Outside Europe

Epidemiology of Rheumatic Heart Disease in Black Schoolchildren of Soweto, Johannesburg

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Summary

A survey to determine the prevalence of rheumatic heart disease (R.H.D.) in Black children was conducted in the creches and primary schools of the South Western Townships of Johannesburg (Soweto). A total of 12 050 Black children were examined by 10 cardiologists in May to October 1972. The overall prevalence rate of R.H.D. was 6·9 per 1000, with a peak rate of 19·2 per 1000 in children of the seventh school grade. The maximal age incidence was 15-18 years and there was a female preponderance of 1·6:1. A rise in prevalence occurred with increasing family size. Most children (92%) were asymptomatic, and in 82·5% R.H.D. was diagnosed for the first time during the school survey. The commonest valve lesion was mitral regurgitation, which was present in 93% and occurred as an isolated lesion in 47·5%. Lancefield's group A β-haemolytic streptococcus was isolated from the throats of 52 per 1000 Soweto children. The auscultatory features of a non-ejection systolic click and late systolic murmur were prevalent (13·9 per 1000) and had several epidemiological factors in common with R.H.D.

A comprehensive preventative campaign is urgently needed in South Africa, directed at both primary and secondary prophylaxis of R.H.D. The socioeconomic status of the community must be improved if optimal prevention is to be achieved.

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Introduction

In most developed countries the reported incidence of both rheumatic fever and rheumatic heart disease (R.H.D.) has declined dramatically.[1] As the onset of this preceded the advent of antibiotics other factors must have played a role. These factors include greater accuracy in the diagnosis of R.H.D. and the recognition of physiological murmurs, a possible decrease in virulence of Lancefield's group A β-haemolytic streptococcus,[2] and a general improvement in the socioeconomic status in those countries.[3] In the Republic of South Africa R.H.D. remains prevalent in all population groups. Each year at least 100 Whites with R.H.D. are referred for the first time to the cardiac clinic of the Johannesburg General Hospital. In the indigenous Blacks established R.H.D. is even more common and is often encountered at a young age and in a severe form, which frequently necessitates cardiac surgery.[4-6] Prevalence data have been based mainly on hospital admissions,[7] necropsy figures,[4] and clinical experience. A preliminary survey[8] of 428 Black Soweto schoolchildren, aged 2-12 years suggested a possible prevalence rate of 5-10 per 1000. In May 1972 an epidemiological survey to define the exact magnitude of the problem in Black children was started in the creches and schools of Soweto.

Subjects and Methods

Soweto, which lies next to the south-western boundary of the city of Johannesburg, was founded in 1932. It now covers an area of 26·2 square miles and is the fourth largest town in South Africa with a population of at least 600 000 Blacks, 55% of whom are below 20 years of age.[9] The inhabitants include the many different Black ethnic groups of Southern Africa, but as a result of integration these groups are differentiated in the present generation mainly by language only. Most of the population are unskilled workers, but a small middle class also exists.

SAMPLING

About 99 000 children were attending school at the time of the survey.[10] With the estimated prevalence rate for R.H.D. of 5-10 per 1000[8] we had to examine 12 000 children to provide enough positive cases for a meaningful statistical analysis. The method of sampling was based on a stratified technique.[11] An age distribution study undertaken before the survey showed that an age range of 2-18 years was obtainable from creches, lower primary schools (first four school grades), and higher primary schools (fifth to eighth school grades). Notwithstanding a fairly wide age range in each class there was still a high correlation between age and educational grade. The Soweto children were thus placed into three strata—creche children (3755), lower primary schoolchildren (61 876), and higher primary schoolchildren (30 393), and the sample size for each stratum was determined. Thirty-two creches,

32 lower primary schools, and 26 higher primary schools were selected from all areas of Soweto. The sample of children from each school grade was drawn at random. Since there was good reason to predict that the prevalence of R.H.D. would increase with age the strata were expected to have different prevalence rates. Thus, in estimating the overall prevalence of R.H.D. in the school population the optimally weighted estimate[11] was used. This consists essentially of estimating the prevalence within each stratum and weighting these estimates with the known total size of the strata. This figure is more accurate than the raw estimate obtained by dividing the number of children with R.H.D. observed by the total sample size. For all other statistical tests the strata were aggregated.

