Abstract

In human and veterinary medicine, reducing the risk of occupationally-acquired infections relies on effective infection prevention and control practices (IPCs). In veterinary medicine, zoonoses present a risk to practitioners, yet little is known about how these risks are understood and how this translates into health protective behaviour. This study aimed to explore risk perceptions within the British veterinary profession and identify motivators and barriers to compliance with IPCs. A cross-sectional study was conducted using veterinary practices registered with the Royal College of Veterinary Surgeons. Here we demonstrate that compliance with IPCs is influenced by more than just knowledge and experience, and understanding of risk is complex and multifactorial. Out of 252 respondents, the majority were not concerned about the risk of zoonoses (57.5%); however, a considerable proportion (34.9%) was. Overall, 44.0% of respondents reported contracting a confirmed or suspected zoonoses, most frequently dermatophytosis (58.6%). In veterinary professionals who had previous experience of managing zoonotic cases, time or financial constraints and a concern for adverse animal reactions were not perceived as barriers to use of personal protective equipment (PPE). For those working in large animal practice, the most significant motivator for using PPE was concerns over liability. When assessing responses to a range of different "infection control attitudes", veterinary nurses tended to have a more positive perspective, compared with veterinary surgeons. Our results demonstrate that IPCs are not always adhered to, and factors influencing motivators and barriers to compliance are not simply based on knowledge and experience. Educating veterinary professionals may help improve compliance to a certain extent, however increased knowledge does not necessarily equate to an increase in risk-mitigating behaviour. This highlights construction of risk is complex and circumstance-specific and to get a real grasp on compliance with IPCs, this construction needs to be explored in more depth.

Introduction

Veterinary professionals can encounter a variety of occupational health risks. A high prevalence of injury has been reported, predominantly in relation to large animal work (BEVA, 2014; Fritschi et al., 2006; Lucas et al., 2009), dog and cat bites and/or scratches and scalpel or needle stick injuries (Nienhaus et al., 2005; Phillips et al., 2000; Soest and Fritschi, 2004). In addition to the risk of injury, the profession is also at risk of other occupational hazards including exposure to chemicals, car accidents (Phillips et al., 2000) and infectious diseases from zoonotic pathogens (Constable and Harrington, 1982; Dowd et al., 2013; Epp and Waldner, 2012; Gummow, 2003; Jackson and Villarroel, 2012; Lipton et al., 2008; Weese et al., 2002). Work days lost because of zoonotic infections are less frequent than days lost to injury (Phillips et al., 2000); however, because of the potential seriousness of some zoonotic infections and increasing reports of occupationally-acquired antimicrobial resistant bacteria in veterinary professionals (Cuny and Witte, 2016; Groves et al., 2016; Hanselman et al., 2006; Jordan et al., 2011; Weese et al., 2006), zoonotic risk in the veterinary profession deserves attention.

There are no recent data on the risk of zoonotic infections in the British veterinary profession. One study published over 30 years ago estimated 64.1% of veterinary surgeons working for government agencies reported one or more zoonotic infections during their career (Constable and Harrington, 1982). Research from veterinary populations overseas indicates a substantial risk of infection within the profession, with incidence of reported infections during their career ranging from 28% in the United States (Lipton et al., 2008), 45% in Australia (Dowd et al., 2013), 47.2% in Canada (Jackson and Villarroel, 2012) to 64% in South Africa (Gummow, 2003).

In both medical and veterinary professions, infection prevention and control (IPC) practices are fundamental to reduce the risk of healthcare-associated infections in patients, as well as occupationally-acquired infections in practitioners. In the United Kingdom (UK), universal and standard precautions are recommended by the Department of Health. In human medicine, research has highlighted sub-optimal compliance with IPC practices. In one UK study, observed hand hygiene adherence in nurses was 20.4% and 60.1%, before and after contact with patients, respectively. In doctors in the same study, the compliance was much lower, at 8.1% and 51.4%, before and after patient contact (Jenner et al., 2006). Non-adherence to guidelines is a global issue, with reported hand hygiene compliance rates of 58% in hospitals in Finland (Laurikainen et al., 2015), 41.2% in an infectious diseases care unit in France (Boudjema et al., 2016) and 40% in paediatric hospitals in New York (Løyland et al., 2016).

In veterinary medicine in the UK, there are no enforceable national policies for IPC practices. For veterinary practices in the Royal College of Veterinary Surgeons (RCVS) accreditation scheme, guidelines are available and specific standards have to be met to retain accreditation status. Only 51% of practices are members of the accreditation scheme (RCVS, 2014) and although guidelines and recommendations are available for non-members, they tend to be practice-specific. Additionally, the emphasis is on patient, rather than practitioner health.

Other countries have developed national standards for IPC in veterinary medicine, specifically related to occupationally-acquired zoonotic infections. These include the Australian Veterinary Association Guidelines for Veterinary Personal Biosecurity and the Compendium of Veterinary Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel, developed by the National Association of State Public Health Veterinarians in the United States (NASPHV).

Even when national guidelines exist, not all practices have IPC programmes (Lipton et al., 2008; Murphy et al., 2010). Where effective procedures and resources are available, their effectiveness is dependent on uptake (Dowd et al., 2013). Decision-making surrounding IPC practices will depend on a number of different factors. There are few data available focussing on awareness and perceptions of zoonotic diseases within the veterinary profession in the UK, however from studies that have been conducted overseas it appears that awareness is poor and compliance with IPC guidelines is low (Dowd et al., 2013; Lipton et al., 2008; Nakamura et al., 2012; Wright et al., 2008).

In a survey of American Veterinary Medicine Association-registered veterinary surgeons, under half (48.4%) of small animal vets washed or sanitised their hands between patients and this proportion was even lower in large and equine vets (18.2% for both). In addition, only a small proportion of large and equine vets washed their hands before eating, drinking or smoking at work (31.1% and 28.1%, respectively), compared with 55.2% in small animal vets. Veterinary surgeons who worked in a practice that had no formal infection control policy had lower awareness, as did male veterinary surgeons (Wright et al., 2008). In a smaller survey of American veterinary professionals, although 77% of respondents agreed it was important for veterinary surgeons to inform clients about the risk of zoonotic disease transmission, only 43% reported they initiated these discussions with clients (Lipton et al., 2008). In a study of veterinary technicians and support staff, only 41.7% reported washing their hands regularly between patients (Nakamura et al., 2012). In a sample of Australian veterinary surgeons, 43.4% wore no PPE for handling clinically sick animals and the majority (67.4%) wore inadequate PPE for handling animal faeces and urine (Dowd et al., 2013).

