EBVM Learning

This tutorial introduces the concepts of Evidence-based Veterinary Medicine (EBVM), and aims to give you a foundation from which you can start to apply EBVM to your own veterinary work.

Read a quick guide to **using this tutorial**, or:
Start the tutorial!

About the tutorial

After a general introduction to the principles of EBVM, each chapter explains one of the five main principles of the methodology. These chapters include detailed examples, opportunities for you to reflect on what you've learned, and quizzes for you to check your understanding. Each chapter will take approximately an hour to complete in full.

The development work on this tutorial was completed by the EBVM Learning project team on 30th October 2015. It was launched at the RCVS Skills Day 2015 and is now managed by RCVS Knowledge.

For the PDF version

Please note: The hyperlinks in this PDF may be out of date. The equivalent links on the website (http://www.ebvmlearning.org/) will be up to date.

About EBVM Learning

This tutorial was written by veterinary educators and practitioners from the EBVM Network, and is supported by RCVS Knowledge

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ABCs of EBVM

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ABCs of EBVM

A new way to think

By the end of this chapter you will be able to:

- Explain the concept of EBVM
- Describe the relevance and importance of EBVM to veterinary practice
- Construct a generalised example of the EBVM cycle

In the ABCs of EBVM section:

- What is EBVM?
- Is EBVM a new concept?
- Why is EBVM important?
  - Information overload
  - Clinical applications
- Does this apply to me?
- Where do I start?
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What is EBVM?

The practise of Evidence-Based Veterinary Medicine (EBVM) is the use of best available scientific evidence, in conjunction with clinical expertise and consideration of owner and patient factors, to make the best clinical decisions for patients.

The precise wording of definitions varies with author, but at its core, EBVM is a structured and explicit method that helps us make decisions, in clinical practice as well as the many other areas where veterinarians might work.

EBVM from EBM

Evidence-based veterinary medicine, like some other areas of veterinary medicine, has drawn upon expertise in the medical field, where applying the principles in practice has become more widely accepted. One commonly used definition of evidence-based medicine (EBM) is:

"… the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients. The practice of EBM means integrating individual clinical expertise with the best available external clinical evidence from systematic research." (Sackett et al., 2000)

There are important differences between the practice of EBVM and EBM, including the patient-(owner)-clinician relationship, as well as the availability and quality of scientific literature; these differences affect how we approach evidence-based practice in the veterinary context, and will be explored within this tutorial.

EBVM through the years

A tale of old – How Dr James Lind cured scurvy

In the 18th century, sailors died from scurvy on a regular basis. In 1747, on Her Majesty's ship the Salisbury, young men under the care of Dr James Lind were dying, despite him following the current treatment recommendations for scurvy. At the time, the Royal College of Physicians recommended sulphuric acid, and the Admiralty recommended vinegar treatments. Dr Lind noted that the recommendations were all written by 'experts' who had never been on a long sea voyage.

Dr Lind elected to review the current evidence and run his own treatment trial to see if he could find a treatment for scurvy. His trial compared the success of a concoction of sulphuric acid, vinegar, nutmeg, cider and seawater to a diet of two

oranges and one lemon in different groups of sailors in similar stages of disease, who were otherwise sharing the same basic diet.

The sailors receiving the citrus fruit clearly improved more quickly than those ingesting the tasty sulphuric acid concoction, and Dr Lind had some evidence for a superior treatment. Following this clinical trial, the Admiralty made lemon juice compulsory for sailors, and deaths due to scurvy declined precipitously.

Dr Lind's study is an excellent early example of the practice of EBM. As a clinician, Dr Lind posed the right, pertinent question about the disease, reviewed the relevant current evidence (literature), recognised the limitations of that evidence and then executed a simple clinical trial which led to a change in the way he treated his patients. Dr Lind also passed on his new knowledge by telling the Admiralty and the Royal College of Physicians, who then instituted change, saving many lives at sea.

Over the last few decades, EBM has significantly impacted and, in many areas, improved patient care. There are now many initiatives in place to assist healthcare professionals in making evidence-based decisions (CEBD, 2014; CEBM, 2014; Cochrane collaboration, 2014; NICE, 2014).

Although different practitioners may define what EBVM is in different ways, it is also important to recognise what EBVM is not. EBVM is not a distinct discipline to be practised only by a few 'EBVM specialists' or a rule book that MUST be followed. Rather, EBVM is a method which can be incorporated into everyday practice to help inform decisions regarding individual cases (be those individual patients or herd health programs), or to design or improve practice protocols or clinical audit processes. Finally, in the words of Cockcroft and Holmes (2003), 'EBVM is not about pursuing dogma': EBVM is not a rigid set of steps that must be strictly adhered to, but is rather a tool for approaching clinical decisions in a methodical way, and can be adapted to suit the situation.

Many of the terms used in defining EBVM are included for a specific reason, but may also raise questions in one's mind. For instance:

- What is meant by 'best' and 'most relevant' available evidence'?
- How do we apply correct weight to our patient's situation as well as the owners' goals and values?
- What weight do we put on our own clinical assessment as compared to what is in the literature?

We will seek to answer all these questions as we proceed through this tutorial – and perhaps come up with a few more! In this introductory section, we will investigate some history of EBM and EBVM, and explore some definitions.

Is EBVM a new concept?

So is EBVM a new paradigm, or just a new way of looking at things?

Medical and veterinary sciences have long been based on observation and appraisal, but in today's world of instant access to information and knowledge, approaching these professions in a different way is essential. Medical doctors' and veterinarians' practices are in many ways similar, but there are substantial differences, such as the veterinarian-client-patient relationship, funding and insurance models and expectations of end of life care, to name but a few. This means EBVM, although based on similar principles, must be different from EBM.

*"This succinct, some would say obvious, definition of what we all try to do anyway, belies the more profound philosophy behind EBVM. At its heart is the confidence in the scientific methodology that has developed over the centuries to enable us to distinguish what is likely to be true from what is likely to be false (or unproven)."*Peter Cockroft and Mark Holmes, Handbook of Evidence-based Veterinary Medicine (2003)

A question to ponder: How often do I use evidence to aid my own clinical decision-making in veterinary practice?

The principles of EBM are now common place in human healthcare, but how has using an evidence base been approached in veterinary practice?

The Evidence-based Veterinary Medicine Association (EBVMA) in North America was founded in 2004 to improve the co-ordination and communication between individuals promoting research, teaching, and clinical application of EBVM to practice (Slater, 2010). In 2009, the Centre for Evidence-based Veterinary Medicine (CEVM) at the University of Nottingham in the United Kingdom was established. This centre has adapted a number of EBM methodologies to the veterinary profession. The RCVS Knowledge, also focusses on the promotion of EBVM internationally and publishes an online resource *Veterinary Evidence*, and a number of different research groups (Savsnet, 2014; VetCompass, 2014), professional organisations (BEVA, 2014; BSAVA, 2014) and practitioners are now becoming involved in EBVM.

It's still early days for EBVM, and the evidence base is growing quickly.

EBVM is taking off, and with growing support from key professional bodies such as the RCVS, BVA and affiliated associations, AVMA, vet schools internationally as well as veterinary practices and practitioners, the quantity of evidence is likely to grow in each of the various specialist areas of the profession.

Why is EBVM important?

The principles of EBVM provide practitioners with a method of dealing with the large amount of different types of evidence available and applying it to clinical decision making.

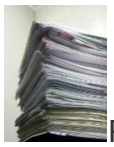
EBVM can help practitioners in a number of areas including optimising clinical outcomes for patients, developing reliable evidence-based practice protocols and evaluating the efficacy of interventions used within practice. The benefits of using these EBVM principles may also include greater client and staff satisfaction and improvements to the business as a whole.

This section introduces a few of the key benefits of the EBVM framework.

Information overload

Over recent decades, there have been massive increases in the availability of information, both in the medical and veterinary literature, but also in mainstream media. These increases affect veterinary practitioners in different ways, and have driven the need for logical approaches to processing data.

The profusion of veterinary literature means it is no longer possible to read all the primary literature, and it may not be possible to subscribe to all the relevant journals. Different search strategies for finding information must be developed, and even when papers are accessible, they may not be directly relevant or of sufficient quality to warrant a change in practice. Studies may be reported in a simple ‘research news’ format, where details of the study design are not available.

 For these reasons, the human medical field now relies on large scale reviews of evidence to form protocols, and general practitioners rarely read primary literature. The availability of evidence syntheses that provide a ‘clinical bottom line’ is also emerging in the veterinary field (e.g. BestBetsforVets and collections of Knowledge Summaries), and in the future, practising veterinarians will need to have an understanding of the use of evidence syntheses, and may well be interested in developing their own.

However, despite this increase in the amount of available literature, there is still scant evidence for many common veterinary conditions, meaning other sources of information have to be considered.

The rise of the Internet, and in particular, applications where end users can easily generate web content have also affected veterinary practice. Clients have access to many of the same resources that veterinary professionals do, but some will lack the clinical knowledge and judgement to assess whether the advice they find online is sensible. They may have attempted diagnosis, and even worse, treatment, before

seeking veterinary advice, and the veterinary surgeon now has an important role in educating owners and debunking myths.

However, not all information on the Internet is unreliable, and where limited scientific evidence is available, certain sources (for example, webinars provided by experts) may provide the 'best available evidence' for the question under consideration. EBVM provides a framework to make use of all the available information by employing logical search strategies, rigorously evaluating the information and applying it to practice.

Clinical applications

There are increasing applications for EBVM in veterinary practices.

In the UK, the RCVS now requires some level of clinical governance in all accredited practices (e.g. monitoring the outcome of cases and acting on the results). Instituting clinical governance across the profession is still in its early days, but there is already a clear need to incorporate the EBVM principles into practice in order to evaluate data and decide whether changes are needed.

Similarly, more practices are developing protocols for the diagnosis and treatment of common conditions for the regularly seen species. In many areas, these protocols will, by necessity, be based on the clinical experience of the practitioners, as this may be the only form of evidence available. However, as EBVM is incorporated into veterinary practice and quality scientific evidence becomes available, it is reasonable to expect that such protocols will instead be developed using the principles of EBVM.

Another time that it is useful to employ EBVM principles is when reading marketing materials and deciding which drugs to stock in the practice and use when treating specific cases, as well as what diagnostic tests to run. It may be useful to evaluate the studies cited by leaflets or advertisements to determine whether the products they promote confer a benefit to your patients.

Does this apply to me?

So why might we need EBVM? Having a systematic method for evaluating what we do helps us to be able to more objectively consider what is likely to work and what is not. Having access to better information and making use of this information enables us to make informed decisions.

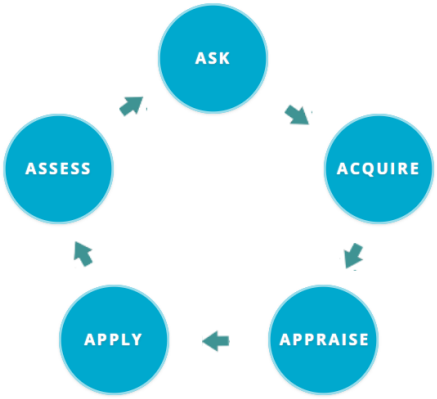
Having all the information at our fingertips also helps us to be able to consolidate and manage information about cases and to communicate well with our clients, especially as that pertains to informed consent.

Being able to recognise and make use of what we know and what we know we don't know also helps us to be more circumspect about our practice and to make fewer mistakes. As humans, we are easily misled, so being aware of this and using evidence to combat it also helps us to avoid errors we might otherwise have made.

Where do I start?

To follow the principles of EBVM, veterinarians need to be aware of the evidence available, read it, decide on its quality and relevance, and then, if appropriate, incorporate it into clinical decision-making.

EBM has been simply explained as five main steps (Heneghan and Badenhoch 2006), which can also apply to EBVM, and have been used to form the structure of this tutorial:



1. **Ask** – defining a clinical question that is of interest and (hopefully!) answerable
2. **Acquire** – finding the best available evidence to answer the question
3. **Appraise** – assessing the quality of the relevant evidence found
4. **Apply** – implementing the evidence into clinical practice where appropriate
5. **Assess** – evaluating the impact of the implementation and changes in clinical practice

Progressing through this tutorial will give you further knowledge about each of these steps in greater detail, as we cover how to ASK and frame a clinical question correctly, how to ACQUIRE the literature that is out there, how to APPRAISE this literature and APPLY what you learn to your practice, as well as how to ASSESS the outcomes of your application and clinical changes.

Challenges of EBVM

Even when there is evidence available, frustratingly, it can be difficult to access. This may particularly be a problem for veterinarians outside of academic institutions, and accessing information can be expensive.

It has been argued that there is a lack of formally published evidence for veterinary medicine (Cockcroft and Holmes 2003; Lanyon 2014), especially in comparison with the very large evidence-base for human medicine. The veterinary profession does not have the same level of centrally managed health care as human medicine (such as the National Health Service in the UK or similar structures in other countries), nor does veterinary medicine have the same level of investment in clinical research.

Much of the clinical evidence is instead generated in private practices and may be hidden away in individual practice management systems and clinical records, which are not routinely translated into formal research publications. There is currently recognition in the veterinary profession that a greater investment in research is required to create a better evidence base to inform clinical decision-making (Lanyon, 2014).

"… case-based research in the 'real world' of veterinary clinics has no funding base to support it" Lanyon (2014)

"… the primary difference between evidence-based medicine and evidence-based veterinary medicine is that, in the latter, the emphasis must be necessarily placed on poorer sources of evidence." Kastelic (2006)

So who's doing it?

There are a number of groups taking the lead on EBVM internationally.

The Evidence-based Veterinary Medicine Association is an international membership organisation through which members of the profession can contribute to activities and discussions, and access resources related to EBVM.

The Centre for Evidence-based Veterinary Medicine at the University of Nottingham is a multidisciplinary team of veterinary and non-veterinary, clinical and non-clinical veterinary researchers working in a number of areas.

In 2013, the charitable arm of the RCVS re-branded itself as 'RCVS Knowledge', with a major mandate being to promote EBVM internationally to the profession and publishes an online resource *Veterinary Evidence*. RCVS Knowledge has also established the EBVM Network, a global network of like-minded people combining to develop the practice and science of EBVM.

And this is just the tip of the iceberg – numerous practitioners and groups are working fervently on disseminating the ideas of EBVM to the wider veterinary community – perhaps it's time for you to join them?

Making the most of this tutorial

To make the most of this tutorial, it would be useful to take time now to think about clinical scenarios that relate to your practice, and that you can use throughout the tutorial to apply the concepts we discuss. You will then be guided through the EBVM cycle, and by the end of the tutorial may have answered a real problem you have encountered!

Clinical examples could arise by considering the following:

- A recent journal article that recommends a different diagnostic method or treatment protocol from that which you currently use

- A particularly challenging or unresolved case
- New marketing material you have received from a pharmaceutical company
- A need for new practice protocols, or to review existing ones
- Questions arising from case discussions within the practice
- An area in which you know you would like to develop your skills
- A disease you and your colleagues approach differently in terms of diagnostics or therapy
- A disease process you treat that you feel has unsatisfactory outcomes
- A case report or publication you are keen to work on

We encourage you to write out two to three examples, making the thought or question as precise as possible. Then, at the end of each chapter, try to apply the skills that have been covered to your example.

Summary

In this chapter, we have learned how to:

1. Explain the concept of EBVM
2. Describe the relevance and importance of EBVM to veterinary practice
3. Construct a generalised example of the EBVM cycle

What next?

You could:

- Practice going through a generalised example of the EBVM cycle
- Move on to the ASK chapter of the tutorial

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Ask

The first and most important step in practising EBVM is to ask the right question(s). Without the right question, we cannot hope to ACQUIRE the correct evidence for critical appraisal, nor can we establish a context within which we can APPRAISE its relevance and quality. Only then can we APPLY our new knowledge in a clinical context, in order to ASSESS its impact on our practice.

By the end of this chapter you will be able to:

- Describe why a well-formed question is fundamental to the EBVM process, and avoid the common pitfalls in asking questions.
- Identify clinical questions in practice.
- Construct a clinical question correctly.

In the Ask section:

- The importance of starting with a good question
- Identifying clinical questions in practice
- How to construct a good question
  - P – Patient: population and/or problem
  - I – Intervention: treatment, prognostic factor or exposure
  - C – Comparator: comparison or control
  - O – Outcome
  - Example PICO questions
- Challenges to building a PICO
- Example scenarios
  - Carprofen and local anaesthesia in calves undergoing disbudding
  - Carprofen in dairy cattle with toxic mastitis
  - Pimobendan versus benazepril in dogs with mitral valve disease and congestive heart failure
  - Renal diets in cats with chronic kidney disease
- Quiz
- Summary
- References

The importance of starting with a good question

Questioning our current practice underpins the principles of EBVM – in order to practice EBVM, we must be prepared to question what we do and change accordingly.

Using a treatment protocol "because it's the one you've always used" or "it's the one you were taught at University" is not practising EBVM. Clinicians are constantly presented with new drugs, new surgical procedures and new evidence from clinical research; the progress of veterinary knowledge and research does not stop on the day of graduation from veterinary college. By questioning our practice in a critical way, we can move in a direction that keeps us up to date; also, by using the best possible evidence, we can offer our patients the best possible outcomes.

Well-formed questions underpin the very core of scientific methodology:
"One cannot get a clear answer to a vague question. The language of science is particularly distinguished by the fact it centres around well-stated questions."
People in Quandaries, Wendell Johnson, 1946, Harper & Row.

One of the most common mistakes those new to EBVM might make is to start searching for answers with only a vague idea of what information is needed. In order to address complex or poorly defined clinical problems, you must first break these problems down into a series of more precise questions. By framing your questions in this narrow, precise way, you increase your likelihood of finding evidence that specifically answers your question.

In equine medicine, rather than asking "*What should I do about recurrent laryngeal neuropathy in horses I see in my practice?*", you could ask "*In adult, racing thoroughbred horses presenting with recurrent laryngeal neuropathy, does ventriculectomy ('Hobday') with ventriculocordectomy, compared with prosthetic laryngoplasty ('tie-back'), have a greater success rate for return to racing?*"

This question could also have many variations: for instance, you could change the outcome you want to measure, and ask "*In adult, racing thoroughbred horses presenting with recurrent laryngeal neuropathy, does ventriculectomy ('Hobday') with ventriculocordectomy, compared with prosthetic laryngoplasty ('tie-back'), have a greater reduction in air turbulence?*"

The University of Oxford have established the Centre for Evidence-Based Medicine(CEBM), focussing on issues surrounding the field of evidence in human medicine. They state that "One of the fundamental skills required for practising EBM is the asking of well-built clinical questions. To benefit patients and clinicians, such questions need to be both directly relevant to patients' problems and phrased in ways that direct your search to relevant and precise answers." Although this was written with human medicine in mind, the principle applies just as well for veterinary medicine and the practice of EBVM.

Identifying clinical questions in practice

To benefit both patients and clinicians, questions need to be focussed and directly relevant to the patient or scenario at hand.

The questions you ask also need to be formatted in such a way as to aid you in your search for answers – see the ACQUIRE section of this resource for more details. A well-formed clinical question is the most efficient route to obtaining a clear answer.

Certain study types (e.g. randomised controlled trials, cohort studies, case-control studies, cross-sectional studies and the like) are specifically designed to answer, and are therefore better at answering, certain types of clinical questions (e.g. those addressing treatment, risk, or prevalence). We will only briefly identify and categorise the main study types below; more details can be found in APPRAISE.

Clinical questions can be divided into five main topic areas: Questions that relate to 1) treatment, 2) prognosis and incidence, 3) aetiology or risk, 4) diagnosis, and 5) prevalence. We will cover these in turn below.

Treatment – These types of questions refer to treatment choices a veterinarian would need to make in order to achieve a desirable outcome. These choices can include drugs or medicines to be used, surgical methods, changes in diet or management, and many more. These types of questions are best answered by randomised controlled trials when they are available.

e.g. Which diet is best to feed cats with chronic renal disease?

Prognosis and Incidence – These types of questions relate to the likelihood of disease or the progression of disease over time. These questions are best answered by cohort studies.

e.g. Does sex affect survival in flat-coat retrievers with cancer?

Aetiology and Risk – These types of questions investigate the origin of disease or the factors influencing development of a certain condition or disease. These questions are best answered by cohort studies, case-control studies or cross-sectional studies.

e.g. What are the risks of general anaesthesia in ferrets?

Diagnosis – These types of questions involve identification of a disorder based on the animal's presenting signs. These questions are best answered by diagnostic test validation studies (also known as diagnostic evaluation studies).

e.g. Which diagnostic test is most reliable for diagnosing fascioliasis in dairy cattle?

Prevalence – These questions consider the frequency of disease at a certain point in time, and are best answered by cross-sectional studies and surveys.

e.g. What is the prevalence of cardiac disorders in Welsh Section A mountain ponies?

Categorising your clinical questions in this way can help you to decide which study design would best answer your question. In the APPRAISE and ASSESS chapters, we will look further at the different levels of evidence and the study types commonly used in veterinary medicine.

How to construct a good question

Your question will generally contain a problem that you are faced with, choices that you have to make in order to manage that problem, and an objective measure of outcome.

Formatting your question correctly is important in ensuring that your search for evidence is structured, systematic and complete. For example, if you want to know whether to implement a practice-wide policy to stop giving routine antimicrobial cover for ovariohysterectomy in dogs:

- your problem would be ovariohysterectomy in dogs;
- your choices would be routine antimicrobial use versus no routine antimicrobial use;
- your objective measure (or outcome) could be post-operative infection rates (although other outcomes could be considered).

In order to ensure that the questions you are asking contain all of the right elements to provide you with the evidence, there are several ways you might choose to format your clinical question. Using a specific format for your question should help you to facilitate your search and ensure that your question is answerable.

In practicing EBVM, you may come across many different ways of formatting your question in terms of problem, choices, outcome and other limits on the answers you seek (e.g. you may come across interesting acronyms such as PICO, PICOS, SPICO, and PICOT, or you may be interested in addressing questions pertaining to clinical audits, etc.).

The most common way to format a question is to use the PICO system, focussing on the:

- P – Patient: population and/or problem
- I – Intervention: treatment, prognostic factor or exposure
- C – Comparator: comparison or control
- O – Outcome

We will focus on the PICO system in this resource, and will now look at each of the elements of PICO in more detail.

P – Patient: population and/or problem

How would I describe a group of patients similar to mine?

The first step in formulating a clinical question in the PICO format is to consider the clinical problem you face. Your key clinical challenge is to manage the problem affecting your patient or group of patients, and to identify evidence to support the best approach, you need to clearly define the problem.

It is helpful to think in terms of the population you are dealing with and to characterise your patient in general terms (e.g. 'A 14-year-old cat' with 'a diagnosis of chronic kidney disease').

In simple terms, you are looking to identify a group of patients similar to the one you are concerned about. At this stage, it can be difficult to decide how specific to be in terms of defining the population and problem. A sensible guideline is to be reasonably specific at first, while being prepared to loosen your definition of the patient if the definition does not yield sufficient evidence in a literature search.

You also need to use your clinical common sense; you are likely to find studies that include evidence regarding the management of geriatric cats in chronic renal failure, while you are unlikely to find many (if any!) studies on specific breeds at precise ages.

QUESTION	PATIENT/PROBLEM
Which diet is best to feed to cats with chronic renal disease?	Cats with chronic renal disease
Which diagnostic test is most reliable for diagnosing fascioliasis in lactating dairy cattle?	Lactating dairy cattle
Does sex affect survival in flat-coat retrievers with cancer?	Flat-coated retrievers with cutaneous lymphoma
What are the risks of general anaesthesia in ferrets?	Ferrets
What is the prevalence of cardiac disorders in Welsh Section A mountain ponies?	Horses

I – Intervention: treatment, prognostic factor or exposure

What is the main subject of interest?

