JOURNAL OF INSURANCE MEDICINE

J Insur Med 2001;33:298–309

ORIGINAL ARTICLE

The First Mortality Follow-up Study: The 1841 Report of William Farr (Physician) on the Mortality of Lunatics

Richard B. Singer, MD

Mortality Article 250L1

Background.—In the 1830s in England, there was a great cultural interest in the collection and publishing of all kinds of statistics. The Council of the Statistical Society of London (founded in 1834) commissioned one of its Fellows, Dr William Farr, to investigate and prepare a report on the mortality of patients in the county asylums, with the mortality in a large number of proprietary houses that were licensed to care for patients with mental illness (then called lunatics) ordered for confinement because of their mental condition. Committees of Parliament had investigated the condition of the mentally ill confined to the asylums and taken measures in an attempt to improve their treatment and to correct abuses.

Results.—Farr collected data from Hanwell, the Middlesex County asylum opened in 1831, and other asylums on annual admissions, resident patients, deaths, discharges, derived years of residence (exposure to risk), and annual mortality rates by duration and as an aggregate. He used similar data from a recent report on a large number of licensed houses. For the best estimate of comparative mortality, an assumed age distribution by sex and rates from the English Life Table No. 1 (constructed by Farr for 1841).

Conclusion.—Farr demonstrated that annual mortality rates were higher at durations 0–1.5 years than at durations 1.5–7.5 years, higher in men than in women, higher in paupers than in other patients, higher in licensed houses than in the Hanwell Asylum, and higher in the 4 large licensed houses than in a collection of smaller ones.

Comment.—A brief sketch of Farr's life is given as a memorial tribute to his pioneer work in vital statistics, life table methodology, public health, and life insurance medicine.

Address: 8 Bluberry Lane, C11, Falmouth, ME 04105.

Correspondent: Richard B. Singer, MD, Consultant to AAIM.

Key words: Comparative mortality, psychotic patients, vital statistics, 1841 mortality study, William Farr.

On March 15, 1841, Dr William Farr read his Report on the Mortality of Lunatics[1] at a meeting of the Statistical Society of London, and the report was published in Volume 4 of the journal of that society in the next quarterly issue of the same year. As far as I have been able to ascertain, this is the very first mortality study in modern format ever prepared and published.[2] It is the only study I have found made in the 19th century. The earliest I

located before finding Farr's study is the *Specialized Mortality Investigation*,[3] published by the Actuarial Society of America in 1903.

William Farr (1807–1883) was a young physician who had abandoned a brief period of medical practice in London to embark on a career in the practical application of vital statistics. His medical training was a preceptorship with a physician in Shrewsbury, followed by 2 years of attending lectures in the hospitals of Paris. His proficiency in mathematics and statistics was self-taught, fostered by his great intellectual curiosity and omnivorous reading. Because of the knowledge he had demonstrated in many articles on vital statistics, he was appointed in 1839 to the newly created Office of the Registrar General to superintend the work on vital statistics, which he continued for 40 years.[4] Thus, at the time of writing his mortality study of lunatics, Farr was also working on English Life Table 1, the first national life table ever constructed and a model for future national life tables around the world.

Through a number of committee investigations and reports from 1807 to 1827, the British Parliament had manifested a keen interest in the condition of mental patients confined under the supervision of London's Metropolitan Commission. As a result of this concern, the Hanwell Asylum in Middlesex County had been built and opened to receive patients in 1831 to supplement the facilities of other hospitals (see below). Parliament's interest continued, and possibly as a result of this, the Council of the London Statistical Society decided to investigate the mortality of all mental patients under the jurisdiction of the Metropolitan Commission. A recent report had been made by a Colonel Sykes on statistics of patients in proprietary houses of various sizes licensed to care for mental patients during the period 1832–1839. Farr, appointed as a Fellow of the London Statistical Society in 1837, was requested to investigate the mortality of mental patients in Hanwell, the three hospitals, and the licensed houses. This is the reason for Farr's report,[1] the results of which are given in this article.

Table 1. Distribution in 1839 of ''Lunatics and Dangerous Idiots'' in Institutions Under the Jurisdiction of the London Metropolitan Commission*

Institution	No. of Males	No. of Females	Total Number
Hanwell Asylum	346	488	834
Bethlem Hospital	148	151	249†
St. Luke's Hospital	104	136	204
Guy's Hospital	—	24	24
34 Licensed Houses	787	926	1713
Total	1385	1725	3110

* From table on page 18 of report.[1]
† Excluding 16 patients out on leave.

