character of this murmur, that of the heart sounds, and the presence or absence of a diastolic murmur are important in deciding whether or not the heart is normal. From the present findings the characteristics of presumed functional systolic murmurs may be defined, but a murmur with apparently similar characteristics may occur in congenital heart disease or none may be audible. It is worth noting that no very loud, long, or high-pitched systolic murmurs were heard or recorded in the normal infants studied, nor any diastolic murmurs.

Foetal murmurs have been previously recorded on infants subsequently found to have congenital heart disease (Smith and Hervert, 1940; Smith, 1941; Menzies and Scott, 1955). The present findings show that murmurs may be recorded in the majority of foetuses near term, and may be audible by foetal stethoscope without a congenital defect being present.

Summary and Conclusions

A series of 230 full-term infants were examined daily from birth for a minimum of eight days, and observations made on sleeping heart rate, sounds, and murmurs. A quarter of this number were re-examined between the ages of 6 weeks and 6 months. Phonocardiograms were taken on an approximate quarter of the series both before and after birth, and also on a number of infants with known congenital heart disease. From these observations some normal auscultatory data in early infancy could be obtained.

The mean sleeping heart rate was tabulated, and showed a significant rise from the second to the eleventh day. All murmurs heard were systolic in timing, and their incidence increased with age, reaching 77% by the eighth day and nearly 90% at follow-up examination. The characteristics of these murmurs could be broadly defined, both clinically and phonocardiographically. It is suggested that the majority probably persist into childhood and are functional in nature.

Deviations from the expected normal may be detected clinically, but, because of the difficulties of auscultation, phonocardiography may be a particularly useful diagnostic aid in this age group.

The demonstration of systolic murmurs in the majority of foetal tracings implies that the chance observation of an intrauterine murmur does not necessarily imply that the infant has congenital heart disease.

I should like to thank Mr. D. M. W. Maxwell and Dr. J. J. Kempton for permission to study their patients and for their encouragement. I am most grateful to Professor E. G. L. Bywaters, Dr. W. W. Brigden, and Dr. G. T. Thomas for their criticism, and am indebted to Dr. E. J. Holborow for statistical aid and to Mr. J. K. Harrison for technical assistance. I should also like to thank the nursing staff of the midwifery department and Mrs. A. M. Caulkin for their unflinching help.

REFERENCES

- Besterman, E. M. M., and Harrison, J. K. (1953). *Brit. Heart J.*, **15**, 130.
 Harris, T. N. (1955). *Amer. Heart J.*, **50**, 805.
 Keith, J. D., Rowe, R. D., and Vlad, P. (1958). *Heart Disease in Infancy and Childhood*, Chapter 2, p. 15. Macmillan, New York.
 Lessof, M., and Brigden, W. (1957). *Lancet*, **2**, 673.
 Levine, S. A. (1933). *J. Amer. med. Ass.*, **101**, 436.
 McKee, M. H. (1938). *Amer. Heart J.*, **16**, 79.
 MacMahon, B., McKeown, T., and Record, R. G. (1953). *Brit. Heart J.*, **15**, 121.
 Menzies, C. J. G., and Scott, F. E. T. (1955). *J. Obstet. Gynaec. Brit. Emp.*, **62**, 935.
 Richards, M. R., Merritt, K. K., Samuels, M. H., and Langmann, A. G. (1955). *Pediatrics*, **15**, 169.
 Siemsen, W. J. (1938). *Illinois med. J.*, **73**, 157.
 Smith, A. L. (1941). *Arch. Pediat.*, **58**, 549.
 — and Hervert, W. J. (1940). *Amer. J. Obstet. Gynec.*, **40**, 102.
 Taylor, W. C. (1953). *Arch. Dis. Childh.*, **28**, 52.

INCIDENCE OF LEUKAEMIA IN SINGAPORE, AND RARITY OF CHRONIC LYMPHOCYTIC LEUKAEMIA IN CHINESE

BY

RONALD WELLS, M.B., B.Sc., M.R.C.P., D.T.M.&H.

AND

K. S. LAU, M.B., B.S.

Department of Medicine, General Hospital, Singapore

The aetiology of human leukaemia is still largely obscure, and therefore variations in the incidence of leukaemia in different population groups are especially interesting because of their potential aetiological significance. The only Asian population for which reliable leukaemia mortality figures have previously been available is that of Japan, where the mortality from leukaemia in both sexes and in all age-groups is much less than that of countries in Europe and North America (World Health Organization, 1955). Several authors have also mentioned the clinical impression that chronic lymphocytic leukaemia is particularly uncommon in the tropics generally (Strong, 1944), in India (Majumdar and Chatterjee, 1953), in Japan and the indigenous population of North and South Africa (Witts, 1957), and in Singapore (Wells, 1958). The predominantly Chinese population of Singapore has had comprehensive and effective medical care since the end of the Japanese occupation, and we have analysed the incidence of leukaemia here during the ten-year period 1949–58.

