

Acid Attack!

Another “Acid Attack”. Unfortunately, this has become a frequently seen headline, something that we would never have expected to see in the British media twelve months ago. The reality is, however, that this kind of incident has been on the increase over the last 8 years, just not at the level we have experienced in 2017 (411 attacks Jan – Sept 2017 in London).

What is at the root of the increase?

Historically, “acid attacks” have been associated with either honor or revenge, however, over more recent years these attacks have become increasingly linked to the gang and drug culture.

We call them “Acid Attacks”, but are they?

Which chemical products cause a chemical Injury (lesion)?

The chemical products that can cause a chemical injury are categorised according to the seriousness of the lesions that they can induce: they are classified as **Corrosive** or **Irritant**.



Corrosive



Irritant

A chemical product is classified among corrosive or irritant agents when it is capable of reacting with biochemical components of the cells and the tissues of the skin, the eye and the respiratory or digestive tracts. The CLP/GHS regulations of the European Chemicals Agency provide the following definitions of corrosive or irritant products (CLP page L 353/87):

Skin corrosion means the production of **irreversible** damage to the skin; namely, visible necrosis through the epidermis and into the dermis, following the application of a test substance for up to 4 hours.

The reversibility of the skin lesions is to be considered in assessing the Corrosive or Irritant nature of a substance.

It is **Corrosive** when it causes a severe lesion. Corrosive products cause irreversible destruction of the tissue with which they come into contact.

It will be considered **Irritant** if it only causes irritation, redness or inflammation of the tissues with which they come into contact, damage caused by Irritant chemicals will usually be reversible.

The same chemical product may be Corrosive or only Irritant depending on the circumstances:

- ❖ If present in a mixture or on its own
- ❖ Depending on its concentration
- ❖ Depending on the environment in which it is present

What is the mechanism of a chemical Injury (lesion)?

The process begins with a chemical reaction between two molecules. On a microscopic level, the chemical lesion results from a **chemical reaction between an aggressive chemical product and a biological constituent**.

This reaction destroys the biological constituent and hence the tissue. This forms the chemical lesion.

The mechanism involved in the development of the lesion depends on many parameters, the most significant of which is the nature of the reaction initiated.

Depending on its type, each chemical product will react with a different component of the biological tissue by means of one of following actions:

- ❖ **Acid-base reaction:** H^+ proton exchange reaction between an acid and an alkali.
- ❖ **Redox reaction:** electron exchange reaction between an oxidising agent and a reducing agent.
- ❖ **Chelation:** formation of a complex from two molecules.
- ❖ **Solvation:** dissolution of a chemical species in a solvent.

Stages of development of a chemical Injury (lesion):

The development of the lesion can be divided into three phases:

- ❖ **Contact** between the chemical product and the tissue.
- ❖ **Penetration** of the chemical product into the tissue.
- ❖ **Reaction** between the product and the biological component of the tissue.

Contact occurs when the chemical product is splashed on the skin or in the eye. Contact with the digestive tract (mouth, oesophagus, stomach...) occurs when the chemical product is swallowed. In the case of the airways, it takes place when vapours or dust particles of the chemical product are inhaled.

Once the product is in contact with the tissue, **it can penetrate** in spite of the biological barriers. The characteristics of the chemical product define its penetration potential and penetration rate into tissue.

Examples:

A solid chemical product cannot readily penetrate through the skin.

A small chemical molecule generally penetrates more quickly than a large molecule.

A molecule penetrates more readily if it is lipophilic.

The chemical product will penetrate into tissue until it encounters a biological constituent with which it can react. The penetration depth of the chemical product into the tissue before it reacts therefore depends on its type.

The chemical product is subsequently able to react with its biological target.

Once the chemical product has reached the biological constituent of the target tissue, the chemical reaction takes place. The biological equilibrium is changed, the tissue is destroyed and the lesion forms.

The lesion only develops, therefore, during the chemical reaction, once the chemical product has reached its target. Each splash of chemical product contains a very large number of molecules capable of reacting with a target molecule or with a target cell of the human body.

The lesion progresses in this manner for as long as any chemical product still remains in contact with the tissue and has not yet reacted.