SUBJECTS STUDIED AND FOLLOW-UP

Table 1 shows the distribution of mental patients by sex and facility of care for all 3110 patients confined in the jurisdiction of the Metropolitan Commission. Female patients outnumbered male, and the facility with the largest number of patients was Hanwell. This relatively new asylum provided most of the hospital patient data. A summary of the Hanwell experience from March 16, 1831, to September 30, 1840 is shown in Table 2. This is a statistical patient balance sheet. Totals are given for all male and female patients admitted during this period, those discharged alive as cured and ''relieved,'' those ''discharged'' because of in-hospital death, and those remaining in Hanwell at the end of the period. All deaths and mortality rates reported subsequently are those for patients while hospitalized; no data are given for long-term follow-up of patients after discharge alive. At the bottom of Table 2, Farr's data are given for years of residence. The text and tables provide abundant proof that Farr was very clear in his concept of exposure, in person-years at risk, as a quantity necessary for the calculation of mean annual mortality rates when survivors and deaths are counted for an interval other than 1 year. Table 2 shows that there was no sex difference in patients admitted and discharged alive in this period. However, there were more male than female deaths, so the Hanwell census in 1840 had

Table 2. Patient Statistics at Hanwell Asylum, March 16, 1831, to September 30, 1840

Activity	Men	Women	Total Number
Admitted March 16, 1831, to September 30, 1840	1013	1016	2029
Discharged March 16, 1831, to September 30, 1840			
Cured*	223	226	449
Relieved*	42	24	66
Died*	374	282	656
Total*	639	532	1171
No. remaining September 30, 1840	374	484	858
Years of residence, March 16, 1831, to September 30, 1840†	2334	3164	5498

* From table on page 18 of report.[1]
† From table on page 20 of report.[1]

shifted to 56% female and 44% male. The sex disparity was even greater for the exposure (bottom line). Mean age of patients admitted at Bethlem Hospital, 1830–1834, was 36.2 years; mean age of 213 patients admitted at Hanwell was 36.5 years, with only 16 patients (7.5%) age 60 years or older. No other data are given for age distribution. Farr devotes the third paragraph of his report to a graphic description of the universality of mental illness in all walks of life and its devastating impact on the patient, the family, and society (''6402 idiots and 7205 lunatics have been returned [reported] to Parliament as paupers''). The population of hospital-confined patients consisted of those with probably severe psychosis and severe mental retardation. All follow-up data were obtained from a study of the records of the hospitals and licensed houses.

EXPECTED MORTALITY

At the time of publication of this report, Farr was working on the construction of English Life Table No. 1 for 1841, published in the Fifth Annual Report of the Registrar General in 1843.[5] In Table 3, for selected ages, data extracted from the tables on pages 354–355 of this report for survivors (l_x) and deaths (d_x) are shown and the corresponding annual mortality rates (q_x) have been added. Compared with recent experience, mortality levels in this 1841 national life table of England are extremely high, especially in children and adults to age 60, and even past age 60, rates are higher than today's rates. Neonatal mortality was so high that the rates in the first year of life were 16% for males and 13% for females. The current lower mortality in females compared with males is much smaller. High maternal mortality contributes to overall mortality in women in the childbearing ages—the invention of obstetrical forceps and anesthesia were still in the future in 1841. So were the invention of bacteriology by Pasteur and the discovery of specific, identifiable causes for infectious diseases.

Farr made a general comparison of mortality rates observed in his categories of patients studied with approximate mortality in the population at ages 30–40 and 40–50 and found them to be much higher. I have tried to improve the estimation of matched population mortality by assuming an age distribution that would produce a mean age close to 36.5 years, as observed in the samples and quoted by Farr. These calculations are shown in Table 4. The left-hand part of Table 4 confirms that the distribution assumed (expressed as the decimal f) does yield a mean age of 36.5 years. In the right-hand part of the table, expected (population) male and female mortality rates, q', have been taken from Table 3. These are multiplied by age-specific values of f to obtain estimated mean q' values, all ages combined. These are estimated as

