EBO | EBM | EMH

Certainty causes crises

What markets, medicine, and war teach us about the known, the unknown, and the unknowable

The model is useful only while we remember that it is not the world.

John Walsh, DO

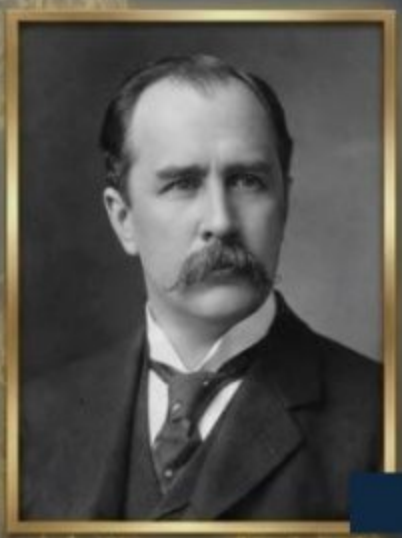
Certainty causes crises

What Markets, Medicine and War Tell Us What is Known, Unknown, and Unknowable

John Walsh, DO

"People search for certainty. But there is no certainty."

~ Richard Feynman



"The good physician treats the disease; the great physician treats the patient who has the disease."

~ William Osler

Commonly attributed to William Osler

Three frameworks, one shared problem

Effects-Based Operations

Military planning assumes effects can be modeled and controlled via systems analysis

Efficient Market Hypothesis

Finance assumes prices aggregate information rationally; deviations are random noise

Evidence-Based Medicine

Clinical practice assumes RCTs and meta-analyses provide transportable, generalizable evidence

The shared epistemic trap

Model-centric thinking

Information sufficiency myth

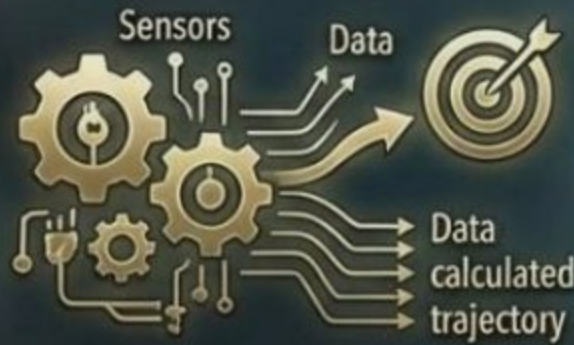
Assumes more data and better models reduce assumed more legible and predictable than they are

Agent rationality: Reductionism

Reductionism: Decomposes complex systems into measable parts, losing emergent properties

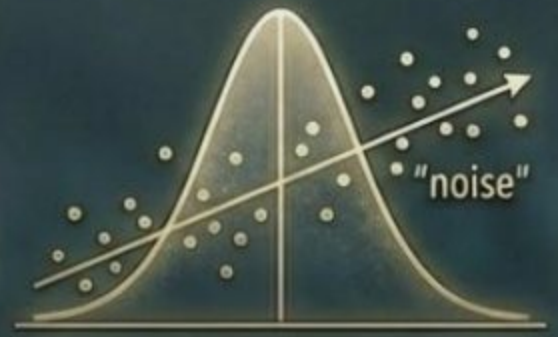
Epistemologies of uncertainty: EBO, EMH, and EBM

EBO: Engineering-Deterministic



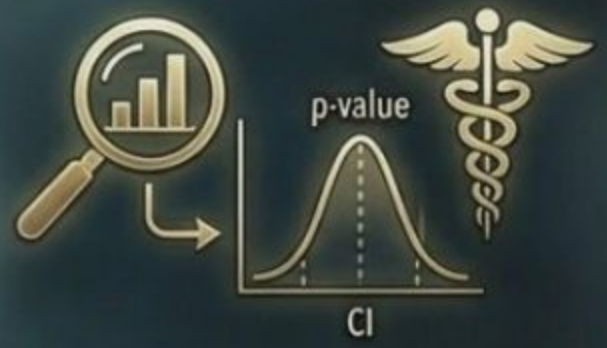
- Uncertainty is treated as a reducible planning problem.
- More data (enemy systems, culture) drives down uncertainty.
- Quasi-deterministic: Better sensors & models produce reliable cause-effect.

