



John M. Gay, DVM PhD DACVPM
Associate Professor of
Epidemiology

AAHP Field Disease Investigation Unit
Washington State University



**Knowing what isn't so
evidence-based medicine**

Looking across the fence into the fog of darkness



Evidence-based Medicine (EBM)

What is it?
Why practice it?
What can Vet Med learn from Human Medicine?

- Pitfalls?
- Shortcuts?

Most discussions are about **how** to do EBM;
My purpose is providing background on **why** to do EBM!

What is "Evidence-based Medicine" (EBM)?

EBM is "an approach to practice in which the clinician is **aware of the evidence** in support of their clinical practice and of the **strength of that evidence**" (1992, McMaster U, Hamilton, Ontario)

Practicing EBM is simply practicing knowing the answers to two questions:

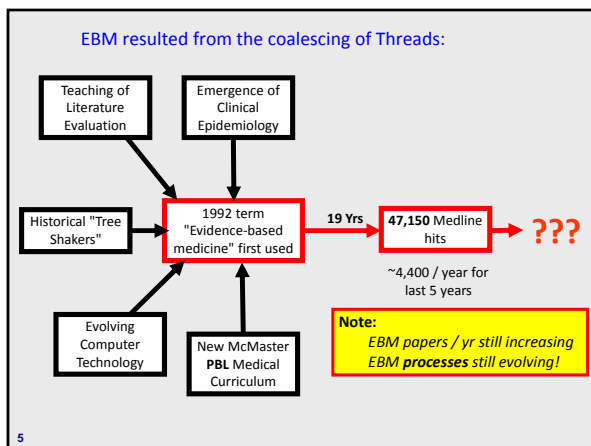
1. **What is the evidence for that?**
"that" being using a diagnostic test, establishing a prognosis, administering a therapy, or recommending a preventive measure
2. **How good (strong) is this evidence?**
How likely are the conclusions from the evidence correct?

This implies awareness of kinds of evidence and possession of the skills to critically assess that evidence

What is "Empirical Evidence" (Facts)?

- Knowledge obtained by looking rather than reasoning or feeling
- **Empirical:** based on verifiable observation or experiment, not on theory or pure logic (OED)
- **Strengthened** by rigorous observation or conducting experiments designed to have a clear, unequivocal supporting or refuting of outcome
- **Weakened** by the opportunity for other explanations to account for the findings
 - Often your judgment as to the degree of impact of this opportunity
- **Stronger Study** – Less opportunity for alternative explanations
- **Weaker Study** – Greater likelihood that alternative explanation does
 - Even intrinsically strong study designs can be seriously weakened by execution errors (detail, details, details, . . .)

Every little kid is an empiricist:
"Don't touch the stove; it's hot!"




EBM Story Timeline & Dignitaries

- Early 1900's - Ernest Codman's "The End Result Idea" led to empirical outcome evaluation

Early "Tree Shakers":

- Florence Nightingale
- Ginza Semmelweis
- Joseph Lister
- John Snow
- William Harvey
- William Osler
- Abraham Flexner



"Tree Shakers" are Important!

Ernest Codman, 1869-1940: A Pioneer of Evidence-Based Medicine: The End Result Idea
[Spine 23\(5\):629-633 \(1998\)](#)

- **"The End Result Idea"**: The idea that every hospital should follow every patient it treats long enough to determine if the treatment was successful, and then to inquire 'if not, why not?' to prevent similar failures in the future
- End Result - System of Hospital Organization: Tracking **and publishing** the results of hospitals and of individual surgeons
- Led to establishing the American College of Surgeons
- **Result**: Harvard fired him as surgery instructor



- acerbic, bitter, flamboyant, eccentric, combative, outspoken
- Codman's Sign, Classification, Tumor, Exercises, Triangle
<http://www.whonamedit.com/>

7

Use of randomisation in the Medical Research Council's clinical trial of streptomycin in pulmonary tuberculosis in the 1940s
[BMJ 317:1220-1223 \(1998\)](#)

