Dermal decontamination and light petroleum distillate toxicity in dogs and cats

Veterinary Update

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Petroleum solvents should not be used for skin decontamination in veterinary medicine. This problem is most likely to occur when veterinarians attempt to remove materials that either stain or adhere to the hair coat; or when owners inappropriately expose their animals to household products that contain these materials.

The current generally accepted recommendations for dermal decontamination are as follows:

- The original product container and an intact label are often the single most useful pieces of diagnostic information in cases of poisoning. Most cases of poisoning are diagnosed on the basis of the clinical history rather than other techniques.

- Dermal decontamination is almost always a lower clinical priority compared with stabilisation/resuscitation (airway, breathing and circulation in that order) and the administration of known effective antidotes. Stabilisation and antidote administration should not be delayed by dermal decontamination. It may be possible for all of these procedures to be performed concurrently.

- Dermal decontamination can expose the treatment team to significant levels of toxicants. Appropriate personal protective equipment (PPE) including chemical resistant gloves, a long sleeve coat and/or shirt, long pants, eye protection and closed footwear are the minimum PPE requirements. Some toxicants will require the use of a full-face gas mask with appropriate canisters. If in doubt, get adequate training in the use of PPE.

  Ill-advised and/or ill-prepared attempts at rescue and decontamination remain a significant cause of human toxicological casualties.

- Flushing of the skin surface with large volumes of water as soon as possible following exposure is recommended. Particular care must be taken to prevent hypothermia during this treatment, especially with small animals. Veterinarians should take particular note that reducing body temperature actually *increases* the effects of pyrethroids and pyrethrins on the nervous system of mammals. Part of the selective toxicity of these pesticides is based on the lower body temperature of insects compared with mammals. On the other hand, it is also important to avoid flushing with water that is too warm, as this will produce dermal vasodilation, increased dermal blood flow and greater dermal absorption of the toxicants.

- Several wash-rinse cycles of the affected area using a *mild* hand dishwashing detergent should be applied as soon as possible following exposure. Again, it is particularly important to avoid both hypothermia and washing/rinsing with materials that are too warm. A particular emphasis is applied to the term “mild” for a reason: strong detergents, strong

surfactants, laundry detergents and machine dishwashing detergents must not be used because of their corrosive potential. It is also important not to go to extremes with this procedure. Even mild detergents cause some defatting injury to the skin in their own right.

- Attempts to chemically neutralize acids and bases on the skin should be avoided because of the risk of thermal injury.

  There is some evidence that products such as Diphoterine may improve the outcomes of skin contact with corrosive materials in humans. However, large-scale trials are lacking and the safety properties of these products in domestic animals have not been assessed.

- Specialised skin decontamination may be required for particular materials (e.g. the use of calcium gluconate gels for hydrofluoric acid exposures). The best source of information regarding this is your local poisons information service. Alternatively the US ASPCA Animal Poison Control Center should be contacted.

- Substances that are adherent to the skin or hair (e.g. adhesives, polymers, bitumen, tar) or produce skin/hair stains should be left in place (and a Elizabethan collar used to prevent self-mutilation) unless they interfere with biological functions e.g. materials adhered to the eye-lashes or that interfere with breathing/eating/drinking/defecation/urination. If the materials interfere with biological functions, an attempt to remove the material can be made using very gentle treatment with a non-irritant, simple cosmetic emulsion. Substances such as Tween 80 and PEG 500 have also been suggested for this purpose. If this is not successful, more aggressive surgical interventions may be required.

- Eye exposures commonly co-occur with skin contamination. Eye exposures are often genuine ophthalmic emergencies: Seek specialist help as soon as possible.

- In general, the assessment and management of chemical skin burns is the same as for thermal burns.

- Dermal exposures may produce significant systemic toxicity (e.g. phenol, hydrofluoric acid, pyrethrins/pyrethroids) that requires additional treatment and support.

- Solvents have no place in dermal decontamination.

- Treat the patient, NOT the poison.

Petroleum distillate and other strong solvents have no place in skin decontamination procedures. Veterinarians often fall into the trap of using these materials when confronted with materials that adhere to the skin/hair coat or that produce skin staining (such as paints, wood stains, glues/adhesives, tar/bitumen). While the presence of adherent material or stains may be upsetting to an owner, this situation is far better than the risk of inducing chemical skin burns and possible systemic toxicity that are associated with light petroleum distillates or other strong solvents.

The case against the use of light petroleum distillates, such as mineral turpentine, in dermal decontamination can be summarized as follows:

- A complete lack of evidence of any clinical efficacy (except in very specialised and rare circumstances).

- The very real risk of combustion and associated thermal injury. These materials, particularly Stoddard solvents, will spontaneously combust when in direct contact with the cotton fibers commonly used in skin dressings. This spontaneous combustion is an oxidation reaction that needs no external ignition source. Setting one's patient or practice on fire is not a desirable outcome of treatment.

- The very real risk of skin irritancy and defatting injury.

- The risk of causing a freeze injury when volatile hydrocarbons are used.

