nosis depends upon clinical judgment. This is given to few: most have to learn it, often by bitter experience. Can we expect newly qualified doctors after a six-year undergraduate course in which most have never had the opportunity of examining a child with a suspected acute abdomen . . . to be expert in handling children? The time allocated to paediatrics, and more particularly to the clinical surgery of childhood in the medical course, is out of proportion to their importance in the work of the general practitioner." In this department medical students have one month's residence in hospital on combined medical and surgical wards during the course of their three months' paediatric training, so that they will be able to see the "acute abdomen" on arrival in hospital among the other emergency admissions. It would be even more important and useful for the student to see such children in their own homes with an experienced family doctor so that he can observe how the latter tackles the problem at first hand.

But, however careful and detailed the teaching at the undergraduate stage, the high level of diagnostic skill so rightly demanded by Mason Brown cannot be achieved at that stage. Practical postgraduate experience must be added to theoretical knowledge, and the doctor who wants to practise good family medicine must be ready to give sufficient time to prepare himself for it. Six months of experience in paediatrics, preferably in a combined medical and surgical unit, should be an essential part of the training of the future family doctor.

Summary

The facts about 313 children with acute appendicitis are presented and analysed with particular reference to the difficulties and delays in diagnosis.

The high rate of perforation is related to the length of history. In many cases parents are to blame for failure to send for their family doctor, and he in turn finds difficulty in diagnosing the disease in the younger child and in those in whom the appendix is lying in a position other than the classical one. In older children the fact that the pain is intermittent or mild is a contributory factor. In making a diagnosis of acute appendicitis the history of the disease is of less help to the doctor than the physical examination.

A plea is made for the better education of parents in the significance of abdominal pain in childhood, and for a period of paediatric residence, preferably in a combined medical and surgical unit, for doctors intending to go into family practice.

My grateful thanks are due to my surgical colleagues already mentioned for all their help, and to Professor S. D. M. Court and Dr. F. J. W. Miller, who shared with them the care of these children. I am particularly indebted to Professor Court and Mr. J. E. S. Scott for their helpful criticisms of this paper.

REFERENCES

- Apley, J. (1959). *The Child with Abdominal Pains*. Blackwell, Oxford.
 Black, W. R. (1948). *Brit. med. J.*, 2, 424.
 Brown, J. J. Mason (1956). *J. roy. Coll. Surg. Edinb.*, 1, 268.
 Buntin, G. L. (1953). *Brit. med. J.*, 2, 71.
 Dennison, W. M., and MacPherson, D. A. (1952). *Glasg. med. J.*, 33, 175.
 Fields, I. A., Naiditch, M. J., and Rothman, P. E. (1957). *J. Dis. Child.*, 93, 287.
 Foster, J. H., and Edwards, W. H. (1957). *Ann. Surg.*, 146, 70.
 Fraser, I., and McCredie, J. A. (1955). *Brit. med. J.*, 2, 867.
 Hindmarsh, F. D. (1954). *Ibid.*, 2, 388.
 Hudson, H. W., jun., and Chamberlain, J. W. (1939). *J. Pediat.*, 15, 408.
 Longino, L. A., Holder, T. M., and Gross, R. E. (1958). *Pediatrics*, 22, 238.
 Minervini, F., and Santulli, T. V. (1958). *J. Pediat.*, 52, 324.
 Scott, H. W., jun., and Ware, P. F. (1945). *Arch. Surg.*, 50, 258.
 Skyrme Rees, W. (1952). *Lancet*, 2, 1199.
 Williams, H. (1947). *Brit. med. J.*, 2, 730.

SMALLPOX VACCINATION

SUCCESS RATES OF SCRATCH AND MULTIPLE PRESSURE TECHNIQUES

BY

GEOFFREY J. BOURKE, M.B., D.P.H., D.C.H.
Lecturer in Social Medicine, Trinity College, Dublin

NOEL CLARKE,* M.A., M.D., B.Sc.
Lecturer in Pathology, Trinity College, Dublin

An outbreak of smallpox occurred in England early in January, 1962. A number of the students returning to Trinity College, Dublin, for Hilary Term, 1962, had spent their vacation in England, and some even in Bradford, where the initial outbreak had occurred (Douglas and Edgar, 1962). In response to their many requests for smallpox vaccination the University authorities decided that vaccination should be offered to any student who wished to avail himself of it.