- Demand for Streptomycin, isolated in 1943, exceeded supply
- Spontaneous cures occurred, confounding studies
- Poorly controlled studies had led to adoption of ineffective, harmful treatments
- **Blind randomization** relieved MRC clinicians of deciding who would be treated



AB Hill

- Physician smoking study – **smoking and lung cancer**
- Established **postulates for assessing cause** in **"The Environment and Disease: Association or Causation?"** [Proc RS Med 58:295-300 \(1965\)](#)
<http://www.edwardtufte.com/tufte/hill>

8

EBM Story Timeline & Dignitaries

- Early 1900's - Ernest Codman's "The End Result Idea" led to empirical outcome evaluation
- Late 1940's – Professor Austin Bradford Hill established the RBCT as the evidence "gold standard"
- 1972 – Dr. Archie Cochrane's bestselling book **Effectiveness and Efficiency: Random reflections on health services**
 - Wrote that not more than 10% of doctors' interventions were proven to do more good than harm
 - Challenged doctors to select procedures and interventions on basis of the **RBCT**

9

EBM Story Timeline & Dignitaries

- Early 1900's - Ernest Codman's "The End Result Idea"
- Late 1940's – Professor Austin Bradford Hill established the RBCT as the evidence "gold standard"
- 1972 – **Dr. Archie Cochrane** challenged physicians to base the selection of their practices on the RBCT
- Late '70's to present – Evidence of problems began accumulating from studies undertaken after Archie Cochrane's challenge:
 1. Problems with **current practices**
 2. Problems with **evaluation of new interventions**
 3. Problems with **information dissemination**
 4. Problems with **information synthesis**

10

What proportion of Medicine is evidence-based?

Resource Guide (Andrew Booth):

- 18 studies, executed between **1995 and 2000**, to determine the strength of evidence supporting clinical procedures
- Of ~128 procedures per study (range of 40 to 1,990)
 - **38% were supported** by RBCT Type I (strongest) evidence
 - **22% were not supported** by convincing experimental or non-experimental evidence - **Dogma!**

What is this % in veterinary medicine??

11

What is "Dogma"?

- Those beliefs put forth **without supporting empirical evidence with which to judge strength**
 - Not presented for efficiency (**textbooks, notes**)
- **OR**
- Unevaluated hypotheses or uncritical observation without awareness of the effects of chance, biological variation and observer bias (**authoritative or established opinion**)
- Repetition across sources or people, whatever their qualifications, does not change the status of such information
- **Some dogma is right, some dogma is wrong; the problem is which is which?**



12

What is Anecdotal Evidence?

- The occurrence of desired event, such as medical recovery
 - Case reports
- Often interpreted as due to therapy applied and thus validating theory on which therapy was based
- Problems:
 - Probability of apparently unusual events is higher than expected by intuition (birthday paradox – 30 : 70%)
 - Unrecognized factors (confounders) may invalidate initial prediction (e.g., dog wasn't as sick as believed or the condition was misdiagnosed)
- Because anecdotes are extremely weak evidence, accumulating similar anecdotes does not significantly increase support for a theory – Case series

The plural of anecdote is not evidence!

13

What is Analogical Evidence?

- Reasoning from comparing known similarities between two systems in which a relationship known to exist in one is reasoned to exist in the other as well
 - If drug X has been shown to be effective against disease Y in a species Z, reasoning that the same relationship exists between similar drugs, similar diseases or similar species
 - Susceptible to error because of the likelihood that different but unknown factors are operating in the two systems
- Very common reasoning in veterinary medicine
 - Necessary basis for action when empirical evidence is lacking
 - Minor species
 - Disease mechanisms are often established in selected species (rodents) and then extrapolated to other species in which direct investigation is impractical