Table 3. Farr's English Life Table 1 for 100,00 Born Alive in 1841

	Male			Female		
Age (years) x	Number Alive at Start x	Number of Deaths d_x	Mortality Rate q_x	Number Alive at Start l_x	Number of Deaths d_x	Mortality Rate q_x
0–1	51,274	8170	.1593	48,726	6461	.1326
5–6	37,385	542	.0145	36,816	505	.0137
10–11	35,564	179	.0053	35,048	213	.0061
15–16	34,573	240	.0069	34,054	257	.0075
20–21	33,324	264	.0079	32,735	273	.0083
25–26	31,671	292	.0092	31,337	289	.0092
30–31	30,473	312	.0103	29,859	305	.0102
35–36	28,867	335	.0116	28,305	319	.0113
36–37	28,532	340	.0119	27,986	323	.0115
37–38	28,192	344	.0122	27,663	325	.0117
38–39	27,848	349	.0125	27,338	327	.0120
39–40	27,499	354	.0129	27,011	331	.0123
40–41	27,145	358	.0132	26,680	333	.0125
41–42	26,787	362	.0135	26,347	336	.0128
42–43	26,425	367	.0139	26,071	338	.0130
43–44	26,058	371	.0142	25,673	340	.0132
44–45	25,687	376	.0146	25,333	343	.0135
45–46	25,311	379	.0149	24,990	345	.0138
50–51	23,376	398	.0170	23,245	355	.0153
55–56	21,355	499	.0210	21,441	400	.0187
60–61	18,808	592	.0315	19,188	530	.0276
65–66	15,589	717	.0460	16,263	666	.0410
70–71	11,823	792	.0670	12,708	768	.0604
75–76	7867	764	.0971	8797	780	.0887
80–81	4316	604	.140	5082	658	.129
85–86	1780	355	.199	2241	419	.187
90–91	481	135	.281	659	176	.267
95–96	64	25	.391	105	39	.371
100–101	11	4	.364	14	5	.357

0.0138 for males and 0.0134 for females; they are significantly higher than the rates for the mean age of 36.5 years. The tabular ages corresponding to these rates are 42 years for males and 44 years for females. These results are in keeping with the well-recognized phenomenon that mean q' for a group with a wide age range is invariably higher than the q' corresponding to the mean age.[6]

RESULTS

Farr always describes the methods used and the content of the 20 tables contained in his report. All of the initial results are for aggregate annual mortality rates as the quotient of total deaths observed to years of residence or number alive 1 year (he never uses the term exposure). A table at the bottom of page 19 of the published report shows numbers of male, female, and total patients remaining at Hanwell Asylum on December 31 for each year from 1831 through 1840. It is probable that similar data were used to estimate aggregate exposure, after adjustment for any factors such as the exposure for the year 1831, in which Hanwell opened. I have used all of these data as exposures, E, in Tables 5 and 6. In addition to deaths, Farr also gives numbers of patients discharged alive as cured or ''relieved.'' Thus, he derives both annual mortality rates per 100 and annual rates of dis-

Table 4. Approximation of Expected Mean Annual Mortality Rate (English Life Table Number 1) From Mean Age and Assumed Age Distribution

Age (years)		Assumed	Weighting	Calculation of Mean q' from Age Distribution*			
Range	Mean x	Distribution f	of Age $(x)(f)$	Male Rate q'	Weighting $(q')(f)$	Female Rate q'	Weighting $(q')(f)$
10–19	15	0.12	1.8	.0069	.0008	.0095	.0011
20–29	25	0.20	5.0	.0090	.0018	.0092	.0018
30–39	35	0.35	12.2	.0116	.0041	.0113	.0040
40–49	45	0.15	6.8	.0149	.0022	.0135	.0020
50–59	55	0.11	6.0	.0184	.0020	.0172	.0019
60 up	65	0.07	4.8	.0426	.0029	.0378	.0026
All ages	36.5†	1.00	36.6		.0138		.0134

* Mean q' derived from assumed age distribution and rates for specific age and sex from English Life Table 1 (see text and Table 3). Tabular ages corresponding to these mean q' values are age 44 for males and age 42 for females.
† Actual mean age for patient sample given by Farr.[1]

charge alive in improved condition. These are not shown in the tables of this article, but sample rates are given in the text. Farr usually separates observed data from derived rates so that results from multiple Farr tables have been incorporated in each of Tables 5–7.

Table 5 contrasts the comparative mortality in the Hanwell Asylum, 1831–1840, with comparative mortality in 34 licensed house, 1832–1839. Results are given for male, female, and total patients, and patients in the licensed houses were further subdivided by status as pauper or other. Farr cites maintenance costs; these were paid from public funds for the paupers, but the family of other patients presumably paid part or all of their costs. Excess mortality was present in all categories of mental patients, with mortality ratios (MRs) ranging from 605% to 1790% and excess death rates (EDRs) from 71 to 253 extra deaths per 1000 per year. At Hanwell, the male EDR was 145 per 1000, the female 75, and the combined 104, with a combined MR of 815%. There was a similar sex difference for the patients in the licensed houses, but excess mortality was twice as high for the paupers, with an EDR of 250 per 1000 for males and 150 for females. Excess mortality for other patients in the licensed houses was slightly lower than the overall mortality at Hanwell, at which the patients were presumably 100% in the pauper category. This differential is emphasized by Farr because it was an important objective of his mortality study.

There were 4 large licensed houses with an average of 256 patients each and 34 smaller houses with an average of 17 patients in each. Farr provides mortality results for these 2 size categories of licensed houses, and these are shown in Table 6 for all patients combined. MR was 1300% for the patients in the 4 large houses but only 625% in the smaller houses. The difference is apparently due to the much higher concentration of paupers in the 4 large houses, 69%, in contrast with only 13% in the smaller houses. This is further confirmation of the higher mortality in paupers than in other patients with an independent income.