Data and Material

We have examined all the Singapore death certificates and post-mortem reports for the 1949–58 period in which leukaemia or lymphosarcoma are mentioned as a diagnosis or cause of death. Over 95% of these certificates and reports refer to patients investigated at the Singapore General Hospital, in the University departments of medicine and clinical medicine, or in the paediatric unit. We have re-examined the diagnostic criteria of 129 patients with leukaemia attending the department of medicine in the 1949–58 period, many of whom were treated by one or other of us, and have also obtained additional clinical data on some of the patients who attended the paediatric unit. After correlation of all these data and elimination of duplicate and doubtful records, we have records of 253 cases of leukaemia and 23 of lymphosarcoma from the 1949–58 period.

Population figures have been obtained by extrapolation from the 1947 and 1957 Singapore Census reports and the Annual Reports of Singapore Births and Deaths.

Crude Leukaemia Mortality Rates

The number of deaths from leukaemia in Singapore in each of the 10 years 1949–58, together with the crude mortality rates, are given in Fig. 1. The figures for Chinese are given separately.

During the ten years under investigation there has been expansion of the Singapore Medical Services, with improved laboratory and diagnostic facilities, and at the same time the Chinese and other Asians in Singapore

FIG. 1.—Crude yearly mortality rates from leukaemia in Singapore, 1949-58.

have shown an increasing acceptance of Western medicine. These factors undoubtedly explain much of the apparent increase in the crude mortality rate from leukaemia. Many Asians, particularly the Chinese and Malays, prefer to leave hospital when in the terminal stages of a fatal illness, to die at home. Some patients in this series, known to have had leukaemia, have died at home, and their death certificates sometimes record other causes of death, or simply "death from natural causes." Thus in this series of 253 cases of leukaemia, only 206 had this diagnosis on their death certificates. The remaining 47 were mostly diagnosed and treated in the department of medicine: 38 of them are known to have died by the end of 1958; the other 9 cannot be traced, and are thought to have died. We estimate that about another 50 patients with leukaemia were probably diagnosed similarly in the department of clinical medicine and the paediatric unit at the General Hospital, and later their deaths were not recorded as being due to leukaemia. They will not have been included in this series.

The above figures suggest that the numbers of deaths from leukaemia shown in Fig. 1 represent about 80% of the cases actually diagnosed in Singapore.

In recent years about 75% of all deaths registered in Singapore have had the causes of death certified by registered medical practitioners or coroners. The remainder have been certified by the police. We believe that a more accurate comparison can be made between the mortality rates from leukaemia in Singapore and those reported in other countries (see Table I, compiled from data given by the World Health

TABLE I.—Mortality From Leukaemia in 17 Countries, 1950-2. Mean Annual Rates per 100,000 Population

Males	Countries	Females
7.0-7.5	United States (White)	5.0-5.4
	Denmark	
6.0-6.9	Sweden	4.0-4.9
	Norway	
	New Zealand	
5.0-5.9	Switzerland	3.0-3.9
	Canada	
	Netherlands	
	Australia	
4.0-4.9	England and Wales	2.0-2.9
	Scotland	
	Germany	
	France	
	Italy	
3.0-3.9	Finland	1.5
	United States (non-Whites)	
	Ireland	
2.0	Japan	

Organization, 1955) if our figures in this series are increased by 33% (see Table II).

TABLE II.—Mortality From Leukaemia in Singapore, 1957-8 (Figures in This Series, and Estimated (Comparable With Table I) Mean Annual Rates per 100,000 Population)

	All Races		Chinese	
	Males	Females	Males	Females
Present series	3.6	1.9	3.8	2.0
Estimated	4.8	2.5	5.1	2.7

Sex Incidence

The sex incidence of the 253 cases of leukaemia is summarized in Table III, and the mean annual mortality rates for Chinese males and females at different ages are shown in Fig. 4. Leukaemia is commoner in men than in women in many countries (see Table I) and at all ages (see Fig. 2, drawn from data given by the World Health Organization, 1955). Our figures are in general agreement with this finding, but we feel that the preponderance of leukaemia in the males is probably exaggerated in our series because there are better medical facilities for men than for women in Singapore, and men appear to be less reluctant here than women in seeking medical treatment.

