The cleaning of instruments and syringes

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SYNOPSIS The dangers to the handler of syringes used for routine injections were found to be negligible, but known infected syringes and those contaminated with antibiotics should be autoclaved before handling as a high proportion of these carry pathogenic organisms.

Mechanical methods of cleaning syringes and instruments are assessed. The use of an artificial soil for testing purposes is described. Using this soil, ultrasonics by themselves are inadequate for cleaning syringes and instruments. Agitation with ultrasonics is essential for syringes, but is insufficient for instruments. Detergents are therefore an essential adjunct to the cleaning process. For syringes Pyroneg proved to be the most satisfactory, particularly if they had been previously siliconized. The best detergent for instruments contaminated with these types of soil was Penesolve 814 at a temperature of 95°C. but the instruments must be adequately rinsed after this treatment. A number of other detergents and cleaning agents are discussed.

During the past few years considerable interest has been aroused in sterilizing and disinfecting methods. Nearly all the communications on this subject stress the importance of cleaning the object thoroughly since failure may interfere with successful sterilization. In spite of this pious resolution little information has been given on how it is to be achieved. Furthermore many exaggerated claims have been made on the efficiency of the various methods available without apparently appreciating that the ability of a method to clean will depend on the type of soil contaminating the objects and the number so affected.

It was decided to investigate the handling and cleaning of syringes, needles, and instruments with a view to modifying or altering our methods. For this reason we investigated first the present system employed in the Portsmouth Central Sterile Supply Department and its possible dangers to the orderlies, and second the ability of the various methods and detergents advocated for cleaning syringes and instruments contaminated naturally during normal use or by the application of artificial soils.

SYRINGES

DANGERS TO HANDLER As we had not actually determined the possible contamination of an orderly by aerosols of pathogenic organisms or

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antibiotics during the process of dismantling syringes, we decided to carry out an investigation of these aspects.

The methods laid down by the Central Sterile Supply Department at Portsmouth since its inception in 1948 for the handling of syringes is as follows:

In the ward, immediately after use, the syringe with its needle is rinsed thoroughly by drawing water backwards and forwards into the barrel four or five times. The needle is then detached and placed in a foam rubber pad in a specially provided cup. The syringe is again rinsed with cold water and, without separating the plunger from the barrel, is replaced in its aluminium container and returned to its carrier box. Syringes which have been used for aspiration of possibly infected material are not rinsed but the plunger is separated from the barrel and both are returned in a nylon bag to the Central Sterile Supply Department, where they are disinfected in a prevacuum high-pressure steam sterilizer before cleaning. This system was introduced, first because it was felt that as the syringes were generally used for sterile injections or the withdrawal of sterile blood they were unlikely to be a risk to the orderly. Second, it was found that unless the syringe was rinsed immediately after use considerable difficulty was experienced in removing the plunger and the soil.

We considered the possibility of bacteriologically examining the syringe on its return but the testing of large objects has already proved difficult and before any reliance can be placed on the results very large numbers need to be tested under perfect conditions. Instead we decided to sample the air around the dismantling area by

TABLE I

Sample in Minutes	TESTS FOR PRESENCE OF AEROSOL	
	Impinger (organisms per litre of air)	Slit Sampler ¹ (organisms per litre of air)
1		0.55-0.97
2		0.52-0.96
5	0.56	0.63-1.06
10	0.55 (0.5-5) ²	
15	0.46	
20	0.7 (0.55)	
25	0.56	
30	0.61 (0.37)	

¹Figures for slit sampler are those obtained from two runs.

²Figures in brackets denote those found in the wash-up room of the Central Laboratory.

both slit samplers and impingers. The results are shown in Table I. For comparison similar investigations were carried out in the 'wash up' room of the Central Laboratory in which normally 1,700 to 2,000 articles are washed daily.

