Managing safety, health and environmental risks in laboratories

Iris van ’t Leven

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Syntax Media – Utrecht, the Netherlands

Table of contents

Inventory of carcinogenic and reprotoxic substances

A cardiological laboratory has made an inventory of the carcinogenic, mutagenic and reprotoxic substances that are used and where they are stored. The information in table 4.3 is incorporated into the company regulations so that all employees know which substances are involved. The assessment has been made on the basis of the H-statements on the label: H350 and H351 for carcinogens, H 340 and H 341 for mutagens and H360, H 361 and H362 for reprotoxic substances.

Table 4.3
List of carcinogens H350/H351, Mutagens H340/H341 and reprotoxic substances H360/H361/H362

Substance	*CAS number*	*H- statements*	*Storage*
Benzene	71-43-2	May cause genetic defects May cause cancer	A1 Safety cabinet
Bichromate sulphuric acid	65272-70-0	May cause genetic defects May cause cancer Suspected of damaging fertility	A2 Safety cabinet
Cobalt chloride	7791-13-1	May cause cancer by inhalation May damage fertility Suspected of causing genetic defects	A3 Toxics cabinet
Hydrazine hydrate	7803-57-8	May cause cancer	A4 Safety cabinet, (ventilated at floor level, cooled)

Continuously operating experimental set-ups

Experimental set-ups that operate more than a day may be left unattended part of the time. By analysing the risks it should become clear whether this is sensible. There is a greater chance of an incident if the owner of the setup is not present. Practical examples: a beaker suddenly boils dry, a faulty heating element creates an overly high temperature, due to evaporation a temperature sensor hangs above a fluid, a cleaning person unplugs a cooling system. If there is no one present at the setup, no one can correct these hazardous situations, resulting in fume hood fires or worse. Appendix 10 includes a questionnaire for assessing the safety of a laboratory setup before it is used. For the sake of safety but also with a view to continuity of the experiment, it is advisable to attach an information card to the equipment stating the name and telephone number of the owner, the substances used in the experimental set-up and their attendant risks, and the measures to be taken in case of an emergency.
After the setup has been commissioned, it is important to inspect it periodically in order to prevent reduction in the safety of a properly designed setup due to aging, wear and tear or breakage. A brief checklist is included in the box.

Checklist for periodical inspection of continuous setups

- Check the quality of glassware and lines, and replace them when they are damaged or cracked.
- Check whether connections are leak-proof. Gas pipelines can be checked with some soapy water or a gas leak spray.
- Check visually whether electrical cables are in good order.
- Check whether chemicals that are released are absorbed and cleared properly.
- Ensure that periodical maintenance of equipment has been arranged and verify that it is actually performed (see also Chapter 7).

Figure 4.5

Glassware and tubing of setups are particularly subject to wear. Connections may loosen over time and start to leak.

Working alone or beyond normal operating hours

Because working with chemicals involves specific risks, staff run additional risks when working alone. After all, there will be nobody around to provide help. Experiments can start to become uncontrolled, hazardous vapours may be released and many other things are imaginable as a result of which an experiment could go wrong. Working alone is not advisable and many laboratories apply strict rules in this respect. Generally, working beyond normal operating hours is not permitted if no emergency services are available or no precautionary measures have been taken.

Figure 5.7

A horizontal laminar flow cabinet blows air into your face; it is only suitable for work with harmless materials and microorganisms.

biological hazard

Biosafety labs and other rooms

Work activities with pathogens and genetically modified organisms must be carried out in specially-equipped laboratories. In these laboratories the risk of spreading microorganisms is much smaller. The higher the risk, the higher the containment level of the laboratory that should be used. Biosafety laboratories are classified accordingly (see table 5.3). Laboratories from category 2 and onwards and ML-II laboratories must attach biohazard signs to their doors. The biological safety officer will be able to help you to assess the conditions under which your work should be carried out.

