Yonsei Medical Journal
Vol. 11, No. 1, 1970

An Analysis of Short-Stay Hospital Records and Measurement of the Prob bility Discharged as Cured from the Severance Hospital, 1967~1969

Dongwoo Lee and Seung Hyun Hahn

Dept. of Preventive Medicine & Public Health
Yonsei University, College of Medicine, Seoul, Korea

(Received for Publication: 20, Aug. 1970)

ABSTRACT

This study presents some of the first statistical findings of the Severance Hospital discharge survey.

The purpose of this study described in this report was twofold:

1) The underlying consideration was model building for the distribution of short-stay hospitalized patients; and

2) The immediate target was a better understanding of the impact of certain measurement probability discharged as cured present in the survey of medical records.

In building up the duration-of-stay model, the conditional probabilities of discharge on a particular day were computed for the January-December, 1967 in order to obtain an appropriate theoretical distribution. The rise and fall of these conditional probabilities as duration of stay increased was characteristic of the log-normal distribution. Therefore, the log-normal distribution,

$$f(t)=\frac{1}{(2\pi)^{1/2}t\sigma}e^{-(\log t-\mu)/2\sigma^2} \qquad t>0$$

was fitted to the available duratin-of-stay data. The parameters found for the distribution were estimated as $\mu=1.834$ and $\sigma=0.675$ in 1967.

As for measuring the probability of patient discharged as cured, life table model was adopted. Discharge as cured including improved patient and death including transferred to other hospital without improved are takan as the two attrition factors for decrement of a single population.

The probabilities of being discharged as cured during the first week after hospitalization were found as $P_0=0.41877$ in 1967, $P_0=0.44113$ in 1968 and $P_0=0.47387$ in 1969.

The average expectations of post discharge life were $e_0=2.048$ weeks in 1967, $e_0=2.160$ weeks in 1968 and $e_0=1.961$ weeks in 1969.

During the first fourteen days after hospitalization the probabilities as cured were ${}_2P_0=0.6814$ in 1967, ${}_2P_0=0.7056$ in 1968 and ${}_2P_0=0.7352$ in 1969, which showed the rate has been steadly increased.

INTRODUCTION

Proper analysis of the short-stay hospital records and measurment of the probability of discharged as cured provide with not only basic date for planning, management and evaluation of hospital administration but also in-

direct suggestions needed in assessing improvement of medical techniques and facilities.

One of the effective ways of analyzing medical records is to develope a statistic model for generating hospital admissions and durations of stay for a given population. This approach could lead to relatively inexpensive evaluation of the effects of alternative procedures and eventually to more efficient and accurate procedures for the continuous collection and estimation of hospital admission and discharge statistics.

Chiang initiated a probability model for hospital admission in 1965. This was primarily due to an exposure to research on a mathematical model of an index of health. Later, a simplified model was fitted as a Poission process with assuming the probability of the individual being hospitalized during a short time interval is independent of the number of previous hospital admissions for the individual.

On the other hand, in order to obtain an appropriate theoretical distribution for duration of hospital short-stay the U.S. Department of Health, Education and Welfare introduced a duration-of-stay model in 1966.

This model developed above suggested was the log-normal distribution such as

$$f(t)=\frac{1}{(2\pi)^{1/2}t\sigma}e^{-(\log t-\mu)/2\sigma^2} \qquad t>0.$$

Life table model was developed in around 1850 in terms of the death rates from all causes by age for a given population.

However, the main development of the methodology has been much more recent. This technique has been applied extensively to other situations in recent years. In general, the method is appropriate whenever an initial group of units is reduced over time by movements outwards of a particular type with no returns. Examples are mortality from specific diseases, first marriage by age, lengths of time in hospital, survival after operation, wearing out of equiment and so on.

Case(1956) used the idea in particular several studies of generation mortality from cancer. Johnson et al(1956) applied life table methodology to the study of mental hospital population. Potter et al(1967) also used the multiple decrement life table methodology in measuring adequate use-effectiveness of intrauterine contraceptive device.