Material and Methods

Notices were displayed in the College informing students that vaccination would be available to those who wished to be vaccinated. Persons under 21 years of age were required to have the written consent of their parents or guardians.

The vaccine used was calf lymph supplied by Connaught Laboratories, Toronto. The batch was stored at 7° C. and small quantities were taken as required. Alternate subjects were vaccinated by linear scratch and multiple-pressure techniques, using a separate capillary tube of lymph for

each individual. The inoculation was made with the sterile round-bodied needle supplied with the lymph, and the needle was then discarded. Three doctors (X, Y, Z), working together, carried out the initial vaccinations in the same hall on two successive days.

Details of Technique

Doctor	Scratch Method (Single Linear)	Multiple-pressure Method (Less than $\frac{1}{4}$ in. (6 mm.) Diameter)
X	Skin break—vertical and less than $\frac{1}{4}$ in.	{ Primary —10 pressures Revaccination —30 "
Y	Skin break—vertical and $\frac{1}{4}$ in.	{ Primary —10 Revaccination —10 "
Z	Skin break—transverse and less than $\frac{1}{4}$ in.	{ Primary —24 Revaccination —24 "

The skin was gently cleaned with an ether swab and allowed to dry. The lymph was expelled from the capillary tube (by means of the rubber bulb provided) on to the skin approximately 1 in. (2.5 cm.) above the insertion of the deltoid, and the vaccination was made through the lymph. Vaccination on other sites was discouraged, but three females who made repeated requests were vaccinated on the lateral thigh. In the scratch method the vaccination was made deep enough (Cross, 1961) to draw the smallest

*Present address: National Institutes of Health, Bethesda 14, Maryland, U.S.A.

visible punctum of blood at some point along the length of the scratch. A standard multiple-pressure technique was used (Leake, 1927). The lymph was rubbed gently with the side of the needle into the injured skin and left exposed for five minutes. No dressing was applied. An instruction sheet was issued to each subject telling him/her to apply a loose plain lint dressing when a definite lesion appeared, advising against active sport or getting the site wet, and indicating the dangers of touching the lesion or the discharge from it. An appointment for inspection of the vaccinated area was also given at this time.

Reading of Results

All vaccinations were inspected on the eighth day, and the minimal lesion accepted at this time as evidence of a successful vaccination was a palpable indurated papule. A simple non-elevated erythema, a scab without a palpable indurated papule, or a statement from the person vaccinated that a reaction had been observed and had since disappeared was regarded as a "no-take" and revaccination was offered. These revaccinations were inspected on the third, fifth, and eighth post-vaccinal days. For the purpose of reading results the following reactions were defined, the classification being supported where necessary by the patient's statement.

Primary reaction—where the maximum local effect occurs around the 10th day in persons not previously successfully vaccinated. The lesion passes through the stages of papule, vesicle, pustule, and scab.

Accelerated (vaccinoid) reaction—where the maximum local reaction occurs generally between the third and seventh days in persons previously successfully vaccinated. The lesion passes through all the stages of the primary reaction, though more rapidly.

Immediate (so-called immune) reaction—where a papular reaction with palpable induration occurs and has not yet reached its maximum and begun to subside by the fifth day.

Revaccination primary reaction—a primary-like reaction in persons previously successfully vaccinated, with evidence of a scar.

Results

The results relate to 994 persons (636 males) on whom complete data were obtained.

