

Deductive Inferences in Guidelines: Lessons from Brain Death

*Gary S Gronseth, MD, FAAN
Professor of Neurology, University of Kansas
AAN Evidence-Based Medicine Methodologist*

*Thomas Getchius
Senior Manager, Clinical Practice*



Uniform Determination of Death Act

An individual is dead who has sustained either:

- irreversible cessation of circulatory and respiratory functions, or
- irreversible cessation of all functions of the entire brain, including the brain stem

A Case

A Guideline

Pronounced dead, man takes 'miraculous' turn

By Mike Celizic

TODAYShow.com contributor

updated 9:23 a.m. CT, Mon., March. 24, 2008

Zack Dunlap doesn't remember much from the day he died, but he does remember hearing a doctor declare him brain-dead. And he remembers being incredibly ticked off.

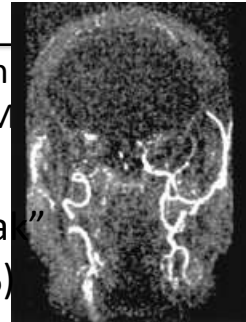
The reasoning

- Several case series (19 patients) of patients meeting clinical and EEG criteria for brain death that documented loss of flow voids in the cavernous portion of the carotid artery with MRA

Sensitivity 100%

- All patients with irreversible cessation of cerebral function lack cerebral blood flow by MRA

“This evidence is weak”
(95% CI 83 to 100%)



Logical Inferences

Inductive

Experience-based reasoning

e.g., Argument by analogy

Case-based reasoning

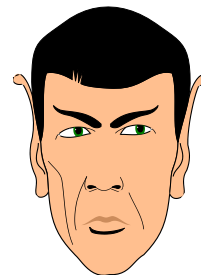
$$p_1, q$$

$$p_2, q \dots$$

$$p_{16}, q$$

$$p_n \rightarrow q$$

“A weak inductive inference.”



A stronger Inductive Inference

- 1000 patients meeting clinical and EEG criteria for brain death after documented loss of flow voids in the cavernous portion of the carotid artery with MRA. Sensitivity 100% (95%CI 99.6 to 100%)
-
- All patients with irreversible cessation of whole brain function lack cerebral blood flow by MR angiography

Logical Inferences

Inductive

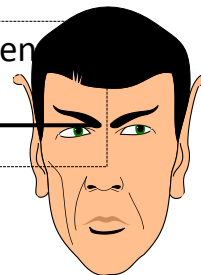
Experience-based reasoning
e.g., Argument by analogy
Case-based reasoning

$$\begin{array}{l} p_1, q \\ p_2, q \dots \\ p_{16}, q \\ \hline p_n \rightarrow q \end{array}$$

Deductive

Rule-based reasoning
e.g., Hypothetical syllogism

$$\begin{array}{l} \text{If } p, \text{ then} \\ p \\ \hline q \end{array}$$



Evidence-
based
premise

A Deductive Inference

- All patients with irreversible cessation of whole brain function lack cerebral blood flow by MR angiography
 - Brain death is the irreversible cessation of whole Brain Function
-
- Patients lacking cerebral blood flow by MR angiography are brain dead

Principle-
based
premise

Principle:

An established truth
An Axiom

A Valid Deductive Inference

- All patients lacking cerebral blood flow by MR angiography have irreversible cessation of whole brain function
 - Brain death is the irreversible cessation of whole Brain Function
-
- Patients lacking cerebral blood flow by MR angiography are brain dead

Conditional probability fallacy

All patients lacking cerebral blood flow by MR angiography have irreversible cessation of whole brain function **=** All patients with irreversible cessation of whole brain function lack cerebral blood flow by MR angiography

Paulos, J.A. (1988) *Innumeracy: Mathematical Illiteracy and its Consequences*, Hill and Wang.

Logical Inferences

Inductive

Experience-based reasoning
e.g., Argument by analogy
Case-based reasoning

$$\begin{array}{l} p_1, q \\ p_2, q \dots \\ p_{16}, q \\ \hline p_n \rightarrow q \end{array}$$

Deductive

Rule-based reasoning
e.g., Hypothetical syllogism

$$\begin{array}{l} \text{If } p, \text{ then } q \\ p \\ \hline q \end{array}$$

A Case

A Guideline

NEUROLOGY

Evidence-based guideline update: Determining brain death in adults : Report of the Quality Standards Subcommittee of the American Academy of Neurology

Erico F.M. Wijdicks, Panayiotis N. Varelas, Gary S. Gronseth, et al.
Neurology 2010;74:1911
 DOI 10.1212/WNL.0b013e3181e242a8