In the veterinary profession, the dichotomy between a professional status and increased risk of infection has been viewed as counterintuitive (Baker and Gray, 2009), as it could be expected a comprehensive understanding of zoonotic disease risks would manifest in more risk-averse behaviour. In both medical and veterinary medicine, education has been identified as a key intervention to increase compliance (Dowd et al., 2013; Ward, 2011); however good knowledge does not necessarily lead to good practice (Jackson et al., 2014). Compliance is influenced by many factors, including motivation, intention, social pressure and how individuals understand or 'construct' risk (Jackson et al., 2014). Understanding of risk and why people engage in risk-mitigating behaviour (or not) is complex and perceived knowledge of the disease is only one factor that should be considered.

A better understanding of how veterinary professionals in Britain understand the risks surrounding zoonotic diseases will aid in the development of effective and sustainable IPC practices, reducing the risk of zoonotic infections within the profession. This paper examines how the veterinary profession in Britain understand zoonotic risk and motivators and barriers for using PPE.

Methods

Study design

A cross-sectional study was conducted October to December 2014; the sampling frame was all 3416 veterinary practices in Great Britain registered in the RCVS database. The RCVS database holds information on registered veterinary businesses, including private practice, referral hospitals, veterinary teaching hospitals and veterinary individuals. Sample size calculations indicated that information from 348 veterinary practices was required for an expected prevalence of 50%, with a precision of 5%. Assuming a 30% response rate, 1000 practices were selected from the RCVS database by systematically selecting every third practice.

The principle veterinary surgeon and head nurse were identified at each practice using the RCVS register and sent a postal questionnaire. A total of 2000 questionnaires were posted to 1000 veterinary practices.

For non-responders, reminder emails were sent out from four weeks after the initial posting and a second reminder, including an electronic copy of the questionnaire was sent out a further four weeks after the first reminder, to any remaining non-responders.

Questionnaire design

The questionnaire was developed based on a similar study in Australian veterinary professionals (Dowd et al., 2013) and a larger, multi-country risk perception study on severe acute respiratory syndrome (de Zwart et al., 2009). The questionnaire was an A4 8-page booklet (available in supplementary information), containing four sections including veterinary qualifications and experience, disease risk perceptions, infection control practices and management of zoonotic diseases. The questionnaire included both closed and open-ended questions and was piloted on a small convenience sample of veterinary surgeons, but not veterinary nurses, prior to being finalised. Questionnaires were designed in automatic data capture software (Cardiff Teleform v 9.0), which allowed completed questionnaires to be scanned and verified and the data imported directly into a custom-designed spreadsheet (Microsoft Excel, Redmond, WA, USA).

Statistical analysis

Descriptive statistics were performed using commercial software (IBM SPSS Version 22, Armonk, NY, USA). Proportions were calculated for categorical data; median and interquartile ranges (IQR) for continuous data.

Risk perception

A "risk perception score" was calculated as the mean value of the scores (high risk = 3; medium risk = 2; low risk = 1), based on the participant's opinion of the risk (high, medium or low) of contracting a zoonosis from eight different clinical scenarios detailed in Figure 2.

Reported use of PPE

Scores for PPE use in five clinical scenarios were calculated using Pearson's correlation coefficient to compare reported use of gloves, masks and gowns/overalls to the recommendations in the NASPHV guidelines. These guidelines were chosen because no UK equivalent that applies across all veterinary species could be found, but the NASPHV standards are likely to be considered as reasonable levels of protection in the UK situation. The clinical scenarios included handling healthy animals (no specific protection advised: possible scores 0 to 3); handling excreta and managing dermatology cases (gloves and protective outerwear advised: possible scores -2 to 1); performing post mortems and performing dental procedures (gloves, coveralls and masks advised: possible scores -3 to 0). A score of 0 indicated compliance, < 0 indicated less PPE than recommended was used and > 0 more PPE than recommended was used.

Redundancy analysis (RDA) was used to determine if demographic or other factors accounted for any observed clustering of the motivators or barriers to use of PPE, or for the reported PPE use in different scenarios.

Redundancy analysis is a form of multivariate analysis that combines principal component analysis with regression, to identify significant explanatory variables. This was performed using the R package "vegan" (Oksanen et al., 2016), based on the methods described by (Borcard et al., 2011). The adjusted R^2 value was used to test whether the inclusion of explanatory variables was a significantly better fit than the null model and a forward selection process was used to select the significant variables that explained the greatest proportion of the variance in the response data (Borcard et al., 2011). Permutation tests were used to test how many RDA axes explained a significant proportion of the variation.

Motivators and barriers to PPE use

Barriers and motivators to use of PPE were assessed by asking respondents to grade the influence of certain factors on their use of PPE (see Figure 4 for a full description of the barriers and motivators). The response options “Not at all”, “A little” and “Extremely” were ranked as 0, 1 and 2, respectively.

Redundancy analyses, as described above, were used to determine if demographic or other factors accounted for any observed clustering of a) barriers or b) motivators to use of PPE. Explanatory variables investigated were gender, age, length of time in practice, position (veterinary surgeon or nurse; owner or employee); type(s) of veterinary work undertaken (small, large/equine or exotics/wildlife); previous experience of treating a zoonotic case; level of concern over risk (for themselves or clients). Additional explanatory variables investigated in the redundancy analysis for reported PPE use were the barrier and motivator scores and the attitude and belief scores (described below).

Attitudes and beliefs

Participants were also asked about their level of agreement with certain statements describing their attitudes and beliefs around zoonotic disease risk and PPE use (see Figure 5 for a full description of the statements) ; the responses “Disagree”, “Agree” and “Strongly agree” were scored as -1, 1 and 2, respectively. Principal component analysis was used to investigate clustering of these “attitude” statements. As only two axes contributed variation of interest (according to the Kaiser-Guttman criterion, which compares each axis to the mean of all eigenvalues), the attitude statements were grouped into two subsets; those that contributed principally to PCA1 (seven statements) and those that contributed to PCA2 (three statements). Cronbach’s alpha was calculated on these subsets of the attitude statements, using the “psy” package in R (Falissard, 2011), to test whether any of these variables may indicate an underlying latent construct. Where correlation was judged to be acceptable or better (Cronbach's alpha coefficient > 0.7), the principal component scores were used as a proxy measure for this latent construct.

Potential explanatory variables, including the same demographic variables used for the redundancy analyses, and responses to motivators and barriers, were tested using linear regression modelling.