EXAMINATION

The children were examined by 10 observers comprising five cardiologists and five trainee consultants who had received at least six months' training in this cardiac unit. Three observers, at least one of whom was a senior cardiologist (J.B.B., G.E.G., or W.A.P.), were present at each session. The survey was conducted on three days of each week and each observer could see up to 25 children an hour. The total sample was examined in five months, from May to October; July was excluded because of the school vacation.

Auscultation was performed on all children in the supine and left lateral positions. A random 10% of children were also examined both standing and squatting. Children with normal hearts were examined by one observer only. All those with abnormal hearts were assessed independently by each of the three observers and possible observer bias was eliminated by "recirculating" these children. When an observer detected or suspected that a child had an abnormal heart that child was recirculated, unbeknown to the other two observers, and later examined by both of them. At the end of each session all children with abnormal hearts as well as those in whom the diagnosis was in doubt were reassessed by the three observers in consultation. In all cases the three observers had to agree that R.H.D. was present before the diagnosis was accepted. Several weeks after the survey had begun, however, it became apparent that a non-ejection systolic click and late systolic murmur were unexpectedly common abnormal auscultatory findings. In such cases, therefore, the child was no longer recirculated but these auscultatory features had to be confirmed by one of the other two observers. Electrocardiograms and blood pressure determinations were recorded on all children with abnormal hearts as well as on the postured group. Children with R.H.D. were referred to hospital for chest radiographs and treatment.

OTHER INVESTIGATIONS

Factors which may play a role in the epidemiology of R.H.D. were investigated. Throat swabs for Lancefield's group A β-haemolytic streptococci were taken from the children and plated immediately on to blood agar culture medium. The nutritional status of all children was assessed both clinically and by a detailed anthropometric study. The age, sex, language, home and school areas, and family size (as assessed by the number of siblings), were recorded. An indication of socioeconomic status was obtained from an additional survey conducted in the homes of the children with R.H.D. and an equal number of controls matched for age, sex, language, educational level, and area. Further details of the family, degree of crowding, and economic conditions were elicited and at the same time a follow-up study on the group with R.H.D. was performed. Statistical analysis of this data was based on two techniques, a χ^2 test for nominal data and a Student's t test for all interval data which was unpaired, except for the socioeconomic home survey, in which there were matched controls.

The many children who had to be examined provided an opportunity of making observations on the prevalence of physiological third heart sounds, innocent murmurs, and congenital heart disease (subjects of further communications, together with the results of the anthropometric and electrocardiographic studies).

Results

GENERAL STATISTICS

A total of 12 050 children were examined with an equal number of boys and girls. There were 2375 creche children and 4827 lower primary and 4848 higher primary schoolchildren. Four arbitrary age groups were represented as follows: 2-6 years, 21%; 7-10 years, 29%; 11-14 years, 35%; and 15-18 years, 15%. The average number of siblings per child was 5·4.

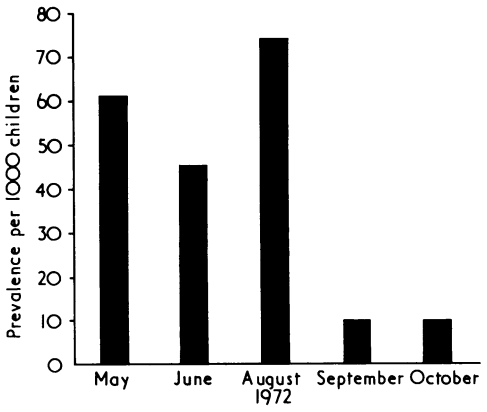

FIG. 1—Monthly carrier rate of Lancefield's Group A β-haemolytic streptococcus in throats of Soweto children. July was omitted due to school vacation.

Lancefield's group A β-haemolytic streptococcus was isolated from the throats of 52 per 1000 children. The carrier rate was highest during the winter months of May to August (fig. 1) and dropped dramatically with the advent of warmer weather in September and October ($P<0.001$). There was a significant correlation with educational grade ($P<0.001$) and the streptococcus was most prevalent in the higher primary schools with a peak of 71 per 1000 in the fifth and sixth school grades.

On clinical assessment 86·5% of children were regarded as being of average nutritional status, whereas under-nutrition was thought to be present in 6·8%. The remainder were assessed as unusually well nourished or obese.