In making a study of mortality in the Hanwell patients by duration after admission but while still hospitalized, Farr had to work with patient admission data for each calendar year. Death and discharge data were available for each calendar year's admissions to the end of 1839. The years selected were 1832–1838. Because patients were admitted throughout each year, Farr assumed an average duration of only 0.5 year in the year of admission so that the duration is 0–0.5 year in the first year of follow-up but a full year thereafter (0.5–1.5 years, and so on). I agree with this assumption, and duration intervals of the lower table

Table 5. Comparative Mortality of Lunatics and Idiots in Hanwell Asylum, 1831–1840, and in 34 Licensed Houses*

Category	Exposure (Patient–Years) E	Number of Deaths		Mortality Ratio $100d/d'$	Mean Annual Mortality Rate per 1000		
		Observed d	Expected† d'		Observed q	Expected q'	Excess $(q - q')$
Male patients							
Hanwell	2334	374	36.0	1070%	160	15	145
Licensed houses							
Paupers	1882	504	28.2	1790	268	15	253
Others	2027	353	40.2	880	132	15	117
Total	4559	857	68.4	1250	188	15	173
Female patients							
Hanwell	3164	282	44.3	635	89	14	75
Licensed houses							
Paupers	2678	443	37.5	1180	164	14	150
Others	2414	204	33.8	605	85	14	71
Total	5112	647	71.3	905	127	14	113
Male and Female Combined							
Hanwell	5498	656	80.3	815	119	15	104
Licensed houses							
Paupers	4560	947	65.7	1440	208	15	193
Others	5041	557	74.0	735	110	15	95
Total	9761	1504	139.7	1080	156	15	141

* Hanwell data from table page 20, data for licensed houses from table page 22 of report.[1]
† Basis of expected deaths: Farr's, English Life Table No. 1 (1841). See Table 3 and 4.

on page 25 of Farr's article have been used in Table 7 of this article. However, from a comparison of the 2 duration tables on page 25, I am convinced that Farr underestimated exposure by using the patient count at the end of the year of observation instead of the midpoint. Discharges each calendar year must be treated as numbers lost to follow-up (w in Table 7) because the patients are outside the hospital and no longer in follow-up. The upper table on page 25 gives number alive at the start of each interval and the numbers of discharges and deaths on an annual basis. From these data, exposure has been recalculated by the customary formula $E = l - 0.5w$. The E values do not differ a great deal from those apparently used by Farr ($E = l - w$) in the lower table on page 25.

The first interval in Farr's table is 0–0.5 years, so the E value as $l - 0.5w$ is divided by 2. The next interval, 0.5–1.5 years, is a full year; subsequent intervals to 7.5 years of follow-up are intervals of 2 years each (the combination of data from successive years). In Table 7, the first two intervals have been combined into one of 0–1.5 years. Excess mortality was highest in the first 18 months, with an MR of 1230% and an EDR of 155 per 1000. Excess mortality dropped to almost less than half of this level in the subsequent intervals to 7.5 years. The excess mortality stabilizes at an EDR level close to 63 per 1000 if the patient remained hospitalized up to 7.5 years. This pattern is undoubtedly due to admission of most of the mentally ill when they were acutely affected by other disease as well as their psychosis. Farr quotes the impression of expert observers that many mental patients were admitted to an asylum with the expectation that they would soon die. Poor adap-

Table 6. Comparison of Mortality of Lunatics in 4 Large Licensed Houses With Mortality in 36 Smaller Licensed Houses

Size of House*	Average Number of Patients n	Exposure Patients–Years E	Number of Deaths		Mortality Ratio $100d/d'$	Mean Annual Mortality Rate per 1000		
			Observed d	Expected* d'		Observed q	Expected q'	Excess $(q - q')$
Large	256	6360	1203	72.2	1300%	189	14	175
Small	17	3311	301	48.0	625	91	14	77

* Patients who were paupers were concentrated in the large houses (69%), with only 13% in the smaller houses. Period of observation was 1831–1839, and mean age of sample was 36 years.

† Basis of expected deaths: Farr's English Life Table No. 1 (1841). See Tables 3 and 4.

Table 7. Comparative Mortality of Lunatics in Hanwell Asylum by Duration of Confinement, 1831–1839

Duration Start–End (years) t to $t + \Delta t$	No. Alive at Start l	Exposure Patients–Years E	Number of Deaths		Mortality Ratio $100d/d'$	Mean Annual Mortality Rate per 1000		
			Observed d	Expected* d'		Observed q	Expected q'	Excess $(q - q')$
0–1.5	1389	1666	282	22.9	1230%	169	13.7	155
1.5–3.5	594	1077	87	15.3	570	81	14.2	67
3.5–5.5	399	597	48	9.0	530	80	15.0	65
5.5–7.5	246	397	27	6.0	450	69	15.2	54
1.5–7.5	594	2071	162	30.3	535	78	14.6	63

*Data from tables on page 25 of report.[1] See text.

