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Dairy cow health and management in the transition period: the need to understand the human dimension

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Abstract

During the transition from the dry period to lactation the dairy cow undergoes a period of physiological, metabolic and immunological change, and is at greater risk of developing disease, to the detriment of health, welfare and production. Many studies have been undertaken to determine appropriate management strategies to improve health and welfare during the transition period, however the incidence of disease, particularly metabolic disease, in this period remains high.

To date, a lack of research attention has been paid to the social factors which may affect the management of transition dairy cows. An understanding of farmer and advisor attitudes and behaviour, and the challenges they face in managing transition cows, may help

to direct farmers towards more effective disease prevention and control. It is also possible that transition cow morbidity may be due to complex interactions that are difficult to manage, despite efforts to implement best practice.

This review paper provides a brief overview of some of the management factors that may influence herd health during the transition period. It then investigates how social influences may relate to the uptake of transition management practices by exploring the use of qualitative interviews investigating farmer and stakeholder attitudes and behaviour in relation to cattle health and welfare, before focussing more specifically on farmer behaviour. Additionally, this paper explores farm advisor behaviour, and how that has been shown to influence farmer adherence to advice, which has particular relevance to transition cow management. It then suggests potential research strategies to investigate the human influences affecting the scale of the problem that may provide solutions to tackle the challenge of improving dairy cow health and welfare.

Introduction

The transition period for a dairy cow is described by Grummer (1995) as the period from 3 weeks pre-calving until 3 weeks post-calving, a definition that has been widely accepted by other authors in this field (Drackley, 1999; Aleri et al., 2016; Atkinson, 2016). During this period important physiological, metabolic and nutritional changes take place, and it is when most metabolic disorders occur (Mulligan and Doherty, 2008). These metabolic disorders include ketosis, fatty liver syndrome, milk fever, metritis, mastitis, retained foetal membranes (RFM) and displaced abomasum (LeBlanc, 2010). How these physiological, metabolic and nutritional changes are managed is of great importance and is strongly associated with the incidence of metabolic diseases, milk yield and fertility in early lactation (Roche et al., 2018).

During the last two decades extensive research has been conducted to attempt to better understand the biology of the transition cow in order to address nutrient requirements and ascertain management strategies to cope with the metabolic and physiological changes that occur during the transition period (Horst et al., 1997; Drackley, 1999; Huzzey et al., 2007; Van Saun and Sniffen, 2014; Zebeli et al., 2015). Despite this, dairy cows continue to experience high rates of metabolic diseases that are detrimental to animal welfare and productivity (and have significant financial impacts to the farmer) (Suthar et al., 2013; Macrae et al., 2019). A review by Mulligan and Doherty (2008) suggested that incidence rates of metabolic diseases were unacceptably high, with rates in well-managed herds remaining similar to those published decades ago.

No single approach, it appears, consistently results in cows successfully adapting to the metabolic changes of lactation with minimal disease events (O'Boyle, 2008). For example, a recent study by Macrae et al., (2019) involving 1748 dairy herds in the UK

confirmed the overall prevalence of subclinical ketosis in the first 20 days of lactation to be 28.5%, and the median herd prevalence of excessive negative energy balance (NEB) to be 59.8% (using a β-hydroxbutyrate threshold of 1.0 mmol/L). When addressing ketosis alone, Van Saun and Sniffen (2014) reported a mean incidence risk of subclinical ketosis at 43%, with Bobe et al. (2004) suggesting that approximately 50-60% of transition cows experience mild to severe fatty liver syndrome, a condition closely linked to the onset of ketosis (Herdt, 2000).

An understanding of the opinions and priorities of farmers implementing nutritional and management strategies is important, or scientific research findings may not be appropriately applied on farm (Lund and Algers, 2003). As Garforth et al. (2004) suggested, there is little value in scientific research if the mechanisms to link farmers with new knowledge are ineffective. Understanding farmer communication with their advisors, local conditions and attitudes, and restrictions on applying best practice may also be helpful. While this does not on its own solve the problem of transition diseases occurring at high levels, it may help to enhance understanding of barriers to certain behaviours and help tailor knowledge and advice so that it acknowledges farmer attitudes, motivations and goals. In their review of transition cow management, Mulligan and Doherty (2008) highlighted a need to engage qualitative research methodologies to develop and implement practical methods centred on the prevention of metabolic diseases during the transition period. A better understanding of farmer knowledge and motivations which impact the decisions and strategies implemented to manage transition cows on farm may therefore benefit cow health and performance.