RHEUMATIC HEART DISEASE

R.H.D. was detected in 80 children, yielding an optimally weighted overall prevalence rate of 6·9 per 1000 with a 95% confidence interval of ±1·5. Creche children (2-6 years) had a comparatively low prevalence rate of 0·8 per 1000. If this first stratum is ignored, as in most other surveys on R.H.D., the prevalence in Soweto schoolchildren is increased to 7·1 per 1000. In lower and higher primary schoolchildren the prevalence rates were 5·2 and 11·0 per 1000 respectively.

A significant variation ($P<0.001$) in prevalence occurred with school grade (fig. 2). The highest prevalence rate was recorded in children of the seventh school grade—19·2 per 1000. In the eighth school grade the rate dropped to 9·9 per 1000 and the difference between these two prevalence rates was close to statistical significance ($P=0.05$).

A linear relationship of R.H.D. to age was observed. The prevalence was 4·2 per 1000 in children of 7-10 years, 9·9 in children of 11-14 years, and 12·2 in the 15-18 years age group. The sex ratio showed a female preponderance of 1·6:1. A variation in pre-

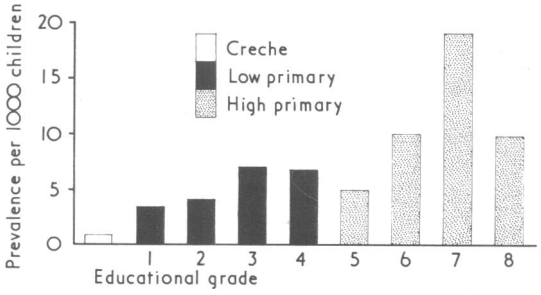

FIG. 2—Varying prevalence of R.H.D. with educational grade of Soweto children.

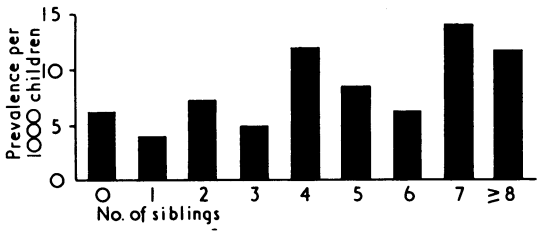

FIG. 3—Association of prevalence of R.H.D. in Soweto children with family size.

valence with family size was also shown (fig. 3), and a χ^2 test did not exclude the possibility of a linear association ($P>0.05$). The prevalence was significantly greater in those children with four or more siblings ($\chi^2=5.18$; $P<0.05$).

There was no significant variation in prevalence with language group or the home and school areas of the children ($P>0.05$). There was also no significant correlation between the prevalence of R.H.D. and the carrier rate of Lancefield's group A β-haemolytic streptococcus in the different areas of Soweto ($P>0.05$).

The socioeconomic home survey showed no significant differences between children with R.H.D. and the comparable control group. The only factor of possible significance was the number of people sharing the child's "bedroom," which was a mean of 4·3 for the children with R.H.D. and 3·9 for the control group ($P=0.05$).

In 82·5% of children with R.H.D. a cardiac lesion was detected for the first time during the school survey. Eight of the 14 children who had had R.H.D. diagnosed earlier were receiving prophylaxis against rheumatic fever. There was no history to suggest previous rheumatic fever in 39 children (49%). A definite history of rheumatic fever was elicited from only nine children, while the remaining 32 had had symptoms compatible with previous rheumatic activity, such as repeated sore throats, arthralgia, and arthritis. Most children (92%) with R.H.D. denied any cardiac symptoms.

Mitral regurgitation was the commonest valvular lesion, occurring in 76 (95%) of the affected children and as an isolated lesion in 38 children. In all the children with rheumatic mitral regurgitation an apical pansystolic murmur was audible. All those with isolated mitral regurgitation had a left-sided third heart sound which, in some instances, was followed by several low pitched vibrations. Mitral stenosis of varying degree was detected in 38 children (47·5%), but pure mitral stenosis was rare, being present in two children only. Aortic incompetence was diagnosed in nine children, three of whom had some associated aortic stenosis. Only one 16-year-old girl with mild aortic incompetence showed no certain clinical evidence of associated mitral valve involvement; she had a definite history of previous rheumatic fever and was receiving penicillin prophylaxis. A non-ejection systolic click was audible in three children with R.H.D., all of whom had an apical pansystolic murmur, and in two a mitral mid-diastolic murmur was also present.