You might be interested in a specific treatment, a factor that will indicate prognosis in a disease process, or the association of a certain exposure with disease, depending on the question. These interventions are often considered with their matching

comparators – something you might compare against the group receiving the intervention (see the next page for further information about comparators).

QUESTION	INTERVENTION
Which diet is best to feed cats with chronic renal disease?	Feeding a renal prescription diet
Which diagnostic test is most reliable for diagnosing fascioliasis in dairy cattle?	Milk ELISA
Does sex affect survival in flat-coat retrievers with cancer?	Being male
What are the risks of general anaesthesia in ferrets?	General anaesthesia by triple injectable agent
What is the prevalence of cardiac disorders in Welsh Section A mountain ponies?	Being a Welsh Section A mountain pony

C – Comparator: comparison or control

What is the intervention being compared to?

Now that you have defined your population and intervention of interest, you need to consider your choices (i.e. what the intervention will be compared to)

The PICO framework allows you to consider quite a wide range of interventions, from considering a new treatment, to examining the impact of a particular exposure to a risk factor, to determining how prognostic a certain test might be.

It is important to realise that any intervention needs to be considered at the same time as a comparator, as without a comparison it is difficult to evaluate the impact of the particular treatment, prognostic factor or exposure you are interested in. The PICO framework considers the treatment, clinical sign or exposure of interest to be the intervention with which we are concerned, and considers an alternative to be the comparator.

If we are evaluating a specific therapy, for example, we would choose that therapy as the intervention, and we wish to find evidence comparing its efficacy with alternative comparators or control treatments. When dealing with a question of diagnosis, however, we may wish to find evidence describing how the consideration of a specific diagnostic test or clinical sign increases our diagnostic accuracy compared to an alternative (a control).

And when considering a question of aetiology or harm, we may wish to discover the association between a risk factor or exposure and the occurrence of disease.

QUESTION	COMPARATOR
Which diet is best to feed cats with chronic renal disease?	Not feeding a renal prescription diet
Which diagnostic test is most reliable for diagnosing fascioliasis in dairy cattle?	Serum ELISA
Does sex affect survival in flat-coat retrievers with cancer?	Being female
What are the risks of general anaesthesia in ferrets?	General anaesthesia by induction and inhalational agent
What is the prevalence of cardiac disorders in Welsh Section A mountain ponies?	Being any other breed of horse

O – Outcome

What can I hope to accomplish or measure?

Finally, any decision between two choices rests on an outcome of interest.

A non-clinical example is solving a problem of choosing a car. If your desired outcome is economy, a fast, flashy sports car might be a terrible solution, whereas if your desired outcome is top speed, that sports car would be ideal.

Choosing a specific desired outcome is a key part of the personalisation that EBVM gives, allowing you to seek evidence, APPRAISE it, and act with a specific outcome or objective in mind that is directly tailored to your individual patient.

For instance, in the case of a geriatric cat with chronic renal disease, you may decide that your desired outcome will be quality of life rather than overall duration of survival.

QUESTION	OUTCOME
Which diet is best to feed cats with chronic renal disease?	Survival time
Which diagnostic test is most reliable for diagnosing fascioliasis in dairy cattle?	Better sensitivity and specificity for diagnosing fascioliasis
Does sex affect survival in flat-coat retrievers with cancer?	Average life expectancy
What are the risks of general anaesthesia in ferrets?	An increased risk of death
What is the prevalence of cardiac disorders in Welsh Section A mountain ponies?	Prevalence of cardiac disorders

Example PICO questions

We have now looked at all the elements required to construct a full PICO question.

Below are structured example PICO questions created around the examples from the Identifying clinical questions in practice page for the five different types of clinical question.

Original question: Which diet is best to feed cats with chronic renal disease?
PICO: In [cats with chronic renal disease] does [feeding a renal prescription diet] compared with [not feeding a renal prescription diet] impact on [survival time]?

Original question: Which diagnostic test is most reliable for diagnosing fascioliasis in dairy cattle?
PICO: In [lactating dairy cattle] does [milk ELISA] compared with [serum ELISA] have [a better sensitivity and specificity for diagnosing fascioliasis]?

Original question: Does sex affect survival in flat-coat retrievers with cancer?
PICO: In [flat-coated retrievers with cutaneous lymphoma], does [being a male] compared with [being a female] affect [average life expectancy]?

Original question: What are the risks of general anaesthesia in ferrets?
PICO: In [ferrets], is [general anaesthesia by triple injectable agent] compared with [general anaesthesia by induction and inhalational agent] associated with [an increased risk of death]?

Original question: What is the prevalence of cardiac disorders in Welsh Section A mountain ponies?
PICO: In [horses], does [being a Welsh Section A mountain pony] compared with [being any other breed] increase the [prevalence of cardiac disorders]?

The PICO framework can be applied to most clinical questions, and is easy to use once you have learned its salient principles.

Using a PICO is a way of identifying and working through potential search terms to retrieve the best set of results possible.

Challenges to building a PICO

Once you have identified your clinical question and created your PICO, there are a few more decisions you may need to make in order to inform and re-adjust your PICO and get the results you need.

Scope versus volume of evidence

The ACQUIRE section, coming next, explains more fully how you can use your PICO question to find the evidence.

Sometimes the question you ask may yield too much or too little relevant evidence. For example, you may find that your PICO has only yielded two papers, neither of which entirely answers your question. Assuming your search was conducted thoroughly, this may mean there is not enough evidence available to answer your question.

In veterinary medicine, we often deal with this problem of a dearth of evidence, and, in order to conduct an extensive search, it may sometimes be helpful to broaden the question you are asking or to search for evidence available in other species to make sure you haven't missed any useful evidence. In doing this, however, you must take care to only use the evidence that directly answers your question of interest, and not be dragged away by other interesting papers which might not answer your clinical question.

Conversely, you may find that your search yields dozens and dozens of results, not all of which specifically relate to the problem or question you have in mind. In this case, it might be necessary to adjust your PICO to be more narrow and focussed, in order to distil only the most relevant evidence to answer your question. How you implement the evidence into practice will be further covered in APPLY and ASSESS.

Choice of interventions and comparators

It is unlikely that all the evidence you obtain will address all the treatments or diagnostic choices that exist for the problem you have chosen. Similarly to adjusting the scope of problem, you may need to refine your selection of treatment choices by excluding or modifying them. Sometimes the treatments you wish to compare have simply not been directly compared in the literature.

Although this is disappointing, it can lead to identifying research gaps that someone (perhaps you!) needs to answer. If you run into a situation where the specific treatments of interest have not been trialled, you may be forced to select the most similar treatments you can find with available information about their use, and then use your clinical judgement to interpret the results of the trials.

Multiple outcomes

Sometimes, a clear choice for your patient will only have a single objective desirable outcome, and it is certainly nice when this is the case in your clinical question. In reality, however, veterinarians often want to investigate a number of different outcomes for ourselves, our clients and our patients. For example, we may wish for a treatment that is effective, easy to use and economic, all at once.

However, many studies in the literature may address multiple outcomes, looking at both efficacy (e.g. survival times) and negative outcomes (e.g. adverse events) as well as costs, all in the same study. Sometimes you may need to look across multiple studies to gather these data; to do this, you will effectively be asking a series of PICO questions, all with different outcomes. One strategy is to refine your outcome to be a composite statement that reflects your overall aims for a case (e.g. 'long-term survival whilst pain free').

Example scenarios

A series of example case scenarios for you to consider are now given. For each example, we suggest you attempt to write out a PICO question, and then expand the text to see an example we give, in the PICO format.

All of the examples used here are available in full from the University of Nottingham's Centre for Evidence-based Veterinary Medicine website BestBETs for Vets

Carprofen and local anaesthesia in calves undergoing disbudding
Carprofen in dairy cattle with toxic mastitis
Pimobendan versus benazepril in dogs with mitral valve disease and congestive heart failure
Renal diets in cats with chronic kidney disease

You can use the tool PICO.vet to help you build a well-structured and focused clinical question.

Carprofen and local anaesthesia in calves undergoing disbudding

Clinical Scenario

During a visit to one of your small beef herds, the owner, Mary Reader, asks you to disbud three calves that have been born within the last few weeks. The last time Mrs Reader had animals disbudded with hot iron cautery, she was upset by how the animals behaved after the procedure – she says they were "out of sorts" and looked uncomfortable.

Whilst Mrs Reader knows the animals must be disbudded, she asks you whether analgesics as well as the local anaesthetic would be likely to reduce the pain from the disbudding. You assure her you always use local anaesthetic, but you wonder if the addition of carprofen would decrease the level of discomfort experienced by the calves.

PICO question

Reveal example question

In [calves undergoing non-chemical disbudding] does [the administration of carprofen in addition to local anaesthetic] versus [local anaesthetic alone] [decrease the behavioural indicators of discomfort associated with the procedure]?

Full example

http://bestbetsforvets.org/bet/143

Carprofen in dairy cattle with toxic mastitis

Clinical Scenario

During a visit to one of your dairy farms, the owner Steve Jones comments that he has had a number of cows sick with mastitis, which he thinks are caused by *E. coli*. He finds these cases very difficult to treat.

Steve has recently seen an advert for an anti-inflammatory drug containing carprofen, which claims that it will improve the recovery rate of cows with toxic mastitis. Over the years, you have had a number of conversations with Steve about the relative merits of different treatment options for cases of toxic *E. coli* mastitis. You wonder if carprofen would make a difference to recovery of cows on Steve's farm.

PICO question

Reveal example question

In [dairy cattle with *E. coli* mastitis] does [the administration of carprofen] compared to [no anti-inflammatory treatment] [improve clinical recovery]?

Full example

http://bestbetsforvets.org/bet/156

Pimobendan versus benazepril in dogs with mitral valve disease and congestive heart failure

Clinical Scenario

Barney is a 7-year-old male neutered Cavalier King Charles Spaniel who presented to you with a cough and a heart murmur during morning surgery. He is in good body condition, but has lost 1 kg in weight since you saw him last year. You have radiographed his thorax, and he has both cardiomegaly and pulmonary oedema. Echocardiography reveals marked mitral valve disease.

His owner is very worried about Barney and has limited money to spend on treatment, but wants to know how long Barney will live and also wants him to have the best treatment possible. You have pimobendan and benazepril available to you on the shelf, and wonder which drug will maximise Barney's survival time.

PICO question

Reveal example question

In [dogs with congestive heart failure secondary to mitral valve disease] does [pimobendan] or [benazepril] [improve the life expectancy of the affected dogs]?

Full example http://bestbetsforvets.org/bet/29

Renal diets in cats with chronic kidney disease

Clinical Scenario

Chloe, a 14-year old domestic shorthaired cat, has just been diagnosed with IRIS late stage II kidney disease. She is not proteinuric, and her blood pressure is normal. You have stabilised her azotaemia, and her appetite is now good. What is the benefit of a kidney prescription diet for this cat?

PICO question

Reveal example question

In [cats with naturally occurring chronic kidney disease] does [a renal prescription diet] compared to [normal diet] increase the [survival time] of affected cats?

Full example http://bestbetsforvets.org/bet/146

Quiz

When constructing a question in the PICO format, what does the letter O stand for?

- Opportunity Incorrect. The letter O stands for Outcome.
- Option Incorrect. The letter O stands for Outcome.
- Order Incorrect. The letter O stands for Outcome.
- Outcome Correct. The letter O stands for Outcome.
- Outline Incorrect. The letter O stands for Outcome.

What study type(s) provide the best evidence for answering questions relating to prognosis or risk?

- Case-control or cohort studies Correct. When asking questions relating to prognosis or risk, the best evidence is provided by case-control or cohort studies.
- Case series or textbooks Incorrect. Case series are a relatively weak form of evidence, used when other evidence is not available to us. Textbooks have many weaknesses; they are not peer-reviewed, are often anecdotal and can be significantly outdated. When asking questions relating to prognosis or risk, the best evidence is provided by case-control or cohort studies.
- Cross-sectional or case-control studies Incorrect. Cross-sectional studies look at data at a specific point in time, and therefore are not strong evidence when asking questions of prognosis or risk. When asking questions relating to prognosis or risk, the best evidence is provided by case-control or cohort studies.

- Randomised controlled trialsIncorrect. Randomised controlled trials are the best evidence for answering questions of therapy. When asking questions relating to prognosis or risk, the best evidence is provided by case-control or cohort studies.
- Surveys or case reportsIncorrect. Case reports are a relatively weak form of evidence used when there is a lack of stronger evidence. Surveys are not a strong study type for answering questions of prognosis or risk. When asking questions relating to prognosis or risk, the best evidence is provided by case-control or cohort studies.

Construct a PICO to answer the question: Which surgical technique should be used to repair a cranial cruciate ligament (CCL) rupture in a Labrador?

- Does [surgery] provide a [good recovery] in [Labradors] with [CCL rupture]?Incorrect. This question is not in the PICO format. The question is out of order and the population, intervention and outcome are ill-defined and there is no control or comparator. The correct format for this question is "In [dogs over 25kg with CCL rupture] does [tibial plateau levelling osteotomy] compared with [lateral fabellar suture] have a [greater chance of return to normal limb function]?"
- In [dogs over 25kg with CCL rupture] does [tibial plateau levelling osteotomy] compared with [lateral fabellar suture] have a [greater chance of return to normal limb function]?Correct. This PICO is written in the correct order and the population, intervention, control and outcome are well defined.
- In [dogs] does a [tibial plateau levelling osteotomy] work better than [lateral fabellar suture] for [CCL rupture]?Incorrect. The population is ill-defined and there is no outcome to measure. How do you define 'work better'? The correct format for this question is "In [dogs over 25kg with CCL rupture] does [tibial plateau levelling

osteotomy] compared with [lateral fabellar suture] have a [greater chance of return to normal limb function]?"

- In [large dogs] is [tibial plateau levelling osteotomy] superior for correcting [CCL rupture]?Incorrect. Although the population is slightly more defined, what does 'large dog' mean? There is no comparator or control mentioned and there is no specific outcome measured. The correct format for this question is In [dogs over 25kg with CCL rupture] does [tibial plateau levelling osteotomy] compared with [lateral fabellar suture] have a [greater chance of return to normal limb function]?

- [Which technique] provides the [best outcome] for [CCL rupture]?Incorrect. This PICO is not correctly formatted, there is no defined population – we could be talking about humans here! The correct format for this question is "In [dogs over 25kg with CCL rupture] does [tibial plateau levelling osteotomy] compared with [lateral fabellar suture] have a [greater chance of return to normal limb function]?"

How should you approach a clinical question with multiple possible interventions or outcomes?

- Construct a series of PICOs, each containing one comparator and one outcome, until all questions are answered.Correct. Because a PICO must be formatted very carefully, in order to assess multiple interventions or outcomes we should construct individual PICO questions for each comparator and outcome. If done systematically this will lead us to the clinical bottom line that answers our question.

- Expand the PICO to contain all of the relevant comparators and outcomesIncorrect. A PICO will not work as it is meant to if you expand it to contain all possible interventions and outcomes. This means when we attempt to ACQUIRE our

information, we will not find all of the evidence available to us to answer this question correctly.

- Expand the PICO to contain some, but not all of the extra comparators and outcomesIncorrect. A PICO will not work as it is meant to if you expand it to contain more interventions and outcomes. This means when we attempt to ACQUIRE our information, we will not find all of the evidence available to us to answer this question correctly.

- Ignore the other comparators and outcomes; one is enough to get the best evidenceIncorrect. If your question has multiple interventions and outcomes you can only reach an answer by including all of the interventions and outcomes and systematically breaking the question down into individual PICOs.

- It is not possible to use the PICO format for questions with multiple comparators or outcomes.Incorrect. Because a PICO must be formatted very carefully, in order to assess multiple interventions or outcomes we should construct individual PICO questions for each comparator and outcome. If done systematically this will lead us to the clinical bottom line that answers our question.

Summary

You should now be more familiar with how to:

- Describe why a well-formed question is fundamental to the EBVM process, and avoid the common pitfalls in asking questions.
- Identify clinical questions in practice.
- Construct a clinical question correctly.

References

Cockcroft P. D., & Holmes M. A. (2003) Handbook of Evidence-based Veterinary Medicine. Oxford: Blackwell Publishing

Lanyon, L. (2014) Evidence-based veterinary medicine: a clear and present challenge. *Veterinary Record,* 174(7), pp. 173-175

Acquire

Having refined a clinical question, the next step is to conduct a search to identify evidence that will help answer the question. EBVM relies on acquiring the best available scientific research and data to help minimise bias in clinical decision-making. As a vet, you need to identify the best sources of scientific information that you have access to, and develop the skills and strategies needed to use them effectively.

By the end of this chapter you will be able to:

- Identify which information sources can help to find the best evidence for veterinary medicine.
- Establish how to get access to these resources for your own clinical practice.
- Translate a clinical question into a database search strategy and understand the fundamentals of efficient searching.
- Manage your references and report your search strategies.

In the Acquire section:

- Where to find the evidence
  - Synthesised evidence
  - Bibliographic databases
  - Access to databases
  - Other sources of information
  - Access to publications
- How to find the evidence
  - A database search strategy
  - Search terms
  - Types of search
  - Boolean operators
  - Search tips
  - Limits and filters
  - Refining your search
  - Citation searching
- Managing your search results
  - Reporting a search
  - Reference management tools
- Quiz
- Summary
- References

Where to find the evidence

Ideally, clinical decisions will incorporate the most current and relevant scientific research, but where is the best place to search for the evidence base for veterinary medicine? Unfortunately, there is no “one-stop-shop”, and so a variety of search tools, databases and methods must be used.

The evidence that supports the clinical decision-making of vets is interdisciplinary and traverses veterinary and human medicine, biomedical sciences and applied life sciences – and so use of a number of different sources may be needed to get optimum coverage of the available evidence.

“Researchers in veterinary medicine depend on the literature of many complementary fields of study. The literature of the biological sciences, including laboratory and clinical science, is essential, as are most aspects of human medicine, since they overlap in varying degrees with veterinary medicine.” Youngen (2011)

The ways in which you can find evidence are outlined below, and more detail is provided throughout this chapter:

- Look for synthesised evidence

  Evidence syntheses aim to provide comprehensive summaries of the best scientific evidence on targeted clinical practice topics. They offer clinicians a quick and efficient way of getting a clinical bottom line for a given clinical question. If you can find an evidence synthesis on your clinical question it is the ideal starting point for EBVM. However, they are still relatively rare and so you will often need to search for primary research.

- Search the bibliographic databases, using the best that is available to you

  Bibliographic databases are tools designed to help you search across the research literature (journals, books, conference papers, etc.) by subject and author. They can focus on a particular subject area, or be inter-disciplinary. Each database systematically indexes articles from a given list of scholarly and professional publications, and so provides the most efficient method for searching the scientific literature. If no secondary evidence already exists in a synthesis, then databases can help with a search of the primary research.

- Review the references of relevant papers

  Citation searching allows you to explore references included in a paper, and also to identify subsequent papers that cite the paper of interest. Mining the reference list is fairly straightforward, but search tools such as Web of Science, Scopus and Google Scholar also allow you to follow a ‘citation map’ to see what other papers on the same topic were published after the one of interest.

- Read key publications

  Hand-searching involves a manual page-by-page examination of journals, conference proceedings or books to identify relevant evidence. This may be an important source of evidence for veterinarians in practice, and also has a

formal role to play when done systematically to identify trials that may not have been picked up by the bibliographic databases (Higgins and Green, 2011).

- Contact researchers and experts

  Seeking and sharing expert opinion has been made much easier with Internet communication tools and social media, and these informal networks can be an effective means of gathering information (e.g. for requesting the full text of an article from the author directly).

- Search the ‘grey’ literature

  Grey literature is material that is not formally published within the conventional, commercial publishing channels and so it will not always be captured by bibliographic databases. Examples include technical reports and working papers from government agencies or scientific research groups, dissertations and some open access material on the Web. Some may be accessible via Internet searches.

- Use unpublished data

  Unpublished data, such as clinical records, practice guidelines and pre-prints of journal articles, can provide useful evidence. Traditionally, peer-reviewed scientific journals, and the bibliographic databases that index them, have been considered the best source of evidence. Research into publication bias (Glanville et al., 2015) suggests that there is a need to go beyond these sources alone, as a significant proportion of research will not be published in peer-reviewed journals. You may have access to conference papers or case reports, and it has been recognised that clinical records and practice data might be harnessed to help veterinary professionals make evidence-based decisions at the point of care (Lefebvre, 2014 and Brodbelt, 2014).

Show all

Vets need to try broad searches of the numerous available sources of evidence as the evidence may be archived in a number of different places within a number of disciplines.

The Internet has brought unprecedented access to information direct to the clinical setting, making it possible for a vast amount of information to be created, disseminated and accessed at great speed, potentially assisting with all of the techniques listed above. However, it can also make acquiring information problematic, as the complexity of the information landscape, the problem of information overload, and the barriers presented by expensive subscriptions to scientific information can be prohibitive.

Navigating the information landscape can seem quite daunting, but this section is designed to offer some practical advice to help.

Synthesised evidence

Evidence syntheses are designed to support clinical decision-making by summarising the available evidence on a clinical topic following a formal search and appraisal of the primary research by a qualified third party.

These can save the practitioner a huge amount of time and effort as the work has already been done for you (though you should check that the information is up-to-date, and that the methodology described seems sound).

For busy practitioners, a quick search of synthesised evidence should be the first port of call. If there is a high quality, up-to-date synthesis of evidence already published, there may be no need to do your own detailed searches.

With an ever-increasing number of publications in the veterinary sciences, it is challenging if not impossible for busy clinicians to keep up with the literature. Reviews summarising the outcomes of various studies are therefore a very efficient method for obtaining the clinical "bottom line" about what works well and what doesn't. 'There are different types of evidence synthesis; the three main types referred to in this tutorial are evidence summaries, systematic reviews with or without meta-analyses, and practice guidelines.

Most GPs in human medicine actually use systematic reviews and evidence summaries and guidelines to answer their clinical questions, and don't do many searches of the primary literature themselves, if any. For example, in the UK they may rely on Nice Evidence Search

Evidence syntheses are an area of new development for the veterinary profession, and we expect these 'secondary evidence sources' to grow and expand as EBVM takes off, but some of the best sources for now are:

Online collections of evidence summaries

- Veterinary Evidence RCVS Knowledge, the charity partner of the Royal College of Veterinary Surgeons (RCVS) in the UK, makes resources available via its open access online portal, including a collection of Knowledge Summaries.
- BestBETs for Vets The Centre for Evidence-based Veterinary Medicine at Nottingham University, UK offers a freely accessible database of Best Evidence Topics (BETS).
- Banfield Applied Research and Knowledge (BARK) In the USA, the research division of Banfield, one of the largest privately owned practices, is actively generating information to support EBVM by conducting population-based research on the medical records from their animal hospitals. BARK data is shared in different formats, including Critically Appraised Topics (CATs) and journal articles.
- Equine Veterinary Journal: Clinical Evidence in Equine Practice online collection lists systematic reviews and critically appraised topics.
- Zoonoses and Public Health Special issue: systematic reviews and meta-analysis in animal agriculture and veterinary medicine.

Evidence summaries published in journals

Some veterinary journals now feature regular evidence summaries. Examples include:

- Veterinary Record: Clinical Decision-Making Starting in April 2015 the Veterinary Record has started a new section called Clinical Decision-Making which will include evidence syntheses such as BestBETs and CATs.
- The quarterly Banfield Journal includes practical clinical articles on the diagnosis and treatment of medical conditions, plus an evidence-based veterinary medicine feature to enhance practitioners' clinical decision-making.

Systematic Reviews

Systematic reviews are considered the "gold standard" of evidence. If you can find a recent systematic review that answers your specific question this will be a great help, as someone else has already spent the time doing the appraisal work for you.