Transition cow management strategies

Challenges for the periparturient cow are complex and interlinked (Mulligan and Doherty, 2008), and to fully review the aetiology of the metabolic diseases and all of the associated management practices to avoid such diseases is beyond the scope of this review. Interested readers are recommended to study the work of, for example, Grummer et al., (2004); McArt et al., (2013), Aleri et al., (2016), Atkinson (2016) and Lacasse et al., (2018).

Suggested management practices to reduce disease incidence include reducing movement to alternative cow groupings to minimise the influence of social stress, increasing cow comfort with adequately sized lying areas, having a minimum time in the close-to-calving pen, providing a spacious environment with adequate feed and water space and keeping the calving area as clean as possible (Cook et al., 2007). Nutrition is also vitally important, and transition diets should ensure optimal balance of mineral and micronutrients (Sinclair and Atkin, 2015; Weeratilake et al., 2019; Atkins et al., 2020), and energy and protein (Lean et al., 2013; Sinclair et al., 2014).

An overview of the nutritional and management factors which positively influence transition cow health and their potential solutions are illustrated in Figure 1 (based on literature from Cook et al., (2007), Mulligan and Doherty (2008), Lean et al., (2013) and Nordlund et al., (2014)). These various factors have been suggested as recommendations to help prevent transition cow diseases, but there appears to be conflicting findings between research studies. For example, Huzzey et al., (2006) found that decreasing stocking density increased time spent feeding, whereas Proudfoot et al., (2009) demonstrated that overstocking transition cows, so that cows had access to 0.3m/cow of feed space instead of 0.6m in the control group, did not adversely affect dry matter intake when using individual electronic feeders and fed twice daily.

[Insert figure 1 here]

The success of these management practices in improving transition cow health and performance relies heavily on farmers correctly and consistently implementing them, and advisors effectively communicating knowledge to farmers in a way that they can interpret and specifically apply to their farm business (Bard et al., 2019). If farmer perception of transition cow diseases and the associated management practices is considered of little importance or significance to subsequent health and production, it is unlikely that they will be implemented correctly (Roche et al., 2019). It can also be hypothesised that farmers may be unaware that they have a transition cow problem, leading to inaction, as found, for example, when investigating farmer perception of dairy cow lameness (Richert et al., 2013). Considering the nature of metabolic diseases, many of which are subclinical and result in 'hidden' losses such as reduced milk yield, a lack of awareness of the scope of the problem is likely. Transition-related problems may not be straightforward to tackle because often there are multiple causes, and there is likely to be no single or simple solution which uniformly fits every dairy herd. Furthermore, if farmer-advisor relationships were explored in relation to transition cow management, this may reveal potential barriers to communication and knowledge exchange between the parties, and farmer-specific reasons as to why some advisor recommendations may not implemented successfully, as demonstrated later in this review paper.

Qualitative interview research in animal health and welfare

There is an ongoing requirement for social science studies to evaluate farm animal health and welfare, and the use of qualitative interviews has become increasingly common as a way of determining whether the findings and recommendations are being applied on farm and to determine drivers for disease incidence at herd level (e.g. Shortall et al., 2018; Donadeu et al., 2020; Robinson, 2020). Qualitative interviews are often used to examine social processes, meanings or experience by capturing the depth and breadth of participants' experiences and perspectives (Mason, 2006). There are other research methodologies from the social sciences that have and can be used to investigate animal health issues (these will be briefly considered later in this paper); we focus here on interviewing.

Determining farmer attitudes can help to establish the barriers to best practice by uncovering the diversity of views that people hold (May, 2018). Understanding the attitudes underpinning farmers' actions are essential pre-requisites for improving outcomes in disease control and animal welfare, and this has proven a fruitful research area for bovine husbandry and health in recent years (Robinson, 2020) and is therefore highly likely to have merit when considering transition cow management. For example, Palczynski et al., (2020a) determined that farmers were receiving inadequate instructions on calf feeding and weaning, and recommended that more consistent recommendations were required from veterinary and nutritional advisors. In the light of this, it is possible that farmers may also be receiving inadequate instructions, or a lack of focussed advice, on transition management from their advisors. Additionally, Fischer et al., (2019) established that antibiotic use and misuse was mainly determined by the strength of the farmer-veterinarian relationship, and the effectiveness of the veterinarians' communication skills within that relationship. This suggests that the farmer-veterinarian relationship and veterinary communication skills may also influence the way farmers treat their transition cows.