† Basis of expected deaths: Farr's English Life Table No. 1 (1841). See Tables 3 and 4.

tation to conditions of confinement might also have a role; yet another possibility, late cerebral syphilis, which was doubtless prevalent at this time, was raised by a discerning medical friend of mine. Farr gives deaths in the first month after admission at Hanwell as producing a mortality rate of about 11%, a very high figure for a period as short as 1 month.

Farr also analyzes, on pages 23–24 of his report, the question ''What is the mortality of the inmates under favorable circumstances?'' He cites annual mortality of only 7% at the Gloucester County Asylum, where ''the diet is generous and nutritious and the patients live as much as possible in the open air.'' He regards this as probably near the minimum for lunatics, and this is confirmed by the observed q of 78 per 1000 at Hanwell after the first 18 months, with an EDR of 63 per 1000. The observed q for paupers in the licensed houses was much higher—208 per 1000, with an EDR of 193 per 1000 (Table 5). Farr comments thus on page 24: ''[mortality] among pauper men at one licensed house was 27 per cent;—as high as the rate of mortality experienced by the British troops upon the western coast of Africa, and by the population of London when the plague rendered its habitations desolate!'' Farr certainly knew his mortality statistics.

COMMENT

The English Life Table No. 1 constructed by Farr while he was writing his report[1] provides vivid evidence of the high mortality rates prevailing in the general population at all ages. Initial improvements in general mortality in the middle of the 19th century were

due to public health measures. This continued to be true after the invention of bacteriology and the ability of physicians to diagnose and understand the epidemiology and immunology of specific diseases. Sulfonamide drugs and antibiotics for their treatment did not come until well into the 20th century. The period of the 1830s was one of particularly rapid development in vital statistics, and William Farr, a physician, was in the thick of it. He certainly carried out in an extraordinary fashion his commission to investigate the mortality of lunatics confined and cared for under the London Metropolitan Commission. He used the most advanced methods to determine the annual mortality and demonstrate that it was higher in the mentally ill than in the general population. Mortality was much higher among paupers in the licensed houses than in the Hanwell asylum, higher in the large than in the smaller licensed houses, and higher in the early months after admission than subsequently. This knowledge was a remarkable achievement at a time when registration had just been started in England for all deaths, births, and marriages.

COMMENTARY ON WILLIAM FARR, MD, DCL, CB, FRS

All of the degrees and memberships shown here were honorary ones conferred on Farr in recognition of the outstanding character of his work and writings accomplished during his long and distinguished career as Superintendent of Statistics in the General Register Office (GRO).[4] The MD was an honorary degree from New York University in 1847. (The degree under which he practiced medicine was an LSA, a licentiate of the Society of Apothecaries, a degree still issued and recognized in the United Kingdom.) The DCL was conferred by Oxford in 1855. Two honorary memberships were as a Companion of the Bath and a Fellow of the Royal Society. There were many more, including an Honorary Membership in the Institute of Actuaries. Who was the William Farr who received so much recognition for his work?

According to Noel Humphreys, who was a colleague of Farr's in the GRO for 25 years, Farr started an autobiography that he never completed, but the partial text survived.[4] Farr was born in 1807; his parents were very poor, his father being a farm laborer. Farr wrote that he lived with his parents only 2 years and was then taken in by Joseph Pryce, the squire and benefactor of the small village of Dorrington. He then lived in Mr Pryce's home until the latter's death in 1838. A different account is given in Eyler's detailed study of the ideas, statistics, and work of William Farr.[7] Eyler quotes county records as showing that Farr was apprenticed at age 8 years to Mr Pryce ''to learn animal husbandry.''[7] Whatever the circumstances, it is clear that Farr was a youngster full of intellectual curiosity, which was recognized and encouraged by Mr Pryce. Farr recalled his benefactor in these words: ''To him I owe my education, the most constant and tender care, and an example of benevolence and integrity.''[4] Local school facilities were limited, but through reading and self-study, Farr apparently learned, in addition to the basic skills, to read Latin, French, Italian, and even started on Hebrew. Although Mr Pryce's library was mostly limited to theological works, Farr borrowed books from others, and he was an omnivorous reader. In 1826, with the support of Mr Pryce, Farr commenced the study of medicine in the Shrewsbury Infirmary with a Dr Webster and also as dresser for a surgeon and apprentice to an apothecary. For several months, Farr walked the 7 miles each way between Dorrington and the Infirmary in Shrewsbury 6 days each week, after which a riding horse was purchased. Farr recalls his study with Dr Webster thus: ''With Dr Webster I read anatomy in Fife. We read Celsus and Gregory's Conspectus. The judicious and enlightened direction, and the elevated tone, Dr Webster gave to my studies, laid the foundation of all that I shall ever do that is useful and good.''[4] (Farr started his memoir in the 1830s when he was still very young.)