The Cochrane Collaboration and the Cochrane Database of Systematic Reviewsprovide the gold standard for high quality systematic reviews in human medicine, and there is now a will in the veterinary community to try and build something comparable. In these early days of EBVM, a direct comparator of Cochrane does not exist for veterinary medicine, but the VetSRev database (see below) has been up and running since 2013.

- The VetSRev database is a freely accessible online database of citations for systematic reviews relevant to veterinary medicine and science. Produced by the Centre for Evidence-based Veterinary Medicine at the University of Nottingham, UK, it aims to disseminate information about existing systematic reviews to the veterinary community. You may be surprised by the number that already exist, and the number published each year is growing exponentially, so the coverage should get better all the time.

Identifying systematic reviews via the CAB abstracts literature database

The publisher of the CAB Abstracts database also offers the following advice for identifying systematic reviews via CAB abstracts: "The "Evidence based research" facet is now available under Refine Results and is designed to filter your search results to systematic reviews and meta-analyses. Apply this filter after you search to view only results drawn from evidence based literature". (CABI web pages, 2015)

Practice guidelines

The evidence-based approach can be used to create practical clinical guidelines – systematically developed statements that assist practitioners with clinical decision-making on a specific topic. Veterinary practices can adopt the EBVM methodology to produce their own guidelines. An EBVM approach can help improve the quality and thus the efficiency and effectiveness of a veterinary practice. Some examples include:

- Practice guidelines for treatment of canine atopic dermatitis by De Boer (2013), which he presented at the 1st International EBVM Network conference.
- The RECOVER guidelines on veterinary CPR, the first evidence-based recommendations to resuscitate dogs and cats in cardiac arrest, produced by the American College of Veterinary Emergency and Critical Care and the Veterinary Emergency and Critical Care Society.

Bibliographic databases

Bibliographic databases are tools used to systematically search the scientific literature to identify relevant papers; therefore they play a vital role in EBVM.

A database systematically indexes articles from a given list of journals and other professional publications, and each database may search a different set of journals – a list of which should be clearly defined by that database.

Databases are more reliable than Internet search engines as they focus on scientific literature and list the sources they search. Although Internet search engines are free, they are often less reliable. Some bibliographic databases are freely available, and may be a better option than relying on Internet search engines. Other databases, however, require a subscription, and it will be up to veterinary practices and practitioners to decide on the most affordable options available to them.

It should be remembered that databases are tools to identify relevant papers. Whilst some databases contain full text articles, many do not, and so you will also need to find ways to access the papers you wish to read; how to do so is covered later in this chapter.

Why would a busy vet in practice want to spend the time, effort and resource searching the primary literature?

Searching the primary literature effectively can be time-consuming, but it can prove worthwhile, particularly when a search of the secondary sources has resulted in too few results, or when practitioners are writing an evidence summary, practice protocol or guideline.

"Veterinary practitioners may believe that there is not enough time to search for science-based information while managing cases, but these perceptions often change after experiencing the effect this new-found knowledge has on treatment response by the patient." Gibbons (2009)

Can't I just rely on Internet search engines like Google for finding evidence?

To some extent this depends on you and how much time you have to browse the Web for information and analyse what you find to decide whether or not you can trust it. If that is all you can do, it is miles better than nothing! Three of the key issues are:

- A lack of peer-review on the Web
  Generic Internet search tools do not confine themselves to peer-reviewed information from the academic and scientific communities, and so, while they will include links to some high quality evidence, the amount of time it will take to locate this amid everything else that is listed can make them inefficient. The onus will be on you to

spend time sifting through results and doing the analysis to discern the validity and currency of the evidence.

- Search engines don't always tell you what they are giving you in a systematic fashion
  Using search engines, you also run a risk of missing some key evidence, as these tools do not take a systematic approach to indexing all the relevant veterinary science journals. Even when you do find promising results on Google, you may find that they cannot be accessed, either because they are hidden behind institutional subscriptions and so would require a membership or payment, or because they come lower down the results list (Google does not actually link to every result it lists).

- The inability to publish a reproducible search strategy
  In evidence-based medicine it is important to publish your search strategy so that it can be reproduced to update the search and so that others may evaluate it. This is not possible with a Google search, for reasons described later in this section.

We have provided some examples of the limitations of Internet search engines.

- Google
  Google is a search engine that crawls the Web and retrieves results using an algorithm which, for commercial reasons, is a closely guarded secret. What we do know is that Google is not concerned with who published the information or the quality of the information. The ranking of search results on Google are subjective as they vary according to IP address, location and previous search history (i.e. which computer is being used, where it is located geographically and the previous searches conducted on it). The frequency and location of keywords and the number of other pages that link back to the page are also taken into account. So while great for browsing the Web, Google generates a search that is not reproducible by others.

- Google Scholar
  Google Scholar is also a search engine, but it restricts the parts of the Web that it crawls to scholarly sources such as academic publishers, scholarly societies and university web sites. This means it can reveal useful results, but unlike bibliographic databases, it does not publish a list of the sources it is searching (in fact it keeps these a trade secret), and so we cannot say with confidence that we have performed a systematic search of all the relevant veterinary journals. However, Google Scholar does have the advantage that it searches the full-text of web resources, and so it may retrieve results that would not be found via bibliographic databases (which search the bibliographic data only, e.g. author, title, abstract, keywords).

- Wikipedia
  Google will often give you results from Wikipedia, the online encyclopaedia written collaboratively by Internet volunteers. Anyone with Internet access can make changes to Wikipedia articles, and people often contribute anonymously using a pseudonym. This has pros and cons: it can be updated very quickly, and articles are dynamic and so can be updated to reflect new evidence. However, the quality of articles depends on the skill and knowledge of individual authors, which can be hard to ascertain from anonymous contributions.

Free databases for veterinary sciences

There are freely available databases are on the Web, some examples of which are:

- PubMed covers the life sciences, including veterinary medicine, and has a focus on biomedicine.
- PubAg focuses on articles pertaining to production animals and animal welfare. Both of these are good places to start if you have limited access to veterinary databases.

Relying on free databases can mean you miss searching some veterinary journals, so you may need to look into other solutions!

Which databases have the best veterinary coverage?

- CAB Abstracts has been shown to give the greatest percentage coverage of journals with veterinary content (Grindlay et al., 2012), and so would be seen by many as the key database for EBVM.

However, CAB Abstracts is costly, and this can be prohibitive. For this reason the publishers, CABI, have created a child-product:

- VetMed Resource which contains a sub-set of the records in CAB Abstracts selected for their relevance to vets. It is said to have a similar percentage coverage of the veterinary journals to CAB Abstracts, and so may be a more affordable option. The only loss might be that it does not index some interdisciplinary journals that may be relevant to some areas of EBVM.

Some veterinary journals that may contain useful evidence are not indexed in PubMed/MEDLINE, but are likely to be included in CAB Abstracts. For example, PubMed/MEDLINE and some other databases do not index all the equine and exotics journals found in CAB Abstracts. Some additional journals found in CAB Abstracts compared to other databases may not contain the highest quality research. However, if you wish to conduct a systematic review of the veterinary literature you would want to use CAB Abstracts.

Key databases for veterinary sciences

The key databases that index veterinary journals are listed here, with an indication of subject coverage and access. Links to the publisher's websites are also given, where further information about each database can be found.

DATABASE / ACCESS INFORMATION	ACCESS	SUBJECT COVERAGE
CAB Abstracts	Subscription required	Applied life sciences, including agriculture, and veterinary and food sciences.
VetMed Resource	Subscription required	A sub-set of CAB Abstracts – articles tagged to the Veterinary Science subset of CAB Abstracts are also available via VetMed Resource.

PubMed	**Free version of Medline**	Life sciences, with focus on biomedicine but includes veterinary medicine
Medline	Subscription required	Life sciences, with focus on biomedicine (same data as PubMed but available via different delivery platforms, which offer some enhanced search functionality)
Web of Science Core Collection	Subscription required	Interdisciplinary citation database
Scopus	Subscription required	Interdisciplinary citation database
BIOSIS Citation Index	Subscription required	Biological sciences
Embase	Subscription required	Biomedical and pharmaceutical subjects
Zoological Record	Subscription required	Zoology and animal science
PubAg	**Free**	Production animals and animal welfare

"Because veterinary research is published throughout a broad range of veterinary, agricultural, human medical, and basic science journals, no one database comprehensively provides indexing and abstracting to all literature relevant to the clinical question. Thus, careful searching using a wide variety of information resources is required." Sarah Anne Murphy (2007)

Do your best, remembering the best you can do might be limited

Finding creative ways to access more databases is a great idea, as relying on just one database, or just the free ones, is likely to compromise the level of recall of relevant evidence. Each database publishes a **'Journals List'** which indicates the scope and subject coverage of the database, for example see the List of Journals Indexed for MEDLINE or the Veterinary Journals Indexed in PubMed. The coverage of information will overlap to some extent between different search tools, and given the inter-disciplinary nature of the veterinary sciences, searching across more than one database will increase the chances of locating relevant research.

Database delivery platforms and interfaces

Some of the databases listed above are available to purchase from different database providers and via different platforms. The different delivery platforms can offer different search interfaces, which may offer enhanced functionality (e.g. clearer presentation of Subject Headings). When reporting a database search, it is important to mention the platform you accessed it on to enable the search to be peer-reviewed and replicated (as different platforms can require different search strategies for optimum searching). Some of the main platforms, with links to the suppliers, are given below:

- EBSCO
- Ovid

- ProQuest Dialog
- Web of Science

Access to databases

An obstacle to the widespread practice of EBVM is access to the databases and journals that can hold high quality evidence. Veterinary practices and individual veterinarians will need to actively investigate the most practical and affordable strategies for accessing the best available evidence in their given situation.

Many databases and journals are not free to access and so vets need to either pay for access, find ways to access them through a third party, or use free resources (which may compromise the quality of their EBVM practice).

In human medicine in places like the UK, doctors rely on National Health Service (NHS) library services to provide access to much of the evidence they need for EBM. The lack of an equivalent to the NHS in the veterinary community means that there is no national body to pay for access to the databases and peer-reviewed journals that hold some of the most useful scientific evidence, and so alternative routes must be found. This is one of the key challenges for members of the veterinary profession looking to take EBVM forward.

Options for accessing bibliographic databases

Free databases

It may be that vets need to rely on free sources of evidence as a pragmatic solution to the problem posed by expensive subscriptions. As long as vets are aware of, and open about, the potential limitations, this approach may still improve the quality of decision-making.

"Keep in mind that no source of evidence is perfect, and the practice of EBVM relies on evidence that is "best available." Gibbons (2009)

PubMed, PubAg, and Google Scholar are all freely available on the Web, as previously described in the section on databases.

Access to databases via professional bodies

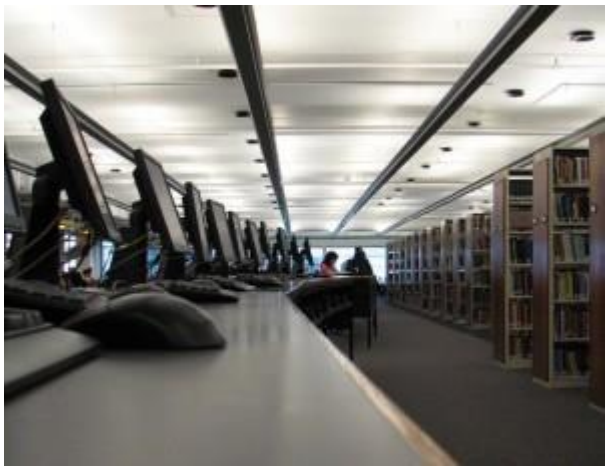
Certain professional bodies also provide access to databases as part of their membership package. Some examples are provided below:

- RCVS Knowledge Library & Information Service offers veterinary practitioners access to veterinary databases and journals for a membership fee. This may well prove an economical way for vets and vet nurses worldwide to get access to the key databases and full-text articles. Even if you're not a member, the Library can provide you with copies of articles at a cheaper rate than most pay-per-article options on publisher websites. The Information Specialists offer a literature search and document supply service which gives practitioners the opportunity to conduct

systematic searches of the veterinary literature, and so this will be an important service for the development of EBVM.

- BSAVA members' access to VetMed Resource – the British Small Animal Veterinary Association offers access to CABI's VetMed Resource as a benefit to all paying members.
- American Veterinary Medicine Association – members of the AVMA will have access to the AVMA Knowledge Base. AVMA professional staff make AVMA literature reviews publically available and invite requests for reviews in new areas.

Access to databases via University, College and Vet School libraries



Many veterinary schools and University Libraries will have made large investments in database and journal subscriptions, but the licence agreements with the publishers restrict access to members of the institution. So while we can train the next generation of vets in the systematic searching required for EBVM using these databases, we cannot promise they will have access to them after graduation.

Vets who have part-time membership of a Veterinary School or University (e.g. those undertaking certificate modules) can take advantage of the free access this gives them to subscription databases and journals via the Library subscriptions.

Subscribe as a practice

Practices can investigate the options for subscribing to databases at the practice level so that all staff working there can get free access. This requires contacting the publishers to get a quote, as the price can vary according to the size of organisation.

- VetMedResource, which includes a sub-set of the CAB Abstracts database, was designed specifically to provide an affordable alternative for veterinary practices (given that the cost of a subscription to the full database can be prohibitive). The compromise here is that the number of journals indexed is smaller, and so coverage not as broad, so some journals that are not strictly veterinary, but that may contain evidence will be missed.

Subscribe as an individual

Some database providers offer options for individual subscriptions.

Free or low-cost access to databases and publications for developing countries

There are also a number of international initiatives to provide free or low-cost online access to databases (and full-text journals) over the Internet. These will be of great value for developing EBVM. Examples include:

- Research4Life offers developing countries free or low-cost access to academic and professional peer-reviewed content online, including access to Agora (Global Online

Research in Agriculture) and other health and environments sources. The service offers access to a wide range of databases and journals from scientific and academic publishers.
- The International Network for the Availability of Scientific Publications (INASP)provides access to a wide range of databases and journals to low-income countries. Journal titles available vary by country.
- Electronic Information for Libraries (eIFL) supports affordable licensing of journals in 50 low-income and transition countries via Library consortia.

Other sources of information

There are other sources of veterinary information on the web, some of which are listed below. Remember, however, that you should be careful to appraise how reliable the source is (more information on this in APPRAISE):

- RCVS Knowledge: sources of evidence – a very useful list maintained by the Library staff at RCVS Knowledge.
- Veterinary Science Search and Veterinary Information Resources – the U.S. National Library of Medicine maintains this list of veterinary information sources, which includes some free-access databases and websites of key animal health organisations.
- Merck Veterinary Manual – this classic reference work is now available for free on the web.
- WikiVet – led by staff at the Royal Veterinary College in the UK, it offers open access veterinary information, and is not open for the public to edit, so the articles are written and edited by veterinarians and vet students.
- Vetstream: veterinary clinical reference is a subscription-based, point-of-care online tool offering information resources on clinical topics, including text, images (X-rays, MRI scans, and ultrasound images) and videos. It lists literature references and links to live searches in PubMed and VetMed Resource.
- Consultant – a diagnostic support system for veterinary medicine from Cornell University College of Veterinary Medicine.
- IVIS (International Veterinary Information Service) – online book chapters and conference proceedings.
- VIN (Veterinary Information Network) – a community website for vets in practice containing databases, message boards, conference rooms, online proceedings, and more.

Access to publications

The full text of publications, notably articles from subscription journals, will often not be accessible via the databases and search engines that list them, and you may need to develop strategies for getting a copy of the full text.

Databases are generally just a search tool (i.e. they do not contain the full-text of the publications themselves). There is therefore a two-step process to acquiring evidence via bibliographic databases:

1. Searching the databases

2. Retrieving the full-text of publications

Access to the publications is not always free, and can require subscriptions or pay-per-view payments, especially if they are in commercially published journals.

The Open Access movement

There is a strong will among many in the academic community to make publications open access, with free and unrestricted access online. Many research councils are now making it obligatory for the publications arising from the research that they fund to be made available open access, and so it is likely that this trend will grow in future years. But for now, not all access will be free.

If you do not have paid-for access, the following alternative techniques may help you get access to the full-text of publications:

Free access to publications

Google and/or Google Scholar

Google will help find any Open Access copies of the publication (e.g. those held in University repositories or websites).

PubMed

PubMed has the full-text of a small subset of the articles it lists, so you may be lucky. Failing this, you can restrict the results to the titles of journals that you do subscribe to.

Access via professional bodies

Most vets will have at least one professional membership, which may give them access to journals and other resources to support EBVM. It is worth investigating which resources your professional bodies give you access to, and perhaps lobbying them for more, as this can be an extremely valuable service offered to members.

Some examples are given below:

- British Veterinary Association – membership provides subscription to Veterinary Record, In Practice (including online archives) and other online resources
- European Society of Veterinary Dermatology – the ESVD offers members full access to over 20 reputable international journals and congress proceedings.

Access via libraries

RCVS Knowledge Library

Membership of RCVS Knowledge Library and Information Service gives you an economical and efficient way of accessing journal articles. Members get access to most veterinary journals, including Veterinary Clinics of North America, JAVMA and

Veterinary Surgery. If the Library does not provide access to the article you need, they can usually get it from another library. Even if you're not a member, RCVS Knowledge Library can provide you with copies of articles at a cheaper rate than most pay-per-article options on publisher websites.

Use your Public Library's inter-library loan service

This is not to be underestimated, as for a small fee public libraries can obtain all manner of publications, including journal articles. If obtained via National Libraries these will often now be emailed to you in electronic format.

Use any access to University Libraries you may have

If you have a University login, you can access the Library subscriptions for free – many of their journals and books will be online now.

National libraries

Some offer national schemes to help get access to subscription resources. For example, vets resident in Scotland should be able to access some eResources through registering with the National Library of Scotland

International libraries

The International Directory of Veterinary Medical Libraries is available from the Medical Libraries Association in the USA.

Paying for access

Pay-per-view

Most journal publishers offer the option to buy individual articles as you need them, which can prove expensive if you are doing a lot of searching. So while it may not always be the most efficient mode of access, it can help sometimes.

Subscribe to key journals

As a practice or individual, once you have identified the journal titles that publish the best evidence in your field of practice. Subscription to the online version enables simple cross-searching of backfiles, which can help with an evidence search.

How to find the evidence

If you want to be able to find the best available evidence, it is worth investing some time learning how to get the best possible results from the key bibliographic databases.

Each database works in a slightly different way, but understanding some key principles can really help, and so this section will take you through these step-by-step.

But there are other places you can also go to for help if you want to develop your search skills.

One of the most effective ways to become an efficient searcher is to take advantage of the free online training available.

Help from the database publishers

Online training tutorials, guides and Help Pages from the database publishers can be a great source of help. For example:

- PubMed online training
- PubMed / Medline search for Veterinary Medicine
- Ovid online training (for Medline, CAB Abstracts and EMBASE if using the the Ovid platform)
- Scopus Learn and support
- Web of Science training and support
- Biosis training
- CAB Abstracts resources for database users (see 'Product user guides and training videos')
- Zoological record training

Help from librarians

Librarians and information specialists can help you to learn more about database searching, and some Libraries offer open-access database guides which anyone can use. For example:

- Database training guides provided by the Medical and Veterinary Subject Librarians at the University of Bristol, UK.
- Veterinary Medicine databases web page from the University of Edinburgh Library, UK.
- PubMed for Veterinarians

Help from YouTube

Free, open access videos, such as those on YouTube can often be incredibly useful when trying to develop a new skill, and database searching is no exception. If you are discerning, you may be able to find some excellent videos to help you learn more about effective database searching.

Let's take a look at a database search strategy, and the key principles that can help you to find the best available evidence.

A database search strategy

A search strategy ensures that a database search will be systematic and comprehensive.

One of the best ways to learn the fundamentals of database searching is to look at an example of a search strategy and see if you can follow the rationale and logic. If you can, it becomes easier to translate the basic principles to your own searches.

Have a look at the search strategy in the table below and work through it line by line to follow the logic.

If the process and terms in this table are unfamiliar to you, please work through the next few pages of the tutorial to learn more about conducting effective database search strategies. You can build a similar search using the 'Advanced' search in PubMed.

In [cats with naturally occurring chronic kidney disease] does [a renal prescription diet compared to normal diet] increase the [survival time] of affected cats?			
Search number	**Search terms used**	**Type of search**	**Comments**
1	(Cat OR cats)	Free-text	A free-text search will find 'cat' or 'cats' anywhere in the bibliographic record (e.g. in the title field, in the journal title, in the abstract, etc.)
2	Feline*	Free-text	A truncated (*) free-text search will find any words which begin with the root word 'feline' anywhere in the bibliographic record. This will find 'felines' as well as 'feline'. You should be careful when using truncation searches though, as a short word will find more search terms, some of which may not be relevant.For example, 'Cat*' will find 'cat' and 'cats', but also 'cattle', 'catalysts' and 'catastrophe'.
3	Felis	Free-text	A free-text search will find 'felis' anywhere in the bibliographic record.
4	Cats	Subject heading	Searching for the subject heading 'cats' should find all bibliographic records which are about cats. Some databases allow you to 'explode' a search – this will include narrower subject headings in your search and will combine them using OR. For example, doing an exploded search for 'cats' will also find 'kittens' and 'feral cats'.
5	1 OR 2 OR 3 OR 4	Combination search using OR	This search combines all the searches used to find any records about cats, using the Boolean operator OR. This is a good way of ensuring that your search is comprehensive.

6	Chronic renal failure	Free-text	A free-text search will find ‘chronic renal failure’ anywhere in the bibliographic record.
7	Chronic renal disease*	Free-text	A truncated free-text search will find ‘chronic renal disease’ and ‘chronic renal diseases’ anywhere in the bibliographic record.
8	Chronic renal insufficienc*	Free-text	A truncated free-text search will find ‘chronic renal insufficiency’ and ‘chronic renal insufficiencies’ anywhere in the bibliographic record.
9	Chronic kidney failure	Free-text	A free-text search will find ‘chronic kidney failure’ anywhere in the bibliographic record.
10	Chronic kidney disease*	Free-text	A truncated free-text search will find ‘chronic kidney disease’ and ‘chronic kidney diseases’ anywhere in the bibliographic record.
11	Chronic kidney insufficienc*	Free-text	A truncated free-text search will find ‘chronic kidney insufficiency’ and ‘chronic kidney insufficiencies’ anywhere in the bibliographic record.
12	Renal failure	Subject heading	Searching for the subject heading ‘renal failure’ should find all bibliographic records which are about renal failure. As with ‘cats’, you can explode your subject heading search.
13	Kidney diseases	Subject heading	Searching for the subject heading ‘kidney diseases’ should find all bibliographic records which are about kidney disease. As with ‘cats’, you can explode your subject heading search.
14	6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13	Combination search using OR	This search combines all the searches used to find any records about chronic kidney disease, using the Boolean operator OR. This is a good way of ensuring that your search is comprehensive.
15	Renal diet*	Free-text	A truncated free-text search will find ‘renal diet’ and ‘renal diets’ anywhere in the bibliographic record.
16	Kidney diet*	Free-text	A truncated free-text search will find ‘kidney diet’ and ‘kidney diets’ anywhere in the bibliographic record.
17	Prescription diet*	Free-text	A truncated free-text search will find ‘prescription diet’ and ‘prescription diets’ anywhere in the bibliographic record.