The valve lesions were mild in 66% of the children, moderate in 29%, and severe in 5%. In only one child, a 7-year-old girl with mixed mitral valve disease, were the leaflets of the mitral valve rigid. In a 9-year-old girl a Starr-Edwards mitral valve prosthesis was present. Acute rheumatic activity was suspected in four children with R.H.D. at the time of examination. In eight cases of R.H.D. the diagnosis was made by the first observer, but was missed on "recirculation." In four of these children R.H.D. was not detected by either of the subsequent observers and in the other four children by one of them.

Fifty-nine of the children with R.H.D. reported to hospital for posteroanterior and lateral chest radiographs. Examination of the chest films was carried out independent of the clinical assessment by three observers, who had previously been shown to be accurate in their observations on cardiac x-ray pictures.[12] There was a good correlation between the radiological and clinical assessments and the mild nature of the cardiac lesions in most children was confirmed. The cardiothoracic ratio exceeded 50% in 26 children and the maximum ratio was 65·1%. In 28 of the children the x-ray pictures were regarded as normal.

Prevalence Rates of R.H.D. Obtained From Recent Surveys

Place of Survey	Year	Age Range (Years)	Prevalence Rate per 1000
Rocky Mountain[25]	1956-61	Predominantly 18 years	5·3
San Luis Valley[39]	1960	6-18 years	3·7
Denver[17]	1963	5-18 years	1·7
Japan[13]	1966	Primary and secondary schoolchildren	3·8
Tokyo[13]	1966	Primary and secondary schoolchildren	0·3
Northern India[14]	1966-70	0-20 years	1·4
Oregon[40]	1966	College students	2·1
Egypt[41]	1967	6-12 years	1·3
Teheran[16]	1969-70	4-15 years	22·0*
Barbados[15]	1970	5-11 years	1·0
Soweto	1972	2-18 years	6·9
		6-18 years	7·1

*Based on 500 children examined at one school only.

LATE SYSTOLIC MURMURS AND NON-EJECTION SYSTOLIC CLICKS

The auscultatory features of a late systolic murmur, non-ejection systolic click, or both were detected in 168 children, giving a total prevalence rate of 13·9 per 1000. The three children who had R.H.D. and non-ejection systolic clicks were not included in this total. A non-ejection systolic click alone was present in 71·4% of these children, an isolated late systolic murmur in 4·8%, and both these features in 23·8%. The prevalence was greatest in children of large families and in the higher primary schools, where a peak rate of 20 per 1000 was recorded in the seventh and eighth school grades. The maximal age incidence was 15-18 years and a female preponderance was also observed.

Discussion

Prevalence rates for R.H.D. obtained from recent population surveys in other parts of the world are listed in the table. Comparing the figures shown in those surveys with those from our Soweto survey not only confirms the expected high prevalence of R.H.D. in Black children in Johannesburg but also shows that Soweto has one of the highest rates in comparable studies anywhere[17] over the past 30 years.

The root cause of this high prevalence almost certainly lies in the low socioeconomic status of this urban Black community. As long ago as 1930 when the incidence of rheumatic fever was already declining in Britain and the United States, Glover[18] stated, "No disease has a clearer cut 'social incidence' than acute rheumatism which falls perhaps 30 times as frequently upon the poorer children of the industrial town as upon the children of the well-to-do. . . . the incidence of acute rheumatism increases directly with poverty, malnutrition, overcrowding, and bad housing." Overcrowding has since been shown to be the most important factor in contributing to a high incidence of R.H.D. and accounting for the varying prevalence with ethnic group and socioeconomic level.[19] In Soweto overcrowding is rife in schools and homes due to a shortage of both and to the large family size. There is no comparable data on the prevalence of R.H.D. among rural Blacks or other racial groups in South Africa and similar population surveys would enable the significance of this factor to be assessed more accurately. Malnutrition may play a role[20] but has not been fully investigated.[1] In the Soweto survey undernutrition was detected more often in the children with R.H.D., but observer bias was probable as the observers making the clinical assessment had already recognized the presence of R.H.D. Confirmation from the anthropometric study is required, but even if obtained the possibility that undernutrition resulted from the rheumatic activity would remain.

