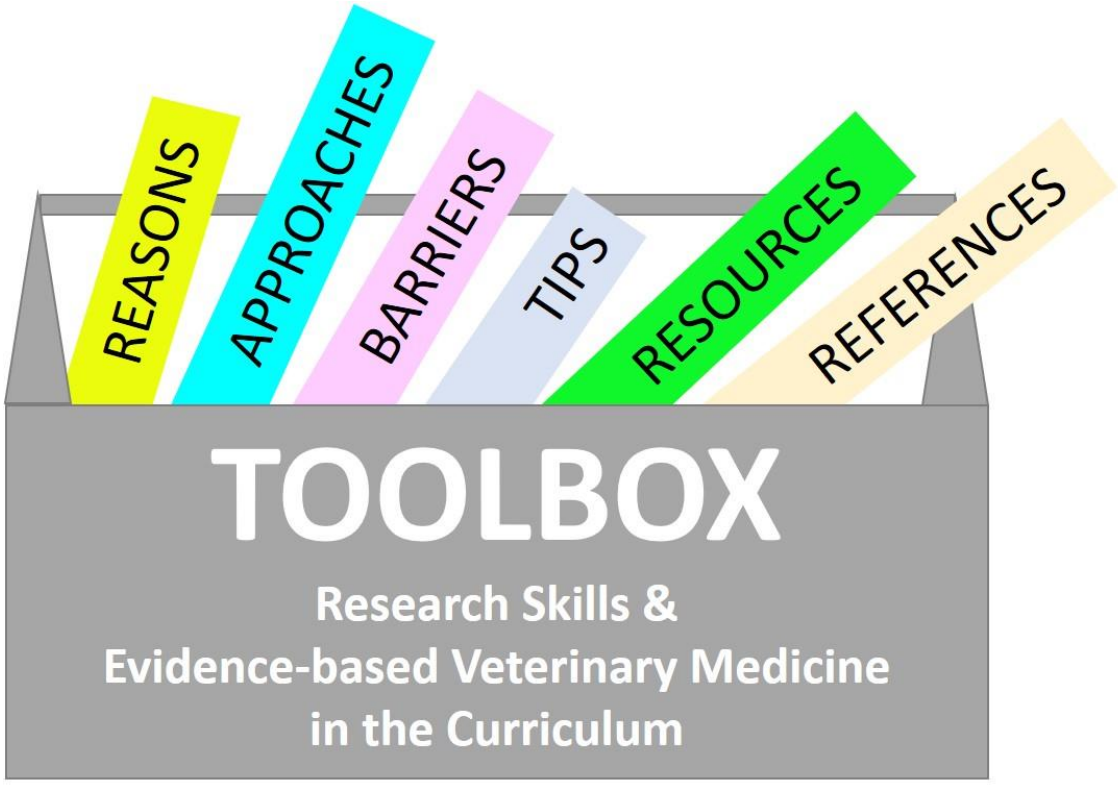
Creating the Next Generation of Evidence-Based Veterinary Practitioners and Researchers:

What are the Options for Globally Diverse Veterinary Curricula?



Project Overview & Background to the Toolbox

A 'toolbox' has been created which includes information for educators to consult when reviewing or introducing research and/or evidence-based veterinary medicine (EBVM) in a curriculum.

Veterinary educators strive to prepare graduates for a variety of career options with the skills and knowledge to utilize, and contribute to, research as part of their lifelong practice of EBVM. In the veterinary curriculum, students should receive a grounding in research and EBVM, as well as having the opportunity to consider research as a career.

An international group with the goal to synthesize evidence to help curriculum designers, course leaders and teachers implement educational approaches that will help inspire future researchers and create evidence-based practitioners was formed and a project undertaken supported by a grant from Council for International Veterinary Medical Education (CIVME). A literature review of the rationale, issues and options for research and EBVM in veterinary curricula was performed as well as semi-structured interviews with veterinary educators from across the CIVME regions. The synthesized data has been used to create the 'toolbox'.