Multivariable regression models were fitted using the base and stats packages in R software (R core team, 2015). A manual stepwise selection of variables was performed based on knowledge of expected potential associations and confounders that made biological sense. Variables were added one by one to the null model. Two-way interactions were tested and variables or interactions were retained if likelihood ratio tests showed a significant improvement in model fit ($P < 0.05$). Non-significant variables were removed, including variables that later became non-significant when additional variables were added.

Ethical approval

Approval for this study was agreed by Anglia Ruskin University Faculty of Health, Social Care and Education Research Ethics' Panel.

Results

Demographic characteristics

Over the 12-week study period, a total of 252 useable questionnaires were returned from the invited individuals, giving an overall response rate of 12.6%. For a number of questions, there were some missing data; therefore the denominator for all results was 252 unless otherwise stated. A summary of demographic characteristics of the respondents is presented in Table 1.

Previous experience of zoonoses

The majority of respondents had managed a zoonotic case within the 12 months prior to completing the questionnaire (93.1%; n=230/247). The most commonly reported infections treated were *Campylobacter* (n=111), dermatophytosis (n=99) and *Sarcoptes scabeii* (n=86).

Overall, 24.6% (n=62/248) of respondents reported they had previously contracted at least one confirmed occupationally-acquired episode of zoonotic disease. When including suspected zoonotic diseases, this increased to 44.7% (n=111/248). The most common zoonotic disease experienced by respondents who reported confirmed or suspected zoonotic infection was dermatophytosis (58.6%; n=65/111). The relative frequency of reported zoonotic infections (confirmed and suspected) is reported in Figure 1, showing the reported frequency in respondents who had qualified or practised outside of Britain, compared with veterinary professionals with exclusively British experience.

Risk perception and awareness of zoonoses

Overall, the majority (57.5%; n=145/251) of respondents were not concerned that they or their colleagues would contract an occupationally-acquired zoonotic disease, however a considerable proportion were (34.9%; n=88/251). Only a small proportion (7.1%; n=18/251; 4.0–10.4) stated they had not thought about the risk of infection. In total, 84.6% (n=209/247) of respondents agreed or strongly agreed they had a high level of knowledge regarding zoonotic diseases.

Based on the eight different clinical scenarios respondents were asked to assess, the highest risk situation for zoonotic disease transmission was considered to be accidental injury, such as a needle stick injury, bite or scratch. Coming into contact with animal faeces/urine was also considered high risk for zoonotic disease transmission. These scenarios were classified as high risk by 18.3% (n=46/245) and 17.1% (n=43/246) of respondents, respectively. The aspect of the job considered to represent the lowest risk of exposure to zoonoses was contact with healthy animals, with 83.3% (n=210/250) of respondents considering this to involve low risk of exposure to disease (Figure 2). The amalgamated risk perception scores ranged from 1 (all scenarios considered low risk) to 3 (all scenarios considered high risk), with a median of 1.5 (IQR 1.25–1.75).

Infection control practices

The majority of respondents reported they were aware of their practice having standard operating procedures (SOPs) related to infection control practices (75.0%; n=189/236). All workplaces provided PPE for members of staff, although 12.3% did not provide training on how to use it. The majority provided separate eating areas (92.9%; n=234/247) and restricted access from staff and visitors to patients in isolation (92.5%; n=225/233).

Reported use of PPE

When asked about what level of PPE was used in five different clinical settings, 68.3% (n=168/246) reported they would not use any specific PPE for handling healthy animals, in line with the NASPHV guidelines. When handling dermatology cases, 23% (n=56/243) reported using no PPE. Only 2.4% (n=8/331) reported not using any PPE for handling urine or faeces; one respondent did not use any PPE for post mortem examination (n=230; 0.4%), and 2% (n=5/244) did not use any for performing dentistry work.

Correlation between the PPE scores for the different scenarios was low, the greatest correlation (r = 0.39) was between the scores for handling excreta and for handling dermatology cases. There was no evidence that respondents who wore more PPE than required in the guidelines (i.e. gloves and/or masks) for handling healthy animals would correctly select the appropriate level of PPE (i.e. gloves, masks and a protective coverall) for post mortem or dentistry. A redundancy analysis indicated that greater PPE use (a higher PPE score) was negatively correlated with a fatalistic attitude for the two higher risk scenarios. Belief that SOPs acted as a motivating factor to use PPE and agreement that “I consciously consider using PPE in every case I deal with” were positively correlated with greater PPE use in dermatological cases, handling healthy animals and excreta (Figure 3).

Motivators and barriers for use of PPE

All respondents indicated that perceived risk would have some effect on their motivation to use PPE, either a little (n=63/248; 25.4%) or extremely (n=186/248; 74.6%). Respondents were also strongly motivated by previous experience with similar cases (n=135/248; 54.5%) and a high profile or recent disease outbreak (n=132/245; 53.9%).

Few respondents indicated any of the suggested barriers to PPE would have a strong influence as a deterrent to using PPE; safety concerns was most frequently cited, with 7.1% (n=18) respondents stating this would be an extreme deterrent to using PPE. When combining both positive responses (extreme and a little influence), time constraints and safety concerns were the most frequently cited barriers, with 56.0% (n=139/248) and 56.9% (n=141/248) of respondents indicated these barriers would affect their decision not to use PPE, respectively. Potential barriers that most respondents considered had no influence on their decision to use PPE were negative client perceptions and PPE availability, with 78.2% (n=194/248) and 76.9% (n=190/247) of respondents stating this, respectively.

Demographic variables that had significant associations with responses regarding motivators and barriers towards the use of PPE are illustrated in Figure 4. The explanatory variables in the model were statistically significant, however they only explained a small amount of the variation in the respondents' perceptions of barriers (adjusted R-square 3.2%) and motivators (adjusted R-square 3.4%). Respondents with previous experience of treating a case of zoonotic disease were less likely to regard time or financial constraints, or concern for adverse animal reactions as a deterrent to using PPE (Figure 4a). Veterinary surgeons were more likely than nurses to be deterred from using PPE because of concerns about negative client perceptions (Figure 4a); although positive client perceptions were marginally more likely to act as encouragement in both vets and nurses who reported themselves concerned about zoonotic risk in relation to clients (Figure 4b). Those working in large animal practice were more likely to be motivated to use PPE by concerns over liability and nurses tended to be more motivated than veterinary surgeons by SOPs and concern over the perceived risk to themselves.

Attitudes and beliefs

Respondents were asked to state their level of agreement with 10 “attitude” statements (see Figure 5 for a description of the statements) reflecting different aspects of zoonotic disease risk control in the workplace. All respondents agreed that using PPE and practising good equipment hygiene was an effective way of reducing the risk of zoonotic disease transmission. The majority thought they had a high level of knowledge regarding zoonoses (n=209/247; 84.6%) and that they were expected to demonstrate rigorous infection control practices (n=229/247; 92.7%). However, 45 respondents (18.2%) stated they just hoped for the best when trying to avoid contracting a zoonotic disease and 37 (14.9%) were concerned their colleagues would think they were unnecessarily cautious if they used PPE in their workplace.