Vaccinations and Reaction Type

As will be seen from Table I, 808 (81.3%) vaccinations were successful on the first attempt; 154 of the 186 unsuccessfully vaccinated presented for a second vaccination, with success in 112 (72.7%) on this occasion. Of all the students vaccinated 210 had not been vaccinated previously; 204 (97.1%) of these were successfully vaccinated

TABLE I.—Vaccinations and Reaction Type

	First Vaccination					Second Vaccination				
	No Previous Vaccination	Previous Vaccination			Total	No Previous Vaccination	Previous Vaccination			Total
	P	A	I	RP		P	A	I	RP	
Successful	204 (97.1%)	505	53	46	808 (81.3%)	3 (50%)	57	49	3	112 (72.7%)
Unsuccessful	6 (2.9%)	180			186 (18.7%)	3 (50%)	39			42 (27.3%)
Total	210 (100%)				994 (100%)	6 (100%)				*154 (100%)

* 32 did not attend for revaccination.

P=Primary. A=Accelerated. I=Immediate. RP=Revaccination primary.

at the first attempt, and three of the six unsuccessful subjects had successful revaccinations.

In the analysis below, in which the differential success rates of the scratch and multiple-pressure techniques are considered, the results of only the first vaccinations are taken into account. The results of the second vaccinations are not included, as it was thought that undue care might have been exercised in performing the second vaccination or that one might have been influenced in interpreting the readings.

Vaccination Techniques and Sex

Table II shows that there is a significant difference between the success rates of the two methods of vaccination, and separate analysis shows that varying the number of pressures in the multiple-pressure technique or varying the length of the scratch, at least within the limits outlined, is not of importance in attaining successful vaccination.

TABLE II.—Technique of Vaccination

	Scratch	Multiple-pressure	Total
Successful	372 (76.7%)	436 (85.7%)	808 (80.0%)
Unsuccessful	113 (23.3%)	73 (14.3%)	186 (19.9%)
Total	485 (100%)	509 (100%)	994 (100%)

$$\chi^2 = 13.10; n = 1; P < 0.001.$$

Tables VII and VIII, however, demonstrate that the difference between the two techniques does not apply to primary vaccination ($\chi^2 = 0.12$, $n = 1$, $P = 0.72$), but to revaccination only ($\chi^2 = 14.03$, $n = 1$, $P < 0.001$).

The analyses which follow were made in order to explore the possible influences of sex, interval since last vaccination, number of previous vaccinations, age, and country of origin* on the outcome of vaccination by the techniques employed.

It will be seen from Table III that for the scratch method at the 5% level there is, *prima facie*, a significant association between successful vaccination and females (or lack of success and males). Before accepting this, however, we must be assured that the results are not affected by such factors as period since last vaccination, number of times

TABLE III.—Scratch Technique: Influence of Sex

	Male	Female	Total
Successful	220 (73.6%)	152 (81.7%)	372 (76.7%)
Unsuccessful	79 (26.4%)	34 (18.3%)	113 (23.3%)
Total	299 (100%)	186 (100%)	485 (100%)

$$\chi^2 = 4.25; n = 1; P = 0.04.$$

previously vaccinated, age, and country of origin. As shown below, age is not a factor promoting differences, and in any event the average age of males and females did not diverge significantly (22.7 years for males and 22.1 years for females).

Country of origin has some influence, and a small part of the observed sex difference may be attributed to the fact that a greater proportion of the males (11.4%) than the females (4.3%) came from outside Europe. If the home distribution had been the same for both sexes the sex differential in the success rates would have been less significant ($\chi^2 = 3.79$, $n = 1$, $P = 0.05$).

Another factor to be considered is the difference between the sex groups in the number of times previously vaccinated, but when one corrects for this factor the significance of the original finding is unaltered ($\chi^2 = 4.10$,

*Where the individual has lived for the greater part of his life.

$n=1$, $P=0.04$). On the other hand, when account is taken of the period since last vaccination, because a greater proportion of males had been recently vaccinated (for example, 24.1% of the males, as compared with 15.1% of the females had been vaccinated within the past ten years) the difference is easily explained; having corrected the figures for the period since last vaccination the χ^2 value is reduced to 2.65 (for $n=1$, $P=0.10$).

