THE PREVENTION OF SYRINGE-TRANSMITTED HEPATITIS*

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In March 1943, during a discussion held by the Medical Society for the Study of Venereal Diseases on the cause of jaundice in syphilitics, MacCallum suggested the possibility of an infective agent being transmitted from patient to patient by means of contaminated syringes. In July 1945, a Memorandum by Medical Officers of the Ministry of Health on "The Role of Syringes in the Transmission of Jaundice" appeared as a Special Article in the *Lancet*. In its "Conclusions" it is stated that "late hepatitis following arsphenamine, gold and other therapies is an expression of 'homologous serum jaundice' communicated by traces of blood transferred on syringes and needles from patient to patient" and that "the resistance of icterogenic agents to disinfection, and the impossibility of removing all traces of blood from syringes by the methods generally used, are factors calling for revision of existing injection techniques". I have made a study of these problems during the past two years, and it was thought that the results of my investigation, hitherto unpublished, might be of interest to other venereologists.

My remarks will be confined to a description of the injection technique developed two years ago in an attempt to reduce the incidence of hepatitis during anti-syphilitic treatment, together with the results obtained. It is not possible here to review the relevant literature nor to discuss data arising from my studies of other aspects of homologous serum jaundice in syphilitics. I should like, however, to trace briefly the chain of circumstances which led to the decision, made in October 1943, to develop a syringe technique specifically designed to eliminate any possible transfer of serum from one patient to another.

In March and April 1943, when MacCullum and Bigger both independently suggested the possibility of syringe transmission of an infective agent arising from the shortage of syringes and consequent difficulty in effecting sterilization by heat, I reviewed the position in my own practice. At that time I was in charge of a busy military centre and was also operating a smaller provincial civil clinic. The latter was attended by civilians and members of the armed Forces in about equal proportions; they shared common waiting and treatment rooms and received similar treatment with the same batches of drugs and the same syringes. In this clinic the syringes and needles, after use, were well washed in running water, immersed in antiseptic and washed out in sterile distilled water immediately before assembly for subsequent use. The antiseptic solution consisted of Lysol, 5 minims, methylated ether, 15 minims, and rectified spirit to 1 fluid ounce. The clinic possessed three 10-cubic-centimetre syringes of Record pattern, which were used in rotation for giving intravenous injections and collecting blood for serological tests, as occasion demanded; consequently the period of immersion in the antiseptic solution of each syringe between use for patients was extremely short. I invited the hospital pathologist to take cultures from the sterile distilled water, the syringes and the antiseptic fluid at the end of a busy clinic session. All cultures proved to be sterile, although we were naturally unable to attempt virus studies. Analysis of case records showed that the incidence of jaundice was about 6 per cent for civilians and about 20 per cent for the patients from the Forces attending the civil clinic. I concluded, at that time, that such a discrepancy in the jaundice rates of civilians and of members of the Forces, treated under apparently identical conditions, was against the theory of syringe transmission. As a consequence I continued to lean towards the theory of amino-acid deficiency, which Beattie, Marshall and others were studying at that time.

In September 1943, I was posted to another Command and quickly realized that there the problem of hepatitis was more serious and—in view of some fatalities from

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acute yellow atrophy—more urgent than my previous experience had led me to believe. At this time I had the good fortune to make official contact with Colonel Sheehan, who was also interested in this problem. He had already collected some data which suggested that the transmission of icterogenic blood from patient to patient, due to faulty syringe technique, was an actual possibility. The most significant part of Sheehan's evidence had just come to light.

It comprised records of 34 patients receiving treatment for syphilis in a Prisoners of War Camp. It so happened that these patients were divided into two groups, one group being treated on Wednesdays and the other on Fridays. The allocation of patients to one or other group was quite by chance but, once started in a particular group, the patient remained in it throughout his subsequent treatment. Apart from this subdivision for treatment, the patients all experienced identical environmental and dietetic conditions and received identical treatment. Syringes were sterilized by boiling at the beginning of the clinic session on Wednesday and again on Friday, but were only washed out between use for patients of the same group. There was thus an opportunity for transmitting a blood-borne infection among the members of one group but not of transmitting infection from one group to the other. It so happened that one patient introduced into the Wednesday group had received antisyphilitic treatment elsewhere before he came to the camp and was already in the incubation stage of hepatitis. In due course jaundice developed. In subsequent weeks 8 other men in the Wednesday group became icteric but the Friday group remained free from jaundice.