Responses to seven of these “attitude” statements tended to cluster together along the first PCA axis (Figure 5, statements A to G). Cronbach’s alpha coefficient for these statements was 0.76, suggesting an acceptable level of internal consistency and a potential underlying latent construct (interpreted here as a “positive attitude” towards IPCs) for these responses. Statements H to K, whilst all contributing greater weight to PCA axis 2, had an alpha coefficient of below 0.5 and were therefore evaluated individually.

Respondents’ scores from the first principal component axis (Figure 5) were used as a proxy to represent this potential underlying “positive attitude” towards zoonotic disease risk reduction and a multivariable linear regression model was used to investigate potential explanatory factors. The only demographic variable that significantly altered model fit was profession, with veterinary surgeons tending to score lower than nurses in this “positive attitude”. Some of the factors identified as motivators and barriers also had a statistically significant association with the outcome. Those who agreed that SOPs, positive client perceptions and risk to themselves motivated them to use PPE scored more highly; whereas those who regarded time constraints as a barrier to PPE use tended to have lower positive attitude scores (Table 2).

There were 18.2% (n=45/247) of respondents who agreed or strongly agreed with the statement, "I just hope for the best when it comes to trying to avoid contracting a zoonotic disease". A multivariable model suggested that respondents who had spent less time in practice tended to agree more with this "fatalistic" attitude, as did those who held the opinion that negative client perceptions deterred them from using PPE. Furthermore, individuals with higher risk perception scores (i.e. who believed they tended to have a medium to high risk of exposure to zoonoses from clinical work) were more likely to agree that they "just hope for the best" (Table 2).

A regression model was also constructed for the statement, "If I use PPE, others in my workplace think that I am being unnecessarily cautious". Explanatory variables included an interaction between gender and profession; nurses, particularly male nurses, were more likely to agree, whereas there was no significant gender difference in veterinary surgeons.

Discussion

The aim of this research was to explore zoonotic disease risk perceptions within a cross-section of the veterinary profession in Britain, and to identify barriers and motivators towards infection control practices and the use of PPE to minimise the risk of disease transmission. The large proportion of respondents (44.0%) who had contracted either a confirmed or suspected occupationally-acquired zoonotic infection highlights the level of occupational risk encountered by veterinary surgeons and veterinary nurses.

A substantial proportion of respondents stated they were concerned about the risk of zoonoses (35%), and the majority thought the highest risk of transmission was through accidental injury, despite few reported zoonoses in the study being transmitted this way. This dissonance may be reflecting other occupational risks encountered by veterinary professionals, of which zoonotic diseases only represent a small proportion. Data from studies conducted overseas suggests veterinary medicine is a high risk profession. In one survey of Australian veterinary professionals, 71% reported at least one physical injury over a 10 year period (Phillips et al., 2000). In addition to practice-acquired injuries, such as dog and cat bites, scalpel blade cuts and lifting of heavy dogs, the risk of car accidents was also noted (Phillips et al., 2000). Further research in the German veterinary profession highlighted workplace accidents as the most prevalent occupational hazard (87.7%), followed by commuting accidents (8.2%). Occupationally-acquired zoonoses only represented 4.1% of the total hazards in the study (Nienhaus et al., 2005). Practitioners are clearly working in a risky environment, particularly large animal vets, where farm environments are known to be inherently dangerous. A total of 7 fatal injuries and 292 major injuries were reported in British farmers or farmworkers in 2013–2014 (HSE, 2014), and a recent survey by the British Equine Veterinary Association revealed that on average, equine vets sustain seven to eight work-related injuries during a 30 year period (BEVA, 2014), highlighting just how hazardous these environments can be. Few data are available on occupational injuries in the British veterinary profession; however, when working in what could be interpreted as a high-risk environment, a constant exposure to risk for those living or working in these types of environment may lead to habituation to, or normalisation of risk (Clouser et al., 2015). Individuals in this study who tended to grade common clinical scenarios as posing a moderate to high risk of zoonosis exposure were also more likely to "just hope for the best", perhaps suggesting they have normalised these situations and do not perceive them as requiring additional precautions.

Within the veterinary environment, it is also possible that risks are rationalised; when faced with a very tangible risk of accident or injury, the more imperceptible risk of zoonotic infection becomes less important. This rationalisation of risk is also noted in the healthcare profession, where healthcare workers are more careful when handling sharps, compared with demonstrating compliance with IPC practices for infectious diseases (Nicol et al., 2009). The invisibility of the disease also plays a role here; the pathogens are not visible therefore the perception of the risk they pose is more abstract. In addition, there is often a time lapse between exposure to the pathogen and onset of clinical signs, making an association between suboptimal IPC behaviour and outcome difficult (Cioffi and Cioffi, 2015). In the UK, personal risk receives little attention in the veterinary profession's media, especially when compared with issues such as mental health, with reports of high levels of psychological distress and suicide in the profession (Bartram et al., 2010) and inclusion of issues around stress and mental wellbeing in surveys (Vet Futures, 2015) and veterinary curricula. This makes zoonotic disease risk less visible and may subject it to an availability heuristic, where the likelihood of an event is judged based on how easily an instance comes to mind (Tversky and Kahneman, 1974). The absence of diseases such as rabies from the UK may also mean that veterinary professionals underestimate the risk of zoonoses because they consider the impacts to be relatively minor, short-term and treatable. This affect heuristic may be especially pronounced when decisions are made under time pressure (Finucane et al., 2000), perhaps reflected in this study's finding that those who viewed time constraints as a barrier to their use of PPE had less positive attitudes towards it.

The disconnect between risk perception and health protective behaviour in the present study could be explained by perceived vulnerability. A risk might be acknowledged, yet if an individual does not feel vulnerable to this risk, there is no motivation or intention to change their behaviour. This perceived vulnerability is one of the factors considered in the protection motivation theory, where concern about a potential threat influences perception of the risk i.e. the more concerned an individual is about a disease, the higher risk they perceive it poses. If an individual feels vulnerable, this acts as a motivator for behaviour change (Schemann et al., 2013). This behavioural model has been applied to horse owners following the equine influenza outbreak in Australia where different levels of perceived vulnerability were identified in a cross section of the equine sector (Schemann et al., 2013, 2011).