Transgenic animals, plants and microorganisms are also handled in other rooms, for example laboratory animal rooms, greenhouses, and growth chambers. Depending on the risk, specific equipping criteria also apply in this respect[1]. In most laboratories slight underpressure is applied to prevent the spreading of agents into the environment. Underpressure can only be maintained if access doors are kept closed! Specific criteria are included in the license for operations that cannot be carried out in these special rooms, such as field tests with genetically modified organisms.

Table 5.3
Containment levels for work activities with biological agents and genetically modified organisms

Containment level	*Corresponding biosafety laboratory*	*GMOs*
low	–	ML-I
moderate	containment level 2	ML-II
high	containment level 3	ML-III
extra high	containment level 4	ML-IV

UV-decontamination is less effective than usually thought

In some laboratories, UV lights are used to keep work areas free of living microorganisms. Research has shown that using UV light for this purpose has many disadvantages[6]:

- Not all microorganisms are UV sensitive
- Only direct radiation is effective, even dust particles may protect microorganisms sufficiently against UV
- Dirty and old lights radiate less effectively.
- Material ages rapidly under the influence of UV.
- Dead microorganisms are not removed and form a nutrient medium for growth of microorganisms.
- UV is harmful for skin and eyes (see section 7.4).

Using UV light to decontaminate large areas is not effective. UV lights can be used in biological safety cabinets in combination with other decontamination methods. Avoid exposure to the eyes. Leave UV lights on only if nobody is at work, not even in the close environment. Be aware of and ensure you make appropriate use of the warning signals available to draw laboratory workers' attention to UV light.

Equipment maintenance

All equipment that is used when working with biological agents or GMOs can be contaminated. These include centrifuges in which the centrifuge tubing has leaked, as well as a vortex that was contaminated because of a liquid overspill. This equipment must be decontaminated after a spill, during regular maintenance or major overhaul, or prior to removal. The Infection Prevention Working Party has developed a sample regulation for microbiological safety during maintenance of medical and laboratory equipment[18]. The HEPA filters in biological safety cabinets must be considered to be contaminated. The people who replace them must be properly informed about potential risks.

Collection and disposal of biological waste

Biological waste should be collected separately. Depending on its composition and the pre-treatment method, this waste should be either disposed of: as infectious waste; as chemical waste; as radioactive waste (RA-afval); as waste containing animal by-products (dierlijke bijproducten); or as domestic waste (restafval). A waste stream scheme is set out in Figure 5.8.

The disposal and transport requirements in part depend on the pathogenicity and the risk of spreading in the environment once escaped. Waste that may have been contaminated with unknown or not very harmful pathogens is disposed of as Specific Hospital Waste (*specifiek ziekenhuisafval* or *SZA-afval* for short) or clinical waste.

eye protection mandatory

- A researcher switches on a light box that he just repaired in order to check whether it works. Exposure lasts about 30 seconds[1].
- Cleaners are working in a laboratory unaware of the fact that the UV light is on. After a while they call on the company medical officer with skin and eye problems.

These examples show that even short-term exposure of the eyes to UV lights might cause damage. The eye reflex makes eyes adapt to the intensity of visible light, but not to that of UV light.

Another example from practice
Two workers in the same laboratory contracted cataracts at a young age. The specialists who treated them expressed their surprise about this phenomenon and UV exposure in the workplace was therefore further evaluated. While working with the UV transilluminator, the laboratory workers only used their face shields when looking directly into the UV source. The face shield was very dirty and therefore less clear, so that they took them off whenever they could. To offer adequate protection, face shields should be worn tight to the face, which will soon give a closed-in feeling. Laboratory workers were inclined to put their face shields further away from their faces which considerably reduced the protection provided.

Immersion lights, photochemical reactors, grow lights, and UV transilluminators all transmit high-intensity UV radiation. With some of these lights, the level of harmful exposure is already reached after a relatively short period. UV light in laboratories is mostly used for decontamination purposes. Lights that are most effective for decontamination purposes are also the most harmful ones for the eyes. Some laboratories use UV lights for detection, in chromatography, for example. This could also result in exposure.

