THE Planning AND Organization OF Central Syringe Services

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THE NUFFIELD PROVINCIAL HOSPITALS TRUST
NUFFIELD LODGE, REGENT'S PARK, LONDON, N.W.1

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THE investigation into the organization and planning of Central Syringe Services covered by this report was undertaken by the Operational Research Team of the Nuffield Provincial Hospitals Trust at the invitation of the Ministry of Health. The team was under the direction of Brigadier J. D. Welch (Retired), who was assisted by:—

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Introduction

THE traditional way of sterilizing syringes has been to boil them. This continues to be the practice in most hospitals, where syringes are boiled together with bowls and instruments, in gas or electrically operated sterilizers in the wards and other hospital departments, but for some time such arrangements have been criticized. First, such decentralized arrangements do not lend themselves to adequate supervision. Contaminated equipment may be added to a sterilizer just before syringes required for use are taken out, or the period of boiling may be less than the recommended minimum of five minutes. Secondly, sterilizers are sometimes left boiling for a long time with consequent waste of gas or electricity. Thirdly, maintenance of syringes and needles is often perfunctory, breakage rates are high and needles never sharpened, but used until blunt and then thrown away. Lastly, boiling is known not to be fully effective against spores. As long ago as 1945 the subject was reviewed in *Medical Research Council Memorandum*, No. 15. This stressed the need for syringe services and the importance of reliable sterilization procedures. It stated that all medical students and nurses must be taught safe methods of sterilization and that they must 'expect syringes used on wards to be sterilized in the hot-air oven or autoclave rather than boiled; and they must know the risks that attend careless and imperfect technique.'

By 1955, a number of hospitals had set up their own syringe services. Some of these services supplied a group of hospitals, some served only a part of their hospital, e.g. the theatres or the laboratory. They used different ways of processing syringes, different ways of packaging them and different levels and types of staffing. Some services delivered syringes to the wards like a milk-round, others demanded their collection from the syringe service. Those hospitals which had established syringe services had had little to guide them and very few could produce reliable figures on how much they had cost. It was, therefore, against such a background that the Ministry of Health invited the Nuffield Provincial Hospitals Trust to undertake an enquiry into the organization of hospital syringe services, with particular reference to costs.

The Operational Research Unit of the Trust which was engaged on this task was given facilities to study the syringe services at three hospitals hereafter referred to as A, B and C. Hospital A had a large syringe service serving a number of outlying hospitals as well as all the hospitals of its own group. Hospital B had a small service producing sterile syringes for its own hospital only. Hospital C supplied sterile syringes to one large hospital and one or two small hospitals in its group. From the beginning it was clear that organization and cost was only part of the problem and the Medical Research Council is now examining standards and methods of sterilizing syringes and needles as a complementary study.

During the course of the study, the question of expendable precharged syringes complete, or otherwise, with needles was considered, because clearly the increasing use of such syringes, if these ever become an economic proposition, will have an effect on the cost of supplying syringes for a hospital as a whole. There are, however, even apart from the cost, considerable limitations to the universal use of this type of syringe in hospitals, and it is unlikely that hospitals will be able to dispense altogether with domestic arrangements for sterilizing syringes. The question of how a service is to work is thus still posed.

The investigating team undertook method studies at each of the services concerned, suggested work rearrangement and conducted a number of experiments with different types of equipment with the general objects of improving organization and increasing productivity. Finally, some firm figures on costs were established. This report contains an account of the conclusions reached together with some suggestions on the planning and organization of a syringe service. The conclusions and suggestions cannot be other than tentative because sterilization is still the subject of scientific enquiry and experiment.

Acknowledgement must be made of the co-operation and kindness shown on the part of the staffs at the hospitals in the experiment, and, in particular, it is wished to acknowledge the assistance given by Dr. E. M. Darmady, Senior Pathologist of the Portsmouth Area Pathological Service, who has studied the recommendations made and agreed them as constituting sound bacteriological practice.

I

General Considerations

It is claimed that a syringe service is of value to a hospital in three respects:—

(*a*) it provides the hospital with some assurance against the risk of using unsterile syringes;

(*b*) it provides the staff and the patients with sharp needles;

(*c*) it relieves hard-pressed nurses of a task for which they are ill-equipped.

The first consideration in planning is to decide upon the ultimate scope of the syringe service. Is it to serve only one hospital or a group of hospitals? Is it likely to develop into a complete central sterile supply department? Whilst it will almost certainly be advisable to begin with a pilot service restricted to a few wards and departments, it is most important to know what the final limit of expansion is likely to be, so that suitable accommodation and sterilizing equipment are chosen from the beginning. Having determined the field to be covered by the service, arrangements should be made in the hospital or hospitals concerned for recording daily over a period of several weeks the numbers of injections, aspirations and other treatments requiring syringes. These numbers will be found to vary considerably, as the diagrams opposite p. 23 show. The record should be classified in wards and by sizes of syringes used. It is emphasized that the size of syringe must be recorded, not the volume of the injection given. In no other way can reliable planning figures be calculated. Estimates by ward staff are not adequate, since it is extremely difficult for them to realize how many times a day they use a syringe when they have but a small stock which is constantly re-boiled and used again.

As in any assembly-line task, adequate initial capital outlay will be repaid by a saving in labour costs; but the amount of mechanization will of course depend upon the scale of the syringe service. For example, in a small service which cleans only some 300 syringes a day it may prove more economical to wash needles by hand rather than to instal a machine. An adequate stock of syringes will meet day-to-day variations in demand, thus avoiding interruption of the routine of work. Such a stock will also reduce the margin of labour required to cover holidays and sickness of staff.

Syringe services are most commonly administered by the hospital pathologist, bacteriologist or pharmacist. Whatever the practice it is advisable that there should be only one controlling authority and not divided responsibility. It is, however, generally accepted that where questions of asepsis arise the pathologist or bacteriologist is always concerned.

CHOICE OF ACCOMMODATION

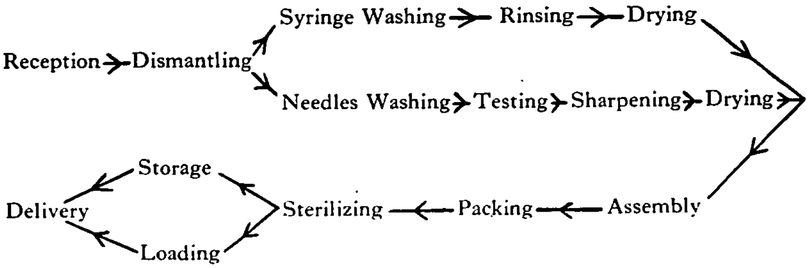
The building selected for a syringe service should be easily accessible from all parts of the hospital in order to facilitate distribution. The availability of services for water, both hot and cold, drainage, and electricity, may also be factors in determining the site. Where a group of hospitals is to be served the department should be on the ground floor and have convenient access to a road, so that trolleys may be easily wheeled from the service to a delivery van. In the case of large services distributing many syringes, time, and possibly also some breakages, will be saved if loading ramps are provided from which trolleys may be wheeled into a van and out again at the other end of the journey.

Unless a syringe department is to be specially built, the choice of accommodation will also be governed by the size of the service and the area required to accommodate it. In most cases an existing room will be adapted for the purpose, and since its shape or the disposition of its windows and doors may reduce the effective working area, a linear measurement of the work line is probably a better guide to the size of room required than an area measurement in square feet. Measurements made show that between 4 and 6 feet of bench space should be allowed for each of the manual tasks of dismantling, washing, assembly, needle-cleaning and needle-sharpening. This will include some space on either side of each worker in which syringes or other articles can accumulate between one process and the next, since it is impossible to ensure that the speed of the work will be the same at all stages. It is advisable to allow more space, where possible, for dismantling and assembly. In addition, 4 to 6 feet should be allowed for each of the non-manual tasks of soaking, rinsing, drying and storing, whilst 6 to 10 feet should be allowed for sterilizing. It will be found, therefore, that a total work line of 50 to 70 feet should be enough for services processing up to 1,000 syringes a day. This will require a room with an area of at least 300 square feet. In services which turn out more than 1,000 syringes a day and which employ more than six people, it will be necessary to duplicate some stages, particularly the benches for assembly and needle-sharpening, and additional bench space should be allowed accordingly. Providing there is a sufficient stock of syringes to allow the work of the service to be organized in a suitable way, it should not be necessary to duplicate washing facilities, since washing and rinsing only take about half as long as assembly. In a large service it is a convenience, however, to have an extra sink for washing containers to avoid the possibility of assembled syringes being held up for lack of clean containers, and a further 4 to 6 feet of bench space should be allowed for this purpose.

A good deal of the work of cleaning and assembling syringes requires close inspection. The work is also tedious and repetitive, so that a room with plenty of windows at eye-level is a great amenity for staff, in addition to providing the light necessary for their work. For this reason the basement is not a suitable place to put a service.

Artificial lighting will be required to supplement daylight in winter. The placing of light fittings and the level of illumination will depend largely upon contrast conditions, such as colour and whether wall and bench surfaces are predominantly matt or shiny. For example, objects seen against a dark background such as a teak bench may require a level of illumination of 50 lumens per square foot, whereas seen against a light ground they may require 150 lumens per square foot. The workroom should have good general lighting to minimize contrast between the work area and the rest of the room. Local lighting for close work such as needle-sharpening may require some diffusion to lessen reflections from the shiny metal of the needles.

The work of a syringe service should be organized on a production line system with one process following another, so that the staff has to move as little as possible. Not only will such an arrangement save work, but there will be less danger of clean and dirty stock becoming mixed. Diagrammatically the work should be organized as shown overleaf.



Depending on the shape of the room chosen to house the service, or upon the position of doors and windows, the work line may be designed to go round the perimeter, or up and down the centre of the room. The latter is probably the better method, so long as proper lighting can be arranged. The wall space is then available for shelving and cupboards in which to store clean syringes and equipment. Because needle-cleaning and sharpening require close inspection, benches for this work should have first priority for space in front of windows. Dismantling and washing are tasks which are probably best done standing up, whilst assembly and needle processing can conveniently be done sitting down. The Department of Anatomy at Birmingham University has established some convenient working heights for women. It has been found there that standing benches should be 35 inches high, sitting benches 28 inches high, and that chairs for use at these sitting benches should have their seats 16 inches from the floor. Such heights, which are a little less than would normally be provided, have been tried in syringe services and found convenient to use.

Sterile storage space will depend upon the size of delivery boxes used, but as a general guide it may be said that 1 foot of shelf 18 inches deep should be allowed for every 50 syringes to the total of the average daily output. If the shelves are spaced 1 foot to 18 inches apart, from near floor level to a height of 6 feet, 1,000 syringes can be accommodated within 6 feet of wall space. In services which deliver syringes, less sterile storage space may suffice as the syringes may be loaded straight from the sterilizer to the trolleys, but space must then be allowed for parked trolleys. Shelves should also be provided over all working benches.

So far only the arrangement of working space has been discussed, but the disposition of stores, personal belongings of staff, cleaners' materials and so on must be considered. Supplies of expendable goods, such as washing agents, sealing materials, needles, etc., which are constantly required may be kept on shelves or in cupboards over the various benches where they are used, as also small items of equipment, such as pads of silicone for lubricating and sponges for carrying needles. Nothing else should be stored in the work room. But nearby accommodation must be available for hats and coats, toilet facilities, cleaners' materials and bulk storage of new syringes, containers and other supplies. The usually indispensable tea breaks must also be catered for in a separate staff room.

In many plans for central syringe or sterile supply departments the supervisor's desk is placed in the centre of the working space, near the sterilizers. This is to ensure proper control of sterilizing procedure in autoclaves, but where a pre-set conveyor belt oven or time-controlled static hot-air oven is used this is not so necessary, and the supervisor will probably prefer the quietness of a separate office, or at least a desk in the staff room, so that her paper work may be done in peace away from the bustle of the work room.

STAFF

A good supervisor is the key to a successful syringe service. A good choice is an experienced nurse with administrative ability. Her training will enable her to understand the necessity for maintaining high standards of cleanliness and sterility, while her professional standing will give her the authority her position requires in relation to the rest of the hospital staff. In some services it may be possible to find the necessary qualities in a technician. There will usually be a conflict between the individual user's desire to have his or her particular requirements catered for and the syringe service's need to standardize as far as possible. A nurse with experience of both ward and theatre work behind her is usually in a better position than a lay supervisor to decide what concessions may reasonably be made to claims for special treatment in matters of detail. In a large syringe service the supervisor should be principally an overseer as the name suggests, only taking part in the routine work of the department if the need arises. The administration and organization of the department will occupy a considerable part of her time, and, in addition to which, she must be free to visit regularly all the departments and wards served by the syringe service, and be ready to deal with any little emergency that may arise. In the early days of the service especially she should observe the work minutely and objectively so that the most economical and time-saving routine can be evolved, and this cannot be done by a person continually engaged in that work. A service which is run by someone with a calm, methodical disposition will have a low breakage rate; to rush when there is an extra pressure of work will result in expensive accidents.