METHOD OF STUDY Samples were taken by impingers using the technique described by May and Harper (1957). The impingers, which were placed 2 ft. above the dismantling bench, contained 10 ml. of media with an anti-foam additive, and when used with a pump capable of producing half an atmosphere of vacuum collected 11 litres of air per minute. After sampling, counts were made without delay using the method of Miles, Misra, and Irwin (1938).

At the first collections, samples were obtained after two, four, six, eight, 10, and 12 minutes, but the bacterial counts were too low to be of value. It was therefore decided to increase the time of the collection, but as it was thought possible that the low counts could be caused by an antibiotic aerosol, this aspect was also investigated. The second collections were made for five, 10, 15, 20, 25, and 30 minutes. As well as carrying out surface counts, the fluid from the 30-minute collection was assayed for the presence of antibiotics using the Oxford method and staphylococcus (Abraham, Gardner, Chain, Heatley, Fletcher, Jennings, and Florey, 1941). No air sample inhibited the growth of the organism.

The following day samples were taken from the same site using a Casella slit sampler. Collection times were shortened to one, two, and five minutes as this apparatus collects 29 litres of air per minute. Results showed that the counts were remarkably similar to those with impingers.

From this we concluded that the risk of infection and antibiotic sensitization by aerosol spread was negligible.

ARTIFICIAL CONTAMINATION It seemed obvious that the only satisfactory way of ensuring that a cleaning method was acceptable was to contaminate all the articles artificially before the test and assess the number improved by each treatment.

Two methods were used to contaminate the syringes: 1 radioactive labelled serum using I^{131} or Cr^{51} , and 2, an artificial soil modified from that described by Hucker (1955). Serum was labelled with I^{131} or Cr^{51} by the method of Veall, Pearson, and Hanley (1955).

Hucker's artificial soil was developed at the National Institute of Health, U.S.A., for testing domestic cleaners in 1955. This was modified by Jones and Warren (1961) for assessing the cleaning method in the I.C.I. Pharmaceutical Division. Both of these soils contain a proportion of fat and we used nigrosin as a marker. Fat is unlikely to be found in the majority of body fluids, and for this reason we decided to use the following formula:—

Base Plasma or serum.....10 ml.
National dried milk powder 6 g.
Nigrosin 1% 1 ml.

To this was added as required:—

Oily penicillin 1 ml.
and/or inj. bismuth 1 ml.
and/or Iron suitable for
injection (Imferon) 1 ml.

It was considered that this soil was more like that normally encountered in the Central Sterile Supply Department or operating theatre. The three additional substances had already in practice proved difficult to remove.

With radioactive labelled serum One drop of radioactive material was introduced into the lumen of the nozzle and allowed to dry at room temperature overnight. The syringe was then placed under the probe of a scintillation counter and the count noted. It was then washed by the method under test and after allowing it to dry in air for a short time was again counted. After subtraction of the predetermined background count the residual radioactivity was expressed as a percentage of the initial activity.

With artificial soil Soil, 0.3 ml., was instilled into the nozzle of the syringe and it was laid on its side. To ensure even distribution it was rotated every 30 minutes during the day and finally allowed to dry overnight. The syringe was then treated by the method of cleansing under test and examined visually with a watchmaker's lens for evidence of soil. An alternative semi-quantitative method was to treat the syringe after cleaning with a fixed quantity of water and compare the intensity of colour against a control of the same volume of water containing an amount of soil equal to that used for contaminating the syringe.

RESULTS WITH RADIOACTIVE LABELLED SERUM In order to assess various techniques that were available, batches of 10 syringes were submitted to each of five methods. These and the results are shown in Table II. In the first, syringes were washed by hand by the orderlies employed for the purpose. In the second the syringes were included in a routine batch, but the orderly was unaware that there were syringes under test. Third, the syringes were 'dunked' in a machine which plunged them in and out of hot water (65°C.), and fourth, they were treated in an ultrasonic machine with a barium titanate transducer giving a peak output of 80 watts at 40 Kc per second. In all these four methods soap solution in hot water was used as the washing fluid. In the fifth it was not possible to use soap solution with the high pressure jets and cold water only was available. It was probable that the absence of soap solution and the lack of water pressure may account in part for the failure.