Table IV demonstrates that, in contrast to the initial results from the scratch technique, for the multiple-pressure method there is no significant association between successful vaccinations and sex. As with the scratch group, one finds a greater proportion of males (12.5%) than females

TABLE IV.—Multiple-pressure Technique: Influence of Sex

	Male	Female	Total
Successful ..	292 (86.6%)	144 (83.7%)	436 (85.7%)
Unsuccessful ..	45 (13.4%)	28 (16.3%)	73 (14.3%)
Total ..	337 (100%)	172 (100%)	509 (100%)

$$\chi^2=0.79; n=1; P=0.40.$$

(5.8%) from outside Europe, but allowance for this factor does not alter the above conclusion ($\chi^2=2.43$, $n=1$, $P=0.13$). Likewise, the fact that 22.6% of the males as compared with 18.6% of the females had not been previously vaccinated does not affect the conclusion that there is no significant sex differential in the rate of successful vaccination ($\chi^2=0.86$, $n=1$, $P=0.36$). A correction for the fact that 20.5% of the males and only 16.3% of the females had been vaccinated in the preceding ten years also does not affect the original null hypothesis ($\chi^2=0.63$, $n=1$, $P=0.44$).

Further analysis of the figures contained in Tables III and IV demonstrates that the scratch and multiple-pressure techniques do not differ significantly in their success rates in females ($\chi^2=0.25$, $n=1$, $P=0.63$), but there is a significant difference between the two techniques in males ($\chi^2=17.24$, $n=1$, $P<0.001$), and this latter difference applies only to revaccination, not to primary vaccination.

Vaccination Techniques and Period Since Last Vaccination

The significant association between successful vaccination and the period since last vaccination is demonstrated for the scratch technique in Table V. When the influence

TABLE V.—Scratch Technique: Influence of Interval Since Last Vaccination

	No Previous Vaccination	Period since Last Vaccination in Years					Total
		0-4	5-9	10-14	15-19	20+	
Successful {No. %	99 97.0	22 59.5	32 50.8	14 58.3	67 76.1	138 80.7	372 76.7
Unsuccessful {No. %	3 3.0	15 40.5	31 49.2	10 41.7	21 23.9	33 19.3	113 23.3
Total	102	37	63	24	88	171	485

$$\chi^2=59.53; n=5; P<0.001.$$

TABLE VI.—Multiple-pressure Technique: Influence of Interval Since Last Vaccination

	No Previous Vaccination	Period since Last Vaccination in Years					Total
		0-4	5-9	10-14	15-19	20+	
Successful {No. %	105 97.2	27 69.2	40 69.0	30 90.9	65 81.3	169 88.5	436 85.7
Unsuccessful {No. %	3 2.8	12 30.8	18 31.0	3 9.1	15 18.7	22 11.5	73 14.3
Total	108	39	58	33	80	191	509

$$\chi^2=36.21; n=5; P<0.001.$$

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of the number of times previously vaccinated (which drops from 2.1 times for those vaccinated within the last five years to 1.4 times for those vaccinated over 20 years ago) is ruled out the conclusion drawn from Table V remains unchanged.

In Table VI the association of successful vaccination by the multiple-pressure technique with the period since previous vaccination is obvious and cannot be controverted by the influence of the other factors which have been considered for the scratch method.

A comparison of Tables V and VI demonstrates the greater success of the multiple-pressure method in each group.

Vaccination Techniques and Number of Times Previously Vaccinated

Scratch Technique.—There is no doubt that the distribution of successful vaccinations by the scratch technique according to the number of times previously vaccinated (Table VII) clearly shows an inverse relation. There are, of course, differences in the composition of these four groups. For example, those who came from outside Great Britain and Ireland formed only 4.9% of those with no previous vaccination, but those vaccinated on two or more occasions formed 35.1%. However, as will be seen below, country of origin is not a factor, and making an allowance for it does not in any way affect the significance of the association shown in Table VII. There is, of course, a strong correlation between the number of times subjects have been previously vaccinated and the period since the last vaccination, but if the latter is eliminated the results still show that the number of previous vaccinations is a significant factor in determining the success of vaccination.

