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Paper

We need to talk about error: causes and types of error in veterinary practice

C. Oxtoby, E. Ferguson, K. White, L. Mossop

Patient safety research in human medicine has identified the causes and common types of medical error and subsequently informed the development of interventions which mitigate harm, such as the WHO's safe surgery checklist. There is no such evidence available to the veterinary profession. This study therefore aims to identify the causes and types of errors in veterinary practice, and presents an evidence based system for their classification. Causes of error were identified from retrospective record review of 678 claims to the profession's leading indemnity insurer and nine focus groups (average N per group=8) with vets, nurses and support staff were performed using critical incident technique. Reason's (2000) Swiss cheese model of error was used to inform the interpretation of the data. Types of error were extracted from 2978 claims records reported between the years 2009 and 2013. The major classes of error causation were identified with mistakes involving surgery the most common type of error. The results were triangulated with findings from the medical literature and highlight the importance of cognitive limitations, deficiencies in non-technical skills and a systems approach to veterinary error.

Introduction

Doctors make mistakes. Errors in patient care kill more people annually than AIDS or breast cancer and almost 1 in 10 visits to hospital result in some level of adverse event (de Vries and others 2008). Quite aside from the emotional cost to both patients and families, the financial burden of medical error totals billions (Mahajan 2010). In recognition of this, driven by public concern and political will, the medical profession over the last 25 years has investigated the causes and types of medical error, drawing on research from other safety critical industries such as aviation. This has led to an empirical understanding of the factors which potentiate mistakes and the types of errors which are most common, followed by the development of interventions to mitigate risks. Vets also make mistakes, but the profession has no compound mortality and morbidity figures, no tools to classify veterinary error and an immature understanding of the causes and facilitators of mistakes.

A model of error

Studies investigating the causes of disasters in nuclear power, offshore oil and aviation, suggest that human factors are major contributors to at least 70 per cent of accidents (Reason 1995). From this perspective, errors are seen as the result of interactions between the *cognitive limitations* of an individual and the environment or *system* which influences their decisions. This approach to error is widely accepted in medicine, informed by studies suggesting that up to 98 000 patients die annually in the USA, not due to their medical condition but because of doctors' mistakes (Kohn and others 1999, Brennan and others 1991).

Cognitive limitations

Cognitive limitations encompass slips, lapses and mistakes. Slips and lapses are the 'absent-minded' errors of distraction and occur when attention is diverted from a well rehearsed task (Reason 1990). Mistakes are described as rule or knowledge based (Rasmussen 1982). Rule based errors involve the incorrect application of previously learned solutions, while knowledge based mistakes occur during attempts to work out a complex problem from first principles. This cognition relies heavily on working memory. It is sensitive to the effects of stress and is prone to conformational bias, the natural inclination to select only that evidence which supports a previous decision (Sexton and others 2000, Reason 1990).

Reason's (2000) Swiss cheese model (Fig 1) identifies the individual, as a final fallible link in a chain of events. These workers, no matter how highly trained and motivated, are still fundamentally subject to their cognitive limitations. As such, they are often the weakest link in a chain of circumstances which, in the case of a doctor, culminates in patient harm (Reason 1990). Indeed, these basic cognitive limits have been identified as one of the leading causes of adverse events in medicine (Harrison and others 1999, Lawton and others 2012).

System failures

System failures relate to the environmental factors which influence events. The Swiss cheese model conceptualises components of the workplace, often far removed from the person at the sharp end, but which directly influence their behaviour and decision making (Reason 2004). Pressures of production, decisions made

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C. Oxtoby, BVSc,
K. White, MA, Vet, MB, DVA, Dipl, ECVAA, MRCVS,
L. Mossop, BVM&S, MMedSci, (ClinEd)PhD, MAcadMed, MRCVS, School of Veterinary Medicine and Science, Nottingham University, Sutton Bonnington Campus, Leicestershire LE125RD, UK
E. Ferguson, PhD, BSc, CPsychol, AFBPsS, FRSPH, School of Psychology, Nottingham University, University Park, Nottingham NG7 2RD, UK

