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AN APPLICATION OF LIFE TABLE METHOD IN THE STUDY OF LENGTH OF STAY

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SUMMARY

Life table method was presented as a method of choice to analyse data arising out of longitudinal studies. The method was employed to study length of stay (LOS) of psychiatric in-patients. The result obtained was compared with LOS calculated by traditional methods. The LOS was 58-60 days computed by traditional methods for the year 1985 for our centre. This was shown by the life table method as the expected LOS at the time of admission. The life table method demonstrated that the rate of discharge increased as the length of stay increased upto 30 days and decreased afterwards. On the other hand, the expected further LOS increased as the length of stay increased upto 3 years. The implications of the findings were discussed.

The present communication was written with two major aims in mind. Firstly, life table method (LTM) was illustrated as a biometric method of choice to analyse longitudinal data. Secondly, LTM was employed to analyse hospital data to study the pattern of length of stay (LOS) of psychiatric patients.

Material and Methods

Length of Stay

The term "length of stay" (LOS) is conventionally used to mean the average number of days spent in hospital by a group of discharged (including those who died) patients. The primary function of the hospital is to restore the patients back to the community as rapidly as possible, and it is reflected by the duration for which the patients stay in the hospital (Sharma et al. 1977). Hence, the study of length of stay has a bearing on the policy of the hospital administration. The uniformity and difference in LOS within a given hospital reveal the distribution of other related factors, viz: type of illness, chronicity, family involvement, etc. The pattern of illness is a valuable indicator of both the effect of treatment programme of the hospital and the level of health in the community. Estimation of LOS is an useful factor to predict future census of the hospital.

Traditionally, length of stay is computed for the psychiatric patients by two methods. In method 1, the number of patients staying in the hospital (census) on each day in a given year is summed over and the resultant sum is divided by the number of patients discharged in that year. In method 2, the lengths of stay of each of the discharged patients are summed and the sum is divided by the number of discharges.

The first method is considered to be

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more simple to compute since hospital census have to be summed for 365 (or 366) days and the census is generally maintained in hospitals. However, if more number of long stay patients remain in the hospital, they tend to boost LOS. On the other hand, method 2 tends to boost LOS if more number of long stay patients are discharged during the current year. For a given bed strength, there may be a tendency for clinicians to keep more or less a fixed number of patients under their custody. In such a situation, if admissions are restricted, LOS increases and decreases if admissions are restricted. LOS may also be affected by the number and distribution of patients who were admitted during the previous years but remain in hospital during the current year and who were admitted during current year, but carried over to the next year.

Life Table Method

Life table method has been widely employed in the study of mortality since it has distinct advantages over other measurements of mortality. Its conventional terms are generally recognized and are an efficient medium of communication. The measurements are also clear and unambiguous and do not have conflicting meanings (Barclay 1958).

Since life table method is a standard means of measuring short-term and long-term risks associated with chronic illness, Berkson and Gage (1950) employed it in cancer research. While Lew and Seltzer (1970) used it in public health, Richard (1969) employed it in family planning. Kramer (1969), Klerman et al. (1974), Balakrishnan and Wolf (1976) and Fleiss, et al. (1976) used life table method in psychiatry.

A life table is the life history of a hypothetical cohort of people, born in the same period and subject to gradual losses by mortality at each age (Barclay 1958). In the study of length of stay, birth is replaced by admission in life table and mortality by discharge (including death in hospital).

Life table enables to estimate the rate of discharge or further stay for different hospital age. In other words, it is possible by life table method, to estimate the probability that a patient would be discharged within a specified period of time after having stayed in the hospital for a given number of days. Similarly, the further stay in the hospital after staying for a specified period may be predicted. These estimates are not possible by the traditional methods of computing length of stay.

Life table method is a method of choice to compare the pattern of LOS in two different hospitals. The chance of discharge is closely associated with the distribution of hospital age of patients in a hospital. Further, hospital age structure is changeable even within a hospital. Therefore, length of stay in different hospital is not comparable without taking hospital age into account. Life table method is well suited under such conditions.

In "generation method" of life table, a cohort of psychiatric patients admitted during a given period are followed untill the last one is discharged. Some members of the group may remain in the hospital even for forty years, which is too long a period to wait for the information. The use of life table is more immediate and it demands a summary of the discharge pattern of a short period. Hence, an hospital stay history is synthesized from dishcarge rates by hospital age during some year or short based period, and thus represents short segments of the experience of many cohorts. Hospital age specific discharge rates are first prepared by a method known as "census method" and employed in the

usual life table method, known as "cohort method". Robins and Sachs (1953) have introduced a method to obtain stay (hospital age) specific discharge rate, following the traditional procedure used in the study of mortality trends.