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Please note that references are color coded in the text and when listed in the reference section as follows:

Black = veterinary

Blue = medical

Summary of themes and subthemes emerging from the literature (Janicke *et al.*, 2020)

Theme	**Sub-theme**	**Including**
Reasons to teach research skills and/or evidence-based veterinary medicine (EBVM)	Societal need/expectation	Need for research capacity within profession Expectations of professional to ensure good outcomes Accreditation and governance
	Careers and employability	Awareness of, and preparing for, a career in research Transferable skills
	The need to develop skills that can be applied in clinical practice/research	For research and to underpin EBVM: Ask/acquire/appraise To apply/assess in clinical work Learning to make decisions in the face of uncertainty
	Promote lifelong learning skills	Practice of EBVM Continuing professional development
Approaches used	Compulsory activities within curriculum	e.g. Research projects, Critically appraised topics (CATs)
	Opportunities beyond the curriculum	e.g. summer projects, student clubs, additional training, CAT club
Barriers	Students	Lack of engagement or awareness of opportunities Lack of training/skills Concerns about coping with uncertainty (EBVM)
	Faculty/staff student interaction	Different perspectives/expectations Faculty/staff experience/training Personnel/staffing levels/resource
	Curriculum	Faculty/staff/curriculum/student time Timing within curriculum Availability of resources
	Finances	Costs of training and student debt Conflict with need to earn and competition from private sector Lack of research funding
Tips for success	Enthusiastic faculty as mentors	Vet Non-vet
	Clinical relevance and contextualization	Clinical experience Current research
	Resources	Technology Training opportunities Funding Micro-level ideas e.g. guidelines for literature search, checklists for CATs
	Collaborative culture	Sharing information/ support Collaboration

Reasons to teach research skills and/or evidence-based veterinary medicine (EBVM)

Four main reasons were identified for including research skills and/or EB(V)M in healthcare curricula: societal needs and expectations, career development and employability, skills important for clinical professional life and promoting lifelong learning. Research and EB(V)M are interlinked, therefore the reasons to include one or both in the curriculum are often interconnected and will be discussed together below.

It is widely acknowledged that not enough medical and veterinary graduate students are interested in a career in academic, biomedical and translational research (Conroy et al., 2018; Ghali et al., 2000; Houlden et al., 2004; Hunskaar et al., 2009; MacDougall and Riley, 2010; Murray et al., 2005; Rosol et al., 2009; Russell et al., 2012; Siemens et al., 2010; Solomon et al., 2003). This issue has been noted in a number of countries including the USA, UK, Australasia, Europe, South East Asia, Canada and Latin America (Funston et al., 2016), despite the societal need for research capacity within the professions. If insufficient graduates choose research as a career there may be serious consequences for health services, including public health and one health (Griffin and Hindocha, 2010; Shankar et al., 2006), as well as for universities and the academic community (Cehrs et al., 2019; Conroy et al., 2018; Fernandez et al., 2019; Funston et al., 2016; Marušić and Marušić, 2018; Murdoch-Eaton et al., 2010; Russell et al., 2012; Shankar et al., 2006; Siemens et al., 2010). Encouraging students to become involved with research during their education has been shown to improve attitudes towards research as a potential career (Burgoyne et al., 2010; Cehrs et al., 2019; Cluver et al., 2014; Fernandez et al., 2019; Funston et al., 2016; McManus et al., 1999; Murray et al., 2005; Solomon et al., 2003; Weller and May, 2013) and also

improve their future career prospects and employability by preparing them better for the requirements of post-graduate training programs (Conroy et al., 2018; Mabvuure, 2012; Murdoch-Eaton et al., 2010; Stubbs et al., 2013; Zee et al., 2014). It is clear that there is a societal need for clinician-scientists and that they have a key role in translating progress in basic science and biomedical research into clinical practice (Burgoyne et al., 2010; Parsonnet et al., 2010; Rosol et al., 2009; Solomon et al., 2003), which is essential to enable the professions to practice evidence-based (veterinary) medicine (EB(V)M).

Stakeholders (institutions, clients, patients, government and professional bodies) as well as professionals themselves expect the best available research evidence to be translated into practice and used by healthcare practitioners to inform their clinical decision making and ensure good outcomes (Toews, 2011). Direct research experience has been shown to be important in developing deeper understanding of research and the development of critical thinking and appraisal skills (Burgoyne et al., 2010; Cardwell et al., 2017; Laidlaw et al., 2009; Murdoch-Eaton et al., 2010; Parsonnet et al., 2010; Riley et al., 2013; Shankar et al., 2006; Van Eyk et al., 2010; Weller and May, 2013; Weston et al., 2017). Critical thinking and appraisal skills are also required to practice EB(V)M (Dean et al., 2017; Laidlaw et al., 2012). In addition, teaching skills directly related to practicing EB(V)M familiarizes future practitioners with the procedure and encourages them to use these skills in the working environment (Ahmadi et al., 2015; Aronoff et al., 2010; Cardwell et al., 2017; Ciliska, 2005; Fajt et al., 2011; Ghali et al., 2000; Hardin and Robertson, 2011; Holmes and Cockcroft, 2004a; Kasch et al., 2017; Klem and Weiss, 2005; Liabsuetrakul et al., 2009; Maggio et al., 2013; Sadeghi-Bazargani et al., 2014; Shurtz et al., 2016; Steele et al., 2013; Umscheid et al., 2016; West et al., 2011). Practitioners that become accustomed to incorporating EB(V)M into their daily practice will improve patient outcomes and develop life-long learning habits