EMH: Probabilistic-Rationalist



- Deviations from intrinsic value are unsystematic and random.
- Uncertainty is formalized as stochastic noise.
- With rational expectations, pricing errors are not systematically exploitable.

EBM: Empiricist-Frequentist



- Knowledge is empirically derived, testable evidence.
- Uncertainty narrowed to statistical terms (confidence intervals, p-values).
- Residual uncertainty (e.g., patient heterogeneity) often only acknowledged philosophically.

The methodological autopsy

External validity: Narrow conditions generalize poorly; transportability assumed, not proven

Reflexivity blindness: Systems adapt and learn; static models crack under feedback loops

Measurement proxy bias:

Track surrogates; gaps between measured and meaningful outcomes

Selection and reporting bias:

Success narratives; failures attributed to execution, not method

Cognitive biases amplify model confidence

Overconfidence: Planners, traders, clinicians all overestimate predictive accuracy of their frameworks

Confirmation bias: Seek data supporting framework; marginalize disconfirming evidence

Herding and conformity:

Following prevailing doctrine becomes safer than questioning it institutionally

Availability bias:

Salient successes loom larger; failures less memorable or attributed to noise

Effects-Based Operations: the 2008 reckoning

Mattis critique:

EBO promised "algebraic" mapping from actions to effects; ignored fog, friction, adaptive enemies

Overconfidence:

Planners believed systems modeling could overcome uncertainty via better intelligence

Reflexivity failure:

Enemy learning and deception invalidated static causal diagrams in real time

Outcome:

Doctrine abandoned; military returned to mission command and commander judgment

Efficient Market Hypothesis: cracks in the edifice

Behavioral departures: Overconfidence, herding, loss aversion create persistent mispricings

momentum, small-cap, and other effects resist simple "random walk" models

Anomalies: Value, momentum, small-cap, and other effects resist simple "random walk" models

Crisis vulnerability:
2008 crash revealed tail risks models underestimated by orders of magnitude

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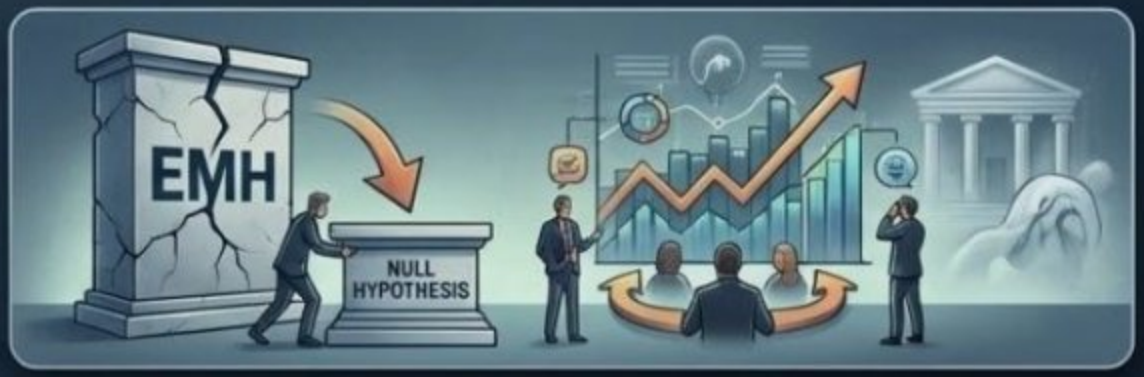


Survival strategy: EMH retreats to 'null hypothesis' role; admitted as idealization, not literal truth

EMH and capital market theory

The Theory: Risk & Reward Relationship

People are risk averse; higher risk must offer higher returns.

Skillful investors seek to capture this premium.

The concept rests on positive risk-adjusted returns.

Academic Definition: Risk = Volatility

Risk is defined as volatility because it is objective, historically ascertainable, and quantifiable.
It indicates unreliability.

The Reality: Risk = Uncertainty & Loss

Practitioners reject volatility as sufficient. Reality means less certainty (wider distribution).

True risk is the actual likelihood of losing permanent capital, not just price fluctuation.