The sex ratio obtained for Chinese males to females is 2:1, approximating to the similar sex ratio of the mean annual mortality rates. The sex ratios for the

TABLE III.—Sex Incidence of 253 Cases (171 Male, 82 Female) of Leukaemia

	Males	Females		Males	Females
Chinese	135	68	Europeans	4	1
Indians	19	4	Eurasians	1	1
Malays	10	7	Others	2	1

FIG. 2.—Mortality from leukaemia in white populations. (The vertical columns represent the ranges reported in 16 countries, 1950-2).

TABLE IV.—*Classification of 253 Cases of Leukaemia and 23 of Lymphosarcoma in Singapore*

	Leu- kaemic	Subleu- kaemic	Aleu- kaemic	Un- known	Total
<i>Chinese (203)</i>					
Granulocytic:					
Acute	18	6	—	17	41
Subacute ..	4	1	—	—	5
Chronic .. .	26	1	1	12	40
Unknown ..	—	—	—	5	5
Lymphocytic:					
Acute	8	4	2	10	24
Subacute ..	1	—	1	—	2
Chronic .. .	2	1	—	—	3
Unknown ..	—	—	—	3	3
Lymphosarcoma (19):					
Monocytic:					
Acute .. .	3	—	—	—	3
Unknown:					
Acute .. .	2	—	1	44	47
Subacute ..	—	—	—	3	3
Unknown ..	1	—	8	18	27
<i>Indians (23)</i>					
Granulocytic:					
Acute	—	1	1	2	4
Subacute ..	1	—	—	—	1
Chronic .. .	4	—	—	2	6
Unknown ..	—	—	—	1	1
Lymphocytic:					
Acute	1	1	1	2	5
Unknown:					
Acute	—	—	—	4	4
Unknown ..	—	—	—	2	2
<i>Malays (17)</i>					
Granulocytic:					
Acute	2	—	—	2	4
Chronic .. .	2	—	—	1	3
Lymphocytic:					
Acute	1	—	—	2	3
Unknown:					
Acute	—	—	—	2	2
Unknown ..	—	—	1	4	5
<i>Eurasians (2)</i>					
Granulocytic, chronic	1	—	—	—	1
Lymphosarcoma (2):					
Unknown .. .	—	—	—	1	1
<i>Europeans (5)</i>					
Granulocytic:					
Acute	1	—	—	—	1
Chronic .. .	1	1	—	—	2
Lymphosarcoma (2):					
Unknown:					
Acute .. .	—	—	—	2	2
<i>Others (3)</i>					
Granulocytic:					
Acute	—	—	—	1	1
Chronic .. .	1	—	—	—	1
Unknown:					
Unknown ..	—	—	—	1	1

Indians and Europeans are largely explained by the preponderance of males in these respective populations.

Age Incidence

The proportion of young people in the populations of the Far East is much higher than in white populations in Europe and North America, and since mortalities from leukaemia in the latter are higher in the older age-groups (see Fig. 2), comparisons of crude mortality rates for these different populations may be misleading. The population structure in Singapore, derived from census returns in 1947 and 1957, is shown in Fig. 3. Chinese mortality rates from leukaemia in different age-groups, based on 202 cases in this series, are shown in Fig. 4. (The age of one Chinese patient with leukaemia is unknown.)

Type Incidence of Leukaemia

We have classified the 253 cases of leukaemia and 23 cases of lymphosarcoma in this series in Table IV, in accordance with the recommendations of the Committee for Clarification of the Nomenclature of Cells and Diseases of the Blood and Blood-forming Organs (1950), except that we have retained the use of the term "lymphosarcoma," which is still generally used in preference to the recommended term "lymphocytic

FIG. 4.—Mortality from leukaemia in Chinese population of Singapore, 1949-58.

FIG. 3.—Age distributions of Singapore Chinese and non-Chinese populations, 1947 and 1957.