Revision of the injection technique accordingly appeared to us to be an urgent matter. It was planned in October 1943 but did not come into operation until the end of that year, as the additional syringes necessary only then became available. The technique itself is relatively simple and can be reproduced in any adequately staffed venereal diseases clinic. The principle underlying the whole procedure is the avoidance of the transfer of blood (and of any icterogenic agent contained therein) from one patient to another. For the sake of brevity, it will be referred to subsequently as the Preston technique, because it was there that it was developed and investigated.

The Preston technique of injection

The equipment used (see Diagram) is as follows.

- (1) A table (T.1) which supports an electric sterilizer (ST.).
- (2) A table (T.2) on which is laid the detachable tray of the sterilizer.
- (3) A large table (T.3) carrying the following apparatus.
 - (a) A tray of sterile needles.
 - (b) Cartons of the various medicaments required for intravenous use.
 - (c) A bottle of distilled water, freshly autoclaved.
 - (d) Sterile gallipots for mixing and dissolving the compounds.
 - (e) A bowl containing sterile wool swabs.
 - (f) Files for opening ampoules.
 - (g) A tall jar containing antiseptic to hold the Cheatle forceps.
 - (h) A large tray for unwrapping the lint square containing the sterilized components of the syringe.
- (4) A table (T.4) to support the patient's arm during injection; it also carries a drop bottle (DB.) containing spirit. The table is covered with a waterproof sheet.
- (5) A chair (C) on which the patient seats himself.
- (6) Two ward screens (Sc. 1 and Sc. 2) for privacy during injection and to prevent any unauthorized person from approaching table T.3.
- (7) A dressing-bucket (B), containing antiseptic, for the reception of used wool swabs.
- (8) A sink with draining-board (Dr.B.).
- (9) A large bowl (L) containing Lysol and supported on a stand.
- (10) A hand-basin (H.B.).
- (11) Two hand-towels (T.L.1 and T.L.2) hung on either side of the hand-basin.
- (12) Syringes (10 cubic centimetres) of all-glass or Record type. The total required is twice the number which can be sterilized at one time. In a busy department either an extra large sterilizer or two smaller sterilizers would be advantageous. The number of needles is the number of syringes plus 50 per cent, to allow for emergency: for example, a sterile needle may be dropped during attachment to the syringe. Each syringe has its own square of lint (2 feet square). This lint square serves a double purpose: (a) the components of the syringe are separated and wrapped in it during sterilization and (b) it later acts as a sterile towel under the patient's arm during the actual injection.
- (13) Two pairs of surgical rubber gloves, of good quality, thin and unpatched.

The procedure for intravenous injection

The Preston technique of intravenous injection is operated by a team of three,

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comprising one medical officer and two special treatment orderlies (hereafter called "S.T.O."). The duties of each member of the team are clearly defined and demarcated and must not be interchanged. It follows that the personnel of the team should be as permanent as possible.

One special treatment orderly, the "clean" S.T.O., never handles the syringe and needle from the time that he hands it to the medical officer, immediately before the venepuncture, until re-sterilization has been completed. His duties are so designed that he never comes into contact with blood, or with any object potentially contaminated with blood, until that object has been washed and sterilized by boiling. The other S.T.O. is described as "contaminated", because he has the task

DIAGRAM OF THE PRESTON INJECTION TECHNIQUE.

of washing out the used syringe, needle and lint square and carrying out their subsequent sterilization by boiling. He wears gloves to protect himself against casual infection through skin abrasions. The medical officer commences on the "clean" side, becomes potentially contaminated and consequently has to decontaminate his hands after each injection. He wears rubber gloves to protect his hands from the corrosive action of the Lysol solution; he is not sterile in the surgical sense. The "contaminated" S.T.O. "scrubs up" at the sink and, ideally, the "clean" S.T.O. and the medical officer "scrub up" at individual hand-basins. Each member has his own towel (TL.1, 2 and 3).