Mr Pryce, in late 1828, died at the age of 90 and left Farr a legacy of £500, which Farr

used to further his medical education in Paris after a brief stay in London. The university and hospitals of Paris were then a center of medical education for students of many nations. Humphreys quotes extensively from a medical friend of Farr's, who was with him during part of this period. Together they attended lectures by many eminent French physicians and scientists. Farr's interest in statistics, hygiene, and public health was aroused by lectures he heard in Paris. The revolution of 1830 put an end to Farr's studies in Paris, and he returned to England, where he was locum tenens at the Shrewsbury Infirmary for 6 months. He then returned to London to resume his studies for his LSA examination. During this time, Dr Webster died and left Farr his library and a bequest of £500. After Farr received his LSA, he apparently saw few patients in his efforts to start a practice in London, but he was very prolific in writing many articles on statistics and medicine.[4,7] These appeared in journals such as *Lancet,* the *British Medical Almanack,* and a new journal, the *British Annals of Medicine,* which he helped edit and which was a weekly publication but one that lasted for only 9 months in 1837. He wrote on various topics in medicine and statistics and repeatedly urged reform in the regulation of medical practice. He regarded medicine as both a science and a social institution.[7] He wrote a lengthy and authoritative article on vital statistics for an encyclopedia, *A Statistical Account of the British Empire,* edited by J. R. McCulloch and published in 1837. This article was widely read and became an enduring classic on the subject. It was probably instrumental in Farr's appointment to the GRO in 1839, initially as Compiler of Abstracts. Eyler[7] emphasizes that Farr never relinquished his interest in medicine and public health during his long and productive career carrying out the multifaceted vital statistics work of the GRO.

At this point, I should refer to the cultural setting of this era of the 1830s. The reader who is interested will find a comprehensive and graphic history of the period from 1815 (the year of the Battle of Waterloo) to 1830,[8] a period that the author, Paul Johnson, characterizes as ''The Birth of the Modern.'' In England, this period after the long Napoleonic wars was marked by development of the industrial revolution (the first English railroad began operation in 1830), cultural ferment, and an increase in population. With conservatives in power in Parliament, pressing social problems did not receive attention until the Whigs started a series of reform acts. The first of these was the electoral Reform Act of 1832, followed by Reform of the Penal Code (1832), the Factory Act (1833), the Poor Law Amendment (1834), and the Municipal Corporations Act (1835). In addition, the Registration Act of 1836 established a network of local registration offices to record all births, marriages, and deaths. Previous records had been incomplete because, since 1538, births, marriages, and burials (not deaths) had been recorded in parishes of the Anglican Church. Some cities published weekly bills of mortality, but these were not complete. This civilian registration system was essential for the national vital statistics now kept by the GRO. Neither the first Registrar General nor his successor had any expertise in vital statistics; this expertise was supplied completely and brilliantly by Farr, who had charge of the clerks working on the production of the statistics. Major George Graham, the second Registrar General, who served from 1842 to 1879, had a good working relation with Farr, was a capable administrator, fully recognized Farr's expertise, and supported Farr's salary advancement to an unusual degree above the civil service limits.

While all of the above events were taking place in the 1830s, there was a veritable explosion of interest in the collection and application of statistics. The Statistical Society of London was founded in 1834 and began publication of its journal in 1837. Early volumes of this journal, which I have examined, are replete with articles on statistics of the most astonishing variety. This was an exciting decade for someone as interested in statistics as Farr was. He soon became an active member and served for many years on the Council of

the Statistical Society of London and ultimately as its president. The 1841 Report[1] was Farr's first in this journal, which eventually became the *Journal of the Royal Statistical Society.*

The construction of life tables was the dominant force in Farr's work on vital statistics at the GRO. For the English Life Table No. 1 the principle of construction was relatively simple, based on use of a ratio with a numerator and a denominator. The numerator was supplied from the deaths for 1841 in the new death register, distributed by sex and by age from birth to 105 years. The denominator was supplied by the 1841 census for England and Wales, the persons living at the census count distributed in the same way. These annual mortality rates were graduated and used for the construction of the English Life Table No. 1, illustrated in Table 3 of this article. Farr always wrote a detailed explanation for each of his life tables; for the English Life Table No. 1, this in the text of the Fifth Annual Report of the Registrar General, published in 1843.[5] In this description Farr, invoking the laws of mortality, gives a vivid prediction of the future outcome of 100,000 born alive in 1841 (as quoted by Eyler[7(p73)]):