Perceived vulnerability may be influencing health protective behaviour in the present study. It is possible that veterinary professionals, because they feel knowledgeable about zoonotic diseases, feel less vulnerable to the risks they pose. This lack of perceived vulnerability may account for the substantial proportion of respondents who stated they would not use PPE when handling clinically sick animals; perhaps because they are confident in their ability to identify those cases with potentially zoonotic or infectious aetiologies. Identification of risk to self as a motivating factor was associated with a more "positive attitude" towards PPE use, but being a nurse was independently correlated with both of these variables. Possibly because nurses often have less influence in decisions over diagnostics or handling of cases, they may feel more vulnerable.

The protection motivation theory is only one of numerous health behaviour models that have been applied to both medical and veterinary research. These models are useful for explaining behaviour change in relation to infection control or biosecurity however they have had limited success in practice (Pittet, 2004). The main criticism of these models is that they make an assumption that behaviour is rational, controllable and therefore modifiable (Cioffi and Cioffi, 2015). In reality, behaviour is affected by many external influences such as culture and society. Society and culture are fluid, constantly changing concepts and consequently it makes incorporating them into behavioural models problematic. So while these models of behaviour are useful in explaining behaviour change to a certain extent, to gain a full understanding of what drives or inhibits behaviour change, social psychology and qualitative research is essential for making real impacts on practice.

In the current study, individuals motivated by SOPs were found to have more positive attitudes towards PPE and also to report better compliance with PPE guidelines for medium-risk scenarios, such as dermatology cases and handling excreta. The “positive attitude” construct, related to self-efficacy, knowledge and confidence in equipment and practices, also clustered with a feeling that there is an expectation to demonstrate good practice. This could be a reflection of the influence of the practice culture on behaviour. In human healthcare, organisational factors, have been identified as one of the main drivers behind poor compliance with IPC practices (Cumbler et al., 2013; De Bono et al., 2014). As compliance with infection control intersects individual behaviour and the cultural norms of the practice, the culture of veterinary practice will also be influencing behaviour surrounding infection control. It appears from the present study that when veterinary practices promote a culture of positive health behaviour and have high expectations of employees, this acts as a motivator for compliance with IPC practices. This highlights that behaviour change should also be implemented at an organisational level, rather than just focussing on individual behaviour.

Veterinary surgeons were more concerned than nurses that using PPE would be perceived negatively by clients. This attitude could be reflecting the importance of the vet-client relationship in veterinary practice. This is particularly relevant in farm animal practice, where vet-farmer relationships are often cultivated over extended time periods and each individual agricultural client represents a significant proportion of practices' income. Respondents working in large animal practice were more likely to be motivated to use PPE by liability concerns, again potentially a reflection of the pressure felt by veterinary professionals from their clients. This is an interesting dichotomy, as the use of PPE not only protects the practitioner, but also the animal from zoonotic disease transmission. Educating farm clients as to what infection control practices they should expect during clinical work on the farm may help mitigate concerns about negative client perceptions.

Choices around PPE use appear to be specific both to individuals and contexts, demonstrated by the low correlation between PPE scores in different clinical scenarios. This finding that protocols are often adapted to a specific situation has been observed previously in veterinary professionals (Enticott, 2012). The models that people construct to inform their behavioural decision making are highly individual and influenced by their biology and environment, but also their past experiences (Kinderman, 2014). In the present study, previous experiences of treating zoonotic cases were correlated with lower concern about potential barriers to PPE use. This may suggest that practical experience of dealing with zoonoses is more influential than the theoretical knowledge in negating negative attitudes to PPE use.

Limitations

A limitation of this study, as with any questionnaire based study, is that self-reported behaviours may not necessarily reflect actual practice. This discrepancy between reporting behaviours and actually performing them has been observed previously, particularly in relation to infection control practices and hand hygiene. One UK-based study highlighted no association between self-reported and observed hand-hygiene practices in a sample of healthcare professionals (Jenner et al., 2006), reflecting how self-reported behaviour should be interpreted with caution in any context. Observation is considered the gold standard method of assessing behavioural practices, however is still subject to bias in the form of observer bias (Racicot et al., 2012) and video recording has been used recently to monitor hand hygiene practices (Boudjema et al., 2016). These methods could also be effectively applied in a veterinary context and qualitative research methods, such as ethnography, would also provide valuable insights into the culture and practices of infection control and health protective behaviours in veterinary practice.

The veterinary practices invited to take part in this study were randomly selected, using systematic random sampling, from the RCVS database. This system of using the RCVS database to sample the veterinary profession has been used previously for other research studies and is an established method of sampling this target population (Nielsen et al., 2014). The selection of practices was random, however the selection of participants at each practice may have been subject to selection bias. To facilitate a greater response rate, where data were available, individual respondents at each practice were selected from the RCVS register. To ensure this was consistent, the principal veterinary surgeon and head nurse were selected for each practice. Using individual names may have increased the likelihood of the participant responding, however this may have introduced some selection bias as the selected participants are likely to be a more experienced professional.

Our results suggested that some workplace factors, such as SOPs and expectations of colleagues, influenced respondents' perceptions and attitudes to PPE use. These might be expected to cluster within practice; the response from a veterinary surgeon and nurse from the same practice might not be completely independent. However, it was not feasible to introduce practice as a random effect, as not enough practices returned two responses (22.2% returned responses from a veterinary nurse and veterinary surgeon from the same practice). As with any questionnaire-based research, this study will be subject to an element of responder bias, and the relatively low response rate of this study may accentuate this bias. This is particularly evident with male nurses, who are few in number, making them difficult to target using random selection methods. According to the latest RCVS annual report, male nurses represented just 2.1% of the total veterinary nurse population in the UK (RCVS, 2014), in the present study, 6% (95% CI 1.7–10.4) of respondents were male nurses. The RCVS database used to sample the veterinary population for this study does not contain information on specialism or type of practice, therefore it is not possible to assess whether this sample is representative of the wider veterinary profession. However, the demographic data on respondents are similar to data from the RCVS annual report; the mean age in our study was 42 years, compared with 41 years in the annual report. In addition, the gender split was similar; in our study, 61.1% (95% CI 55.1–67.1) of respondents were female and the RCVS reported 57.1% were female (RCVS, 2014). Despite similarities between the respondents and the veterinary population in the UK, the low response rate means the results from this sample may not necessarily be generalisable to the wider veterinary population, however this study is the first to provide these baseline data on attitudes and beliefs regarding zoonoses in the British veterinary population, which can be built on with future studies.

