DISPENSABILITY OF POST-OPERATIVE PENICILLIN IN SEPTIC-HAND SURGERY

BY

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The aim of this work was to evaluate the common use of penicillin after operations upon septic lesions of the hand. Localized infections only were considered, and attention was focused principally upon the rate of healing of abscess cavities following the evacuation of pent-up pus. Patients were treated in a special clinic, for Webster (1947) and other workers have obtained improved results by centralizing the treatment of hand sepsis.

Wilkes (1954) emphasized the economic importance of sepsis with a large series of hand infections where the average time lost from work was 24 days. A Ministry of Pensions and National Insurance digest for 1953-4 shows that the number of spells of certified incapacity due to cellulitis and abscess was 6% of the total from all causes. Although falling, this figure leaves no room for complacency, and close inspection of the methods of dealing with this type of lesion, with revision of these therapies where necessary, is constantly indicated.

Scope of the Investigation

All patients required surgery and were treated as out-patients. Children under 10 years were excluded. Each patient was assigned without bias to one of three categories—those dealt with by surgery alone, by surgery plus oral penicillin, or by surgery plus depot penicillin. There were 42, 34, and 27 patients respectively in each of these categories who had received various forms of chemotherapy elsewhere before attending the hand clinic.

The diagnostic classes were: (1) *Paronychia* of any degree, except with pus deep to the nail. (2) *Onychia*: pus under the nail (a) tracking from an adjacent focus such as a terminal abscess or paronychia, or (b) developing *in situ*—for example, an infected subungual haematoma. (3) *Pulp abscess* of the terminal pulp of the finger. (4) *Other abscesses*: (a) subcutaneous, on the volar or lateral aspects of a finger; (b) dorsal abscess of the hand or finger, often originating in an infected hair follicle; (c) web abscess; (d) palmar space abscess. (5) *Septic blister*: occasionally rectified if a subcutaneous extension was found at operation. (6) *Chronic infections* were those whose pre-operative duration exceeded 27 days.

When clinically indicated radiographs (of both hands) were taken.

At operation swabs were taken from the exposed infected tissues for culture and for sensitivity tests to penicillin and erythromycin.

The criteria of healing were a dry completely epithelized wound, full function of the affected member, and no need for further dressings or attendance. The healing-time was the number of days between operation and final discharge.

All the patients were seen by me pre- and post-operatively; some of the operations were done by colleagues with agreed uniformity of procedure.

Surgical Technique and Post-operative Treatment

Each loculus of pus and the point of maximal tenderness were ascertained with patience and precision in the pre-operative planning of an approach to the lesion. The fore-

limb was thoroughly washed and upper garments were removed. All operations were performed under general anaesthesia (trichlorethylene, nitrous oxide, and oxygen) in a bloodless field obtained by elevation of the limb and applying a pneumatic tourniquet.

The planned incision, remote from pressure areas, of minimal length, and in the optimum position for drainage, was generally made in the line of a skin furrow (longitudinal or slightly oblique on the antero-lateral aspect of a finger or transverse on the dorsum). Sometimes an undesirable site where the abscess pointed had to be used.

The roof of a septic blister was removed and a collar-stud extension sought. In paronychia a formal flap was raised and an appropriate portion of the nail-base removed; a unilateral incision sufficed for less extensive cases. For onychia, only nail undermined by pus was removed; this was occasionally combined with a unilateral paronychia incision or the opening of a terminal abscess. Web-space abscess was opened by an antero-posterior incision.

Pus and slough were removed by gentle mopping or excision and the abscess cavity was inspected by direct vision. Loculations were opened, avoiding unnecessary interference with healthy tissue. The skin edges, always in a precarious state of vitality, were never forcibly retracted or held by coarse instruments. Only the corner of a small portion of tulle gras was slipped between the lips of the incision or under the paronychia flap. Early in the investigation it seemed beneficial to avoid too much tulle gras, so just enough was used to keep the wound edges apart or to cover a raw area with a little circumferential overlap.

A generous dressing of gauze and cotton-wool was firmly applied, the tourniquet released, and the limb elevated during the recovery period. The arm was kept in a sling and daily exercise periods were advised. Codeine compound tablets were prescribed. Two days after operation a simple dry dressing was applied, and also at later inspections at two- or three-day intervals, an infrequency which reduced the chance of cross-infection, the expenditure of materials, and the strain on the dressings staff.