14

Considering Empirical Evidence

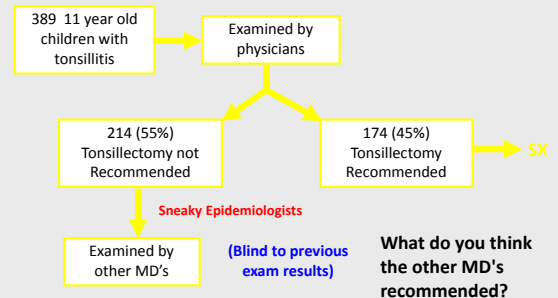
- Because the opportunity to verify (repeatability) and to assess evidence strength is key, the methods used to acquire the evidence must be described or referenced sufficiently to enable this verification and assessment (transparency)
- Remember: The empirical evidence can be correct (e.g., the sun "rises" predictably) but the underlying theory that it is believed to support is wrong (e.g., the sun orbits around the earth)

The importance of the "materials and methods" fine print

15

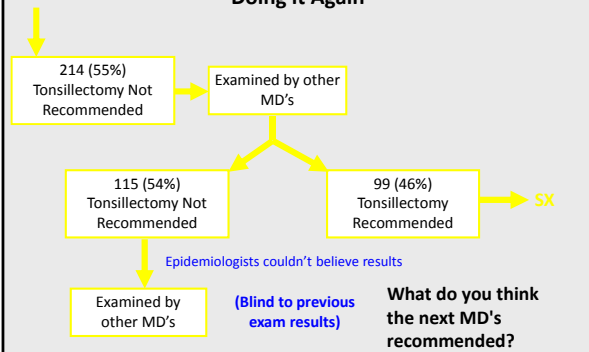
Evidence of problems with common current practice

Tonsillectomy Study (NEJM 232:691)



16

Doing it Again



17

And Again



What like this is happening in animal health?

If we haven't looked "well", we don't know!

18

Clinician-Discoverers – Marshall, Warren, and *H. pylori*

NEJM 353(23):2421-2423
<http://content.nejm.org/cgi/reprint/353/23/2421.pdf>

The Nobel Prize in Medicine 2005
 "for their discovery of the bacterium *Helicobacter pylori* and its role in gastritis and peptic ulcer disease"

http://nobelprize.org/nobel_prizes/medicine/laureates/2005/index.html

Fascinating story of:

- How they challenged dogmas that:
 - Due to acid, the stomach was sterile
 - Stress and spices cause ulcers
- Serendipity
- How advancing technology enabled their research
- How the medical community resisted their findings




Challenging dogma remains difficult but necessary

19

Evidence of Continuing Problems

Eddy DM (1990). *The Challenge*. JAMA 263:287-290

Similar to the earlier Tonsillectomy study:

- In Vermont, the chance of having one's tonsils removed were 8% in one community and 70% in another
- Surgeons given written descriptions of surgical problems split down the middle ... half recommending surgery, half not
- When surveyed again two years later, the same surgeons often disagreed with their previous opinions, with **40% changing their recommendations**
- Variability occurs because physicians must make decisions about phenomenally complex problems under difficult circumstances with little support
- Physicians are in the impossible position of not knowing outcomes of different actions, but having to act anyway

20

Evidence of Process Problems

Eddy DM. *The Challenge*. JAMA 263:287-290 (1990)

- Cardiologists evaluating high quality angiograms for stenosis of coronary vessels:
 - ... asked to estimate whether the percentage of stenosis ... was greater or less than 50%, they **disagreed on 60% of the patients**
 - ... on two successive readings of the same angiograms, the observers **changed their minds from 8% to 37% of the time**, depending on the vessel segment
- In general, observers looking at the same thing will disagree with each other or even with themselves from **10% to 50% of the time**
- Pathologists reading human biopsy slides (**Not just a clinician's problem**)
 A panel of expert pathologists disagreed two or more times on the interpretation of **38%** of human skin melanoma biopsy specimens as benign or malignant. (*Hum Pathol* 27:528-31 (1996))

Admittedly, the test cases are likely the tough ones rather than the "slam dunks"

21

Are Problems with Current Practices Important?

