprising, that all of the variables in the approximating models are also key variables in the "true" acuity algorithm. As a result, all cases classified as potentially avoidable with the "true" algorithm are also classified as such by the approximating models. Conversely, a number of cases classified as potentially avoidable by the approximating models are not classified so by the "true" algorithm. As the number of variables included in the approximating showing improvement by small increments as each variable is added to the model, it appears that, at most, ten or twelve variables are needed to produce 95 percent accuracy. Beyond twelve variables, successive additions of variable is added to the model, it appears that, at most, ten or twelve variable are needed to produce little improvement in classification. Detailed examination of misclassified cases does not show any systematic pattern which might suggest added terms of qualifications in the approximating model.

As a demonstration of one mode in which norms might be established for control of utilization, **Table 4** shows a number of surgery categories performed in each of the three hospitals with comparative percentages of potentially avoidable patient-days. Systematic differences can be seen between the types of surgery as well as between hospitals within surgery types. Similar profiles could be established for physicians, adjusted for case mix, thought individual physicians were not identified in this study.

In addition to their use in control, data on potential avoidability can be applied to identification of hospital management problems. Using acuity profiles by day-since-admission, substandard performance of a hospital in treating a specific class of cases can be traced to the originating problem, e.g facility or manpower shortages, turnaround of laboratory tests, or inefficient facility scheduling.

As we have demonstrated, a maximum of twelve variables need be reported on a daily basis for every in-patient. Examination of the variable list **[Table 1]** should convince the reader that all of the measurements can be conducted quickly from an attending nurse's knowledge of the patient and with only the most cursory reference to the patient's file. The measurement process can easily be incorporated into the routine midnight census. Note that all variables are binomial to facilitate ease in assessment and recording.

Table 4 Potential Avoidability Norms for Hospitals Specific to Certain Broad Surgical Categories

Surgery Category Percent P.A Sample Size	Hospitals			Total
Neurosurgery	25.0%	47.5%	28.5%	35.1%
	40	40	14	94
Ophthalmology	34.9	48.4	70.58	45.1
	63	64	17	144
Thoracic	41.0	26.4	56.2	38.2
	39	34	16	89
Abdominal	28.7	43.2	29.4	34.4
	73	67	34	174
Urological	30.2	31.8	38.3	33.4
	86	91	86	263
Breast	69.5	17.3	6.6	37.5
	42	23	15	80
Gynecological	44.6	34.4	55.5	44.4
	56	90	81	227
Obstetrical Procedures	49.3	32.8	68.5	52.3
	79	76	105	260
Orthopedic	50.0	54.6	41.9	50.1
	186	260	136	582
All Categories	42.2%	42.4%	47.0%	43.4%
	915	1,007	615	2,537

Computation of the acuity score can be accomplished at the same time as measurements are recorded using a programmed pocket calculator. Alternatively, measurements can be recorded on custom mark-sensed coding sheets and batch-processed after discharge. Periodic processing of the resultant data base can be done commercially at reasonable cost to the hospital, or in areas where hospitals are centrally administered, the raw data can be processed the responsible institution.

In short, potential avoidability is a concept which can be reliably measured in an inexpensive fashion with considerable payoff to management as an indicator of problem areas and especially as a utilization control device.

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How to cite this article:

Jayashree D N and Harish Babu G A.2016, Optimal Allocation of In-Patent in Acute Care Hospitals. *Int J Recent Sci Res.* 7(4), pp. 10272-10275.

TSSN 0976-3031