The majority of respondents worked in small animal practice, which partly reflects the distribution of British practice types, but as the questionnaire was posted to the practice, this may have made it easier for small animal practitioners to respond as the majority of their time is spent within the practice premises. This means the study may be more representative of small animal veterinary professionals, rather than large and equine practice. To negate this in future studies, the use of stratified sampling would be a useful sampling method to ensure representative samples from each sector of the veterinary profession.

Conclusion

This study aimed to investigate risk perceptions of zoonotic disease transmission in the veterinary profession in Britain. The high infection rate within the profession suggests transmission of zoonotic infections from patient to clinician should be of concern. This study identified a few concepts that were reported to influence the use of PPE including a fatalistic attitude, the social environment and an individual's position within the practice. Improving education provided to veterinary professionals may help improve compliance with SOPs and infection control practices to a certain extent, however this study has highlighted that increased knowledge does not necessarily equate to exhibiting risk-mitigating behaviour. This suggests construction of risk is complex, circumstance-specific and can be influenced by a number of different internal and external factors. A qualitative study, using mixed qualitative methods including in-depth interviews and focus group discussions, to explore the construction of risk in the veterinary profession, is currently being developed to understand these concepts in more depth.

Conflict of interest statement

No competing interests were declared.

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Table 1: Summary of demographic characteristics for a sample of 252 British veterinary nurses and veterinary surgeons from a cross-sectional survey of the British veterinary profession conducted in 2014.

Demographic characteristic	Veterinary surgeon *n* = 136 (54.0%)	Veterinary nurse *n* = 116 (46.0%)
Gender		
Female	46 (33.8)	108 (93.1)
Male	89 (65.4)	7 (6.0)
Median age (years)	52 (IQ 39.5–57)	34 (IQ 30–40)
Median years in practice	26.5 (IQ 14–33)	14 (IQ 9–19)
Country of qualification		
UK	116 (91.3)	86 (100.0)
Australia/New Zealand	6 (4.7)	
South Africa	3 (2.4)	
Europe*	2 (1.6)	
Specialism		
Small animal	104 (76.5)	97 (83.6)
Mixed	19 (14.0)	17 (14.7)
Large/equine	8 (5.9)	2 (1.7)
Other[†]	5 (3.7)	0
Type of practice		
Private	129 (94.9)	110 (94.8)
Referral	5 (3.7)	3 (2.6)
Other[‡]	2 (1.5)	3 (2.6)
Experience of managing a zoonotic case in the previous 12 months		
Yes	94 (80.3)	50 (48.5)
No	23 (19.6)	53 (51.5)
Level of concern over risk to self/colleagues		
Not thought about it	10 (7.4)	8 (6.9)
Not concerned	64 (47.4)	81 (69.8)
Concerned	61 (45.2)	27 (23.3)
Level of concern over risk to clients		
Not thought about it	7 (5.2)	20 (17.2)
Not concerned	37 (27.4)	63 (54.3)
Concerned	91 (67.4)	33 (28.4)

*Serbia and Spain; [†]Includes poultry and game birds and aquatics and fishers; [‡]includes academic institutions, veterinary teaching hospitals and animal welfare charities;

Table 2: Multivariable regression model outputs for agreement with statements describing attitudes and beliefs on zoonotic disease risk and infection control practices* in a sample of 252 veterinary professionals from a cross-sectional survey of the British veterinary profession conducted in 2014.

	β	**S.E**	**P**
"Positive attitude" (PCA1 score)			
Intercept	-0.27	0.13	0.04
Time constraints	-0.14	0.04	<0.01
Perceived risk	0.14	0.06	0.03
Positive client perceptions	0.09	0.04	0.02
SOPs	0.09	0.04	0.04
Vet	-0.19	0.05	<0.01
"Fatalism" ("I just hope for the best…")			
Intercept	0.05	0.14	0.7
Years in practice	-0.06	0.02	<0.01
Negative client perceptions	0.13	0.05	0.01
Risk score	0.23	0.06	<0.01
Overcautious ("others ... think that I am being unnecessarily cautious")			
Intercept	0.16	0.04	<0.01
Negative client perceptions	0.17	0.05	<0.01
Male	0.13	0.08	0.09
Nurse	0.17	0.08	0.03
Male nurse	0.39	0.19	0.04

* Responses of "Disagree", "Agree" and "Strongly agree" were scored as -1, 1 and 2, respectively. A full description of the motivators, barriers and attitude statements are provided in Figures 4 and 5.

Figures

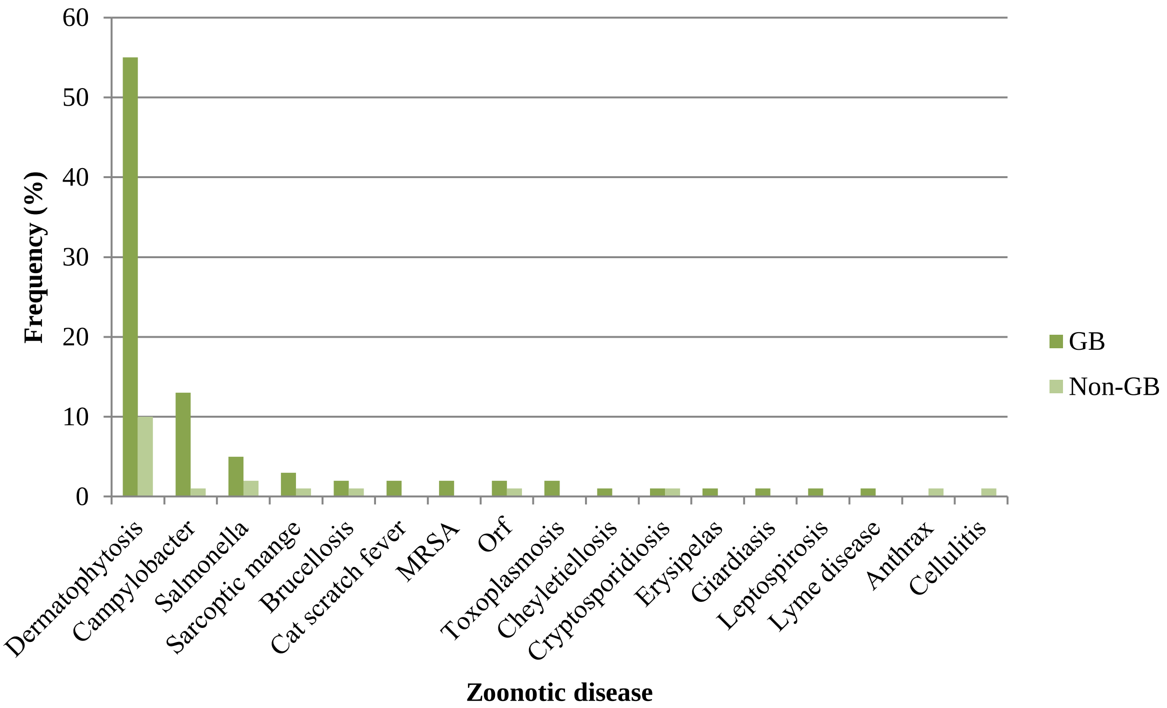


Figure 1: Relative frequency of reported zoonotic infections in a sample of 111 veterinary professionals from a cross-sectional survey of the British veterinary profession conducted in 2014, who reported a confirmed or suspected episode of occupationally-acquired zoonotic infection during their career, comparing those who had qualified or practiced outside GB (n=19) with those who had qualified or practiced exclusively within GB (n=92).

