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SAFETY IN PATHOLOGY LABORATORIES

M JEGATHESAN. CS CHIN and HH LIM.

Institute for Medical Research, Kuala Lumpur, Malaysia.

Summary

The many dangers in pathology laboratories include those associated with the properties of various potentially hazardous chemicals used in the processing and analysis of patients' samples and post-mortem specimens, infections from pathogenic micro-organisms arising from the biological materials handled, and accidents linked to the equipment and instrumentation employed. The practice of safety for the protection of laboratory workers against injury and ill-health is therefore of serious concern. The hazards in pathology laboratories and practical safety measures aimed at controlling the dangers are discussed, with the objective of promoting safety conciousness and the practice of laboratory safety.

Key words: Laboratory safety, code of practice, hazards.

INTRODUCTION

Pathology laboratories perform examinations and investigative analyses on patients' specimens and post-mortem materials. In the course of such investigations, procedures which are employed require the use of chemical reagents and various instruments. Thus, hazards that workers in pathology laboratories face include specific risks from toxic chemicals (including carcinogens), radiochemicals, pathogenic microorganisms in patients' samples and post-mortem specimens, and general risks from mechanical, electrical and fire hazards. The danger can be aggravated by ignorance of the hazards, careless attitude of laboratory personnel, poorly-designed laboratories and over-crowding

Safety conciousness and safe laboratory practices are therefore of primary importance for the protection of laboratory workers against injury and infection, and the prevention of damage to property. It is therefore imperative that there be a safety program which should begin with the recognition and understanding of the hazards, followed by implementation of safety rules and regulations.

An attempt at identifying the major hazards in pathology laboratories is made, with consideration of practical safety measures for minimising risks.

HAZARDS ASSOCIATED WITH CHEMICALS

A wide range of chemicals which are potentially dangerous are employed in pathology laboratories. The many, varied techniques and procedures involved in specimen processing and testing – from simple qualitative analyses to complicated, multi-step analytical determination~ – require their use. Very few chemicals are completely harmless; mdst are to a greater or lesser degree dangerous. There are exhaustive lists of chemicals which document their dangerous properties for reference.[1-3] The dangers associated with chemicals arise from the attendant fire hazard with organic solvents, and the corrosive, toxic or other harmful nature of various other substances. Injury, burns, and acute or chronic poisoning (including the risk of cancer) often arise as a result of lack of care which stems from ignorance of the properties of the chemicals used. It follows that the risks associated with hazardous chemicals may be controlled by matching *adequate knowledge* of the properties of these substances with know-how of protective equipment and preventive measures.

Hazard warning symbols on the labels of chemical packings or containers are useful in drawing attention to potential hazards associated with the materials. Manufacturers from the European countries in general adopt standard symbols recommended by the Council of Europe. In addition, risk and safety phrases from the EEC Directive of 14th July. 1976 (76/90/EEC) and the UK Packaging of Dangerous Substances Regulations (S1 No. 3-09 HMSO) may also be included for the benefit of users. The American manufacturers

Address for reprint requests: Dr. M. Jegathesan. Director and Consultant Bacteriologist, Institute for Medical Research, Jalan Pahang. 50588 Kuala Lumpur, Malaysia.

have their own system of providing hazard warning on the labels which is even more elaborate. Besides symbols, the degree of hazard, rated with numbers from 0 to 4 – basically following that of the National Fire Protection Association "NFPA" 704M system – with regards to health, fire and reactivity is indicated. There are also brief ***instructions*** on handling, spillage control and first aid requirements. The warning symbols are further complemented with ***colour codes*** when the rating is very high. In addition to informative labelling, ***wall charts*** for quick reference of these matters of safety with various hazardous chemicals are produced by reputable manufacturers for the promotion of greater safety in laboratories. All these are valuable aids for the safe handling, storage and disposal of chemicals.

Risk from Fire and Explosion

Many of the commonly-used organic solvents like diethyl ether, ethyl alcohol, methyl alcohol and acetone have ***flash points*** below 21°C, and are highly flammable. Some have very low ***ignition temperatures*** and can even be ignited on contact with surfaces below red heat. As a flammable vapour must be present in concentrations of the order of 1% or more by volume if its mixture with air is to become flammable, the risk of fire can be reduced by preventing build up of the ***vapour pressure*** through restriction of use of these solvents and the quantity employed at any time. These flammable solvents should be kept separate from oxidising agents, and preferably stored in a fire and explosion-proof store with ***no ignition source.*** The quantity stored should be maintained at the bare minimum.

Fuel gases like butane, propane, acetylene and hydrogen are used with instruments like the flame photometer, atomic absorption spectrophotometer and gas chromatograph. To prevent the escape and accumulation of these gases in the laboratory, ***checks for leakage*** from the cylinder valve and other parts of the gas system should be carried out at regular intervals and especially after connecting the regulator to the cylinder valve. A soapy solution could be used to check for leakage. Gas cylinders should be stored in a cool place, preferably outside, and the gases piped into the laboratory. With adequate ***ventilation,*** escaped gases will then be able to disperse more rapidly.