TABLE II
RESULTS OF CLEANSING METHOD

Method Used	Percentage of Initial Activity Less Background (mean of 10 syringes)
Hand washing (known)	5.2
Hand washing (unknown)	12.5
Dunking machines	7.5
Ultrasonic washing	2.5
Jet washing	11.7

Table II indicates that washing with ultrasonic is probably superior to the other methods. It must be remembered that as syringes are normally lubricated with silicone between use the problem of cleaning is not nearly so great as with instruments.

SEMI-QUANTITATIVE RESULTS USING ARTIFICIAL SOIL Ninety-six syringes were contaminated as described, divided into four batches of 24 and submitted to four forms of treatment all at room temperature.

1 Five-minute soak, five minutes with ultrasonics, five-minute rinse, the syringes being lowered and raised 1 in. 20 times per minute throughout the process ('dunking').

2 Five-minute soak, five minutes *without* ultrasonics and five-minute rinse, the syringes being lowered and raised as above ('dunking').

3 Five-minute soak, five minutes with ultrasonics and five-minute rinse, the syringes remaining stationary throughout.

4 Five-minute soak, five minutes without ultrasonics and five-minute rinse, but again the syringes remaining stationary.

The results are shown in Table III. By the first treatment 88.2% of the soil was removed, whilst by the second, third, and fourth treatments the proportions were 81.6%, 83.0%, and 61.6% respectively. This suggests that treatment with ultrasonics by themselves is not entirely satisfactory and must be combined with movement to dislodge softened but still adherent soil.

TABLE III

REMOVAL OF ARTIFICIAL SOIL FROM 96 SYRINGES			
Method	Dunking	Ultrasonics	Proportion of Soil Removed (%)
1	Yes	Yes	88.2
2	Yes	No	81.6
3	No	Yes	83.0
4	No	No	61.6

EXPERIMENTS USING A HEINIKI WASHING MACHINE This apparatus has been recommended for cleaning syringes and relies on a series of moving high pressure jets using detergent and water to dislodge the soil. To assess its value the following investigation was carried out.

Forty-eight new syringe barrels were taken and soiled as follows: 16 with artificial soil containing 10% procaine penicillin, 16 with artificial soil containing 10% inj. bismuthi B.P.C., and 16 with artificial soil containing

10% Imferon. Of the soils, 0.3 ml. was left in each syringe barrel and allowed to dry overnight. After the routine washing cycle all barrels were macroscopically perfect with the exception of two which retained a small amount of inj. bismuthi.

INSTRUMENTS

In the Portsmouth Central Sterile Supply Department the method of handling soiled instruments differs from that for syringes since immediately after use the instruments are placed in a paper bag attached to the dressing trolley. At the conclusion of the dressing procedure the top of the bag is screwed up and placed in a small wet-strength paper sack in the sluice room (Darmady, Hughes, Verdon, Tuke, and De la Court, 1960). Finally, the sack is collected by an orderly and returned to the department in yet another paper sack, thus making three coverings in all. The sack of instruments is next disinfected in a prevacuum high-pressure sterilizer. This procedure was adopted because it was anticipated that many instruments would carry pathogenic organisms, and if not treated might be a danger to the orderlies during the cleaning process. As, however, the number of infected instruments and those showing visible dirt was unknown, we decided to investigate this in greater detail.