Autopsy evidence of Physician Diagnostic Error Rates

Changes in rates of autopsy-detected diagnostic errors over time: A systematic review *JAMA* 289(21):2849-2856 (2003)

- 53 autopsy series published 1966 - 2002
- **24% major error rate** (4.1% - 49.8%)
 - Involved 1st cause of death but did not affect outcome
- **9% class I error rate** (0% - 20.7%)
 - **Likely resulted in death!**
- Accounting for steady improvements, current major error rate is likely 8% -24% and class I rate is likely 4% - 7%
- Of 850,00 individuals dying in US hospitals each year, without misdiagnoses 34,850 would have survived to discharge
- Advancing technology alone is not the answer

What is it in veterinary medicine??

22

Investigator enthusiasm is inverse to degree of control

Table 3. Degree of control versus degree of investigator enthusiasm for portacaval shunt operation in 53 studies with at least ten patients. The table is revised from Grace, Muench, and Chalmers (8), table 2. p. 685

Degree of control	Degree of enthusiasm			Total
	Marked	Moderate	None	
Well controlled	0	3	3	6
Poorly controlled	10	3	2	15
Uncontrolled	24	7	1	32
Total	34	13	6	53

Science 198:684-689 (1977)

- Muench has a set of statistical laws, one of which says "nothing improves the performance of an innovation as much as the lack of controls"
- Because tables for other therapies have similar results, **one must be cautious in accepting results of weakly controlled investigations**
- The rows for "poorly controlled" and "uncontrolled" studies suggest that **repeated, weakly controlled trials are likely to agree and build up an illusion of strong evidence because of the large count of favorable studies**

Concurrent comparisons!

23

Do Study Design Weaknesses Matter?

BMJ 323(7303):42-46 (2001)

Meta-analysis relating key methodological quality aspects of controlled trials to their effect estimates

Effect estimates of weaker studies were larger than those of stronger studies in 10 of 11 meta-analyses

Odds Ratios from trials with inadequate blinding were **30% more "beneficial"** than those with adequate blinding

You betcha it matters!

24

Problems with Information Synthesis & Dissemination

A comparison of results of meta-analysis or randomized control trials and recommendations of clinical experts: Treatments for Myocardial Infarction

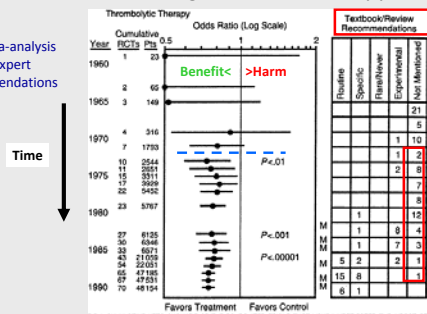
JAMA 268(2):240-248 (1992)

- Contrasted the results from 182 RCTs with the recommendations of 43 review articles and 100 textbook chapters by publication date
- Classified recommendations of experts as:
 1. Routine – use routinely
 2. Specific – used only in selected patients with particular indication
 3. Rare/Never
 4. Experimental
 5. Not mentioned

This study took a **huge** amount of work!
And it had big impact – 754 citations to date

Not recommending a beneficial therapy

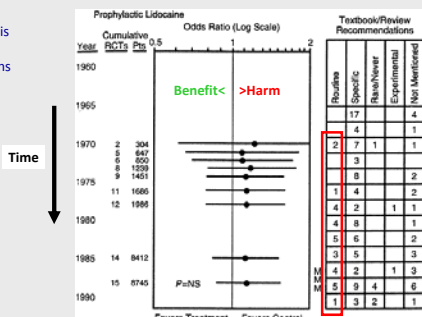
RCT meta-analysis vs. Expert Recommendations



Problem of both information synthesis and diffusion

Continuing to recommend a questionable therapy on basis of biological plausibility

RCT meta-analysis vs. Expert Recommendations



Thorax pump failure shows weakness of biological plausibility

Intended to improve blood flow during acute cardiac failure resuscitation

- (++) Biological plausibility
- (++) Lab experimental results
- But equivocal field results to date

Reinforces lesson of the necessity of empirical field evaluation
The Problem of External Validity!