By conducting interviews during a lameness intervention study, Atkinson (2020) established that farmer attitude influenced incidence, and farmers that had the lowest lameness incidence in their cows felt that it was within their control, had a better understanding that lameness affected their business, and could better estimate the extent of it in their herd. These findings agree with a study by Leach et al., (2010), who determined that farmers' perception and awareness of lameness influenced their success in reducing its incidence, and that farmers often underestimate the extent of the problem in their herds. This suggests that farmer perception and awareness of metabolic diseases may influence their transition management success, particularly given the unseen nature of subclinical metabolic diseases. Social science studies therefore demonstrate that by determining farmer and related stakeholder opinions, one can elucidate possible barriers to the implementation of optimal transition cow management strategies and uncover ways of facilitating positive behavioural change and improved cattle health and welfare outcomes.

Studying farmer behaviour

Many behavioural studies aim to identify farmer attitudes in order to create a persuasive message or stage an intervention resulting in an intended change of behaviour (Kristensen and Jakobsen, 2011). An attitude is produced by emotional and behavioural beliefs (ideas that a person holds as being true, deeply held and difficult to change), and is an intrinsic frame of mind affecting one's thoughts or behaviour (Ajzen, 1991). Only with a positive attitude towards a task will there be motivation, engagement and intention to complete it (Jain, 2014). This is not to be confused with an opinion, which is an external and explicit response to something, and that is changeable through experience, knowledge and persuasion (Tourangeau and Galešić, 2008).

Traditional methods of attempting to change farming practice and behaviour include the introduction of legislation to implement and enforce certain practices or standards (Barnes et al., 2013); financial penalties such as deductions in milk payments for high somatic cell counts (SCC) (or premiums for the reverse) (Vaarst et al., 2002; Valeeva et al. 2007); and advisor-based extension methods to educate farmers in new practices such as the BVD-Free England campaign (Armstrong et al., 2018). Although these traditional methods are effective at facilitating large scale changes quickly, they are not always popular or well implemented (Morgans et al., 2019). While penalties and premiums have been shown to be significant drivers for farmers to improve mastitis management, factors related to farm performance and the individual farmer were equally motivating, such as taking pleasure in having healthy animals (Valeeva et al., 2007) and being a 'good farmer' (Swinkels et al., 2015). This highlights the importance of understanding the intrinsic motivations of the farmer.

A systematic review investigating farmer behaviour by Rose (2018) emphasised the positive influence of trained facilitators on farmer decision-making and highlighted the importance of 'knowledge exchange' between advisors and their farm clients. This approach seeks to understand farmers' local environments and barriers to change and create farmer-centred solutions based on their individual intrinsic motivations (Bopp et al., 2019). According to Kristensen and Jakobsen (2011), knowledge should be tailored to context, and when practices are more in line with farmer goals and priorities, farmers are more likely to adopt them (Derks et al., (2013). Important behavioural constructs affecting farmer behaviour include self-efficacy, feeling in control of decision-making (Ellis-Iversen et al., 2010; O'Kane et al., 2017) and self-identity, which is the extent to which the behaviour is considered to be part of one's self (Terry et al., 1999). This is in line with recommendations from Bard et al., (2019) who outlined that influencing farmer behaviour involves understanding their rooted beliefs, and empowering them to make their own decisions,

because behaviours associated with social identity are more likely to persist (Charng et al., 1988).

Farmer attitude, however, does not always match behaviour, as reported by Thompson et al., (2020), who observed space provided for housed dairy cows. Approximately half of the farmers in their study provided their cows with less space than their cited minimum value (Thompson et al., 2020). This suggests that other factors may play a part in management decision making, such as habits and social norms (Shortall et al. 2018). Thompson et al., (2020) established that although farmers believed loafing space was important, barriers exist which prevent implementation, and while exploring these barriers would be beneficial, they are likely to be centred around context-bound factors such as cost, practicality and the individual farm layout. The evidence emerging from the qualitative social science literature on farmer behaviour shows that interviewing farmers can provide a different way of approaching problems and providing possible solutions, with the overall aim of improving the wellbeing of the animals they care for. This has relevance for the investigation of transition dairy cow management by farmers and their advisors.

