500 Class 01 (Zoom)

https://thomaselove.github.io/500-2025/

2025-01-16

Agenda for Zoom Meeting

Thursday 2025-01-16 from 10 to 11 AM. Zoom details in your email and on Canvas.

- Welcome to 500
- Logistics of the Course, Assignments
- A Motivating Example: Aspirin and Mortality in Heart Patients
  - How can we avoid being misled?
  - Causal Effects as comparing potential outcomes
- Your Questions

Course Overview

- Randomized Experiments vs. Observational Studies
  - Randomization as the "fundamental basis for inference"
  - Observational Studies and Causal Effects
- Propensity Scores: Crucial Tools for Causal Models
  - Selection Bias: key issue for observational studies
  - Dealing with Bias (both overt and hidden)
  - Subclassification (stratification) and direct regression adjustment
  - Matching and weighting using the Propensity Score
  - Sensitivity Analysis
- Instrumental Variables and Other Techniques
- Using R, RStudio and Quarto to accomplish all of this

Paul Rosenbaum's 2023 book *Causal Inference*

My Expectations

- You are interested in learning about the effects of an intervention, treatment or policy on subjects when the treatments cannot be assigned at random.
- You have little interest in technical details of methods, but serious interest in designing, conducting and analyzing observational studies skillfully.
- You have access to software (specifically R) which you can use to obtain basic hypothesis testing, regression and logistic regression results.

This Year is Unusual

- Classes 1-8 (before Spring Break) involve:
  - a recorded 60-90 minute lecture (like this one)
  - a Zoom meeting to discuss the lecture and other issues from 10-11 AM on Thursday
- After Spring Break, starting with Class 9 (2025-03-20) we will meet in person from 8:30 AM to 11:15 AM in Wolstein Research Building room 1217 on the CWRU campus.
- For all sessions, Dr. Love is available after class for informal "office hours".
- Recordings of class sessions will be available through Zoom on Canvas when things work properly.

The Web Site

https://thomaselove.github.io/500-2025 is at the bottom of every slide

- Syllabus
- Calendar
  - links to class sessions, final word on all deadlines
- R and Data
  - Installing/Updating R, RStudio, R Packages
  - Data and Code
- Sources / References
  - Some things are **password-protected**.
- Links to Canvas, and to ways to Contact Us
- Assignments ...

Assignments / Deliverables

1. Course Project
   - Semester-long project, with your first proposal draft due 2025-02-13.
   - Second proposal draft 2025-02-27.
   - Final presentation of your work in class April 10, 17 or 24.
2. Observational Studies in Action
   - Present methods/results from a published article using propensity scores.
   - You'll present once as primary reviewer, once as second reviewer.
   - First step is to identify a study and claim it by 2025-02-19.
3. Labs
   - Lab 01 is due Thursday 2025-01-30 at 9 AM to Canvas.
   - There is a "Lab 0" worked example to look at first.
   - Deadlines and instructions for all labs are on the website.

There are no quizzes or examinations in 500.

A Key Goal for the Project and Course

- Help you learn how to tackle a problem, rather than just be able to perform particular statistical techniques.
  - Goal: think and solve problems when trying to infer causal effects from observational data
- But the need to think in statistical terms is omnipresent
  - Identifying researchable problems
  - Dealing with variation
  - Interplay of Design and Analysis
  - Preparing, writing and revising results, in a replicable way.

Section 1

A Motivating Example (Aspirin and Mortality)

Aspirin and Mortality in Heart Patients

Suppose you want to understand the effect of aspirin (acetylsalicylic acid: ASA) on mortality among patients undergoing stress echocardiography.

- What is the population?
- What is the outcome?
- What are the treatments?

Potential Outcomes and The Aspirin Study

Potential Outcomes and The Aspirin Study

Potential Outcomes and The Aspirin Study

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ASA and Mortality in Heart Patients

Suppose you want to understand aspirin's effect on all-cause five-year mortality among patients undergoing stress echocardiography.

- Comparing ASA to "No ASA"
- What are the potential outcomes here?

Potential Outcomes and The Aspirin Study

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Potential Outcomes and The Aspirin Study

Potential Outcomes and The Aspirin Study

Aspirin – "No Aspirin" Effect =

–

ASA and Mortality in Heart Subjects

- Suppose you want to study the effect of aspirin (acetylsalicylic acid: ASA) on all-cause mortality.
- You identify an interesting group of Subjects as those undergoing stress echocardiography.
    - Your goal is to compare ASA Subjects to "no ASA" Subjects

What would be the **ideal** study?