MATERIAL

The principal source of information in this report is the Severance Hospital's file of existing patient medical discharge record. From this record, a survey was undertaken in order to get patient's statistical information on the characteristics and his hospitalization covering from January 1967 to December 1969.

However, the scope of the survey is limited to consider the length of short-stay and type of discharges because of unstandardized medical recording.

Since the measurements shown in this report are based on the entire existing records, they are not subject to sampling error but there are nonsampling errors and bias. These may include hospital non-response, item non-response and transcription and processing errors. The nonsampling errors of particular concern are those involved in the recording and coding of diagnosis and operations.

RESULTS

Duration-of-Stay Model

Before fitting the observed distributions of length of patients' hosbital stay to the log-normal distribution, frequencies of the observed discharges by length were plotted on the log-normal probability paper(fig. 1) to check if

The cumulative percent distribution of disch-

Table 3. Number, percent and cumulative percent distribution of discharge by length of stay and by calender year, 1967~1969

Length of stay(day)	1967			1968			1969		
	No.	%	cum.	No.	%	cum.	No.	%	cum.
1	536	5.3	5.3	607	5.6	5.6	478	4.7	4.7
2	854	8.4	13.7	934	8.5	14.1	1,185	11.6	16.3
3	1,314	12.9	26.6	1,521	13.9	28.0	1,708	16.7	22.0
4	1,024	10.1	36.7	1,104	10.1	38.1	1,103	10.8	43.8
5	754	7.4	44.1	907	8.3	46.4	772	7.5	51.3
6	598	5.9	50.0	625	5.7	52.1	575	5.6	56.9
7	672	6.6	56.6	727	6.7	88.8	667	6.5	63.4
8	494	4.9	61.5	505	4.6	63.4	503	4.9	68.3
9	415	4.1	65.6	436	4.0	67.4	380	3.7	72.0
10	346	3.4	69.0	343	3.1	70.5	291	2.8	74.8
11	278	2.7	71.7	306	2.8	73.3	239	2.3	77.1
12	287	2.8	74.5	286	2.6	75.9	234	2.3	79.4
13	177	1.7	76.2	215	2.0	77.9	172	1.7	81.1
14	238	2.3	78.5	232	2.1	80.0	229	2.2	83.3
15	178	1.8	80.3	168	1.5	81.6	158	1.5	84.8
16	153	1.5	81.8	148	1.4	83.0	138	1.3	86.1
17	145	1.4	83.2	139	1.3	84.3	128	1.3	87.4
18	142	1.4	84.6	152	1.4	85.7	98	1.0	88.4
19	133	1.3	85.9	125	1.1	86.8	93	0.9	89.3
20	94	0.9	86.8	86	0.8	87.6	80	0.8	90.1
21	132	1.3	88.1	93	0.9	88.5	75	0.7	90.8
22	91	0.9	89.0	79	0.7	89.2	69	0.7	91.5
23	85	0.8	89.8	76	0.7	89.9	70	0.7	92.2
24	78	0.8	90.6	51	0.5	60.4	34	0.3	92.5
25	58	0.6	91.2	60	0.6	91.0	68	0.7	93.2
26	62	0.6	91.8	57	0.5	91.5	51	0.5	93.7
27	37	0.4	92.2	41	0.4	91.9	24	0.2	93.9
28	55	0.5	92.7	57	0.5	92.4	40	0.4	94.3
29 & over	739	7.3	100.0	851	7.6	100.0	576	5.7	100.0
Total	10,170	100.0		10,931	100.0		10,238	100.0	

arges by duration of stay is shown in figure 2.

About 5 percent of the discharges occurred on the first day of admission and a range of 14 to 16 percent of the patients were discharged on the second day. The median length of stay by year was 6 days in 1967, 6 days in 1968 and 5 days in 1969 respectively. The modal length of stay was 3 days, and the average length of stay by year was 7.9 days in 1967, 7.2 days in 1968 and 6.8 days in 1969 respectively. About one-half of the patients were discharged in 6 days or less.