The "contaminated" S.T.O. places the dismantled syringes, each wrapped in its own lint square, on the tray of the sterilizer (ST) on the table called T1 in the diagram. He lowers the tray, closes the lid of the sterilizer and switches on the current. Sterilization is continued for 20 minutes after boiling has commenced.

The "contaminated" S.T.O. then switches off the current, raises the lid by its handle and moves the lever which elevates the tray of the sterilizer. After cooling has taken place, the "clean" S.T.O. lifts the tray by its two handles and places it on table T.2. The needles and gallipots have been sterilized previously in the same manner.

The "clean" S.T.O. works at table T.3. He has a large deep tray (previously sterilized by "flaming") and in this he unwraps the lint square, assembles the syringe, makes up the solution of the arsenical compound to be administered and attaches a needle to the charged syringe.

In the meantime the patient has been seated at the chair (C) before the table (T.4), and the medical officer, wearing a white gown, has washed his gloved hands thoroughly with soap and warm running water at the hand-basin (H.B), then immersed them for one minute in a solution of Lysol or of carbolic (1 in 20) contained in the bowl (L), and finally dried them on his own towel (TL.1).

The "clean" S.T.O., using Cheatele forceps, presents the sterile lint square and the medical officer lays it over the waterproof sheet on the table T.4. The patient then extends his arm and himself applies the necessary pressure to distend the veins, by grasping the extended arm with the opposite hand and clenching the fist of the arm in which the injection is to be given. The medical officer, using the drop bottle (DB), prepares the skin of the antecubital fossa with spirit. The "clean" S.T.O. places the loaded syringe on the lint square beside the patient's arm, from which it is picked up by the medical officer, who then proceeds to give the injection. While the injection is being given a sterile wool swab is dropped on to the lint square by the "clean" S.T.O. (using forceps) and the patient himself picks it up and, as the medical officer withdraws the needle from the vein, applies it firmly to the site of venepuncture. The patient then proceeds to the bucket (B) where the soiled swab is deposited.

If the correct method of venepuncture is used there should be no bleeding when the needle is withdrawn. This objective is readily achieved by increasing the linear distance between the respective points at which the needle enters the skin and vein. On withdrawal of the needle, the overlying skin seals off the point at which the vein was punctured and thus prevents blood escaping from the point at which the skin was punctured. The avoidance of bleeding in this way, when the needle is withdrawn, is an important part of the Preston technique.

After withdrawing the needle on completion of the injection, the medical officer carries the syringe, needle and lint square to the draining board (DR.B) beside the sink. He then returns to the hand-basin (H.B) and decontaminates his gloved hands in preparation for the next injection. Meanwhile the "contaminated" S.T.O. dismantles the used syringe and washes it, together with the needle, in cold running water at the sink. The lint square is not washed out unless it has been visibly contaminated with blood. These items are now ready for re-sterilization, as described above.

Each member of the team must fully understand not only his own part, but the whole technique. Although they work as a team, their duties are separate and independent and must never be interchanged. Blood spells danger and any object which becomes contaminated, unavoidably or by accident, must be handled only by the "contaminated" S.T.O. and must be washed thoroughly and sterilized before re-use. The medical officer must constantly supervise the whole technique to insure that any fault is immediately detected and remedied. Although the procedure may sound laborious and time-consuming when described in detail, an experienced team of competent workers can treat 30 patients per hour. It is obvious that this technique demands more than a sterile syringe and needle. It is clear, in addition, that the technique seeks to eliminate the less obvious opportunities for contamination throughout the whole preparation and administration of a therapeutic agent by the intravenous route.

Results with the Preston technique

I have records of 167 soldiers suffering from early syphilis who commenced

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treatment between January 1944 and January 1945. They received the standard army course of weekly injections of neoarsphenamine and bismuth. These patients mingled with the other syphilis out-patients whilst awaiting their turn for treatment, and no attempt was made to segregate them either in the waiting room or as regards order of injection. No instructions were issued with regard to diet or the consumption of alcohol, and it is believed that these 167 patients are comparable in respect of these two factors with other soldiers receiving similar treatment in the clinic. All these 167 patients remained under treatment and observation at Preston over a minimum period of 6 months, the majority for longer periods. In order to exclude a subclinical hepatitis, serial estimations of the serum bilirubin were carried out in 30 patients. The results were, without exception, within the range of normality.