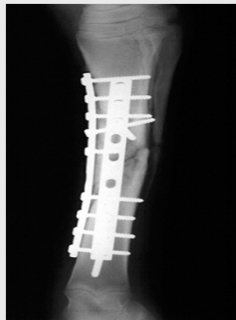


<http://www.chemomedica.at/product.php?id=111>

Relying on experts is dangerous

Sir William Arbuthnot Lane
Scottish surgeon, 1856 - 1943

- Developed internal fixation to align fractures
- Used silver wire, then screws followed by plates and screws
- Hence, the label "Lane's plates"

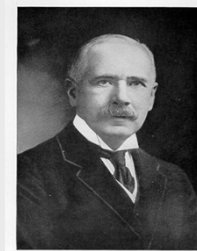


He also promoted erroneous ideas

Sir Lane:

- Was "eccentric", regarding humans as machines
- Performed many total colectomies as a cure for "auto-intoxication"
- 10% mortality risk

The danger of authorities without supporting evidence



Sir William Arbuthnot Lane

Problems with Information Synthesis

The Medical Review Article: State of the Science

Ann Intern Med 106:485-488 (1987)

- Evaluated 50 reviews published 1985 to 1986 in *Ann Intern Med*, *Arch Intern Med*, *JAMA*, *NEJM* using 8 information syntheses guidelines
 - 34% met 3 of 8 criteria
 - 64% met 4 or 5 criteria
 - 2% met 6 or 8 criteria
 - 6% used quantitative synthesis
 - 42% mentioned future research directions
- These results indicate that current medical reviews do not routinely use scientific methods to identify, assess, and synthesize information
- Medical reviews are often subjective, scientifically unsound and inefficient
- The methods used in this systematic assessment of reviews are proposed to improve the quality of future review articles**

The beginning of converting medical information synthesis into a transparent, replicable and valid scientific process

Narrative reviews > Systematic Reviews

31

The Medical Review Article Revisited: Has the Science Improved?

Ann Intern Med 131:947-951 (1999)

Evaluated all the reviews on clinical topics published in in 1996 in:

- 3 of 4 randomly selected core high impact journals (*Ann Intern Med*, *JAMA*, *NEJM*)
- 3 of 8 randomly selected core journals with lower impact factors
- 5 blinded raters used 10 validated criteria

1987: 64% met 4 or 5 of 8 criteria!

Progress in the wrong direction?

32

Systematic Reviews: Synthesis of the best evidence for clinical decisions

Ann Intern Med 126:376-380 (1997)

Systematic review procedures evolved to correct this problem

Feature	Narrative Review	Systematic Review
Question	Often broad in scope	Often a focused clinical question
Sources and search	Not usually specified, potentially biased	Comprehensive sources and explicit search strategy
Selection	Not usually specified, potentially biased	Criterion-based selection, uniformly applied
Appraisal	Variable	Rigorous critical appraisal
Synthesis	Often a qualitative summary	Quantitative summary*
Inferences	Sometimes evidence-based	Usually evidence-based

* A quantitative summary that includes a statistical synthesis is a meta-analysis.