Oral penicillin was given at the makers' recommendation of 1,200,000 units of "cristapen" daily in divided doses. A printed dosage schedule was included with each supply of tablets and a few patients suspected of not adhering to it were excluded from the series irrespective of their clinical progress.

Depot penicillin was given by intramuscular injection as "seclopen," 1 ml. containing 300,000 units of procaine benzylpenicillin and 100,000 units of sodium benzylpenicillin, morning and evening until the inflammatory reaction had subsided and the wound was virtually healed. Serum levels of penicillin were estimated in each of three blood samples obtained by venepuncture on successive post-operative days before the morning injection in 42 patients of this group.

Results

Of the 357 patients treated, 16 (4.4%) failed to return for dressings, 15 (4.3%) had chronic infections, and 6 (1.7%) had complications. No case of erysipeloid was seen. A patient with acute suppurative tenosynovitis and another two with septic interphalangeal arthritis were referred for in-patient treatment. Both cases of palmar abscess were superficial to the aponeurosis.

Table I shows that in the "depot penicillin" treatment group the overall average healing-time was 0.23 day less than in the "no chemotherapy" group. Shortening of the average healing-times in the depot category for onychia, pulp abscess, other abscesses, and septic blister was 0.2, 1.0, 0.4, and 0.6 day, respectively; paronychia took 0.02 day longer. In the "oral penicillin" category the healing-times were shorter in onychia, pulp abscess, and other abscesses by 2.1, 1.2, and 0.4 days respectively, but in the paronychia group healing took 1.6 days longer.

TABLE I.—Results of Treatment

Type of Lesion	No Chemotherapy		Oral Penicillin		Depot Penicillin		Total No. of Patients	Average Healing-time (Days)
	No. of Patients	Average Healing-time (Days)	No. of Patients	Average Healing-time (Days)	No. of Patients	Average Healing-time (Days)		
Paronychia ..	39	8.46	34	10.06	29	8.48	102	9.00
Onychia ..	13	8.92	10	6.80	8	8.75	31	8.19
Pulp abscess ..	20	11.10	31	9.90	31	10.13	82	10.28
Other abscesses ..	31	10.06	32	9.69	31	9.65	94	9.80
Septic blister ..	3	6.00	3	6.00	5	5.40	11	5.73
Overall ..	106	9.42	110	9.50	104	9.19	320	

TABLE II.—Overall Results for Patients not Receiving Preoperative Chemotherapy

Post-operative Treatment Group					
No Chemotherapy		Oral Penicillin		Depot Penicillin	
No. of Patients	Average Healing-time (Days)	No. of Patients	Average Healing-time (Days)	No. of Patients	Average Healing-time (Days)
64	9.07	76	9.25	77	9.67

Patients who received no chemotherapy before operation were assessed separately (Table II). The overall average healing-time in the "depot" group was 0.4 and 0.6 day more than in the "oral" and "no chemotherapy" groups, respectively.

Chronic cases were placed on the same rota as acute cases and treated similarly; 13 (87%) were paronychia and 10 (66%) had received previous treatment by incision or penicillin or by both. The average healing-time was 83.3 days, although the average preoperative duration was 83.3 days, as Table III shows. Two (16.6%) gave cultures of *Staphylococcus aureus* sensitive to penicillin and erythromycin, 7 (58.3%) produced no growth, and 3 (25.1%) gave *Staph. aureus* resistant to penicillin but sensitive to erythromycin.

Bacteriological results are shown in Table IV. Of the 260 swabs taken from acute infections 220 (84.6%) produced growths of *Staph. aureus*, 37 (14.2%) gave no growth, 2 (0.8%) gave *Staph. albus*, and from 1 (0.4%) a strain of yeast was isolated. Of the cultures of *Staph. aureus* 183 (83%) were fully sensitive to penicillin, and 37 (17%) were penicillin-resistant. All were sensitive to erythromycin.

Penicillin Blood Levels.—Of the 42 patients whose blood samples were examined 34 (81%) had bacteriostatic levels of penicillin. The specimens from 4 (9.5%) patients were contaminated or destroyed and 4 (9.5%) had no penicillin or very small amounts.

X-ray films revealed no bone infections.