18	Therapeutic diet*	Free-text	A truncated free-text search will find 'therapeutic diet' and 'therapeutic diets' anywhere in the bibliographic record.
19	Renal diets	Subject heading	Searching for the subject heading 'renal diets' should find all bibliographic records which are about renal diets. As with 'cats', you can explode your subject heading search.
20	Therapeutic diets	Subject heading	Searching for the subject heading 'therapeutic diets' should find all bibliographic records which are about therapeutic diets. As with 'cats', you can explode your subject heading search.
21	15 OR 16 OR 17 OR 18 OR 19 OR 20	Combination search using OR	This search combines all the searches used to find any records about diets, using the Boolean operator OR. This is a good way of ensuring that your search is comprehensive.
22	5 AND 14 AND 21	Combination search using AND	This search combines the previous combination searches, using the Boolean operator AND. This will now limit results to records about renal diets in cats with chronic kidney disease.

Search terms

Once you have written your question (see ASK), use the PICO terms to design your search strategy.

Let's look at an example based on one of the PICO questions used in ASK:

In [cats with naturally occurring chronic kidney disease] does [a renal prescription diet compared to normal diet] increase the [survival time] of affected cats?

The first step is to make a list of the key concepts to search for. In this example, the key concepts for the search strategy would be 'cats', 'kidney disease' and 'diets'.

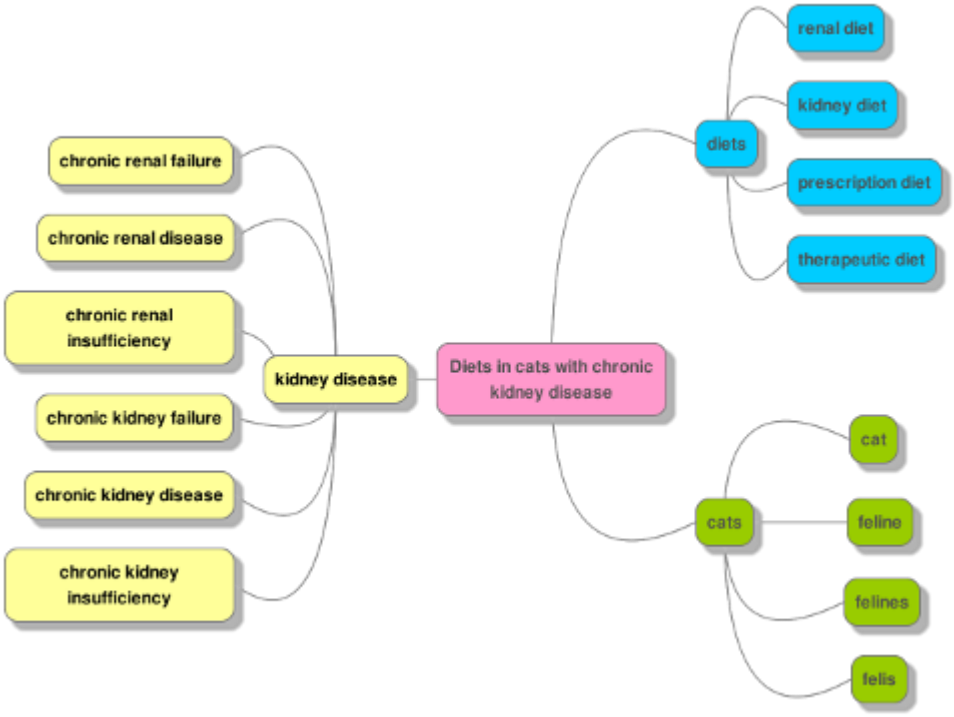
Note that the PICO and the search strategy are not the same thing – it is likely you will not search on all your PICO terms. For example, "Outcome" terms are often excluded from a search because they can be broad terms with many alternatives, meaning key articles may be missed if they are used.

The next step is to think of alternative terms for each concept. Think about alternative spellings for your terms (e.g. UK English / American English spellings); synonyms – different terms with the same meaning; colloquial phrases, and related terms which you would like included in your results.

Be as specific as possible, and where you are interested in a largish area (such as kidney disease), list all the more specific topics (like types of kidney disease) that

you want to cover. See below for diagrams showing how you may organise your major subjects and keywords.

Feline	Chronic renal failure	Kidney diet
Felines	Chronic renal disease	Renal diet
Felis	Chronic renal insufficiency	Prescription diet
	Chronic kidney failure	Therapeutic diet
	Chronic kidney disease	
	Chronic kidney insufficiency	



Types of search

There are two types of search: free-text searching and thesaurus searching, and using a combination of the two can help maximise the chances of you recalling all the most relevant evidence.

Free-text search

A free-text search means the database will find exactly what you type in the search box. This might seem the most simple and easy way to search, but it's not necessarily the most effective way. You should be aware that free-text searching:

- *Ignores plurals*: For example, if you search for 'dog' in some databases, you will not retrieve results containing the word 'dogs'.
- *Ignores spelling differences*: For example, a search on 'animal behaviour' (the English spelling) will not always retrieve results containing 'animal behavior' (the American spelling).
- *Can retrieve too many irrelevant results*: For example, a search on 'nutrition' will retrieve every instance of this term in every record in the database, regardless of whether it was a focus of the publication.

When searching using free-text search terms it's important to remember that words you use to mean one thing can have an entirely different meaning in another subject area. For example, the word 'membrane' has a different meaning depending on whether you're a biologist or an engineer. This is particularly important if you're searching a resource which isn't subject specific, such as Google Scholar.

Thesaurus search

If the database has a thesaurus you should take full advantage of this, as it will automatically retrieve results containing related terms, which you may not have thought of, and will help focus your search.

A thesaurus can be called different things:

- MeSH (Medical Subject Headings) in PubMed and Medline
- CAB thesaurus descriptors in Cab Abstracts
- Subject Headings
- Controlled Vocabulary
- Keywords

One of the most common mistakes in veterinary searches, is that the thesaurus term for the Species was not used, and so a large number of relevant papers are missed. For example, a search on horse in Medline, will not retrieve records that use the plural horses. However, a search on the thesaurus term horses will retrieve records that contain any of these terms:

- *equus przewalskii*
- *domestic horse*
- *horses*

- *domestic horses*
- *horse domestic*
- *horse*
- *horses domestic*
- *equus caballus*

Combine free-text and thesaurus searches

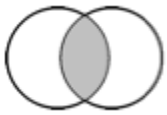
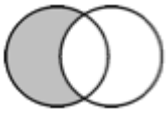
It is recommended practice to run both a free-text search and a thesaurus search for each of your key concepts and then to combine the two searches with the Boolean operator OR. This will maximise the chances of you retrieving all the most relevant evidence for that concept.

If you go back to our example of a search strategy you can see an example of how this can be done.

Boolean operators

Boolean operators are used to combine search terms and instruct the database or search engine how to search and retrieve the information you require.

The Boolean operators are **AND**, **OR** and **NOT**. These search conventions are used by most search engines and search tools. You should become familiar with using them as they could make a big difference to the relevance and number of results you get.

cats dogs 	AND	AND retrieves only the records containing all of the combined terms: this example has retrieved records about both cats and dogs.
cats dogs	OR	OR retrieves records containing any of the combined terms: this example has retrieved records about either cats or dogs, or both. Records are not duplicated in the results.
cats dogs 	NOT	NOT retrieves records containing one term but excludes records containing an unwanted term: this example has retrieved records about cats, but has left out anything about

		dogs. Use NOT with caution, as it can exclude records which may be useful.
Kidney disease cats dogs	AND & OR	Use more than one Boolean operator to make more complex refinements: this example has retrieved records about kidney disease and either cats or dogs.

Some search engines require that you use brackets or inverted commas around the keywords you are combining using the Boolean operator OR. This is referred to as nesting. If you are unsure whether to use them, check the help tab on the resource you are using for searching guides.

For example, you may need to structure your search as:

(cat OR cats OR dog OR dogs) AND kidney disease

Search tips

When searching bibliographic databases, it's important to remember that the database will only search for what you tell it to search for.
If you're looking for resources on 'livestock', the database won't assume that you're interested in searching for cattle, sheep, goats, and poultry, etc. unless you tell it that you are. Be sure to be specific in your searches.

It is good practice to search for the terms for each concept separately so that you can try combining them in different ways in the *Search History of the database.*

This has the advantage of enabling you to see the number of search results each concept gets, which might help you to refine your search terms. Boolean operators allow you to build your search up term by term, and then combine these terms in a variety of different ways, depending on how useful the results are. We will say more about this in the section on refining your search.

There are some useful features you can use when searching:

- *Truncation* – This usually uses the symbol asterisk *. You can use it at the end of a search term. This allows you to search for all possible endings, e.g. therap* will find therapy, therapies, therapeutic etc.; diet* will find diet, diets, dietary, etc.
- *Proximity searching using ADJn, NEAR, NEXT* – These work best when searching closely related words that you would expect in a paragraph, e.g. therap* NEAR diet*
- *Wildcards* – This usually uses the question mark symbol ? It replaces a letter within a word, e.g. an?esthesia will retrieve anaesthesia and anesthesia.

Note – The symbols used for wildcards and truncation vary between different databases and search tools. You should check the help pages for each database to see what they support before starting your search. For instance, Google (as one of the main search engines) doesn't support truncation with an asterisk – it does this automatically (using stemming algorithms), however asterisks can be used in Google as wildcards.

You can use these features to ensure that searches are comprehensive. For example, when searching for information on cattle, a comprehensive search could be:
(cow OR cows OR cattle OR calf OR calves OR bovi OR steer OR steers OR freemartin)*

Limits and filters

You can apply limits and filters to ensure that you have fewer irrelevant results to look through.

Most databases offer the ability to refine your search results using different parameters:

- Publication date
  The most commonly used limit is publication date – you can limit your search results to articles published in a particular year range. However, it's important to remember that older papers may still be valid and relevant.

- Geographical area
  Some databases allow you to limit by geographical area (for databases which use subject headings, there are usually geographical subject headings which you may wish to use). However, bear in mind that you may exclude some relevant articles when you limit by geographical area.

- Language
  Most databases also allow you to limit your results to publications in a particular language, or languages. Whilst this may be useful, it's not best practice if you wish to carry out a comprehensive search. There may be an abstract in a more commonly used language available which should give useful information about the content of the paper.

- Publication type

You can also restrict to certain publication types such as journal article, conference paper, randomised controlled trial, meta-analysis or review.

- Search filters
  Some databases allow you to apply search filters (also called methodology filters) to your search. Search filters are pre-created search strategies which can be used to retrieve particular types of study, such as systematic reviews or meta–analyses. You can use the help pages of databases to find out which filters are available in that database. For example, CABI has produced a search filter to retrieve systematic reviews or meta-analyses in CAB Abstracts and Global Health called CABI filters.

Refining your search

Searching databases is an iterative process. As you review your results, you may decide to refine your search strategy to include, exclude or amend some search terms, limits and/or filters. This is a normal part of the literature searching process.

Here we offer some advice on strategies to use to address the most common search problems:

If you have too many hits

- *Be specific:* Use search terms that are as precise as possible.
- *Boolean operators:* Use the powerful AND or NOT operators to refine your search. Use NOT with caution!
- *Limit:* Reduce the parameters of your search by selecting publication year, language, publication type, etc. There is a full range of limits, but use some with caution, e.g. restricting your search to articles in English is an arbitrary measure, probably excluding excellent research.
- *Focus:* Some databases have a “major heading” option for subject heading terms, restricting the search to articles with your term as a main subject. Again, use this with caution as you may miss some excellent articles.
- *Search filters/methodology filters* (see the “Limits and Filters” section earlier): Apply ‘ready-made’ search filters to find the right data. Some databases have them as Limits, or you can use methodological filters for systematic reviews, meta-analyses, etc.
- *Subheadings:* Some databases have subheadings – shortcuts to popular facets of research, varying by subject heading. Be cautious with subheadings – they are not always robust, and you may miss relevant articles.

If you have many irrelevant hits

- *Subject Headings:* You will retrieve a higher proportion of relevant articles if you search with subject headings rather than with free-text alternatives.
- *Permuted Index* (Ovid interface – in the Tools menu): Search for all subject headings containing your word, you will be able to select the most appropriate subject headings from a list.
- *Thesaurus Display:* Use the subject tree/index to find more precise subject headings.
- *Limit:* See above.

- *Boolean operator NOT:* A search on ‘pregnancy’ will retrieve a fair number of articles also about childbirth. Searching for ‘pregnancy NOT childbirth’ will exclude the articles including childbirth. Beware! You may exclude many useful articles.

If you have too few hits

- *Check your spelling:* It may seem obvious, but incorrect spelling, particularly in free-text searching, will reduce the number of results. It’s easy to spell cattle with three “t”s, for example! Beware of alternative spellings during textword / keyword searches (e.g. behaviour / behavior; immunisation / immunization).
- *Explode:* Use the explode option to include a broad subject heading and all the narrower terms branching off from it (this is easier to visualise if you look at the Tree Display).
- *Avoid subheadings:* Select ‘All Subheadings’ when you are presented with the option, because the subheading system is not entirely reliable.
- *Synonyms:* Most database content is international, so if your search terms do not map to any appropriate subject headings, think of North American or other equivalents.
- *Lateral searching:* Look at the subject headings tagged onto a relevant article. Use those terms to expand the scope of your search.
- *Free-text searching:* An alternative for terms that are too new or are not sufficiently widely used to be subject headings.
- *Related terms:* Use the truncation symbol (the symbol can vary between databases, but the most common one is *) in your textword / keyword search to retrieve words with a common root. ‘Tubercul*’ will bring up tuberculosis, tuberculin, tubercule, etc.
- *Search other databases too:* No database is complete. In addition to CAB Abstracts and Medline/PubMed, try the Biosis Citation Index, Web of Science, etc.
- *Avoid limits:* Especially ones that don’t influence the quality or relevance of search results (e.g. abstract only).

Citation searching

Citation searching is a powerful method for finding publications relating to your field of research, which might not be found using conventional search strategies.

This type of search is often done in addition to standard database searching, to increase the recall of all the relevant literature. However, this method should not be used in isolation when searching for evidence as large amounts of information could be missed.

Citation searching uses one relevant publication to locate others, by exploring the list of references at the end of the publication in the bibliography (*going back in time* and reading what the authors read to inform the article), and by exploring other publications that cite your reference (*going forward in time* and reading subsequent publications that listed your reference in their bibliography).

The metaphor “citation pearl growing” is sometimes used to describe citation searching, as it’s like seeing a single grain of sand (your one useful reference) grow into a beautiful pearl (a list of many useful references).

Where to do citation searches

Certain subscription databases have a *citation index* created from the lists of references that appear at the end of journal articles. This means you can also find articles that cite that journal article, as well as the articles which that article references.

- Web of Science (from Thomson Reuters – includes the three original citation indexes, including the Science Citation Index)
- Scopus (from Elsevier – the main competitor to Web of Science)

More recently, other online journal collections and databases have included citation indexes, notably:

- ScienceDirect

A free option, that does not require subscription:

- Google Scholar Citations

Google Scholar now offers citation information on search results, though given the different coverage of Google Scholar from bibliographic databases, these results may not tally with those of the formal, bibliographic databases (i.e. Google Scholar comprises automatically generated lists which include pre-prints and non-reviewed websites, as opposed to the curated, published and peer-reviewed content in Web of Science for example).

How to do citation searches

Choose a key publication that is highly relevant to your search (and ideally more than two years old). Then, in one of the tools listed above, conduct a search for this article (e.g. an author/ title search or use “Cited Reference Search”). The citations relating to your article will be accessible via links called variably “Citation network”, “Cited By”, or “Related Articles”.

Advantages of citation searching

Citation searching can turn up publications that were not found via standard database searches because you are not constrained by the vocabulary of a search strategy or bibliographic record. You may also find articles from unexpected disciplines.

But the main advantage of citation searching is that you can follow a line of scholarly communication on a given topic over time, by going backward and forward from a seed reference. You may also be able to gauge the impact of a publication by looking at the citation count, the logic being that articles that are frequently cited have had greater impact or influence in the scientific community (though of course there will be exceptions to this).

Managing your search results

It is essential to keep records of the search strategies you use and the references that you find, if you are to make your searches repeatable.

If you plan to publish an evidence synthesis, then the target publisher may have reporting standards that you need to follow. For examples, see:

- Guidance on compiling a Knowledge Summary from RCVS Knowledge, which includes a requirement for reporting the Search Strategy and the Search Outcome.
- Reporting a literature search for BestBETs for Vets.

The process of scanning the results of a database search generally goes as follows:

- *Title sift* – scanning all the titles your search pulls up to see if they are really relevant to your question (and discard those that are not).
- *Abstract sift* – reading through the abstracts from your title sift to see if they are really relevant to your question.
- *Full-text sift* – reading through the full manuscripts from your abstract sift to see if they are really relevant to your question.
- *Studies* included in your review.

Following this process you will be left with the studies to include in your review.

"An ability to sort through a mountain of data, evaluate the quality of findings, and obtain what is useful and relevant is a skill needed by the twenty-first century equine veterinarian as much as the ability to pass a tube or perform a rectal palpation" Nolen-Walston et al. (2007)

Reporting a search

It is good practice to keep a record of the searches you run and to report on this so that the process for identifying the evidence base is transparent and reproducible.

Reporting your search in a standard way enables the search to be replicated in the future, to identify any new evidence published since the last search was run. It also demonstrates the quality of the search strategy and allows others to assess this – they will want to have confidence that the search captured the most relevant literature.

What to report

As a minimum, the following should be reported:

The search strategy

- The date on which the search was conducted.
- The names of the databases (including the platform and database coverage dates if known).
- The search strategies (e.g. the full search terms used, with an explanation of any decisions made about these if not self-explanatory).

- Any limits or filters applied to the search (e.g. date, language).
- Names of any other sources searched.
- Details of any supplementary searching.

The search outcome

- How many publications were found in the searches and how many were included in the synthesis.
- The criteria used for selecting or excluding articles (e.g. duplicates, languages, dates, types of study).

Reporting guidelines for evidence syntheses

Reporting standards exist for evidence-based medicine that might be adopted by those conducting formal systematic reviews of meta-analyses in veterinary medicine. For instance, it is best practice to follow the PRISMA guidelines for systematic reviews or meta-analyses in order to ensure that all the information the reader might need has been reported.

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

Hide this content

The PRISMA for systematic reviews and meta-analyses (Moher et al., 2009) consists of a 27 item checklist and a four phase flow diagram that can be used to report a search strategy of meta-analysis.

For reporting a literature search, the most relevant sections of the PRISMA checklist are:

Information sources (item 7): Describe all information sources (such as databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.

Search (item 8): Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.

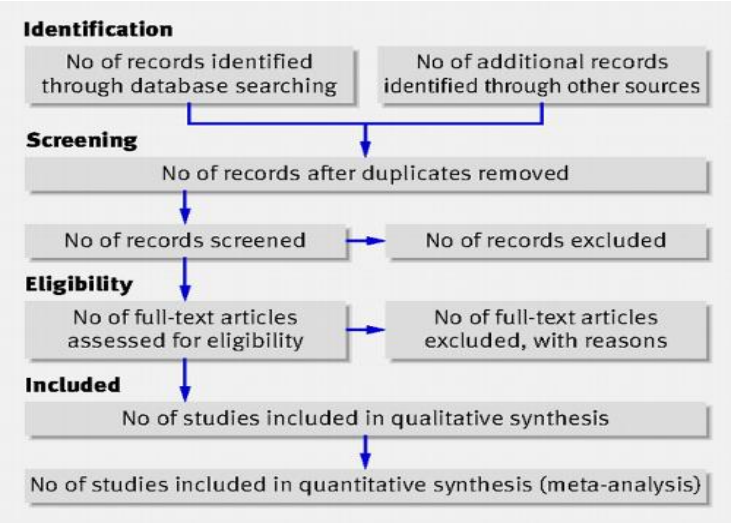


Figure 1, from Moher, et al. (2009)

The Cochrane Handbook for Systematic Reviews of Interventions (Higgins and Green, 2011) offers guidance on best practice for human evidence-based medicine which might be adapted for use by the veterinary profession. The Cochrane Handbook recommends reporting the following in the search process in the Methods section:

- List all databases searched.
- Note the dates of the last search for each database AND the periods searched.
- Note any language or publications status restrictions.
- List grey literature sources.
- List individuals or organisations contacted.
- List any journals and conference proceedings specifically hand searched for the reviews.
- List any other sources searched (e.g. reference lists, the Internet).

Reference management tools

You will find references which you may want to use later or which you plan to cite. Reference management tools, or bibliographic management tools, allow you to store and organise your references.

You can create collections of references on different topics, different conditions, different treatment outcomes, etc., and you can add your own notes to each bibliographic record. As these tools are electronic, they can be searched easily, allowing you to retrieve your key references on a particular topic quickly.

Many reference management tools allow you to add attachments to the records. For example, you may wish to add your own clinical images, web pages, PDFs or links to full-text.

You can add records to reference management tools manually, but it's more common to export a set of records from a bibliographic database into whichever reference management tool you're using. Most databases support this and have an 'export' option.

When you're exporting records from a bibliographic database to a reference management tool, it's a good idea to export the whole record. You can always delete some of the fields later, but you may find that you want to retain things, such as the subject headings and the abstract, as these include information which you can search later.

Most reference management tools have plug-ins which work with Microsoft Word and other word processing packages, allowing you to embed your references into a document. You can also re-order and change referencing styles for references in documents, either as you write or after you've completed a document. Reference management tools usually support a wide range of referencing styles, and many list them by journal title as well as by citation style.

Most web-based reference management tools allow you to create groups of records and share them with other people, so if you're working on a clinical project, you can easily share references with colleagues.

There are several reference management tools available. Some are free to use (e.g. EndNote basic, Mendeley, Zootero), and some you have to pay to use (e.g. EndNote, Reference manager).

The University of Edinburgh have produced a comparison table which gives information on some of the reference management tools you may wish to consider.

Quiz

RCVS Knowledge is publishing a collection of evidence syntheses to support EBVM – what are they called?

- BARKIncorrect. BARK stands for Banfield Applied Research and Knowledge, the research division of one of the largest privately owned practices in the USA, who also produce evidence syntheses.
- BestBETS for VetsIncorrect. BestBETS for Vets are evidence syntheses produced by the Centre for Evidence-based Veterinary Medicine at Nottingham University.
- CATSIncorrect. In human medicine, CATS stands for Critically Appraised Topics, a type of evidence synthesis, but in the vet community it was felt it could be confused with the feline species!
- Knowledge SummariesCorrect. RCVS Knowledge in the UK is creating a global network of vets to collaborate and create an open source repository of Knowledge Summaries to support EBVM.
- Systematic reviewsIncorrect. This is a generic term for a comprehensive summary of all the published evidence on a particular clinical topic.

What bibliographic database has been shown to have the greatest percentage coverage of journals with veterinary content?

- BIOSIS Citation IndexIncorrect. This is the key database for biological sciences, and so while it may give some useful results, it would not be the key database for clinical veterinary practice.
- CAB AbstractsCorrect. However CAB Abstracts is costly and so many vets use the related product, VetMed Resource which contains a sub-set of the records in CAB Abstracts, selected for their relevance to vets.
- MedlineIncorrect. This is the key database for human medicine, though it also covers many of the key peer-reviewed veterinary journals, and will be strong on inter-disciplinary journals in health sciences.
- PubMedIncorrect. PubMed is a free version of Medline, the key database for human medicine, though it also covers many of the key peer-reviewed veterinary journals, and will be strong on inter-disciplinary journals in health sciences.
- VetMed ResourceIncorrect. VetMed Resource is a related product of CAB Abstracts and so contains a sub-set of the records from the parent database, selected for their relevance to vets. It is much cheaper than CAB Abstracts and so is used by many vets for this reason.

What does the VetSRev database help you to find?

- Grey literatureIncorrect. Try again.
- Knowledge SummariesIncorrect. Knowledge Summaries is the term used by RCVS Knowledge to describe evidence syntheses generally, not specifically systematic reviews.
- Peer-reviewed articlesIncorrect. The Bibliographic databases such as CAB Abstracts and Medline would do this.
- Systematic reviewsCorrect. VetSRev is a freely accessible online database of citations of systematic reviews relevant to veterinary medicine, produced by the Centre for Evidence-based Veterinary Medicine at Nottingham University.
- Vets who are vicarsIncorrect. Nice try!