E-mail for correspondence: svxco1@nottingham.ac.uk

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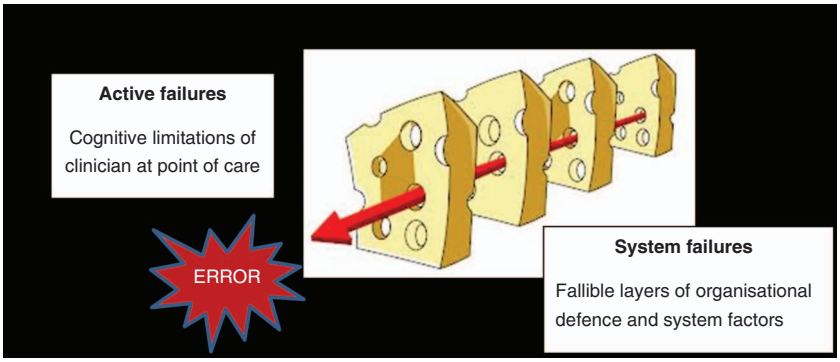

FIG 1: Reason's Swiss cheese model of error. Adapted from Reason (2004)

by management and failures in ergonomics all contribute to individual mistakes, but are often overlooked in the aftermath of an error. Medicine now recognises the importance of these factors and non- technical skills (Yule and others 2006). Deficient communication skills have been identified as one of the major causes of mistakes in medicine and have been implicated in 43 per cent of surgical errors (Carne and others 2012, Gawande and others 2003). The importance of effective leadership is identified with reference to promoting patient safety in the implementation of interventions such as the safe surgery checklist, pre op briefings and leadership of a surgical team, (Treadwell and others 2013, Gore and others 2010, Flin and others 2010) while errors of judgement in young clinicians have been linked to suboptimal levels of senior supervision (Gawande and others 2003).

An understanding of cognitive limitations, together with the effect of the system is vital to facilitate training and design of organisations in which clinicians work (Zhang and others 2004). Frameworks and models of error causation such as the London protocol (Taylor-Adams and others 2004), the Eindhoven PRISMA model (Van der Schaaf and Habraken, 2005) and the Yorkshire framework (Lawton and others 2012) provide a structured format for root cause analysis to aid the investigation of adverse events. These can be helpful in defining and conceptualising the causes of error and allow clinicians and management to recognise them. There is currently no such model available to veterinary practice.

Types of error

In addition to determining the causes of error, medical research has categorised the types of error using evidence from incidence rate studies and literature review. Surgery is consistently linked to approximately 50 per cent of errors (Leape and others 1991, Wilson and others 1995), with surgeons and interns identified as the most likely groups of clinicians to err (Thomas and others 2000). de Vries and others (2008) review of 74 485 cases in eight major studies concluded that 39.8 per cent of adverse events are linked to operations, with general surgery and orthopaedics consistently overrepresented. Of the non-surgical events, errors involving drugs are most common, responsible for 15.1 per cent of the adverse events (de Vries and others 2008). Cardiovascular drugs, analgesics and hypoglycaemic agents account for 86.5 per cent of preventable adverse drug events, with inappropriate drug selection and inadequate monitoring over time the most frequent errors (Thomsen and others 2007). In comparison, anaesthesia related errors are responsible for only 2 per cent of mistakes (de Vries and others 2008).

This pattern is reflected in claims to medical insurance companies, with surgery, improper treatment and failure to diagnose, the most common sources of complaint (Floyd 2008).

The veterinary model

McMillan (2014) describes the topic of patient safety as 'embryonic' in relation to veterinary practice. Clinical governance in the form of clinical audit is now prominent policy in the Royal College of Veterinary Surgeon's Code of Professional Conduct and is mandated in their voluntary Practice Standards Scheme (The Royal College of Veterinary Surgeons 2015). The only comparable incidence studies in the veterinary literature are limited measures of peri-anaesthetic mortality. These do not attempt to identify the contribution of error, and lack a human factors approach and systems perspective when analysing the causes of death (Brodbelt, 2010, Johnston and others 1995). At present, despite intuitive acknowledgement that mistakes occur, the only evidence from which to estimate the incidence or causes of error across the profession is Mellanby and Herrtage's (2004) survey of 108 recent veterinary graduates. This small but insightful study reported that 78 per cent admitted to making errors and 82 per cent stated they 'frequently or always' worked unsupervised. The subjects of the study identified lack of experience, time or supervision as well as communication breakdowns between colleagues as the most common causes of their mistakes. Attitudes to error have also been reported in the veterinary literature, with Hartnack and others' (2013) Delphi study of veterinary anaesthetists finding universal acknowledgement that mistakes and near misses occur, a fear of punishment in the aftermath of error and an acknowledgment that 'nobody speaks of them'. Just as Sexton and others (2000) found similarities between the working cultures of pilots and doctors, this suggests parallels between the attitudes of doctors and vets. Fear and a lack of belief that incident reporting will make a difference are cited as the two most important barriers to reporting of medical error, preventing individual and organisational learning and impairing efforts to prevent recurrence (Leape 1997, 1999).