Within 24 (21 days days in 1969), around 90 percent of the discharges had occurred.

Especially, on the seventh day, fourteenth day and twenty first day there was a little higher rate of discharges than that on neighbouring days in each year.

As shown in figure 2, the cumulative percent there were any significant discrepancies between

the observed and the theoretical frequencies.

As shown fig. 1, the plotted dots of each year of 1967 and 1969 were on a fairly straight line except the extreme upper and lower tail respectively.

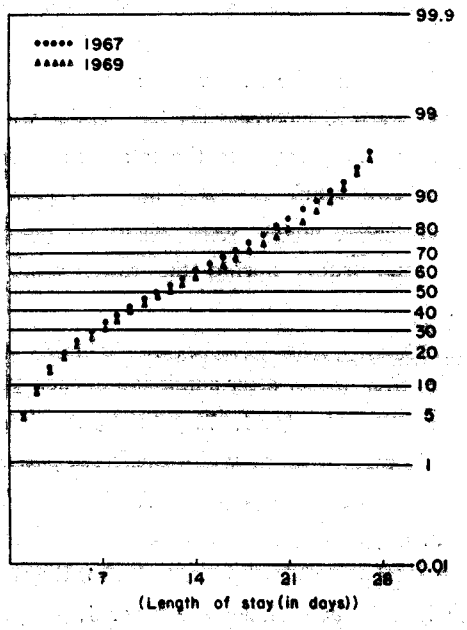

Fig. 1. Plotting the observed distribution of length of stay to the log-normal probability paper, 1967 and 1969.

Therefore, the log-normal distribution was fitted to the observed distribution of length of hospital stay for the survey data of 1967 to 1969.

The parameters, μ and σ, in f(t) were estimated from the

$$\bar{x} = e^{\mu + \sigma^2/2}$$

$$\frac{s^2}{\bar{x}} = e^{\sigma^2} - 1$$

where $\bar{x}$ and s^2 are the mean and variance of the observed duration-of-stay distribution.

The estimated parameters μ and σ for the log-normal fit the duration-of-stay distribution in each calender year are given in table 1.

Table 1. Estimates of the parameters μ and σ for log-normal distribution fitted to duration-of-stay distributions by calender year

Year	μ	σ
Jan.-Dec., 1967	1.83	0.68
Jan.-Dec., 1968	1.74	0.68
Jan.-Dec., 1969	1.67	0.48

Discharge Status

The number and percent of patients discharged alive, tranferred to other hospitals or dead within the calendar year are given in table 2. There were 4.1 deaths in 1967, 3.6 deaths in 1968 and 3.6 deaths in 1969 among each 100 discharges.

Length of stay

There were 31,339 short-stay discharges from Severance hospital during the three years from 1967 to 1969. These discharges are distributed by duration of stay and by year in Table 3.

Table 2. Number and percent distribution of patients discharged from short-stay hospital by year and by discharge status, 1967~1969

Status of Discharge	1967		1968		1969	
	No.	%	No.	%	No.	%
Alive	7,754	76.2	8,338	76.3	7,662	74.8
Alive but transferred to other hospital	1,999	19.7	2,192	20.1	2,213	21.6
Dead	417	4.1	401	3.6	363	3.6
Total	10,170	100.0	10,931	100.0	10,238[1]	100.0

1) Excluded those patients who are not discharged at the time of survey.

distribution of discharges by length of stay rose sharply until about the 10th day, then gradually leveled off until a virtual plateau was reached from 28 days on.