Mercury-vapor lamps, xenon lamps and neon lights transmit UV of a lower intensity. When the work is carried out at a normal distance from these lights, exposure will not be higher than in the outside air.

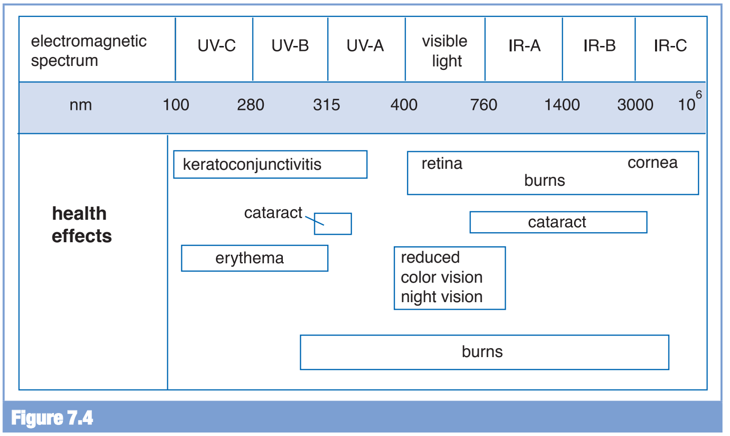

Figure 7.4

Biological effects of extensive exposure to UV light, visible light and infrared light (source: International Commission on Illumination)

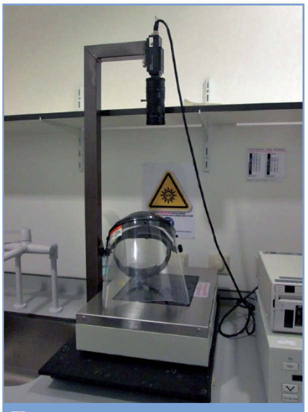

Figure 7.5

Transilluminator with face shield.

Preventive measures

Determine whether using UV actually has added value in your case. The following key points apply if you still need to work with UV:

- Opt for UV lights whereby radiation is shielded as far as possible.
- Shield the UV radiation in experimental set-ups in order to limit the amount of scattered radiation.
- Inform your colleagues if you need to work with UV. This can be done by switching on the warning signs present in the laboratory.

In the event of potential UV exposure, UV goggles should definitely be worn. These goggles should also be worn when not looking directly into the radiation source. From a viewpoint of availability and hygiene, the use of personal UV goggles is preferred. It is also advisable to wear protective clothing and a UV-resistant face shield. Of course, UV goggles do not prevent exposure of the skin. Properly maintain goggles and face shields so that they remain pleasant to use.

Blue Light Hazard[6]

Sources of light and radiation with other wavelengths may also be harmful (figure 7.4). Intensely radiating blue LEDs, for instance, may cause photochemical aging of the retina (Blue Light Hazard). Blue LEDs are also close to UV and sometimes inadvertently radiate UV. When using intense radiation sources, check whether screening of the light source or the use of laser goggles is necessary.

7.5 Lasers

The light transmitted by lasers carries particular risks[7]. A laser is characterized by an electromagnetic beam with a small diameter but with a high power density. As a result of the high power density, lasers may damage the skin and eyes. The eye usually projects incoming light at a single point (see figure 7.6).

Because of this projection, the laser beam as such is concentrated even more on a small surface. All the heat is released at this point and, with high-power lasers, it cannot be discharged quickly enough to avoid retinal damage. With normal light, the eye reflex protects the eye if exposure is too high. However, the laser beam may have such a high intensity that the eye reflex no longer responds in time. Furthermore, lasers are generally used in darkened rooms so that the pupil's diameter is particularly large, which, in turn, increases the risk of eye damage. The eye reflex does not respond at all with UV and infrared lasers and therefore offers no protection whatsoever. Far infrared lasers (FIR) and far ultraviolet lasers (FUV) do not penetrate deep into the eye but could still damage the cornea and/or lens.