Middle Articles

COMPUTERS IN MEDICINE

Computer Method for Deriving Hospital Inpatient Morbidity Statistics Based on the Person as the Unit

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In a previous paper (Acheson and Barr, 1965) an account was published of the patterns of readmission from home and of transfer between hospitals for patients in the Oxford area. It was shown that within the calendar year 1962 9.5% of the patients discharged from hospital were readmitted and discharged again once or more, 4.9% were transferred once or more between hospitals, and 1.9% were readmitted and transferred.

It was also shown that for certain conditions morbidity rates calculated from discharges rather than from persons discharged were inflated to a considerable degree. The material for 1962 was based on a manual system of record linkage, and the analysis was by business machines. This paper describes a method of calculating inpatient morbidity and fatality rates by means of a computer. Each patient is counted once in any one year regardless of the number of admissions to the same or different hospitals with the same complaint.

Material and Method

The Oxford Record Linkage Study has recorded details of every birth, admission to hospital, and death occurring in the Oxford area since the beginning of 1962. Information about these events is brought together into a series of personal cumulative files. From 1963 onwards a computer system of record linkage has been employed. The basis of the system is a master file written on magnetic tape which contains the cumulative records of the persons.

Each personal file consists of identifying data, together with a record containing statistical information for each of the defined events which the person has experienced. For each new event two cards are punched; the first contains the name, date of birth, N.H.S. number (when available), and other identifying information, and the second contains statistical data. These cards are read into the computer, where they are edited and then written on magnetic tape. The data on this magnetic tape are sorted into a sequence based on soundex code of surname, sex, and initial of first forename. The identifying information on each new record is compared with the corresponding information on all records on the master file, which fall into the same soundex-sex-initial pocket. If a linkage is obtained the new statistical record is added to the person's file; if no linkage is obtained a new personal file is created. The computer used for this operation was an IBM 1401 with 16,000 characters of core store and six magnetic tape-decks.

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The linked file for 1963–4 was scanned for all persons who had been discharged from hospital once or more. A new item was formed from the existing record for each episode of inpatient treatment and written on another magnetic tape. The following information was contained in the new item:

- Personal identifying number, sex, age, and place of residence.
- Diagnosis on discharge (four-digit code from *International Classification of Diseases*).
- Month and year of discharge.
- Source of admission.
- Disposal, including whether living or dead on discharge from hospital.
- Hospital.
- Duration of stay in hospital.
- Markers to denote the birth of a baby (in the case of women) or death in that year anywhere within the area, together with the month of the event.

Information concerning the delivery of a baby and death was abstracted from the relevant records in the cumulative personal file. A distinction between deaths in hospital and elsewhere was maintained.

The data on the magnetic tape were sorted into diagnostic order and by personal number within each diagnosis. From

ISC DIAGNOSIS (PRINCIPAL)		COMPUTER NUMBER	AGE	DEATH IN YEAR	BIRTH IN YEAR
325	Female	001106	96		
		005663	04		
		007842	39	*	
		009520	30		
		010748	67	*	
		010999	62	*	
		013377	11		
		013751	19		
		013778	31		
		014738	18		1
		014914	05		
		015048	28		
		015346	63		
		017459	58		
		017623	15		
		021503	03		
		022208	05		
		023683	31	*	
		023689	27	*	
		024365	61	*	
		024372	36	*	
		024846	25		1
		024847	22		
		024849	43		
		024853	10		
		024857	63		
		024858	18		
		024859	23		1
326	Male	003408	25		
		013692	17		
		020624	57		
	Female	011104	15		
		011881	25		
		014771	51		
		022208	05		

FIG. 1.—Morbidity analysis listing for 1963 in Oxford Record Linkage Study area (excluding Oxford C.B.C.).

this sorted tape two forms of output information were produced: (1) a list, in diagnostic order, giving certain data about each person discharged from hospital with that diagnosis (see Fig.); and (2) a table, in the same sequence, giving numbers of hospital discharges, of persons discharged, and of deaths in hospital from which hospital morbidity and fatality rates were calculated (see Table).

Results

The section of the list dealing with diagnostic rubrics 325 and 326 (mental deficiency and other disorders of character) is shown in the Fig. Separate lists were produced for 1963 and 1964 and for the Oxford county borough and Oxfordshire. In addition to denoting the personal number, diagnosis, age, and sex of each patient, the list indicates the fact of death if this occurred anywhere in the area in that year, whether at home or in hospital, by means of an asterisk. Delivery of a baby to females within the year is indicated by the numeral "1." Confidentiality is maintained, since no names appear on the list and the personal number which is listed has no meaning outside the computer system.