INSTRUMENT INFECTION RATE As soon as the dirty instrument sacks were returned to the department, instead of being autoclaved they were opened as aseptically as possible and the serrated teeth of each pair of forceps rubbed with a sterile cotton wool swab previously moistened with sterile serum digest broth. The swab was broken off into digest broth and incubated at 37°C. After 72 hours the broth was subcultured on to blood agar and McConkey agar and the organisms identified. In all 1,000 dressing forceps were examined, 500 from each of two different hospitals. The results are shown in Table IV. Perhaps the surprising feature is the total

TABLE IV
INFECTED DRESSING FORCEPS

Organism	No. of Instruments Examined	
	Hospital A	Hospital B
	500	500
<i>Possible pathogenic organisms</i>		
<i>Staphylococcus pyogenes</i> (coagulase positive)	41	31
<i>B. haemolytic streptococcus</i>	0	2
Lancefield group A		
<i>Proteus</i>	8	14
<i>Ps. aeruginosa</i>	10	12
Coliform organisms	33	16
<i>Saprophytic organisms</i>		
Micrococci	46	31
<i>Streptococcus viridans</i>	1	5
Non-haemolytic streptococcus	4	9
<i>Streptococcus faecalis</i>	2	4
<i>Gaffkya tetragena</i>	2	2
Subtilis group	11	4
Total no. of instruments infected	143	126
	269/1,000 = 26.9%	

number of instruments infected. This can in part be explained by the fact that each set of four used instruments is placed in the same bag and therefore may contaminate each other; on the other hand as the instruments would have become infected 24 hours before testing, it is also possible that some of the organisms might have died.

Table IV shows that of the 1,000 instruments examined at random, 269 were infected; of these 94 can be regarded as carrying pathogenic organisms and could be potentially dangerous to the staff. We therefore concluded that all instruments should be autoclaved before they were handled.

CLEANLINESS OF WARD INSTRUMENTS The number of ward instruments which showed visible dirt to the naked eye was assessed by examining 24,957 which had been returned to the Central Sterile Supply Department. Those that were dirty were divided into four groups:

Group 1 Very slightly soiled, probably metallic marks rather than organic matter. Under less critical conditions these might have been passed as clean.

Group 2 Small spot on one or both blades.

Group 3 Moderately soiled with pus/blood etc., or adherent paper or dressing material.

Group 4 Fairly heavily soiled with pus, blood, etc.

To ensure that a standard inspection was made, all examinations and grading were done by one of us (S.E.D.). The results of these are shown in Table V. From this is seen that of 24,957 instruments examined, 439 (1.76%) showed visible dirt. The figure may at first seem small but it must be remembered that of four forceps provided for each dressing procedure, two are used for placing the sterile dressing in position. It follows therefore that in order to assess the value of a cleaning method a very large number of instruments must be examined.

TABLE V

DIRTINESS OF WARD INSTRUMENTS

Group 1	194 (0.78%)
Group 2	134 (0.54%)
Group 3	84 (0.34%)
Group 4	27 (0.11%)
Total	439 (1.76%)

It is obvious that the detailed examination required is beyond the scope of most central sterile supply departments. Furthermore it is probable that the number showing visible dirt will vary with the type of case normally handled in the hospital.

Having obtained a measure of the size of the problem, various methods of cleaning were investigated. Of the markers used two were similar to those employed for syringes, *viz.*, radioactive material and artificial soil. The third was dyed pus made by adding a few drops of 1% Nigrosin to about 5 ml. of bacteria-free pus.

USE OF RADIOACTIVE MATERIAL As the instruments were routinely disinfected by high-pressure steam before cleaning it was decided to treat 10 pairs of artificially contaminated mosquito and dressing forceps either in the

TABLE VI
RADIOACTIVITY REMAINING ON INSTRUMENTS AFTER
CLEANING IN AN ULTRASONIC BATH

Forceps

Method of Disinfection	Mean of 10 Instruments Expressed as a Percentage of Initial Count	
	Mosquito	Dressing
No disinfection	4.5	1.7
High pressure sterilizer	73.0	64.0
Conveyor oven	73.0	51.5

steam sterilizer or by dry heat in a conveyor oven. They were then treated in an ultrasonic bath containing soap solution. The results (Table VI) show that after heating the residual counts were extremely high when compared with those found when heat treatment was omitted.

These findings were somewhat surprising, particularly as no visible soil was present. They suggested that heat treatment was responsible for interchange of radioactivity with the metal of the instrument. Similar findings were also found using Cr^{51} as a label.