Uptake of management practices related to the transition dairy cow

To the authors' knowledge there have been no social science studies conducted to understand the management of transition dairy cows in Europe. Recently, however, a qualitative North American study was published by Mills et al., (2020) where they used semi-structured interviews to identify barriers to optimal transition cow management in Canada. Mills et al. (2020) identified four main themes relating to barriers to improve transition management: farmer attitudes to the health and welfare of transition cows; farmer and stakeholder definitions of the transition period and information sources which could improve that; factors influencing transition cow management, with stocking density being a key

245 aspect; and finally, the involvement and influence of the farm veterinarian. Mills et al.
246 (2020), while not including non-veterinary advisors in their study, emphasised a need to
247 investigate the perspectives of nutritionists, feed representatives and business consultants.
248 This has yet to be undertaken for transition cow management, but it is likely that these non-
249 veterinary advisors exert a considerable influence over farmer decision-making in this area
250 (Lowe 2009) that is likely to develop as the veterinarian becomes more consultancy- based,
251 and farmers outsource farm services to other professionals (Woodward et al. 2019).

252 The animal feed industry promotes the use of different transition cow supplements
253 including drenches, calcium binders, boluses, protected amino acids, choline, 'fresh cow
254 drinks' for recently-calved cows, and a variety of methods for mineral supplementation
255 (Sinclair and Atkins 2015). This variety and choice of products could be confusing to
256 farmers. Ingram (2008) suggested that when farmers consider practices to be more
257 knowledge-intensive and demand more attention to detail and observation than conventional
258 practices, they can be off-putting to adopt. In addition to the variety of products being
259 marketed, some transition cow management strategies also demand considerable attention to
260 detail for implementation. For example, pre-calving cows on a dietary cation-anion balance
261 diet to prevent milk fever must be fed a diet strictly monitored in anionic salt concentrations,
262 which requires regular and time-consuming forage mineral analysis, and measurement of
263 urinary pH (DeGaris and Lean, 2008).

264 Diet formulation and methods of feeding and housing differ between farms, so
265 strategies may need to be adapted specifically to each farm based on its size, available labour,
266 housing type, forage and other resources, and the associated knowledge must therefore be
267 situated (Hassanein and Kloppenburg, 1995; Ingram, 2008). Knowledge has been shown to
268 be better when it is anchored in a local situation, as it encompasses barriers and constraints
269 that are specific to that area (Chenais and Fischer, 2018). Decontextualised knowledge is

difficult for farmers to understand and enact as behavioural change (Hamilton, 2018). It is likely that there is no "one size fits all" approach to transition management, because the best decision depends on the internal logic and context-bound reality on each dairy farm (Kristensen and Jakobsen, 2011).

As concluded by Bard et al., (2019), veterinary advice was more likely to enact change if it was delivered from a trusted advisor, encompassed a shared farmer-veterinarian understanding, and was interpreted in a way that was meaningful to that farmer and his/her unique circumstances on a local level. Scientific knowledge also plays a role, as outlined by Ritter et al., (2019), who recently concluded that farmers with post-secondary education were more satisfied with veterinary consultancy, perhaps because they had a deeper understanding and/or were more confident, and therefore more likely to adopt veterinary advice. The literature outlines that different forms of knowledge, both situated and scientific, combine with motivation, and when the factors interlink, they construct the necessary steps of utilising the available knowledge, adapting it to the individual's needs, and building farmer confidence to aid in the decision-making process. This has been illustrated in Figure 2 (adapted from Valeeva et al., 2007, Rose, 2018 and Thomas et al., 2020).

[Insert figure 2 here]

Farmers are also exposed to multiple sources of knowledge and advice to which they attribute varying levels of perceived influence and credibility. Veterinarians and non-veterinary advisors such as nutritionists, dairy business consultants and animal feed sales representatives with differing levels of scientific knowledge and practical experience will undoubtedly influence farmer decision-making (Ellingsen et al., 2012; Bruijnis et al., 2013). Although the veterinarian may be considered to be the farmer's most trusted advisor (Enticott