The aim of this study was to explore the causes and types of error in veterinary practice and present an empirical framework, grounded in theoretical concepts but specific to the veterinary profession. Two research questions were postulated:

1. What are the causes of error in veterinary practice?
2. What are the types of error in veterinary practice?

Materials and methods

The two research questions in this study concerning the causes and types of error required a combination of methodological approaches. Three separate sets of data were obtained, two sets of which informed a qualitative investigation into the causes of error occurring in veterinary practice.

Causes of error

A qualitative approach was used to investigate the causes of error because of the need to look in depth at the topic and lack of previous research in this area.

Retrospective case review

Twelve months of descriptively written records of insurance claims relating to the period of January 2013–January 2014 were obtained from the UK veterinary profession's largest indemnity

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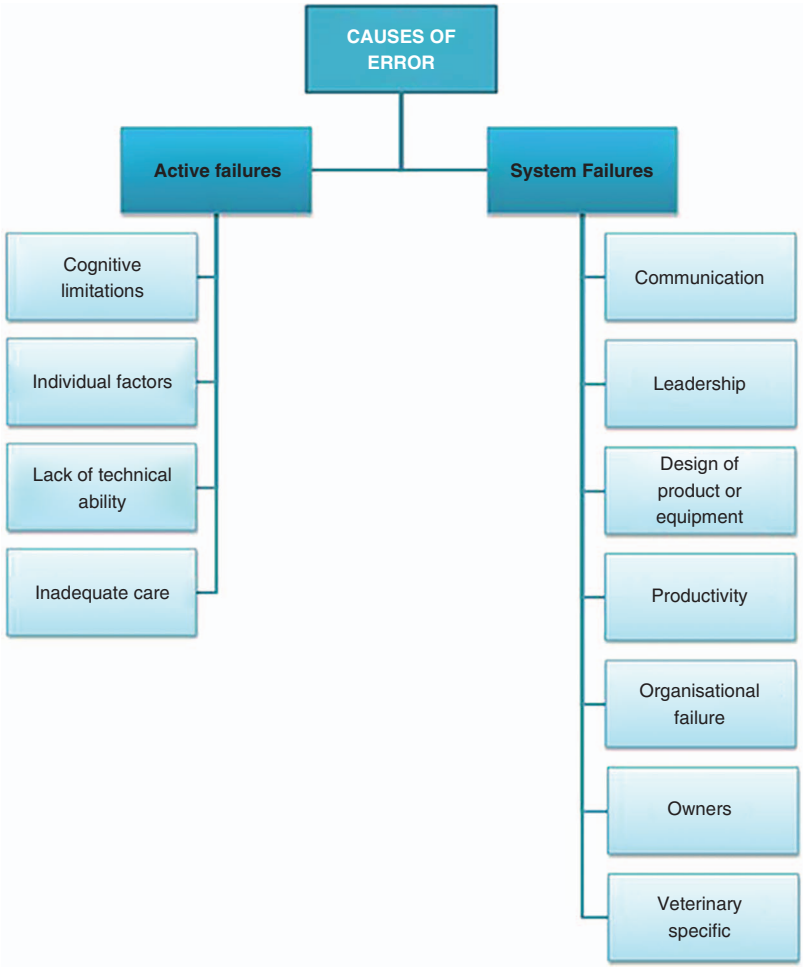

FIG 2: Causes of error in veterinary practice

insurer. Reports that did not contain enough information to clearly identify a causal factor, or those which resulted only in financial loss, were excluded from the study.