(Blanco et al., 2014; Feetham and Raffan, 2014; Grochowski et al., 2007; Holmes and Cockcroft, 2004b; Holmes and Ramey, 2007; Ilic et al., 2015; Maggio et al., 2015, 2013; Schmidt, 2007; Shurtz et al., 2016; Vandeweerd et al., 2012; Zwolsman et al., 2012) and be more equipped to deal with uncertainty when there is incomplete or unclear data (Dean et al., 2017; Hosny and Ghaly, 2014). In addition, training in research and EB(V)M skills leads to the acquisition of other transferable skills such as problem solving (Zee et al., 2014), oral and written communication, teamwork, time management and an understanding of ethics and governance (Boninger et al., 2010; Burgoyne et al., 2010; Choi et al., 2019; Conroy et al., 2018; Laidlaw et al., 2009; Mabvuure, 2012; Murdoch-Eaton et al., 2010; Weston et al., 2017), all of which can increase employability. Including research skills in training can also make students and clinicians more aware of the health problems of their community and country (Shankar et al., 2006).

These societal expectations of and by professionals to ensure good outcomes have led to research and EB(V)M being included into many accreditation standards and as a specified competence for professional and governing bodies in many countries, including the USA and Canada (AAVMC, 2019; Ahmadi et al., 2015; AVMA COE, 2019; Blanco et al., 2014; Ciliska, 2005; Maggio et al., 2013; Parsonnet et al., 2010; Toews, 2011; West et al., 2011), UK and Australia (Cake et al., 2016; Dean et al., 2017; General Medical Council, 2018; Meats et al., 2009; Mullan et al., 2017; Murdoch-Eaton et al., 2010; Riley et al., 2013; RCVS, 2014; Sandars et al., 2010; Weston et al., 2017), Europe (Bok et al., 2014, 2011; Dekker, 2011; EAEVE, 2019) and the Middle and Far East (Bangladesh Veterinary Council (BVC), 2017; Hosny and Ghaly, 2014).

Approaches used for teaching

A variety of approaches for teaching research and EB(V)M to health professionals have been described and include both compulsory and elective courses.

Approaches used to teach research skills

- Teaching of theoretical concepts using a blended method of didactic lectures, small group discussion, problem-based-learning and case studies (Marušić and Marušić, 2018)

- Short research projects of up to one year duration such as elective summer projects (Cluver et al., 2014; Solomon et al., 2003) or research rotations (Houlden et al., 2004; Riley et al., 2013) as well as compulsory embedded research projects (Cehrs et al., 2019; Duggan et al., 2013; Laidlaw et al., 2009; MacDougall and Riley, 2010; Millar et al., 2009; Weller and May, 2013; Weston et al., 2017)

- Longitudinal approach including initial didactic teaching of theoretical concepts followed by an individual research project (Boninger et al., 2010; Cardwell et al., 2017; Dekker, 2011; Laidlaw et al., 2012; van Eyk et al., 2010; Wen and Weatherley, 2018)

- Longitudinal individual research projects over multiple years (Conroy et al., 2018; Fernandez et al., 2019)

- Intercalated degrees (Collins et al., 2010; McManus et al., 1999; Stubbs et al., 2013)

Approaches used to teach EB(V)M

Integrating EB(V)M into the curriculum is a much more recent endeavor and there are even more approaches described in the literature:

- Lecture based EB(V)M skills courses (Ilic et al., 2015, 2011; Zee et al., 2014)
- Blended learning EB(V)M skills courses (Aronoff et al., 2010; Ghali et al., 2000; Ilic et al., 2015, 2013; Maggio et al., 2015; Maloney et al., 2015; West et al., 2011; Zee et al., 2014)
- Assessment of one or more of the 5 "A"s of EB(V)M (Arlt and Heuwieser, 2011; Ilic et al., 2011; Maggio et al., 2013)
    - Asking a clinical question
    - Acquiring (searching for) information
    - Appraising information
    - Applying information
    - Evaluating the impact of a change in practice
- Development of critically appraised topics (CATs), predominantly in the clinical years, but earlier implementation has also been described (Arlt et al., 2012; Hardin and Robertson, 2011; Kasch et al., 2017; Steele et al., 2013)
- Integration of EBM within problem-based-learning session (Hosny and Ghaly, 2014; Liabsuetrakul et al., 2013, 2009; Umscheid et al., 2016)

Barriers

Four themes relating to barriers to inclusion of research and EB(V)M in curricula were identified relating to students, faculty/staff, the curriculum itself, and financial resource.