TABLE VII.—Scratch Technique: Influence of Number of Previous Vaccinations

	Not Previously Vaccinated	Previously Vaccinated				Total
		Once	Twice	Three or More Times	Total	
Successful {No. %	99 97.0	218 76.2	46 57.5	9 52.9	273 71.3	372 76.7
Unsuccessful {No. %	3 3.0	68 23.8	34 42.5	8 47.1	110 28.7	113 23.3
Total ..	102	286	80	17	383	485

$$\chi^2=45.59; n=3; P<0.001.$$

Multiple-pressure Technique.—Table VIII shows that there is an association between successful vaccination by the multiple-pressure technique and the number of previous vaccinations. Only part of this association can be explained when account is taken of the country of origin. Likewise, taking into account the period since previous vaccination only partly explains the association—the value of χ^2 reducing to 15.3, which, when $n=3$, still has a chance

TABLE VIII.—Multiple-pressure Technique: Influence of Number of Previous Vaccinations

	Not Previously Vaccinated	Previously Vaccinated				Total
		Once	Twice	Three or More Times	Total	
Successful {No. %	105 97.2	248 86.4	65 71.4	18 78.2	331 82.5	436 85.7
Unsuccessful {No. %	3 2.8	39 13.6	26 28.6	5 21.8	70 17.5	73 14.3
Total ..	108	287	91	23	401	509

$$\chi^2=27.37; n=3; P<0.001.$$

probability of less than 1%. We must conclude, therefore, that the association noted is undoubtedly significant.

Vaccination Techniques and Age

When the success rates are analysed by age there is no association with this factor for either the scratch ($\chi^2=4.89$, $n=6$, $P=0.56$) or the multiple-pressure ($\chi^2=5.48$, $n=6$, $P=0.48$) method, so age obviously does not influence the success rates of either technique in this study.

Vaccination Techniques and Country of Origin

At first glance a clear association between success, country of origin, and the scratch technique is suggested ($\chi^2=18.02$, $n=5$, $P=0.005$), there being a higher proportion of successful vaccinations among those coming from Ireland and Great Britain; in fact, this association is an illusion. The groups from the different areas varied appreciably in their previous vaccination histories. Of the 428 persons from Great Britain and Ireland, 97 (22.7%) had not been previously vaccinated, whereas only 5 (8.8%) of the 57 from elsewhere had primary vaccinations. More significantly, only 12.4% of those from Great Britain and Ireland had been vaccinated in the last ten years as compared with 35 (63%) of those from outside these islands. To these two factors—times previously vaccinated and period since last vaccination—then, can be attributed the apparent association noted. When the success rates in each area are standardized so as to eliminate the effect of the period since last vaccination, the χ^2 value becomes 2.65 ($n=5$, $P=0.75$).

As with the scratch technique, an association is suggested between success, country of origin, and the multiple-pressure method ($\chi^2=26.04$, $n=5$, $P<0.001$). In this instance, however, the association does not lend itself to complete explanation by the factors examined in the preceding paragraph. There were 107 (24.2%) of the Great Britain and Ireland group who had not previously been vaccinated but only 1 of the 67 from elsewhere. Furthermore, only 53 (12%) of those from Great Britain and Ireland had been vaccinated in the last ten years as compared with 44 (65.7%) of those from elsewhere. When one corrects the intercountry comparisons to allow for these factors, the significance of the association of home with success rate of vaccination lessens, but the value of χ^2 does not drop below 19.6, which, for $n=5$, is of course still highly significant ($P=0.002$). Looking more closely at the results, the most important departures from the null hypothesis are in respect of those persons who come from Africa. This was also found in those vaccinated by the scratch method, but the departure from expectation in that case was not so pronounced.

Discussion

In a comprehensive monograph on smallpox, Dixon (1962), referring to vaccination, states that, "simple as it may appear, it is difficult to get unbiased accurate observations on the different techniques carried out under identical conditions."