Focus groups

Focus groups were used to collect the second data set investigating the causes of error in order to explore these issues in depth. Individual participants were identified using convenience sampling. A snowballing technique was then employed to invite their colleagues to attend semistructured group interviews and discuss their experiences of error using the Critical Incident Technique (Flanagan 1954). Critical Incident Technique facilitates the exploration of true root cause factors rather than simply participant's opinions, as it is based on the detailed description of a recalled event. After agreeing to take part, participants were sent an information sheet explaining the purpose of the study and asking them to recall some personal examples of errors they had made or witnessed, before the group. To instil confidence and facilitate full disclosure of a sensitive subject, they were assured that the results of the discussions would be anonymised and strictly confidential. To develop rapport and engender trust, each group began with the discussion of two examples of the author's (CO) own mistakes, while working as a practising vet. Each participant was asked to provide examples of errors they had experienced in practice. These were used as a basis for discussion by the group, and recorded and transcribed verbatim. The groups were performed until saturation was achieved with no new domains of error causation identified by ongoing focus groups.

Data analysis

Both sets of data were separately entered into the software package NVIVO (NVivo qualitative data analysis software; QSR International, V.10, 2012). Data were coded by thematic analysis and an iterative method, so as to allow the emergence of themes and not constrain them with predetermined categories. This coding process was informed by Reason's (2000) Swiss cheese model and error theory. Emerging subdomains were grouped into overarching themes. To ensure objectivity and confer greater reliability to the data, 10 per cent of both case record reviews and focus group transcripts were reviewed by a second researcher and any disagreements were resolved by discussion and amendment of the coding tree. Magnitude coding was carried out on the insurance claim records in order to assess the emergence of the most prominent categories. The two sets of thematic coding were then combined to produce the final typology of the causes of veterinary error.

Types of error

Numerical data was obtained from the UKs largest veterinary professional indemnity insurer relating to claims recorded between January 2009 and December 2013. It was therefore appropriate to analyse this data using a quantitative approach in order to investigate the types of error in veterinary practice.

Data analysis

The data were ordered by frequency of the type of adverse event, using categories predetermined by the insurance company, namely: Advice, Diagnosis, Parturition; non-surgical, Parturition; surgical, Anaesthetics, Treatment; medical, Treament; surgical.

Ethical approval for the study was granted by the University of Nottingham, School of Veterinary Medicine and Science ethics committee, approval number 582 120420.

Results

Causes of error

Five hundred and two insurance cases were extracted from the available data. One hundred and fifty-six (31 per cent) did not

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TABLE 1: The causes of error coded from 225 insurance claims

Coded cause of error	Number of claims
Cognitive limitation	115 (51%)
Owner contribution to error	33 (15%)
Lack of technical knowledge or skill	31 (14%)
Productivity	16 (7%)
Failure of communication	12 (5%)
Failure of leadership	8 (4%)
Veterinary specific	8 (4%)
Inadequate care/negligence	2 (<1%)

contain an error and were reported for financial gain or other dispute. One hundred and twenty-one (24 per cent) did not contain enough information to allow a cause of error to be identified with confidence. These descriptions were excluded from further coding, resulting in 225 claims coded for the cause of error (Table 1).

A total of nine focus groups were explored over the period of three months during the spring of 2014. Eight were a mix of vets, nurses and support staff, one comprised nurses only. Seven of the groups were made up of practice teams who worked together on a regular basis, two of personnel who did not work together. The sample included small animal and mixed practices from the South-West and midlands areas of the UK.

The subdomains of error causation from both data sets were organised into two separate frameworks of their major domains. There was considerable overlap between the two sets of coding and the two coding trees were merged to form the final typology, in which the major domains are divided into two theoretical branches: active failures and system failures (Fig 2). These stem from Reason's (2000) Swiss cheese model where active failures represent errors of the individual and system failures are defined by organisational influences (see online supplementary Appendix 1 for the complete coding tree).

Active failures

Cognitive limitations were an important source of error in individual clinicians, with slip and lapse type errors identified from both the record review and focus groups. These 'absent-minded' errors or oversights included examples such as omitting to turn on the oxygen before a procedure, or leaving a swab in an abdomen after an otherwise routine surgical procedure and were often associated with a sense of distraction.