Evidence-Based Medicine: an orthopaedic reality check

Surgical masking: Cannot blind surgeons to technique; RCT assumptions often violated

External validity collapse: Trial populations lack comorbidity, frailty, heterogeneity of real patients

Surrogate outcome trap:

Studies use disease-oriented evidence; patient-oriented outcomes diverge

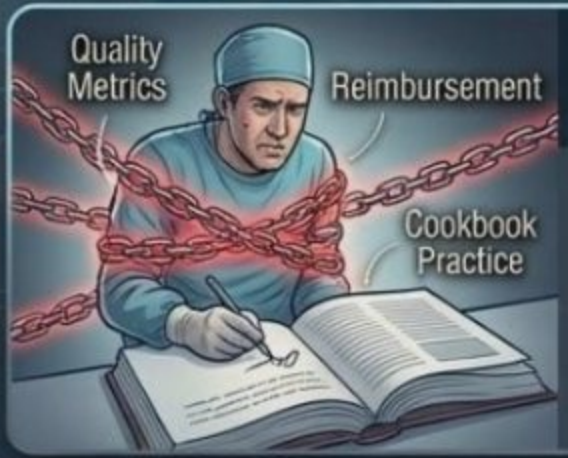
Guideline paradox:

Evidence-based policies change case mix and clinician behavior, invalidating original evidence

Where EBM fails orthopaedic surgeons

Surgical variation: Technique, experience, and judgment are devalued in favor of guideline compliance

Rare conditions: Sparse evidence for complex presentations; guidelines offer little guidance



Bureaucratization:

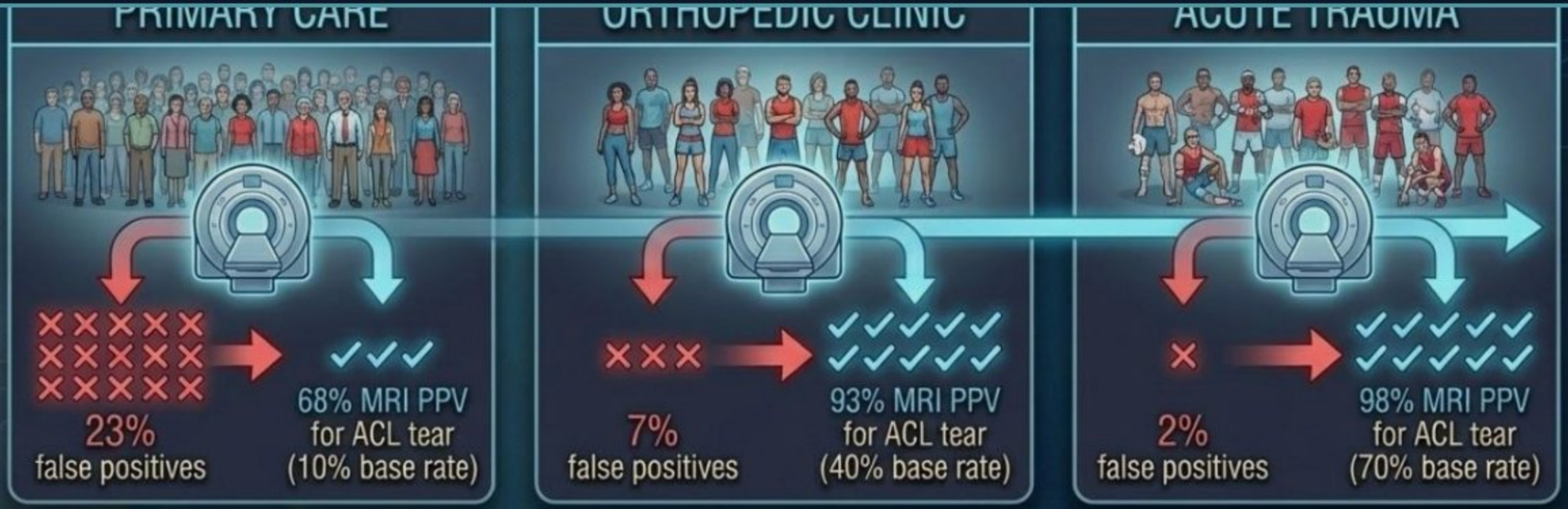
Quality metrics and reimbursement enforce cookbook practice; discourage adaptation

Patient heterogeneity:

Multimorbidity, frailty, preferences create subgroups where trial effects don't replicate

Why context determines test value

Base-rate neglect: accuracy is not clinical utility



Same 95%/95% test. Different contexts yield 68%, 93%, and 98% PPV.
EBM focuses on test accuracy; clinical utility requires knowing base rates.

