Current Practice

FORENSIC MEDICINE AND TOXICOLOGY

Role of the Forensic Science Laboratory

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Much of the work of a forensic science laboratory has no connexion with medicine. However, there are three areas in which forensic science and forensic medicine or pathology overlap.

(1) Cases of suspected driving while impaired by drink. This constitutes a separate topic in its own right, which I do not propose to discuss here.

(2) Crimes of violence. These may be sexual or non-sexual in origin, and fatal or non-fatal in outcome. The police surgeon or other doctor examines the victim or the body, and the pathologist makes the post-mortem examination if necessary. The laboratory may receive clothing, swabs, control specimens from the body, control material from the scene of the crime, and indeed practically anything which may be of evidential value.

(3) Cases where poisoning is suspected or has to be eliminated as a cause of illness or death. These may be divided into (a) non-fatal cases, in which the forensic toxicologist may receive for analysis samples of food, wash-outs, urine, etc., and (b) fatal cases, in which after necropsy the toxicologist will receive from the coroner or investigating officer the organs and whatever other material may be considered relevant.

Under (2) the forensic laboratory may receive: (1) Vaginal, labial, oral, anal, penile, or dermal swabs to be examined for semen. (2) Control samples of head and body hair, of whole blood, and of saliva for checking the secretor factor. (3) Clothing and/or bedding which may bear (a) seminal stains; (b) blood-stains; (c) stains of other body fluids; (d) extraneous hairs, textile fibres, plant debris, etc.; (e) stab or bullet holes. (4) Parts of bodies, removed at necropsy, which may carry valuable contact traces. These are most commonly whole or clipped-off finger nails, but may be whole hands or excised wounds.

Control Specimens

Control specimens should be representative and adequate in size, and should bear clear indications of the part of the body from which they come.

Anything taken from a victim or dead body should be received by the laboratory so far as possible in the condition in which it was first found. This principle may of course have to be modified by the overriding considerations that the preservation of life is paramount, and that in a serious crime the final authority must always rest with the police.

Controls from Body

These are usually blood, saliva, or hairs. Normally not less than 2 ml. and not more than 5 ml. of liquid blood should be supplied. No anticoagulant should be added; the erythrocyte

antigens retain their properties best in clotted cells. However, when blood is also required for alcohol determination at least 10 ml. should be supplied (unless it is known that the laboratory is going to use the new gas-chromatographic method of analysis), and it should contain anticoagulant. It is better, therefore, to provide two samples, one with and the other without anticoagulant, but if only one can be supplied its treatment must depend on what investigation is required.

Saliva is the best and most convenient control for ascertaining the secretor factor, and has a higher ABO antigen content than blood. Again, at least 2 ml. should be taken.

Control samples of head or pubic hair (any others are rarely necessary) should preferably be pulled out, but if they must be cut it should be as close to the root as possible. At least 20 should be taken. Head hairs should be taken from various parts of the head (and, ideally, labelled with their positions of origin), since they can vary greatly.

Body Fluid Stains

With any dry stain or deposit the laboratory may have to identify (1) the fluid causing it; (2) its species origin; and (3) if human, its group.

Stains to be examined in the laboratory must not be allowed to remain wet at normal temperatures for any length of time nor subjected to heat, since bacterial action in the first case or protein denaturation in the second may vitiate any subsequent tests. Wet articles must be air-dried at normal temperatures. The police normally attend to this.

The identification of urine stains may be important in strangulation cases or in certain cases of sexual perversion, and is normally done by showing the presence of urea in quantity. Saliva stains are most easily identified by the presence of amylase (no colour with starch/iodine after digestion), but the presence of squamous epithelium cells may also provide helpful confirmation.

Blood stains may be identified by the methods fully described in the textbooks of forensic medicine. The ideal peroxidase-detecting reagent has not yet been found. It should be sensitive, as specific as possible, easy to prepare and apply, and safe in use (non-carcinogenic). However, some of the existing reagents can, by suitable methods, be made more specific for blood than the textbooks suggest.

Semen

Semen may have to be identified either on swabs or in stains on fabrics. Ordinary cotton-wool throat swabs should be used. They should be submitted in test tubes or plastic containers exactly as taken, and appropriately labelled with the relevant data—chiefly name and position (high vaginal, low vaginal, thigh, etc.). The swab should *not* be placed in any medium. Smears on slides are also most unwelcome to the laboratory.

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Though seminal stains on fabrics may be apparent by their appearance or feel, it is now almost universal practice to use the acid phosphatase test for screening swabs and suspected stains, or for testing the whole surface of an article which may bear otherwise undetected stains.