> Nurse: I think it's when people get interrupted doing a task. You're busy doing it. Somebody says, 'Can you just do this?', and you can so you stop what you're doing and you go there and then you forget that actually-
>
> CO: You were at that stage in your task?
>
> Nurse: Yeah. Even if it's just holding the back of the cat for a second because it's wriggling and then you just forget that you're half-way through it.
>
> (Focus group 7)

Other types of cognitive limitations included failures in both long-term and short-term memory and the effects of conformational bias in the form of diagnostic tunnel vision. Mistakes presented as a limited means of self-checking in younger vets, or an overreliance on mental models in older clinicians.

> Vet: Because I think you would be inclined to be more cautious I think if you were a, if you were a newer graduate, so if you'd been given that as a newer graduate and you don't know how often these things happen and you know it does happen you might be more inclined to check and see.
>
> (Focus group 2)

A *lack of technical knowledge or practical ability* was also identified as a causal factor, as were *issues concerning individuals* such as self reported fatigue or illness and the effects of stress.

> CO: But what do you think made you delay?
>
> Vet: Because I was knackered, I mean I was knackered and it was busy, and I was kind of … you know you are trying to do lots of other things…
>
> (Focus Group 4)

Reassuringly, *inadequate care* in the form of deliberate and intentional negligent behaviour was an uncommon finding, even among insurance record reviews (2/225).

System failures

Deficiencies in the non-technical skills of leadership and communication were identified as causes of error from both sets of data.

Lack of leadership in the form of failure to take charge of situations, understand and allow for other member's strengths and weaknesses and clearly allocate roles within a team were commonly discussed.

> Vet: We had a horse up at [place anonymised] and it was a thing where there were three people and each one thought the other person was monitoring the anaesthetic …that horse didn't get up off the table
>
> Nurse: I mean you still have days like that, don't you, where I'm like, right then, are you in charge are you?
>
> Vet: yes
>
> (Focus group 6)

Insufficient supervision of younger vets and nurses, and a perception of being 'thrown in the deep end' were common, with the resulting stress identified as contributing to mistakes.

> Vet: …. I think she [the nurse] was just thrown in at the deep end and on a night duty and me being a newish graduate was too busy doing my own thing and expecting her to have done that side of things there goes the catastrophe really
>
> (Focus group 1)

Failures in leadership from the profession's governing body in the form of weak industry regulation was also identified by the focus groups with a sense of resignation that often vets who were perceived to practice on the edges of professionalism appeared to 'get away with it'.

> Vet: My boss swept things like that under the carpet …… and yet he to my knowledge is still practising…. And I know that a lot of things had been brought forward against him which makes me wonder about the legislation of the whole profession sometimes
>
> (Focus group 8)

Lack of communication included poor transfer of information at clinical handovers, a failure speak up to senior members of staff or ask for help from colleagues.

> Vet 1: I've said to the nurses if I've gone in the room and said, 'Is everything okay? Have they done their swab count?', "No. I asked them to do the swab count and they said no they're not doing it".'
>
> CO: Okay. Right.
>
> Vet 1: I think there are some nurses not even asking them to do the swab count
>
> (Focus group 5)

Chaotically informal methods of communication between members of the clinical team were identified, with overreliance on assumption and lack of formal protocols.

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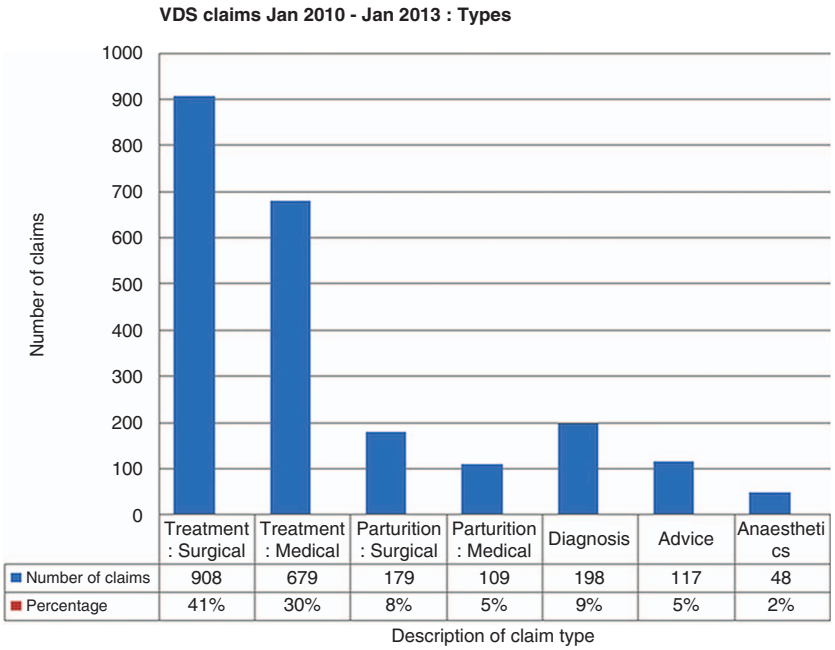