Four biases distort orthopaedic decisions

Anchoring Bias: Example: Preop imaging of osteoporosis anchors fixation choice despite better intraop bone quality

Confirmation Bias: Surgeon convinced patient is "good TJA candidate," ignores neuropathy and unrealistic expectations

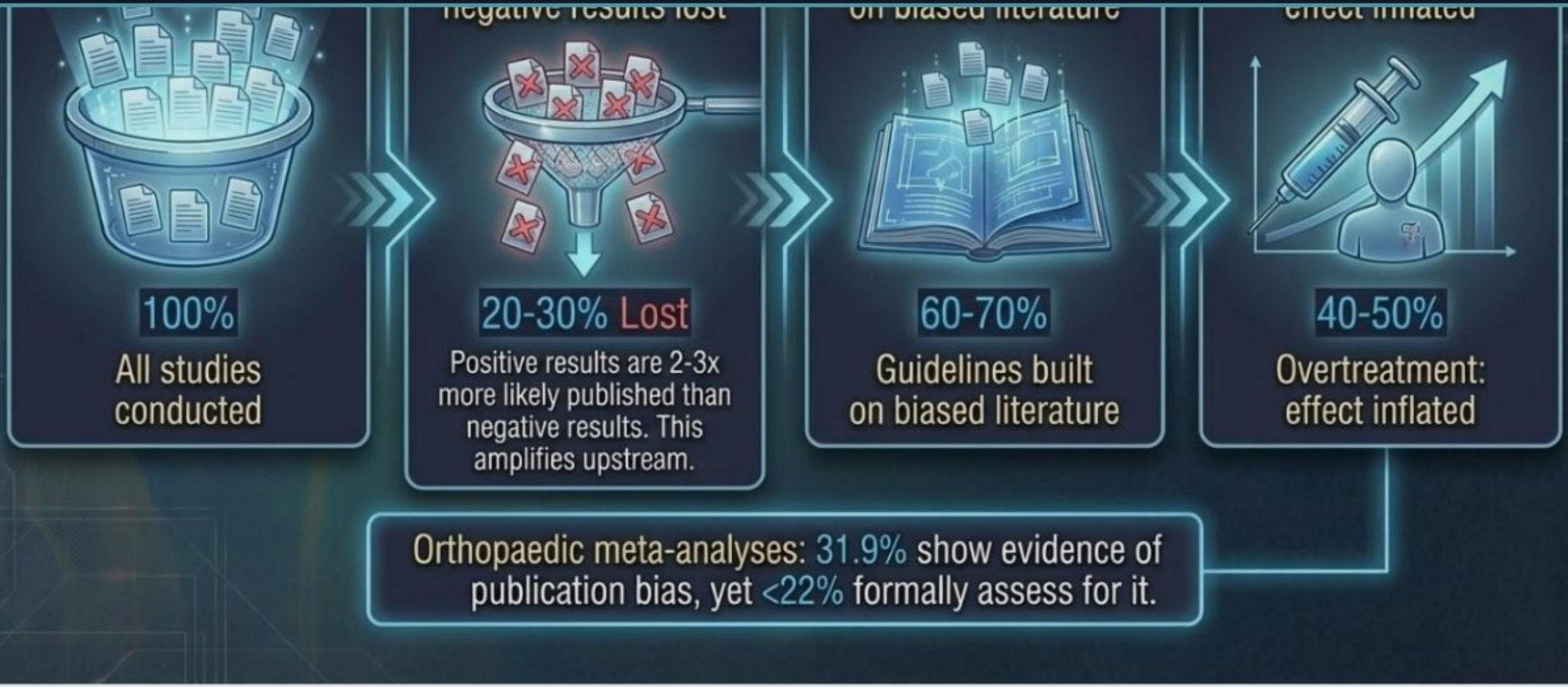
Overconfidence

Finding: 83% of ortho surgeons rate themselves "above average"; overestimate outcome prediction accuracy