P

For patients
with suspected brain death

I

does any test

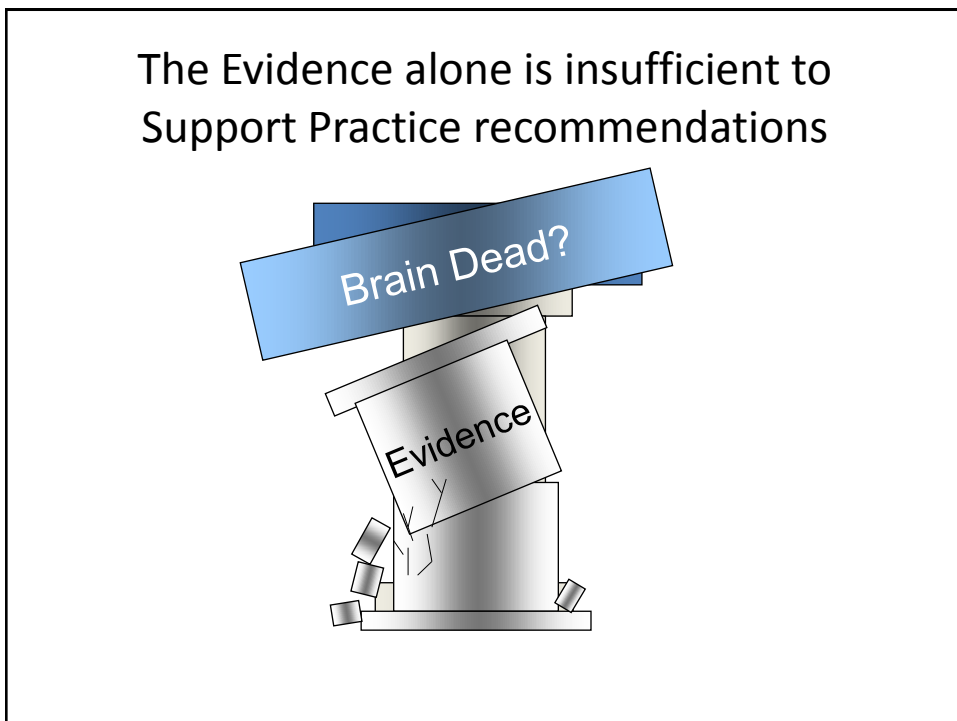
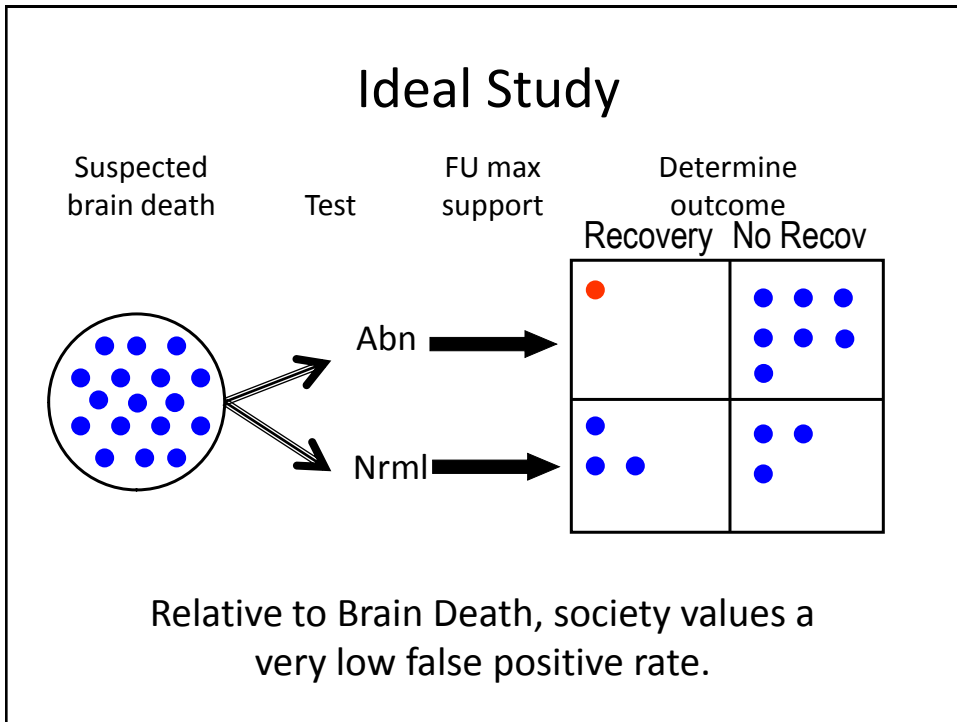
C

as compared to a clinical reference
standard

O

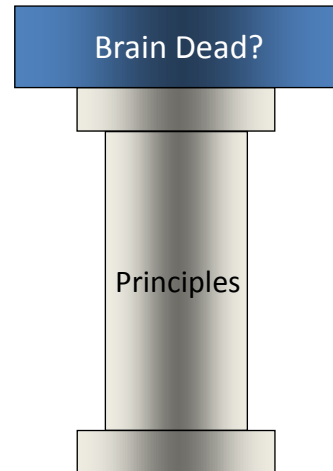
accurately identify patients
who are brain dead?