Reporting Standards - rapidly evolving area
CONSORT, STARD, BEME, ARRIVE, REFLECT, MOOSE

33

Per Jan Sargeant, McMaster Univ
 2nd EBVMA Symposium, MSU (2006)

Steps in traditional narrative review

- Write what we think is important
- Find references to support our view
- Insert these as needed

Using reviews "outsources" the responsibility for critical evaluation

Steps in systematic review

- Question formulation
- Exhaustive literature search
- Relevance screening
- Quality assessment
- Data extraction and synthesis
- Written report
- Dissemination
- Repeat process to update

Systematic reviews done to standards make that "outsourcing" safer

34

On-line Systematic Review Systems

The Current Path of Human Medicine

- Developed because:
 - No clinician can read all of the relevant literature
 - Even expert searchers find only half of the RBCTs in MEDLINE
 - Systematic reviews often quickly outdate
 - Busy clinicians do not have the time to practice EBM on a paper-by-paper basis! (Know how to do it? – Yes!)**
- On-line collaborations enable experts at remote sites to cooperate in establishing and updating systematic reviews addressing important clinical questions

Time is the busy clinician's scarcest resource
 Usefulness = (Relevance X Strength) / Work
Initial EBM approaches overlooked this fact!

35

I may well be sawing the limb off but:

36

EBVM is *Personal Protection* in the World of Ideas

Why "personal protection"?

Because of the way our minds naturally work if we let them!

- Be very careful what you put in that head, because you will never, ever get it out. Cardinal Wolsey (1475-1530)
- It ain't so much the things we don't know that get us into trouble. It's the things we know that just ain't so. "Artemus Ward" (Charles Farrar Browne, 1834-1867)
- It is impossible for anyone to learn that which he thinks he already knows. Plutarch

As one wag observed, is the only route to change the dying of the "old guard"?

37

Nature of Human Thinking

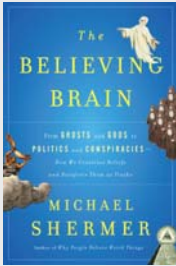
"Human nature" is to:

- Weigh information consistent with current belief heavier
- Ignore or discount discordant information
- Search for belief-confirming data rather than belief-refuting data
 - EX: Selective necropsy to confirm a gross diagnosis (drives pathologists nuts)
- Prior belief biases observation by subtly changing perception, particularly of the vague or ambiguous
 - EX: Radiographs, clinical signs
- These **cognitive biases** occur **unconsciously** and **despite the observer's best intentions!**

The fundamental reasons for "blinding" and objective measurement rather than subjective assessment!

38

Two major problems are the imperfect nature of our senses and our believing brain



Michael Shermer

- We form our beliefs for subjective, personal, emotional, and psychological reasons in the context of environments created by family, friends, colleagues, culture, and society
- We defend, justify, and rationalize our beliefs with a host of intellectual reasons, cogent arguments, and rational explanations

Beliefs come first, explanations for beliefs follow

39

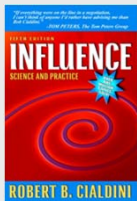
We have incredible, but flawed, sense-making capacity

"We try to make sense of the world, and in our brain nature has gifted us with a double-edge sword"

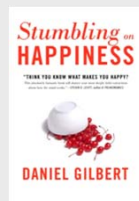
- "It is a complex and sophisticated information processing machine, capable of understanding not only the universe itself but of understanding the process of understanding"
- "By the same process of forming beliefs about how the universe works, we are most capable of self-deception and illusion, of fooling ourselves while we are trying to avoid being fooled by nature"

40

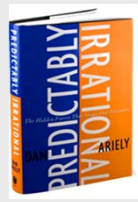
Should you believe it possible to be unbiased and completely rational, I suggest one of the following:



Robert Cialdini



Daniel Gilbert



Predictably Irrational: The hidden forces that shape our decisions
Dan Ariely

These remove any illusion . . .

41

Consider learning in the DVM curriculum:

- Most of the veterinary curriculum is taught as **dogma**
 - The information needed to judge credibility is not provided
 - Lectures, core textbooks
 - Habits of continual deliberate, systematic, critical thinking are not well developed (and, given resource limitations, possibly cannot be)
- Analogical evidence is the most prevalent basis of reasoning taught in much of the curriculum
- Most of everyone's individual case experience remains anecdotal

Resource Efficiency vs. Educational Efficacy
< balance >

42

Lack of quality evidence is a major vet med problem

Aragon CL, Budsberg SC. Applications of evidence-based medicine: cranial cruciate ligament injury repair in the dog.