Table of Discharge and Fatality Rates

Principal I.S.C. Code	Diagnosis	No. of Discharges 1963–4	No. of Persons Discharged 1963–4	No. of Deaths in Hospital 1963–4	Uncorrected Discharge Rate per 10^5 per Annum	Corrected Discharge Rate per 10^5 per Annum	Uncorrected Fatality Rate per 10^2 per Annum	Corrected Fatality Rate per 10^2 per Annum	Reduction Factor (%)
001–008	Tuberculosis of respiratory system	371	320	19	53·3	46·0	2·6	3·0	13·8
140–148	Cancer of mouth and pharynx	98	75	6	14·1	10·8	3·1	4·0	23·5
150	Cancer of oesophagus	52	37	15	7·5	5·3	14·4	20·3	28·9
151	Cancer of stomach	156	132	57	22·4	19·0	18·3	21·6	15·4
152, 153	Cancer of intestine, except rectum	210	167	41	30·2	24·0	9·8	12·3	20·5
154	Cancer of rectum	187	141	45	26·9	20·3	12·0	16·0	24·6
161	Cancer of larynx	57	30	5	8·2	4·3	4·4	8·3	47·4
162, 163	Cancer of bronchus	496	349	132	71·3	50·2	13·3	18·9	29·6
170	Cancer of breast	357	286	34	102·9	82·4	4·8	5·9	19·9
171	Cancer of cervix uteri	208	102	14	59·9	29·4	3·4	6·9	51·0
172–174	Cancer of other parts of uterus	67	52	7	19·3	15·0	5·2	6·7	22·4
177	Cancer of prostate	116	97	30	33·2	27·8	12·9	15·5	16·4
190, 191	Cancer of skin	106	78	5	15·2	11·2	2·4	3·2	26·4
196, 197	Cancer of bone and connective tissue	42	28	5	6·0	4·0	6·0	8·9	33·3
300–309	Psychoses	1,080	944	120	155·2	135·6	5·6	6·4	12·6
310–324 326	Psychoneuroses and disorders of personality	1,151	1,050	7	165·4	150·9	0·3	0·3	8·8
325	Mental deficiency	138	126	19	19·8	18·1	6·9	7·5	8·7
608	Stricture of urethra	126	76	0	18·1	10·9	0	0	39·7
722	Rheumatoid arthritis	181	156	5	26·0	22·4	13·8	16·0	13·8

The Table shows part of the systematic tabulation which was produced. The columns from left to right give the number of discharges, the number of persons discharged once or more, and the number of deaths in hospital, together with the uncorrected and corrected discharge and fatality rates. The column on the extreme right is the factor (expressed as percentage) by which each uncorrected morbidity rate is inflated and each uncorrected fatality rate reduced on account of readmissions of the same patient for the same condition. The figures for carcinoma of the cervix illustrate an extreme instance of the inaccuracy which may occur when the number of discharges is used as the basis for calculation of morbidity and fatality rates.

Discussion

In spite of their incompleteness, statistics derived from records of spells of inpatient treatment in hospital are likely to continue for many years to be the principal source of morbidity data available on a national scale. The problems of adding data from outpatients and from episodes of domiciliary care to the material are formidable, and routine analysis of these categories of sickness are unlikely to be seen on a national scale in the near future.

It is therefore important to make the best use of the material which is likely to be available in the short term. The Hospital In-Patient Enquiry which was set up after the war (Ministry of Health and General Register Office, 1959 *et seq.*), and which required the collection and analysis of data about every tenth spell of inpatient treatment throughout England and Wales, will shortly give place to the Hospital Activity Analysis, which entails the collection of abstracts for all spells of treatment (Benjamin, 1965). A conservative estimate of the cost of processing data on the recommended scale for the 4,900,000 episodes of inpatient treatment carried out in England and Wales in 1966 would be £1m.

This paper describes a computer system which eliminates two of the errors inherent in morbidity statistics published by the Hospital In-patient Enquiry—namely, the inflation of morbidity rates and the underestimation of hospital fatality rates. Both these errors stem from a single cause—namely that, as the abstracts are not identifiable, patients admitted more than once for the same condition are counted more than once in the tables. The Hospital Activity Analysis, in the form in which it is at present being implemented, will also be liable to these errors because the only identification data which is scheduled for processing is the filing number of the hospital or department concerned.

A further penalty of failure to include adequate identification data in the part of the abstract which is processed is that it is impossible to collate data of the subsequent fate of patients in other hospitals or elsewhere to the abstract in hand, or to relate the abstract to the previous history. At present, information about the fate of patients after discharge from hospital is defective (Hubbard and Acheson, 1967). In terms of the flow of medical information each hospital or hospital group is thus isolated in the Hospital Activity Analysis from all others and from the other branches of the Health Service (Acheson, 1967).

Summary

A computer method is described whereby hospital inpatient statistics may be derived in which the person rather than the discharge is the unit. The key to such a system is the provision of adequate data about the identity of the person treated. Results are presented which measure for selected conditions the magnitude of the errors introduced by counting, as is the practice in conventional statistics, the same person who is readmitted for the same condition more than once.

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