A case of carrier gas confusion: unintentional use of carbogen

(Word count 798)

A veterinary practice unintentionally used carbogen, a mixture of 95% oxygen and 5% carbon dioxide, as an anaesthetic carrier gas over a 5-month period. The error went unnoticed until the practice obtained a multiparameter monitor with capnography. Fractional concentration of inspired carbon dioxide was persistently elevated in all patients despite new non-rebreathing systems with fully functional one-way valves being used, adequate fresh gas flow rates and active soda lime in the circle systems. A veterinary nurse (RVN) eventually discovered the source of the problem and was able to rectify the mistake.

Although unusual, this incident demonstrates a compromise of patient safety through the failure to identify and resolve an error at different organisational levels and at different timepoints. Reason's Swiss cheese model is widely accepted as a means of analysing critical incidents within healthcare systems (Reason 2000). The premise of this model is that such systems incorporate a series of barriers which prevent a mistake from leading to patient harm – human and veterinary. These levels of defence are penetrable at points of weakness in their structure and if each barrier is sequentially permeated an incident occurs. Reason describes four different levels of defence which include unsafe acts, preconditions for unsafe acts, supervisory factors and organisational influences. Failures may be active, resulting from human error, or latent, resulting from defects in organisational or cultural aspects of the system.

The initial active failure was the erroneous placement of an order which appeared to result from memory lapse or cognitive distortion. This type of error is common in veterinary practice and in one study accounted for 51% of mistakes resulting in indemnity insurance claims (Oxtoby et al. 2015). A subsequent failure to rectify the mistake suggests that there were insufficient barriers present to prevent the gas from being delivered to patients.

Carbogen has several specific uses in human medicine but to the authors' knowledge there is no described clinical veterinary application and there is little indication to extrapolate its use from human medicine in a primary care setting. An initial query raised by the gas supplier does not appear to have been heeded and the clinician confirmed the order, presumably believing it to be correct. An RVN who overheard the conversation was concerned a mistake had been made but felt unable to question this assuming the '*vet knew what she was doing*'. Psychological impediments to communication between teams including perceived hierarchy contribute to the creation of an unsafe environment which increases the risk of patient harm (Weller et al. 2014) and thus sets the preconditions for unsafe acts.

The order was placed on repeat and therefore subsequent deliveries could be requested via an online order form without speaking to an operator. Assuming that the correct gas had been received in the first instance, the contents of repeat orders were not checked, and the error went unnoticed. Over a period of 5 months, five deliveries of three J-type (6,800 litre) compressed gas cylinders were received by the practice. No further questions were asked by the supplier.

Upon receipt, the cylinders were placed by the delivery company in a storage facility outside of the practice building. They were checked on arrival, but only the colour coding system was observed. Cylinders had a black body and a shoulder consisting of white and grey segments (Fig. 1a) indicating the components of the gaseous mixture. This adhered to the International Standards Organisation (ISO) coding system. However, when placed in the facility the white segments were positioned facing outwards and, as a result, the grey segments were sometimes obscured by shadow and were not necessarily obvious to the viewer (Fig. 1b*).* Although the gas name labels contained the correct information identifying the gas as '*95% Oxygen/ 5% Carbon Dioxide Medical Gas Mixture*', these were not inspected. Compressed gas cylinders are required by law to be marked with a gas name label but colour coding systems, although widely adhered to, are not enshrined in legislation. The procedure for checking the supply was thus not adequate to detect the presence of the wrong gas.

The cylinders were connected to the regulator via BS3 bull nose valves (Fig. 1c) which are currently used for both carbogen and 100% oxygen. The Schrader outlet valve on the regulator was marked 'O_2' (Fig. 1d*)*. The BS3 valves are currently in the process of being replaced with gas specific valves to comply with the ISO 5145 regulations, but completion is not due until 2026 (BGCA-TSC7, 2019). In the meantime, the potential to connect the piping to the incorrect gas cylinder remains.

The majority of errors and disasters in many industries can be attributed to latent risk factors. These are failures in the design of the system, organisation or environment that go unrecognised until they harm patients (van Beuzecom et al. 2010). This case is an example of latent risk factors within the workplace contributing to an error. Although, no short-term adverse effects were observed in these patients, preventing future harm requires these factors to be addressed.

References

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