Existing syringe services employ a variety of different grades of staff, including domestics, nursing cadets and male technicians. In general, women should be employed rather than men. In 1955 it was established by the Industrial Disputes Tribunal that the work in syringe services should be done by ancillary staff. They should be paid at a composite rate, according to the division of their time between various tasks, in so far as these correspond to the following grades:

	Per Week	
	London	*Elsewhere*
Laboratory Assistant	127*s*. 6*d*.	119*s*. 6*d*.
Set Assembler	131*s*. 6*d*.	123*s*. 6*d*.
Sterilizer Attendant	133*s*. 6*d*.	125*s*. 6*d*.
Needle Sharpener	139*s*. 6*d*.	131*s*. 6*d*.

These rates are for women. If men are employed the rate of pay will be 38*s*. 6*d*. per week higher than those shown above. Since the hours of work are regular it has proved popular, generally, with married women.

A staff of one person for every 200 syringes to be cleaned a day will be required. But if the department is poorly equipped or organized this rate will not be reached. Nor will it be achieved until the staff has acquired considerable experience and the method of work has been studied to bring it to maximum efficiency. If, therefore, a syringe service is started in a small way and gradually expanded, a proportionately larger staff may be engaged at the outset, aiming at an output of something like 125 syringes each a day.

EQUIPMENT

Sterilizers

The whole question of the methods of sterilization of syringes is now under consideration by a sub-committee of the Medical Research Council. Anything written here touching on this subject will certainly have to be reconsidered in the light of any pronouncements that they may make. However, pending more authoritative recommendations from the Medical Research Council, it is hoped that the remarks made in the following paragraph will be of some assistance.

Syringes may be sterilized in autoclaves or hot-air ovens. There are, however, certain practical difficulties about sterilizing them in the former. There is no certainty that steam will reach all the surfaces of an assembled syringe, even if the barrel and plunger are put together wet. This means that the syringe must be sterilized dismantled and assembled afterwards under aseptic conditions, which are difficult to secure. It is also difficult to ensure that the syringes are dry after sterilization by steam, although a dry syringe is essential for taking blood samples and for giving some drugs. In the United States it is common practice to use autoclaves as hot-air ovens by not admitting steam to the chamber. But only a low temperature can be achieved, each load must stay in about six hours which is inconvenient. For these reasons autoclaves are not recommended for the sterilization of syringes.

Hot-air Ovens

Hot-air ovens may be of three kinds, gas or electric convection ovens, or infra-red radiant heat ovens. The gas-heated convection oven is unreliable as the temperature varies greatly between one part of the oven and another, and for this reason is unsatisfactory. An efficient electrically-heated oven, provided it is fitted with a fan to ensure that the hot air is properly circulated, is suitable. It is also advisable for it to be fitted with automatic time control, thus ensuring that the contents of the oven are held at the required temperature for the requisite time.

The oven capacity in a syringe service will usually be based upon a compromise between capital cost and convenience of working. A number of small ovens permits more continuity in the work of the department, but involves a greater capital outlay, particularly since each one should be equipped with a fan and automatic time control (see p. 41). A syringe service turning out 500 syringes a day will require a total oven capacity of between 10,000 and 12,000 cubic inches, whilst a service with an output of 1,000 syringes daily will require about 20,000 cubic inches. With such a sterilizing capacity it will be possible to load the ovens so that there is plenty of air space round each syringe, which is essential if any degree of uniformity of temperature in the oven is to be attained.[1] If the oven is heated from the bottom, the syringes should be placed vertically in the oven trays to permit the rising hot air to circulate freely. In this case the oven trays should be fitted with frames which will hold the syringes upright and spaced well apart from one another. If the hot air enters through holes in the side of the oven, the syringes may be laid flat, but should be only one layer deep. The staff must be forbidden to overload the oven; any syringes in excess of the maximum permitted load which may remain at the end of one day must be kept back and sterilized the next day.

Radiant-heat Ovens

Radiant-heat ovens employing infra-red elements are more expensive than the ordinary convection type, but since the infra-red rays have the property of quickly raising the temperature of objects which they strike, the length of time that syringes have to remain in an infra-red oven is less than in a convection oven. The effective capacity of the former is thus proportionately greater. Ovens with moving belts are a recent innovation, and may prove more reliable than static ovens, since they ensure that every syringe receives the same amount of heat for the same period of time, whilst they also prevent the danger of overloading an oven.

A technique for sterilizing articles by exposing them to gamma-rays is now being developed and may be adapted for use in the hospital field before long.

Drying Ovens

It is not usually convenient to employ sterilizing ovens for drying syringes before assembly, since the use of one oven for

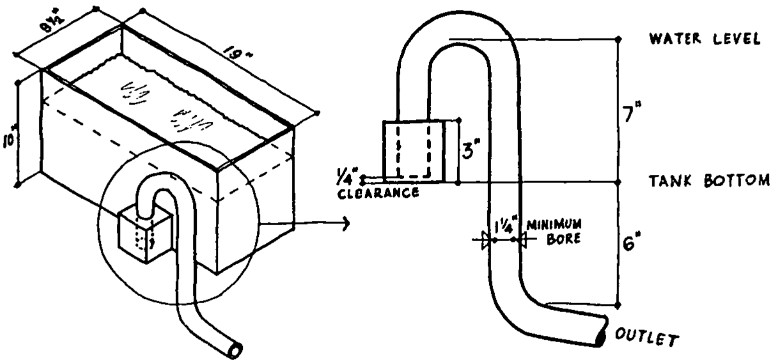
[1] *Journal of Clinical Pathology*, November, 1954. Vol. 7, No. 4, p. 290: 'Temperature Levels in Hot-air Ovens', by E. M. Darmady and R. Barrington Brock.

both purposes is inclined to create bottlenecks in the work of the department. It is, therefore, more satisfactory to have a separate oven or cabinet for drying. Hot-air blowers have been experimented with and have been found unsatisfactory, because this method is only efficient when each container and barrel is placed on a separate jet of air, which is a laborious procedure. A small infra-red moving-belt oven is excellent because the syringes dry quickly and are automatically transported from sink to assembly bench, but this is an expensive item for all but the largest services. Quite efficient hot-air cupboards can be built, employing a small heating element combined with a fan to create a draught of hot air. There are also commercial drying cabinets which can be made suitable for the purpose. But whichever type of drying cabinet is employed, its maximum efficiency will only be obtained if all containers and barrels are inverted and held on pirn boards (see Appendix 'A') or in special racks which keep them well spaced apart.

Sinks

Sinks should be made of stainless steel or plastic to minimize damage to syringes. When a large sink or bath is provided for the overnight soaking of syringes the use of these materials is not so important, as the articles to be immersed will be contained in trays or baskets. Sinks for washing should not be so big that it is possible to tip large numbers of syringes in on top of one another. Polythene bowls or babies' baths let into the bench top and fitted with plug-holes are very satisfactory.

Some syringe services employ various kinds of water jets for rinsing syringe barrels; this is laborious and syringes may be rinsed just as thoroughly in a sink arranged automatically to drain and refill itself. Such a system ensures regular, complete, changes of water, which is often neglected when syringes are rinsed by hand in an ordinary sink. The syringe barrels are placed in the rinsing sink on pirn boards or in racks, nozzles uppermost, and the rise and fall of the water for about five times produces sufficient friction to rinse them thoroughly, provided plenty of really hot water (180° Fahrenheit) is available. Rinsing sinks are best constructed to suit local conditions, as their size is dependent upon factors such as the pressure of the water supply and the dimensions of the handling equipment used. A sketch showing how these sinks may be constructed is shown below.



RINSING TANK to accommodate about 50 syringes in 3 baskets or on pin boards.

Choice of Syringes

Whatever the make, syringes should have glass barrels and plungers as this is the easiest material to clean. All-glass syringes are easier to keep clean than those with metal nozzles, but are more fragile, and when their nozzles become chipped may leak at the needle hub. Where metal nozzles are to be used, care should be taken to select a make with a glass-metal seal which will stand up to high temperatures; if an oven is accidentally allowed to overheat, the cement in some syringes melts and causes blockage in the nozzle. It is widely claimed that in the long run syringes with interchangeable barrels and plungers are cheaper than non-interchangeable ones, in spite of their greater initial cost. A careful record of breakages, however, kept over two periods of ten weeks in a hospital which used non-interchangeable syringes showed that there would have been no economy had replacements been made with interchangeable syringes. The figures for breakages over this period were:—

Total number of breakages in 20 weeks	963
Both parts broken	23·6 per cent.
Barrel only broken	55·0 „ „
Plunger only broken	21·4 „ „
	100·0 „ „

The cost of replacing these syringes may be compared as follows:—

TABLE I. *Cost of Replacement*

	Inter-changeable.	*Non-inter-changeable.*
First ten-week period .	£145 14 2	£142 6 9
Second ,, ,, .	£118 4 7	£121 16 11
	£263 18 9	£264 3 8
Difference . . .	*£0 4 11*	

The choice, therefore, as to which type is employed seems to be largely a question of personal preference. In a large service, however, the interchangeable type will be simpler to handle, and no time will be lost in sorting out mis-assorted syringes – for parts will become mixed even in the best-regulated syringe services.

The entire stock of syringes should be of the same type. It is a mistake, for instance, to suppose that work will be saved by the use of cartridge syringes for certain kinds of injection. The special nozzles of these syringes take longer to clean than do ordinary needles and entail a separate pack for issue to the ward. Similarly, the numbers of 1-ml. syringes may be substantially reduced, since 2-ml. syringes can be used in their stead; except, possibly, for some intra-dermal injections. Every additional size of syringe requires an additional size of container and a different size of hole in distribution boxes, so further complicating the work of the department. Similarly, it is preferable to stock only eccentric nozzle syringes in the large sizes, since if both concentric and eccentric nozzle syringes are used their containers will require distinguishing marks. It has been found that hospital staff are generally quite content to use eccentric nozzle syringes for all purposes.

It will be argued later that the complete stock of syringes held by each ward and department should be changed once in 24 hours. Enough syringes are therefore required for processing to-day so as to provide wards, etc., with their total requirements to-morrow. This provision necessitates twice the average daily usage as stock in the syringe service. It has, however, been found that this is not in itself enough. As will be seen later (p. 22), the daily usage fluctuates considerably and there will inevitably be a number of days of peak usage. Because these peaks occur only occasionally, it is uneconomical to provide all users with sufficient syringes to meet their maximum requirements on any one day. It is equally inadvisable to allow wards to borrow from each other since checks on usage and breakage would thus be impossible. Accordingly it will be found advantageous to establish reserves of syringes where wards can draw them on peak days. In the hospital in which the service is sited, these reserves can conveniently be held in the syringe service itself. But if the hospital is some way from the syringe service then subsidiary reserves must be set up in the distant hospitals. These reserves require a larger number of syringes. It has also been found essential that syringe services should hold some syringes so that they can process their syringes at times of their own choosing. Only with the availability of some such reserve of syringes, can the orderlies of the syringe service always have work available to do. Without such a reserve they may have to wait daily until the syringes are returned from the wards, thus wasting time and reducing output. It has been found in practice then that the total number of syringes required for most services is about four times the average daily usage, although there may be certain hospitals which are closely grouped and which can do with less. Surveys of syringe usage in the hospitals covered by the experiments showed that syringes were required in the following proportions:—

2 ml.	58 per cent.
5 „	20 „ „
10 „	10 „ „
20 „	12 „ „

The above proportions are calculated from daily usage of syringes in general acute hospitals. Special hospitals may need to adjust these proportions to suit their particular requirements.

Washing Machinery

Special machines for washing syringes have long been accepted as standard equipment for syringe services in the United States. But, so far as is known, only one such machine has been made in this country and that machine has not proved a success and is no longer in use. Further, although industry has been approached, no firm has yet shown any real interest in the project. There are important difficulties to be surmounted. First, the number of syringes to be washed is too few to justify any large-scale machinery, as is used for example in the milk, brewery or chemical trades. Secondly, the syringes are of four different sizes, each of which may require different fittings. Thirdly, syringe washing is not one of the most time-consuming tasks in a syringe service and there is a danger that any machine produced may need as much labour to serve it, as is required to wash the syringes by hand. It is possible that the near future may see the production of a British machine which has surmounted these difficulties—one hospital is already experimenting in this way—but until something is forthcoming washing will certainly continue to be done by hand. It will be found that a rotary nylon brush is helpful in cleaning the containers.

Handling Equipment

The receptacles in which syringes are carried from one process to another are, in a sense, minor equipment, but a great deal of thought should be given to choosing them, so that it is possible to use the same carrier from dismantlement to sterilization and thus avoid unnecessary handling. Moreover, they should be chosen at an early stage in planning since the dimensions of sinks and storage shelves will be determined by the size and shape of the receptacles used.