Census Method: Stay Specific Discharge Rate

The data required for the census method to compute stay specific discharge rate are (1) the number of patients admitted during the year under study, (2) the distribution of hospital stay of patients discharged during the year, (3) the patients census at the beginning of the year and (4) the patient census at the end of the year. With these data, the hospital age specific discharge rate could be estimated by the life table method (Robins and Sachs 1953).

Fig. 1 shows schematically the manner in which stay specific discharge rates are computed. Each entry in the life table refers to some particular hospital age in days. For each patient, hospital age is the number of completed days in the hospital after admission. Different intervals (x to x+n) of hospital stay are represented by col. 1 (Fig. 1). Col. 3 represents the patient census (C_x)at the beginning of the year and col. 5 shows the patient census at the end of the year (W_x) for each hospital age interval (x to x+n). The number of patients discharged ($_nD_x$) during the year is shown in col. 7 for each interval. W_x is the number of patients withdrawn from the current year either by discharge ($_nD_x$) or by carrying over to the next year ($W_x = W_x + {}_nD_x$). Col. 2 represents the number of patients (l_x) observed at the beginning of the each interval (patients observed in the previous interval plus the patients stay in the beginning of the year in the previous interval, minus the patients withdrawn in the previous interval). The number of patients exposed in the interval (x to x+n) is denoted by and is presented in col. 6 ($L_x = l_x + {}^1/_2 C_x - {}^1/_2 W_x$). In the last but one column, $_nq_x$, the stay specific discharge rate is given for each interval. In the last column, q_x, the chance that a patient would be discharged within the next day is given.

Cohort Method: expected further LOS.

Once the hospital stay specific rates are available by the method described above, the cohort method of life table could be computed for the hospital stay data. The steps involved in this method are shown in Fig. 2.

Similar to the census method, the first column in Fig. 2 is the hospital age interval (x to x+n) in days. The hospital age specific discharge rate, $_nq_x$ is entered in col.3 ($_nq_x$ is obtained from census method). The number of patients who stay in the hospital (l_x) at the beginning of the hospital age interval (x to x+n) is entered in col.2. The total cohort (l_o) is entered in the first line of col.2.

The number of patients who were discharged or otherwise withdrawn during successive period of observation ($_nd_x$) is entered in col.4, which is obtained by $l_x \times {}_nq_x$ (multiplying col.2 and col.3). The average number of patients hospitalized (L_x) in each interval is entered in col.5, which is obtained by $L_x = l_x - {}^1/_{2n}d_x$ (col.2 $- {}^1/_2$ col.4). Person-units of hospital stay in the interval x to x+n (t_x) is entered in col.6, which is obtained by $t_x = L_x \times n$ (number of stay units in the column multiplied by col.5). The total units of hospital stay in the interval x to x+n and succeeding intervals (T_x) is entered in col.7, which is obtained by backward cummulative sum of col.6. The hospital age specific average units of hospital stay remaining to each patient in the interval x to x+f (e_x) is given in col.8, which is obtained by $e_x = t_x/l_x$ (col. 7 divided by col.2). After entering the total

cohort on the first line of col. 2, the successive entries of l_x are made by substracting sum of discharges and withdrawals from l_x in the previous line (e.g. $l_4 = l_3 - d_3$).

Thus, e_x is the expected length of stay for those patients who have stayed in the hospital for x days. The readers could understand that e_o is the expected length of stay at admission, which equals to length of stay computed by traditional methods.

Sample Studied

The data for the period 1980-85 pertaining to inpatients in the department of psychiatry of our centre was used to compute length of stay by traditional methods and life table methods. The results obtained by these methods are compared.

Results

Length of Stay

The number of admissions and discharges during the period 1980-85 in the department of psychiatry of our centre are presented in table 1 together with the length of stay computed by the traditional methods. The average length of stay decreased during 1981, but increased from 1982 onward.

Table 1
Admissions and discharges with average length of stay for the period 1980 – 85.