In only one of these 167 patients treated solely by the Preston technique did jaundice develop (0.6 per cent).

Controls

(1)-(a) In 1943 jaundice was a frequent complication of arsenotherapy in most Army Venereal Disease Centres throughout the United Kingdom. Thus Sheehan records an incidence of 50 per cent and 75 per cent in two series of military cases, and Salaman and his colleagues report an incidence of 25 out of 67 (37 per cent) at 4 months and of 38 out of 56 (68 per cent) at 6 months after the commencement of treatment.

(b) A closely controlled evaluation of the respective merits of Mapharside and neoarsphenamine was undertaken at Preston during the first half of 1943. Alternate cases were assigned to treatment with Mapharside and with neoarsphenamine respectively. The cases were followed up closely and the incidence of jaundice, estimated at least 15 weeks after the first intravenous injection, was as follows.

Among patients receiving Mapharside, 35 cases of jaundice in 83 patients (42 per cent).

Among patients receiving neoarsphenamine, 31 cases of jaundice in 71 patients (43 per cent).

It is probable that longer observation of this series would have revealed a still greater incidence of jaundice.

(2) (a) In 1944, over 600 cases of jaundice are known to have occurred in army patients treated for syphilis in Home Commands. (This figure is based on notifications to the Consultant Venereologist, The War Office.)

(b) In 1944 a total of 44 cases of jaundice were seen at Preston. All the patients had commenced arsenotherapy in other centres and 21 had not received any intravenous injections at Preston. The remaining 23 cases received intravenous injections at Preston over short periods whilst in the incubation stage of hepatitis. It is obvious, therefore, that infective cases were introduced into the Preston clinic throughout 1944.

(c) I have been able to trace some 99 cases in which the patients commenced arsenotherapy at Preston in 1944 and subsequently were transferred to other centres. In all these cases the follow-up extended to a minimum of 6 months from the time of the patient's first intravenous injection. It was found that 24 of these 99 patients had become jaundiced. The period elapsing between the last injection at Preston and the onset of hepatitis in these 24 patients varied from a maximum of 164 days to a minimum of 66 days, the mean being 114 days. Only one case occurred after an interval of under 75 days, and it is reasonable to conclude that all these 24 patients became infected after leaving Preston.

Discussion

Throughout 1944, therefore, patients who received arsenotherapy by the Preston technique had a jaundice rate of 1 : 167 (0.6 per cent), whereas other patients, who commenced treatment at Preston but continued at other centres, experienced an incidence of jaundice of 24 per cent, which is forty times greater (see Table).

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At the same time, in a notable but unassessable proportion of patients who had begun treatment at various other centres and been subsequently transferred into the Preston clinic, jaundice developed within the incubation period of the disease. Before the revision of the injection technique the incidence of jaundice amongst patients treated at Preston was in excess of 43 per cent (see Table). The following conclusions are accordingly reached.

(1) That the majority of cases of post-arsphenamine jaundice have been examples of syringe-transmitted homologous serum jaundice.

(2) That such hepatitis, being due neither to syphilis nor, directly, to its treatment, is readily preventable by the careful use of an injection technique such as has been described.

INCIDENCE OF JAUNDICE

Year	Source of information	Incidence
1943	Cases reported by Sheehan	50 and 75 per cent
	Cases reported by Salaman, King, Williams and Nicol	37 and 68 per cent
	Cases treated at Preston	At least 43 per cent
1944	Patients receiving all injections at Preston	0.6 per cent
	Treatment begun at Preston and continued elsewhere	24 per cent
	Treatment begun elsewhere and continued at Preston	23 cases

The essential precautions.—Are all the details of the Preston technique essential? Will a sterile needle and syringe not prove to be adequate? In order to answer these questions, let me record briefly the experience of a small military syphilis clinic which came under my administrative care, but the operation of which was in other hands. During a routine visit in October 1944, I found that this clinic had recently had some cases of jaundice. Further investigation disclosed that in 15 patients treated at this centre between January and September 1944 hepatitis was known to have developed; detailed study of their case notes made it appear to be probable that they were examples of syringe-transmitted homologous serum jaundice.

