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 up to 30 days and decreased afterwards. On the other hand, the expected further LOS increased as the length of stay increased up to 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
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 until 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 discharge 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. 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. The number of patients discharged (D_x) during the year is shown in col. 7. Col. 2 represents the number of patients (l_x) observed at the beginning of each interval (col. 2 - col. 1). The number of patients exposed in the interval (L_x) is obtained by L_x = l_x - \frac{1}{2} n D_x (col. 2 - col. 1). 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 cumulative sum of col. 6. The hospital age specific average units of hospital stay remaining to each patient in the interval x to x+n (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 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_0) is entered in the first line of col. 2.

The number of patients who were discharged or otherwise withdrawn during successive period of observation (d_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 - \frac{1}{2} n D_x (col. 2 - col. 4).
cohort on the first line of col. 2, the successive entries of \( l_x \) are made by subtracting sum of discharges and withdrawals from \( l_x \) in the previous line (e.g. \( l_1 = l_0 - d_1 \)).

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 \( e_0 \) 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.

| Year | Admissions | Discharges | Length of stay | No. of patients staying at the end of the year |
|------|------------|------------|----------------|-----------------------------------------------|
|      |            |            | 1             | 2                                             |
| 1980 | 3886       | 3929       | 55            | 45                                           |
| 1981 | 3590       | 3694       | 52            | 37                                           |
| 1982 | 3522       | 3485       | 52            | 40                                           |
| 1983 | 3146       | 3132       | 57            | 51                                           |
| 1984 | 2670       | 2714       | 60            | 60                                           |
| 1985 | 2806       | 2782       | 60            | 58                                           |

For the same period (1980-85), the distribution of discharged patients by their length of stay is 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.

**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
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 up to 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 viewpoint. 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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