Which of these Boolean searches would recall the most results for this species?

- cattle OR bovineIncorrect. OR does retrieve records containing any of the combined terms, but adding truncation to one of the terms here would give you more results.
- cattle AND bovineIncorrect. AND should be used to combine different concepts as it retrieves only records containing both terms.
- cattle NOT bovineIncorrect. NOT excludes records containing an unwanted term, so here only results containing the term cattle would be retrieved.
- cattle OR bovi*Correct. OR retrieves records containing any of the terms and so should be used to combine synonyms, and by using the asterix to truncate bovi* you retrieve words with all possible endings such as bovid, bovine and bovidae.
- cattle AND bovi*Incorrect. AND should be used to combine different concepts as it retrieves only records containing both terms.

Summary

You should now be more familiar with how to:

- Identify which information sources can help to find the best evidence for veterinary medicine.
- Establish how to get access to these resources for your own clinical practice.
- Translate a clinical question into a database search strategy and understand the fundamentals of efficient searching.
- Document and report your search strategies in standard formats.

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Appraise

Appraising is the next step in the EBVM cycle, where you evaluate the quality, validity and applicability of the study you are reading, to the question you have asked (or you want to answer)

By the end of this chapter you will be able to:

- Describe the most important factors that should be appraised when you read a paper.
- Explain how to appraise literature (and other information).
- Use tools that support the appraisal process.

In the Appraise section:

- **Why appraise scientific information?**
  - Is the study design appropriate to answer your question?
  - Not everything you read is true!
- The level of evidence
- What else should be appraised?
- A few other things to consider
- Assessing information quality
  - How to deal with the results
- Quiz
- Summary
- References

Why appraise scientific information?

Scientific literature is extremely important, but not always entirely valid.

Once you have identified one or more articles that deal with your question of interest, you can then start to read them. Or you may read an interesting article you came across while thumbing through a scientific journal. Questions that should immediately come to mind are:

1. Does the paper have the right study design to answer my clinical question?
2. Which level of evidence does the paper provide?
3. Is the quality of the paper good enough to help me answer my particular question?
4. Is the paper relevant to my clinical question, my population or my patient?

Scientific literature provides one of the most important links between research and practice, as it can be used to disseminate information far and wide, can be translated into a number of different languages, and provides a long-standing record of work that was done and of conclusions reached. However, evidence found may include different sorts of clinical trials, observational risk factor studies, case reports or expert opinions that provide similar or contradicting information. In some cases, authors of these papers advertise for cure-alls and panaceas; in others, they may present revolutionary discoveries they have observed in only two animals. Some of these papers may sound too good to be true – but are they?

"Don't believe everything you read!"

As the reader, it is often left up to you to discern quite a bit about the papers you read. Papers may differ considerably, not only in the relevance of information to real, practical scenarios, but also in the certainty you can have that the presented data are valid (Glasziou et al. 1997). Even study results published in prestigious journals may be biased by different factors, or be unreliable because of serious flaws in the design or conduct of the study. These same biases may also occur in other information that you get via expert presentations, drug company leaflets, etc., and it is up to you as a consumer of this information to demand high quality!

Every practitioner's aim is to provide the best patient care. It is up to you to make a multitude of decisions every day, with the awareness that it is important to use diagnostic procedures and therapeutic interventions that are the most effective and that have an optimal *risk:benefit* ratio. In addition, as a practitioner, of course you want to be able to provide an owner with accurate information regarding the

prognosis for their animal, and to take into consideration established risk factors for certain conditions in your diagnostic work-up.

In order to help you do these things in the best way possible, using EBVM, this section will highlight the skills needed to appraise the quality of information available.

Is the study design appropriate to answer your question?

When considering whether a paper answers your question, you should try to establish whether the methods used in the paper are appropriate. More information is given below, or you can go back to ASK

TYPE OF QUESTION	EXAMPLE QUESTION	STUDY TYPE THAT WILL BEST ANSWER THE QUESTION*
Treatment	In [dogs with osteoarthritis], does [supplementation with glucosamine and chondroitin] compared to [no supplementation] [reduce lameness]?	Randomised controlled trial
Prognosis and Incidence	In [flat-coated retrievers with cutaneous lymphoma], does [being a male] compared with [being a female] affect [average life expectancy]?	Cohort study
Aetiology and Risk	In [ferrets], is [general anaesthesia by triple injectable agent] compared with [general anaesthesia by induction and inhalational agent] associated with [an increased risk of death]?	Cohort study, Case-control study, Cross- sectional study
Diagnosis	In [lactating dairy cattle] does [milk ELISA] compared with [serum ELISA] have [a better sensitivity and specificity for diagnosing fascioliasis]?	Diagnostic test validation study
Prevalence	In [adult racehorses] what is the [prevalence of laryngeal neuropathy] in winter?	Cross-sectional study

* For all question types, meta-analysis and systematic reviews are more robust than individual studies.

A brief description of the common study types are outlined below in the table (adapted from Dean 2013). When reading a paper, it is important to read the methods section to determine what type of study was conducted; this may sometimes differ from the description in the title or abstract! It is important to understand what was done so that you can determine whether the method was appropriate to answer your question. Be aware that if you read around the subject of study design, you may find different descriptions; epidemiologists are still arguing about what constitutes what study type. This basic description is provided to help you interpret papers you find, and explain the meaning of the terms as used in this tutorial.

STUDY TYPE	DESCRIPTION (ADAPTED FROM DEAN 2013)
Meta-analysis	A meta-analysis is a quantitative statistical analysis (generally) conducted as part of a systematic review. By combining the data, a meta-analysis provides more evidence than each individual study is able to on its own.
Systematic review	A systematic review is a defined and rigorous method of collating and summarising the information from all published papers addressing a particular question. The methods used to search the literature, assess the quality, and make conclusions are explicitly stated in the methods section.
Randomised controlled trial	A randomised controlled trial is an intervention study used to assess a treatment or other intervention. Study subjects are randomly allocated to either the intervention group or a control group (which receives either no treatment, a placebo, the current best treatment or a comparator). Ideally, the study should be 'blinded' so that anyone involved with the animals does not know which treatment each animal received.
Cohort study	A cohort study is an observational study where exposed and unexposed groups (cohorts) are followed over a period of time. At the end of the study period, the outcome (e.g. disease) is measured. Cohort studies can identify risk factors associated with disease and estimate incidence.
Case-control study	A case-control study is a retrospective study comparing animals with the disease (cases) and without the disease (controls) of interest. The animals' histories are examined to identify risk factors for the disease.
Cross-sectional study	A cross-sectional study looks at a sample of the population at a single point in time, most commonly to determine the prevalence of a certain disease.
Diagnostic test validation study	A diagnostic test validation study is used to establish the usefulness of new diagnostic tests. Animals are tested using the new diagnostic test and the current gold standard to establish the sensitivity, specificity and likelihood ratios for the new diagnostic test.
Case series	A case series is a description of the presentation, diagnosis, treatment and outcome of a group of animals with the same disease. There are no disease-free animals for comparison, and any differences in management are not randomly allocated (for example, they may be due to the owners' preferences or different protocols between centres).
Case report	A case report is a description of a single case (or small number of cases).
Expert opinion	Expert opinion can be one individual's opinion or part of an elicitation process based on a panel of experts used to answer a question of interest. Expert opinion may provide some evidence where no information is available (e.g. new treatment efficacy or application to a new population).

Not everything you read is true!

You may have heard the common phrase 'caveat emptor' or 'Buyer, beware!', but do we think this way about veterinary information? We probably should, and particularly when it comes to the literature we use to make decisions about our patients.

Some projects assessing the quality of published literature in different fields of veterinary medicine have revealed substantial deficits in reported studies, even those in very reputable peer-reviewed journals (Cockroft et al. 2007, Kastelic et al. 2006)! When you read a paper, you should keep this in mind, as you may find conclusions formulated by authors that are based on weak, or even no, scientific data. Other papers may report information generated using inappropriate study designs (see The level of evidence) which therefore invalidate the conclusions. As we're on the topic of EBVM, we can see there is actually evidence for this: reviews on veterinary topics reveal that, for instance, less than a quarter of papers are good enough to enable us to draw sound conclusions from them (Simoneit et al. 2011)!

A question to ponder: What is the actual quality of the paper I am reading? Is it good enough to incorporate the information into my practical work?

This chapter focuses on appraising the quality of scientific literature. When appraising other information sources, it is important to be even more critical. Consider the origin of the information, who wrote it, and why? Some of the limitations of internet searching are discussed in ASK, but the principles discussed in this chapter can also be applied when reading other sources of information.

The level of evidence

As we saw in the ASK section and previously in this module, there are a number of types of questions we can pose; these can, in turn, be answered by a number of different studies designed in various ways.

Information on treatment, prognosis and incidence, aetiology and risk, diagnosis, and prevalence can be derived from different sources and study designs. All study designs, however, are prone to methodological issues that will affect the certainty that the findings presented are valid. There is no perfect study, but the limitations of studies should be clear to the reader and help you along in trying to interpret and apply the information. It is very important to emphasise that the assessment of the quality of the study should be the first step when considering the implementation of new concepts into practice.

A number of study types exist and well-designed studies in each of these categories can be used to address veterinary questions of interest. One way to start is to think about how much evidence a particular type of study can provide for the type of question you are asking. As long as the study you are evaluating is of acceptable quality, choosing the type of study that is most appropriate to answering your question is the best way forward. The table below ranks studies in this way, with those that can show the best evidence at the top of the table, down to those that show the least evidence towards the bottom.

In human medicine, D.L. Sackett introduced the 'pyramid' or 'hierarchy' of evidence to aid in teaching appraisal of the scientific literature. This pyramid was designed to enable people to understand the concept that not all study designs are equal, but it is most applicable to questions about interventions (treatments). It is now widely accepted that appraising literature is more complicated than this pyramid can

account for. In veterinary medicine especially, this pyramid is difficult to apply, and beginning with your clinical question may be more straightforward. Again, remember that a good quality study is essential, no matter what level of evidence the study seems to provide.

In your clinical decision-making, you should rely on the strongest evidence available, and therefore determine the level of evidence a paper provides before implementing the information in clinical practice. You may also need to accept that the "best available" evidence may be lower down in this table than you might prefer (e.g. there may only be a handful of individual case reports rather than a systematic review), but take heart – some evidence is better than none!

Also remember that within each level of evidence, individual information should be evaluated and may be considered to be stronger or weaker after a thorough appraisal.

	Question Intervention					
Level of evidence	Treatment	Prognosis	Risk	Diagnosis	Prevalence	Incidence
1 (most robust)	Systematic review and meta-analysis	Systematic review and meta-analysis	Systematic review and meta-analysis	Systematic review and meta-analysis	Systematic review and meta-analysis	Systematic review and meta-analysis
2	Randomised controlled trial	Cohort study	Cohort study	Diagnostic test evaluation study	Cross-sectional study	Cohort study
3	Cohort study	–	Case-control study	–	–	–
4	Case report or case study	Case report or case study	Case report or case study	Case report or case study	Case report or case study	Case report or case study
5 (least robust)	Opinion consensus	Opinion consensus	Opinion consensus	Opinion consensus	Opinion consensus	Opinion consensus

This table has been adapted and simplified from the Oxford Centre for Evidence-based Medicine – Levels of Evidence 2009 and further information about each type of study is provided below.

Systematic reviews and **meta-analyses** follow a very strict protocol for summarising the evidence. They can be applied to many different types of questions. RSVC Knowledge provide a checklist of issues to consider in the evaluation of a systematic review.

There are many sources of veterinary evidence, and it can be helpful to break them down into primary (original research) and secondary (reviews with commentary on a number of primary studies) sources. With secondary sources, it's important to distinguish **systematic reviews** from **narrative reviews** of the scientific literature.

Systematic reviews

Systematic reviews employ standardised and rigorous methodologies to review scientific literature, with a view to minimising bias. They conduct a comprehensive literature search to identify, appraise, and synthesise all the relevant studies on a particular topic. They will formally and openly report the sources they use as well as the search strategies used to find those sources, so that searches can be peer-reviewed and replicated.

Narrative reviews

Narrative reviews, on the other hand, do not involve explicitly systematic searches of the literature, and so only tend to cover a subset of studies based on availability or author selection. This can introduce an element of selection bias. It is worth noting that narrative reviews can be informative, particularly if a systematic review does not currently exist on a particular topic, but they are not as robust as systematic reviews.

Meta-analysis

Meta-analysis involves applying statistics to the systematic review, providing a quantitative summary of the information obtained, and traditionally it focused on the estimation of a combined measure (e.g. relative risks or treatment effects) and weighted the included studies according to their size. By combining the results of several studies, the precision of the estimate can be increased through increased sample size and resultant statistical power.

For instance, ten studies looking at one specific type of treatment, when taken together, are much more powerful than one study on its own. The type of objective quantitative assessment of the results that a meta-analysis provides enables conclusions to be drawn based on information included in all the studies available. Nowadays, it is widely accepted that meta-analysis also provides an estimate of the relative importance of different factors affecting the outcome of interest. From a clinical point of view, this is very useful, since it helps to identify important risk factors that could apply to a particular patient with the characteristic of interest and the most likely outcome of a particular intervention.

Randomised Controlled Trials are clinical trials with random allocation of the animals to at least two groups (e. g. intervention and control). Given that the allocation of animals to the intervention of interest is performed randomly, all other characteristics of the population should be equally distributed across the treatment groups, thus decreasing bias. Therefore, evidence of a cause–effect relationship is more credible in these types of studies.The EBVM Toolkit from RCVS Knowledge provides a checklist of issues to consider in the evaluation of controlled trials.

When considering evidence provided by **controlled trials without randomisation** and **cohort studies**, one of the important points to consider is how well executed these studies might be, because without randomisation, equal distribution of characteristics of the animals included is not assured, and the results

may be biased. However, well-designed and well-analysed studies in this level could provide strong evidence of a cause-effect relationship. Cohort studies are also particularly useful in assessing evidence relating to prognosis. The EBVM Toolkit from RCVS Knowledge provides a checklist of issues to consider in the evaluation of a cohort study.

Case-control studies are considered to be a lower level of evidence for risk factors, given that they are more susceptible to multiple types of bias than cohort studies. However, well-designed and properly analysed case-control studies can provide solid evidence, for instance on risk factors for specific conditions. The EBVM Toolkit also provides a checklist of issues to consider in the evaluation of a case-control study.

Cross-sectional studies are best at measuring prevalence of disease in a population. However, well-executed cross-sectional studies can provide valuable evidence for certain risk factors, e.g. sex of the animal. The EBVM Toolkit provides a checklist of issues to consider in the evaluation of a cross sectional study.

Diagnostic evaluation studies are specifically designed to establish whether a new diagnostic tool accurately identifies disease in ill animals, and absence of disease in healthy animals. Animals are tested for the disease using both the existing 'gold standard' diagnostic test, and the new diagnostic test, and the sensitivity, specificity and likelihood ratios for the new test are calculated. Guidelines on evaluating diagnostic evaluation tests can be found here.

Case reports lack a comparison group, so it is very difficult to establish cause-effect relationships or indeed to be sure if an intervention made a difference in the first place, as we do not know what would have happened if another course of treatment, or no treatment was given.

Opinion **consensus (or expert judgement) reports** are positions reached by individuals or groups of experts, and are not necessarily supported by clinical research data. However, depending on how the expert opinions are elicited, results from expert opinion studies can have as much weight as the evidence from some other study types, and sometimes may provide better evidence than case reports or case series. For more information on study designs, the Centre for Evidence-based Medicine provides a guide

What else should be appraised?

The level of evidence is a good indicator of how prone to bias the study is likely to be due to its design.

In most instances, however, there is overlap between the different levels, for example when looking at treatment, a well-designed cohort study may provide better evidence than a poorly designed controlled trial. Therefore, the appraisal should address aspects including the sample size, enrolment criteria, allocation, blinding, statistical methodologies and objectiveness in the discussion of results. Within the

different study designs, you should assess possible biases that may have influenced the study outcomes.

You do not need to be a research scientist or a statistician to appraise the literature!

From a practical point of view, when you read papers, you should focus on the major issues that determine the quality of information. If you look through the literature, you will find that many articles are biased by poor reporting of crucial information like age and medical history of the enrolled animals, by inappropriate definitions or diagnoses of diseases, or by a lack of (or inappropriate) control groups (Dean 2013). This means that it is not your task to check or be familiar with every statistical procedure, but rather to be aware of key issues relevant to specific study designs. Below you can find, listed by types of EBVM questions, some resources provided by RCVS Knowledge and other organisations that highlight the key considerations to critically appraise different study designs.

Treatment

Evidence related to treatment often relates to intervention studies or randomised controlled trials. Occasionally, systematic reviews may address questions of treatment choice. There are a number of resources to guide you in appraising these study types:

RCVS Knowledge Appraisal Toolkit

- Systematic reviews
- Controlled trials

Centre for Evidence-based Medicine Guidelines for Appraisal

- Systematic reviews
- Controlled trials

Prognosis

Prognosis relates to the course of disease over time, and evidence related to prognosis can provide an invaluable source for the clinician when advising their client on the likely course of disease. Frequently, evidence related to prognosis is derived from cohort studies, and hence appraisal of this study type is particularly relevant in this setting.

RCVS Knowledge Appraisal Toolkit

- Cohort studies

Center for Evidence-based Medicine Guidelines for Appraisal

- Prognosis worksheet

Risk factors

Evidence related to risk factors can be relevant to the practicing veterinarian when advising on the likelihood of disease given the specific animal's characteristics, diet, environment, treatment, etc. When making judgements in relation to the likely casual

association between a reported risk factor and disease, often the observational studies will need to be interpreted. Evidence from cohort, case-control and cross-sectional studies will need to be appraised.

RCVS Knowledge Appraisal Toolkit

- Cohort studies
- Case-control studies
- Cross-sectional studies

Diagnosis

Veterinarians use diagnostic tests on a daily basis, yet often do not fully appreciate the evidence (or lack thereof) underpinning those tests when making major decisions for the animals they treat. Interpretation of evidence related to diagnostic tests is an important area of EBVM that can be overlooked.

Center for Evidence-based Medicine Guidelines for Appraisal

- Diagnostic tests

External validity

Another question that should be taken into account when appraising studies is whether the subjects (e.g. animals or specimens) used in the study are representative of the patient you are considering. Can the study results be transferred to your patient? Or are the subjects in the study you are considering so dissimilar that the results of that study do not apply to your patient?

The external validity of the paper is part of the whole assessment. It is important to understand the difference between the (average) effect on a population as compared to the effect for an individual patient. For example, on average, the effect could be beneficial, but be sure you consider that this average effect does not mean that it will produce that outcome every time in a given individual.

A few other things to consider

In addition to the design and quality of the study, there are a few other considerations when deciding how reliable a paper is.

However, these have less absolute answers and are just important concepts to be aware of.

A question of reporting

In many cases, careful appraisal of a paper may leave you uncertain about whether basic concepts of study design were actually considered when planning and conducting a study, or, in fact, whether the study methods and results have simply been poorly reported.

This means that a study might actually have been well designed and conducted, but the reporting was poor. Important deficits that are frequently found in veterinary literature are: missing descriptions of the type of animals used in the study, no clear description of diagnostic methods, and inappropriate documentation of treatments and outcome measurements, to name just a few.

Hide this content

Poor reporting reduces the transparency of research and limits the reader's ability to critically appraise information, as what is not included cannot possibly be appraised! Hence, poor reporting has a significant impact on clinical decision-making. In order to improve reporting and transparency of scientific work, reporting guidelines have been and are continuing to be developed.For example, the CONSORT, PRISMA and STROBE statements aim to improve the reporting of a number of types of epidemiological studies. The REFLECT statement is a modification of the CONSORT statement, making it useful for veterinary science, as it relates to livestock and food safety (Sargeant et al. 2010). Currently, however, only about 35% of veterinary journals refer to these guidelines (Grindlay et al. 2014), although it is hoped many more studies will use them in future.

The EQUATOR Network provide many guidelines for appraising the scientific literature.

In the end, if certain information is not given in a paper, you should regard this as not having been considered in the study design or study implementation. It is better to be safe than to be sorry when appraising literature that will lead you to make important decisions about your patients!

Peer-review and publication bias

Considerations such as whether an article has been peer-reviewed or if an area suffers from publication bias should be considered when you are appraising the literature.

Hide this content

Peer-review

Peer-review has been the quality-control process for scientific publishing for hundreds of years, ensuring that information is checked and verified by subject experts before it is formally published. This saves a huge amount of time on the part of the reader, as there is less onus on them to make the only fundamental analysis of the quality, accuracy and validity of the content themselves. Peer-reviewed publications from the scientific and veterinary communities are key sources for EBVM practitioners.

However, some limitations and possible biases of peer-review have been identified (Benos et al. 2007). For example, it has been demonstrated that gender and affiliation of the authors has an impact on the review outcomes. It is important to

remember that peer-review is not perfect, and published peer-reviewed studies vary in quality. Even for all its drawbacks, however, studies show that manuscripts improve considerably after the peer-review process (Goodman et al. 1994, Benos et al. 2007). At the time this tutorial was published, peer-review had not been formally evaluated to determine if it is indeed able to improve the practical relevance of published information.

Publication bias

Traditionally, peer-reviewed scientific journals and the bibliographic databases that index them have been considered the best sources of evidence, but research into publication bias (Glanville et al. 2015) suggests that there is a need to go beyond these sources alone, as a significant proportion of research will not be published in peer-reviewed journals.

Publication bias occurs when researchers publish the results of studies showing that a treatment works well and don't publish those showing it did not have any effect. If this happens, analysis of the published results will not give an accurate idea of how well the treatment works.

This publication bias is perhaps particularly relevant in the field of clinical veterinary medicine, where many practitioners may not be publishing their work as peer-reviewed articles, and much of the scientific data may be hidden in the so-called 'grey' literature (e.g. conference papers), or in practice records and case reports. For more information about finding this 'grey' literature, see ACQUIRE.

Assessing information quality

Evaluate the literature with three steps which can be applied each time you read a paper, even when you are busy with your daily practice.

Taken together, these three steps don't take long, but they will enhance your ability to use and apply the knowledge you gain from reading and appraising scientific literature.

1. Determine the evidence level: Where in the hierarchy of evidence should this paper be placed?
2. Evaluate the quality criteria for the specific study, and decide whether you agree or disagree with its statements concerning study design, information content, objectivity and overall validity.
3. Decide whether you agree with the conclusions of the study, based on your assessment. Is the study of such poor quality that the results are completely unreliable, or is it good enough to provide valid results? And do these results apply to your patient and the current situation with which you are dealing?

Try working through these steps with a sample study and a blank criteria checklist. You can check your answers against a completed checklist.

How to deal with the results

If you read and appraise an article, and find it of good quality, you will perhaps be happy to incorporate it into your decision-making process. This is a great outcome of using EBVM!

However, critically appraising a paper will sometimes uncover the fact that the paper you are reading has limitations. A poor overall evaluation does not inevitably mean that the information is completely wrong or useless, but it indicates that the risk of bias is fairly high. Therefore, you should be cautious in implementing information from all papers, especially those of questionable quality, in clinical practice.
The APPLY section of this tutorial will help you learn how to incorporate what you read into your daily practice.

If you feel that a paper is not of sufficient quality to support your decision making, do not be afraid to discard it!