1. Students

1.1. Lack of engagement or awareness of opportunities

In general students do not perceive skills gained by being involved in research beneficial to their goal of becoming a clinician, in fact they assume researchers become isolated from patients and clinical practice (Atchison, 2009; Burgoyne et al., 2010; Cehrs et al., 2019; Funston et al., 2016). In addition, they are concerned about falling behind their peers especially if they perceive research involvement during their professional training as being risky or requiring a large time commitment, which may have a negative impact on their overall academic performance (Burgoyne et al., 2010; Parsonnet et al., 2010; Russell et al., 2012). Another barrier is their lack of awareness of available opportunities within their university, including research skills training within the curriculum as well as research options outside of the curriculum such as summer projects (Funston et al., 2016; Rosol et al., 2009; Russell et al., 2012). Similarly, when engaging with EBV()M before being exposed to the clinical environment, students do not perceive the skills learnt relevant and are reluctant to spend the time necessary to acquire, appraise and apply the literature (Shurtz et al., 2016). Fundamentally, although students have a broad awareness of what constitutes research and EB(V)M, they do not fully comprehend the specifics and relevance to their future careers (Murdoch-Eaton et al., 2010).

1.2. Lack of training/skills

Many students report a lack of basic research skills and feel inadequately equipped and lacking in confidence to undertake a research project independently (Russell et al., 2012; Wen and Weatherley, 2018). This is likely due to the common issue of insufficient research methodology training, often with the added difficulty in attaining a research supervisor with sufficient training in mentoring to assist with this and other aspects of the research project (Funston et al., 2016; Siemens et al., 2010). Equally, using a nonintegrated approach in the curriculum when teaching EBM leads to fragmented learning and the students' inability to transfer the skills into clinical practice (Maggio et al., 2015).

1.3. Concerns about coping with uncertainty

A core element of research and EBM is acknowledging the need for further information on a subject and a willingness to ask questions. Students struggle with the inability to find evidence pointing to a definitive answer and are reluctant to deal with the uncertainty that is inherent in research and EB(V)M (Aronoff et al., 2010; Blanco et al., 2014; Dean et al., 2017; Maggio et al., 2016; Parsonnet et al., 2010; Shankar et al., 2006).

2. Faculty and staff/student interaction

2.1. Different perspectives/expectations

Faculty and staff generally view teaching research skills within the curriculum favorably (Cardwell et al., 2017) in contradiction to the students' perspective (see 1.1) and it is essential that faculty conceptualize and promote the importance of research to becoming a well-rounded clinician (Murdoch-Eaton et al., 2010). In opposition to this, faculty have a less positive attitude towards EB(V)M, possibly due to a lack of interest and skills in this field, the time needed to teach and perform these skills as well as a perception that this would

suppress the freedom of clinical decision making that could lead to a decrease in the overall quality of patient care by limiting the influence of individual physician experience and expertise (Ilic et al., 2015; Vandeweerd et al., 2012).

On top if this other stakeholders (graduates, employees and patients/clients) often do not consider research and EB(V)M skills a necessary competency, most likely due to a too narrow definition of what they believe it entails (Cake et al., 2016). For example, stakeholders valued "research skills" less than skills such as "critically appraise scientific publication" or "managing scientific information" despite these being essential elements of both research and EB(V)M (Bok et al., 2014; Cake et al., 2016; Rhind et al., 2011)

2.2. Faculty/staff experience/training

Student perception of supervision quality significantly correlates to positive student attitude toward research projects (Burgoyne et al., 2010; Cardwell et al., 2017; Cehrs et al., 2019; Choi et al., 2019; Funston et al., 2016; Mullan et al., 2017; Rosol et al., 2009; Weller and May, 2013), and good mentoring has a strong influence on research productivity, such as publications (Griffin and Hindocha, 2010; Shankar et al., 2006; van Eyk et al., 2010). Therefore, formal training in mentoring is necessary to ensure good supervision and a successful student learning experience (Burgoyne et al., 2010; Weller and May, 2013). In order for students to learn and apply EB(V)M appropriately, faculty, staff, and other mentors must have adequate proficiency in teaching EB(V)M and a lack of faculty mentors experienced with new technology and software can be a significant barrier to student learning (Blanco et al., 2014; Ilic and Forbes, 2010; Maggio et al., 2016, 2015; Meats et al., 2009; Shurtz et al., 2016; West et al., 2011). Senior clinicians believe their experience is the best guide for making medical decisions, but should learn to use evidence to assist in making these decisions in front of students (Ilic and Forbes, 2010).