	Treatment : Surgical	Treatment : Medical	Parturition : Surgical	Parturition : Medical	Diagnosis	Advice	Anaesthetics
Number of claims	908	679	179	109	198	117	48
Percentage	41%	30%	8%	5%	9%	5%	2%

FIG 3: Types of insurance claims

CO: so do you have quite a strict handover procedure from your night nurse to your day nurse is there a strict handover procedure?

Nurse 1: there isn't

Vet: outpatients are a free for all aren't they. There's no strict …

Nurse 1: It's whoever's available

(Focus group 2)

Design of products or equipment issues included similar looking bottles of drugs and names of products, often in close proximity on dispensary shelves or in prep room drawers. Unfamiliar computer systems and confusion over choices on drop-down menus as well as poor design and layout of equipment were highlighted.

Vet: I got it anaesthetised and I was using a machine that had the American configuration of gas flow meters rather than the European. So oxygen was on the right instead of the left. There was no difference in the profile of the knobs nor was there a difference in the colour of the knobs.

(Focus group 5)

Productivity and its inherent influence on time pressure and resultant stress was a consistent factor, as were levels of staffing, especially relating to night shifts and the provision of 24 hours care.

Vet: And out of hours, that definitely comes into play with sort of mistakes in our areas, that whole out-of-hours situation when it is just the two of you, and it is just ridiculous sometimes.

CO: What, just understaffed?

Vet: Oh massively, yes.

(Focus Group4)

The financial pressures inherent in running a viable business and their implications on safety were also identified as a causal factor, while *organisational failures* included a lack of management-directed safety systems or team protocols.

The *effects of the owner* included loss to follow-up investigations and the refusal of recommended treatment options for either financial or emotional reasons.

Veterinary specific causes of error included animal factors such as aggression or the ability to run faster than the attending veterinarian and unique environmental conditions affecting outcomes such as operating in the non-sterile environment of a cow shed.

Types of error

Two thousand two hundred and thirty-eight insurance claim figures were ordered, showing trends in types of reported error (Fig 3). Surgery was a consistently high-risk factor for litigious complaints, accounting for 63 per cent of parturition claims and 57 per cent of treatment claims. The most common types of surgical claims include complications related to bitch spay operations (n=128), retained surgical items (n=76) and haemorrhage (n=67).

Of medical treatment claims, errors involving drugs were common (n=152) of which incorrect choice of drug and overdose were the most common types of error.

Anaesthesia claims made up only 2 per cent (n=48) of the total records.

Discussion

This study is the first attempt to explore the causes and types of error across veterinary practice and concludes that there are many similarities between the veterinary profession and other safety critical industries. Cognitive limitations accounted for a large proportion of errors. These mistakes, which on first impression appear sheer carelessness, are explained by the effects of distraction on fallible mental processes. As an often repeated automatic task, setting up an anaesthetic machine or remembering to count the swabs out of an abdomen represent 'steps' in a mental schema. As such they are vulnerable to being performed out of sequence or omitted altogether. Recognition of this in medicine has resulted in interventions such as the Safe Surgery Checklist, the use of which has the potential to reduce mortality and morbidity rates by over 50 per cent (Treadwell and others 2013). Similar methods have the potential to improve outcomes in veterinary work, as demonstrated by the application of a simple anaesthesia checklist in veterinary anaesthesia (Hofmeister and others 2014).