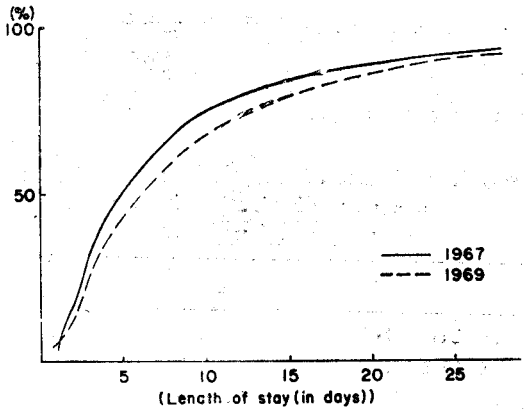

Fig. 2. Cumulative percent distribution of patients discharged after short-stay by length of stay and by year, 1967, 1969.

Length of stay by status of discharge

The total of discharged patients in each year were distributed by length of stay with controlling status of discharge in table 4.

In 1967, as shown in table 4, 38.0 percent (or 3,863 patients, which were about 50 percent of the total live discharges during the same year) of the patients were live discharges during the first week after admission. During the following week, the rate of live discharge was 43.6 percent, and from the third week and on the rate gradually decreased.

On the other hand, in 1968, 40 percent (or 4,369 patients, which were aboute 52 percent of the total live discharges during the same year) and 42.4 percent in 1969 (or 4,343 patients, which were about 57 percent to the total live discharges during the same year) were the rate of live discharges during the first week after admission respectively.

The percent of patients remaining in the hospital after specified numbers of weeks differed slightly between calendar years. For example, the distribution of percent remaining by length of week in 1967 were 43 percent after the first week, 21 percent after the second week, 11 percent after the third week and 7 percent after the fourth week.

Deaths during the first week after admission by year were 3.2 percent (or 320 deaths, which were about 77 percent to the total deaths during the same year) in 1968 and 2.7 percent (or 280 deaths, which were about 77 percent to the total deaths during the same year) in 1969.

The patients transferred to other hospitals during the first weeks after admission in each year were 15.5 percent (or 1,571 patients, which was about 79 percent to the total transferred patients during the same year) in 1967, 16.1 percent (or 1,757 patients, which was about 80 percent to the total transferred patients during the same year) in 1968 and 18.2 percent (or 1,865 patients, which was about 84 percent of the total transferred patients during the same year) in 1969.

Probability of "discharged as cured"

In order to measure the probability of the patients discharged as cured from the short-stay, a generation life table methodology was applied to the data of patients discharged in 1967, 1968 and 1969 respectively. The probability obtained by the method and other life table items such as number of patients remaining at a specified moment after entry, number of patients discharged as cured during the specified period and the average expectation of length of stay was shown in table 5.

In 1967 the probability of individual being discharged as cured during the first week after the individual's admission was about 0.42 and

Table 4. Number and percent distribution of discharge from hospital short-stay by length of stay, by status of discharge and by year