From the preceding analyses in this study the following facts emerge: there is a significant difference between the success rates of the scratch and multiple-pressure techniques of vaccination; multiple pressure gives a higher success rate in revaccination. This difference between the success rates of the two methods, following the statistical analysis presented above, appears to be due to the greater failure of the scratch method in previously vaccinated males.

A number of authors are of the opinion that there is a higher success rate with the multiple-pressure method (Edsall, 1947; Mole, 1947). The only direct comparison of the scratch and multiple-pressure techniques in adults which we can trace is that of Mole (1947), who found that multiple-pressure technique gave a significantly higher success rate for revaccination.

Smallpox vaccination differs from most immunological procedures since it is necessary to introduce active virus into the living cells of the epidermis. In primary vaccination this is relatively easy, and we have noted above that there is no significant difference for sex or technique among primary vaccinations. In revaccination, however, we come up against the problem that residual immunity may impede the multiplication of virus. It is almost certain that in the scratch method there is a greater outpouring of cell constituents and/or extracellular fluid from the injured area than in the multiple-pressure method, where the skin injuries are more discrete, and consequently the outflow of these substances is more scattered and less concentrated. This greater outflow in the scratch method may be sufficient to interfere with virus propagation in some cases and could therefore explain the difference in the success rates for the two methods among revaccinations.

It remains to explain the difference between the two techniques in males. Mole (1947) reported a sex difference in the results of both methods among males and females in the R.A.F., all of whom had been previously vaccinated. Males showed a higher failure rate than females, but analysis of his figures does not demonstrate any *significant* difference for these methods among males and females. The figures are, unfortunately, rather small (122 males and 52 females), but they show the success rate to be lowest when the scratch method was used in males.

It has been noted that the difference between the scratch and the multiple-pressure method in males does not apply to primary vaccinations, and this suggests that antibody plays an important part when revaccinating males. If, as has been stated, there is a greater outflow after a scratch injury, then to explain the difference in the success rates for the two techniques in males without a similar difference in females it is possible that (1) there is a greater residual titre of antibody in males; (2) male antibody may have a greater avidity for vaccinia virus; (3) there is a greater outflow of antibody in males after the scratch technique; (4) the vaccinators unconsciously produced less trauma with the scratch method in females, despite the adoption of a pre-defined scratch technique. It is impossible at present to state which, if any, of these hypotheses is correct.

From the foregoing analysis and discussion it is clear that if maximum success is to be achieved when revaccinating males the multiple-pressure method should be used and the scratch method avoided. The importance of this finding lies in the possibility that antibody sufficient to prevent a "take" when the scratch technique is used may, on the other hand, be insufficient to protect against an attack of smallpox.

Summary

The results of the vaccination of 994 persons against smallpox by the scratch and multiple-pressure techniques are presented. The two methods are taken separately and the relation of successful vaccination to five relevant factors is considered.

On the first attempt a total of 808 (81.3%) vaccinations were successful and 186 (18.7%) unsuccessful. Of the 154 second vaccinations, 112 (72.7%) were successful and 42

(27.3%) unsuccessful. The total successes from both vaccinations numbered 920 (92.6%).

Multiple pressure gave a higher success rate than the scratch technique in persons previously vaccinated, and the difference between the success rates for the two methods is due to the greater failure of the scratch method in previously vaccinated males. No significant difference for either sex or with either technique was noted among primary vaccinations.

Some possible explanations for the difference between the two techniques in previously vaccinated males are discussed.

We acknowledge with thanks the advice and encouragement given to us by Professor W. J. E. Jessop, Professor R. A. Q.

O'Meara, and Professor F. S. Stewart. We are grateful to Dr. J. D. McKeever, Dr. M. T. Deasy, Miss N. Douglas, Mrs. E. McSweeney, and Miss M. Hanna for their assistance. We are indebted to Mr. E. H. Thornton, lecturer in statistics, for his advice. Finally our thanks are due to Dr. M. D. MacCarthy and Mr. J. Knaggs, Central Statistics Office, Dublin, for their help, and to the students of the University who made this study possible.