Step 1. Identify a large group of Subjects from the population at Time 0.

- We want to understand the causal effect of aspirin on all-cause five-year mortality among patients undergoing stress echocardiography.
- Having identified a set of patients, what is the ideal study?

Step 2?

ASA and Mortality: Ideal Study

Identify a large group of patients from population at Time 0

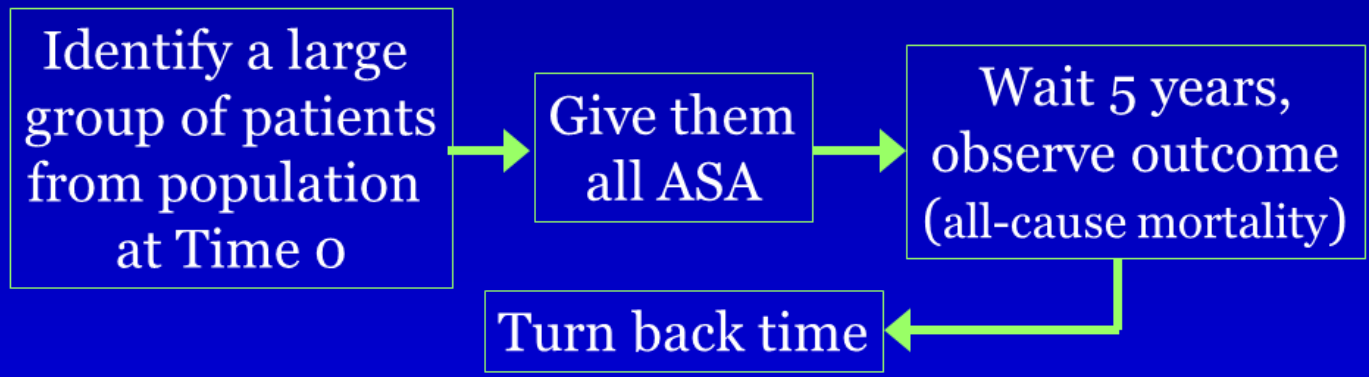
ASA and Mortality: Ideal Study

Identify a large group of patients from population at Time 0

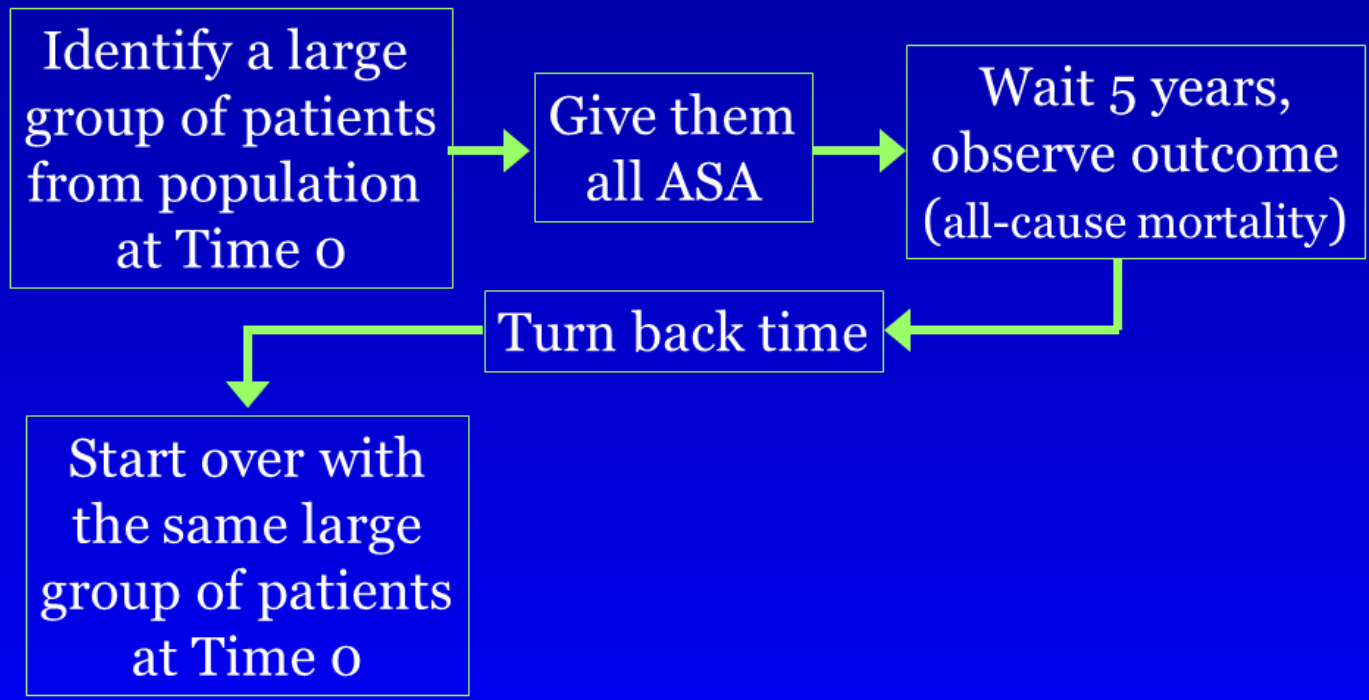
Give them all ASA

ASA and Mortality: Ideal Study

ASA and Mortality: Ideal Study



ASA and Mortality: Ideal Study



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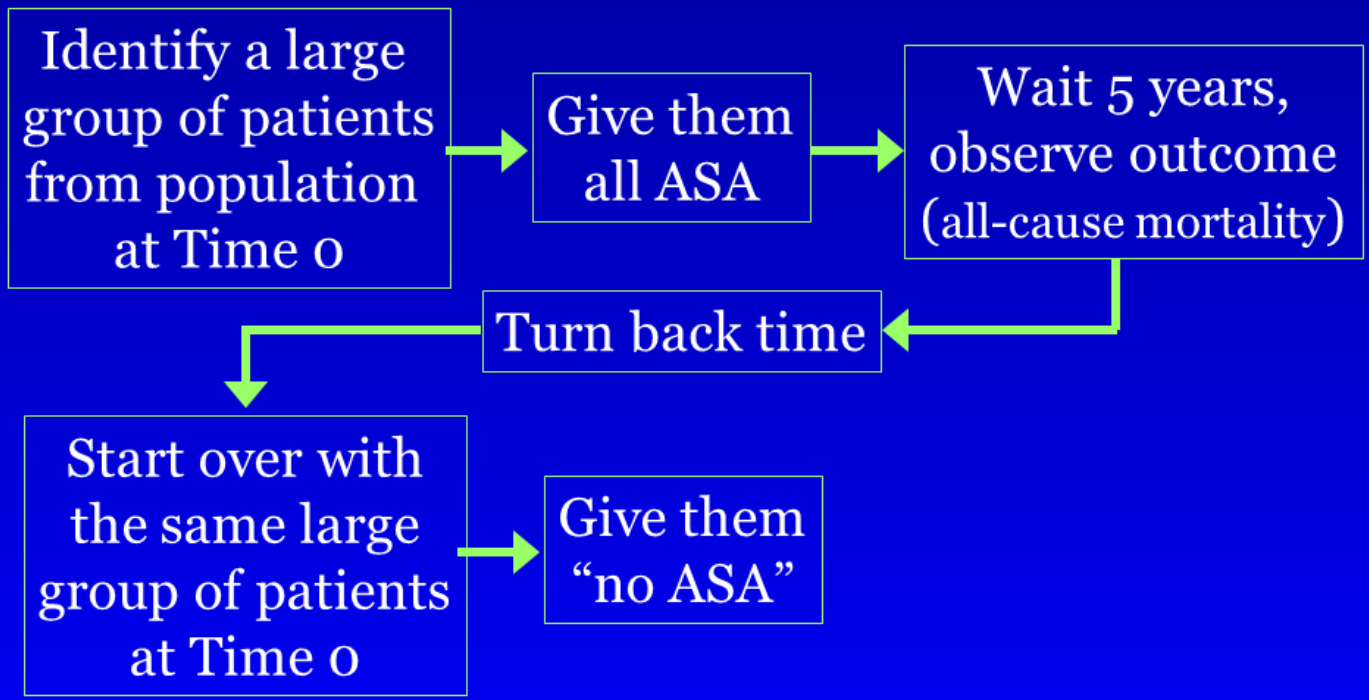