Vet Surg 34(2):93-8. (2005)

- **OBJECTIVE:** Evaluate the literature reporting surgical interventions for canine cranial cruciate ligament (CCL) injury using EBVM
- **STUDY DESIGN:** Systematic literature review
- **METHODS:** Search through Medline, PubMed, VIN, and CAB Abstracts performed August 2004 identified **240 sources of information**
- Studies were evaluated for study design (retrospective, prospective, randomization), surgical technique, short- and long-term follow-up, and evidence classification

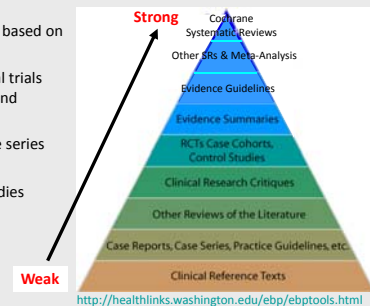
Why did they pick this procedure?

\$\$\$\$\$

43

Evidence strength classification is a pyramid from weak to strong

- **Class I:** Systematic reviews based on multiple RBCT's
- **Class II:** High quality clinical trials using historical controls, sound observational studies
- **Class III:** Uncontrolled case series
- **Class IV:** Expert opinion or extrapolated from other studies



<http://healthlinks.washington.edu/ebp/ebpools.html>

This pyramid is important!

44

Aragon CL, Budsberg SC. Applications of evidence-based medicine: cranial cruciate ligament injury repair in the dog.

Vet Surg 34(2):93-8. (2005)

- **RESULTS:** 28 (**12%**) sources **qualified for evidence classification**
- **No class I or class II studies** were present, 5 studies were class III and 23 studies were class IV
- 17 studies were retrospective and 11 were prospective
- Results ranged from:
 - Variety of subjective findings including clinical impression, radiographic analysis, synovial fluid analysis, gross pathology, and histopathology
 - Objective results, although infrequent, included force plate analysis and cadaveric biomechanical testing

The human literature is sufficiently deep that they seldom use studies less than class II in systematic reviews

45

Poor evidence strength results for most common veterinary surgical procedure

- **Class I: 0** systematic reviews based on multiple RBCT's
- **Class II: 0** high quality clinical trials using historical controls, sound observational studies
- **Class III: 5** uncontrolled case series
- **Class IV: 23** expert opinion or extrapolated from other studies



Poor evidence has a price, particularly when its poor quality is not recognized!

GRADE Working Group

46

Aragon CL, Budsberg SC. Applications of evidence-based medicine: cranial cruciate ligament injury repair in the dog.

Vet Surg 34(2):93-8. (2005)

- **CONCLUSIONS:** At this time, the application of EBM suggests that there is not a single surgical procedure that has enough data to recommend that it can consistently return dogs to normal function
 - Assessing and categorizing the evidence becomes increasingly important as more data becomes available and research quality improves
- **CLINICAL RELEVANCE:** An EBM paradigm did not provide sufficient evidence favoring 1 surgical technique for management of canine CCL injury

The lack of quality evidence is a consistent finding across EBVM systematic reviews

47

Hofmeister, King, Read, Budsberg. Sample size and statistical power in the small-animal analgesia literature

J Small Anim Pract 48(2):76-9 (2007)

- Searched Pubmed and selected journals between 1994 and 2004 for analgesia papers that reported:
 - 'no difference' between experimental groups in the abstract, results or conclusion
 - Were randomized, prospective and blinded
- Found 46 studies of which 22 provided sufficient data for power analysis
- Performed power analyses to determine sample size for detection of 20%, 50% and 80% treatment effect with power of 80%
 - 5 (**23%**) had sufficient power to detect a **20% treatment effect**
 - 12 (**54%**) had sufficient power to detect a **50% treatment effect**
 - 18 (82%) had sufficient power to detect an **80% treatment effect**

Most important question:
What is the minimum treatment effect difference that would lead the selection of one over the other?