Framing Bias

Example: TJA presented as "avoid progression" vs "restore function" alters choice despite identical risks

How bias distorts the evidence base



Uncertainty is not a bug; it is the feature

Aleatoric (Randomness)
Aleatoric: Patient variability, tissue response, healing biology—irreducible randomness

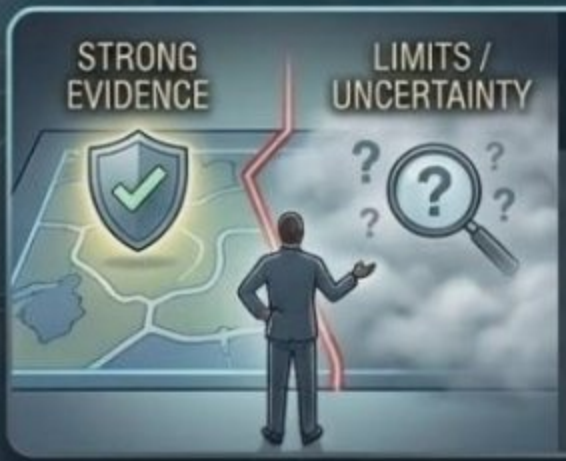
Epistemic (Knowledge Gaps)
Epistemic: Trial evidence gaps, external validity limits, mechanistic unknowns

Decision (Trade-offs)
Decision: Trade-offs among interventions without clear dominance; values matter

Cross-framework lessons for orthopaedics

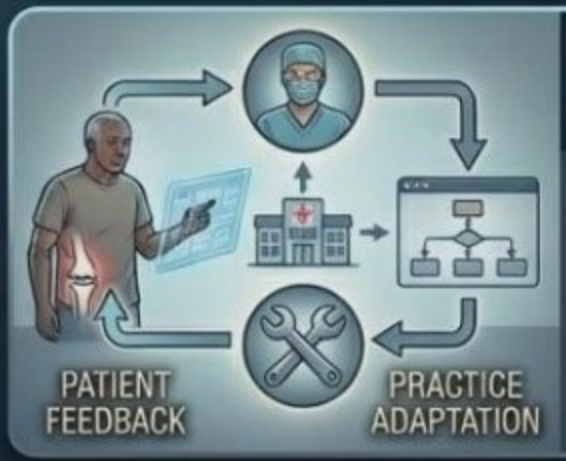
Models inform, not determine: Use evidence as decision aid, not truth machine

Preserve expertise: Experience, judgment, and tacit knowledge correct rigid frameworks



Explicit humility:

Specify domains where evidence is strong; admit limits candidly



Adapt locally:

Feedback from patients and outcomes should reshape practice in real time

Morbidity and mortality: feedback that matters

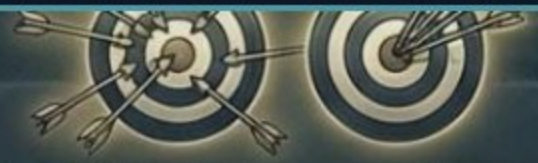
Real patients: Actual comorbidity, surgeon skill, contextual factors absent from RCTs

Failure signal: Complications force recalibration; guidelines revised when evidence fails locally

Adaptive learning: Surgeons adjust technique, patient selection, decision-making in near real-time

Humility culture: Acknowledging what went wrong, not defending guidelines

Noise: the flaw in human judgment



Definition: The unwanted variability in judgments that should be identical. Unlike 'Bias' (a consistent, directional error), Noise is random, scattered, and often invisible.

The Difference Between Bias and Noise

Bias: A systematic deviation (e.g., a scale that always adds 5 lbs).

Noise: Random scatter (e.g., a scale that gives a different reading every time you step on it).

Types of Noise

Occasion Noise: Internal variability in the same person based on mood, fatigue, or even the weather.