Principle-Based Practice Recommendations

Brain death is the irreversible cessation of whole Brain Function



A chain of deductive inference from evidence and principles

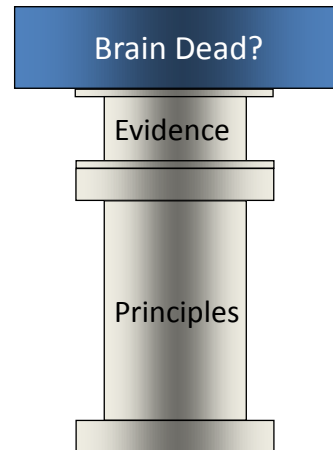
- Brain death is the irreversible cessation of whole Brain Function
- Some causes of the cessation of whole Brain function are reversible
- Cessation of whole brain function of unknown cause may be reversible
- Patients, families and society value a very low false positive rate.
- To declare a patient dead by brain criteria, the physician must know the cause of the brain injury

Principle-Based Practice recommendations: To establish irreversibility the declaring physician must

Determine the cause.

Observe the patient for sufficient
time to ensure that function
does not return

Ensure the absence of
confounding conditions.



Assessing the Soundness of Deductive Inferences

- Brain death is the irreversible cessation of whole Brain Function
 - Some causes of the cessation of whole Brain function are reversible
-
- Cessation of whole brain function of unknown cause may be reversible

Step 1. Assuming the premises are true, does the inference make sense?

Step 2. Are the premises true?

Assessing Soundness Modified Delphi Process

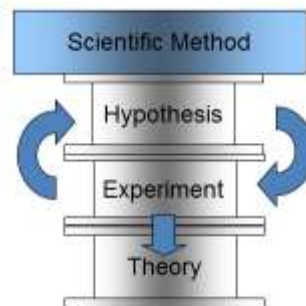


- Compelling (100%)
- Convincing (>80 to 100%)
- Plausible (>50% to 80%)
- Not plausible ($\leq 50\%$)

Examples of principles

- Societal values
 - Definitions of death
 - Safer care is better
 - Less expensive care is better
- Scientific “Theories”
 - Neuroanatomic principles
 - Open airways are good

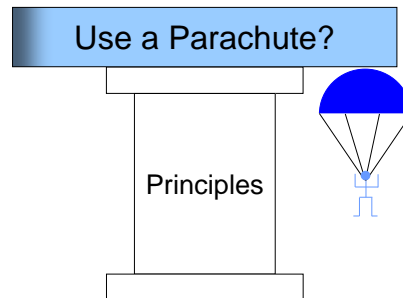
Principle:
An established truth
An Axiom



Parachute use to prevent death and major trauma related to gravitational challenge: systematic review of randomized controlled trials

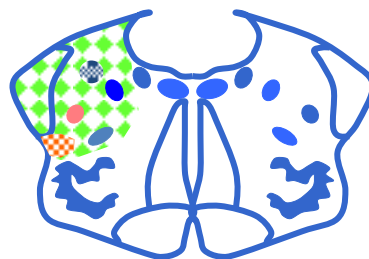
Gordon C S Smith, Jill P Pell

A strong recommendation based wholly on established principles supports a strong recommendation to wear a parachute



A Neuroanatomic Diagnostic Principle

- A patient presents with
 - Right Horner's syndrome
 - Right palatal weakness
 - Left body numbness
- This patient has a lesion of the lateral medulla