- The very real and substantial risk of producing a chemical skin burn, particularly with sustained or repeated contact.

- The destruction of the barrier function of the skin that may actually increase skin absorption.

- The combination of washing with a detergent and wiping with a light petroleum distillate may exacerbate the skin damage.

- The very real risk of aspiration associated with grooming behaviours.

- The risk of absorption of the solvent and the possibility of systemic effects.

It should be noted that "mineral turpentine" (synonyms: white spirit, Stoddard solvent, solvent naphtha, petroleum spirits) is a family of light petroleum distillates that falls within the C9-C14 Aliphatic (2-25% aromatic) hydrocarbon solvents category. The C9-C14 Aliphatic (2-25% aromatic) hydrocarbon solvents are chemically very different from true turpentine (synonyms: spirit of turpentine, oil of turpentine, wood turpentine). This hydrocarbon solvent category consists of complex hydrocarbon mixtures that contain C8-C14 branched and straight chain paraffins and naphthenes (cycloparaffins), which represent about 70% of the volume. Aromatic hydrocarbons such as alkylbenzenes (single ring) and alkylnaphthalenes (double ring) may be present at up to 25% by volume. Olefins are usually not present at more than 5% by volume.

"Natural" turpentine contains various plant resin-derived polymers of isoprene, most of which fall within the essential oil family. The predominant isoprene polymer present in the "natural" turpentine depends upon its plant source. Most "natural" turpentine products are derived from distilled pine resins and the predominant essential oil in the material is pinene. Pinene is notably toxic for cats.

Light petroleum distillates of the C9-C14 Aliphatic (2-25% aromatic) hydrocarbon solvents category are also very commonly encountered components of household products, including many paints, wood stains, glues/adhesives, cleaning products, degreasing products, solvent products, lubricants and fuels. Thus this short commentary is also relevant to accidental or malicious exposure of dogs and cats to these substances.

The light petroleum distillate toxidrome has at least 4 components:

- The single most critical hazard is hydrocarbon aspiration pneumonia. In dogs and cats,

this can occur either by ingestion (or malicious oral dosing) or by the animal grooming the contaminated hair coat. If these petroleum distillates are present at ≥ 10% and overall the product has a kinematic viscosity of less than ≤ 20.5 mm^2/s at 40°C (the viscosity cutoff is approximately the viscosity of "Johnson's Baby Oil") there is a significant risk of aspiration. Veterinarians should note that while clinical signs such as petroleum smelling breath, coughing, gagging etc. are indicators of petroleum distillate aspiration, the majority of cases will display few or no clinical signs before the onset of respiratory distress at several hours to several days following exposure (typically 24-48 hours post-exposure). Radiological changes are also typically delayed and slow to develop. For the most part, petroleum aspiration pneumonia is a quiet, insidious process involving progressive respiratory distress, often with fatal respiratory failure at 24-48 hours post-exposure (depending on the aspirated volume).

Veterinarians should take note that any medication or procedure that suppresses the gag or swallowing reflexes will increase the risk of hydrocarbon aspiration pneumonia.

- Narcosis and other CNS effects are the second of the classical tetrad of effects associated with light petroleum distillates. Evidence of CNS effects may include restlessness, head pressing, episodic stargazing, pupillary dilation, ataxia, generalised cognitive depression and so forth. The severity of these effects does show some patterns in relation to composition: as a "general rule of thumb", the higher the aromatic content, the more potent the narcotic properties and the more severe the CNS effects. It is the CNS and narcotic properties of the light petroleum distillates (combined with their low cost) that make them attractive drugs of addiction.

- Skin, digestive mucosae and respiratory mucosae irritancy is the third member of the tetrad. The modes of action for these effects are: (a) defatting injury to the skin and other membranes; and (b) solvent action on cell membranes. As "general rules of thumb" the longer the contact with the skin and the greater the aromatic content (i.e. the greater the product's solvent action), the more severe the skin/mucous membrane damage is likely to be. Some very light petroleum distillates that evaporate very rapidly from the skin surface (e.g. the C3-C6 distillates in petrol) can produce freeze injuries to the skin.

- The final member of the classical hydrocarbon solvent tetrad of toxicological effects is sensitization of the myocardium to catecholamine-induced arrhythmias. As "a general rule of thumb", myocardial effects usually require exposures sufficient to produce narcosis/ CNS effects. There are also relatively clear structure-activity relationships for effects on the myocardial electrical system: (a) in general, the higher the C4-C5 aliphatic hydrocarbon content, the more potent the substance is as a myocardial sensitizer. Within this spectrum, butanes (C4) are generally considered to be the most potent myocardial sensitizer; and (b) the higher the simple aromatic content, the more potent the substance is as a myocardial sensitizer.

  Thus if CNS or narcotic effects are present, or if the product involved in the exposure is known to have a high C4-C5 and/or high simple aromatic content, monitoring of cardiac electrical activity is an important feature of clinical management. Handling stress may also increase the risks associated with catecholamine sensitization. There is some evidence that catecholamine sensitization may last for several days.