2.3. Faculty/staff resource

The difficulty in finding available faculty to serve as a research supervisor or mentor, especially in smaller schools, is a contributing barrier to providing research opportunities for students (Parsonnet et al., 2010), in fact students that are unengaged and averse to a research project can lead to mentors losing interest in working with students (Siemens et al., 2010). As mentioned above, a major barrier to teaching EB(V)M is the lack of trained faculty committed to transferring those skills (Blanco et al., 2014; Sadeghi-Bazargani et al., 2014; Shurtz et al., 2016)

3. Curriculum

3.1. Faculty/staff/curriculum/student time

The most significant and most common barrier to overcome when integrating both research and EBM is the lack of time in the curriculum (Blanco et al., 2014, 2014; Ciliska, 2005; Dean et al., 2017; Doig, 2008; Funston et al., 2016; Hardin and Robertson, 2011; Ilic et al., 2013; Ilic and Maloney, 2014; Kasch et al., 2017; Klem and Weiss, 2005; Laidlaw et al., 2012; Maggio et al., 2016, 2015; Parsonnet et al., 2010; Riley et al., 2013; Russell et al., 2012; Sadeghi-Bazargani et al., 2014; Stubbs et al., 2013; Umscheid et al., 2016; Vandeweerd et al., 2012; Wen and Weatherley, 2018; Weston et al., 2017; Zee et al., 2014). Curriculum designers must shorten courses to make the time or identify how to integrate research/EB(V)M into existing courses.

3.2. Timing within curriculum

Aside from finding the time *within* the curriculum, identifying *when and how* to do this is also a major issue. In research there is conflicting evidence regarding timing and impact on student interest (Cluver et al., 2014; Grochowski et al., 2007). EB(V)M skills training is often

taught early in the curriculum before students have the knowledge necessary to allow clinical application and understand and apply EBVM principles (Aronoff et al., 2010; Dean et al., 2017; Hardin and Robertson, 2011; Ilic et al., 2013, 2011; Shurtz et al., 2016). Other studies where EB(V)M was introduced later in the curriculum suggest earlier integration would be beneficial (Steele et al., 2013). It is suggested that longitudinal teaching of EB(V)M skills throughout the curriculum best enables students to carry on practicing EB(V)M as clinicians (Ghali et al., 2000; Hosny and Ghaly, 2014).

3.3. Availability of resources

In research a lack of resources such as opportunities (see 1.1) and interested research active mentors (see 2.3.) as well as funding (see 4.3.) also play a role. Aside from these factors, some studies show that increasing availability of additional resources such as dedicated administrators, librarians and collaboration with clinicians (Boninger et al., 2010; Choi et al., 2019; Conroy et al., 2018; Funston et al., 2016; Mabvuure, 2012) as well as clear guidelines for faculty and students (Mullan et al., 2017; Robinson et al., 2007) encourages student learning and engagement. Difficulties making resources such as technology and software available to allow students to perform EB(V)M is major barrier, but even when these are available, the lack of high-quality, patient-centered publication, especially in veterinary medicine creates a significant barrier for the translation of research into clinical practice (Ahmadi et al., 2015; Arlt et al., 2012; Kastelic, 2006; Meats et al., 2009; Russell et al., 2012; Toews, 2011).

4. Finances

4.1. Costs of training and student debt

Students are reluctant to take on the additional time commitment of a research project or an intercalated degree not only because of the prolonged training time, but also because of

the additional costs associated with the extra time (Collins et al., 2010; Conroy et al., 2018; Funston et al., 2016; Mabvuure, 2012; McManus et al., 1999; Rosol et al., 2009; Stubbs et al., 2013). Postgraduate tuition fees are often not covered by student loans (Mabvuure, 2012) and summer studentships or extracurricular research opportunities are often poorly paid or unpaid (Murray et al., 2005).

4.2. Conflict with need to earn and competition from private sector

Increasing debt drives students to graduate quickly and find employment in the private sector, where research skills are not considered important (Cehrs et al., 2019; Rosol et al., 2009). Universities must be able to provide comparative salaries and better grant opportunities in order to compete with the private research sector (Rosol et al., 2009). Some countries face an added challenge in competing with first world universities for academic clinicians who leave universities in less-developed countries for opportunities in first world universities (Shankar et al., 2006).