et al., 2012), there are many unregulated consultants who visit farms and offer similar advisor services (Atkinson 2010; Ruston et al., 2016). Farmers are likely to be influenced by non-veterinary advisors if their input is considered credible and the advisor has legitimacy (Sutherland, 2013; Eastwood et al., 2017). Conflicting knowledge and different advice from multiple advisors can place farmers in a state of cognitive dissonance (Kristensen and Jakobsen 2011). This is an under-researched area, and although there are notable examples of research papers considering the influence of veterinary advice (e.g. Kaler and Green, 2013; Bellet et al., 2015; Robinson, 2020), there is a dearth of qualitative research examining non-veterinary advisors and their role and influence on livestock health (Mills et al., 2020). Interestingly, Bruijnis et al. (2013) reported that feed advisors and foot trimmers appeared to have most influence on farmers' intentions to improve dairy cow foot health, rather than veterinarians. The range of advisor-influencers on dairy farmer behaviour are illustrated in Figure 3 (based on Garforth et al., 2013; Ruston et al., 2016; Mills et al., 2020; Palczynski et al., 2020b; Burton, 2004; Rose, 2018; Fischer et al., 2019). No research has yet been conducted that investigates the influence of non-veterinary advisors such as nutritionists and dairy farm consultants on farmer decision-making regarding transition cow management. Conducting research in this area may help advisors to tailor their knowledge transfer to farmers, allow for maximum uptake of knowledge, and increase the probability of adopting optimal management practices based on scientific evidence.

[Insert figure 3 here]

Studying advisor behaviour

Advisor communication has emerged to be a pertinent factor when addressing farmer adherence to advice and uptake of practices (Jansen et al., 2010). This was analysed by Ritter

et al. (2019) who determined that farmer preparedness to adopt veterinary advice was positively associated with their satisfaction, and negatively associated with the dominance of the veterinarian during the farm visit. Behavioural models such as the theory of planned behaviour suggest that intrinsic motivation is important in achieving compliance (Ajzen, 1991), and when advice addresses the goals of the farmer it builds on their intrinsic motivation to implement change (Jansen and Lam, 2012). Derks et al., (2013) established that veterinarians were, however, reluctant to ask their clients about their goals. It was unclear why, but it was suggested that some veterinarians are reluctant to set targets as they feel they could be judged unfavourably if these goals are not met.

Veterinarians are aware of their influence and the requirement to be proactive, but they often struggle to maintain this in daily practice (Mee, 2007). The extent of this was highlighted by Ruston et al. (2016), where veterinarians reported difficulties in influencing farmer behaviour change, and despite coming under pressure to shift their role of 'fire-fighter' to a more preventative herd-health advisor, veterinarians were not promoting disease prevention services effectively to farmers. Jansen et al. (2010) outlined that veterinarians are poor at active listening, however as Kristensen and Jakobsen (2011) explained, communication skills are not part of the traditional veterinary curriculum, and the purpose is not to transfer their own knowledge, but to empower the farmer to make their own decisions, as discussed earlier. The literature therefore demonstrates a requirement for veterinarians (and other non-veterinary advisors) to invest in improving their communication skills, and to understand the different farmer learning styles and psychology behind behavioural changes and motivation (Atkinson, 2010).

Prevention of disease requires the engagement of the farmer, the veterinarian, and non-veterinary advisors (Garforth et al., 2004; DEFRA, 2012) to be coupled with effective and targeted knowledge exchange, training, and change of attitudes towards transition disease

prevention (Mulligan and Doherty, 2008). This includes veterinary and non-veterinary advisors communicating with each other (Smith and Hollis, 2007). This is not always put into practice, as Ruston et al. (2016) found that veterinarians felt threatened by non-veterinary advisors that also offered preventative herd health measures. Although veterinarians perceived these non-veterinary advisors to be amateurish, little was done to ensure occupational dominance (Ruston et al., 2016). Challenges in collaboration of inter-professional practice can be seen in parallel in other areas of veterinary practice including small animal practice (Kinnison et al. 2014), working with farriers (Moyer et al., 2012) and with equine physiotherapists (Bergenstrahle and Nielsen, 2016). These difficulties centre on power, status, the appreciation of professional roles, and lack of (or poor) communication (Kinnison et al., (2014). To the authors' knowledge, no research has been conducted investigating communication between dairy veterinarians and livestock nutritionists. However, May et al., (2017) suggested that veterinarians and nutritionists can effectively work together in the American feed-lot when 'blame' is removed, and the focus is primarily on how advisors can collectively solve farm challenges. When farmers frequently had a "round table discussion" with their veterinarian, their preparedness to adopt veterinary advice increased (Ritter et al., 2019).