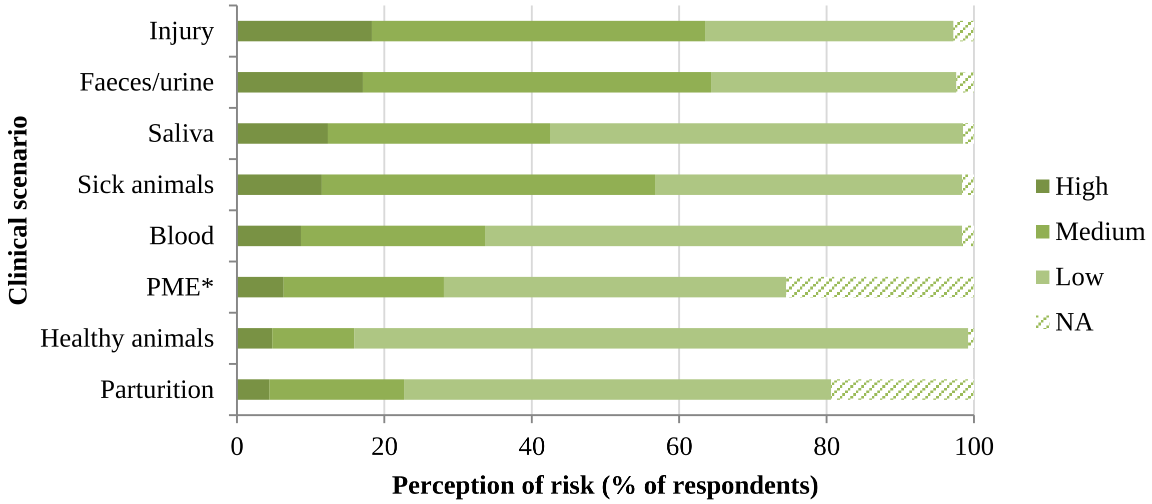


Figure 2: Perceptions of risk from eight different clinical scenarios in a sample of 252 veterinary professionals from a cross-sectional survey of the British veterinary profession conducted in 2014. The clinical scenarios respondents were asked to assess risk of included contact with animal faeces/urine; contact with animal blood; contact with animal saliva or other bodily fluid; performing *post mortem* examinations, assisting conception and parturition for animals, contact with healthy animals; contact with clinically sick animals and accidental injury.

* *Post mortem* examination.

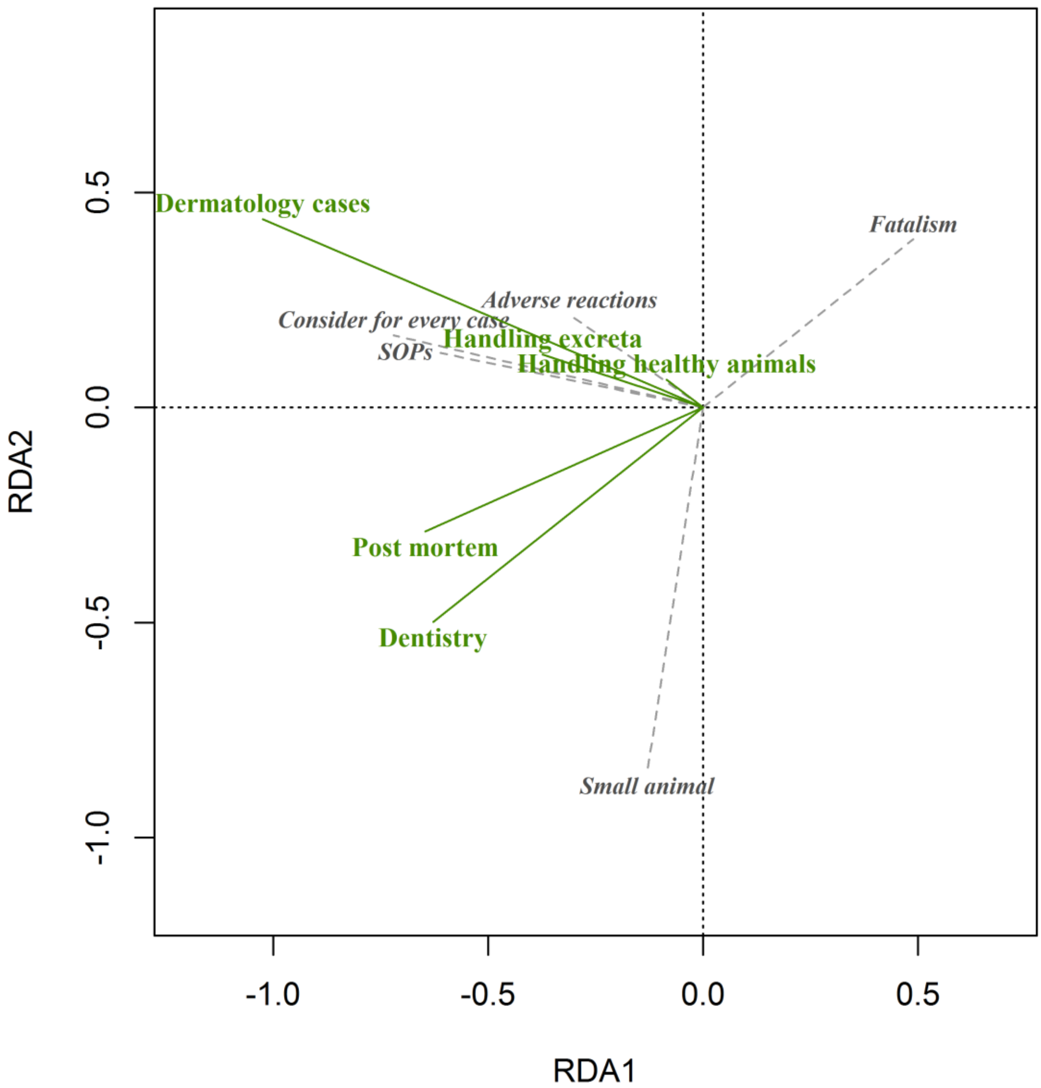


Figure 3: Triplots showing reported use of personal protective equipment (PPE) in five different clinical scenarios in a sample of 221 veterinary professionals from a cross-sectional survey of the British veterinary profession conducted in 2014. Angles between variables reflect their correlations. Solid green lines represent the normalised PPE scores; dashed lines represent the explanatory variables. PPE use was scored in comparison with the National Association of State Public Health Veterinarians in the United States (NASPHV) guidelines.