> The mental faculties, developed and ripened by experience, will not protect the frame from the accelerated and insidious progress of decay; the toil of the labourer, the wear and tear of the artisan, the struggles and drains of intellect, and more than all of these, the natural falling off of vitality reduces the numbers to 9,398 by the age of eighty. Here we may pause for a moment. It would formerly have been considered a rash prediction in so uncertain a matter as human life to pretend to assert that about 9000 of the children born in 1841 would be alive in 1921; such an announcement would have been received with as much incredulity as Halley's prediction of the return of a comet after the lapse of 77 years. What knew Halley of the vast realms of aether in which the comet disappeared? Upon what grounds did he expect its re-appearance from the distant regions of the heavens? Halley believed in the constancy of the laws of nature; hence he ventured from parts of the comet's course to calculate the time in which the whole would be described; and it will shortly be proved that the experience of a century has verified quite as remarkable a prediction of the duration of human generations, so that, although we little know the labours, the privations, the happiness or misery, the calms or tempests, which are prepared for the next generation of Englishmen, we entertain little doubt that 9000 of 100,000 of them will be found alive at the distant Census in 1921. After the age of 80 the observations grow uncertain; but if we admit our accuracy, 1140 will be alive at the age of 90; 16 will be centenarians; and of the 100,000 one man and one woman—like the lingering barks in an innumerable convoy will reach their distant haven in 105 years and die in 1945.

Thus, Farr gives expression to his faith in the statistical laws of the life table by comparing them with the laws of physics and astronomical bodies.

English Life Table No. 2, published in 1853, was based on the population of the 1841 census but utilized the deaths for the 7 years 1838–1844. The results were remarkably similar to those of Life Table No. 1. English Life Table No. 3, published as a separate volume in 1864, was much more complicated in its construction because it utilized deaths for 17 years, 1838–1854, and the population data from the census of 1841 and the census of 1851. It was absolutely necessary to take into account the duration of the observation period and calculate years of life at risk to match the period in which deaths were observed. This concept of exposure to risk was emphasized again and again in Farr's explanation of other life tables he constructed as well as the English Life Tables.

Farr's interests in science and his fellow men were wide ranging, as attested in the 563 pages of his writings selected by his colleague, Noel Humphreys, for the memorial volume.[4] The writings are divided into 6 sections: population, marriages, births, deaths, life tables, and miscellaneous. Each section has its own table of contents and a brief introduction.[4(pp3,66,85,109,443,495)] Farr had a great interest in the population and was a principal architect of the censuses of 1851, 1861, and 1871 as a commissioner or assistant commissioner of the Census Board. He wrote numerous articles as well as the sections on population in the Annual Reports of the Registrar

General. In the 39 years from 1837–1876, Farr noted that the population of the United Kingdom increased 29%, at an annual rate of 0.66%.[4(p89)] During this period, there were 26,129,906 births registered, with an estimated additional 5% unregistered (registration of births was not compulsory until 1874), and there were 17,079,018 deaths, for which registration had been compulsory since 1837.[4(p89)] Farr discussed fluctuations in birth rates and marriage rates in relation to war and peace and to prosperity and economic depression.[4(pp3,66,85,109,443,495)] He was especially interested in improving the cause-of-death information and prepared numerous versions of a nosology to accomplish this.

Farr was one of the outspoken social reformers of the Victorian age, although he was always pragmatic rather than dogmatic.[7] He used his mortality statistics to demonstrate the excess mortality in congested urban areas and reiterated this theme in all his writings, from the Fifth Annual Report of the Registrar General[5] to the Supplement to the 35th Annual Report for 1860–1871 three decades later.[7(ch6)] Farr also combined rural counties and demonstrated that age-specific mortality was much lower in this ''healthy district'' than in urban areas. He analyzed the time curve of acute mortality in diseases like cholera and smallpox and showed that these followed a pattern characteristic of the disease. He was also deeply interested in hospital mortality, and for many years, carried on a correspondence with Florence Nightingale in support of her efforts to improve sanitary conditions and design of hospitals.[7(ch7)] He was a member of a government commission to investigate the high mortality of British troops in India. These were among the topics in Farr's many writings, which appeared in the annual Reports of the Registrar General, in medical journals, in the *Journal of the Statistical Society*, and elsewhere.