Week & Year	Patients under treatment at weekly intervals after entry	Patients discharged as cured during week following	Died during week following	Transferred to other hospital during week following
1967				
0	10, 170(100. 0)	3, 863(38. 0)	320(3. 2)	1, 571(15. 5)
1	4, 416(100. 0)	1, 925(43. 6)	40(0. 9)	270 (6. 1)
2	2, 181(100. 0)	892(40. 9)	17(0. 8)	67 (3. 1)
3	1, 205(100. 0)	414(34. 4)	13(1. 1)	39 (3. 2)
4	739(100. 0)	207(28. 0)	4(0. 5)	13 (1. 8)
5	515(100. 0)	114(22. 1)	6(1. 2)	15 (2. 9)
6	380(100. 0)	67(17. 6)	6(1. 6)	8 (2. 1)
7	299(100. 0)	52(17. 4)	4(1. 3)	5 (1. 7)
8	238(100. 0)	34(14. 3)	1(0. 4)	— (—)
9	203(100. 0)	28(13. 8)	2(1. 0)	4 (2. 0)
1968				
0	10, 931(100. 0)	4, 369(40. 0)	299(2. 7)	1, 757(16. 1)
1	4, 507(100. 0)	2, 012(44. 6)	48(1. 1)	263 (5. 8)
2	2, 184(100. 0)	811(37. 1)	19(0. 9)	81 (3. 7)
3	1, 273(100. 0)	377(29. 6)	12(0. 9)	32 (2. 5)
4	852(100. 0)	216(25. 3)	3(0. 4)	21 (2. 5)
5	612(100. 0)	119(19. 4)	5(0. 8)	16 (2. 6)
6	472(100. 0)	67(14. 2)	1(0. 2)	5 (1. 1)
7	399(100. 0)	71(17. 8)	3(0. 8)	5 (1. 3)
8	320(100. 0)	61(19. 1)	3(0. 9)	— (—)
9	256(100. 0)	20 (7. 8)	1(0. 4)	2 (0. 8)
1969				
0	10, 238(100. 0)	4, 343(42. 4)	280(2. 7)	1, 865(18. 2)
1	3, 750(100. 0)	1, 789(29. 8)	38(0. 6)	221 (3. 7)
2	1, 702(100. 0)	685(40. 2)	20(1. 2)	65 (3. 8)
3	932(100. 0)	323(34. 6)	9(1. 0)	24 (2. 6)
4	576(100. 0)	166(28. 8)	5(0. 9)	13 (2. 3)
5	392(100. 0)	80(20. 4)	4(1. 0)	8 (2. 0)
6	300(100. 0)	60(20. 0)	2(0. 7)	7 (2. 3)
7	231(100. 0)	41(17. 8)	2(0. 9)	— (—)
8	189(100. 0)	29(15. 3)	—(—)	3 (1. 6)
9	156(100. 0)	32(20. 5)	1(0. 6)	1 (0. 6)

his average expectation of length of stay was about 2 weeks. This probability in 1968 was 0. 44 and in 1969 it was 0. 47, which shows the rates were getting incresed. During the second week after admission, the probability was 0. 45 in 1967, 0. 47 in 1968 and 0. 50 in 1969.

DISCUSSION

Duration-of-Stay Model

Recently the U.S. Department of Health, Education and Welfare applied the theoretical duration-of-stay model to the interview survey data for the period July 1958-July 1960.

Table 5. Measurement of probability of discharged as cured by lengt of stay and by calendar year, 1967～1969

	Remaining Patients after entry	Number of patients discharged as cured during week following	Probability of discharged alive	Average expectation of length of stay
1967				
0	10,000	4,188	0.41877	2.048
1	5,812	2,626	0.45177	2.164
2	3,186	1,329	0.41707	2.534
3	1,857	652	0.35114	2.992
4	1,205	341	0.28336	3.340
5	864	257	0.22596	3.461
6	607	250	0.17962	3.706
7	357	63	0.17657	4.966
8	294	42	0.14315	4.923
9	252			
1968				
0	10,000	4,411	0.44113	2.160
1	5,589	2,645	0.47330	2.471
2	2,944	1,189	0.38004	3.242
3	1,755	529	0.30136	4.099
4	1,226	315	0.25714	4.651
5	911	180	0.19784	5.087
6	731	104	0.14286	5.162
7	627	113	0.17974	4.928
8	514	98	0.19152	4.900
9	416			
1969				
0	10,000	4,739	0.47387	1.961
1	5,261	2,613	0.49659	2.277
2	2,648	1,093	0.41277	3.031
3	1,555	549	0.35281	3.811
4	1,006	295	0.29277	4.627
5	811	165	0.20725	4.608
6	643	168	0.22599	4.681
7	498	145	0.17826	4.898
8	410	88	0.11200	4.841
9	364			

Their estimates of the parameters μ and σ for the log-normal distriubtion of the duration-of-stay by sex and age group were calculated. For male, the estimates of μ and σ for the age group of 15～24 years were 1.51 ± 1.02, for 35～44 years, they were 1.74 ± 1.00, for 45～64 years, they were 2.08 ± 0.93 and for 65 years and over, they were 2.30 ± 0.89. On the other hand, the estimates of μ and σ for female patients excluding delivery cases, 1.19 ± 1.01 for 15～24 years, 1.46 ± 0.94 for 25～34 years, 1.65 ± 0.90 for 35～44 years, 1.94 ± 0.91 for 45～64 years and 2.33 ± 0.85 for 65 and over.