Year	Admissions	Discharges	Length of stay		No. of patients Staying at the end of the year
			Method 1	Method 2	
1980	3886	3929	55	45	523
1981	3590	3694	52	37	419
1982	3522	3485	52	40	456
1983	3140	3132	57	51	464
1984	2670	2714	60	60	420
1985	2806	2782	60	58	444

For the same period (1980-85), the distribution of discharged patients by their length of stay its presented in table 2. The proportion of patients whose length of stay was less than one month increased during 1980-82, but decreased from 1983 onward. On the other hand, proportion of patients who stayed five years and more increased during the study period, 1980-85. Thus, since more of long stay patients were discharged, method 2 boosted the average length of stay. For the same reason, the strength of chronic patients has been reduced in the hospital. But, the strength of in-patients was almost same during 1981-85, and more for the year 1980. On the other hand, number of admissions decreased. Thus, during the period 1980-85, method 1 also boosted the average length of stay.

Table 2
Distribution of length of stay for the discharged patients for the period 1980-1985

Length of Stay	1980	1981	1982	1983	1984	1985
Less than a Month	56.8*	64.4	67.8	65.1	62.3	60.2
1 Month < 2 Months	28.1	24.5	21.9	22.6	24.9	27.0
2 Months < 3 Months	8.6	6.3	5.6	7.2	6.1	5.9
3 Months < 1 Year	5.5	4.5	3.9	4.0	5.0	5.1
1 Year < 5 Years	0.96	0.33	0.52	0.96	1.32	1.29
5 years & More	0.05	0.03	0.23	0.26	0.30	1.43

Hospital Stay Specific Discharge Rate

Following the life table method (census method) described by Robins and Sachs (1953), the hospital stay specific discharge rate is presented in table 3 for various hospital ages for the year 1985. The chance of a patient getting discharged was low at the time of admission and increased steadily as the hospital age increased (col. 8). After the hospital age of 31-60 days, the chance of getting discharged was decreasing and low for the hospital age of two years or more (721-1080 days). Col. 9, in table 3, gives the rate of discharge per 1000 patients per day for each hospital age interval. The pattern is illustrated in Fig. 3 The highest rate of

Table 3
Computation of stay-specific discharge rates, 1985

Stay interval (days)	Patients observed at the beginning of stay interval	census at beginning of observation period	Total with-drawals and discharges during the period	Total with-drawals during the period	Person periods of exposure in this interval	Patients discharged in this interval	Stay specific discharge rate	Rate of dis-discharge per 1000 per day
x to x+n	l_x	C_x	W_x	W_x	L_x	${}_nD_x$	${}_nq_x$	${}_{1000}q_x$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1-5	2806	31	183	33	2805.0	150	0.05347	10.694
6-10	2654	19	302	29	2649.0	273	0.10306	20.612
11-20	2371	59	789	58	2371.5	731	0.30824	30.824
21-30	1641	36	568	46	1636.0	522	0.31907	31.907
31-60	1109	47	798	46	1109.5	752	0.67778	22.593
61-90	358	22	189	24	357.0	165	0.46218	15.406
91-120	191	21	79	19	192.0	60	0.31250	10.417
121-150	133	9	36	11	132.0	25	0.18939	6.313
151-180	106	22	29	20	107.0	9	0.08411	2.804
181-270	99	24	46	19	101.5	27	0.26601	2.956
271-360	77	24	35	16	81.0	19	0.23457	2.606
361-720	66	49	68	42	69.5	26	0.37410	1.039
721-1080	47	25	24	19	50.0	5	0.10000	0.2778
1081-1440	48	11	16	11	48.0	5	0.10417	0.2894
>1440	43	55	64	51	45.0	13	0.28889	—