TABLE III.—Chronic Cases

Type of Lesion	No.	Duration (Days)	Healing Time (Days)
Paronychia ..	13 (87%)	85.2 (average)	12.7 (average)
Onychia ..	1 (7%)	112	12
Subcutaneous abscess	1 (7%)	30	8
Overall ..	15	83.3	12.3

TABLE IV.—Bacteriological Results

	Staphylococcus aureus				Other Growth	No Growth	Total Cultures
	Penicillin-sensitive	Penicillin-resistant	Erythromycin-sensitive	Total			
Acute infections	183 (83%)	37 (17%)	220 (100%)	220	3	37	260
Chronic infection	2 (40%)	3 (60%)	5 (100%)	5	—	7	12

Complications.—Six patients had prolonged healing-times due to factors summarized in Table V—namely, inadequate surgery in three cases; a yeast infection, refusal to rest the part, and general uncleanliness in the others. Each had a deviation from the treatment method of its original category, perforce or through not attending, and therefore could not be legitimately included in one treatment group. However, an analysis including these cases, except No. 1, in their original categories showed no significant difference between the overall average healing-times of the different treatment groups.

An allergic reaction occurred in a patient who had a palmar abscess. While taking oral penicillin he developed a generalized irritative rash and swelling of the lips which was relieved by 50 mg. of diphenhydramine hydrochloride three times a day for a few days.

Occupation.—Table VI shows that more than half of the patients were unskilled workers, jute-workers, or housewives; groups which account for a high proportion of the population of Dundee. The remainder were distributed amongst engineering trades, miscellaneous skills, farm- and wood-workers, building and contracting trades, electricians,

TABLE V.—Complications

No.	Diagnosis	Healing Time (Days)	Details
1	Pulp abscess	189	Depot penicillin group. Yeast infection. Admitted for antibiotic and operative treatment. Large loss of pulp substance but good flexion finally
2	" "	19	No chemotherapy group. Misdiagnosed and treated as septic blister. Given scopolon two days after operation. Discharged spontaneously
3	Palm "	30	No chemotherapy group. Misdiagnosed as septic blister. No extension seen at operation but further incision and scopolon given 5 days later
4	Paronychia	21	No chemotherapy group. Single incision inadequate. Double incision and removal of nail-base 10 days later
5	"	45	No chemotherapy group. Robust farmer, declined to rest limb or attend for regular dressings. Repeatedly superinfected
6	"	50	Depot penicillin group. Double incision and removal of nail-base adequate. Personal hygiene very poor

TABLE VI.—Occupational Incidence

Occupation	No.
Unskilled worker	73 (20.4%)
Jute-worker ..	73 (20.4%)
Housewife ..	55 (15.4%)
Housewife with other occupation	19 (5.3%)
Unemployed and school children	45 (12.6%)
Engineering trades	34 (9.5%)
Unclassified skills	29 (8.1%)
Farm-worker ..	12 (3.4%)
Wood-worker ..	11 (3.2%)
Building and contracting trades	3 (0.8%)
Electrician ..	3 (0.8%)
	357 (100%)

and schoolchildren. The low occurrence of electricians, 0.8%, is surprising in view of their frequent handling of small, sharp-pointed instruments and wire.

The preponderance of unskilled workers suggests that occupational interest and skill may be associated with personal attendance to cleanliness and well-being, whilst the hazards of the home or the housewives' degree of selflessness may be of a high degree.

Discussion

Penicillin assistance to localization in infections of the hand is generally accepted and has been supported by Gordon (1951) and Robins (1952). Post-operatively its value is not clear. Curr (1945) found the results of administering intramuscular penicillin to a few cases not encouraging;

Harrison *et al.* (1949), in a detailed study, concluded that systemic penicillin produced a significant reduction in the healing-time in pulp infections; Bolton *et al.* (1947) noted benefit in bony felons but not in simple pulp abscesses; Pilcher *et al.* (1948) questioned the best application of penicillin to infected hands, although acknowledging the antibiotic's general benefits; and a reduction in healing-time of acute paronychia, effected by intramuscular procaine penicillin and particularly by benethamine penicillin, has been shown by Williams *et al.* (1956). Bentley (1950) has advised post-operative penicillin for several days in infections of the hand. Bailey (1952) suggests intelligent selection of cases for chemotherapy rather than routine penicillin cover, and the use of the newer antibiotics if penicillin-resistant strains of *Staph. aureus* continue to increase. These conflicting opinions prompted the investigation.