Investigation of the injection technique showed that, although the syringes and needles were boiled between use for patients, all the other precautions of the Preston technique were absent. Revision of the injection technique, with due attention to the less obvious points of potential contamination, was followed by the abatement of the epidemic. These other possibilities of transference of infection in a busy clinic have also been recognized and stressed by Salaman and his colleagues. Moreover, in the series of 99 cases in which treatment was commenced at Preston and subsequently continued in other centres, jaundice developed in 24 per cent, although, by 1944, a directive on the boiling of syringes and needles should have been operative in all military centres. It is concluded, therefore, that more is required than a sterile needle and syringe and that none of the added precautions of the Preston technique can be relaxed with safety.

Use of penicillin.—Penicillin is now being used widely in the treatment of syphilis and may ultimately replace arsenotherapy. Are the lessons taught by the Preston experience to be rendered obsolete by the intramuscular administration of antisyphilitic remedies, to the exclusion of the intravenous route? At first sight the answer might seem to be in the affirmative but further consideration suggests caution. There is certainly less opportunity for the transference of blood from patient to patient in a clinic in which parenteral therapy is confined to the intramuscular route. This explains the almost complete absence of jaundice in children—and in adults too—in clinics in which treatment has been restricted to bismuth only, or to arsenotherapy by the intramuscular route. I have, however, met with examples of homologous serum jaundice occurring in other centres after treatment

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for gonorrhoea, as well as after intramuscular penicillin injections for syphilis. Moreover, the syringe transmission of infection is not confined to the venereal disease clinic. Thus homologous serum jaundice has been reported after gold injections for rheumatoid arthritis (Hartfall, Garland and Goldie), after the routine withdrawal of blood for erythrocyte sedimentation tests in sanatorium patients (Sheehan), and after the administration of intravenous anaesthetics (Darmady and Hardwick); malarial infection has been transmitted among patients receiving intravenous injections (Salvarsan Committee's second report). It will be appreciated, therefore, that a satisfactory syringe technique has wide applications not only in venereal diseases clinics but elsewhere also.

The Medical Research Council's recent report, *The Sterilization, Use and Care of Syringes*, recommends the sterilization of needles and syringes in the hot-air oven or the autoclave and the use of single-dose containers for injection fluids. These methods were used in the injection technique developed by Salaman and his colleagues (1944). For mass injections the Council recommends a team of four, which is the number required to operate the technique described by Salaman and his co-workers. These methods demand optimal conditions, whereas it would appear that the Preston technique achieves maximal results with a minimum of personnel and equipment.

Recommendations

In order to reduce the risk of syringe transmission, of blood from one patient to another, it is recommended that the following precautions should be observed.

(1) Specimens of blood for serological or other tests should be collected with a needle and tube only. If syringes are used, they should be reserved solely for this purpose.

(2) Syringes used for penicillin or other compounds given by the intramuscular route should be of not more than 5 cubic centimetres' capacity; they should not be used for the collection of blood or for intravenous medication.

To eliminate the possibility of syringe-transmitted infection, the careful operation of an injection technique similar to, or observing the principles of, the Preston technique, is recommended.

Summary

The development and operation of a syringe technique designed to eliminate the transmission of blood from one patient to another in a large syphilis clinic is described. The results obtained, together with controls, indicate that hepatitis complicating arsenotherapy is usually an example of homologous serum jaundice and is readily preventable.

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DISCUSSION ON THE PRECEDING PAPER

Air-Cdre. G. L. M. McElligott (the President) said that Maj. Laird's paper had been most carefully and convincingly presented. Few of them would quarrel with the statement that the majority of these cases of post-arsphenamine jaundice were, in fact, of infective origin. With regard to penicillin, he had had reported to him, before May 1945, no fewer than 6 authenticated