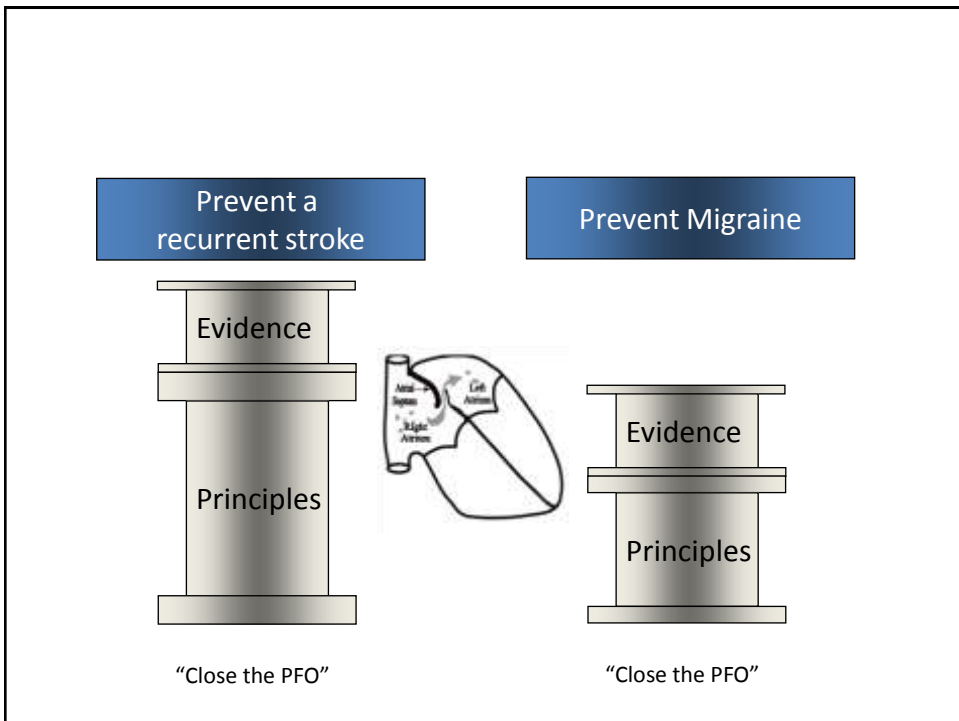
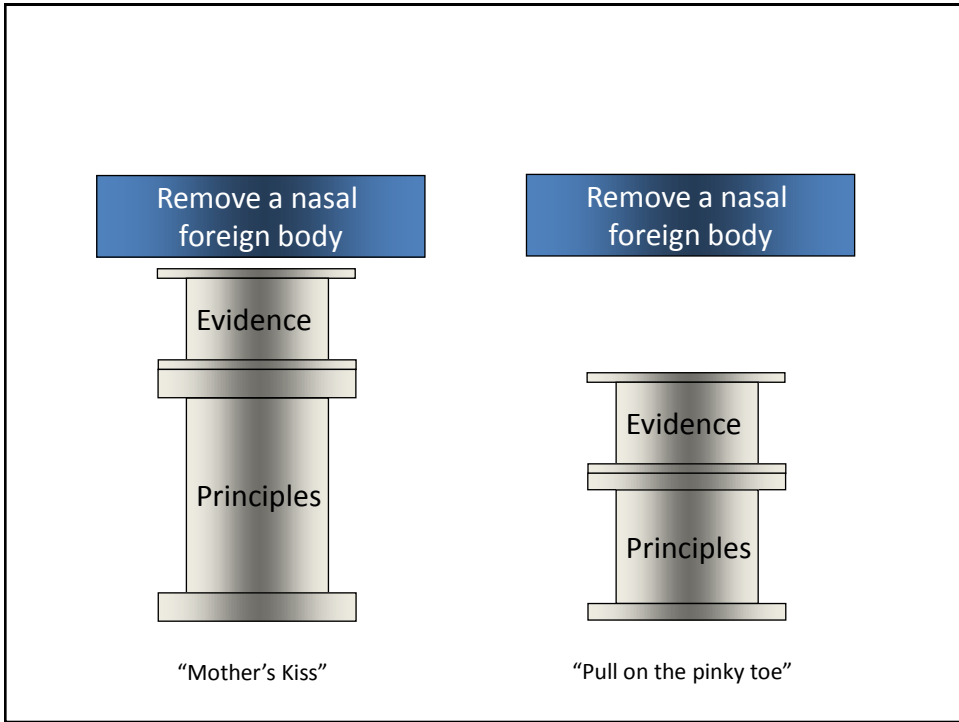
Deductive Inferences in Guidelines

- Explicit deductive inference is another tool we have to formulate reasonable, actionable recommendations.
- The inferences will usually be based upon a combination of evidence-based and principle-based premises.
- Guideline developers should explicitly enumerate premises and the deductive inferences that support their recommendations.
- The soundness of the inferences should be assessed (e.g. Modified Delphi process).

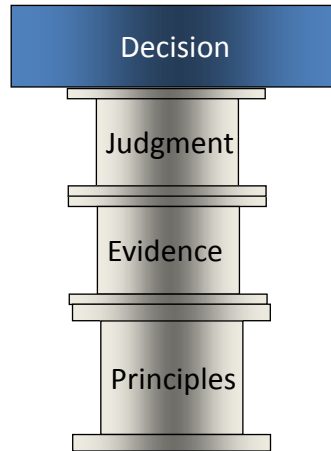
The inductive approach to knowledge should “supplement and not supersede” Aristotle’s



J.S Mill



Three Pillars



Scientific Method