The Soweto rate probably represents an underestimate of the true prevalence of R.H.D. in this community. Because education for Black children in South Africa is not compulsory an unknown number of children do not attend school and were not represented in the Soweto sample. Therefore, the population examined may have been a relatively privileged group. Children with severe R.H.D. would also be less likely to attend school.

A possible explanation for the unexpected fall in prevalence rate from the seventh to the eighth school grade is that there may be a tendency for children with more severe R.H.D. to drop their attendance in the eighth school grade or remain in the previous grade due to poor scholastic performance as a result of their illness. Alternatively, the higher prevalence in the seventh grade may be the direct effect of an epidemic of streptococcal infection in previous years.

The auscultatory findings of a non-ejection systolic click, late systolic murmur, or both almost invariably arise at the mitral valve,[21] and have aroused considerable interest in recent years.[22 23] Billowing of the mitral leaflets, especially the posterior leaflet, has often been shown by angiocardiographic studies.[22] Multiple aetiological factors, which include R.H.D., may affect the complex mitral valve mechanism and produce these auscultatory features.[21 23-26] Against the background of a high prevalence of R.H.D. and low socioeconomic status in Soweto the possibility that an unknown and probably large proportion of the 168 children with non-ejection systolic clicks or late systolic murmurs have mild R.H.D. cannot be ignored. The evidence we found for a rheumatic aetiology is by no means conclusive, but neither is it contradictory. A female preponderance also occurs in the idiopathic "billowing mitral leaflet syndrome,"[21 22] and since that entity may show slow progression[27] the increasing prevalence of late systolic murmurs and non-ejection systolic clicks in older children is not meaningful evidence of a rheumatic aetiology. There was, however, a correlation between the prevalence of R.H.D. and these auscultatory findings and large family size and thus, by inference, overcrowding. Further elucidation of this problem is essential. We shall carefully follow-up the 168 children who are not on prophylaxis against rheumatic fever to observe the natural history and examine, where possible, their siblings to detect R.H.D. or a familial incidence of the "billowing mitral leaflet syndrome." Studies to assess the prevalence of these features in population groups in which R.H.D. is less common would be contributory.

A comprehensive preventative campaign against R.H.D. is urgently needed in South Africa and should be directed at both primary and secondary prophylaxis.[28] The low incidence of a previous history of rheumatic fever may indicate a common tendency of rheumatic fever to present in a mild form or with carditis alone,[29] as has been suggested to occur in Blacks of the United States.[30] Primary prophylaxis against the antecedent streptococcal infection is therefore very important. It is mandatory for long-term and optimal prevention that the socioeconomic status of the community, and especially overcrowding, be improved. Nevertheless, it would be some time before a socioeconomic level could be reached at which a decline in the prevalence of R.H.D. would be expected from an improvement in living conditions alone.[31] Therefore, additional prophylactic measures are essential to solve the problem in the immediate future. Education of the populace so that sore throats would receive adequate medical attention is both necessary and practicable. Unfortunately, about a third of cases of rheumatic fever occur in the absence of a previous symptomatic streptococcal throat infection.[32] So if primary prophylaxis is to be effective the streptococcal infection must be actively sought or prevented. Routine throat cultures on school-children could be performed.[33] Alternatively, antibiotics could be given to the entire school population prophylactically at times of increased risk, such as during the winter. Parenteral benzathine penicillin is the most reliable form of treatment and prevention,[34] but its use in an apparently normal Black school population is limited by the untoward effects of local discomfort and the risk, however small, of fatal anaphylaxis.[35] The use of oral penicillin V or sulphonamides is more practicable though it has disadvantages due to the erratic compliance of schoolchildren. The development of a safe and effective antistreptococcal vaccine which could be given to all children would obviate these disadvantages and provide an immediate and simple means of primary prophylaxis.[1 32]

Mild mitral regurgitation was the commonest valve lesion in Soweto children; if infective endocarditis does not supervene and recurrences of rheumatic fever are adequately prevented the rheumatic process may be arrested and may even regress.[36] Secondary prophylaxis would entail the routine examination of higher primary schoolchildren by trained auscultators to detect the large reservoir of children with undiagnosed R.H.D. Existing health services should be expanded for the adequate surveillance of these children. Ideally, a special rheumatic fever and R.H.D. care centre should be established in Soweto and later in other areas of South Africa. Such a centre could carry out and co-ordinate the functions of both primary and secondary prophylaxis and monitor the incidence of these conditions to assess the effectiveness of preventative measures.[31] Considerable organization and the co-operation and expertise of the health authorities are required.