The type of receptacle will be governed largely by the type of syringe which is to be used. For interchangeable syringes it is best to dismantle the barrels straight on to pirn boards and the plungers into wire baskets. Containers should for preference also be placed on pirn boards, as this will reduce the time taken for drying. Non-interchangeable syringes, however, will require some sort of rack in which the plungers and barrels can be kept together in pairs (a suggestion is illustrated in Appendix 'A'). In either case the carrier should be designed to hold the syringes vertically, nozzle upwards, and separate from each other to prevent damage, and to promote draining and quick drying. It is preferable for pirn boards and baskets to be fairly small, say 9 × 9 × 9 inches, holding 25 syringes. Large receptacles take longer to fill. They also take up room on the work bench, whereas the smaller receptacles can stand on shelves over the benches. Small baskets are more suitable for use in an automatic rinsing tank, as this must be reasonably small to ensure rapid filling and emptying.

Needle Cleaning and Sharpening Equipment

Various kinds of jets have been manufactured which are more or less satisfactory for cleaning needle shafts, but few of these are much speedier or more efficient than squirting needles through by hand with a syringe. One hospital has evolved a simple multi-jet needle washer which can be alternately connected to water and compressed air supplies. It has the added advantage of being easily portable so that needles can be carried on it from one process to another, thus saving labour and protecting the needle from damage. A large number of these devices is required, however, if unnecessary putting on and taking off of needles is to be avoided, and they are costly. None of the devices which clean by means of jets of liquid clean the hubs, however, a task which up to date has had to be done by hand with a swab of cotton wool. Recent trials with an ultra-sonic instrument designed for cleaning small metal parts were extremely satisfactory, for both shaft and hub were cleaned at the same time with considerable saving in labour.

In many syringe services needles are continually being blunted through careless handling. Professor L. P. Garrod, as was reported in the *Nursing Times* of 28th November, 1953, has shown how easily this can happen. The points of needles should be protected by being stuck at all times into cushions, except when mounted on syringes or packed separately for theatre use. Cellulose foam sponge 3 or 4 inches thick is an excellent material for this purpose, and there should be a liberal supply of such cushions in order that needles can be stuck into them between one process and another. Finally, the department should be equipped with a needle-sharpening machine fitted with a 3-inch grinding wheel, and a microscope, preferably a binocular stereoscopic one, giving a magnification of about 15 diameters. Good inspection lamps are essential for needle-sharpening.

Packaging

It is probably in the field of packaging that there is the greatest variety between one syringe service and another. Some services use a multi-pack which consists usually of a metal box holding, perhaps, a dozen syringes. Other services pack their syringes separately in aluminium or glass containers. The aluminium containers may be of thick spun aluminium costing more than 5*s.* each or of thin extruded aluminium costing a few pence. Glass containers may be simple laboratory test tubes costing not much more than 2*d.* or tubes specially designed to hold syringes and costing more than 4*d.* There is also considerable variety in methods of sealing containers. Some aluminium containers have a simple cap which sometimes fits and sometimes does not. Some have screw tops. Glass containers may be sealed with cellophane or paper, either of which may be held in place with gummed paper, or they may be sealed with plastic seals shrunk on after sterilization.

Multi-packs

Few of these methods of packaging syringes are really satisfactory. Let us consider first the multi-pack. A series of observations have shown that this has some serious disadvantages.

(*a*) Most of the multiple containers used are only sealed at one point and if removed from the sterilizer when hot, unsterile air will be drawn into the box through the crack between lid and walls. In any case, after the box is first opened all the contents are potentially unsterile.

(*b*) The multi-pack usually leaves the nozzles inadequately protected. Used syringes may accidentally be returned to the pack, thus allowing bacteria to pass from them to the sterile syringes.

(*c*) There is no certainty that each syringe has had the same heat treatment since syringes in the middle of the pack may receive less heat than those on the outside.

On the other hand, it is claimed that the multi-pack is less costly in labour since the sealing of containers for each syringe is eliminated. Time studies made in a syringe service where both methods are used showed that filling a multi-pack with 15 syringes took longer than putting the same number of syringes into test tubes and sealing them with cellophane and gummed-paper strips. This was because of the difficulty of inserting the syringes into their holes in the boxes without allowing the capillary tubing protecting the needle to drop off. The multi-pack box is also more expensive than extruded aluminium containers. Taking all these points into consideration, there can be no doubt that the multi-pack is not as cheap or as safe as is sometimes claimed, and it is not recommended.

Individual Packs

If, then, syringes should be packed individually, what is the best way to do this? Various kinds of paper, cellophane and nylon film have been tried as expendable wrappers. But none of them has yet been found capable of withstanding the temperatures of hot-air sterilization. Cellophane is popular because it turns brown at 160° Centigrade and therefore acts as an indicator of the temperature achieved. Unfortunately it also becomes brittle when heated and, if handled before it has had time to reabsorb moisture from the atmosphere, it may crack and cease to be an effective seal. Such cracks are not always easily noticeable. Again, none of these expendable materials affords any protection against breakage of the syringe, whilst a container of some kind has always to be provided in which to return the used syringe. Accordingly, containers which are wholly expendable are also not recommended.

This leaves glass and metal containers which in any case are the types most generally used. Any container should be long enough to take the syringe mounted with a needle. (If the needle is already mounted on the syringe there is considerably less danger of accidental contamination between opening the syringe container and giving the injection than is the case when the needle is packed separately and mounted in the ward.) The container should also completely cover the syringe rather than allow the plunger to project. (If the plunger is allowed to protrude it must be covered with one of the expendable wrappings which, it has already been argued, cannot stand up to hot-air oven temperatures without danger of damage.) It seems then that the best type of containers are special glass test tubes or extruded aluminium containers. Spun aluminium containers are not only much more expensive, but absorb heat less readily than the lighter extruded type. The latter are designed to fit the syringe closely so that no additional packing in the form of silicone rubber rings, paper or cotton wool are necessary. This closeness of fit, together with the resilience of the light metal, appears to give syringes greater protection from damage than other types of container. Though less strong than spun aluminium, it is reasonably durable and costs only a fraction more than the equivalent special glass container. Further details and an illustration of such a container are given in Appendix 'A'.

Glass is a popular material for syringe containers since it permits a final inspection and allows the user to see exactly what the contents are without breaking the seal. It is also easily cleaned and absorbs heat more readily than metal. Glass has, however, the great disadvantage of fragility, and its use will always incur a considerable bill for replacements. One syringe service using glass containers and processing just under 1,000 syringes a day is having to meet an annual replacement bill of £300. This represents 0.3*d*. (5 to 6 per cent.) on the cost of each sterilized syringe.

Seals

It remains to consider how these containers can best be sealed. The seal is very important and should have the following properties:—

(*a*) It must form an effective seal against the entry of bacteria or viruses;
(*b*) it should be impossible to remove without leaving a clear indication that this has been done;
(*c*) it should be unaffected by temperatures up to 200° Centigrade.

There are few seals in use which meet such criteria. Ordinary caps and screw caps fastened down with gummed paper fail to meet (*a*) and (*b*). Plastic caps fail to meet (*c*). The only cap which is known to meet all three criteria is the expendable aluminium foil capsule used by certain suppliers to seal their soft drink or milk bottles. Such caps cannot be taken off without being destroyed; they seal the container very securely and will stand temperatures double those encountered during sterilization. They are obtainable in many colours, which may be used as a code to indicate contents or date of sterilization; they are also extremely quick and simple to put on and they cost about a farthing each. Further details are given in Appendix 'A'. At one hospital an output of about 400,000 syringes in a year entailed an outlay of £435 for capsules. Previously, when permanent caps were in use, the annual cost of sterile labels was £60 and that of the kraft paper used for packing into the space between the cap and the top of the plunger was £120. Permanent caps also took almost twice as long to put on and seal as did expendable foil capsules. It may be concluded therefore that the difference in cost between the two types of caps was appreciably less than the difference between the £435 and £180 involved. Because of their convenience, the syringe service concerned would never from choice go back to their original caps. This expandable capsule seems to be the best seal yet obtainable. It will, of course, be appreciated that if syringes are processed in an autoclave no sealing capsules of any kind can be employed until after sterilization is complete.

Needles

In many services needles are protected against blunting by one of three methods. Capillary tubing or cellophane drinking straws may be slipped over the needle shafts, or stilette wires inserted. Capillary tubing requires cleaning after use and is laborious to cut up. Cellophane drinking straws have the advantage of being expendable, but discolour the needle if overheated. Stilette wires may be inserted into the needle and allowed to bend round when the syringe is placed in its container, so acting as a spring. The insertion of the stilette is, however, time consuming and numbers of them get left behind in the containers when the syringes are withdrawn. Probably a drinking straw or capillary tubing is the best method of protecting the needle point.

It is sometimes necessary to use two needles for one injection. For example, the theatres may require filler needles for mixing injections. The best method of packing these additional needles is either in a small waisted tube or, if a straight tube is used, to place a sleeve of drinking straw or capillary tubing over the shaft of the needle to prevent the point from touching the bottom of the tube. Needle tubes can be sealed with aluminium foil capsules in the same way as syringes. Illustrations of these needle packs are shown in Appendix 'A'.

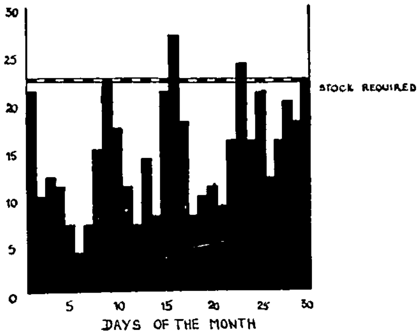
II

Day-to-day Working Methods

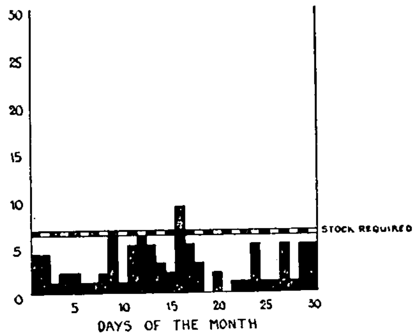
WARD PROCEDURE

IT has been stated earlier in this paper that when a syringe service is planned a record should be made so as to assess the stock of syringes required to equip the service. This record may also be used to assess the number of syringes to be issued to each ward and department. It will be found that the number of syringes used by any particular ward varies greatly from day to day. Histograms showing the syringes used each day over a month in a ward of a hospital are shown overleaf. If the maximum number ever likely to be used were to constitute the daily issue then, clearly, many of the syringes would be travelling backwards and forwards unused between the syringe service and the department concerned on most days in the month. This would be a waste of capital resources. A balance must be struck—and in practice this will not be found to be difficult—between the needs of the wards and proper economy in the service. Such a balance will mean that the needs of the wards will be covered on most days of the week, but occasionally they may find themselves short of a syringe which will result in a nurse or ward orderly having to go to the local syringe service reserve to get what is wanted. This is preferable to sending a nurse round to borrow from some other ward. Each histogram overleaf shows the agreed numbers that were issued to this ward, and the sort of balance that may be expected to work satisfactorily in practice. Syringes should be delivered to the wards and departments in the type of box illustrated in Appendix 'A', holes surplus to a ward's daily assessment being covered with some form of adhesive tape. This will facilitate checking stock, since an empty hole will at once betray a missing syringe. Two such boxes will be needed by each ward, one in use to-day and the other in the syringe service being filled to-day for use to-morrow. The complete stock of syringes held by each ward or department should be changed every day. Only in this way is it possible to keep an effective control

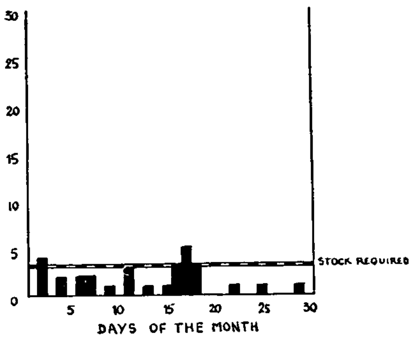
DAILY USAGE ~ 2ml. SYRINGE



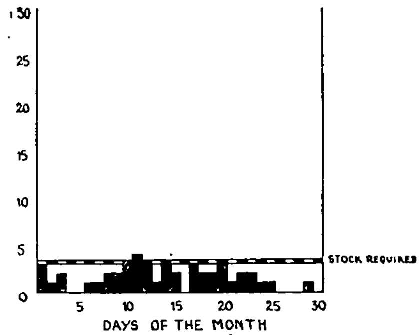
DAILY USAGE ~ 5ml. SYRINGE



DAILY USAGE ~ 10ml. SYRINGE



DAILY USAGE ~ 20ml. SYRINGE



of missing or broken syringes, and ensure the constant turnover of all syringes. But, if the service covers a group of hospitals, it may not be practicable to deliver every day to small outlying hospitals.