We therefore came to the conclusion that the use of radioactive tagged protein was not satisfactory as an artificial soil for assessing the cleaning process where heat was to be used.

METHOD OF APPLYING ARTIFICIAL SOIL The serrated teeth of the forceps were dipped in artificial soil, allowed to dry overnight at room temperature, and treated in the steam sterilizer. They were then submitted to the cleansing process being tested and the result assessed by examining the teeth with a watchmaker's lens for the continued presence of soil.

TREATMENT WITH ULTRASONICS In order to assess the value of ultrasonics in the presence of neutral, alkaline, or acid solutions the following tests were performed:—

The immersion fluids were (1) demineralized water, (2) 10% aqueous solution of sodium carbonate, (3) 3% aqueous solution of citric acid. All the forceps were treated in the ultrasonic bath for five minutes at 60°C. Silicone had not been previously applied. The results are shown in Table VII.

TABLE VII

EFFECT OF VARIOUS FLUIDS ON THE CLEANING OF
DRESSING FORCEPS IN AN ULTRASONIC BATH

Fluid	No. Tested	No. Clean
Water	30	0
10% Sodium carbonate	30	0
3% Citric acid	30	9

This indicates that under the conditions of the experiment ultrasonic treatment does not clean instruments adequately.

VALUE OF HEINKE WASHING MACHINE As this machine is also advocated for cleaning instruments its potentialities were investigated as follows:—

Fifty dressing forceps were soiled with bacteria-free pus containing a trace of Nigrosin, allowed to dry over-

night at room temperature, and then disinfected in the high-pressure steam sterilizer.

After a routine washing cycle the results read with a watchmaker's lens were as follows. Three forceps were macroscopically perfect. On four forceps, a small spot of pus was detected on the serrations. All others (43) showed improvement but were not good enough for re-issue.

It was therefore clear that mechanical cleaning by itself was inadequate and would have to be assisted by detergents.

USE OF DETERGENTS In an attempt to improve and accelerate the cleaning of instruments a number of detergents were investigated. Among them were Tide, Daz, Surf, Omo, Teepol, liquid Palmolive, liquid toilet soap and Liquid Lux, commonly employed for domestic purposes, and for industrial purposes Trilene, Polywash, and Polyclens. As these are primarily designed to remove fat and not protein it was not surprising that they were quite ineffective and will not be considered further in this paper.

Three others which appeared promising were investigated in greater detail with and without the assistance of ultrasonics and at varying concentrations and temperatures.

Radioactive material having proved to be an unsatisfactory marker in the presence of detergents, the soils used were the artificial soil already described and bacteria-free pus mixed with Nigrosin. Both were allowed to dry on the serrations of dressing forceps and autoclaved as before. Finally, after processing, they were examined visually using a watchmaker's lens.

Biotergic Biotergic, which is stated by the makers to be designed to clean instruments, syringes, needles, and gloves, and to be used at a concentration of 0.5% at 50°C., was tested in a variety of ways. In each batch 60 instruments at a time contaminated with artificial soil were soaked in the Biotergic solution and six withdrawn at three-minute intervals up to 30 minutes. They were then treated for five minutes in an ultrasonic bath (as described earlier) which was filled alternatively with water, acid/dichromate, sodium carbonate, sodium hydroxide, and a wetting agent. Owing to foaming Biotergic could not be used in the ultrasonic bath. No improvement was noted with water but with sodium carbonate, sodium hydroxide, and the wetting agent some lessening of the concentration of soil was noted. With acid dichromate, four out of six instruments at 21 and 24 minutes, five out of six at 27 minutes, six out of six at 30 minutes, were completely clean. However, we could not recommend the use of acid/dichromate in unskilled hands as it is dangerous. In all 240 instruments were treated with Biotergic.