Investigating the human dimension to transition cow management

This review has demonstrated the breadth of work already taken across multiple themes in relation to farmer and advisor attitudes and behaviours, and this section considers avenues for research specifically to investigate the human dimension of transition cow management. Possible social science research methods to investigate how human influences may relate to the uptake and implementation of transition-related management practices

include conducting questionnaires, focus groups and semi-structured individual interviews with dairy farmers and their farm-advisors. Each of these methods have their undoubted merits but may also offer specific drawbacks. Questionnaires allow a wider reach to participants and provide opportunity for what may be considered more objective quantitative analysis, but they fail to provide in-depth insight into a participant's attitude, even when 'open' questions are asked (Beiske, 2007). Focus group interviews offer more discussion with other participants, allowing natural conversation to emerge between participants based on prompts from a group moderator, and provide multiple views in one interview. While this approach better reflects real world interaction, some participants may be discouraged from discussing their opinions and experiences in the company of others (Gibbs 1997). Semi-structured individual interviews are, in the opinion of the authors, a powerful tool to allow researchers to explore participants' responses further, whilst maintaining relevance to the topic guide and retaining an element of privacy and specificity at the level of the individual. Logistically, individual interviews are easier to conduct with farmers and other relevant stakeholders, avoiding the inherent challenges in gathering groups of people at mutually convenient times, and overcoming the potential reluctance of sharing commercially-sensitive information with others if assured of anonymity.

Following these considerations, a mixed methods approach could be employed whereby a farm audit could be conducted to include nutritional, cattle and housing measurements on participants' farms, to assess nutritional and management risk factors pertaining to metabolic diseases. This would allow comparisons to be made between farmer perceptions and understanding of their current transition cow health and management practices and what is actually happening on the farm, while also providing the opportunity to benchmark against current scientific recommendations. Such a study may aim to investigate whether farmers are aware of the scope of their metabolic problems, the related risk factors,

394 and how to solve them. Furthermore, if farmers are not aware, it may investigate what
395 contributes to this lack of awareness or inaction. On the contrary, if farmers are aware of
396 their risk factors, and are successfully acting to reduce metabolic diseases, such a study
397 would provide valuable direction on what can be learned from farmers. This will assist in
398 developing behavioural intervention strategies, and address some of the external people
399 factors that influence farmer behaviours (such as advisor relationships and behaviour).
400 Establishing advisor attitudes and opinions and understanding what influences them to
401 provide focussed transition advice may also help to uncover reasons for the ongoing high
402 incidence of metabolic diseases on dairy farms.

403

404 **Conclusions**

405 The overall aim of this review has been to hypothesise, based on previous research on
406 related cattle health and welfare themes and other aspects of farm business, that social
407 influences may relate to the uptake and implementation of transition management practices at
408 farm level. The review of the literature on the transition cow demonstrates the scale of the
409 problem which remains to be solved, and we have argued that social science research
410 methodologies, particularly individual interviewing, could usefully elucidate what motivates
411 farmers to adopt particular methods of management in relation to the transition dairy cow,
412 what prevents them from taking on improved practices and why transition cow management
413 approaches remain suboptimal on many dairy farms, despite farmer and advisor intervention.
414 Veterinarians and nutritionists are persuasive and powerful actors influencing farmer goals
415 and priorities, and subsequently farmer behaviour, attitudes and experiences in relation to
416 transition cow management also need to be investigated. As qualitative research has helped
417 to identify various social factors which influence management of several other areas of dairy
418 cow health and welfare, the reliability and depth of insight that interviewing provides makes

it repeatable and relevant for transition cow health. Additionally, how much farmer decision-making is influenced by non-veterinary advisors such as nutritionists is an important area for investigation using social science research methods, particularly as non-veterinary advisors continue to develop specialist roles alongside or in competition with veterinary practices. These 'people factors' in transition cow health remain an important and largely unexplored area of research which needs to be addressed if the conundrum of why the ever-increasing volumes of scientific research findings and knowledge are not improving transition cow health can be solved. Reducing metabolic disease prevalence is vitally important if dairy production is to be more efficient and sustainable in the future, and for cow welfare to be substantially improved.

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Conflict of interest statement

None of the authors have a financial or personal relationship with other people or organisations that could inappropriately influence or bias the paper.

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