TABLE V.—Incidence of the Various Types of Leukaemia in Different Population Groups

References	Regions	No. of Cases Analysed	Incidence of Leukaemia						Remarks
			Chronic		Acute and Subacute			All Acute, Subacute and Monocytic	
			Lymphocytic	Granulocytic	Lymphocytic	Granulocytic	Monocytic		
Ward (1917)	Many countries	729	12%	34%	—	—	—	55%	No data on acute forms of leukaemia
Panton and Valentine (1929)	London	172	15%	52%	—	—	—	34%	
Gardikas <i>et al.</i> (1955)	England	Almost 1,000	30%	30%	—	—	—	—	
Scott (1957)	London	169	—	—	—	—	—	—	The 169 cases of acute, subacute and monocytic leukaemia include 5 erythraemias, 57 acute, subacute, and lymphocytic, 84 granulocytic, and 23 monocytic leukaemias. No data on chronic forms
Gauld <i>et al.</i> (1953)	Scotland	647	32%	26%	22%	11%	9%	42%	
Husebye and Gaustad (1956)	Oslo, Norway	122	16%	21%	—	—	—	63%	
Nordenson and Asplund (1956)	Sweden	1,548	38%	9%	3%	21%	2%	53%	821 acute, subacute, and monocytic leukaemias include 221 stem-cell leukaemias and 190 "paraleukaemien." These figures exclude 187 "retikulosen"
Gram and Nielsen (1932)	Denmark	300	37%	35%	3%	3%	—	29%	
Videbaek (1947)	Copenhagen, Denmark	310	41%	25%	—	—	1%	34%	
Donner and Maly (1954)	Prague, Czechoslovakia	539	32%	36%	—	—	—	32%	86 acute leukaemias include 66 with cell type undifferentiated; 300 total excludes 3 aleukaemic granulocytic leukaemias and 241 other leukaemias (7 aleukaemic) all not further differentiated
Alferi and Capone (1954)	Rome, Italy	244	20%	33%	13%	11%	2%	40%	
Ruol and Corsi (1954)	Padua, Italy (adults)	305	27%	30%	11%	9%	2%	42%	
Rosenthal and Harris (1935)	New York, U.S.A.	455	23%	35%	7%	29%	33%	40%	244 cases include 14 "istioleukaemia" and 1 basophil leukaemia. 98 acute, subacute, and monocytic leukaemias include 36 erythraemias
Rosenthal (1954)	New York, U.S.A.	479	22%	18%	3%	45%	13%	60%	
Leavell (1938)	New York, Boston, and Philadelphia, U.S.A.	478	27%	38%	—	—	—	—	
MacMahon and Clark (1956)	Brooklyn, U.S.A. (white)	1,516	26%	21%	9%	31%	5%	52%	128 acute, subacute, and monocytic leukaemias include 61 "emocitoblastiche" and 2 "eritroleucemie." 305 total cases also include 2 chronic "istioleucemie" and 1 chronic "eritroleucemie." These figures exclude 2 acute "reticulo-istiotarie," 12 acute and subacute, and 20 other leukaemias, all not further differentiated
Kirshbaum and Preuss (1943)	Cook Co., U.S.A. (white)	94	24%	17%	11%	27%	3%	59%	
Latourette <i>et al.</i> (1954)	Michigan, U.S.A.	777	29%	31%	12%	10%	18%	40%	
Sacks and Seeman (1947)	Baltimore, U.S.A.	92	22%	18%	27%	28%	4%	60%	160 cases of chronic granulocytic leukaemia include 3 eosinophil leukaemias, 15 cases of monocytic leukaemia, 6 "aleukaemic leukaemias"; 455 total cases also includes "6 myelocytic and 4 polymuclear cell leukaemias associated with polycythemia"
Wintrobe (1951)	Baltimore, U.S.A. (white)	142	33%	35%	—	—	—	32%	
Bethell (1943)	Michigan, U.S.A.	415	19%	37%	14%	21%	10%	44%	
Best and Limarzi (1952)	Chicago, U.S.A.	851	33%	25%	8%	18%	5%	42%	These figures exclude 7 plasma-cell and 3 reticulum-cell leukaemias, and other cases of myelofibrosis, myelomatosis, and follicular lymphoblastoma
Rubnitz (1952)	Nebraska, U.S.A.	100	25%	37%	—	—	—	38%	
Steinkamp (1954)	St. Louis, U.S.A.	548	—	—	—	—	—	—	
Kirshbaum and Preuss (1943)	Cook Co., U.S.A. (coloured)	27	11%	15%	4%	30%	7%	74%	No data on acute forms
Wintrobe (1951)	Baltimore, U.S.A. (coloured)	21	33%	43%	—	—	—	24%	
MacMahon and Clark (1956)	Brooklyn, U.S.A. (coloured)	70	17%	26%	23%	23%	4%	57%	
Rosenfeld (1955)	Sao Paulo, Brazil	273	11%	27%	—	—	—	62%	Excludes 2 lymphocytic and 1 chronic leukaemia, all not further differentiated
Gunz and Hough (1956)	New Zealand	523	15%	19%	25%	25%	1%	66%	
Earle (1943)	Samoa	7	—	—	43%	57%	—	100%	
Chatterjee (1958)	Calcutta, India	252	6%	38%	18%	25%	10%	54%	346 cases of acute, subacute, and monocytic leukaemia include 77 with no data on cell type. These figures exclude 8 lymphocytic and 6 granulocytic (chronicity not stated), 9 chronic leukaemias (not further differentiated), and 7 others (no further data given)
Hibino <i>et al.</i> (1958)	Japan	321	1%	62%	32%	—	4%	36%	
Present series	Singapore (Chinese)	168	2%	24%	15%	27%	2%	74%	
									125 acute leukaemias include 50 with cell type undifferentiated; 168 total excludes 5 granulocytic, 3 lymphocytic, and 27 other leukaemias, all not further differentiated