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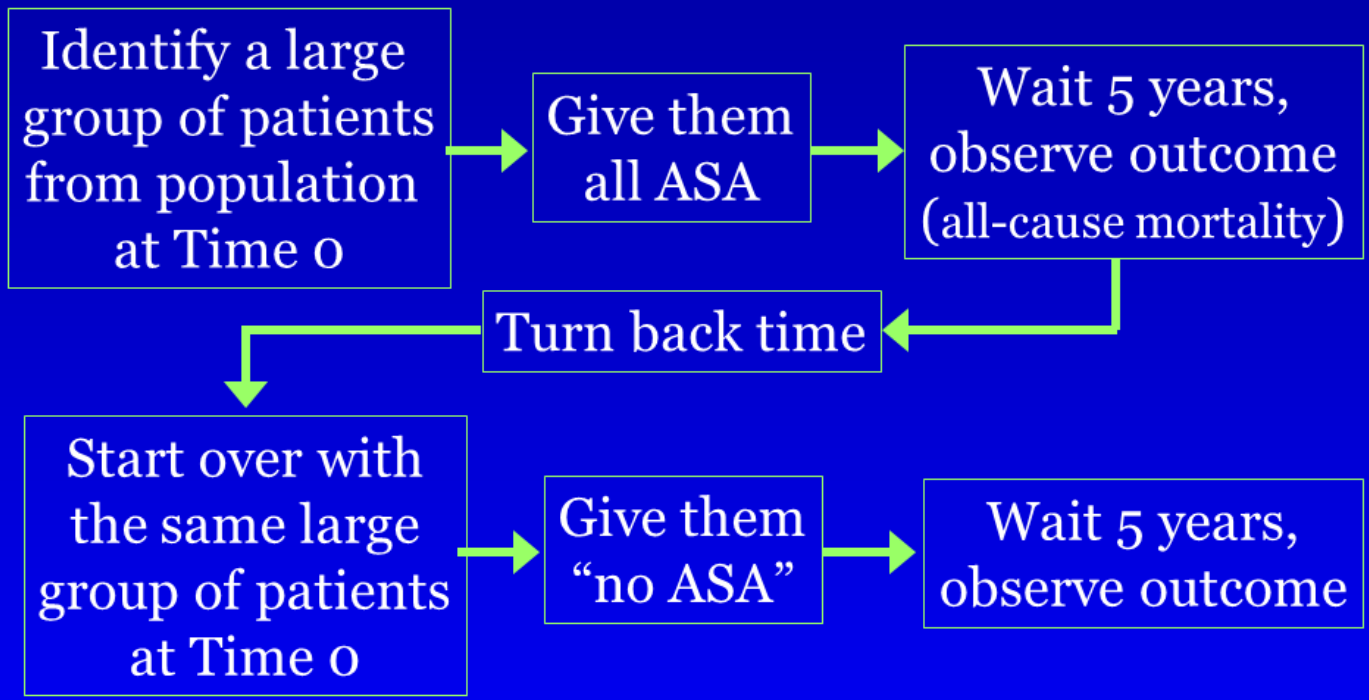