A number of substances react vigorously to produce flammable or explosive gases and heat. Among these are the strong oxidising agents, and the water sensitive concentrated acids and alkalis, hydrides and carbides, and the alkali earth and alkali metals. As a safeguard against injury should an explosion occur, reactions involving the use of such materials should be carried out behind a ***protective screen*** and the quantity used kept to a minimum.

Risk from Chemical Bums and Poisoning

The alkaline substances, strong acids, dehydrating and oxidising agents are particularly ***corrosive,*** and can damage or destroy living tissues. Gloves and ***protective clothing*** should, therefore, be worn when handling corrosives. For the protection of the eyes, safety spectacles or goggles could be used.

Among the more familiar toxic substances are the cyanides and heavy metal salts which cause acute or chronic poisoning. Mercury, lead, arsenic and a number of organic substances are cumulative poisons, and are injurious to health on long exposure. There are also compounds like cyanides, sulphides, chlorates and nitrates which react with acid to produce poisonous gases. Where it is not possible to ***substitute*** the use of such substances with less harmful ones, all practical precautions should be taken to reduce exposure to the lowest level. The danger of ingestion of these substances through pipetting and through contamination of the hands and food can virtually be eliminated by ***prohibiting mouth pipetting*** and by good laboratory habits and hygiene on the part of the laboratory worker. The risk of inhalation of harmful gases, vapours, dusts and liquid aerosols is reduced if experiments using toxic substances are carried out in a ***fume cupboard.*** In the disposal of hazardous wastes, small quantities of less toxic compounds may be flushed down the sink with copious amounts of water, while the highly hazardous ones could be subjected to reactions to break them down to less harmful materials prior to disposal.

The known and suspected ***cancer-inducing substances*** belong to the following general groups of compounds – the polycyclic hydrocarbons, aromatic amines, nitroso compounds, azo compounds and hydrazines, alkylating agents and the heavy metals and their derivatives. Various regulatory bodies and organisations have compiled lists of carcinogens which differ substantially from one another. The

list of the International Agency for Cancer Research (IACR), France, for example, is different from that of the Occupational Safety and Health Administration (OSHA), USA, and these lists are revised from time to time. The same safety measures for handling, storage and disposal of toxic substances could be extended to carcinogens. Where possible, these materials are best replaced by less dangerous substances.

Risk from Ionising Radiation

In pathology laboratories, ionising radiation is encountered in the use of the radio-immunoassay (RIA) technique which usually employs iodine–125 and tritium tracers. As the technique involves only very small quantities of radioactive materials, that is, in the region of microcuries, the degree of hazard is minimal. RIA tests can in fact be quite safely performed on open benches without special precautions. Regular radiation monitoring is not mandatory. It is, however, prudent to exercise the same safety measures as applied to the handling of toxic chemicals.

HAZARDS ASSOCIATED WITH PATHOGENIC MICRO-ORGANISMS

Workers in pathology laboratories handle biological materials, and are therefore exposed to the risk of ***laboratory-acquired infections*** (LAI). Exposure can occur in the course of receiving, processing and disposal of these materials. Pike, 1978 reported 479 cases of LAI caused by 159 different infectious agents which included bacteria, viruses, rickettsiae, fungi, chlamydia and parasites.[4] Bacteria and viruses were the major agents involved, but infections by chlarnydia had the highest death rate. The top ten infections which accounted for over 50% of LAI were listed as Brucellosis, Q fever, hepatitis, typhoid fever, tularemia, tuberculosis, dermatomycosis, Venezuelan equine encephalitis, Psittacosis and coccidioidomycosis. Materials, manipulations and laboratory accidents that have contributed to LAI include clinical specimens, human autopsies, aerosols, animal bites and scratches, ectoparasites, spillage and splashing, syringes and needles, mouth pipetting and broken glassware.[5]

Risk from Inhalation of Aerosols and Infective Airborne Particles

Aerosols probably play a major role in causing LAI as they can cause multiple infections from a single source. Many laboratory techniques and accidents generate aerosols[6,7] including the flaming of and spontaneous discharging from the bacteriologist's loop, preparation of slides for examination, slide agglutination reactions, the use of syringes in animal innoculation, and egg innoculation and harvesting. Aerosols may also be generated in the process of blending, mixing of liquids with pipettes, lyophilisation and centrifugation. Besides aerosols, LAI can be caused by inhalation of infective, airborne particles originating from opening or accidental breakage of lyophilised cultures, explosion of frozen culture ampoules, dried microbial cultures, dried materials on stoppers and caps of containers, and contaminated dust dispersed from animal cages.

Good laboratory practices and the use of safety devices (for example, centrifuge safety cups) can minimise the creation and dispersal of these infective particles. For additional protection, biological safety cabinets should be used to contain the aerosols at source and prevent contamination of the environment.

Risk from Contamination and Accidental Ingestion

Spillage and ***breakage*** of containers lead to gross ***contamination of work areas,*** equipment and workers. Splashes and spray of infectious materials directly in the face or eyes have resulted in severe infections. Infections can also be acquired from accidental ingestion in the execution of mouth pipetting and the consumption of ***contaminated food and drinks*** left in laboratory refrigerators.