Empirical evidence is presented regarding the importance of team training and the development of non-technical skills (Fletcher and others 2003). Many improvements have been made in recent years with the recognition that optimising communication between clients and vets is essential for a working

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relationship (Latham and Morris 2007). Much less effort has been directed to the development of communication within the clinical team and the essential role of leadership. This study has shown that deficiencies in these non-technical skills contribute to errors and poor outcomes. Poor teamwork has been shown to contribute to 43 per cent of adverse events in emergency departments and this has fuelled the development of team training programmes such as MedTeams (Morey and others 2002). These interventions aim to improve observable teamwork behaviours amongst staff and reduce the incidence of adverse events. The development of similar training programmes for the veterinary profession would be a valuable area of further research.

The types of errors identified draw interesting parallels with the patterns of medical error types and litigation claims. Errors relating to surgery are consistently high across both the professions, and their indemnifiers. Conversely, anaesthesia seems to account for a small proportion of both medical and veterinary insurance claims. This was not reflected in the focus group discussions where errors linked to anaesthesia were one of the most commonly discussed, nor by the self-report of recent graduates who identified errors linked to anaesthesia in 10 per cent of failings (Mellanby and Herrtage 2004). This highlights the importance of clinical audit, and honest, open, incident reporting, facilitated in organisations such as the National Health Service by the National Reporting and Learning System. However, fear of personal retribution and practical constraints such as lack of time and facility are identified as influential factors in doctors' reporting behaviour (Brubacher and others 2011, Hartnell and others 2012). Closely associated is the fear of legal repercussion, which provokes the practice of defensive medicine, defined as 'medical care that is primarily or solely motivated by fear of malpractice claims and not by the patient's medical condition alone' (Floyd 2008). Anaesthesia is a procedure which is inherently risky, is often carried out by junior or trainee clinicians, on an animal which is unable to report any slip-ups which may occur. It may be that veterinary anaesthetics are at a higher risk of operator error than is currently perceived but the profession at present has no way of investigating this, due to a lack of incidence reporting data, and very possibly, fear of the consequences of such reports. This has been addressed in both aviation and medicine in the form of team training and culture change (Helmreich and Merritt 2001).

These results must be interpreted in context. Retrospective claims records are reported for the purpose of malpractice litigation. They do not represent a random sample of the population, and case record review is a method known to underestimate the level of system factors (Sari and others 2010). Quantifying qualitative codes as a form of magnitude coding can be helpful to assess the size of the code or category, and these results show interesting parallels with the literature, but such figures cannot be extrapolated to the greater population and are only descriptive of this sample (Saldaña 2012). The focus groups were selected by convenience sampling and although they were performed until saturation was achieved, they too are not a truly random sample. Any study including interview data is vulnerable to the effects of social desirability, hindsight and recall biases which may affect the results. The inclusion of a human factors expert could be considered at the coding stage in future studies. Further research using observational techniques and statistically significant sample sizes would further validate these results. However, the findings are reflected in the medical and safety literature, conferring some degree of validity.

Conclusion

There is little surprise in the fact that the causes of error are to a large extent universal, rather than specific to a profession as they are based on the same cognitive processes that underlie human decision making. However, there are causes of mistakes that are unique to the veterinary context, involve the 'owner effect', the nature of animal patients and the pressures produced by the fact that clients often pay directly for the service they receive in a competitive marketplace. Thus the medical typology cannot be directly applied to the veterinary context. The apparent lack of awareness and subsequent failure to prioritise patient safety at an organisational level was also apparent, which reflects the paucity of research and emergent nature of this subject. This study presents empirical evidence of the effect that poor leadership, communication and teamwork can have on patient outcomes and quality of care. It identifies the importance of non-technical skills within the veterinary profession, and a systems perspective in the aftermath of mistakes. Although the importance of good communication skills, especially between the clinician and the client are now being addressed at the undergraduate level, there is very little continuing professional development targeting the non-technical skill set, interprofessional communications and the importance of clinical leadership and teamwork is underresourced and researched, especially in comparison to the field of human medicine. The authors hope that the typology may be used to inform the discussion of critical incidents during mortality and morbidity meetings, and to direct the resources of a practice in an effort to prevent mistakes, rather than simply reacting to the actions of the clinician after the event. The challenge will be to widen the focus of the profession's efforts to improve, and accept that an understanding of human factors and mastery of non-technical skills fundamentally underpins veterinarian's ability to deliver gold standard care.

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C. Oxtoby, E. Ferguson, K. White and L. Mossop

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