sarcoma." We have listed lymphosarcoma in Table IV immediately below the lymphocytic leukaemias to emphasize the close relationship between lymphosarcoma and chronic lymphocytic leukaemia. The only definitive distinction between the two conditions appears to be that lymphosarcomas (lymphomas) "are not characterized by diffuse marrow dissemination early in their course" (Committee for Clarification of the Nomenclature of Cells and Diseases of the Blood and Blood-Forming Organs, 1950), a distinction which we have sometimes been quite unable to make in retrospect. If chronic lymphocytic leukaemia and lymphosarcoma are in fact only slightly different manifestations of the same condition, the relative rarity of the former in the Far East would have less aetiological significance if compensated by a relatively greater number of lymphosarcomas.

However, even if the cases of lymphosarcoma in our series are added to those of chronic lymphocytic leukaemia, the proportional incidence of the two together in the Chinese population is still far less than that of chronic lymphocytic leukaemia in white populations (see Table V), and the mortality in the older age-groups of Chinese is not greatly altered (see Table VI). The highest proportions of chronic lymphocytic leukaemia have been reported from Scandinavia, with successively lower proportions in other white populations, in American coloured populations, in Indians, and in Japanese, Chinese (present series), and Samoans (see Table V).

FIG. 5.—Age distribution of 115 cases of acute leukaemia in Singapore Chinese.

FIG. 6.—Age distribution of 40 cases of chronic granulocytic leukaemia in Singapore Chinese.

of leukaemia in younger age-groups all over the world, and the Singapore incidence is therefore to be expected because of the high proportion of young people in our population. The age distribution of 115 cases of acute leukaemia in Singapore Chinese is given in

TABLE VI.—Mortality Rates in Different Age-groups of Chinese From Leukaemia and Lymphosarcoma. (Rates per 100,000 Population)

Age-groups in Years	Leukaemia Alone		Leukaemia and Lymphosarcoma	
	Males	Females	Males	Females
<5	1.31	0.53	1.31	0.53
5-9	2.40	1.44	2.53	1.44
10-14	3.96	1.86	4.34	2.07
15-19	2.24	1.11	2.24	1.11
20-24	3.38	1.35	3.90	1.35
25-29	2.06	1.49	2.65	1.49
30-34	2.69	2.84	3.03	2.84
35-39	3.10	1.47	3.44	1.47
40-44	4.25	2.35	4.60	2.74
45-49	1.96	2.80	2.35	3.26
50-54	2.00	3.49	2.25	4.65
55-59	4.29	2.31	4.29	2.31
60-64	2.38	1.05	2.38	2.10
65-69	2.38	1.54	4.74	1.54
70+	2.83	1.38	2.83	1.38

Fig. 5, showing a peak distribution in the 10-19 age-group, and contrasts with the age distribution of 40 cases of chronic granulocytic leukaemia in the same population, showing a peak in the 30-39 age-group (see Fig. 6).

Summary

A total of 253 cases of leukaemia known to have occurred in Singapore during the 10-year period 1949-58 are analysed. In the last two years of this period the reported mortality from leukaemia was 3.6 per 100,000 males per annum, and 1.9 per 100,000 females per annum. The mortality rates from leukaemia in Singapore are compared with those reported from 17 other countries.

The rarity of chronic lymphocytic leukaemia is confirmed in Chinese, this form accounting for only 3 out of 203 cases of leukaemia in Singapore Chinese. This finding is compared with the proportional incidence of the commoner forms of leukaemia reported in several other countries.