Yet another major field of interest for Farr was insurance. With each of his English Life Tables, he provided a complete set of actuarial tables for life insurance and instructions for their use.[7(pp84–89)] Farr hoped that life insurance companies would adopt his tables in preference to defective ones such as the Northampton Table. Although a few companies did adopt one of the English Life Tables, most preferred to employ tables based on mortality of insured lives rather than on mortality in the general population, and by midcentury, many companies had acquired sufficient experience to produce a reliable life table. For various reasons, there was friction between Farr and some actuaries,[7(pp84–89)] although in 1852, Farr was made an honorary member of the Institute of Actuaries.[4(pXXII)] Farr advocated a plan to provide life insurance from government-sponsored savings banks, and a system of this sort was started, with Farr as the consulting actuary. There were many insurance and annuity projects in which he was involved, including health insurance, a supplement to the government allowance under the Poor Law, retirement benefits for the civil service, and others.[7(pp84–89)]

Farr married soon after starting his practice in London, but his young first wife soon died of consumption. He later remarried and had 6 children.

Farr's extraordinary abilities in his work and some of his personal characteristics are described by Humphreys,[4] his close associate of 25 years:

> Those who had the privilege and pleasure of his friendship, or even his acquaintance, treasure their memory of the man, quite apart from the inevitable respect they feel for his talents and services. . . . He was essentially modest and unassuming in his manner. . . . He was a delightful and delighted host, and although, in consequence of his extensive and varied information and acquirements, his conversation was always welcome, he was not what is called a great talker, whereas he was a thoroughly good listener. His keen enjoyment of and participation in the pleasures of others, especially the pleasures of children, the simplicity of his tastes, and his ready powers of self-forgetfulness when surrounded by young people, were among his most marked and pleasing characteristics. None who knew him really well will ever forget the almost magnetic effect of his ever ready, spontaneous, thoroughly hearty, and most musical laugh.

Major Graham retired as Registrar General

in 1879. Despite his age of 72, years Farr applied for the position, but the government appointed someone else, again a person not expert in vital statistics. Farr was bitterly disappointed and resigned, with superannuation, in early 1880. There was a great outcry of protest in the medical profession that he had been unjustly treated. The truth is that Farr's health had been adversely affected by a serious illness and by the death of his wife in late 1876. This and Farr's age may have played a role in government's decision to appoint a younger person as Registrar General. Events proved the wisdom of this decision. Farr lived only 3 years in retirement, in a state of declining health and declining mental faculties, and he died in 1883.

Farr deservedly received many additional honors and much public praise on his retirement and more praise after his death.[4] The British Medical Association presented him with a gold medal in 1880. In this commentary, I have barely scratched the surface of the scope of the life work of this extraordinary man of science. Farr, with only an early 19th century physician's training, developed multiple and major practical applications of life table methodology and vital statistics, applications to so many fields of science and the public good, a truly astonishing accomplishment. To conclude this brief appreciation, I can do no better than quote Eyler's assessment of the man: ''This complex of notions not only helps to explain Farr's particular ideas and interpretations, it also partially accounts for a feature of his work that recent observers have found so puzzling, the enormous breadth of his interests, which transcends any contemporary scheme of disciplinary boundaries. Farr moved from life insurance to hospital mortality, from estimates of human capital to studies of Asiatic cholera, from discussions of population growth to improvements in nosology with perfect ease, because he regarded them as part of the same enterprise, the construction of a numerical science of health and human progress.''[7(p200)]

REFERENCES

1. Farr W. A report on the mortality of lunatics. *J Stat Soc (Lond)* 1841;4:17–33.
2. Actuarial Society of America. *Specialized Mortality Investigation.* New York, NY: Actuarial Society of America; 1903.
3. Singer RB. Examples of early mortality follow-up studies. *Nat Cancer Inst Monogr.* 1985;67:15–21.
4. Humphreys NA, ed. *Vital Statistics—A Memorial Volume of Selections of the Reports and Writings of William Farr, MD, DCL, CB, FRS, Late Superintendent of the Statistical Department of the Registrar General's Office, England.* London: Sanitary Institute; 1885.
5. Government of England. *Fifth Annual Report of the Registrar General of Births, Deaths and Marriages in England.* 2nd ed, revised and corrected. London: H. Claves and Sons for Her Majesty's Stationer's Office; 1843.
6. Singer RB. The application of life table methodology to risk appraisal. In: Brackenridge RDC, Elder WJ, eds. *Medical Selection of Life Risks.* 4th ed. New York, NY: Stockton Press; 1998:chapter 4.
7. Eyler JM. *Victorian Social Medicine—The Ideas and Methods of William Farr.* Baltimore, Md: Johns Hopkins University Press; 1979.
8. Johnson P. *The Birth of the Modern—World Society 1815–1830.* New York, NY: Harper-Collins; 1991.

In 1852, William Farr, published a report of the Registrar-General on mortality due to cholera in England in the years 1848-1849, during which there was a large epidemic throughout the country. Farr initially believed that cholera arose from bad air ("miasma") associated with low elevation above the River Thames. John Snow (1855) later showed that the disease was principally spread by contaminated water. This data set comes from a paper by Brigham et al. (2003) that analyses some tables from Farr's report to examine the prevalence of death from cholera in the districts of London