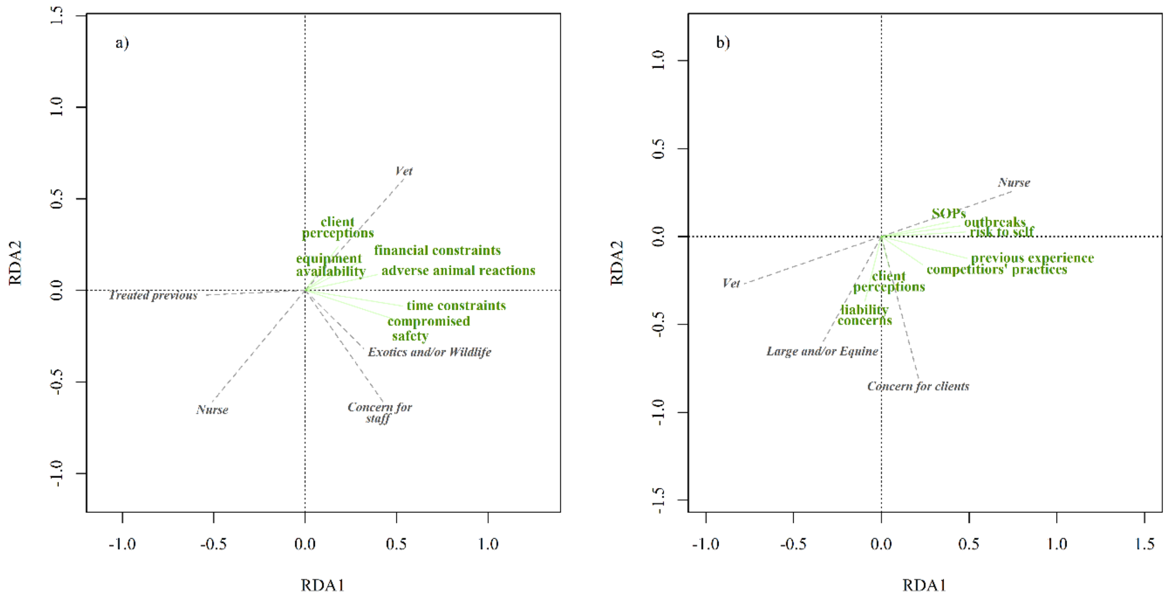
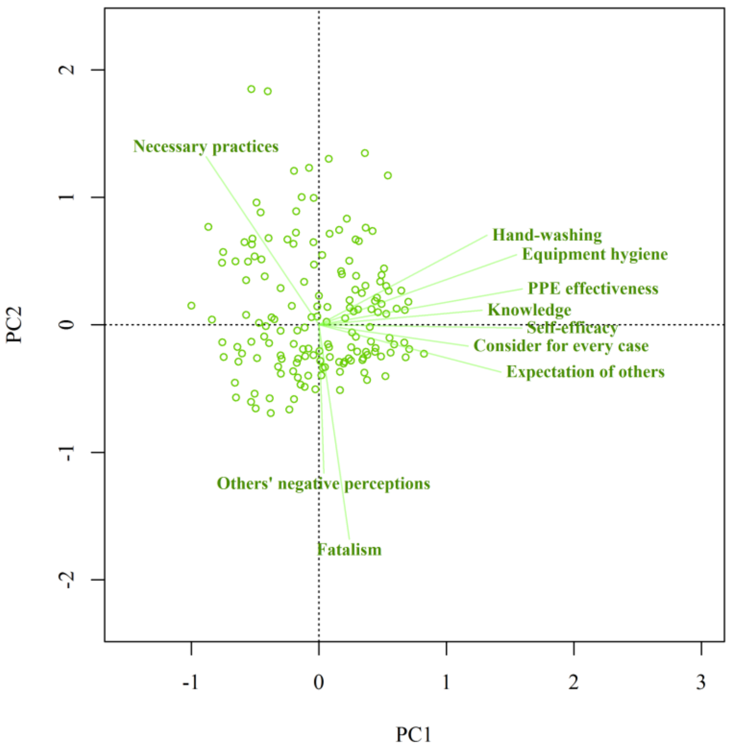


Figure 4: Triplots showing a) barriers and b) motivators to the use of personal protective equipment (PPE) in a sample of 240 veterinary professionals from a cross-sectional survey of the British veterinary profession conducted in 2014.. Angles between variables reflect their correlations. Solid green lines represent the barriers/motivators; dashed lines represent the explanatory variables. Options for barriers for PPE use included time constraints; financial constraints; safety concerns; negative client perceptions; adverse animal reactions to PPE; availability of equipment. Options for motivators for PPE use included perceived risk to self, previous experience, practice guidelines, practices of competing veterinary practices, liability concerns, positive client perceptions and a recent disease outbreak.



A. I feel I am able to take effective action to protect myself from risk of zoonotic disease **(self-efficacy)**

B. Using PPE is an effective way of reducing the risk of zoonotic disease **(PPE effectiveness)**

C. Regular hand washing is an effective way of reducing the risk of zoonotic disease **(hand washing)**

D. I have a high level of knowledge about zoonotic diseases **(knowledge)**

E. I consciously consider PPE to protect myself from zoonotic disease in every case I deal with **(consider for every case)**

F. Practising good equipment hygiene is effective **(equipment hygiene)**

G. I am expected to demonstrate stringent infection control practices at work **(expectation of others)**

H. I only practise stringent infection control practices when I think it's necessary **(necessary practices)**

J. If I use PPE, others think I am being unnecessarily cautious **(others' negative perceptions)**

K. I just hope for the best when it comes to trying to avoid contracting a zoonotic disease **(fatalism)**

Figure 5: Principal component analysis of attitudes and perceptions related to zoonotic disease risk, from a sample of 244 veterinary professionals from a cross-sectional survey of the British veterinary profession conducted in 2014, based on the responses to 10 statements about attitudes towards risk of zoonotic infection and infection control practices.