Quiz

When considering treatment options, list the four strongest types of evidence in descending order of strength (i.e. strongest to weakest evidence) from the following list:

- Case report
- Cohort study
- Expert opinion
- Instinct
- Internet
- Randomised controlled trial
- Systematic review
- Textbook

○	Expert opinion, Systematic Review, Cohort study, Case reportIncorrect. The standard hierarchy of evidence for answering questions of treatment is: meta-analysis > systematic review > randomised controlled trial > cohort study > case-control study > cross-sectional study > case series > case report > textbook/anecdotal/expert opinion
○	Internet, Expert opinion, Randomised controlled trial, Systematic reviewIncorrect. The standard hierarchy of evidence for answering questions of treatment is: meta-analysis > systematic review > randomised controlled trial > cohort study > case-control study > cross-sectional study > case series > case report > textbook/anecdotal/expert opinion
○	Systematic review, Randomised controlled trial, Cohort study, Case reportCorrect. The standard hierarchy of evidence for answering questions of treatment is: meta-analysis > systematic review > randomised controlled trial > cohort study > case-control study > cross-sectional study > case series > case report > textbook/anecdotal/expert opinion

- Systematic review, Case report, Cohort study, TextbookIncorrect. The standard hierarchy of evidence for answering questions of treatment is: meta-analysis > systematic review > randomised controlled trial > cohort study > case-control study > cross-sectional study > case series > case report > textbook/anecdotal/expert opinion
- Internet, Expert opinion, Randomised controlled trial, InstinctIncorrect. The standard hierarchy of evidence for answering questions of treatment is: meta-analysis > systematic review > randomised controlled trial > cohort study > case-control study > cross-sectional study > case series > case report > textbook/anecdotal/expert opinion

In a randomised controlled trial, what is the purpose of random allocation?

- Characteristics of study participants are equally distributed across comparison groupsCorrect. Random allocation reduces the risk of selection bias and distributes participants equally across comparison groups.
- To provide evidence of an important effect of the interventionIncorrect. Random allocation reduces the risk of selection bias and distributes participants equally across comparison groups.
- Study participants do not know who received the placebo treatmentIncorrect. Random allocation reduces the risk of selection bias and distributes participants equally across comparison groups.
- Researchers do not know who received the intervention or the placeboIncorrect. Random allocation reduces the risk of selection bias and distributes participants equally across comparison groups.
- Statistical analysis of the data will be straightforwardIncorrect. Random allocation reduces the risk of selection bias and distributes participants equally across comparison groups.

You are appraising a study comparing the effects of two different diets for chronic kidney disease in cats. The researchers were not blinded to the diet being fed. What potential weakness does this introduce to the study design?

- Unconscious biasCorrect. Blinding of the researcher who is measuring the outcomes is designed to limit any conscious or unconscious bias that may arise from knowing which patient received which treatment. Non-blinding is a study weakness that you should be able to identify when appraising the literature.
- Lack of study powerIncorrect. Lack of study power means that there were not enough study participants in the comparison groups in order to show the statistical significance hypothesised. Blinding of the researcher who is measuring the outcomes is designed to limit any conscious or unconscious bias that may arise from knowing which patient received which treatment. Non-blinding is a study weakness that you should be able to identify when appraising the literature.
- Non-random allocationIncorrect. Non-random allocation means that when patients were allocated to treatment groups, this was not done randomly, which may increase bias. Blinding of the researcher who is measuring the outcomes is designed to limit any conscious or unconscious bias that may arise from

knowing which patient received which treatment. Non-blinding is a study weakness that you should be able to identify when appraising the literature.

- Uncontrolled variablesIncorrect. Uncontrolled variables means that there are factors other than those you are measuring which may influence the outcomes that you measure. Blinding of the researcher who is measuring the outcomes is designed to limit any conscious or unconscious bias that may arise from knowing which patient received which treatment. Non-blinding is a study weakness that you should be able to identify when appraising the literature.
- Poorly matched control groupIncorrect. Poorly matched control groups is an example of selection bias and leads to uncontrolled variables. Blinding of the researcher who is measuring the outcomes is designed to limit any conscious or unconscious bias that may arise from knowing which patient received which treatment. Non-blinding is a study weakness that you should be able to identify when appraising the literature.

Why are systematic reviews and meta-analyses considered to provide the best evidence?

- (●) Their statistical analyses are complicatedIncorrect. Many randomised controlled trials or cohort studies can have very complicated statistical analyses! Systematic reviews and meta-analyses objectively summarise all available evidence to answer a specific question using rigorous selection criteria for inclusion of studies.
- They include all available information on a particular topic, regardless of where it was obtained fromIncorrect, systematic reviews and meta-analyses objectively summarise all available evidence to answer a specific question using rigorous selection criteria for inclusion of studies.
- They are written by experts in the topic of interestIncorrect. Systematic reviews and meta-analyses can be written by someone with no former knowledge of the particular subject, they need only be an expert in writing systematic reviews and meta-analyses. Systematic reviews and meta-analyses objectively summarise all available evidence to answer a specific question using rigorous selection criteria for inclusion of studies.
- They objectively summarise all available evidence to answer a specific question using rigorous selection criteria for inclusion of studiesCorrect. Systematic reviews and meta-analyses are both objective and systematic, and they contain all of the relevant evidence available, ranked according to strength of evidence.
- They combine clinical trials, cohort studies, case-control studies and expert opinion all in one studyIncorrect. Some systematic reviews may only contain randomised controlled trials, others may contain a large variation in study type. Systematic reviews and meta-analyses objectively summarise all available evidence to answer a specific question using rigorous selection criteria for inclusion of studies.

Summary

You should now be more familiar with how to:

1. Describe the most important factors that should be appraised when you read a paper.
2. Explain how to appraise literature (and other information).
3. Use tools that support the appraisal process.

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Apply

Once you have ACQUIREd and APPRAISEd the evidence on your particular clinical question, it is important to determine whether the answers you have generated can be applied to your circumstances: the country, location or clinic where you work, the case in front of you and/or the availability of therapies and owner possibilities you are dealing with. The application of evidence into practice can sometimes be challenging, as we'll see in this chapter.

By the end of this chapter you will be able to:

- Use a structured framework to determine whether the evidence is applicable to you, your patients and your environment.
- Describe ways of communicating new evidence to colleagues and clients.
- Construct a strategy to maximise the chances of successfully implementing evidence-based changes in your practice/clinic.

In the Apply section:

- Applying evidence to practice
- How relevant is the evidence?
- Discuss important evidence
- Prepare a strategy for change
  - 'Piloting' your plans
- Quiz
- Summary
- References

Applying evidence to practice

It has been shown that implementation of evidence into practice is one of the most challenging things to do when compared with finding the evidence and appraising it (Bergus et al. 2004).

There are a number of reasons why it is difficult to apply evidence to practice, but it ultimately comes down to to the availability of essential resources (Sackett and Straus 1996) and the motivation of the individual clinician to make the changes (Kiefe et al. 2001).

Studies in the medical field have shown that, despite these challenges, it is possible to integrate evidence into practice at the patient side (Sackett and Straus 1996).

A study conducted by Sackett and Straus (1996) examined whether it was feasible to find and apply evidence during clinical rounds in the Nuffield hospital, University of Oxford, UK. An ‘evidence-cart’ containing multiple sources of evidence (a computer, projector, database compact discs, critically appraised topics, etc.) was wheeled around during rounds. Despite some physical challenges with the cart, clinicians were mostly (90% of cases) able to search for and find relevant evidence within the time available to them. In a post-exercise questionnaire, it was found that most clinicians who reported making use of the sources on the cart found them to be beneficial and easy to use.

Clinicians are trained to assimilate information gleaned from taking a clinical history, performing a clinical exam on an animal or group of animals, interpreting diagnostic tests, monitoring previous responses to treatments and understanding client circumstances and expectations (Holmes and Cockcroft 2004). Integrating evidence works on the same principles that veterinarians use every day, with the evidence becoming an important component of the decision-making, alongside the circumstances of the owner and animal in front of you.

An example of assimilating evidence is given in Holmes (2009), where parallels are drawn between treating equine lameness in a champion dressage horse and in a Thoroughbred mare at stud. Even if the condition were the same in both animals, it may be unlikely that the same treatment regime would be selected in each circumstance, for a number of reasons. The evidence behind prognosis and outcomes for the specific lameness condition may become crucial in the decision-making around treatment approaches for these cases because of the differing requirements for each owner and animal.

It is perceived that there are three main areas of importance that come between appraising the evidence and implementing strategies for determining how effective the implemented changes have been:

- evaluating the relevance of the evidence;
- discussing important outcomes with colleagues, clients or others;
- preparing strategies for change.

How relevant is the evidence?

When you read a study, you must make a judgement about how similar your patient is to the population or sample being examined in that particular study, and whether that study is worth considering for the individual circumstances in front of you.

Since a perfect study examining the whole population of animals you are interested in will rarely exist (especially in veterinary medicine!), it is up to you to decide if the evidence you have found is pertinent to your individual clinical question. Studies are often conducted on a number of subject animals, and may therefore only be truly representative of a particular subset of a particular population of animals.

Some pertinent questions to ask may be:

- Does the population of animals in the study represent the animals that you see (e.g. animals seen at referral practices versus first opinion practices)?
- Does the evidence focus on animals with single morbidities (as opposed to animals with comorbidities)?
- Does the evidence in the study focus on using one therapy versus combinations of therapies?

Thinking about how to apply the evidence from published studies to the individual animal, or group of animals, you are working with raises four different questions, as outlined by Del Mar et al. (2008):

1. What are the potential effects of treatment, both beneficial and harmful?
2. Are there differences in the effects of treatments on different sub-groups of animals?
3. Are there differences in levels of risk between different groups/sub-groups of animals?
4. How do the benefits and harms relate to the individual animal or group of animals you have in front of you?

We will now illustrate these four questions using a clinical scenario about the use of analgesic products for calf dehorning.

1. What are the potential effects of treatment, both beneficial and harmful?

When making clinical decisions, it is important for veterinarians to weigh up the best evidence on both the benefits and harms of any interventions proposed.

Calf-dehorning example

In some countries, long-acting analgesic products are not approved for pain relief in livestock. Some of these countries allow veterinarians to use medicines in an extra-label fashion, when the health of the animal is threatened and when the veterinarian

determines that particular drug is indicated. Extra-label drug usage, however, is not permitted if it results in violating food residue legislation.

Conversely, in many countries, both long-acting and short-acting products are approved as therapy to provide pain relief.

Because you have recently begun working at a practice that has not historically used analgesia for long-term pain relief post-dehorning in cattle, you wonder if you should propose using a non-steroidal anti-inflammatory drug (NSAID) for calves being dehorned, and if so, which NSAID would be preferable, parenteral flunixin or meloxicam? You search the literature and find two references which appear to be particularly relevant to this question:

- Heinrich A, Duffield TF, Lissemore KD, Millman ST. The effect of meloxicam on behavior and pain sensitivity of dairy calves following cautery dehorning with a local anesthetic. J Dairy Sci. 2010 Jun;93(6):2450-7. doi: 10.3168/jds.2009-2813. Accessed at: http://www.sciencedirect.com/science/article/pii/S0022030210002481
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In the first study (Heinrich et al., 2010), you note that meloxicam (0.5 mg/kg) was shown to significantly prevent the relapse of pain after the effect of a cornual block had worn off in calves undergoing dehorning with cautery when compared to placebo-treated calves. Pain was measured by reduced sensitivity to pressure, ear-flicking and head-shaking, and meloxicam-treated calves were significantly different from calves receiving a placebo ($p<0.05$). This research was done on Holstein heifer calves that were six weeks of age.

The second study (Fraccaro et al., 2013) described significantly lower blood prostaglandin E2 concentrations in the flunixin-treated (2.2 mg/kg) group compared to the placebo group after surgical/cautery dehorning; the difference between concentrations in the meloxicam group and the placebo group was not statistically significant. However, meloxicam had a 2½ times longer half-life than flunixin, suggesting that its effect should last longer. This research was done on Holstein steer calves that were six months of age.
When appraising the quality of this evidence, you consider a number of things:

- Both studies were performed in cattle.
- Heinrich's study was carried out in a dairy production system, while Fraccaro's study was in a beef production system. You consider this, but decide that it is unlikely that the production system would make a difference in interpreting these study results.
- Heinrich's study was carried out in Ontario, Canada, while Fraccaro's study was done in Kansas, USA. Again, you think it is unlikely that the region would make a difference in interpreting the results of these particular studies.
- Both studies utilised research animals, although, again, you consider it unlikely that the source of animals would make a difference in interpreting the study results.

- In both studies, animals were randomly allocated to the treatment groups, minimising biases associated with group allocation.
- Heinrich's study involved two groups of 30 calves, whilst Fraccaro's study had much smaller groups (seven calves in each group). It is possible, therefore, that because of the smaller group sizes, the effect of the individual variation of animals within Fraccaro's study might be more likely to account for some or most of the differences between the groups.

Close

2. Are there differences in the effects of treatments on different sub-groups of animals?

Certain sub-groups of animals (e.g. certain age groups) may be more likely to respond either positively or negatively to specific interventions. When thinking about how you might apply the evidence, you will need to consider which sub-groups of animals were utilised in the research being considered.

Calf-dehorning example

Fraccaro's study showing flunixin was better than meloxicam used a surgical procedure for dehorning, followed by cautery (for bleeders); this procedure was also performed in older calves, whereas Heinrich's study used cautery dehorning in younger calves. The Fraccaro study also had a small sample size, and only measured changes in a blood parameter (prostaglandin E2), whereas Heinrich's study used behavioural changes. After considering all of this, you decide that it is unclear whether the age of the calves would alter the interpretation of the studies, but you keep the details in the back of your mind.

3. Are there differences in levels of risk between different groups/sub-groups of animals?

By the nature of how and where they are kept, or their innate attributes, different groups or sub-groups of animals may have different levels of immunity and exposure to various pathogens. These differences may lead to different manifestations of disease severity in these different groups.

Calf-dehorning example

It might seem unclear as to whether being a six-week-old calf or a six-month-old calf would make a difference to treatment response in this particular case and scientific question.

4. How do the benefits and harms relate to the individual animal or group of animals you have in front of you?

It is down to you as the veterinarian to make a judgement on the applicability of the research findings to your patients, which could involve a number of considerations. You might choose to reflect on your previous experience with similar cases, or to have a more in-depth discussion with the owner. You might also want to discuss the matter with colleagues, or consult an online forum to gain a broader view of the question at hand.

Calf-dehorning example

It is unclear whether different groups of animals would make a difference in interpreting the study results. Perhaps the type of dehorning could make a difference in the interpretation of the results. The combination of surgical dehorning and cauterization of bleeders would be expected to produce more tissue trauma and pain than simple cauterization, as well as on-going infection and its associated pain.

Another pertinent question to ask might be whether or not the findings of the studies are clinically relevant to your case, that is, will they really make a difference to the animal(s) in front of you? Once again, it is up to you to make a judgement about whether or not the outcomes measured would be expected to translate into meaningful clinical benefits to the patient and owner in front of you.

Calf-dehorning example

Because Heinrich's study assessed behavioural changes in the calves, it would seem to be more clinically relevant than Fraccaro's study, where changes in blood parameters were measured.

If you do not think the evidence from the papers you are considering is relevant enough to apply to the animal or group of animals you are treating, you can have a discussion with the owner of the animal(s) about the uncertainties around the options available (Legare 2009). Additionally you may choose to:

1. Rely on the information in other forms of evidence such as textbooks, and online websites
2. Do what you would normally do in these circumstances before you were aware of the published evidence, or
3. Rely on your local clinic's advice or guidelines or advice from colleagues who have handled these types of clinical problems before.

Calf-dehorning example

The Heinrich study would seem to provide relevant evidence in relation to the particular circumstance in front of you, while the Fraccaro study suggests that meloxicam could potentially last longer than flunixin. The Fraccaro study also only provides blood-related evidence of flunixin perhaps being better than meloxicam with respect to prostaglandin E2 concentrations. Without any clinically relevant observations, however, this evidence would not be enough to suggest that it is preferred over meloxicam, even in six-month-old Holstein steer calves being surgically dehorned.

Discuss important evidence

If, after reviewing the evidence, you feel that substantial changes are warranted, it is important to share your ideas with the rest of the colleagues in your practice, and potentially with owners.

There are a number of ways that can be used to promote evidence to your colleagues within the practice. A number of strategies, as outlined by Scott and Glasziou (2012), may be employed to do this:

Promotion of evidence to colleagues via:

Electronic communication

Using e-mail or other electronic means of communication will allow your colleagues to read through some of the material you have found, or have produced, before discussions begin in person.

In relation to cardiopulmonary resuscitation (CPR) in small animals, research shows that, in relation to chest compressions and ventilation rates, the optimum rates veterinarians should use have been updated (100-120 compressions/min and 10/min ventilation rate).
These RECOVER guidelines are freely available, and can be circulated around to individuals in your practice.

Journal clubs

Highlight the evidence you found as part of a journal club session within your practice.

You might want to spend a journal club session discussing how the RECOVER guidelines were constructed using the papers published in the Journal of Veterinary Emergency and Critical Care.

Practice meetings

These are an opportunity to raise awareness of new evidence and to discuss how your colleagues approach cases. If these meetings don't currently exist, use this as an opportunity to start regular meetings to discuss cases and approaches.

You could discuss how individuals within the practice currently approach CPR in small animal patients, and whether the team feels there are any changes that could be made in relation to the recommendations in the RECOVER guidelines.

Rounds

Discuss the evidence in relation to a case which you are currently working on.

Use a recent case where CPR was indicated, and discuss how the case fits into the suggested workflow in the RECOVER guidelines.

Resources that highlight any new evidence sources

Highlight resources that could give your colleagues insight into the evidence and help them make clinical decisions.

You might choose to highlight relevant documents associated with the RECOVER guidelines and point out other secondary resources that might be of use in relation to dealing with emergency cases (e.g. BestBETs for Vets, Knowledge Summaries, Banfield CATs, EBVMA CATs, and more listed in ACQUIRE.

It is possible that your colleagues may not agree with the changes that you are suggesting. Many barriers (e.g. time pressures) have been highlighted in the literature in relation to reasons why evidence cannot be applied into practice (Legare 2009). Don't let this stop you from making a change individually to the patients that are in your care. It may be that after a period of time, you will be able to use some of the techniques in the ASSESS stage of the EBVM cycle to help further promote the changes you are advocating.

Promotion of the new evidence to clients:

Owner compliance

Owners may be wary of new treatments or different approaches, particularly if they are familiar with treatments that have previously been described, so it will be of benefit to spend time discussing the new evidence with clients. Discussing evidence with clients will potentially improve patient adherence to treatment regimens and management strategies.

Mrs. Lee has been using a glucosamine supplement for the last two years in an attempt to reduce the clinical signs of osteoarthritis in her dog. You know that there is a Best Evidence Topic (BestBET) and a 'What is the Evidence?' publication in the Journal of the American Veterinary Medical Association outlining that this supplement may not be effective. Mrs. Lee has been using the product for some time, and is convinced that there are some benefits gained by using it. Talking with Mrs. Lee about the benefits of other therapies for reducing the clinical signs of osteoarthritis which have been recognised in research studies will be important for her. Developing a structured treatment regime in conjunction with Mrs. Lee that uses other therapies such as carprofen (or other NSAIDs) without glucosamine will be important. It is crucial that together you identify re-assessment points and schedule check-ups proactively so that Mrs. Lee can provide you with feedback about the new regime and how it is performing in relation to how comfortable her dog is.

Prepare a strategy for change

It is important to remember that making any changes, however small, can have a large impact, not only on your caseload but also at the level of the clinic/practice. It is impossible to anticipate all the potential effects of a change, but it is important to consider as much detail as you can prior to implementing any changes.

Changes can be initially made at the caseload level (e.g. you changing how you treat cases), or potentially, after some discussion with your colleagues, at the practice level. Research has been carried out previously looking at the success of change implementation, specifically at the factors that facilitated and hindered proposed actions in the medical field (Haley et al. 2012). These included:

Who

Reflect on previous episodes of ‘change’ within the clinic/practice and what the facilitators and barriers to it were – factor these into your strategy.

You are interested in developing a framework that the vets in your practice can follow when doing lameness work-ups in horses. You have noticed that, on occasion, different vets approach these cases differently, which leads to confusion amongst the staff in your clinic as to what equipment and consumables they should be preparing prior to the assessment. You did attempt using a new framework a year or so ago, but it was a week when one of the vets was on holidays and the other was at a continuing education course, and you were busy with the additional work, so you abandoned your plans after the first day.

When

Ensure that you have highlighted a specific time that can be used to make any changes; is it easy for other things to take priority in a busy clinic/practice.

Pick the most appropriate time to implement the changes. For example, if it requires others to help, make sure it isn’t during a busy period so that people will have the time to help you.

You know that in a month’s time, a new graduate is joining the practice and will be spending the first two days of the week shadowing you. You also know that these days are deliberately being kept quiet so that the new graduate can get to grips with the clinic/practice. You think this may be a good time to trial the framework as there will be less time pressure on you, and it will probably be of benefit for the new graduate also.

What

Ensure that you are clear as to what you are actually changing, and what actions are required. It may be beneficial to make a note of any changes in order to compare the associated outcomes at a later stage (e.g. what was done, the date, dose rates, approaches attempted).

Your aim is to get the vets to follow a lameness work-up framework, which will probably contain the steps they carry out anyway, but perhaps in a slightly different order to how they might have approached these cases previously. You may want to discuss the suggested changes with the other vets in the practice/clinic to make sure everyone is clear about the changes you are suggesting. You could also run an initial pilot where you trial the framework first prior to getting the other vets involved.

How

If possible, plan to implement small changes one at a time if they require alteration to normal protocols in a number of areas within the clinic/practice.

This step may help you and the other vets to not feel overwhelmed by what may be required in order to make the changes.

You plan to trial the framework during the two days that the new graduate is shadowing you as a starting point. This will allow you to get feedback from the new graduate to add into your review of how well the framework worked at the end of the two days. Depending on the confidence of the new graduate, you may be able to get them to trial aspects of the framework.

Make sure you have everything you think you might need beforehand (e.g. all necessary equipment, therapies, resources, people) to make the transition as seamless as possible.

You might ask the receptionist to potentially book more (or less, dependent on how much you are wanting to change) lameness work-ups for you on the days you want to trial the framework. If there are other staff that usually help with activities such as lunging, or preparations for nerve or joint blocks, it may be useful to have a short discussion with them to explain what you are attempting to do, and what additional equipment or resources you may need that might be different to what is usually prepared.

It is important to have a periodic systematic assessment of any changes implemented to ensure that they have had the desired effect on patient outcomes. Techniques for doing this can be found in the next stage of the EBVM cycle under ASSESS.

‘Piloting’ your plans

If you’re still not convinced that the evidence fully pertains to you, one way to start putting evidence into practice might be to run a sort of ‘pilot’ to assess the possible effects of your new approach in the context of your practice.

You might start with implementing the changes on one or two cases first, and then you can ASSESS what might be changing. For instance, you might consider borrowing or leasing a particular piece of equipment if you think it might be required, so that you can evaluate how useful the equipment might be to your practice before you make a large financial investment.

Or, in your search for evidence, you may discover that there is anecdotal evidence about potentially efficacious treatments that some colleagues have heard of, but there is still no study data to support this efficacy. You might decide to follow up these leads at a later time, as you know that some caution should be applied in these situations where only circumstantial evidence exists.

Or, depending on what changes you are considering, you may first decide to talk to your client about the new approach or treatment and the possible side-effects that might result. This approach should be considered on the basis of good ethical practice and local governing body guidelines.

The choice is up to you, but once you apply your evidence, you will also want to ASSESS how that application has gone!

Quiz

When planning to implement changes in order to practise in a more evidence-based way, what is the best approach?

