GATE: Graphic Approach To Epidemiology

1 picture, 2 formulas & 3 acronyms
The Krebs Cycle

1. Glycogen → Pyruvate
2. Acetyl CoA
3. Isocitrate
4. 2-Oxoglutarate
5. Succinyl CoA
6. Succinate
7. Fumarate
8. Malate
9. Oxaloacetate
10. Energy
The GATE frame:

• Graphic Appraisal Tool for Epidemiological studies – a framework for appraising studies

• Graphic Architectural Tool for Epidemiological studies – a framework for designing studies
1. a framework for study design
2. a framework for study analysis
3. a framework for study error
4. a framework for practicing EBP

1 picture, 2 formulas & 3 acronyms
1. GATE: design of epidemiological studies: 

*the picture & 1st acronym: PECOT*

every epidemiological study can be hung on the GATE frame.
British doctors measured smoking status.

Smokers vs. non-smokers over 10 years.
Lung cancer: yes or no.

Longitudinal (cohort) study
Observational studies: allocated by measurement.
1st acronym: PECOT

Population/Participants

British doctors
smoking status measured

Exposure
smokers

Comparison
non-smokers

Outcomes
Lung cancer

Time
10 years
British doctors

Randomly allocated to aspirin or placebo

aspirin       placebo

Heart attack

yes

no

5 years

Randomised Controlled Trial

**RCT: allocated to E & C by randomisation process**
GATE Frame *picture & 1st acronym*

Middle-aged American women

Receive Mammogram screening Test

Mammogram positive

Mammogram negative

Breast cancer

yes

no

Diagnostic (prediction) study
Middle-aged Americans

Body mass index measured

overweight

‘normal’ weight

Diabetes

yes

no

Cross-sectional (prevalence) study
Middle-aged Americans

Body mass index measured

obese

‘normal’ weight

Diabetes

yes

pre-

no

Cross-sectional study
Middle-aged Americans

Body Mass Index (BMI) measured

High BMI  
Low BMI

Blood glucose

Cross-sectional study

GATE Frame *picture & 1st acronym*
2. GATE: analysis of epidemiological studies: 

the 1st formula: outcomes ÷ population

The numbers in every epidemiological study can be hung on the GATE frame
1st formula: the Occurrence of outcomes = number of outcomes ÷ number in the population

British doctors

smoking status measured

Exposed Group* smokers

Comparison Group* non-smokers

Outcomes
Lung cancer yes no

Participant Population

* a Group is a sub-population
1st formula: occurrence = outcomes ÷ population

Exposed Group Occurrence (EGO) = a/EG
= number of outcomes (a) ÷ number in exposed population (EG)
1st formula: occurrence = outcomes ÷ population

Comparison Group Occurrence (CGO) = \( \frac{b}{CG} \)

= number of outcomes (b) ÷ number in comparison population (CG)

British doctors

smoking status measured

Exposed Group

smokers

Outcomes

yes

Lung cancer

no

Comparison Group

non-smokers

Time

10 years
The goal of all epidemiological studies is to measure (& compare) the occurrence of outcomes in (different) populations (EGO compared with CGO).

EGO: Occurrence (risk) of cancer in smokers

CGO: Occurrence of cancer in non-smokers

10 years

British doctors

smoking status measured

smokers

cancer yes

cancer no

Lung cancer

\[ 18 \]
The goal of all epidemiological studies is to measure (& compare) the occurrence of outcomes in (different) populations *(EGO compared with CGO)*

- **EGO:** Occurrence of MI if taking aspirin
- **CGO:** Occurrence of MI if not taking aspirin

**Diagram:**
- British doctors
- Randomly allocated to aspirin or placebo
- Heart attack (MI)
- 5 years
- a, b, O

**Notes:**
- P
- aspirin
- placebo
- yes, no
- Randomly allocated to aspirin or placebo
The goal of all epidemiological studies is to measure (& compare) the occurrence of outcomes in (different) populations (EGO compared with CGO)

Middle-aged American women

Receive Mammogram screening Test

Mammogram positive

Mammogram negative

EGO: Occurrence of cancer if mammogram +ve

CGO: Occurrence of cancer if mammogram -ve

Breast cancer

a b
d q

P
The goal of all epidemiological studies is to measure (& compare) the occurrence of outcomes in (different) populations (EGO compared with CGO)

EGO: Average blood glucose in EG
CGO: Average blood glucose in CG

EGO = sum of all glucose levels in EG ÷ number in EG
Comparing EGO & CGO

- Risk Ratio or Relative Risk (RR) = EGO ÷ CGO
- Risk Difference (RD) = EGO − CGO
- Number Needed to Treat/’expose’ (NNT) = 1 ÷ RD

its all about EGO and CGO

Measures of occurrence include: risk; rate; likelihood; probability; average; incidence; prevalence
3. GATE: identifying where errors occur in epidemiological studies: *the 2nd acronym: RAMboMAN*

the GATE frame with RAMboMAN can be used to identify risk of error in most/all epidemiological studies
were **Recruited** participants relevant to the study objectives? 
*who are the findings applicable to?*
RAMboMAN: how well were participants Allocated to exposure & comparison groups?