4.3. Lack of research funding

Difficulty in finding funding for research is an international challenge especially with competitive funding environments skewed toward established, senior researchers reducing the number of enthusiastic mentors (Conroy et al., 2018; Funston et al., 2016; McManus et al., 1999; Riley et al., 2013; Shankar et al., 2006). In addition there is pressure on faculty/staff to generate income rather than support student research (Cluver et al., 2014). These issues are not limited to research, financial barriers exist for teaching and practicing EB(V)M with the cost of assessing literature often restrictive (Sadeghi-Bazargani et al., 2014).

Tips for success

Research skills

Recurring themes considered important for improving student perception of research and encouraging graduates to consider a career in research and/or academia are finding knowledgeable and supportive mentors and support staff (Atchison, 2009; Blanco et al., 2014; Boninger et al., 2010; Burgoyne et al., 2010; Cardwell et al., 2017; Cehrs et al., 2019; Choi et al., 2019; Conroy et al., 2018; Fernandez et al., 2019; Funston et al., 2016; Hunskaar et al., 2009; Mabvuure, 2012; MacDougall and Riley, 2010; Mullan et al., 2017; Murdoch-Eaton et al., 2010; Rosol et al., 2009; Shankar et al., 2006; Weller and May, 2013; Weston et al., 2017), longitudinal integration into the curriculum (Atchison, 2009; Cardwell et al., 2017; Laidlaw et al., 2009; Millar et al., 2009; Mullan et al., 2017) and clinical relevance of the project for the individual student researcher (Atchison, 2009; Burgoyne et al., 2010; Grochowski et al., 2007; Hunskaar et al., 2009; Laidlaw et al., 2012; Millar et al., 2009; Siemens et al., 2010; Weller and May, 2013; Weston et al., 2017) as well as sufficient funding (Atchison, 2009; Conroy et al., 2018; Rosol et al., 2009; Shankar et al., 2006)

EB(V)M

Similarly to teaching research, for successful teaching of EB(V)M a longitudinal integration within the curriculum is considered beneficial (Arlt and Heuwieser, 2011; Blanco et al., 2014; Ghali et al., 2000; Ilic and Maloney, 2014; Liabsuetrakul et al., 2013, 2009; Maggio et al., 2016, 2013; Meats et al., 2009; Umscheid et al., 2016), as is ensuring that facilitating faculty/staff are knowledgeable and enthusiastic and good 'role-models', (Aronoff et al., 2010; Blanco et al., 2014; Ciliska, 2005; Dean et al., 2017; Dinkelman et al., 2011; Ilic and Forbes, 2010; Klem and Weiss, 2005; Liabsuetrakul et al., 2009, 2009; Maggio et al., 2016;

Maloney et al., 2015; Sadeghi-Bazargani et al., 2014; Shurtz et al., 2016; Vandeweerd et al., 2012; West et al., 2011). Interestingly, a number of studies explicitly mention collaborating with librarians in teaching elements of EB(V)M as being beneficial. In addition, the availability of high-quality teaching resources (Aronoff et al., 2010; Maggio et al., 2015; Maloney et al., 2015; Sadeghi-Bazargani et al., 2014; Shurtz et al., 2016) and ensuring that topics are clinically relevant to the students improves their learning (Ilic and Maloney, 2014; Zwolsman et al., 2012). An interesting suggestion is that a competencies framework should be developed to be used by accrediting bodies and guide curriculum development (Ciliska, 2005; Meats et al., 2009).

Learning outcomes

A list of learning outcomes has been identified from the literature. Depending on the approach used within the curriculum, students will have the opportunity to perform some or most of the following.

Learning outcomes for research skills

- Identify research focus
- Perform a literature review including:
    - Identify a list of search terms
    - Construct a search
    - Perform a database search
    - Identify relevant literature from search
    - Synthesize literature in a report
- Identify research question and write a hypothesis
- Develop aims to address the hypothesis and develop an appropriate experimental design
- Write a research proposal
- Write an ethics application
- Write an Institutional Animal Care and Use Committee (IACUC) application
- Collect data including:
    - Use of quantitative methods e.g. laboratory work, field studies
    - Use of qualitative methods e.g. focus groups, interviews
    - Retrospective data collection
- Analysis of data including:

    - Quantitative data
    - Qualitative data
    - Use appropriate statistical tests
- Report the findings including:
    - Written abstract submitted for poster or oral presentation
    - Written report e.g. short thesis, manuscript submission
    - Demonstrate appropriate referencing and avoidance of plagiarism

Learning outcomes for EBVM

- Ask a question
    - Identify a clinically relevant question
    - Construct the question (PICO)
- Acquire the evidence
    - Search the literature
- Appraise the evidence for
    - Relevance to the question
    - Quality
- Apply the evidence
    - Integrate new knowledge into clinical practice
    - Communicate the new knowledge e.g. in the form of a CAT
- Assess
    - Evaluate and monitor the impact on practice