Each day, then, every ward receives a box of sterilized syringes from the syringe service. If possible, syringes should be delivered to the wards and departments by syringe service personnel. They will then have direct contact with the users, and any queries as to missing syringes or complaints about them can be settled on the spot. The supervisor of the syringe service should make a point of going round the hospital frequently to ensure that the service is giving satisfaction.

Where the syringe service does not deliver round the hospital, used syringes must be checked as they are brought back to the department. Each rack should be examined for broken or missing syringes. To avoid taking the syringes out of their containers at the reception desk and again at the dissembly bench, and to save keeping nursing staff waiting at the service, an agreement should be reached whereby wards accept the service's word with regard to breakages. Once confidence is established, this is not difficult and saves a lot of time. It is preferable to arrange for syringes to be exchanged only between certain hours in order to interrupt as little as possible the work of the service.

On opening the syringe container in the ward, the expendable cap should be discarded so that capless containers will clearly distinguish used syringes from sterile ones. If, on opening, the needle is found to have fallen off, the syringe should not be used but another taken. If it is unavoidably necessary to change the needle on a sterilized syringe, this must be done with sterile forceps so as not to imperil sterility. Care should be taken when drawing up drugs not to damage the point of the needle by hitting the sides of the bottle or ampoule. Piercing the rubber cap of multi-injection bottles does *not* blunt the point of the needle (*Nursing Times*, 28th November, 1953). Damage to the needle point must also be avoided when the syringe is placed in a receiver and taken to the bedside. In some hospitals syringes are replaced in the containers after the drug has been drawn up. This reduces the risk of contamination as well as preserving the needle point.

After use it is essential that syringes and needles are rinsed through with plain water. The importance of carrying out this simple task cannot be over-emphasized. Delay in rinsing will allow blood to coagulate or drugs to dry, so causing syringes to stick. At best, the omission of rinsing makes the task of cleaning the syringes much more difficult.

When the syringe has been rinsed the needle should be removed. The nurse should do this with forceps in order to prevent contaminating her fingers when using antibiotics. If used with care forceps should also minimize the danger of breaking the nozzle of the syringe. The syringe should then be returned to its container, and the needle stuck into a cellulose foam cushion provided for this purpose (see Appendix 'A').

PROCESSING

Syringes are susceptible to damage caused by jarring against one another. The barrel rims are particularly vulnerable to minor chips which the heat of sterilization may develop into major cracks. Every care should therefore be taken to keep syringes from being piled up on top of each other, or carried about in handfuls. Syringes should be slid gently out of their containers on to a cellulose foam bath mat spread on the dismantling bench. If they are to be soaked, the parts must be separated, placed on pirn boards or in wire baskets and immersed in a tank. When ward boxes have been emptied they should be wiped over or washed as necessary. They can then be stored near the sterilizer ready for refilling with sterilized syringes.

Washing

This, next to sterilizing, is the most important task in a syringe service. It is also a difficult one owing to the shape of syringe barrels and the variety of substances which pass through them. At present soap is generally preferred as a cleansing agent because traces of certain detergents left in syringes have been known to have harmful effects. Soap, however, is not as efficient as a suitable detergent and unless used with distilled water, is liable to form a scum. It is possible that the best method of cleaning syringes may prove to be two washes, the first in a mildly acid detergent, and the second in a mildly alkaline detergent. In this way both oily and organic substances should be removed. Experimental work is being done on these lines, but it is not yet possible to draw definite conclusions.

If detergents are used, they must be of a type which does not cause blood to haemolyse. They should be neither strongly acid nor strongly alkaline, since the one may corrode the metal nozzles and the other the glass. After washing, syringes must be thoroughly rinsed in several changes of water. The greatest care must always be taken to remove any traces of detergent.

Although many services use rotary brushes for cleaning syringe barrels, washing must still be considered a manual operation. If syringes have been rinsed on the wards and soaked in the syringe service, they can be cleaned by drawing up and expelling soap or detergent and hot water once or twice with the plunger. This will clean the inside of the nozzle as well as the barrel. Any syringes not rinsed after use and in which blood or other substances have consequently dried, may require brushing with a test-tube brush and their nozzles pulling through with a pipe-cleaner. The use of a rotary brush is not recommended as water is not then adequately forced through the nozzle. A photograph of orderlies washing syringes is opposite p. 26.

Rinsing

This must be done in really hot water. Some syringe services like to rinse first in hot tap water, then in distilled water (this is particularly advisable when the local water supply is 'hard'), because this gives the glass a brighter finish. It is preferable to heat the distilled water as this will speed the drying of the syringes.

Rinsing may be done manually either by drawing up and depressing the plunger or by holding the barrel over a jet of water. It can be done very satisfactorily, however, in an automatic syphon tank, details of which have already been given. Each pirn board-full of syringes or basket of plungers should be allowed to stand in the rinsing tank long enough for the water to change several times. In this way the tasks of washing and rinsing may be performed by one orderly.

Drying

Syringes must be thoroughly dried before being assembled, as once they are sealed in their containers moisture cannot escape, and for blood-taking and administering certain drugs, it is essential to use a dry syringe. Both syringes and containers will dry most rapidly if inverted on pirn boards so that they drain, and air can circulate freely around them. Syringes should be allowed to cool after drying, as the introduction of a plunger lubricated with cold silicone into a hot barrel may cause the latter to crack.

Needle Processing

Needle washing machines are used in the United States, but no satisfactory machine has yet been made in this country. A multi-jet device has been designed by one hospital which can be connected alternately to water and compressed air supplies, thus enabling 42 needles at a time to be rinsed and dried. Various single jets have also been devised but none of these clean the needle hubs. Cleaning by hand with a syringe is probably as speedy and efficient as any form of water jet. One syringe service has succeeded in eliminating the labour of hubbing needles by hand by soaking needles for 24 hours in xylene, rinsing them and then soaking for a further 24 hours in ether soap. This cleans the needles very efficiently, but the xylene is costly, and must be used with care as it is inflammable and gives off unpleasant fumes. Quite recently an ultra-sonic instrument for cleaning small metal objects has been tried with great success for cleaning needles. The machine consists of a small tank in which water is vibrated at ultra-sonic frequencies which shake the needles clean. During a trial week it was found possible to wash 1,000 needles an hour, the washing process consisting of five minutes in an acid detergent, a rinse and then five minutes in an alkaline detergent. At the end of the week the needles cleaned by the ultra-sonic method were still quite bright, both inside and outside the hub, whereas a control set of needles cleaned by hand over the same period of time had become discoloured. The inside of the hubs in particular had become very brown, although each hub had been cleaned regularly with a swab of cotton wool (details of the ultra-sonic instrument are given in Appendix 'A').

The following recommendations are made on the assumption that needles will be cleaned by hand. The routine would of course require adapting if any of the above-mentioned labour-saving devices were introduced. When the syringe has been used on the ward, the needle should be detached and stuck into the cellulose foam cushion provided with each syringe delivery box. When the box reaches the syringe service these cushions should be removed

Washing and rinsing

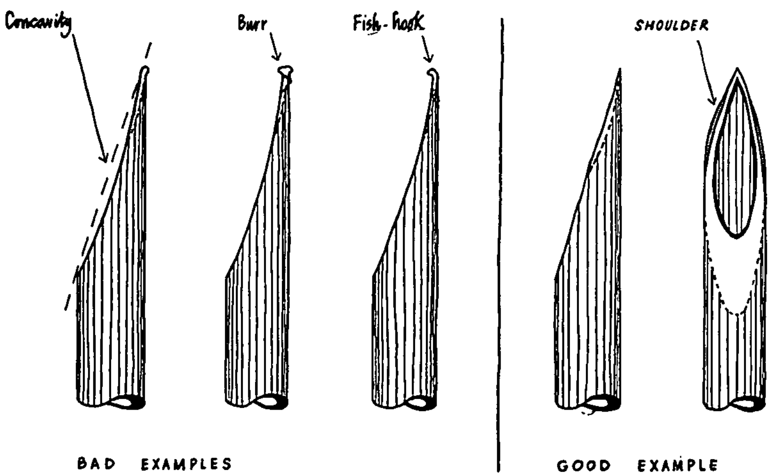
Assembly and sealing benches

from the box and passed to the needle-cleaning bench. Here the cushions are turned over and placed in a dish in which the needles can soak, hub down, in a suitable cleaning fluid. The following day they can be boiled in the same position for a few minutes. The sharpness of the point will not thereby be dulled. The water having been drained off and the sponges turned right way up, the hub of each needle should then be cleaned with a swab of cotton wool. Small revolving brushes are sometimes used to clean needle hubs, but it is difficult to keep the brushes clean. The shafts of the needles should next be squirted through with hot water and detergent, followed by plain hot water, and finally with compressed air to blow out any moisture. Blocked needles should be given further soaking and boiling before again being squirted through. Poking with stilette wire may scratch the interior, but may sometimes be the only way of clearing a badly blocked needle.

The first step to be taken towards ensuring the sharpness of needles is to prevent blunting them. This may sound self-evident but it is wholly neglected in many syringe services, where the needles are thrown together in dishes or tipped in bulk from one receptacle to another. At all times when they are not being handled or are not packed ready for use they should be kept stuck into cushions or laid out side by side on trays with a soft lining. Cellulose foam sponge is an excellent material for needle cushions and may be used at all stages of cleaning as it is easily washed and withstands boiling. The cushions should be several inches thick and can be cut from large sheets as required. An extra refinement is the provision of a support, such as is used for picture frames, so that the pads stand up at an angle. It is better to have a number of small cushions than a few large ones.

Needle sharpening is avoided in some hospitals on the grounds that the work is too specialized to be undertaken by orderlies, or that it is too costly in labour. Experience in a number of syringe services has shown that most people can learn to sharpen needles well, although it may take them some months to become proficient. It is also work at which women are nearly always better than men. Claim may be made that needles can be tested for sharpness by being passed between thumb and finger nail or by being stuck through thin rubber stretched over a jar. The first test will only show if the needle is hooked and the latter if it is very blunt. For preference all needles should be inspected for sharpness, cleanliness and freedom from flash under a microscope with a magnification of about 15 diameters, after they have been subjected to the cleaning processes described above.

Needles may be sharpened on a fine Arkansas stone lubricated with a light mineral oil, or on a rotary wheel. The former method will take longer than the latter when it comes to re-pointing a badly hooked needle but, on the other hand, it will wear the needles down less quickly. If a rotary grinding wheel is used, it should be 3 inches in diameter to give the needles a short strong point. It should be a fine grain stone to suit the steel of which the needles are made. A machine which revolves at a relatively low speed is to be preferred to avoid unnecessary heating and wear. The needles should be sharpened wet, and any which require more than slight retouching should be dipped in water from time to time. Attention to thesede tails will prolong the life of needles. Hard steel will take a sharper edge, will be less easily blunted, and less quickly worn down than milder steel. Good quality needles of Austenitic 18/8 steel should therefore be used, and if well treated, will remain serviceable for two or three years. Intra-muscular needles should be discarded when they have been worn down to less than 1¼ inches. The diagrams below show the shape of point that is to be desired.



NEEDLE POINTS

After cleaning, washing and, as necessary, sharpening, needles should be rinsed with plain hot water in the same way as for washing and finally compressed air should be blown through them to remove as much moisture as possible. If they are required quickly for mounting on syringes, they may be put in the drying oven for a few minutes.

A proportion of needles, particularly fillers, which are supplied to theatres or to wards for special purposes, will have to be packed in small glass tubes (see Appendix 'A'). This is more conveniently done at the needle bench than at the main syringe assembly bench.

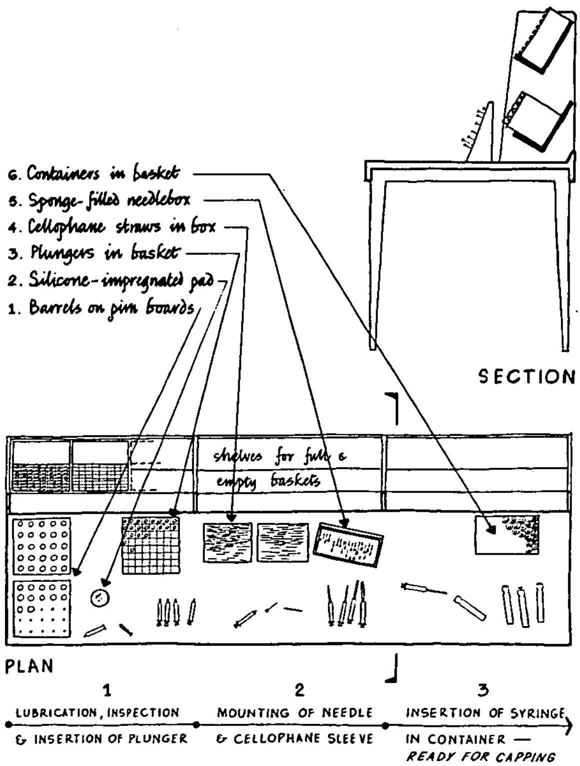
Assembly

Syringes should be inspected for cleanliness as barrel and plunger are picked up for assembly. Particular attention should be given to the inside of the nozzle, and any dubious barrels returned for re-washing and pulling through with a pipe-cleaner. Each plunger should be lightly rolled over a small pad of cellulose foam impregnated with silicone lubricating fluid (a mixture of 510/500 silicones) inserted in a barrel and worked up and down and round once or twice to spread the silicone. The pad, which will require changing from time to time, should be kept in a shallow tin with a lid, with which it can be covered when not in use to prevent it collecting dust. Dipping the plunger into a pot of silicone fluid is not so satisfactory as it leaves a blob of silicone on the end of the plunger where it is not required, and which will not be dispersed when the plunger is worked round in the barrel.