We are grateful for the help and co-operation we have received from Professor G. A. Ransome (department of medicine), Professor T. A. Lloyd Davies (department of social medicine), Professor R. Kirk (department of pathology), Dr. L. S. da Silva (senior Government pathologist), Dr. K. Shanmugaratnam (senior clinical pathologist), Dr. E. Field (physician in charge of the paediatric unit), Mr. Choo Kim Hock (registrar of births and deaths), and Mr. E. J. Phillips (chief Government statistician).

REFERENCES

- Alfieri, A., and Capone, M. (1954). *Polliclinico, Sez. prat.*, **61**, 681.
 Best, W. R., and Limarzi, L. R. (1952). *J. Lab. clin. Med.*, **40**, 778.
 Bethell, F. H. (1943). *Ann. intern. Med.*, **18**, 757.
 Chatterjee, J. B. (1958). Personal communication.
 Committee for Clarification of the Nomenclature of Cells and Diseases of the Blood and Blood-forming Organs (1950). *Amer. J. clin. Path.*, **20**, 563.
 Donner, L., and Maly, V. (1954). *Čas. Lék. česk.*, **93**, 1056.
 Earle, A. M. (1943). *J. Pediatr.*, **43**, 398.
 Gardikas, C., Leonard, B. J., and Wilkinson, J. F. (1955). In *Modern Trends in Blood Diseases*, edited by J. F. Wilkinson, p. 230. Butterworth, London.
 Gauld, W. R., Innes, J., and Robson, H. N. (1953). *Brit. med. J.*, **1**, 585.
 Gram, H. C., and Nielsen, R. (1932). *Ugeskr. Læg.*, **94**, 437.
 Gunz, F. W., and Hough, R. F. (1956). *Blood*, **11**, 882.
 Hibino, S., Takikawa, K., and Kimura, K. (1958). *Proc. 6th. int. Congr. int. Soc. Hematol., Boston, 1956*, p. 172. Grune and Stratton, New York.
 Husebye, K. O., and Gaustad, V. T. (1956). *Acta med. scand.*, **156**, 183.
 Kirshbaum, J. D., and Preuss, F. S. (1943). *Arch. intern. Med.*, **71**, 777.
 Latourette, H. B., Lampe, I., and Hodges, F. J. (1954). *Univ. Mich. med. Bull.*, **20**, 283.
 Leavell, B. S. (1938). *Amer. J. med. Sci.*, **196**, 329.
 MacMahon, B., and Clark, D. (1956). *Blood*, **11**, 871.
 Majumdar, A. R., and Chatterjee, S. C. (1953). *Bedside Medicine*, 9th ed., p. 988. Scientific Publication Concern, Calcutta.
 Nordenson, N. G., and Asplund, A. G. (1956). *Acta med. scand.*, **154**, 31.
 Pantou, P. N., and Valentine, F. C. O. (1929). *Lancet*, **1**, 914.
 Rosenfeld, G. (1955). *Acta Un. int. Cancr.*, **11**, 313.
 Rosenthal, N. (1954). *Bull. N.Y. Acad. Med.*, **30**, 583.
 — and Harris, W. (1935). *J. Amer. med. Ass.*, **104**, 702.
 Rubnitz, A. S. (1952). *Neb. St. med. J.*, **37**, 95.
 Ruol, A., and Corsi, G. C. (1954). *Acta med. patav.*, **14**, 627.
 Sacks, M. S., and Seeman, I. (1947). *Blood*, **2**, 1.
 Scott, R. B. (1957). *Lancet*, **1**, 1053.
 Steinkamp, R. C. (1954). Quoted by J. V. Cooke, *Blood*, 1954, **9**, 340.
 Strong, R. P. (1944). *Stitt's Diagnosis, Prevention and Treatment of Tropical Diseases*, 7th ed., p. 1591. Blackiston, Philadelphia.
 Videback, A. (1947). *Acta med. scand.*, **127**, 26.
 Ward, G. (1917). *Brit. J. Child. Dis.*, **14**, 10.
 Wells, R. (1958). *Trans. roy. Soc. trop. Med. Hyg.*, **52**, 431.
 Wintrobe, M. M. (1951). *Clinical Haematology*, 3rd ed., p. 808. Kimpton, London.
 Witts, L. J. (1957). In *The Leukaemias: Etiology, Pathophysiology and Treatment*, edited by J. W. Rebuck, F. H. Bethell, and R. W. Monto, p. 154. Academic Press, New York.
 World Health Organization (1955). *Epidem. vital Statist. Rep.*, **8**, 81.