For more details about the learning outcomes for the 5 A's: http://www.ebvmlearning.org/

Resources

This section contains a list of resources that may be useful for educators. The list is not exhaustive and is based primarily on those mentioned in the papers from the literature review. A hyperlink to the resource website is provided and a description based on that written by the author or organization has also been included in most instances. Some resources are open access while others e.g. if included in a journal paper, may require an institutional login. The resources have been grouped under the following headings:

- Research skills
- Evidence-based (veterinary) medicine
    - Veterinary (EBVM)
    - Medicine (EBM)
- Questionnaires and assessment tools
- Databases and associated resources
- Reference management software
- Statistical packages

Research skills

- "Developing research skills in medical students: AMEE Guide No. 69" (Laidlaw *et al.* 2012)

  This guide is for those involved in curriculum design who want students to develop research skills and acquire the attributes that help develop research. The guide details why research skills and attributes are important for students pursuing a medical degree. Methods to encourage student development of research skills and attributes are

explored. This paper also addresses some of the barriers and associated strategies to overcome those barriers for student development of research skills and attributes.

- "How to Read a Paper" series published by the British Medical Journal (BMJ)

  The articles in this series provide an explanation for reading and interpreting various types of research papers.

- The National Veterinary Scholars Symposium

  An annual conference for veterinary students to showcase and share their research.

Evidence-Based (Veterinary) Medicine

Veterinary (EBVM)

- BestBETs for Vets

  BestBETs were first developed by the Emergency Department of Manchester Royal Infirmary, UK. BestBETs for Vets are reviews of the current best evidence on very specific clinical topics. While BETs are not fully comprehensive overviews of all literature, they are a simple and quick tool for veterinary clinicians to incorporate evidence into clinical practice.

- Centre for Evidence-Based Veterinary Medicine

  The Centre for Evidence-based Veterinary Medicine (CEVM) is based at the School of Veterinary Medicine and Science at the University of Nottingham. It is a multidisciplinary team of veterinary and non-veterinary, clinical and non-clinical researchers working in a number of areas to provide information on projects and useful resources for the veterinary profession to promote the use of Evidence-based Veterinary Medicine principles.

- EBVM Learning 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.

- "Training Evidence-Based Veterinary Medicine by Collaborative Development of Critically Appraised Topics" (Sebastian *et al.* 2012)

  There are two useful resources/forms described in the paper as:

  Literature Evaluation Form (Figure 1 in the paper) included three steps: 1) determine the evidence level (meta-analysis, clinical trial, case report, expert opinion or experience); 2) evaluate additional quality criteria and agree or disagree with given statements concerning study design, information content, objectivity, and actuality; 3) the pre-determined rating points are summed to obtain the overall rating score.

  Critically Appraised Topic (CAT) Documentation Form (Figure 2 in the paper) including the clinical background of the CAT, the question developed, and data from the literature search, including databases, keywords, and inclusion and exclusion criteria are documented on a CAT documentation form. Bibliographic details and abstracts of selected articles, the evaluation results, and the conclusions can also be listed on the CAT documentation form.

- Royal College of Veterinary Surgeons (RCVS) Knowledge

  RCVS Knowledge is the charity partner of the Royal College of Veterinary Surgeons (RCVS). Our mission is to advance the quality of veterinary care for the benefit of animals, the public, and society.

- RCVS Knowledge: Knowledge Summaries

  Providing veterinary teams with practical evidence-based tools to solve patient problems efficiently in a "Knowledge Summary" format.

- Veterinary Evidence Journal

  Veterinary Evidence is an open access journal run by RCVS Knowledge and aims to include the following type of publication: knowledge summaries, research articles, commentaries, clinical audit, systematic reviews, case studies, post-primary research, primary research, short communications, methodology, editorials and teaching articles.

- VetAllTrials

  VetAllTrials is an emerging international consortium dedicated to the development of one or more veterinary clinical trial registries. We are also involved in the development of policies and standards that support the open access publication of research outcomes and clinical trial data – worldwide.

- VetSRev Database of Veterinary Systematic Reviews

  This database is produced by the Centre for Evidence-based Veterinary Medicine (CEVM) and is powered by refbase, an open source database front-end for managing scientific literature & citations.

Medicine (EBM)

- BestBETs

  Best Evidence Topics (BETs) were developed by the Emergency Department of Manchester Royal Infirmary, UK to provide physicians with a tool to rapidly access the best current evidence on a wide range of clinical topics. BETs were developed using a

systematic review of literature. BETs cover emergency medicine, cardiothoracics, nursing, primary care, and pediatrics.