Next the syringes are mounted with needles. These should be attached in such a way that the aperture of the needle is in line with the graduations on the syringe barrel. They should be put on firmly enough to ensure that they will not fall off, but not so tightly that the nozzle of the syringe may be damaged when they are taken off. If desired, the needles are then sleeved with lengths of cellophane drinking straws, or stilette wires are inserted. The wires should extend at least 2 inches beyond the needle, so that when the syringe is placed in its container the wire bends round and forms a spring which prevents the needle from falling off. The syringe is now ready to be slipped into its container.

The outside of the top of the container should be moistened with water so that the gum on the inside of the capsule may grip. The capsule should then be put on, clamped firmly in position by a hand-operated machine and the completed syringe placed in the tray or basket in which it is to be sterilized.

The arrangement of the assembly bench is one which will repay careful thought, so that all the equipment required is at once conveniently to hand but does not take up unnecessary room. The illustration below shows how shelves over the bench may be used to hold baskets of empty containers ready for filling, and filled ones ready for capping. This leaves room on the benches for the pirn boards carrying barrels, for boxes of needle sleeves, pads of clean, sharp needles for mounting and so on.



ASSEMBLY BENCH : Work-division into three stages.

The process of assembling syringes involves several distinct operations. One person working alone will usually batch the assembly work, forming a large pile of syringes at one stage before starting the next. Since the piling up of syringes is to be avoided, assembly is best done by a team of two or three orderlies so that the syringes are inspected, lubricated, assembled and mounted with needles in a continuous flow. Once syringes are safely in their containers they can accumulate until such time as it is convenient to cap them. Some photographs are shown opposite p. 27 of teams assembling and sealing syringes.

Sterilization

As stated in the introduction to this paper the whole question of the standards of sterilization for syringes is now under review by the Medical Research Council, who will be publishing recommendations in due course.

Storage and Issue

Syringes should be allowed to cool after sterilization before they are moved, as they are fragile when hot and needles are likely to fall off the syringes, especially if they are of the all-glass variety. When cool, the syringes may be packed straight into ward delivery boxes ready for issue. The shelving for accommodating sterile syringes should be near the sterilizer and where there is no delivery service should also be accessible to the hatch or door at which syringes are exchanged. Sterile stock should be kept at a distance from the main work benches in order to avoid any possibility of unsterile syringes being placed amongst the sterile ones. No capsule manufacturer has yet produced a cap which changes colour when heated. Such a cap is technically simple, and would be a useful indication that the container had been through the sterilizer and would provide a further insurance against any mixing of sterilized and unsterilized containers. It is to be hoped that such a capsule will soon be on the market. Any spare or special needles in test tubes will need to be kept separately in boxes or drawers.

Records

The daily usage of syringes by sizes and by departments, and all breakages and losses, again by department, should be noted in addition to keeping the usual records of supplies received from stores. A record of daily usage gives a general picture of the work of the department and will provide such statistics as may be needed from time to time. For example, it may be necessary to modify ward stocks, following increases or decreases in their daily usage. Histograms showing the relationship of ward stocks to usage are shown on p. 22.

Since breakages are mainly due to carelessness and since the cost of replacements is the second largest item in the annual budget of any syringe service, it is important for hospital staff to know that every accident is recorded and will not be lightly passed over. A periodical analysis of the records will show where breakages are occurring. In Appendix 'B' is an account of how syringe breakages may be reduced. If these are found to exceed 1·5 per cent. of the turnover of syringes then enquiries on the lines of Appendix 'B' may be begun.

III

Cost

CAPITAL COSTS

It has been stated in the introduction to this paper that particular attention would be paid to the costs of syringe services. Let us consider first the capital cost of setting up a syringe service. This will vary enormously from hospital to hospital. One hospital will require to bring plumbing or electric power a long way, another may have to spend a considerable amount on buildings. As such factors differ so much from hospital to hospital, it is not possible here to arrive at any figure of the complete capital cost of setting up a service. But, perhaps, some figures of the cost of some items of equipment essential to syringe services may help. Even these should be treated with caution.

TABLE II. *Capital Cost of Equipment*

	For a Service producing about 500 *syringes a day* £s (approx.)	*For a Service producing about* 1,000 *syringes a day* £s (approx.)
Sterilizers	£250–£350	£380–£550
Drying Cabinet (commercially manufactured)	£50	£80
Syringes (interchangeable)	£955	£1,700
„ (non-interchangeable)	£560	£1,000
Containers	£52	£90
Boxes	£50	£100
Microscope	£50	£50
Needle Sharpening Machines	£8 or £26	£8 or £26
Capping Machine (Triple-headed)	£54	£54
Pirn Boards and Laboratory Cages	£25	£40
Trolley	£25	£40

The capital cost per unit of service is therefore somewhat less for a large service than for a series of small ones. This is a common feature of most enterprises. Given the right circumstances, e.g. the existence of a suitable building, etc., the large service supplying, perhaps, a group of hospitals could offer an excellent opportunity for savings.

RUNNING COSTS

Experience has shown that it is difficult to obtain from hospitals reliable figures on running costs. One hospital may claim that it is processing syringes for about 3*d.*, whilst another may be well satisfied with 5*d.* or more per sterile syringe. Upon examination such claims were often found to be unreliable. For example, one service had kept no proper record of the number of syringes processed; another used syringe service labour for other tasks, only guessing the amount of time spent on syringes. It was important, therefore, to get some reliable figures since information on cost is of prime importance to hospitals wishing to set up central syringe services.

The cost of running the services was, at the three hospitals mentioned in the introduction to this paper, assessed in the following manner. The amount paid out in wages, including National Health Insurance and superannuation, was obtained from the hospital finance department. The cost of all consumable stores issued during a period of six months was obtained from the supply department. Stock was taken of the number of syringes held on the wards and in the syringe service at the beginning and end of the six months, and the difference in stock were checked against lists of syringe breakages and losses recorded in each service over the period. Electricity consumption was specially metered. The numbers of syringes processed were taken from the normal syringe service records which were checked for accuracy. The figures thus obtained were then adjusted to cover a period of 52 weeks rather than the 26 weeks involved. The costs of the syringe services do not include, however, depreciation of capital equipment (other than syringes and the delivery van at hospital A) nor do they include any proportion of hospital costs for rates, cleaning services and water. In any case these latter elements of cost are small in proportion to those of the service as a whole and cannot easily be compared one hospital with another.

The costs of the syringe services to the nearest pound are shown below.

Running Costs at Hospital A

(The largest syringe service in the country serving not only the hospital group but a number of hospitals outside the group as well.)

	£s *per year*
Wages (including N.H.I. and Superannuation)	3,918
Syringe Replacements	2,333
Delivery van (including $\frac{2}{5}$ share of driver's wages and depreciation)	402
Needles	280
Glass Tubes (for needles)	117
Capsules	300
Consumable Stores	206
Electricity	85
	£7,641

Number of syringes processed	380,000
Cost per sterile syringe	4·75*d*.

Note 1: This hospital runs a van which delivers syringes to outlying hospitals as well as serving the central laboratory. It has been estimated that two-fifths of the work of the driver and van is taken up with delivery and collection of syringes. Syringes are also delivered to all wards of all the hospitals that the service supplies. This delivery round takes up 8·5 orderly hours of work a day. The total cost of delivery is therefore £789 a year (van £402, orderly's time £387) or 10·2 per cent. of the annual cost of the service. Without delivery the cost per syringe would be 4·3*d*.

Note 2: During the period of costing some syringes were still packed in heavy aluminium containers which required kraft paper for packing and sterile labels for sealing. Such materials represented £117 of £206 of consumable stores. When 'Ideal' capsules are used for all syringes, the proportion of consumable stores will decrease and the amount spent on capsules will increase to a similar extent.

Running Costs at Hospital B

(A small service providing sterile syringes for its own hospital only.)

	£s *per year*
Wages (including N.H.I. and Superannuation)	1,806
Syringe Replacements	804
Needles	232
Test Tubes (ordinary)	48
Cellophane	36
Consumable Stores	42
Electricity	24
	£2,992

Number of syringes processed	140,000
Cost per sterile syringe	5·1*d*.

Note: During the work undertaken at this hospital there were indications that the syringe service were rather generously staffed, particularly as they did not undertake a delivery round. Since the investigation closed there has been a reduction in the number of staff employed and the cost per sterile syringe is now somewhat less than the 5·1*d*. quoted.

Running Costs at Hospital C

(A syringe service dealing with a large hospital and some outlying hospitals as well.)

	£s per year
Wages (including N.H.I. and Superannuation)	3,161
Syringe Replacements	1,605
Needles	69
Glass Containers	390
Capsules	238
Consumable Stores	99
Electricity	37
	£5,599

Number of syringes processed	224,000
Cost per sterile syringe	5·9*d*.

Note 1: No delivery round is undertaken in the principal hospital.

Note 2: The figure of £69 for needles has been obtained from the numbers invoiced to the syringe service over a year as it was not possible to take stock of needles. This syringe service takes great care of its needles but, in spite of this, it is thought that this figure is unrepresentatively low.

Note 3: This hospital could reduce the annual bill for test tubes. The matter is in hand.

Note 4: As the service is only open for a few hours on Sundays for the exchange of ward stock, there is a double quantity of syringes to be cleaned on Mondays. This system calls for a large stock of syringes and a larger staff than would be necessary were a seven-day week to be worked.

It may be a convenience to study these figures as a proportion of total costs, hospital by hospital. This is done in Table III below:—

TABLE III. *Comparative Costs*

(All in percentages of total cost.)

	Hospitals		
	A	*B*	*C*
	per cent.	*per cent.*	*per cent.*
Wages	51·3	60·3	56·8
Syringe Replacement	30·5	26·8	28·9
Needles	3·7	7·8	1·2
Test Tubes	1·4	1·7	7·2
Capsules: Cellophane	..	1·2	..
Capsules: 'Ideal' Capsules	4·0	..	4·2
Consumable Stores	2·7	1·4	1·7
Electricity	1·1	·8	..
Delivery Van	5·3	..	..
	100·0	100·0	100·0
Cost per sterile syringe	4·7*d*.	5·1*d*.	5·9*d*.

RUNNING COSTS

Some remarks on these costs are called for. Which size of syringe service is likely to be the cheapest to run? Should very large services be developed or should each hospital run its own service irrespective of size? First it will be seen that the largest service (Hospital A) is the cheapest in spite of the fact that it undertakes a delivery round, which is not done at either of the other two hospitals. But it is only a little cheaper. If the cost of delivery of syringes is excluded from the costs of Hospital A, its cost per sterile syringe would be 4·3*d.* as against 4·75*d.* But if the other two hospitals each take certain measures—which they already have in hand—their costs too might be reduced. The costs of Hospital A indicate the economies in the labour element which may be expected in the larger services. But any dramatic reduction in the costs of labour generally cannot be expected. The tasks which occupy so much of the labour in syringe services (e.g. assembly) are not such as are ever likely to be done other than by hand irrespective of the size of the service. Secondly, attention must be drawn to the cost of the delivery van. This costs £400 per annum and represents 5·2 per cent. of this hospital's total costs. It is clear that as hospital syringe services get bigger, so the costs of distribution go up, the saving on labour to some extent being offset by the increased costs of distribution. Lastly, attention must be drawn to the total annual costs. The small service costs some £3,000 a year to run, the service of average size costs some £5,500 a year and the very large service £7,000 a year. In each case these figures are only a very small slice of the annual group budgets. As the financing and administration of hospitals is generally centred in the group, is it worth breaking up the group organization for comparatively small sums? The answer might well be 'Yes' if large economies were to be expected by doing so. But this is not the case. Economies there would be, but they would probably not be measured in more than several hundreds of pounds a year. It must also be remembered that if syringe services were to become so large that a turnover of syringes every 24 hours were not possible, many more syringes would be needed. This would increase the capital costs of the service. This increased capital would be locked up in syringes which would only be travelling instead of being used.