R.H.D. remains a formidable health challenge in the Republic of South Africa despite the declining incidence in other economically advanced countries. The cost of instituting and maintaining an effective preventative programme is far outweighed by that of admitting patients with established R.H.D. to hospital and treating them, either medically or surgically.[37]

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Clinical Topics

Comparison of Results of Treatment of Hydrocele and Epididymal Cysts by Surgery and Injection

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Summary

A comparison has been made between a series of hydroceles and cysts of epididymis treated by surgery with a complication rate of at least 17% haematoma and 10% sepsis, an average hospital stay of five days, and a much longer time off work, and a series treated by tapping and injection (described in detail) requiring one to three visits to outpatients, an almost negligible complication rate, and no failures in those completing treatment.

Introduction

Hydrocele and cyst of the epididymis may be treated by operation or by tapping and injection. An assessment of the results of both methods with their complications is presented here. Patients with both conditions who had been treated by operation by junior or senior staff members of the Radcliffe Infirmary were reviewed from the records retrospectively from the end of 1973 until 100 had been found who had had no other simultaneous operation on the groin or scrotum (mainly for hernia).

The operations were of all types including excision of the sac, unfolding of the sac, and plication of the sac through a small incision, depending on the size of the swelling and the operator's inclination.

Results of Operation

The total number of patient-days averaged just over five, with 64 patients spending one to five days and 46 patients spending over five days—a total of 504 hospital-bed days. Forty-two complications were recorded and some may have been unrecorded as this is a retrospective study; there were 17% with haematoma, 10% with sepsis, and 15% with "swelling with induration" (clearly used as a euphemism for haematoma at times). The time off work would have been a minimum of two weeks and much longer with some, one patient being off work for at least 10 weeks. At times scrotal bandaging was used to diminish the high incidence of haematoma and the less traumatic plication operation was also employed, notation being inadequate to allow a true analysis of these points. Nevertheless, on analysis, the complication rate was surprisingly high.

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COMMENT

Treatment by tapping is often employed in those needing immediate relief or those refusing operation, but most doctors do not use an injection in such patients. I have used tapping and injection for over 20 years for the small and medium-sized hydroceles, with surgery for the large ones, but the method for the larger ones has been tried only in the last few years. Only when an attempt was made, two years ago, to assess the results from the outpatients' notes was it found that the latter were not included in the excellent disease and operation index of the hospital and their recovery for analysis would have been a Herculean task for the record clerks. So a prospective study was made of the patients treated through part of 1972, '73, and early '74 to provide a retrospective sample.

Results of Prospective Study

Cysts of the epididymis numbered 18 in 14 patients, the largest three being 420 ml (14 oz), 360 ml (12 oz), and 250 ml (8 oz). Five patients made one outpatient attendance for tapping and injection, seven made two, five made three, and one made six.

Fourteen hydroceles in 12 patients were treated to cure, the largest being one of 650 ml and two of 600 ml. One patient with a 700-ml hydrocele asked for surgery after two injections (a small one of 20 ml on the other side being cured with one injection) and was not discouraged from operation.

Two patients at the second visit were noted to have nodular testicles, with blood-stained fluid in one after tapping, and were promptly explored in case of any remote possibility of tumour; both proved to have some fibrin accumulation only.

Five patients attended once for tapping and injection, three attended twice, and four attended three times; for a hydrocele of 650 ml eight visits were made, but this patient was lost to my view and quite inadequate amounts were injected. My staff did some of the treatments, as service exigencies made it impossible for me to do them all. Generations of students have had the method demonstrated to them, almost all of these treatments being given in an outpatient session.

In this series there were no complications of haematoma or sepsis, but in the hundreds treated in the last 20 years I have produced two cases of haematoma (due, no doubt, to pricking a largish vessel in tapping) and one of sepsis, undoubtedly following a haematoma. The