- JAMA Evidence

  Evidence-based medicine (EBM) integrates the best available evidence with clinical experience that allows clinicians to recommend, and their patients to make, informed choices consistent with their values. JAMA evidence helps decision makers identify the best available evidence by providing guides to the systematic consideration of the validity, importance, and applicability of claims about the assessment of health problems and the outcomes of health care.

- Centre for Evidence-Based Medicine, Oxford University

  The Center for Evidence-Based Medicine (CEBM) is based at the University of Oxford, is a WHO collaborating center, provides EMB courses and is involved in a range of partnerships.

- Making Evidence Based Medicine Simple Series

  Includes modules on: Diagnostic Testing, Meta-analysis, Therapy, Clinical Decision Rule, Harm, and Prognosis

- PRISMA

  PRISMA (Preferred Reporting Items for Systematic Reviews) is an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses. PRISMA focuses on the reporting of reviews evaluating randomized trials, but can also be used as a basis for reporting systematic reviews of other types of research, particularly evaluations of interventions. PRISMA is used by authors, reviewers and editors to help improve the reporting of systematic reviews and meta-analyses.

Questionnaires and assessment tools

- "Development and validation of the ACE tool: assessing medical trainees' competency in evidence based medicine" (Ilic *et al.* 2014)

  A 15-item instrument "Assessing Competency in EBM" (ACE) validated to measure user performance across the four main steps of EBM: formulation of the clinical question, search of the literature, critical appraisal and application of the evidence to the patient. This tool provides a novel assessment for medical trainees' EBM competency in knowledge, skills, and attitude.

- Knowledge, Attitudes, Access, and Confidence Evaluation (KACE). "Validation of an Instrument to Assess Evidence-Based Practice (EBP) Knowledge, Attitudes, Access and Confidence" (Hendricson *et al.* 2011)

  The abstract summarizes the validation of an assessment instrument designed to measure the outcomes of training in evidence-based practice (EBP) within the context of dentistry. Four EBP dimensions are measured by this instrument: (1) understanding of EBP concepts, (2) attitudes about EBP, (3) evidence accessing methods, and, (4) confidence in critical appraisal. The instrument is the Evidence Based Practice Knowledge, Attitudes, Access, and Confidence Evaluation (KACE) that has four scales, totaling 35 items: EBP knowledge (10), EBP attitudes (10), accessing evidence (9) and confidence in critical appraisal (6).

- "Development of an evidence-based practice questionnaire for nurses" (Upton *et al.* 2006)

  The abstract reports the development and validation of a self-report measure of knowledge, practice, and attitudes towards evidence-based practice (EBP) to provide a means to quantify the extent to which certain barriers hinder increased application of

EBP by clinicians. The questionnaire was developed based on established psychometric methods and included three distinct scales to measure EBP, attitudes towards EBP, and knowledge of EBP. This questionnaire can be utilized to measure EBP implementation.

- "Do short courses in evidence based medicine improve knowledge and skills? Validation of Berlin questionnaire and before and after study of courses in evidence based medicine" (Fritsche *et al.* 2002)

  An instrument to measure knowledge and skills in evidence-based medicine and investigates whether or not intensive 3-day courses in EBM lead to increased knowledge and skills for German students. The questionnaire reliably assessed knowledge and skills in EBM and found the intensive 3-day courses resulted in a significant increase in knowledge and skills.

- OSCE station prototype : "A model for assessing information retrieval and application skills of medical students" (Berner et al. 2002)

Databases

There is a range of databases and associated resources available to search the literature. Some of the most commonly used in veterinary and medical science are listed below, most require a subscription although PubMed is a free part of Medline.

Most relevant for veterinary medicine:

- PubMed from the US National Library of Medicine National Institutes of Health
- PubAg from the USDA National Library of Agriculture
- CAB Abstracts – provides comprehensive coverage of veterinary journals
- VetMed Resource (a more streamlined version of CAB Abstracts)

Databases with a medical and/or broader science base include:

- Medline
- Ovid
- Embase
- Scopus
- Web of Science

Reference management software

- A document comparing reference management tools has been created by the University of Edinburgh, UK. The sheet can be used to assist in selection of the most appropriate tool for individual needs and circumstances e.g. cost, size of bibliography.

  http://www.docs.is.ed.ac.uk/mvm/BiblioManagersTable.pdf?t=1319975641pa

  The options are:

  - Endnote
  - Mendeley
  - RefWorks
  - Zotero

Statistical packages

- Social Science Statistics

  A website offering a wide range of free resources for students and researchers working with statistics in the social sciences including calculators, tutorials, etc.

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