In general, it looks as if the best syringe organization is one centred in the hospital group, where perhaps one van, distributing other things as well as syringes, can be used to the maximum extent consistent with a daily delivery and a small mileage. Within the delivery round of that van, the larger the number of 'customers' the cheaper will be the product; and if local health authority clinics, general practitioners and district nurses can be included, without increasing van mileage, then the cost per sterile syringe will be proportionately reduced. It is emphasized that this applies in general only. In a closely knit industrial area it might well be possible to supply syringes to two or more hospital groups from one service and still maintain a daily delivery. But there does not seem to be any evidence that a large national or regional service on Blood Transfusion Service lines would effect such marked economies as to make it worthwhile.

If, then, syringe services are unlikely to develop beyond the present group organization, what is likely to be their future? The establishment of a syringe service is unlikely to produce any tangible reductions in the hospital budget. This is because the cleaning and sterilizing of syringes on the wards takes only a fractional proportion—perhaps an hour a day—of the total time spent by nurses in preparing sterile equipment, and even if they are relieved of the care of syringes, sterilizers will still be required in the wards for other equipment. But if all sterilization were to be removed from the wards and done centrally, not only might an improved quality of sterilization result but appreciable economies might also be expected. Hospital engineers know only too well the heavy costs of the maintenance of ward sterilizers, whilst the cost of the gas or electricity that these consume is probably an even heavier item. Hospitals are now turning towards the idea of centralizing sterile supplies, and it seems that syringe services are more likely to develop as part of central sterile supply departments, supplying all the sterile equipment which their hospitals require, than in the direction of big units processing syringes only.

IV

Summary and Planning Data

THE previous Sections have outlined how syringe services should be planned, how they should run and what they are likely to cost. This final Section summarizes the conclusions so far reached and provides some basic facts which it is hoped will assist any hospital authority considering the initial planning of a syringe service.

GENERAL

A syringe service, even if it starts in one hospital only, is likely to end up by supplying the whole group at least. Accordingly, the department should give on to a road where a loading ramp will permit of trolleys being wheeled straight into a delivery van. Ease of access within the hospital in which it is situated is also essential. In view of the possible later adoption of a system of central sterile supply, consideration should be given to placing the syringe service where it could be expanded into a central sterile supply department, if required.

A syringe service will need a work room or rooms together with ancillary accommodation for cloak-rooms, cleaners' materials, supervisor's office, and bulk stores. In order to house the necessary sinks, benches and equipment, the minimum size for a work room is about 300 square feet. This room should be arranged to provide a work line of 50 to 70 feet. Such a room is large enough to process up to 1,000 syringes a day. Beyond this figure, 6 feet of additional bench space and a proportionate increase in area will be needed for each 200 additional syringes processed a day.

The service may be run by either the pathologist or the pharmacist. It is not a satisfactory arrangement for the responsibility for running the service to be vested in some other member of the staff. If the pharmacist runs the service then the pathologist should be made responsible for making independent checks to ensure that sterility is being achieved. It is generally accepted that where the question of asepsis arises or is likely to arise the pathologist or bacteriologist is primarily concerned. Immediate supervision within the service is best done by a nurse with administrative ability. She should have a status equivalent to that of a departmental sister, her position being somewhat similar to that of an X-ray sister. She should be appointed by the appropriate hospital committee and the pathologist or pharmacist must assist in selecting her, since she should always be responsible directly to whichever of these two is in charge of the syringe service. As the hours are regular the job usually suits a married ex-ward sister. It may sometimes be possible to employ a suitable technician. The remainder of the staff should be women and such staff may be graded as follows, and receive a composite rate of pay according to the division of their time at different tasks.

	Wage Per Week (Women)	
	London	*Elsewhere*
Laboratory Assistant	127*s*. 6*d*.	119*s*. 6*d*.
Set Assembler	131*s*. 6*d*.	123*s*. 6*d*.
Sterilizer Attendant	133*s*. 6*d*.	125*s*. 6*d*.
Needle Sharpener	139*s*. 6*d*.	131*s*. 6*d*.

Staff additional to the Supervisor will be needed on the scale of one orderly per 200 syringes to be processed a day, although it must be appreciated that this output will not be reached until the service is running smoothly and the staff has gained experience.

In order to arrive at the number of syringes they require, hospitals setting up a syringe service should discover how often syringes are used daily. Some measure of standardization of product is essential. It has been found that hospitals can manage very well using only 2, 5, 10 and 20 millilitre syringes. Syringes will be required on the scale of four times the average daily usage, and in the following general proportions:

2 ml.	58 per cent.
5 ,,	20 ,, ,,
10 ,,	10 ,, ,,
20 ,,	12 ,, ,,

These proportions may, however, vary if there is anything exceptional in the organization of the hospital.

There is no appreciable difference in the replacement cost to a syringe service if interchangeable or non-interchangeable syringes are used. If, however, a syringe service is to process about 1,000 or more syringes a day, then interchangeable syringes are to be preferred.

Multiple packs of a number of syringes in one box are not recommended, nor are such sealing materials as paper, cellophane or plastics suitable. Containers should be of glass or aluminium and will be needed in the same numbers as the syringes. Glass containers allow the contents to be seen which is an advantage, but replacements for broken containers will cost a hospital about £300 a year per 1,000 syringes processed a day. Aluminium containers should be of the extruded type. They are about the same price as glass containers but the breakage rate is negligible.

Syringes in their containers require a box for delivery. This may be of cardboard or aluminium. The cardboard boxes are about half the price of the aluminium boxes, but it is doubtful if their life exceeds about three years. Hospitals setting up a syringe service would probably be well advised to purchase cardboard boxes to start with, reconsidering their policy when the boxes wear out.

EQUIPMENT

The following equipment will be needed in any syringe service set up.

Sterilizers

Electricity is preferable to gas as a source of heat as it can be more accurately controlled. It is essential that conventional hot-air ovens should be fitted with fans, and it is advisable for them to have automatic time control as well. These attachments will add between £15 and £20 to the cost of each oven. A number of small ovens permits a more even flow of work, but will incur greater capital outlay. An economic arrangement for a service with an output of 500 syringes a day would be three ovens with a capacity of about 4,000 cubic inches each (cost—£300 to £340) or two ovens with a capacity of about 5,000 cubic inches each (cost—£250 to £280). In each case two more ovens would be required for syringe services turning out 1,000 syringes a day.

Several manufacturers are developing infra-red ovens with moving belts. These will bring syringes up to sterilizing temperature within 5 to 10 minutes by means of radiant heat, thus shortening considerably the sterilizing cycle and increasing the effective capacity of the oven. The moving belt ensures that each syringe receives the same treatment, permits a continuous flow of work, and eliminates any temptation to overload the oven.

Drying Ovens

As a general rule sterilizers should not be used for drying. A hot-air cabinet is suitable. This can be heated to temperatures between 110° to 120° Centigrade. Since it takes about half as long to dry a syringe as it does to sterilize it, the capacity in syringes an hour of any hot-air cabinet selected should be about half that of the sterilizer chosen.

Sinks

These are required for soaking, washing and rinsing. Soaking sinks should have a capacity of about 1 cubic foot per 50 syringes processed a day. Ordinary domestic sinks are suitable for washing; but if the output exceeds 500 syringes a day, two sinks are necessary. Rinsing sinks are required on the same scale as washing sinks but these should be equipped for automatic rinsing. Unless made of stainless steel or plastic, sinks for soaking and washing should be lined with cellulose foam to reduce breakages.

Benches

These should be easily cleaned, and preferably covered with linoleum or formica. Teak is also very suitable. Benches at which work is to be done standing should be 35 inches high, and those for sitting work should be 28 inches high. Chair seats should be 16 inches from the floor.

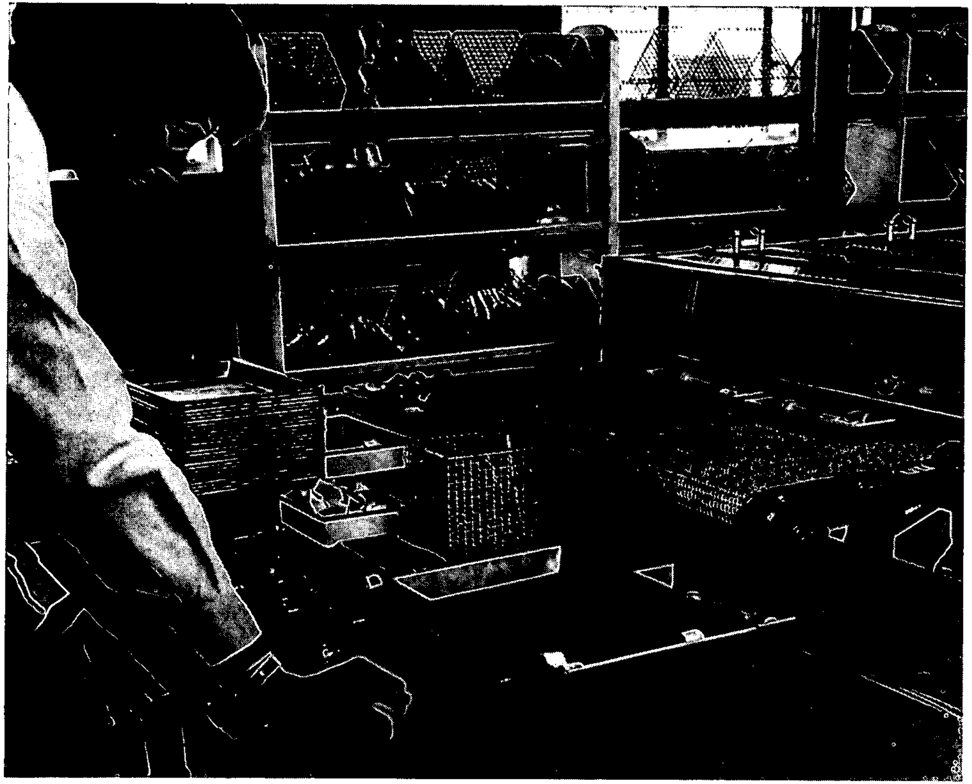
Other Small Equipment

Some details of other small equipment needed and the names of firms who supply such equipment is shown in Appendix 'A'.

COSTS

It is hardly possible to forecast the capital cost of setting up a syringe service since the important factors of buildings, power, and plumbing vary so much from hospital to hospital. But, broadly, a service covering a group of hospitals is usually the cheapest to set up. Some idea of the capital costs of certain items of equipment are shown in Table II on p. 33.


Delivery trolley



Sealing machine and sterilizer

The running costs of syringe services are a more important factor than initial capital costs, since the initial capital outlay is little more than the recurring annual expenditure. An estimate of the annual cost of running a syringe service is shown below. This gives an approximation only for services processing 500 and 1,000 syringes a day. The actual costs of running three services and the number of syringes each processed is given on pp. 35 and 36. But the figures below will probably be sufficient for budgetting purposes.

TABLE IV. *Estimated Running Costs*

	For a Service producing about 500 syringes a day £s a year (approx.)	*For a Service producing about 1,000 syringes a day £s a year (approx.)*
Wages	£2,200	£4,000
Syringe Replacements	£1,100	£2,000
Needles	£150	£280
Capsules	£180	£360
Consumable Goods	£60	£100
Power	£35	£60
	£3,725	£6,800
	* £150	* £300

* These sums to be added if glass containers are used.

THE FUTURE OF SYRINGE SERVICES

Thus a syringe service supplying, say, a group of hospitals seems cheaper both to establish and to run than a series of small services each supplying its own hospital. This is to be expected. But there is no evidence that the very large service supplying, say, the region or part of it will make for large economies. On the contrary it may prove more expensive. If a syringe service were to be so large that syringes processed to-day were not in the hands of the wards in time for use to-morrow, a lot of capital would be locked up in syringes travelling backwards and forwards instead of being used. A rapid turnover of syringes is a feature of most services and is a valuable economy. There are indications that the future of syringe services lies more in becoming part of a central sterile supply service, probably supplying a large hospital or hospitals of the group, and thus following the general hospital administrative pattern.

APPENDIX A

NOTES ON EQUIPMENT

(The following appendix gives the names of known manufacturers of the special equipment described. There will be, of course, other firms, not mentioned below, who may be equally capable of supplying this equipment.)

STERILIZERS

ORDINARY hot-air sterilizers, complete with fans, are readily obtainable from the many manufacturers who make them.

Infra-red moving belt sterilizers of different types may be obtained from any of the following firms:

Messrs. Townson & Mercer Ltd.,
Beddington Lane, Croydon, Surrey.

Metropolitan-Vickers Electrical Co. Ltd.,
132/5 Long Acre, London, E.C.4.

Messrs. George Vokes (Engineering Div.) Ltd.
High Road, New Southgate, London, N.11.

SYRINGE CONTAINERS

Containers should be of such a length that they will take a syringe with a needle mounted. To avoid the use of extra packing, the top of the container should be level with the head of the plunger. Plungers may vary in length, but if aluminium foil capsules are used, they will accommodate any plungers which may protrude slightly. Silicone rubber washers for protecting the rims of barrels should not be necessary in extruded aluminium containers because of the close fit of the container and the resilience of the metal, but they may be necessary with glass. Glass containers may be made with a small knob of glass to prevent rolling. This knob forms a weak spot in the container and probably causes as many breakages as it prevents.