Our estimates through the log-normal fit 1.83 ± 0.68 were for the data of 1967 which included all ages and both sexes. In 1968 the estimates

were 1.74±0.68 and in 1969 they were 1.67±0.48. The estimates obtained in this report are not directly comparable to the above U.S. data because of the different classification between the data. However, on the average the estimates obtained in this report are somewhere between the range of the parameters for the age group 15 to 44 years.

Discharge Status

According to the data from the nation-wide hospital sample survey of discharged records conducted in 1964 by the U.S. Department of Health, Education and Welfare, the percent of patients discharged alive was 96.5 and the percent of those who died was 3.0. The rates obtained in this report for the period of 1967~1969 were about 72~76 percent and about 4 percent respectively. This 4 percent death rate seems to be quite low.

As for the length of stay, the modal and average lengths of stay, given by the above mentioned survey, were 3 and 7.7 days respectively. The modal and average lengths of stay in this report also showed 3 and 7~8 days respectively. The cumulative percent distribution of discharge by length of stay in this report showed the same pattern to that of the above mentioned in the U.S. survey.

The probability of discharged as cured through the life table methodology showed low rates by lengths of stay. About 50 or less out of 100 admitted patients were able to be discharged as cured throughout the lengths of stay. These low probabilities are considered to be due to many reasons such as the individuals having far advanced disease when admitted to the hospital, lack of proper medical facilities, negative attitude toward medical treatment and less definitive diagonostic and treatment services. Another factor is that due to difference of socio-economic and personal characteristics of the patients.

In the future it is recommendable to design and conduct more studies on this kind of research for further analysis and explanation of the concerned interests.

REFERENCES

Case, R.A.M.: *Cohort Analysis of Mortality Rates as an Historical or Narrative Technique, British Journal of Preventive and Social Medicine, 10, pp. 159, 1956.*

Chiang, C.L.: *An Index of Health, Mathematical Models, Vital and Health Statistics, PHS Pub. No. 1000-Series 2-No. 5, May 1965.*

Chiang, C.L.: *A Stochastic Study of the Life Table and Its Applications, Biometrics, Vol. 17, No. 1, pp. 57-58, March, 1961.*

Kramer, M., Goldstein, H., Israel, R. and Johnson, N.A.: *Application of Life Table Methodology to the Study of Mental Hospital Population, Psychiatric Research Reports, No. 5, American Psychiatric Society, June, 1956.*

Potter, R.G., Chow, L.P., Jain, A.K. and Lee, C.M.: *Expanded Report on Social and Demographic Correlates of IUCD Effectiveness: the Taichung IUCD Medical Follow-up Study, (Mimeographed), University of Meichigan Population Studies Center, February, 1967.*

U.S. Department of Health, Education and Welfare: *Comparison of Two Methods of Constructing abridged Life Tables, Series 2, No. 4, February, 1964.*

U.S. Department of Health, Education and Welfare: *Variance and Covariance of Life Table Functions Estimeted from a Sample of Deaths, Series W, No. 20, March, 1967.*

U.S. Department of Health, Education and Welfare: *Patients Discharged from Short-Stay Hospitals, Series 13, No. 1, October, 1966.*

U.S. Department of Health, Education and Welfare: *Utilization of Short-Stay Hospitals, Series 13, No. 2, August, 1967.*

U.S. Department of Health, Education and Welfare: *Computer Simulation of Hospital Discharges, Series 2, No. 13, February, 1966.*

Simmons, W.R. and Bryant, E.E.: *An Evaluation of Hospitalization Data from the Health Interview Survey, American Journal of Public Health, 52(10):1638-1647, October, 1962.*

The Population Council: *Intra-Uterine Contraception: Recommended Procedures for Data Analysis, No. 18(Supplement), April, 1967, New York.*