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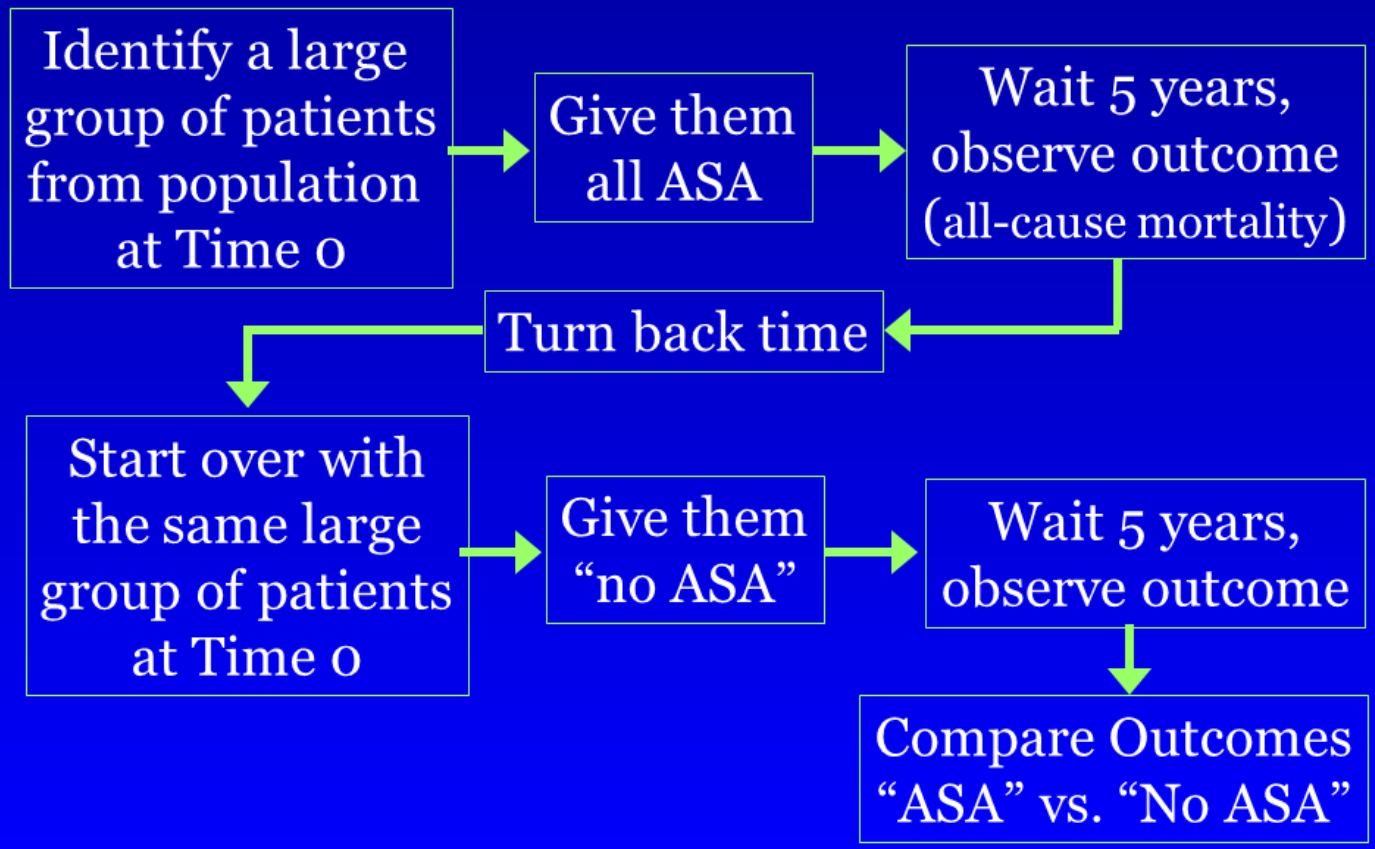