- Apply all changes at one time to minimise disruptionIncorrect. This can cause a big disruption to the running of the practice, which can be off-putting for clinicians and clients. If possible, plan to implement small changes one at a time if they require alteration to normal protocols in a number of areas within the clinic/practice.
- Make a big announcement that the practice is starting to use an evidence-based approachIncorrect. This will make it sound as though you never used evidence before! Once changes are in place, you can describe your practice as using evidence-based treatment protocols or being an evidence-led practice.
- Do not set a timeline, be vague about what will change and whenIncorrect. Without set goals it will be difficult to motivate change or measure outcomes. If possible, plan to implement small changes one at a time if they require alteration to normal protocols in a number of areas within the clinic/practice.
- Plan to implement small changes one at a time until you have applied them allCorrect. If possible, plan to implement small changes one at a time if they require alteration to normal protocols in a number of areas within the clinic/practice.
- Implement half of the changesIncorrect. While it is advisable not to implement all changes at once, if you have agreed on new evidence-based protocols it makes sense to implement them all. If possible, plan to implement small changes one at a time if they require alteration to normal protocols in a number of areas within the clinic/practice.

In certain circumstances it is sensible to pilot proposed changes to clinical practice. In this context, what does 'piloting' your changes mean?

- Managing and guiding vets very closely for the first few months after changes have been madeIncorrect. Micromanaging cases and clinicians is unlikely to win you any friends or be an effective way of assessing change.
- Rolling the changes out at all branches/ for all vets simultaneouslyIncorrect. If you wish to pilot a scheme before investing in new equipment/ drugs/ protocols then you should start small.
- Announcing your practice as part of a pilot evidence-based veterinary medicine schemeIncorrect. There is no pilot scheme. Evidence-based veterinary medicine is a choice and practices are self-motivated to begin.
- Asking vets to apply the change as and when they feel necessaryIncorrect. This approach will lead to inconsistency and make change difficult to assess.
- Implementing changes in a few cases initially, and then assessing the impactCorrect. In this way, you can assess the impact of your changes before investing in new equipment or new practice guidelines.

Summary

You should now be more familiar with how to:

- Use a structured framework to determine whether the evidence is applicable to you, your patients and your environment.
- Describe ways of communicating new evidence to colleagues and clients.
- Construct a strategy to implement evidence-based changes in your practice/clinic.

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Assess

Assess is the final step of the EBVM cycle and it is vital as you can use the skills to establish if the EBVM process has made a difference to your practice. It is the only way of establishing if the evidence has made an impact on your patients and improved care. EBVM starts in practice, as the questions should all come from clinicians (ASK) and the ASSESS stage ensures EBVM stays in practice.

By the end of this chapter you will be able to:

- Explain why it is important to assess/audit the implementation of EBVM in practice.
- Describe how to assess/audit EBVM in practice.
- Use practice examples to demonstrate the use of clinical audit and the assessment of EBVM in practice.

In the Assess section:

- Why do we need to assess?
  - Do we need to assess?
  - Are we ready to assess?
  - How will assessing help clinical practice?
- How do we assess implementation in practice?
  - Reflection
  - Clinical audit
    - Clinical Audit: introductory video
    - Clinical audit in the veterinary world
    - Where to start in clinical audit?
    - Defining the standards and establishing the protocols for the audit
    - Monitor changes against standards or select criteria, and don't forget to keep track of performance!
    - Making sure clinical audit gets done – the administrative side
    - Acting on the results of clinical audit
- Quiz
- Summary
- References

Why do we need to assess?

The only way we can establish if the care of patients is improved by the application of evidence to practice is to measure the effect of the APPLY stage.

If a practice policy, diagnostic procedure or treatment strategy has changed as a result of finding (ACQUIRE) and appraising (APPRAISE) the evidence, it is important to look at the consequences of this change. How has it affected the patients? Did it make any difference? Has care improved or declined? Are further changes needed?

Various methods of approaching how you ASSESS the effect of applying EBVM to practice will be outlined in this chapter.

Do we need to assess?

It is vital to assess what we do in practice in order to ensure our practice is moving with the times and adapting and responding to the advances in the profession.

One reason we need to assess is for the basic reasons of clinical governance. The benefits of reflecting on what we are doing and highlighting areas where we can make improvements are far reaching and can range from improved customer satisfaction and patient care, to improved biosecurity practices or financial returns.

In the UK, the RCVS Practice Standards Scheme and the RCVS clinical audit toolkit part 2 'Clinical Governance' state that:

"The practice must have a system in place for monitoring and discussing the clinical outcome of cases and for acting on the results."

All practices must have:

"… some system for monitoring and discussing the clinical outcome of some common procedures. This may vary from clinical audit reports to notes of clinical discussion meetings but inevitably starts with some form of record keeping."

The highest level Veterinary Hospitals in the UK must also comply with the following:

"Regular Morbidity and Mortality meetings should be held to discuss the outcome of clinical cases. Hospitals must be able to produce records of such meetings and demonstrate any changes in procedures as a consequence of any resultant action list. Continued monitoring to assess the effectiveness of any changes must be undertaken."

But it's not just abiding by standards that drive us to assess what we do. Development of an ethos of reflection on and assessment of our practices is a vital part of developing as a veterinarian in our confidence and competence. A key issue is to develop a practice philosophy that supports EBVM, and, in the areas of

assessment, to continually look for areas of improvement. We all want to be better at what we do, so why not use the assessment or audit cycle to try and work out where we can most usefully put our effort?

Practical example: Could we revise our radiography protocols to ensure we get a higher proportion of diagnostic quality images?

As we become more proactive in EBVM, we may go further than identifying areas requiring improvement and be able to proactively establish a system to regularly (continuously or periodically) assess outcomes. We can then use that information to review our treatments, protocols and procedures, for the betterment of ourselves and our veterinary patients.

Are we ready to assess?

A simple way of assessing your own performance as an EBVM practitioner is to ask yourself some questions, and to provide truthful answers!

Some suggested questions are:

- Do I identify and prioritise problems to be solved (specifically in relation to what information I need to make my best decisions)?
- Do I perform a competent and complete examination of each animal, in order to establish the likelihood of alternative diagnoses?
- Do I have an accurate knowledge of disease manifestations, the sensitivities and specificities of the clinical signs I am looking for, and the frequency of occurrence of different combinations of clinical signs within a disease?
- Do I search for missing information when I know I am lacking it?
- Do I appraise information I am given in terms of scientific validity?
- Do I understand terms such as specificity and sensitivity, which enable me to interpret important information in my daily practice?
- Do I have the resources to access the Internet and use these to the best of my ability?
- Am I aware of the veterinary information databases?
- Do I actively consider if the application of new information I am given is scientifically justified and sensible for the situation to which I might apply it?
- Do I explain the pros and cons of the different options to owners, taking into account and making clear their different utilities?

Of course none of us would be able to answer ‘yes’ to all of these questions for each case we see. Equally, there are probably many more questions that we should be asking ourselves as we aspire to be better clinicians. Nonetheless, EBVM provides an approach that seeks to address the ever increasing information overload that veterinary clinicians face in the 21st century.

How will assessing help clinical practice?

Assessment of EBVM is evaluating the effectiveness of the EBVM process, or the impact of the implementation of new processes or protocols, in clinical practice, for the benefit of veterinarians, clients and patients alike.

Whether it is implementation of a well-researched new treatment, diagnostic or biosecurity protocol or simply reflection on a series of cases that were managed in a particular way in order to better understand how that management might be improved, if we don't reflect on what we are doing, our practices may remain stagnant and become rapidly outdated.

It is important to appreciate that EBVM is neither dogmatic nor static. It is a tool to help us improve our clinical practice. To achieve this goal, we need to assess whether the process is helping us in our clinical decision-making in an effective manner. Our time and effort is a cost associated with our practice, and the tools and resources we use help us to optimise the benefits we get from our efforts.

Part of our assessment may well seek to identify clinical decisions (and the information needs related to those clinical decisions) that will lead to the greatest benefit for our patients. An important outcome of assessment is the identification of areas where there are deficits in the evidence base as well as the ability to identify actions we might undertake to help address those deficits.

How do we assess implementation in practice?

It is possible to assess implementation of EBVM through a number of formal and informal routes.

This assessment can be anything from personal reflection on individual cases at the end of a busy day, to formal practice-wide audits with specific goals in mind.

These assessments can be incorporated into small gaps of time throughout the day (reflecting while having a cup of coffee or mentally running through the day on your drive home), or specific times can be set aside to actively address individual questions or problems experienced in your daily practice, or by the business as a whole.

We will now look at these two methods of assessment in more detail.

Reflection

At its simplest level, we can use reflection to assess clinical outcomes – either as an individual or as a group (e.g. during clinical rounds). This is a simple and direct method of pulling out the essence of EBVM.

If you have made a decision, reflect on how you arrived at that decision. Ideally, reflection should be informed by referring to the literature, as well as just relying on the information you have to hand. It is then that you can really put the whole EBVM cycle to the test: ASKingthe correct question, ACQUIREing and APPRAISEing the evidence, APPLYing that information and then finally ASSESSing if the application was appropriate. We often only reflect on the cases where something went wrong or we had an unexpected outcome, but any decision can benefit from reflection – be it a decision on diagnostic testing, treatment, or any other part of the management of a case.

During monthly clinical rounds in a busy small animal practice, Sam reported that his last case of cranial cruciate ligament (CCL) rupture had re-presented with rupture of the CCL in the contralateral limb three months after surgery.

On presentation, Sam had noticed that the dog was not using the limb he had initially operated on, and suspected poor return to function of the operated limb had been a factor. The owner was upset because when she had anterior cruciate ligament surgery herself, she had received an intensive programme of physiotherapy postoperatively, and wondered if the lack of physiotherapy could have been a factor in her dog's new CCL injury.

One of Sam's colleagues, Nicky, could recall similar cases in the practice and remembered reading a paper about early intensive physiotherapy used postoperatively after CCL surgery in dogs. Sam and Nicky worked together in an informal EBVM cycle of reflection, asking the question 'In dogs with CCL injury, does postoperative physiotherapy compared to our traditionally prescribed controlled exercise programme improve function in the operated limb?'. They found a few papers that supported this approach, and although the evidence was not based on large multicentre trials in dogs, they felt there was sufficient evidence to apply physiotherapy as part of the postoperative management plan.

Together they looked up their local physiotherapy animal special interest group, found a local animal-qualified physiotherapist and implemented referral for postoperative physiotherapy immediately, starting with Sam's patient following its second surgery.

The head nurse was tasked with keeping a record of the cases of contralateral limb rupture as well as documenting client feedback on the physiotherapy, all of which were scheduled to be reviewed in a meeting in 12 months' time.

Keypoints:

- This example shows a simple use of EBVM to address a problem following reflection on a case (it could equally have been used pro-actively before a problem arose).
- A question was asked, information was acquired and appraised (albeit relatively informally), and the veterinarians applied the information in developing a new management protocol for dogs with CCL injury.
- In order to ensure that this new management protocol is actually doing what the veterinarians hope it will do, it is essential that they also implement a system to assess the response against clear criteria. In this case the criteria are:
    1. The number of cases presenting for contralateral limb CCL injury.
    2. Client feedback on the management protocol.
- A realistic time frame was set in order to ensure the protocol could be appropriately evaluated.

Reflection and unstructured EBVM is simple and easy to incorporate into everyday practice, but it is important to try to still follow the 'ABCs'. Reflection without support of the literature or without a clear question can lead to a vague outcome.

It has been recognised in the medical field that most clinicians (including 'experts') only remember clearly their last three cases of a particular condition, and this impacts on how they manage the next case – reflection should always include sourcing appropriate information to support that reflection!

Clinical audit

Clinical audit is part of clinical governance but can also be part of assessment. Clinical audit can help with assessing the implementation of EBVM in practice, for personal and practice-level professional improvement, and does not have to be led by the requirements for clinical governance.

What clinical audit is and what it isn't

Clinical audit is (NICE 2002):

"A quality improvement process that seeks to improve patient care and outcomes through systematic review of care against explicit measures and the implementation of change."

The key component of clinical audit is that clinical performance is reviewed (or audited) to ensure that what should be done is being done. If what should be done is not being done, clinical audit provides a framework to enable improvements to be made. RCVS Knowledge have published a clinical audit toolkit which is designed within more of a clinical governance framework, and is useful as a reference for practitioners, remembering that clinical auditing can take place outside of clinical governance stipulations.

Clinical audit is not research, which can be defined as:

"A structured activity which is intended to provide new knowledge which is generalisable (i.e. of value to others in a similar situation) and intended for wider dissemination." (UK Department of Health, 2002)

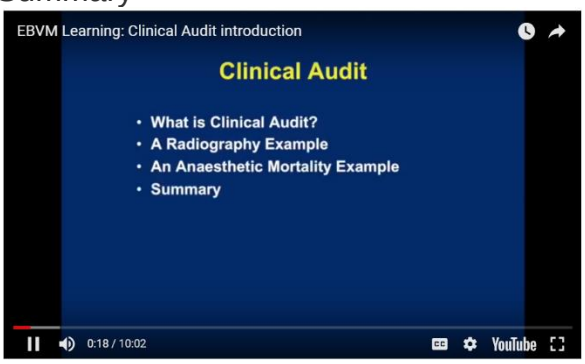
	CLINICAL AUDIT	RESEARCH
Purpose	To improve patient care by testing clinical practice against set standards	To provide new knowledge (e.g. to set or change clinical standards)
Methods	Review of patient management or parts of management (e.g. diagnostic protocols, treatment options) using the principles of the clinical audit cycle	Testing an hypothesis or addressing clearly defined questions, aims and objectives
Intervention	Does not involve doing something to patients beyond routine clinical management	May involve interventions / treatments / samples or investigations that would be considered additional to routine care
Analysis	Simple statistics only (e.g. means, proportions, percentages)	Requires data analysis (qualitative or quantitative)
Outcomes	Leads to improvements in practice (if necessary) through development and implementation of action plans/strategies	Improves knowledge

It should be remembered that research forms the basis of guidelines or standards to be audited, and so research may need to be undertaken first, by necessity, in some areas of veterinary medicine before a useful audit can take place. But if that research has been done, clinical audit can be undertaken and prove quite useful to clinical practice!

Clinical Audit: introductory video

This 10 minute video (https://youtu.be/BHRRWz4w9UQ) will introduce you to Clinical Audit, and covers:

- What is Clinical Audit?
- Examples
- Summary

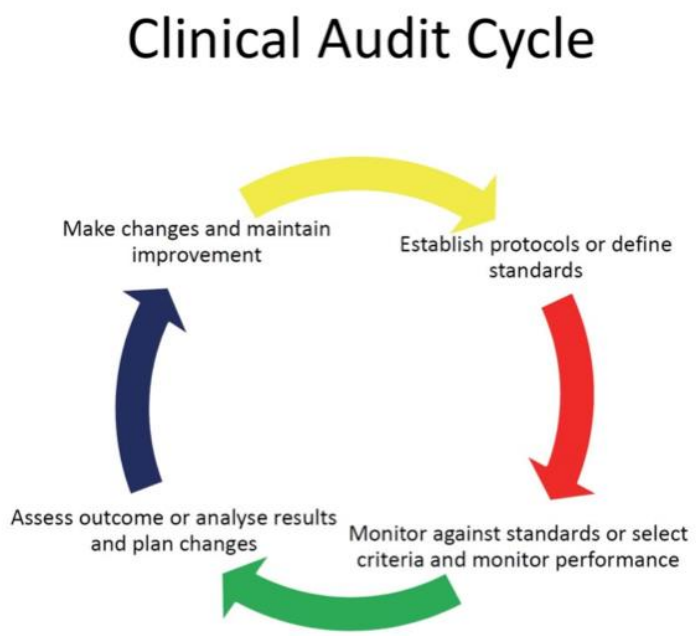


Clinical audit in the veterinary world

One thing to be very careful about in comparing the audit process in veterinary medicine to the audit process in human medicine, is that there are many fewer practice guidelines in veterinary medicine.

In many realms of veterinary medicine, there may be no identifiable standards for what veterinarians do, so, in many situations, we need to rely on developing evidence-based standards (Mair 2006). In essence, although the primary aim of clinical audit is not research, we are often forced down the research route in order to identify appropriate standards for our specific clinical audit (e.g. by carrying out service evaluations or surveys of our performance). Either way, these processes can still become a part of the clinical audit cycle (see below).

Although audit is valuable, there does have to be a balance struck between increasing workload and management, and the benefit gained from the process of auditing. This balance can be achieved by ensuring you are assessing the right areas of your practice (for more information, see below).



The audit cycle or loop, adapted from Viner and Jenner (2005) and Mair (2006)

Where to start in clinical audit?

Like most things in life, clinical audit is best learnt through practical experience. It is better to gain this experience with small, simple projects that are narrowly focussed rather than attempting to do everything all at once.

In essence, veterinarians will do some small-scale clinical research in the clinic to see how well they are performing. So you'll collect some data, interpret that data in the context of your practice, and then decide if you ought to change anything. When the cycle is complete, you'll decide when to do it again. The process is of limited value if you only do it once, but it doesn't mean that you need to look at everything all the time in an ever spiralling auditing frenzy!

Choosing an area to audit

Start with something that:

- has a clearly defined outcome or is clearly measurable;
- you care about (or believe that some stakeholders care about);
- is influenced by decisions made within the clinic (i.e. if you have no control over the outcome, there's not point auditing it!).

Good areas for a first audit are:

- peri-operative deaths;
- suspected nosocomial infections;
- post-surgical complications for common elective surgeries (e.g. neutering).

Performing the audit

The steps that are involved are:

1. Set a timetable or schedule for the audit, and identify who will do the work.
2. Collect the data/information.
3. Assess the findings, and decide on actions.
4. Decide when to do it again (i.e. when to go back to Step 1.).

Defining the standards and establishing the protocols for the audit

One of the best starting points for EBVM is in designing practice-wide protocols rather than trying to ensure that every vet is practicing EBVM in every instance. Protocols covering subjects such as antibiotic use, or routine parasite control and prevention, are generally straightforward to design and implement. A protocol may also be part of a diagnostic plan (e.g. the clinical question could be 'Does implementation of routine testing for this disease in this animal presenting with certain signs reduce complications or recurrence following diagnosis?').

Ideally, there would be an evidence base available that could inform the protocols you are assessing, and that evidence base would include practice-specific factors (e.g. local resistance patterns, demographics of the client/patient population). However, in many areas, protocols may lack high level evidence for some or all parts. A number of examples exist for this: use of Tissue Plasminogen Activator in

pleuropneumonia in horses, use of nutraceuticals in a number of species, incorporation of physiotherapy into patient management and even anthelmintic protocols in small animals!

These knowledge gaps do not, however, preclude you from setting up protocols based on the best evidence available, but they should prompt you to enter into assessment/audit cycles fully aware that you might not have all the measures by which to evaluate your protocols. This approach might make you more considerate of ensuring your specific protocol is achieving what you hoped it would.

Example Scenario 1: Dry cow therapy

Rachel has just returned from a conference where a drug company stand offering a constant supply of amazing chocolates, as well as freebie merchandise, has convinced her of the merits of a new dry cow therapy. Furthermore, she has gone to the effort of using EBVM in asking whether this therapy will work in prevention of mastitis on her farms, and at a recent clinical rounds has presented the veterinary team at her clinic with an appraisal of the literature which looks supportive of this new therapy. Rachel has been approved by the partners at her clinic to go ahead with trialling this new therapy on interested farms where she thinks it will be most effective, as long as she audits the results.

In order to spread the word about this new therapy, Rachel establishes a new protocol for dry cow therapy, using the new product, which includes the types of farms where the new therapy is likely to be most effective. She then circulates her protocol to the other practice veterinarians so that they are aware of the new therapy and the evidence behind its use. Rachel also develops a data collection sheet that she and other vets can use to audit the use of this new therapy and compare new dry period infection rates on farms using the new therapy, with historical dry period infection rates when other therapies have been used.

Rachel defines a standard and sets a protocol: Farms with a certain known pathogen profile causing dry period infections are recommended to use the new dry cow therapy on selected cows in accordance with a set protocol.

Example Scenario 2: Small animal dental imaging

Tom has just recently performed a Knowledge Summary for his practice that has demonstrated that high definition computed radiography in dogs and cats has diagnostic capability for periodontal disease that is superior to visual examination.

On the basis of this evidence, and because of the potential to improve animal welfare by reducing additional visits or prolonged morbidity associated with undiagnosed disease, the partners have just invested in dental radiography. Tom now wants to establish and demonstrate to the partners that this has been a good investment and that it has improved animal welfare.

Tom defines a standard and sets a protocol: All dogs and cats presented for dental treatment will have survey radiographs of the mouth and, where appropriate, diseased teeth will be removed.

Monitor changes against standards or select criteria, and don't forget to keep track of performance!

EBVM includes patient, client, experiential and practice factors as well as the peer-reviewed scientific literature, and all of these will influence the information you gain and want to gain from a clinical audit.

For example, you might want to know if implementation of a protocol or new treatment will improve client satisfaction, decrease costs to the client, increase profit margins, save time, improve veterinary compliance, reduce side effects, increase survival, or increase quality of life. In order to answer this 'What if?', you need to ensure you are asking the right questions to the right person (e.g. quality of life is often best evaluated by owners through practical questions involving the animal's daily life, not by their veterinarian).

Some examples of ways in which we could monitor changes against standards or criteria might be:

- Making sure that recurrence or complication rates for a specific disorder are equivalent to a recent multicentre case series found in the literature.
- Setting nosocomial infection rates to reduce by a certain percentage from the current baseline if no history of actual rates is available.
- Insisting that client-reported quality of life or pain score ratings should be equivalent to published results, should improve from what they currently are in your clinic, or should be greater than a predefined percentage.
- Necessitating that client satisfaction should improve, or remain static where it has already been at high levels.
- Requiring veterinary or owner compliance to be above a certain cut-off percentage (e.g. veterinary adherence to safety protocols would be expected to be 100%, while expectations of client compliance to puppy vaccination schedules may be set slightly lower).
- Stipulating that cost implications of implementing a new protocol should be comparable to those associated with the previous protocol, or that the new protocol will have a demonstrable cost benefit to the client and/or practice.

The overarching principle to successful implementation and adoption of both EBVM and clinical audit is to keep things small and simple, especially to start off with. It should be possible for you to set a modest goal of clear benefit, and to achieve it. Communication is also important – be sure you keep records of the process and of your findings so that you can compare the next cycle with the last. Discuss the tasks and progress with colleagues both during and after each audit cycle. Good communication will help to involve the more experienced (and often busiest) members of the practice who may at first be reluctant or unable to engage otherwise.

Example Scenario 1: Dry cow therapy

Rachel has selected two criteria against which to monitor the performance of her new dry cow therapy protocol, and she will review these after farms have been using the new therapy for at least six months.

1. The cost implications – are the costs of this therapy to the farmer directly or indirectly comparable to the previous therapy?
2. Improvements in somatic cell count (SCC) and clinical mastitis rates – has the bulk tank SCC reduced or stayed at the same level, and has the incidence of clinical mastitis in the post-calving period reduced or stayed the same in cows treated with the new dry cow therapy?

Example Scenario 2: Small animal dental imaging

Tom has selected three criteria to monitor the dental radiography unit, and will evaluate these after the technology has been in use for 12 months:

1. Has the number of teeth removed from dental patients remained the same, increased or decreased?
2. Have owners completed feedback surveys of the post-dental behaviour in their dog or cat, and are these surveys indicating that owners are happy with the results they are seeing?
3. Has the average dental invoice amount increased or decreased?

Making sure clinical audit gets done – the administrative side

Although vets are clearly central to the auditing process, an audit team including veterinary nurses and lay staff can also make an enormous contribution.