Pyronex This substance was designed for cleaning of laboratory glassware, syringes and needles, at a concentration of 0.7% and at a temperature of 50°C. and in practice had proved satisfactory for syringes if they had been previously siliconized. However, experiments showed that after five minutes' soaking and five minutes' treatment in the ultrasonic bath in such solution 144 instruments contaminated with artificial

soil and 107 with natural soil from the wards, none could be passed as completely cleaned, although a number were considerably improved. On the other hand if the instrument was siliconized first 61 out of 72 were cleaned. Four different types of silicone were used, but the type of silicone did not make any significant difference in the numbers cleaned. In all 323 instruments were treated with Pyronex.

The application of silicone means an additional stage in processing. It takes time, as the forceps have to be dipped, air dried, and cured at a minimum temperature of 200°C. before packaging and resterilization. This adds about an extra three hours to the cycle and although Pyronex is itself relatively cheap, the extra process must increase the cost.

Penesolve 814 This material was primarily designed as a descaling and rust remover, and is strongly caustic. It is recommended that it should be used at high temperature. For the purposes of these experiments, the Penesolve 814 was used as 3% solution at a temperature of 95°C. Seventy-nine forceps contaminated with artificial soil, 107 with visible contamination from the wards, and 74 with stained sterile pus, all of which had been previously autoclaved, were found to be completely cleaned after this treatment. Six forceps had also been treated with silicone but in these the silicone had lifted and would have required treatment before issue. The results are shown in Table VIII. It is claimed that Penesolve 814 has to be used as hot as possible, 95°C. being the most suitable temperature. Experiments showed that this statement was fully confirmed by the fact that at 50°C. only eight out of 12 forceps contaminated with artificial soil were properly clean. As Penesolve 814 is strongly caustic it was thought that instruments treated repeatedly might be damaged. That this was not so was shown by treating a set of six pairs of forceps in a 3% concentration at 95°C., for 10 minutes on 25 occasions. There was no visible sign of damage to the metal.

TABLE VIII

RESULTS OF SOAKING FORCEPS PRE-AUTOCLEAVED IN 3% PENESOLVE 814 AT 95°C. FOR 10 OR 12 MINUTES

Type of Soil	No. Treated	No. Clean
Normal ward soiling	107	107
Artificial soil	79	79
Stained sterile pus	74	74

The same batch of solution was used on each occasion, being made up to its original volume with water. In order to ascertain whether it had deteriorated to a degree which would be detrimental to its cleansing ability, a further six instruments contaminated with artificial soil were treated in it for 10 minutes and all were cleaned. As a corollary, the effect of reducing the concentration was tried. Sets of 12 pairs of forceps with artificial soil were treated for 10 minutes in concentrations of 2½%, 2%, 1½%, and 1%. Using the 1% concentration 11 out of 12 were satisfactory and with the others 12 out of 12 in each case.

As a final test a mixed batch of old and very dirty and discoloured instruments, including 50 pairs of dressing forceps and a number of Spencer Wells, mosquito and cheatele forceps, bowls, retractors, scissors, etc., contaminated with artificial soil, were treated in the normal way for 10 minutes. Except in six cases the results were highly satisfactory.

The disadvantages of Penesolve 814 are that, as already stated, it is caustic and has to be used hot, 95°C. being the most suitable temperature. Contact with eyes, skin, or clothing must be avoided. Aluminium is etched so that this material cannot be used. It is, however, clear that in automatic cleaning processes where there is no manual handling, rinsing in two changes of hot water completely removes the detergent and can be controlled by checking the pH of the final rinsing water.

It is also of interest to note that it is not entirely the strong caustic which is responsible for the cleansing action, since no change was encountered when 12 instruments were each treated with 10% sodium hydroxide, 10% sodium carbonate, and 10% sodium carbonate plus 1% Teepol.

OTHER CLEANING AGENTS There are a number of detergents which are stated to be particularly designed for use in cleansing instruments and syringes. These were also investigated at various concentrations and temperatures with and without the aid of ultrasonics.