Rapid intervention following contact makes it possible to restrict the extent of the lesion:
Emergency Decontamination is Paramount

Factors that worsen the Injury (lesion):

The type, depth and severity of the lesion depend on many factors:

- ❖ The nature of the aggressive chemical product.
- ❖ Its concentration.
- ❖ The contact time between the tissue and the chemical product.
- ❖ The temperature and pressure of the chemical product.

Steps required for effective decontamination:

- ❖ **Remove** the chemical remaining on the surface of the skin or eye to avoid further penetration.
- ❖ **Stop** the aggressive chemical action.
- ❖ **Stop** further penetration of the chemical inside the tissue.

SOLUTION USED FOR EMERGENCY DECONTAMINATION

Water:

Historically water has been the default solution of choice and its use has continued on the basis of argument which are more practical than scientific, because of its general-purpose potential, its non-toxic character and its availability. Water also allows the chemical agent, on the surface of the contaminated tissue, to be carried away by a mechanical washing effect.

However, there are limits to water washing:

- ❖ It does not act on the potentially irritating or corrosive nature of the chemical agent.
- ❖ There is no rapid return to a physiological state. The effect of carrying the chemical agent away is limited to the surface tissue and has no in-depth effect. (* See Note)

- ❖ Water, because it is hypotonic to the body, favours the penetration of the chemical agent into the tissue, the “wash in” effect.
- ❖ In order to obtain optimal results, it is necessary to intervene IMMEDIATELY, according to the European Standards EN15154, (10 seconds according to the ANSI standard) after the splash. However, there is sometimes only partial effectiveness, in particular with highly concentrated corrosive agents.
- ❖ Large quantities of water are required to maintain continuous washing for 20 minutes. (Following the European Standard - EN15154 suggestion of “60 litres per minute for 15 minutes, would require 900 litres of potable water)
- ❖ Despite following the recommended protocol; secondary care, surgical intervention and even fatalities are reported in the scientific literature.

(*) Note. Some consider **pH** to be irrelevant in the effective first aid management of chemical splashes, however, it provides a valuable indicator, alongside **pain** as to the effectiveness of the management protocol. As an example: If a casualty presents with a pH 1 (acid) or 14 (base) chemical splash, it is vitally important that the pH is brought up or down respectively, so that we stabilize the pH in the physiological safe area of 5.5 – 9 and this needs to be achieved as quickly as possible. Pain and pH are two valuable indicators in the effective management of chemical splashes.

Alternative washing Solutions

Comparative studies have shown the possibility of improving on washing with water. These studies give both Clinical and Medical evidence that the use of safe, effective polyvalent washing solutions that are amphoteric, chelating and hypertonic, result in a greatly improved outcome. Some critics of these type of washing solutions argue that there is a lack of clinical data but the clinical data is there.

Over the last fifteen years there has been a substantial increase in the amount of data published by medical professionals, from around the world, showing the definite benefits achieved when using these type of washing solutions. It has been, quite rightly, argued that there comes a point when the overwhelming amount of medical evidence becomes clinically significant. There has also been a huge increase in the use of these solutions within industry, where it has been recognised that significantly better results are achieved when using these type of solutions compared to washing with water.

The benefits of safe, effective, polyvalent washing solutions that are amphoteric, chelating and hypertonic such as DIPHOTERINE® Solution:

- ❖ Washing: Keeps the same mechanical washing effect of water.
- ❖ Polyvalent: Is effective on the corrosive and irritant action of chemicals.
- ❖ Safe: Conforming to The Medical Devices Directive and European Standard EN15154
- ❖ Effective: Proven to be effective on the Corrosive and Irritant effects of over 1400 chemicals.

- ❖ Amphoteric: Suppresses the aggressive of corrosive and irritant chemicals.
- ❖ Chelating: Attracts and binds the aggressive chemicals molecule.
- ❖ Hypertonic: Creates a flow away from the tissue.

Once the decontamination has been completed and has been effective (pH and pain have been stabilized), the chemical lesion no longer progresses. It is then possible to treat any established damage in order to facilitate cicatrisation.

Note: If the chemical product is toxic, this hazard must also be dealt with.

Chemical lesions may require **secondary treatment** and management by a physician. The treatment must be **adapted to the specific hazard of each chemical product and to the severity of the lesion.**

While the threat of aggressive chemical attacks continues, it is important that we continually challenge our existing protocols and endeavor to utilize more effective solutions when they exist and develop new ones when they don't.

Water is better than nothing but, it is not the only solution available and it is not the most effective solution available!