The enzyme acid phosphatase is derived from the prostatic secretion, and the reagent contains a phenolic phosphoric ester and a suitable coupling reagent which produces a distinctive colour by reaction with the phenol hydrolytically liberated by the enzyme. The test is not, however, quite specific (for example, vaginal secretion, especially of young girls, may also react), so its results must be confirmed.

Normally the ultimate proof consists in identifying spermatozoa or their heads by microscopy. This is of course difficult if the man was oligospermic and impossible if he was azoospermic. In these cases chemical identification of the constituents of semen may be used, but a much more specific serological method is now available, thanks to the development of an anti-human-semen serum.

Species Identification

Species identification is almost always done by some form of the well-known precipitin test, using antisera for man and the various species of domestic and farm animals likely to be encountered. The technique used to consist in the layering of stain extracts and antisera in small tubes, but a modern and better method uses electrophoresis, which is made possible by the fact that the reacting proteins and antibodies move towards opposite poles. Stain extracts and antisera are pipetted into adjacent "wells" in a gel layer, and a positive result is shown by the appearance of an opalescent line half-way between the wells after electrophoresis. This method is more economical of expensive antiserum than the tube one, and can also be used with initially turbid or cloudy stain extracts, with which tube tests are impracticable.

Blood Grouping

The grouping of dried human blood and secretions (commonly semen or saliva) has made great strides in the last few years, and is now a subject of such complexity that it is impossible even to enumerate all the possibilities here. ABO grouping has long been used, but recent developments (mainly associated in this country with the names of Coombes, Dodd, Kind, Pereira, Culliford, and others) have been towards greater sensitivity, so that smaller stains can be grouped, and towards the utilization of more blood-group systems.

The classical indirect absorption-inhibition method depended upon measuring the reduction by the stain antigens of the antiserum titre. That meant that a fairly large stain—say, about the size of a sixpenny piece—was needed to produce a significant titre reduction in the smallest volume of antiserum that it was practicable to use. Absorption-inhibition is still frequently used for the grouping of seminal or saliva stains from secretors, but for bloodstains the method has been fairly generally abandoned in favour of the newer absorption-elution methods. In these, what is actually identified is antibody which has been absorbed by the stain antigen and subsequently eluted. This direct method makes it possible to group much smaller stains: 1 cm. of a single thread of a fairly heavily blood-stained fabric is sufficient for ABO and MN grouping.

The technique can be applied not only to ABO but also to MN grouping, and also possibly in the not too distant future to rhesus grouping. The identification in dried stains of the other group systems depending on the erythrocyte antigens (Kell, for example) is not yet possible. The problem has not yet been sufficiently investigated to say whether it ever will be.

The other group systems which can now be used relate to the known genetically determined variations in the composition of some of the intracellular and serum proteins and enzymes. The most useful systems are of course those in which several variants occur, each present in a relatively large percentage of the population. These include the haptoglobins, intracellular adenylate-kinase and phospho-gluco-mutase, and serum cholinesterase. The identification of the S variant of haemoglobin can also on occasion be useful in areas where there is a large coloured population. Not all laboratories will be able to apply some of these newest methods.

The method of grouping is in most cases either electrophoresis of a stain extract followed by "development" of the separated protein or enzyme fraction by a suitable stain or reagent, or else immunoelectrophoresis, in which the electrophoretically separated protein fractions are detected with a suitable antiserum. The serum cholinesterase groups may also be distinguished by a kinetic method using the differential rates of reaction after addition of an inhibitor.

Of all these tests the peroxidase tests for blood are the most sensitive, being able to detect amounts too small to be seen, and the grouping tests, especially the newer ones just described, the least sensitive. With the precipitin test it is possible to identify as human a blood-stain too small to be grouped.

Examination of Clothing

Clothing may have to be examined for stains; for extraneous hairs, fibres, and other debris; and for bullet and shot holes, stab cuts, etc. It is important that the laboratory receives the articles in their original condition and that wet ones are air-dried.

Police officers concerned with this work are instructed in dealing with such articles. Doctors should remember that, for example, thoughtlessly laying a garment down where it can pick up debris unconnected with the case can cause the laboratory much extra work or even vitiate its results. When clothing has to be cut off a victim or body it should be done so that any cuts or holes connected with the crime are left intact. It is helpful if cuts made during medical examination or treatment are marked. Ligatures should be cut at a point away from the knot, which should be left intact.

Examination of hairs and fibres occurring as contact traces, and contact debris generally, is part of a forensic laboratory's everyday routine, but this work is a little remote from medicine.

Toxicology

The investigation of poisoning cases may be discussed fairly briefly. The ever increasing scope, sensitivity, and reliability of instrumental methods of analysis have greatly extended the bounds of what the toxicologist can do, but have at the same time made his work more complex and more specialized. But he works only with what he receives, and it is unfortunately still true that what he receives is not always that from which he can extract the most information.