Spills should be decontaminated with an effective disinfectant, and bench tops and other work surfaces need to be ***decontaminated*** at least once a day. Mouth pipetting should be prohibited. All biological materials and laboratory wastes must be rendered non-infectious, preferably by autoclaving before they leave the work area. Otherwise, they may pose a danger to the community.

Risk from Abrasions and Wounds

Infections resulting from penetration of the skin and mucous membrane can occur from ***accidental innoculations*** with infected hypodermic needles, jabs and cuts from lancets and scalpels, ***cuts*** by broken pipettes and glassware, and animal bites and ***scratches***

(including nasal secretions and wound discharges of infected animals). With newly-imported animals, there is the additional risk of exposure to infection by agents which are previously unknown.

To minimise infections, all cuts, abrasions, and animal bites and scratches should be attended to immediately, and if necessary brought to the attention of a physician. ***Immunisation*** should be considered if a worker is required to handle highly infectious materials.

HAZARDS ASSOCIATED WITH LABORATORY EQUIPMENT AND INSTRUMENTATION

A variety of specialised instruments as well as common laboratory equipment and appliances are employed for processing and testing specimens. Most of these are electrically-powered, and can therefore pose an ***electrical*** problem, besides mechanical and other possible hazards associated with their use. A common fault is the adding on of more and more equipment without regard to the power points available, and, consequently, the need to use multi-plug adapters which may lead to ***over-loading.*** Old heating instruments, like the hotplates, furnaces and ovens may have their insulation becoming brittle or worn threadbare because of the heat to which they are subjected.

Injuries may be sustained from contact with the moving or trapping parts of various machines. Without the protection of a ***belt guard,*** for instance, a worker may be easily injured by getting his clothing or fingers caught between the belt and the wheel of the shaker and vacuum pump. The table-top centrifuge must be securely anchored to prevent its "walking" and subsequent knocking down of other equipment and apparatus, or its falling off the bench.

The incorporation of sufficient safeguards (including positive exhaust ventilation) is necessary if flammable solvents are to be used with the centrifuge. Centrifuges with induction-driven motors (no ignition source) could be considered. For instruments like the atomic absorption spectrophotometer and gas chromatograph which use flammble gases, secure and permanent gas connection lines and fittings are essential for their safe operation. A suitable ***exhaust*** connection is required to prevent the build-up of dangerous levels of flammable gases, and hazardous vapours and fumes emerging from the flame unit.

The autoclave can pose hazards arising from ***heat, steam*** and ***pressure.*** This laboratory equipment falls under the category of "unfired pressure vessels" which, under the Factories and Machinery Act of 1967, require inspection and certification of fitness by the Factories and Machinery Department of the Ministry of Labour. Procedures for certification of fitness are stringent, and include design approval, leak test and permission to install and operate, and the certificate issued is subject to renewal every 15 months.

It is not possible to anticipate and discuss all the potential hazards associated with laboratory equipment and instrumentation. The general rule for safe operation of the different instruments and even common laboratory equipment is that the operator must be guided by information in the technical manuals and by personal experience.

CONCLUSION

Safety and health in the place of work must be an individual and personal responsibility as well as being a management responsibility. Not only must the manager and all members of the staff know the hazards involved, but they must be clearly seen to be directly interested and involved in the promotion of health and safety in work. Strict procedures should be written into analytical and other procedures employed in the laboratory, and a safety comniittee or a safety officer appointed to provide advice and general supervision. The overall aim is the control of risks. This control must include the provision of proper protective equipment, first aid procedures, evacuation plans and training, besides a safety policy and its implementation.

Locally, there are no statute laws and safety regulations which are specifically applied to laboratories, although there are in existence various Acts, like the Factories and Machinery Act of 1967, Chemists Act of 1975, Quality of Environment Protection Act of 1974 and Licensing of Atomic Energy Act of 1984 which have provisions bearing on various aspects of safe practices with regards to laboratories. However, laboratories, including medical laboratories in larger government institutions and universities have safety committees which undertake the responsibility of compiling safety codes and rules, and providing guidelines for their unplementation.

In 1985, a Steering Committee for Safety in Laboratories, under the Ministry of Science, Technology and Environment, with representatives from different government departments, research institutions, universities and various professional bodies, was set up. It established the Technical Committee which was entrusted with the task of producing a uniform Code of Practice for Laboratory Safety. To date, 3 parts, that is, on General Aspects, Chemicals and Microbiology have been drafted, while 4 more covering other aspects of safety are under preparation. Laboratories intending to initiate a safety program could refer to these documents, and draw out sections which have relevance to their needs.

Safety is, in the end, an attitude of the mind, and no efforts on this matter can guarantee safe practices within the laboratory. It can only be hoped that this presentation, besides imparting the relevant information on hazards in pathology laboratories, further stimulates the awareness of safety as being an integral part of laboratory procedures.

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