System Noise: Variability between different experts in the same role (e.g., two doctors giving different diagnoses for the same symptoms).

The Solution (Decision Hygiene)

Algorithms over Intuition: Simple rules and models often outperform "expert" intuition because they are noise-free.

Aggregating Judgments: Averaging the independent opinions of multiple people to cancel out individual noise.

A surgeon's charter for framework humility

1. Be Explicit

State assumptions and domain of validity. Where is evidence strong? Where is it sparse?

2. Preserve Judgment

Evidence guides; experience and patient context decide. Deviation from guideline requires explanation, not apology.

3. Measure Outcomes

Track patient-important outcomes, not surrogates. Use feedback to adjust, not defend.

4. Embrace Uncertainty

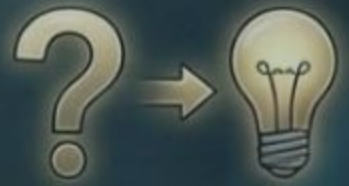
Name uncertainty to patients. Share decision-making. Acknowledge limits candidly.

Munger: multidisciplinary thinking

Figure Out What Works & Do It

Repeat what works.
The fundamental algorithm of life.
Most don't work hard enough to find it.

Solve Problems Using Inversion



Invert the problem.
What causes the opposite of what you want? Avoid those things.

Think In Terms of Decision-Trees

Use elementary probability and structure. Essential for navigating life's choices.

Use Opportunity Cost as a Filter

A huge filter in life. Always consider the value of the best forgone alternative.

Grab Ideas From Every Discipline

Integrate big ideas from diverse fields. The solution is often just outside your own profession.

A latticework of mental models

isolated facts and try and bang 'em back."

Multi-Disciplinary Approach

Build a "toolkit" of the big ideas from major disciplines: Mathematics, Biology, Psychology, Physics, and Economics.

Synthesized Thinking

Do not look at a problem through one lens. This leads to the "Man with a Hammer" syndrome (where every problem looks like a nail).

Lollapalooza Effects

When multiple mental models or biases act in the same direction at the same time, they produce an outsized, non-linear result.

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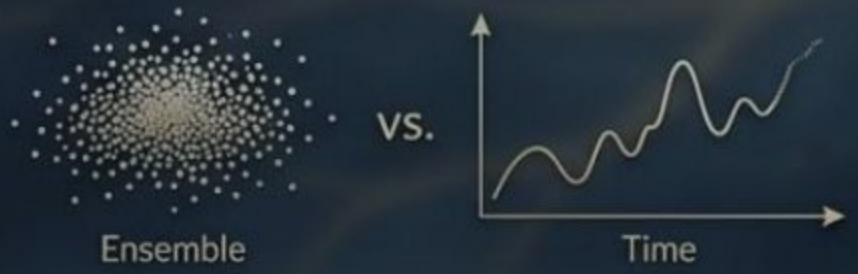
Ergodicity: survival before averages

THE CONCEPT: Ensemble vs. Time Averages

Definition: The distinction between Ensemble Averages (group probability) and Time Averages (individual experience over time).

The "Peters" Critique: Standard Economics assumes systems are ergodic (group average = individual average). In reality, most real-world processes are non-ergodic.



KEY TAKEAWAYS: Surviving Non-Ergodicity

- **Path Dependency:** If a path leads to "zero" (ruin), the long-term group average is irrelevant.
- **Multiplicative Nature of Life:** Life is sequential. Manage exposure to never hit a "terminal" state.
- **Rationality Redefined:** In a non-ergodic world, "risk-aversion" is rational for survival.

The logic of risk taking

The central tenet: Focus on consequences (payoffs) rather than probability

Skin in the Game

You should not have an opinion if you don't have exposure to the downside. This filters out 'bullshit' and ensures accountability.

The Barbell Strategy

Play it very safe in some areas and take high-risk, high-reward bets in others. Avoid the "middle" where you are vulnerable without the big upside.

Survival First

Never take a risk that has a non-zero probability of ruin. If you fail and are out of the game, your "expected return" is irrelevant.

The Black Swan

Definition: An event that is an outlier, lying outside the realm of regular expectations.

The Three Attributes

Rarity

It is a statistical outlier; nothing in the past can convincingly point to its possibility.