48

Perino LJ, Hunsaker BD. A review of bovine respiratory disease vaccine field efficacy
Bovine Practitioner 31.1: 59-66. (1997)

From some 800+ reports identified:

- "We are impressed with the small number of useful reports . . . while there are hundreds of reports in the literature, most suffer from one or more design flaws or limitations. . . it suggests that we may be making less than optimal recommendations on vaccine use because of a lack of clinically relevant information."
- "it is time to critically evaluate vaccination as a management tool"

Limited evidence in the literature almost a decade later that this challenge was taken up
What is the long term impact of these open questions on producer usage of veterinarians?

49

Keene BW. Towards evidence-based veterinary medicine
J Vet Intern Med 14: 118-119. (2000)

- During a period in which **60 studies** relevant to a particular veterinary clinical question were published in the veterinary literature, **5,400 studies** were published in the human literature for the equivalent human clinical question
- **Almost a 100 to 1 ratio**
- **Many of these were based on inherently stronger study designs**

Implies that we can not follow the human EBM path of **combining existing evidence** but that we have to **generate strong evidence first**

The most significant contribution of veterinary systematic reviews for some time to come will be identifying critical clinical research **needs**
 (Also noted by Cockcroft and Holmes)

50

The way forward?

1. Establish the structure to manage information exchange and translation
2. Assemble **species x discipline interest groups** and establish the communication structure within
3. Establish criteria for determining the important clinical questions
4. **Determine the most important clinical questions**
5. Perform systematic reviews on each to establish the state of evidence and identify the weak but critical evidence
6. **Establish multi-group collaborative studies to generate strong evidence**
7. Update the systematic reviews as further evidence becomes available

I don't have all the answers but I believe that for the good of the profession the discussion must start
Our clients do (or soon will) expect nothing less!

51

Personal computers and the Internet
 The core of the opportunity

- Take full advantage of this technology to facilitate multi-practitioner, multi-center collaboration
- Enables:
 - More rapid case accumulation
 - Broader base for external validity
 - Reduced load per participant



My Office Computer System

This will not be easy! Or quick!
 Covey's "Effective vs. Efficient"

52

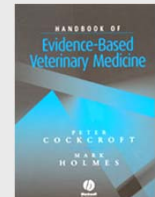
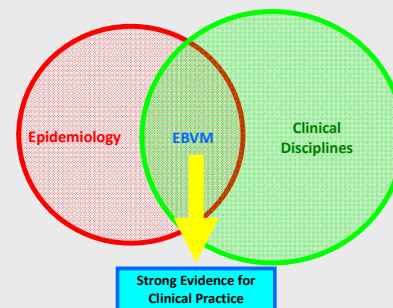
EBVMA – Evidence-based Veterinary Medical Association

- Website - <http://www.ebvma.org/>
- Founded to organize the research, training and practice of evidence-based medicine
- Composed of individuals who desire that the principles inherent in the concept of evidence-based medicine become the foundation of veterinary medical training and practice

53

Evidence-based Veterinary Medicine:

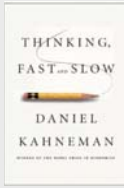
The best discipline intersection for clinical practice



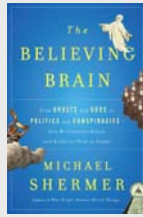
[WWWeb.Epidemiology & Evidence-based Medicine Sources for Veterinarians](http://WWWeb.Epidemiology&Evidence-basedMedicineSourcesforVeterinarians)

54

Understanding the processes of human cognition is an active research area:



[Daniel Kahneman](#)



[Michael Shermer](#)

These remove any illusion of pure, logical, mechanical rationality