Extruded aluminium containers are obtainable from:

Messrs. W. H. Bailey & Sons, Ltd.,
80 Bessborough Place, London, S.W.1,

or in larger quantities from

Messrs. Venesta Ltd.,
Vintry House, Queen Street Place, London, E.C.4.

Glass containers are obtainable from:

Messrs. Franco-British Glass Company,
15–17 King Street, St. James's, London, S.W.1.

SEALING CAPSULES AND SEALING MACHINES

'Ideal' Capsules

These are aluminium foil caps with pleated sides of a type widely used for bottles. Those supplied for sealing syringes should be made of a grade of foil heavy enough to ensure the absence of pin-holes, and should be gummed inside with extra strong gum. To fix them, the top of the syringe container is moistened on a wet sponge, the capsule is placed over it and clamped firmly on by a hand-operated machine. 'Ideal' capsules are available in a variety of sizes and colours, the colours serving if necessary to indicate the contents of the containers. These capsules should not be embossed as this process may cause pin holes.

'Alka' Caps

These caps are similar to milk-bottle tops. They are stouter than 'Ideal' capsules, but have the disadvantage of not accommodating so well any extra long plunger knobs which protrude beyond the top of the container. Being made of strong aluminium foil they may safely be embossed to indicate contents if desired. Like 'Ideal' capsules, 'Alka' caps are clamped on by a hand-operated machine.

'Ideal' capsules and capping machines are obtainable from:

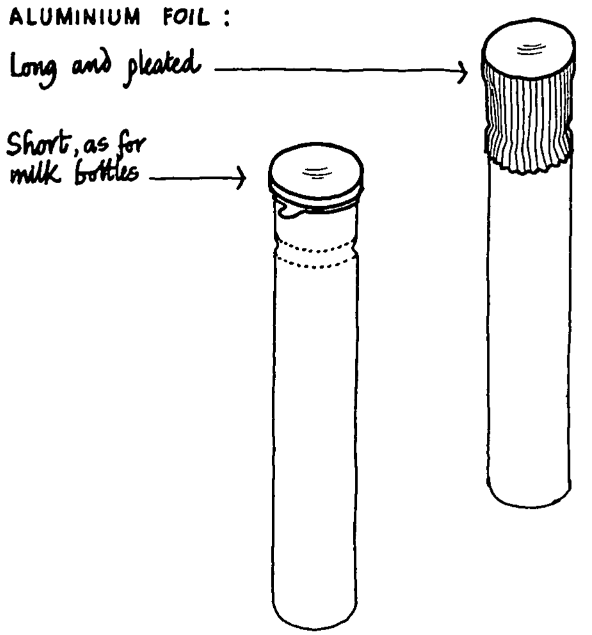
Messrs. Ideal Capsules, Ltd.,
Edinburgh Avenue, Slough, Bucks.

An illustration is shown overleaf.

'Alka' capsules and capping machines are obtainable from:

The Alka Company, Ltd.,
Maxwell Way, Gatwick Road, Crawley, Sussex.

An illustration is shown below.



SYRINGE CONTAINER CAPSULES

NEEDLES

These should be of good quality. Cheap needles are not likely to be an economy as they are made of milder steel which blunts easily and is soon ground down below a useable length. Inferior metal may also corrode or break. Needles in which the shaft is swaged into the hub are probably better than those which are soldered.

No British Standard has yet been laid down for needles but the following tests used in the United States may be of value to users.

A. *Resistance to Corrosion*

The shaft should withstand immersion in 10 per cent. citric acid at room temperature for 5 hours; boiling for 30 minutes; and immersion for 48 hours in distilled water without showing appreciable corrosion after drying by evaporation. These tests should be made in a glass vessel.

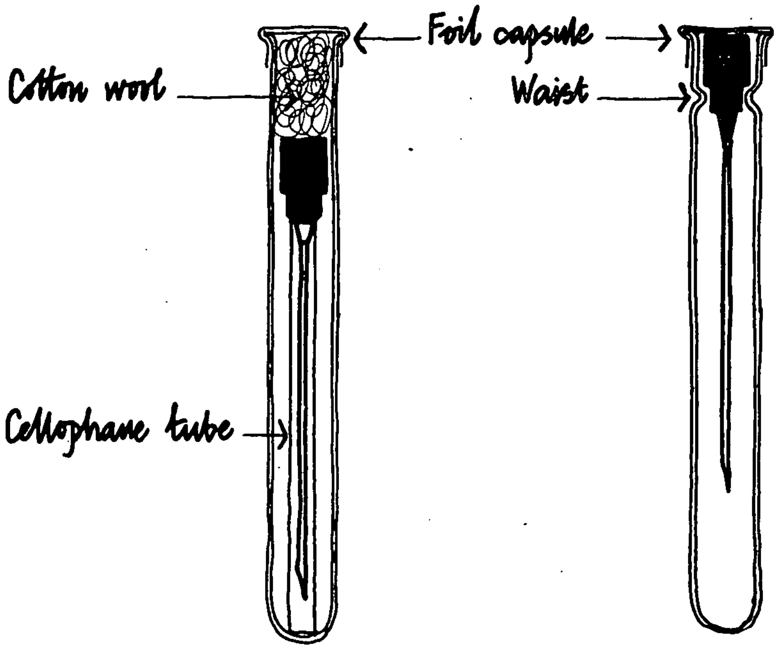
B. *Resistance to Breakage*

The shaft should have sufficient flexibility so that, with the hub in a fixed position, the shaft may be bent 20 times both sides of vertical 20–25 degrees without breaking.

C. *Resistance to Bending*

In the absence of the technical equipment necessary to measure stiffness, an unknown brand of needle may be checked against a satisfactory known brand by sticking the needles (mounted) into an orange and observing any excessive bending on the part of the unknown brand of needle. Resistance of the orange to the hypodermic needle approximates to the resistance of the human body.

Two convenient methods of packing needles are shown below.



NEEDLE PACKS — Alternative types.

ALUMINIUM PIRN BOARDS

These are made of sheet aluminium into which are inserted lengths of aluminium tubing. The use of tubing rather than rod permits a draught of hot air to penetrate the interior of barrels and containers during drying.

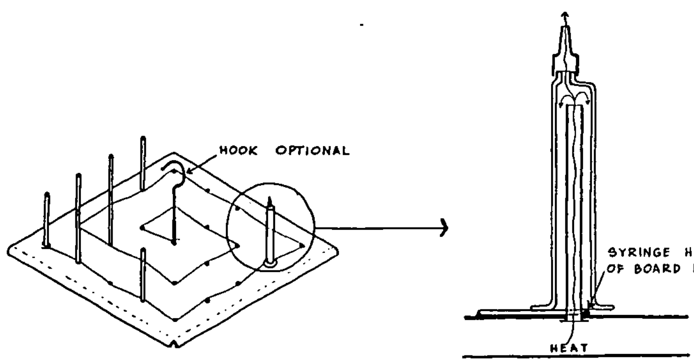
The syringes and containers may be kept clear of the base plate by twisting wire round the bases of the upright tubes, the syringes resting on the wires. The tubes should not be so long as to support the syringes since this may impede the circulation of air within them. It is preferable to have a separate pattern for 20 millilitre syringes, to permit greater density per board of the smaller sizes, thus saving space.

The base plate should have an edge which permits the board to be lifted. Alternatively a hook may be substituted for the central tube.

Aluminium pirn boards may be obtained from :

Messrs. James Hustler & Sons, Ltd.,
White Lund, Morecambe, Lancashire.

An illustration of a pirn board is shown below.



PIRN BOARD for 24 syringes.

LABORATORY CAGES

Wire baskets or cages of the same area as the pirn boards will be required for carrying plungers and containers between one process and the next. These can be obtained from most surgical suppliers.

DELIVERY BOXES OR RACKS

These may be made either of aluminium or cardboard. The aluminium rack is nearly twice the price of the cardboard box, but is virtually indestructible. The cardboard boxes last two or three years and protect the syringes better, being softer than the aluminium racks. Hospitals starting a syringe service would probably be well advised to order cardboard boxes in the first instance and then to reconsider their delivery arrangements in the light of their experience with cardboard boxes.

One hospital has found that the following number of syringes can conveniently be made to fit into cardboard boxes of the same external measurements.

Standard box	holding	18 × 2 ml.
	and	5 × 5 ml.
	and	3 × 10 ml.
	and	4 × 20 ml.
Theatre box	holding	20 × 20 ml.
Small box (half standard dimensions)	,,	12 × 2 ml.
	and	6 × 5 ml.
	and	2 × 10 ml.
	and	2 × 20 ml.

These boxes may be obtained from:

Messrs. Dring, Ltd.,
The Airport, Portsmouth, Hants.

Another hospital finds aluminium racks holding the following quantities convenient:

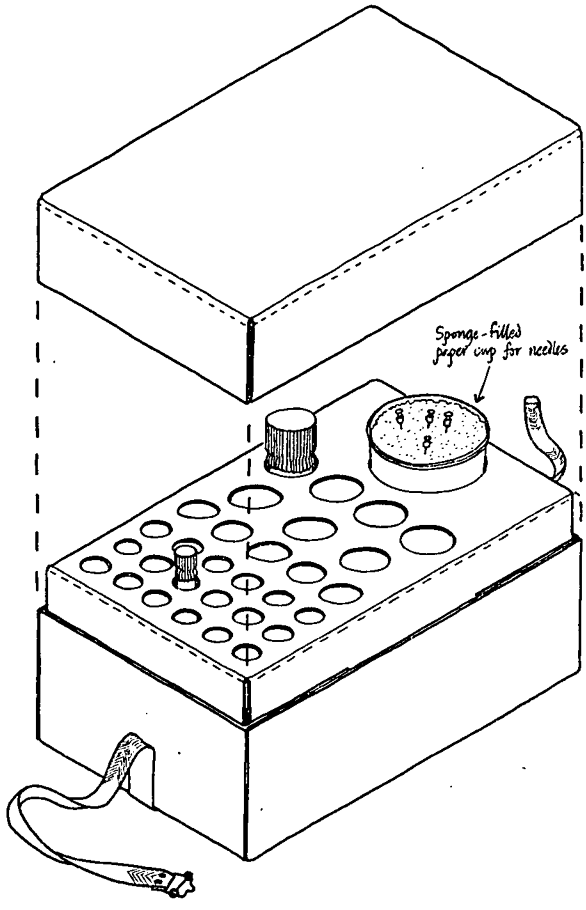
	36 syringes	all 2 ml.
or	29 syringes	2, 5 and 10 ml.
or	{10 syringes 18 ,, }	10 and 5 ml.
or	20 syringes	all 20 ml.

These racks may be obtained from:

Messrs. Samuel Parkes & Co. Ltd.,
Pretoria Works, Willenhall, Staffordshire.

Whether box or rack is decided upon, it should contain a space for a container to take dirty needles. This container should be at least 4 inches deep and be fitted with cellulose foam sponge.

An illustration of a delivery box is shown below.



CARDBOARD DELIVERY BOX

DELIVERY TROLLEYS

It is preferable to construct special trolleys for delivering syringes so that the boxes or racks of syringes can easily be loaded and unloaded. Where a group of hospitals is served the trolleys should also be of such dimensions that they may be wheeled into the delivery van. One hospital had a satisfactory trolley built in its own workshops from 'Dexion' angle aluminium, a material which is light and at the same time easily put together.

An illustration of this delivery trolley is shown opposite p. 42.

MISCELLANEOUS

Ultra-sonic Needle Cleaner is obtainable from:

Dawes Instrument Company,
99 Uxbridge Road, Ealing, London, W.5.

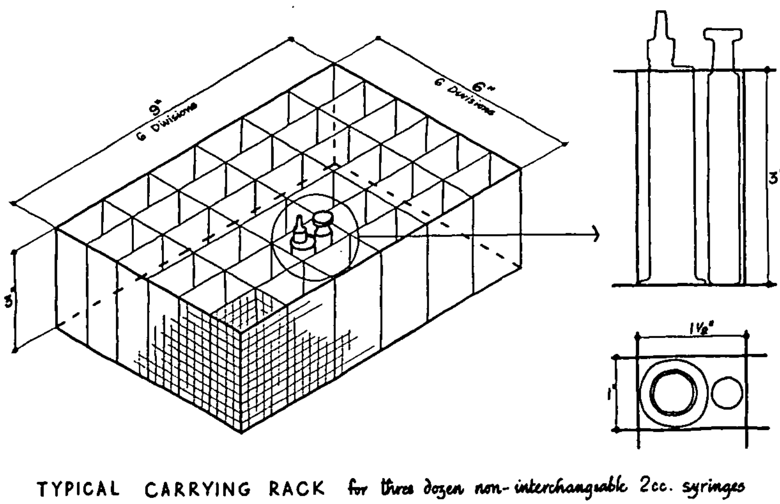
Carrying Racks for Non-interchangeable Syringes

Hospitals may wish to design their own. In this case the principle to be borne in mind is the need to keep both barrel and plunger together.