S. J. Clayton's detergent for surgical instruments and glassware Soaking for 12 minutes in a 2% concentration at 50°C. was used with and without ultrasonics. This was repeated at 95°C. without ultrasonics. In all 24 instruments soiled with stained pus were treated, but none were cleaned.

George Gurr's 7X detergent Using a 1% concentration a similar series of experiments was carried out, but none of the 24 instruments were cleaned.

Hawksley's Cresta Clean Two per cent solutions at room temperature and at 95°C. without ultrasonics were used, the time of exposure being 10 minutes in each case. None of 100 instruments contaminated with artificial soil or stained pus were cleaned.

Medical and Pharmaceutical Developments' R.B.S. 25 concentrate Soaking in a 3% solution overnight at room temperature or for 10 minutes at 95°C., artificial soil was not removed from any of 24 instruments.

Diversey's Bril-tak Soaking for 10 minutes in a 1% solution at 95°C. cleaned 11 out of 24 instruments contaminated with artificial soil. Using a 3% solution under similar conditions 17 out of 24 were satisfactory.

DISCUSSION

Our experiments suggest that there is little danger of infection to orderlies during dismantling and processing of syringes. On the other hand a comparatively high proportion of instruments used in wards is found to be contaminated with pathogenic organisms which could constitute a hazard. To eliminate this it is advised that syringes known to be infected and all instruments should be disinfected

in a high-pressure prevacuum steam sterilizer before handling.

CLEANSING METHODS Unless syringes and instruments are soiled by artificial means, very large numbers must be examined in order to obtain adequate information as to the efficiency of the various cleansing methods. As the natural contamination rate is so low it would be necessary to examine two million instruments in order to be satisfied that a proposed method was reliable. The failure to recognize this may account for the exaggerated claims that methods and detergents have been found to be satisfactory.

Apart from the difficulties of handling radioactive material, serum labelled with I^{131} or Cr^{51} is a useful means of studying various methods employed in cleaning syringes. However, it is not a satisfactory contaminant for metal instruments which have to be disinfected by heat as a reaction with the metal appears to occur. For this reason it is thought that the artificial soil described can be used either with syringes or instruments and can give a qualitative or semi-quantitative answer.

Bacteria-free pus, which approaches most nearly the normal contamination of syringes used for aspiration and of instruments used in septic cases, can also be employed.

SYRINGES The most successful of the cleaning methods tried, as judged both by radioactive labelling and artificial soil, was the use of the ultrasonic bath particularly when combined with 'dunking'. The ultrasonic vibration loosens the soil and the dunking washes it away. All syringes processed by the Portsmouth Central Sterile Supply Department are lubricated with silicone which also assists the removal of soil. The use of a detergent carries some risk should any remain in the syringe and be injected into the patient, particularly if the injection is intrathecal, and for this reason we would recommend a mild detergent such as Pyroneg.

INSTRUMENTS As instruments are heat treated before cleaning they present a more difficult problem and, as Table VII shows, the ultrasonic bath employed was largely unsuccessful.

The small number of experiments undertaken with the Heinike washing machine suggested that it was reasonably successful in cleaning syringes but was ineffective with instruments contaminated with the artificial soil when they had been autoclaved previously. This also suggests that high-pressure jet cleaning is also unlikely to be successful and whatever mechanized treatment is employed a detergent is necessary.

Previously it was thought that temperatures above 70°C. were likely to cause increased coagulation of the protein which would aggravate attempts to remove it. In this investigation it was found that the most reliable method was to use a high temperature and a strong caustic detergent such as a Penesolve 814 in order to dissolve the residue completely and that its removal is assisted by agitation of the fluid or the instruments. It would also appear that a number of detergents have little or no effect of the type on soil likely to be encountered in central sterile supply departments, particularly if the soil has been 'fixed' by pre-heat treatment. It is also of extreme importance to ensure that both syringes and instruments after treatment are rinsed with at least two changes of water so that no trace of detergent remains to become a hazard to the patient.

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