Eight Principles

The toxicologist would be happy if all of the following principles were always observed.

(1) Each organ from a necropsy should be put in a separate container.

(2) Either the whole organ should be sent or, if the pathologist wishes to retain a part for sectioning, etc., the weight of the whole should be given.

(3) The part of the body from which a blood sample is taken should be stated. Portal vein blood, for example, will normally contain a higher concentration of the compounds sought than blood from other parts of the body. This fact has the double consequence that blood from another part of the body is preferable, and that calculations based on an unknowing analysis of portal vein blood may lead to wrong results.

(4) The toxicologist should be told of any drugs administered either in an attempt to resuscitate a moribund victim or during the treatment of one who is recovering. Modern methods of analysis will easily detect therapeutic doses of most drugs, and it causes the toxicologist much unnecessary work if he extracts these during his analysis and has to identify them.

(5) Whether the victim is living or dead, stomach washouts which have been taken should always be kept and the whole volume submitted for analysis.

(6) As much urine as is available should always be sent, whether in fatal or non-fatal cases. Urine is the best fluid on which to conduct "general-unknown" screening tests.

(7) Since certain poisons are deposited or retained or most easily detected in certain organs, these organs should always be submitted when these poisons are suspected. These organ/poison pairs include not only the well-known arsenic in hair

and nails and lead in the long bones but also the kidneys for heavy metals and the brain and/or lungs for volatile poisons.

(8) For some poisons the type of container used for the organs is important. In particular, polyethylene should not be used if volatile poisons are suspected. The containers may not be gas tight, and, more important, traces of plasticizer from the polyethylene may interfere in the subsequent gas-chromatographic analysis now normally used for this type of poison. Also (though this is admittedly rather a counsel of perfection), in the nowadays uncommon event of lead being suspected as a cause of fatal poisoning, it is helpful if a polyethylene bag is used to isolate the organ from contact with glass, since some types of bottle glass contain traces of lead.

Conclusion

It is obviously impossible in an article such as this to describe in detail everything that a forensic science laboratory does or would like to do. Also, since techniques are constantly being changed and improved, making the previously impossible possible or the difficult less difficult, the final advice must be: If in doubt, consult the lab.

NEW APPLIANCES

New Instrument for Banding of the Pulmonary Artery for Ventricular Septal Defect

Mr. J. S. BAILEY, Department of Thoracic Surgery, Westminster Hospital, London S.W.1, writes: Narrowing of the pulmonary artery in infancy for a large ventricular septal defect was described by Muller and Dammann (1952) as a definitive procedure before the advent of open heart surgery. A series of cases published from different centres confirms the value of this procedure as a palliative measure in infants who would otherwise die from pulmonary complications and

cardiac failure associated with the severe left-to-right shunt (Albert *et al.*, 1961; Craig and Sirak, 1963; Goldblatt *et al.*, 1965).

Since 1957 this operation has been carried out at Westminster and St. George's Hospitals in selected cases. A Terylene or nylon tape 0.5 cm. wide is passed round the root of the pulmonary artery, the two ends being threaded through the flattened eye of a silver probe bent to 90 degrees. The ends of the tape are held by an assistant in one hand while the other hand advances the probe down the tape to narrow the pulmonary artery to the desired degree. The tape is sutured together just distal to the probe, which is then withdrawn. Fine control of the band is required to maintain the correct degree of occlusion while the band is sutured, and this is not easy for the assistant.

The instrument described here was designed to allow such fine adjustment to the tension of the band around the artery and to fix its position in space while it is sutured in place (Fig. 1).

Technique.—The pulmonary artery is approached through an anterior left thoracotomy in the fourth intercostal space when the diagnosis is certain. The main trunk is mobilized and the tape passed around it. The ends of the tape are passed through the slot in the foot of the instrument and drawn up between the clamp jaws. The tape is tightened and the jaws are closed over it. The degree of occlusion is now fixed and the tape can be sutured at leisure (Fig. 2). It is important not to twist the clamp nor to pull on the artery, since both manœuvres will themselves increase the degree of occlusion. The clamp should be applied with the shaft towards the surgeon's left hand, as in this position it is easier to suture the tape.

My thanks are due to Mr. C. E. Drew, who operated on all the cases in which this instrument has been used. I would also like

to acknowledge the help given by Mr. A. M. Stewart, of the physics department, St. George's Hospital, who made the original instrument, and Dr. P. Hansell, of the depart-

Fig. 1

Fig. 2

ment of medical illustration, Westminster Hospital, for the photographs.

The instrument is now available from Messrs. Allen and Hanburys Ltd.

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