Extreme Impact

It carries a massive, transformative effect on systems or history.

Retrospective Predictability

Human nature concocts explanations for its occurrence after the fact, making it explainable and predictable in hindsight.

The Lesson

Don't try to predict Black Swans; instead, build robustness and antifragility to withstand their inevitable occurrence.

Antifragility

The Triad

Fragile	Robust	Antifragile
		
Fragile: Damaged by disorder (e.g., a teacup).	**Robust:** Neutral to disorder (e.g., a phoenix or a heavy stone).	**Antifragile:** Benefits from disorder (e.g., Hydra—cut off one head, two grow back).

Key Principles

Post-Traumatic Growth:

Systems that require stress to function (e.g., bone density through lifting weights or immune systems through germ exposure).

Optionality:

The "antifragile" has more to gain than to lose. By having options (rather than a fixed plan), you can exploit positive "Black Swan" events when they occur.

Over-Compensation:

The mechanism by which the body or a system prepares for future, larger stressors by building excess capacity after a small shock.

Beyond Robustness: While the robust resists shocks and stays the same, the antifragile actually gets better from disorder, volatility, and stress.

Via Negativa: the negative way

The Principle:
Knowledge by Subtraction

The principle that we know what is wrong with more clarity than what is right.

Knowledge grows by subtraction.

Strategic Application:
Improvement by Removal

Improvement by Removal: You improve your life more by removing 'downside' factors than by adding 'upside' factors.

Less is More: Complexity creates fragile systems. Simple rules (heuristics) are more robust.

The Definition of Wisdom:
Knowing What to Avoid

Wisdom is knowing what to avoid to ensure survival and success.

A unified philosophy of uncertainty

The Reality (Black Swans)

Acknowledge that the world is dominated by rare, high-impact, and unpredictable events. Predicting them is a fool's errand.

The Strategy (Antifragility & Barbell)

Do not just aim to survive volatility—position yourself to profit from it. Use the Barbell Strategy to protect your downside while capturing asymmetric upside.

The Tactical Filter (Via Negativa)

Focus on what to avoid and what to remove. Success is often the result of not being stupid rather than being exceptionally brilliant.

The Decision Framework (Ergodicity & Risk)

Prioritize survival above all else. In a non-ergodic world, "expected returns" are a myth if you hit a point of ruin.

The Intellectual Foundation (Latticework)

Use multiple disciplines to identify these patterns. Avoid the "Man with a Hammer" syndrome by synthesizing ideas from biology, physics, and history.

The Unified Goal

To move from Fragile (relying on predictions and models) to Antifragile (thriving on disorder) through subtraction, multi-disciplinary thinking, and a focus on consequences over probabilities.

The choice is not EBM versus intuition

Frameworks used honestly (Humility)

with explicit humility about their limits—and frameworks used as doctrine to avoid the hard work of judgment in uncertainty.

Frameworks used as doctrine (Avoidance)

to avoid the hard work of judgment in uncertainty.

EBO collapsed.

EMH retreated.

EBM must evolve.

Or it will share their fate.

Sources and quotation verification

1. Feynman RP. The Pleasure of Finding Things Out. Perseus Books; 1999. The certainty passage on the opening slide is verified in this collection.

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3. US Joint Forces Command. Commander's Handbook for an Effects-Based Approach to Joint Operations. 2006.

4. Mattis JN. Memorandum for US Joint Forces Command: Assessment of Effects Based Operations. August 14, 2008.

5. Fama EF. Efficient capital markets: a review of theory and empirical work. J Finance. 1970;25:383-417. doi:10.2307/2325486.

6. Shiller RJ. From efficient markets theory to behavioral finance. J Econ Perspect. 2003;17(1):83-104. doi:10.1257/089533003321164967.

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2. Ioannidis JPA. Why most published research findings are false. PLoS Med. 2005;2:e124. doi:10.1371/journal.pmed.0020124.

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4. Greenland S, et al. Statistical tests, P values, confidence intervals, and power: a guide to misinterpretations. Eur J Epidemiol. 2016;31:337-350. doi:10.1007/s10654-016-0149-3.

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