REFERENCES

- Cross, R. M. (1961). *Bull. Wld Hlth Org.*, **25**, 7.
Dixon, C. W. (1962). *Smallpox*, p. 131. Churchill, London.
Douglas, J., and Edgar, W. (1962). *Brit. med. J.*, **1**, 612.
Edsall, G. (1947). *Lancet*, **1**, 887.
Leake, J. P. (1927). *Publ. Hlth Rep. (Wash.)*, **42**, 221.
Mole, R. H. (1947). *Lancet*, **1**, 597.

BONE INVOLVEMENT AFTER VACCINATION AGAINST SMALLPOX

BY

W. COCHRAN, M.B., F.R.C.S.Ed.
Paediatric Surgeon, Ulster Hospital, Belfast

J. H. CONNOLLY, M.D.
Virologist, Virus Reference Laboratory, Department of Microbiology, Queen's University, Belfast

I. D. THOMPSON, M.D., F.R.C.S., D.M.R.D.
*Radiologist, South Tyrone Hospital, Dungannon, and
Mid-Ulster Hospital, Magherafelt*

Involvement of bone is one of the rarest complications after vaccination against smallpox. The following case is presented as the first one in the British Isles confirmed by virus isolation, and also because the condition may be difficult to distinguish from the other hyperostoses of infancy.

Case History

The patient was the second male child of healthy parents. Neither the parents nor the elder brother had reacted abnormally to smallpox vaccination. At the age of 3½ weeks the child was vaccinated by scarification high over the left deltoid. The reaction was "severe"; and there was massive but intact vesiculation set in an area of intense erythema 1 in. (2.5 cm.) in diameter, which subsided completely in three weeks.

When 7½ weeks old and 28 days after vaccination, a diffuse, firm, and slightly tender swelling was found over the left scapula without evidence of superficial inflammation or of skin involvement and without much systemic upset. Eight days after this there was a loss of function of the left arm and the swelling over the scapula appeared larger. On admission to hospital the child was pale and looked ill, his Hb was 9.5 g./100 ml., the W.C.C. was 17,000/c.mm. (neutrophils 47%, lymphocytes 48%, eosinophils 2%), and the blood group was A, Rh+. An x-ray film of the left shoulder (Fig. 1) showed considerable deposition of periosteal new bone on both costal and dorsal surfaces of the body of the scapula, extending on to the lower surface of the spine. The scapular lesion was unilateral and the ipsilateral clavicle and humerus were not involved. Excessive periscapular soft-tissue swelling could be seen on x-ray examination at this stage.

Biopsies of the left scapula taken at 37 and 46 days after vaccination were not informative, being bacteriologically sterile and showing a non-specific histological picture of oedematous reactive changes in the periosteum and muscle fibrosis with a notable lack of inflammatory cell infiltration.

X-ray examination 56 days after vaccination showed a significant increase in the periosteal new bone deposited on the scapula. A poorly demarcated, translucent area was seen in the body of the left scapula in the region of the glenoid margin. This later spread in the body of the scapula and still later in the recovery stage a peripheral zone of sclerosis appeared, suggesting an attempt at repair. We feel it unlikely that these

changes are the result of a limited bone biopsy. They probably represent an area of osteitis. X-ray examination of the mandible, then, showed no abnormality.

Sixty-two days after vaccination his condition deteriorated and he was transferred to the surgical unit of the Royal Belfast Hospital for Sick Children. At this time he was pale and was running a low-grade pyrexia, though he was active and (at 12 weeks) weighed 14 lb. 14 oz. (6,750 g.). The scapular mass was now 4 cm. in diameter but no longer tender, and full passive movement was present at the shoulder-joint.

A third biopsy of the left scapula consisting of a piece of the body of the scapula, new bone, greatly thickened periosteum, and contiguous muscle was removed 67 days after vaccination. At operation the skin and subcutaneous fat looked normal, but the muscle was swollen, pale, unduly firm, and much less vascular than normal. Both bone and muscle

FIG. 1.—X-ray film of left shoulder region showing, in profile view of the scapula, considerable deposition of new bone. This was 40 days after vaccination and 12 days after the first local signs being noted.