Was Allocation to EG & CG successful?

RCT: Allocated by randomisation (e.g. to drugs)

Cohort: Allocated by measurement (e.g. smoking)

EG & CG similar?

E & C measures accurate?
How well were Participants Maintained in the groups they were allocated to (i.e. to EG & CG) throughout the study?

Compliance
Contamination
Co-interventions
Completeness of follow-up
Were outcomes measured **blind** to whether participant was in EG or CG?
were outcomes measured objectively?
Were the *Analyses* done appropriately?

Adjustment for confounding
Were the Analyses done appropriately?

Intention to treat?
the 2\textsuperscript{nd} formula: \[\text{random error} = 95\% \text{ confidence interval}\]

There is about a 95\% chance that the true value of EGO & CGO (in the underlying population) lies somewhere in the 95\% CI (assuming no non-random error)
the 3rd acronym: FAITH
Critically appraising a systematic review

- **Find** – were all potentially relevant studies found?
- **Appraise** – were studies appraised for validity?
- **Include** – were only appropriate studies included in the final analyses?
- **Total-up** – were studies pooled appropriately?
- **Heterogeneity** – were studies too heterogeneous (i.e. too different) to pool?
4. GATE: a framework for the 4 steps of EBP
The steps of EBP:

1. Ask
2. Acquire
3. Appraise
4. Apply
[5. AUDIT your practice]
EBP Step 1: ASK - turn your question into a focused 5-part PECOT question

1. Participants
2. Exposure
3. Comparison
4. Outcomes
5. Time
EBP Step 2: **ACQUIRE** the evidence – use **PECOT** to help choose search terms

1. **Participants**
2. **Exposure**
3. **Comparison**
4. **Outcome**
5. **Time frame**
EBP Step 3: APPRAISE the evidence – with the picture, acronyms & formulas

Recruitment
Allocation
Maintenance
blind
objective
Measurements
ANalyses

Occurrence = outcomes ÷ population
Random error = 95% Confidence Interval
EBP Step 4: **APPLY** the evidence by **AMALGAMATING** the relevant information & making an **evidence-based decision**:' the **X-factor**
X-factor: making evidence-based decisions

Practitioner expertise: ‘putting it all together’ - the art of practice

Clinical expertise in the era of evidence-based medicine and patient choice. EBM 2002;736-8 (March/April)
There is a GATE for every study design

www.epiq.co.nz

& an on-line post-grad course in EBP
HAPPY 50th ROD

GATE - Way to the future!
Extra slides
Why do we need to use evidence efficiently?

Medical Articles Per Year

- **Biomedical:** 5,000? per day
- **MEDLINE:** 2,000 per day
- **Trials:** 75 per day

EBP: informing decisions with the best up-to-date evidence
The epidemic of evidence

Bastian, Glasziou, Chalmers PLoS 2010 Vol 7 | Issue 9 | e1000326
About 1/2 of ‘valid’ evidence today is out of date in 5 years

About 1/2 of valid evidence is not implemented

"...and, as you go out into the world, I predict that you will, gradually and imperceptibly, forget all you ever learned at this university."
GATE Frame *picture & 1st acronym*

Case-control study

Observational study: allocated by measurement
Middle-aged American women

Measured with ‘gold standard’ for breast cancer

Breast cancer positive

Breast cancer negative

Mammogram

positive

negative

Diagnostic test accuracy study
The goal of all epidemiological studies is to measure (& compare) the occurrence of outcomes in (different) populations (**EGO compared with CGO**)

Middle-aged American women

- **Positive** Mammogram if breast cancer
- **Negative** Mammogram if no breast cancer

**EGO:** Likelihood of +ve Mammogram if breast cancer

**CGO:** Likelihood of +ve Mammogram if no breast cancer

- Measured with gold standard for breast cancer

Diagram:

- **P**
- **T**
- **a**
- **b**
- **c**
- **d**

- **EG**
- **CG**

- Breast cancer
- No breast cancer
British doctors

Smoking status measured

Exposed Group
smokers

Comparison Group
non-smokers

Outcomes
Lung cancer

EGO = \( \frac{a}{EG} \) during time \( T \) (a measure of cumulative incidence)
EGO = \( \frac{a}{EG} \div T \) (a measure of incidence rate)
1st formula (with time):
occurrence = (outcomes ÷ population) ÷ Time

Middle-aged American women
Receive Mammogram screening Test

Mammogram positive
Mammogram negative

Breast cancer

EGO: Occurrence of cancer if mammogram +ve
CGO: Occurrence of cancer if mammogram -ve

EGO = (a ÷ EG) at time T (a measure of prevalence)