Part of the solution to the epidemiological and surgical problems posed by the continued emergence of resistant staphylococci is suggested by the work of Clarke *et al.* (1952), who found that the greatest numbers of resistant staphylococci were in environments where most antibiotic treatment was given, and by the investigations of Blowers *et al.* (1955), which showed that where the routine administration of penicillin was stopped the proportion of resistant strains declined. These findings strengthen the belief that excessive use of penicillin is an important factor in reducing its value and that this may be restored by limiting administration to essential cases.

To deny a patient the possible benefits of penicillin demands sound proof of its dispensability. The reduction in the overall average healing-time of less than a quarter of a day in the "depot penicillin" group as compared with the "no chemotherapy" group, under the conditions of this investigation, does not justify the administration of penicillin post-operatively without a special reason.

The argument that the uncontrolled factor of preoperative chemotherapy in this series might selectively affect healing times is invalidated by the figures in Table II, which closely correspond to the overall figures (Table I) of the whole series, upon which a statistical analysis was carried out.

The distributions of the observed healing-times about the means are not symmetrical, and in order to justify the application of conventional tests of significance to the data the transformation factor $y = \sqrt{x+1}$ was applied, where x was the healing-time in days. This brought the distributions closer to normality without selectively affecting the variance. An analysis of variance on the transformed data for paronychia, onychia, pulp abscess, and other abscesses showed that the small differences in healing-time between the treatment groups could have arisen by chance on more than one occasion in 20 and thus did not achieve significance. However, the "depot penicillin" treatment effects for web abscess were significant at the 5% level, but there was no significant difference between the healing-time in the "no chemotherapy" and "oral penicillin" groups. The numbers in the dorsal (5), palmar abscess (2), and septic blister subgroups were too small for separate comparison.

TABLE VII.—Results of Treatment of Web Abscess

	No Chemotherapy	Oral Penicillin	Depot Penicillin
No. of cases	4	5	6
Average healing time (days)	11.5	12.2	7.3

Where $p < 0.05$.

Table VII shows the results of the treatment of web abscess. The reduction of four days in the average healing-time of the "depot penicillin" group may be due to the laxity of the tissues in the web spaces, permitting ready access of a blood-borne antibiotic which an increase in tension, such as would occur around an abscess in a digit, might be sufficient to reduce. Even in these cases, however,

the high blood levels obtained twice daily with seclophen seem to have been essential, and more cases are required to give confidence in the findings.

The success of surgery in chronic infections was striking. Although the average healing-time exceeded that of acute infections the results in this small series warrant further investigation into the timing of surgical intervention and the extent of drainage required, particularly in paronychia.

The six complicated cases clearly portray the consequences of misdiagnosis or mistimed surgery. In the most favourable circumstances Cases 2, 3, and 4 might have been saved one or two weeks of disability each. The presence of these three patients in the "no chemotherapy" group must be regarded as coincidental when the progress of the 106 others in this group is considered. The prolonged healing-time is readily explicable in each case by the factors outlined in Table IV. Lessons learned from these cases were usefully applied in the management of others, particularly at the stage of planning the incision.

Summary and Conclusions

A study of the post-operative care of 357 cases of sepsis of the hand is described. Three unselected treatment groups were obtained, receiving either no chemotherapy, oral penicillin, or intramuscular penicillin. The respective healing-times were 9.4, 9.5, and 9.2 days.

Careful clinical examination, accurate diagnosis, and precise surgery are of greater importance than routine chemotherapy. Indications for chemotherapy are suggested.

Some observations on infecting organisms, chronic lesions, and occupational incidence are made.

Routine post-operative penicillin does not hasten healing in septic lesions of the hand which require surgical treatment, provided that a careful technique is based upon anatomically accurate diagnosis.

Penicillin has been safely excluded from the post-operative environment of uncomplicated acute infections of the hand, and this may be a more fundamental counter to the emergence of resistant organisms than recourse to other antibiotics.

Possibly web abscess and threatened infection of the structures that move or support the hand are the only firm indications for chemotherapy, which will not act as a cover for misdiagnosis or inappropriate surgery.

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