The auditing process is not a light undertaking, and it may place additional burdens on staff. Support staff in a practice are a source of valuable knowledge, as they have extensive experience that can be used to help smooth the process and make sure all the practicalities of the audit have been addressed. Specific points to be addressed include:

- Who within the clinic will be responsible for collecting the data?
- Does an appropriate recording system exist in the practice (e.g. Is a paper-based system most appropriate? Would investing in a computer-based system be easiest?)
- Who will analyse the audit and make sure all the veterinarians are responsible for keeping good records?
- Are the results of the audit fit for purpose? With what will you compare the results you generate?
- How will you disseminate the results, both within and outside the practice?

Example Scenario 1: Dry cow therapy

Rachel has asked the practice administrator to collate the bulk tank SCC and clinical mastitis records of the farms using the new protocol. Rachel will then compare these numbers against the previous records and calculate the cost:benefit of using the new therapy. She will then prepare a report for the veterinarians at the practice, as well as for the farmers on whose operations using the new therapy is expected to be

beneficial (both those who have so far adopted the new therapy and those who have not).

Example Scenario 2: Small animal dental imaging

Tom is able to tally the number of teeth removals per dog or cat for the 12 months prior to the installation of the computed radiography system, as well as those for the 12 months after its installation in order to compare them. He can also extract the total cost per dental visit from the system. His trainee vet nurse has designed an owner feedback survey (including key questions about overall demeanour, eating behaviour and breath) as part of her nursing degree course, and has been collating the results of this survey for presentation to the practice partners.

Acting on the results of clinical audit

Once you have the results, it is time to act on them! If you started off by establishing criteria by which you will assess your new protocol or practice, then it is a simple matter of comparing your results with those criteria.

When you start an audit, the most difficult part will probably be collecting the data. Do not be surprised if you find that the action that needs to be taken is the systematic collection of relevant data so that you have something to compare to in the next audit!

Most audits will involve calculating some simple descriptive values (means, proportions, percentages), as discussed previously in this chapter. Some simple analysis will allow you to decide if your results show that the changes you have made are as good as, or better than, your defined criteria.

In many cases, the audit process may well indicate that no change is required. For example, an audit of peri-operative fatalities, or post-surgical wound breakdowns/infections, may indicate that rates have not changed recently and that they remain at levels that are similar to those in other clinics. The point of clinical audit is that it provides baseline data or reference points for comparison. Clinical audit also ensures that a process is in place that will likely result in early identification if things start to go wrong.

Part of the audit process should be for you and your colleagues to identify thresholds that might trigger you to further action. That action might involve further in-depth investigation, or it may involve an increased frequency of the audit cycle to see if preliminary results are indeed a trend in the wrong direction, or just an anomaly that should be monitored but perhaps not acted on at this time. On the whole, a common sense approach is required. However, an explicit and systematic process can help veterinary clinics avoid falling into complacency or inertia.

There are two important things to remember. Firstly, don’t worry if the first attempt at data collection isn’t successful; if you’ve given it your best on the first try and discover you need more data, try and implement changes that will make things better on the next attemp. Being able to generate accurate, interpretable data the first time

around is not common, and the first step is often to develop ways to obtain data that will help you assess what you are doing in your clinic!

A second pitfall is the temptation to over-analyse or over-interpret the data that is obtained. Always try and retain a focus on the question that was originally addressed – you need first of all to reflect on whether this question was answered by the data you collected. For example, if you are looking at anaesthetic or peri-operative mortality rates for elective surgery, you may need to consider how to interpret the numbers for when it was decided that an animal would be best served by being euthanised during surgery. On the whole, it is best not to attempt to look at a number of factors (surgery type, anaesthetic protocol, species of animal, etc.) during the first audit cycle.

However, in subsequent audit cycles, you may choose to expand the data collection and analysis, if that is appropriate. For example, it may well be of benefit to consider colic surgery in equine practice separately to any other types of equine surgery, as it is likely to have a greater mortality risk (including a greater chance of euthanasia). The results of such an audit also enable you to include these figures in the decision-making process when discussing treatment choices with owners using pertinent data from your own clinic.

Example Scenario 1: Dry cow therapy

Rachel and her colleagues were able to identify only six farms that met the criteria for pathogen profiles that were likely to benefit from use of the new dry cow therapy. Of those farms, only two chose to participate – the others thought they might wait for the results from these participants before deciding whether or not to switch to a new product, as they were happy with the effectiveness of their current dry cow therapy.

After six months of using the new dry cow therapy, the practice administrator reported that one farm's overall SCC had risen by 10%, although the other farm's SCC had fallen by 12%. Clinical mastitis rates in the post-calving period were the same on the first farm, but had increased by 7% on the second farm. Based on these figures, and the fact that the new therapy was slightly more expensive than the products the two farms had previously been using, Rachel calculated that there was no financial benefit to either farm.

Although these numbers were disappointing, the farmers and veterinarians realised that the outcome measures were affected by a number of factors, of which dry cow therapy was only one. Both farms were happy with the new therapy and decided to continue using it, and two other farms also decided they would switch products after culture results revealed pathogens which were resistant to the dry cow therapies they had been using. Rachel agreed to work with those farms as well, and to report back on the numbers in another six months to further evaluate the new treatment.

Example Scenario 2: Small animal dental imaging

Two hundred dental cases per year occurred in both years that Tom assessed. Over the year following implementation of dental radiography, there was a 20% increase

in total extractions, which was consistent with radiography identifying additional diseased teeth in dogs and cats.

During the period of the audit there were 95 responses to the animal welfare questionnaire: 60 from dog owners and 35 from cat owners. 85% of dog owners indicated a positive response, with dogs showing increased activity levels ('acting years younger') and/or owners reporting reduced halitosis. Only 60% of cat owners indicated a positive response, however, with changes mentioned primarily associated with improved appetite. There were no negative responses (indicating no reports of worsening of conditions), but respondents that did not reply positively indicated that they did not notice any particular response to dental treatment in their pets. No client queried the bill (although a practice policy of providing clear estimates for dental work had been instituted concurrently).

The average dental invoice increased by 36% which, over the 200 patients seen in the previous 12 months, provided a noticeable increase in gross income. This represented a margin of double the purchase price of the dental radiography investment.

The implementation of dental radiography was considered beneficial from both an animal welfare and financial aspect, and client feedback was good, despite the increased cost. Tom's practice decided to continue to monitor client feedback, dental invoices and the numbers of extractions they perform, with a view to reviewing the data again in 12 months' time.

Quiz

When is it most important to assess and reflect on our clinical decision-making?

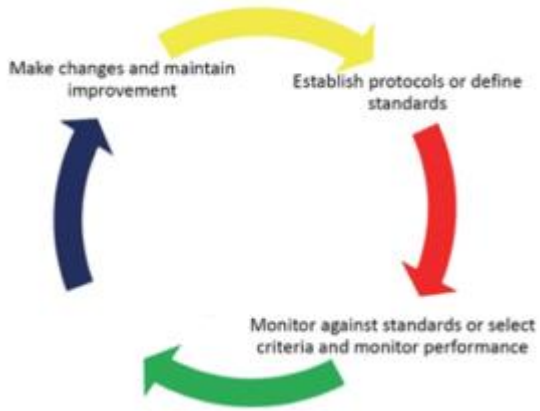
- When something has gone wrongIncorrect. While it is important to reflect in these situations, it is also important to reflect and assess our decision-making even when things do not go wrong.
- Assessment and reflection should be an on-going processCorrect. Reflection and assessment should be a continual process.
- When we have an unexpected outcomeIncorrect. While it is important to reflect in these situations, it is also important to reflect and assess when outcomes are expected.
- When deciding to buy new equipmentIncorrect. While assessing whether new equipment would be beneficial to clinical outcomes is important, reflection and assessment should be a continual process.
- Before a practice inspectionIncorrect. It is important to view reflection and assessment as an on-going part of practice.

What is the definition of clinical audit?

- A quality improvement process that seeks to improve patient care and outcomes through systematic review of care against explicit measures and the implementation of changeCorrect. The key component of clinical audit is that clinical performance is reviewed (or audited) to ensure that what should be done is being done.

- A structured activity which is intended to provide new knowledge which is generalisable (i.e. of value to others in a similar situation) and intended for wider disseminationIncorrect. This is a definition of research. The key component of clinical audit is that clinical performance is reviewed (or audited) to ensure that what should be done is being done.
- A quantifiable method of testing a new hypothesis in clinical practiceIncorrect. Clinical audits do not test hypotheses. The key component of clinical audit is that clinical performance is reviewed (or audited) to ensure that what should be done is being done.
- A method of conducting research in clinical practice, in order to get specific data relevant to that populationIncorrect. In some cases research is needed first in order to perform a clinical audit, however the key component of clinical audit is that clinical performance is reviewed (or audited) to ensure that what should be done is being done.
- A process by which protocols and guidelines are created by policy-makers and implemented at a national levelIncorrect. Clinical audit is done at a practice level. The key component of clinical audit is that clinical performance is reviewed (or audited) to ensure that what should be done is being done.

What step is missing from this clinical audit cycle?



- Assess outcome or analyse results and plan changesCorrect. The missing step in this cycle is the assessment and planning step.
- Statistical analysisIncorrect. The missing step in this cycle is the assessment and planning step.
- Test hypothesis on a pilot sampleIncorrect. The missing step in this cycle is the assessment and planning step.
- Establish refined protocols and different standardsIncorrect. The missing step in this cycle is the assessment and planning step.
- Decide on population upon which to apply changesIncorrect. The missing step in this cycle is the assessment and planning step.

Place the 5 steps of the Evidence-based Veterinary Medicine (EBVM) cycle in the correct order.

- Acquire, Apply, Appraise, Ask, AssessIncorrect. The correct order is Ask, Acquire, Appraise, Apply and Assess.
- Ask, Acquire, Appraise, Apply, AssessCorrect, this is the right order.

- Ask, Acquire, Assess, Apply, AppraiseIncorrect. The correct order is Ask, Acquire, Appraise, Apply and Assess.
- Assess, Acquire, Apply, Appraise, AskIncorrect. The correct order is Ask, Acquire, Appraise, Apply and Assess.
- Appraise, Ask, Acquire, Apply, AssessIncorrect. The correct order is Ask, Acquire, Appraise, Apply and Assess.

Summary

You should now be more familiar with how to:

- Explain why it is important to assess/audit the implementation of EBVM in practice.
- Describe how to assess/audit EBVM in practice.
- Use practice examples to demonstrate the use of clinical audit and the assessment of EBVM in practice.

References

Mair, T. S. (2006) Evidence-based medicine and clinical audit: what progress in equine practice? *Equine Veterinary Education,* 18(1), pp. 2-4

National Institute of Clinical Excellence (2002) Principles of Best Practice in Clinical Audit. Radcliffe Medical Press: Abingdon. Available online from: http://www.uhbristol.nhs.uk/files/nhs-ubht/best_practice_clinical_audit.pdf[Accessed 27 Sept 2016]

Viner, B. P. and Jenner, C. S. (2005) Clinical audit learning form the medical profession. *Veterinary Record,* 157(22), pp. 695-696

What next?

Congratulations! You've completed the EBVM Learning tutorial. We hope you feel you've improved your knowledge about EBVM, and thought of ways you can apply it to your everyday practice.

There is an increasing momentum behind EBVM within the profession, so there will be growing numbers of resources for you to access to continue to improve your EBVM learning. If you haven't done so already, check out the links within this tutorial and see what else is out there on different sites.

Other ideas would be to join forces with others who are interested in EBVM, such as signing up to some of the Knowledge Groups organised by RCVS Knowledge, becoming a member of the EBVMA, subscribing to the CEVM mailing list, and many more!

Last, but definitely not least, we welcome your thoughts on the tutorial via the feedback form.

Help

- **Using the tutorial**
- Glossary
- Links
- Feedback

Using the tutorial

There are a number of ways of approaching this tutorial. We recommend that you work through the entire resource, however you may wish to use the individual chapters as standalone learning.

- If you are entirely new to the concept of EBVM, it is best to start with the ABCs of EBVM and work through the tutorial from there.
- You may wish to tackle one chapter this week, the next chapter in a few weeks' time, or you may wish to spend the day learning about EBVM and work through the whole resource in one go.
- The side menu displays the content in each chapter.
- If you want to learn more about a specific topic, the expandable boxes enable you to read about the subject in more detail or you can try using the search box to identify every place this subject is discussed.
- Each page has previous/next links at the bottom to help you progress through the tutorial, or you can jump to specific sections or pages in the tutorial using the main navigation bar at the top, or the menu on the right-hand side.
- Remember to use the glossary for any clarification of words and terms you don't understand.

Other features

Some pages include further information to expand on the basic text, which is indicated as:

Select this to reveal the extra content

We have also included additional information in the form of:

Useful information

Tips

Examples

There are lots of links to other websites included in the tutorial. These are indicated with this icon and by default will open in a new tab/window.

If you're unsure about a particular term used in the tutorial, you can look for a definition in the glossary.

Glossary

Accredited practices (RCVS): The Royal College of Veterinary Surgeons is the United Kingdom's professional registration body. The RCVS Practice Standards Scheme is a voluntary initiative to accredit veterinary practices in the UK. Through setting standards and carrying out regular inspections, the Scheme aims to promote and maintain the highest standards of veterinary care.

Audit cycle: A systematic review of a practice, process or performance to establish how well it meets predetermined criteria. The procedure includes identifying problems, developing solutions, making changes to practice and then reviewing the whole operation or service again. [1]

Best Evidence Topic (BET): A BET is a simple, unbiased review of current best evidence on a very specific clinical topic. It is designed to be a quick and achievable method of incorporating evidence into clinical practice. It is similar to a Critically Appraised Topic (CAT) or a Knowledge Summary (KS).
See: https://bestbetsforvets.org

Bias: Systematic (as opposed to random) deviation of the results of a study from the 'true' results, which is caused by the way the study is designed or conducted. [1]

Bibliographic databases: Bibliographic databases store information about journal articles and conference proceedings (e.g. title, author, abstract, key words) within a specified subject area. Databases can be searched to help find references.

Boolean operators: Simple words (AND, OR, NOT or AND NOT) used to combine or exclude keywords in a search, resulting in more focused and productive results.

Case report: A case report is a description of a single case (or small number of cases).

Case series: A case series is a description of the presentation, diagnosis, treatment and outcome of a group of animals with the same disease. There are no disease-free animals for comparison, and any differences in management are not randomly allocated (for example, they may be due to the owners' preferences or different protocols between centres).

Case-control study: A case-control study is a retrospective study comparing animals with the disease (cases) and without the disease (controls) of interest. The animals' histories are examined to identify risk factors for the disease.

Critically Appraised Topic (CAT): A 'critically appraised topic' is a quick and simple form of evidence synthesis where a specific clinical question is answered by searching the relevant literature. It is similar to a Best Evidence Topic (BET) or a Knowledge Summary (KS).

Citation search: A citation search allows you to specify a key article, author or book, and find other articles that have included that specific resource in their bibliographies.

Clinical audit: A process for monitoring standards of clinical care to ensure the best possible care (known as 'best practice'). Clinical audit can be described as a systematic 'cycle'. It involves measuring care against specific criteria, taking action to improve care if necessary and monitoring the process to sustain improvement. As the process continues, an even higher level of quality is achieved. [1]

Clinical bottom line: This is the overall answer to a clinical question, based on critical appraisal of the relevant evidence found through searching the veterinary literature.

Clinical decision-making: Clinical decision-making is a balance of experience, awareness and knowledge and information gathering, along with using appropriate assessment tools, your colleagues and evidence-based practice to guide you.

Clinical governance: Clinical governance is a systematic approach to continuously maintaining and improving the quality of patient care within a health system.

Clinical research: Clinical research is scientific research in a clinical context. Clinical research directly involves a particular patient or population. A clinical trial is one type of clinical research that follows a pre-defined plan or protocol.

Clinical question: A question that may occur in veterinary practice. The question may be regarding drug efficacy, diagnostic test evaluation, prognosis, risk, etc.

Complication rate: The number of subjects in an at-risk population that will develop complications in a given amount of time.

Clinical relevance: How relevant the study results are to actual clinical outcomes. Effects identified as statistically significant are not always clinically significant, either because the effect is small or the outcome is not important.

Cohort study: A cohort study is an observational study where exposed and unexposed groups (cohorts) are followed over a period of time. At the end of the study period, the outcome (e.g. disease) is measured. Cohort studies can identify risk factors associated with disease and estimate incidence.

Comparator: The standard intervention against which an intervention is compared in a study. The comparator can be no intervention (for example, best supportive care) or a commonly administered treatment. [1]

Control: A group of patients in a study who do not receive the treatment or test being studied. Instead, they may receive the standard treatment (sometimes called 'usual care') or a dummy treatment (placebo). The results for the control group are compared with those for a group receiving the treatment being tested, in order to assess any differences in response. [1]

Cross-sectional study: A cross-sectional study looks at a sample of the population at a single point in time, most commonly to determine the prevalence of a certain disease.

Diagnostic tests: Tests used in order to aid diagnosis of a patient (e.g. haematology, biochemistry, etc.).

Diagnostic test validation study: A diagnostic test validation study is used to establish the usefulness of new diagnostic tests. Animals are tested using the new diagnostic test and the current gold standard to establish the sensitivity, specificity and likelihood ratios for the new diagnostic test.

Electronic communication: Communication such as email, web forums, wiki software, Facebook and Twitter accounts.

Epidemiology: Epidemiology is the study of the distribution and determinants of health-related states or events (including disease), and the application of this study to the control of diseases and other health problems. [2]

Evidence: Information on which a decision or guidance is based. Evidence is obtained from a range of sources, including randomised controlled trials, observational studies and expert opinion (of healthcare and other professionals and/or patients). [1]

Evidence synthesis: An evidence synthesis is a collation of the current evidence available to answer a clinical question. Evidence syntheses may come in many forms and can appraise the evidence in various ways. Some examples are knowledge summaries, critically-appraised topics, best evidence topics, systematic reviews and meta-analyses.

Expert opinion: Expert opinion can be one individual's opinion or part of an elicitation process based on a panel of experts used to answer a question of interest. Expert opinion may provide some evidence where no information is available (e.g. new treatment efficacy or application to a new population).

External validity: The degree to which the results of a study hold true in non-study situations, for example in routine veterinary practice. May also be referred to as the generalisability of study results to non-study populations. [1]

Grey literature: Grey literature is information or research output produced by organisations outside of commercial or academic publishing and distribution channels.

Intervention: In clinical terms, a drug treatment, surgical procedure, diagnostic test or management change.

Journal club: Normally, practice-run journal clubs involve clinicians meeting at regular intervals to review recently published literature of relevance in an in-depth way.

Knowledge Summary (KS): A knowledge summary is a short critical summary of the best available information on a defined clinical question. It provides a concise conclusion which should be easily accessible by clinical staff. It is similar to a Critically Appraised Topic (CAT).
See: https://www.veterinaryevidence.org/index.php/ve/browseSearch/sections/view?sectionId=2

Meta-analysis: A meta-analysis is a quantitative statistical analysis (generally) conducted as part of a systematic review. By combining the data, a meta-analysis provides more evidence than each individual study is able to on its own.

Morbidity: The number of cases of an illness, injury or condition within a given time (usually a year). It can also refer to the percentage of patients with a particular illness, injury or condition within a defined population.

Mortality: The proportion of a population that dies within a particular period of time. The rate is often given as a certain number per 1000 animals.

Narrative reviews: A narrative review is a review of the evidence done by an expert in the area, without the use of systematic guidelines and checklists which sets them apart from systematic reviews.

Open access: Literature that is available to be viewed and used without subscription.

Outcome: The impact that a test, treatment, policy, programme or other intervention has on an animal, group or population.

Peer-review: Review of a study, service or recommendation by those with similar interests and expertise to the people who produced it to make sure the study results are accurate and valid. Peer-reviewers can include both professionals and 'lay' experts. The peer-review process subjects scientific research papers to independent scrutiny by other qualified scientific experts (peers) before they are made public. [1,3]

PICO: Acronym indicating **P**opulation, **I**ntervention, **C**omparison and **O**utcome framework. This is a structured approach for developing review questions, dividing each question into four components: the population (the population under study); the interventions (what is being done); the comparators (other main treatment options); and the outcomes (measures of how effective the interventions have been). [1]

Pilot study: A small-scale 'test' of a particular approach that aims to highlight any problems or areas of concern and amend it before a full-scale study begins. [1]

Population: A group of patients with a common link, sharing the same medical condition, breed or other characteristics. The population for a clinical trial will be all the patients the test or treatment is designed to help (such as Labradors with hip dysplasia). It is best if populations involved in studies are representative of the whole population of interest. [1]

Population health: Not merely the sum of the health of the individuals that make up a population, but the distribution of disease and health factors within that population.

Primary evidence: Primary evidence in EBVM generally refers to the original research papers written by those who conducted the study at the time of the study e.g. peer-reviewed journal articles that report on a single scientific study.

Publication bias: Publication bias occurs when the results of studies showing that a treatment works well are published, and studies showing it did not have any effect are not published. If this happens, analysis of the published results will not give an accurate idea of how well the treatment works. [1]

Practice meetings: Practice meetings are a formal forum for all practice staff to raise and discuss any issues concerning the practice.

Practice protocols: Protocol-based care within veterinary practices means having standardised, evidence-based guidelines for veterinarians to use in certain circumstances (e.g. a farm animal practice might have protocols for first and second line antimicrobial treatment of mastitis based on pathogens known to be present on a farm).

Randomised controlled trial: A randomised controlled trial is an intervention study used to assess a treatment or other intervention. Study subjects are randomly allocated to either the intervention group or a control group (which receives either no treatment, a placebo, the current best treatment or a comparator). Ideally, the study should be ‘blinded’ so that anyone involved with the animals does not know which treatment each animal received.

Recurrence rate: The number of an at-risk population that will have a recurrence of a disease in a given amount of time.

Reflection: Reflection on current practices means looking back at the effect the current guidelines, protocols or standards of care have on clinical outcomes, and assessing whether changes may be necessary.

(Relative) Risk: The ratio of the risk of disease or death among those exposed to certain conditions compared with the risk for those who are not exposed to the same conditions. If both groups face the same level of risk, the relative risk equals 1. [1]

Rounds: Practice rounds is a forum for clinicians to meet in order to discuss ongoing and hospitalised cases. This is an effective way of ensuring case continuity as well as discussing case management.

Sample: Participants of a study recruited from the study’s target population. If these participants are recruited in an unbiased way, it may be possible to generalise the results to the target population as a whole. [1]

Search strategies: Search strategies are the methods we can employ in order to systematically search the veterinary literature for evidence that may answer our clinical question.

Secondary evidence: Secondary evidence in EBVM generally refers to publications that review, summarise or synthesise previous studies and are usually written by a third party e.g. text books, review articles, meta-analyses, knowledge summaries, systematic reviews.

Sensitivity: The sensitivity of a clinical test refers to the ability of the test to correctly identify those patients with the disease.

Specificity: The specificity of a clinical test refers to the ability of the test to correctly identify those patients without the disease.

Strength of evidence: The strength of evidence is determined by a combination of the study type, robustness of study design and applicability of study results.

Study design: The way a study is designed. Case-control study, cohort study, non-randomised controlled trial, and randomised controlled trial are all examples of study designs using different research methodologies. [1]

Study quality: The extent to which a study has conformed to recognised good practice in the design and execution of its research methods. [1]

Survey: A study in which information is systematically collected from people (usually from a sample within a defined population). [1]

Systematic review: A systematic review is a defined and rigorous method of collating and summarising the information from all published papers addressing a particular question. The methods used to search the literature, assess the quality, and make conclusions are explicitly stated in the methods section.

Synonym: A word or phrase that means the same as another word or phrase in the same language.

Veterinary literature: Veterinary literature is the source of evidence available for us in the veterinary profession. There are many veterinary peer-reviewed journals published worldwide, some are subscription only and some are increasingly open access.

References

1: NICE glossary
2: WHO website
3: Sense About Science