These carrying racks are made to order by:

Adelphi Manufacturing Co. Ltd.,
21 Duncan Terrace, London, N.1.

An illustration of a carrying rack is shown below.



TYPICAL CARRYING RACK for three dozen non-interchangeable 2cc. syringes

Rotary Brushes are obtainable from:

The Thomas Hill Engineering Co. (Hull) Ltd.,
247 and 249 Beverley Road, Hull, Yorks.

Needle Sharpening Machines are obtainable from:

Matburn Ltd., Red Lion Street, London, W.C.1,

or 'Tomac' Needle Sharpener, through

T. H. Spicer & Sons,
29 Willoughby Road, Hornsey, London, N.8.

Microscopes

These are usually made up from various standard units and the price depends upon the units chosen. For preference the microscope should combine the following features:

(*a*) inclined binocular eyepiece of about 15 diameters magnification;

(*b*) a solid base on which the needle can be placed for examination.

APPENDIX B

SYRINGE BREAKAGES AND REPLACEMENTS

(For all glass—or glass with metal nozzle—syringes)

REPLACEMENT COSTS

1. From a detailed study of three sterile syringe services (referred to below as A, B and C) it is evident that the annual cost of replacing broken, condemned, and lost syringes is between 26 per cent. and 29 per cent. of the total annual cost of running a syringe service, and is the second largest item in the annual budget.

BREAKAGE RATES

2. These are computed by taking the total numbers of syringes broken, condemned, and lost, and expressing this figure as a percentage of the turnover, or number used, in the same period. In the year during which these studies were carried out (1956) Hospitals A, B and C had the following turnover and breakage rates:

	Turnover	*Breakage Rate*
	(approx.)	*per cent.*
Hospital A . . .	380,000	1·3
Hospital B . . .	140,000	1·8
Hospital C . . .	224,000	2·0

A reasonable 'target' maximum breakage rate appears to be 1·3 per cent. to 1·5 per cent.

INCIDENCE OF BREAKAGES

3. At Hospital B, during a survey of 20 consecutive weeks duration, breakages were as follows:

In wards and departments . .	·5%–2·2% (average 1%)
In sterile syringe service	·31%
Found damaged after reception (mostly chipped rims and plunger heads)	·25%
Condemned syringes	·15%
Lost (possibly undiscovered breakages) . .	·13%

At Hospital A, which showed a lower annual average rate, service breakages varied between ·2 per cent. and ·3 per cent., appearing to drop to the lower figure after the introduction of an improved method of carrying from process to process in the service. Here ward breakages averaged ·6 per cent.

THE BREAKAGE RATE AND THE HOSPITAL

4. The atmosphere conducive to a low breakage rate appears to be one of steady, unhurried work. High breakage rates appear, both in the service and in the wards when there is great pressure of work and possibly too great speed, or lack of rhythm, or anxiety.

The attitude of those in authority to syringe breakages is also an important factor; and to encourage an interest in, and concern for, a low breakage rate, some form of periodical bulletin may be issued from the service. It will also help to maintain an awareness of the cost of broken syringes to the service, if the replacement cost is worked out and included in the bulletin.

In Hospital B where a survey of breakages was carried out with a view to analysing and reducing breakages the weekly bulletin took the form shown below.

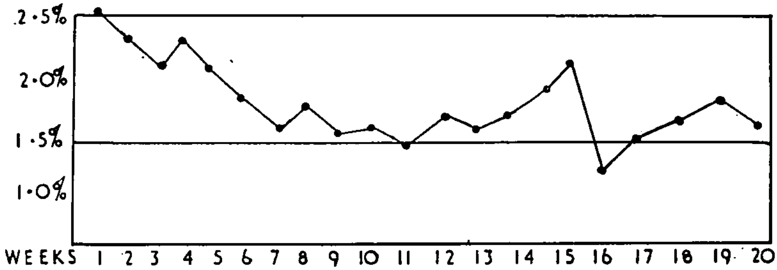
SYRINGE SERVICE BULLETIN

July 24th–30th, 1956

Estimated numbers handled in week	2,960
Numbers broken and condemned	52
,, ,, by wards	33
,, ,, by Service	7
,, ,, (doubtful)	5
,, condemned	7
This week's percentage of numbers broken and condemned to numbers handled	1·75%
Last week's percentage	1·57%
'Target' maximum percentage (which represents expenditure of approximately £600 a year with present rate of turnover).	1·5%
Cost of replacement for the week (This represents an annual cost of approximately £743 if breakages are maintained at this level.)	£14 5*s.* 10*d.*

This weekly bulletin was circulated to the Matron, Sister Tutors, all wards, and to the Housemen, with the following effect:

SYRINGE BREAKAGE RATE



CONTACT BETWEEN SERVICE AND WARDS

5. It appears desirable that close personal contact be maintained between an efficient syringe service supervisor and the wards. At Hospital A which was the largest of the services studied, the sister supervisor regularly visited wards, discussed breakages (which had to be reported to Matron) investigated complaints, or made them (the service delivered syringes to the wards). Breakages for the year were ·5 per cent. and ·7 per cent. lower than at Hospitals B and C respectively.

Any interest which can be aroused in the work of the service itself is of value in encouraging a low breakage rate. Student nurses who visit the service while being instructed in the handling of syringes, will tend to treat the syringes with greater care, especially if emphasis is placed on the value of the service to the ward staffs. Students and doctors also may be encouraged to visit the service, and study its methods and statistics. And all staff, both in the service and on the wards, should know the approximate value of the syringes they handle.

In such ways (and with the provision of as many good aids to safe handling as practicable) not only may those using the syringes be kept aware of the careful and costly work which a syringe service entails, but with good will they may assist in making the breaking of a syringe a rare occurrence.

GENERAL REMARKS ON CARE AND HANDLING

6. It is hoped that the following detailed remarks on care and handling may be of help in reducing syringe breakages. The manufacturers emphasize that syringes should not be handled in

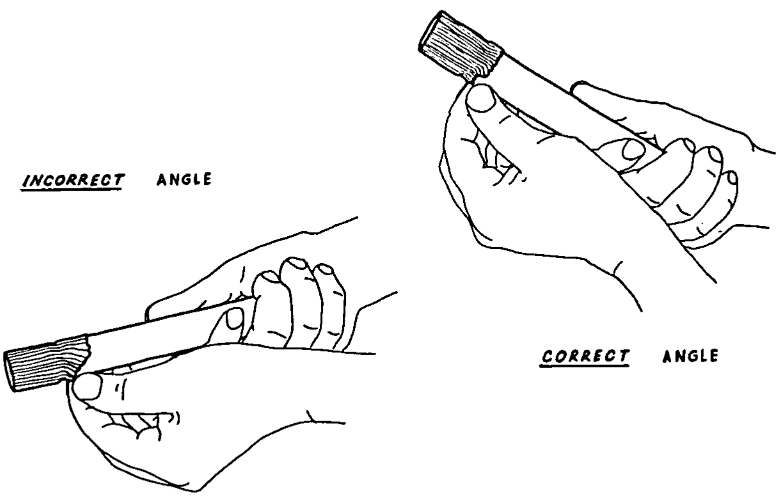
bulk, picked up in handfuls, or, if it can be avoided, placed in piles. They should not be allowed to jostle one another in movement. Where these instructions are ignored, the syringes tend to be weakened by damaging vibrations, or they develop small chips and fine cracks which later, when sterilizing heat is applied, expand and cause breakages under normal handling procedure. Breakages can be divided into two main categories:

(1) Mechanical—Those caused by dropping or striking the syringe against a hard surface.
(2) Thermal—Those caused indirectly by the heat of the sterilizing ovens.

EXAMPLES OF MECHANICAL BREAKAGES AND RECOMMENDATIONS FOR MINIMIZING THESE

7. (*a*) *Broken in transit, e.g. flanges damaged nozzles off.* Pack syringes securely in individual containers to prevent jostling. Carry them in some form of metal rack, or cardboard box which holds them upright. (See diagrams on pp. 50 and 51.)

(*b*) *Dropped when opening syringe on the ward.* See that the pack is not difficult to undo. Instruct users to hold test tube upright when opening, to avoid syringe suddenly shooting from the tube on to bench or floor.



UNPACKING SYRINGE CONTAINER

(*c*) *Dropped when drawing up injection.* Where possible open and draw up injection over trolley or bench which is covered with sheet rubber, cellulose foam, or some other resilient surface, so that accidental dropping may not cause breakage.

(*d*) *Dropped when carrying to or from patient's bedside.* Use a trolley wherever possible. One hospital that was visited has a special properly fitted injection trolley and places syringes in receivers or racks on the trolley. See that the container is large enough to hold the syringe full length when charged. An individual receiver for each syringe is required. Replace syringes in their containers after use.

(*e*) *Rolling from trolleys.* See that trolley wheels are running smoothly. The anti-static electricity chains may be adjusted where these tend to catch the nurse's foot or trolley wheels in movement. (Experiments are in progress with a trolley top with a lip edge. This, it is thought, should largely eliminate this type of breakage which is most frequent where syringes are laid on a sterile towel on the top of the trolley.)

(*f*) *Broken when attempting to release stuck syringe.* A hair, cotton fibre, or dusting powder, coming in contact with a withdrawn plunger will cause syringes to jam. Do not attempt to release a stuck syringe by hand, but return it to the service. Always rinse used syringes in cold water and/or antiseptic lotion at first possible moment after use. Leave needle mounted while doing this.

(*g*) *Nozzle broken off when dismounting needle.* Always use forceps for dismounting needle—and twist needle gently.

(*h*) *Broken when checking stock.* Wherever possible keep unused syringe stocks, and syringes waiting for return to service, in racks or boxes where they can be seen and counted easily.

(*j*) *Syringe flanges breaking away.* This type of breakage is frequently due to shock when the flange of the syringe comes into sharp contact with the rim or waist of the protecting glass tube or container. Rings of silicone rubber tubing (in appropriate bores) cut $\frac{1}{8}$ inch to $\frac{1}{4}$ inch deep, and placed under the flange will largely overcome this damage. These rings stand up to sterilization heat and need only be renewed occasionally. Some types of metal tubes do not cause shock damage to flanges.

(*k*) *Damage in processing.* Dismantle barrels if possible on to pirn boards (see diagrams on p. 48) which hold the barrels with nozzle uppermost. Keep in this position (so that the syringes do not jostle one another) except when handling. Where the non-interchangeable syringe is in use, special racks can be used to keep both parts together throughout processing. If the syringes are soaked in the service at reception (and not before) it may be possible to have wire baskets and pirn boards which can then be stacked in the soaking tank. One service visited dismantled syringes into fine mesh wire trays with compartments to hold individual syringes, and these were then left overnight. If neither of these methods can be adopted (and the syringes are not to be soaked), dismantlement into polythene bowls is recommended. Dismantle and assemble at a bench covered with sheet rubber, cellulose foam rubber, or some other resilient surface, to minimize danger of breakage through accidental dropping.

(*l*) *Broken (in service) when attempting to release stuck syringe.* Soak for 24 hours minimum. If coagulated blood is present, soaking in a 5 per cent. solution of sodium citrate will loosen this. Then release with a mechanical releaser (made by Edwards Surgical Supplies Ltd., 83 Mortimer Street, London, W.1.). Other methods suggested are: (i) boiling syringes in 25 per cent. glycerine for 10 minutes and removing plunger while still hot; (ii) placing syringe in iced water for 5 minutes and then immersing, up to flange, in hot water for a few seconds and quickly removing contracted plunger.

EXAMPLES OF THERMAL DAMAGE AND RECOMMENDATIONS FOR MINIMIZING THIS

8. (*a*) *Cracking and breaking after lubrication.* Lubrication of syringes when not sufficiently cooled after drying may cause damage by sudden change of temperature.

(*b*) *Solder between metal nozzle and glass melting causing blockage; metal nozzle becoming unstuck.* This is apt to happen with certain makes of syringes, if the oven temperature is excessive.

(*c*) *Syringes reported as cracking or breaking in use.* This is mostly thought to be due to damage by knocking, etc., which causes fine cracks which expand in the heat of the sterilizing process, and 'give' under normal pressure. Other, rarer, causes may be strains in the glass itself; foreign matter between plunger and barrel; use of too small a needle for size of syringe, causing excessive pressure as the plunger is depressed.

(*d*) *Syringes rendered unserviceable because of 'poor fit'*. Sterilizing by boiling will cause a deposit to be left (especially in the case of hard water) on the syringe parts, and the syringe will gradually cease to function smoothly. Rinsing of syringes (which are to be sterilized by hot air) in distilled water, removes this cause of damage.

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