Table 4
Computation of expectation of further length of stay, 1985

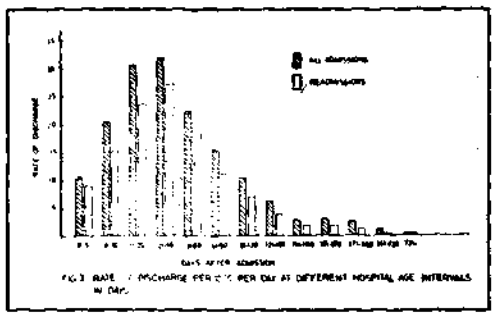
Stay interval (in days)	No. remaining at beginning of interval out of 100,000 admissions	Stay specific discharge rate per 1000	No. discharged in specified intervals	average No. of patients hospitalized in this interval	Total hospital stay in this interval (days)	Total hospital stay in this & succeeding intervals (days)	Expectation of further length of stay (days)
x to x+n	l_x	${}_nq_x$	${}_nd_x$	L_x	t_x	T_x	E_x
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1-5	100,000	53.47	5,347	97,326	486,630	5,891,380	58.9
6-10	94,653	103.06	9,755	89,775	448,875	5,404,750	57.1
11-20	84-898	308.24	29,169	71,813	718,130	4,955,875	58.4
21-30	58,729	319.07	18,739	49,359	493,590	4,237,745	72.2
31-60	39,990	677.78	27,104	26,438	793,140	3,744,155	93.6
61-90	12,886	462.18	5,956	9,908	297,240	2,951,015	229.0
91-120	6,930	312.50	2,166	5,847	175,410	2,653,775	382.9
121-150	4,764	189.39	902	4,313	129,390	2,478,365	520.2
151-180	3,862	84.11	325	3,699	110,970	2,348,975	208.2
181-270	3,537	266.01	941	3,067	276,030	2,238,005	232.7
271-360	2,596	234.57	609	2,292	206,280	1,961,975	755.8
361-720	1,987	374.10	743	1,616	581,760	1,755,695	883.6
721-1080	1,244	100.00	124	1,182	425,520	1,173,935	943.7
1081-1440	1,120	104.17	117	1,062	382,320	748,415	668.2
>1440	1,003	288.89	290	858	366,095	366,095*	365.0

* estimated

discharge was for the hospital age 21-30 days and lowest at the time of admission and after hospital age of two years or more.

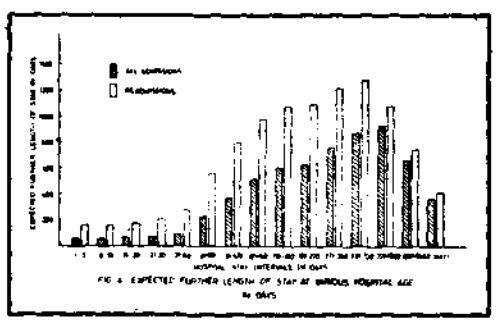
Expected Further Stay

The life table expressing the expectation of further length of stay for patients who



stayed already in the hospital for periods ranging from one to 1440 days is presented in table 4.

At admission, the expected length of stay was 60 days. This was nothing but the average length of stay computed by the traditional methods. The expected further stay increased steadily for the increase in the hospital age upto 2-3 years and decreased afterwards. Thus, the scope of continuing in the hospital has increased as the hospital age of a patient has increased in general. The pattern of hospital age specific further stay is shown in Fig. 4.



In Fig. 3 and Fig. 4, the pattern of hospital age specific discharge rate and the hospital age specific further stay are shown respectively for the readmissions also. While the rate of discharge was less, the length of further stay was more for every hospital age.

Discussion

The topic of length of stay for the psychiatric inpatients has become increasingly relevant from the cost-effective view point. As noted earlier, the primary function of a hospital is to restore the patients back to the community as rapidly as possible. Available research evidence offers little evidence for recommending long-term hospitalization for psychiatric patients (Mattes 1982). A number of studies indicated that a shorter feasible inpatient stay is the best for the patient and the most cost effective (Herz et al. 1971; Caffey et al. 1976; Glick et al. 1976; Hargreaves et al. 1977; Herz et al. 1979; Stein and Test 1980). On the other hand, the brief hospitalization was suspected to lead to frequent readmission (Caton, 1982). For readmission, the chance of discharge was less and expected further stay was more. Thus, information on length of stay of psychiatric patients is greatly useful for the hospital administration, especially since the long-stay patients occupy more than half of the beds in Indian mental hospitals (Somasundaram et al. 1982; Reddy et al. 1987).

The traditionally employed methods to obtain LOS have their limitations as they are affected by long-stay patients as well by admission policy. Specifically, they could not answer what proportion of admitted patients may stay in hospital after a specified period or how much more period a given patient may stay in the hospital having stayed already a specified period. In the present study the application of life table method demonstrated answers to such questions.

For the year 1985, the LOS was 60 days for our centre as determined by the traditional methods which are either based on census or on discharged patients. The life table method demonstrated that the expected LOS was 60 days at the time of admission and increased over a period of stay at hospital (table 4).

Life table method could be employed for each diagnosis so that the natural course of the illness could be studied for the period of hospital stay. The method can play a role in studying hospital care. Even complex problems like the relation between certain clinical and social factors with the outcome may be studied by LTM. In conclusion, it may be stated that there will undoubtedly be further applications of significance as the properties of the life table become more widely known (Spiegelman 1957).

Further multiple decrement stay tables are suggested to study the probabilities of patients dying in the hospital or leaving against medical advice. The modern computer facilities must be best used in large to obtain accurate data collection and computation in such studies.

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