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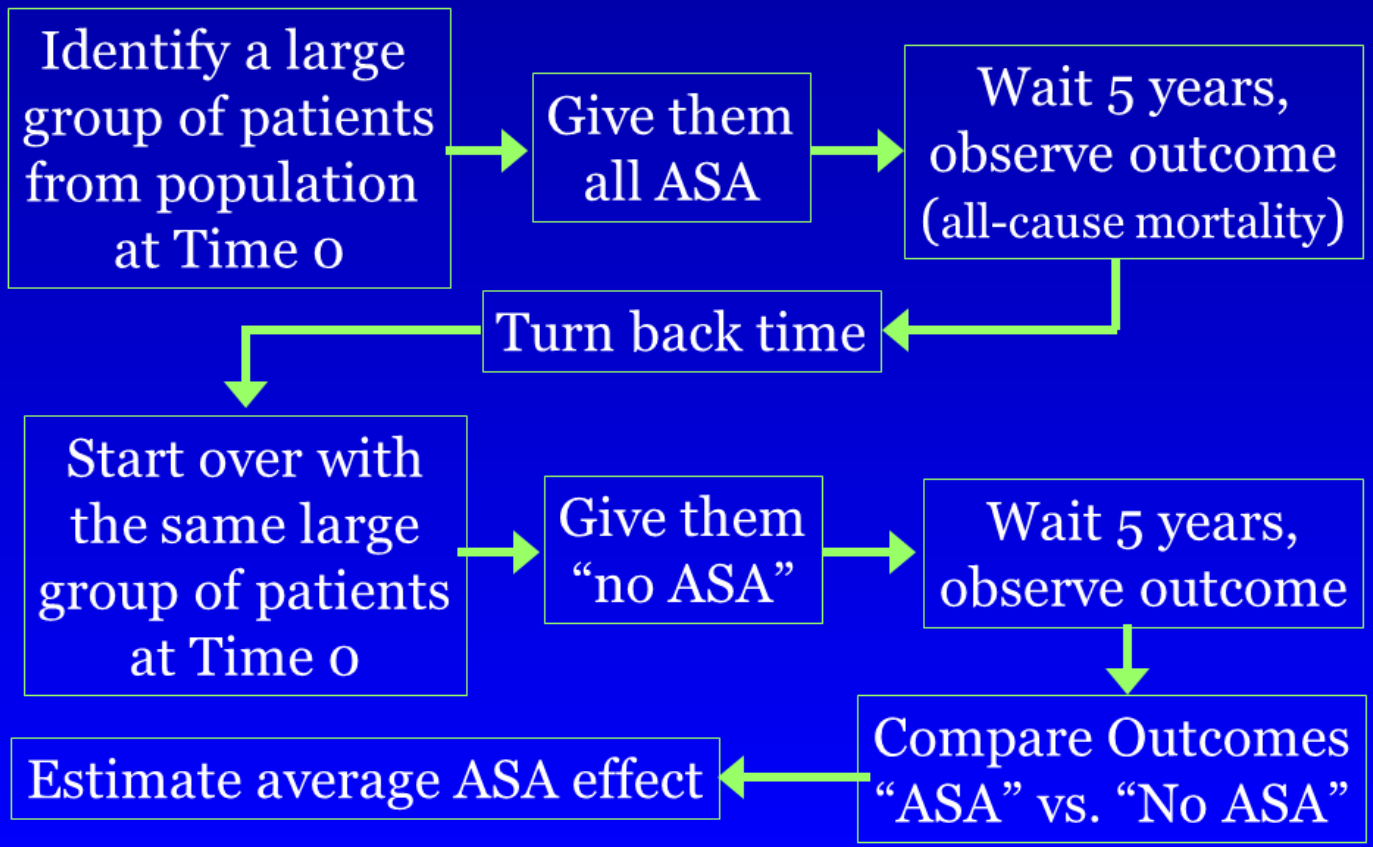


ASA & Mortality: Next Best Study

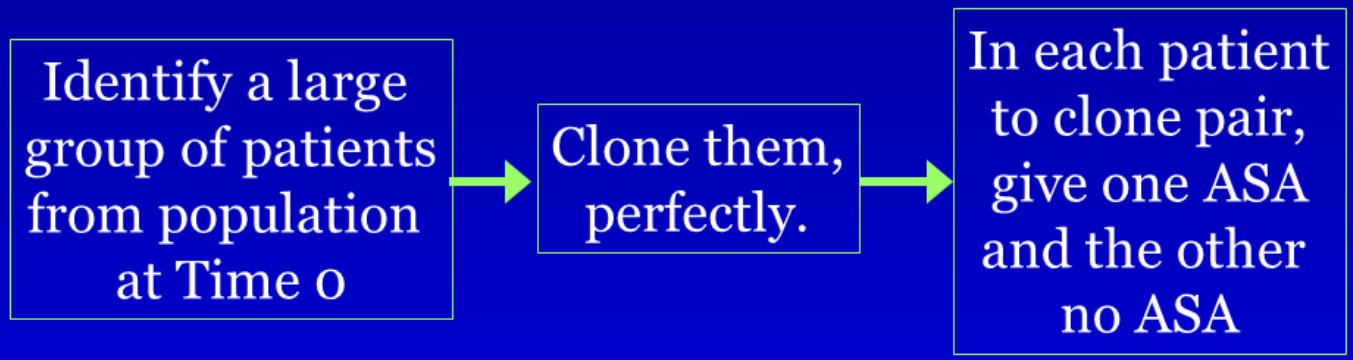
Identify a large group of patients from population at Time 0

ASA & Mortality: Next Best Study

Identify a large group of patients from population at Time 0

Clone them, perfectly.

ASA & Mortality: Next Best Study



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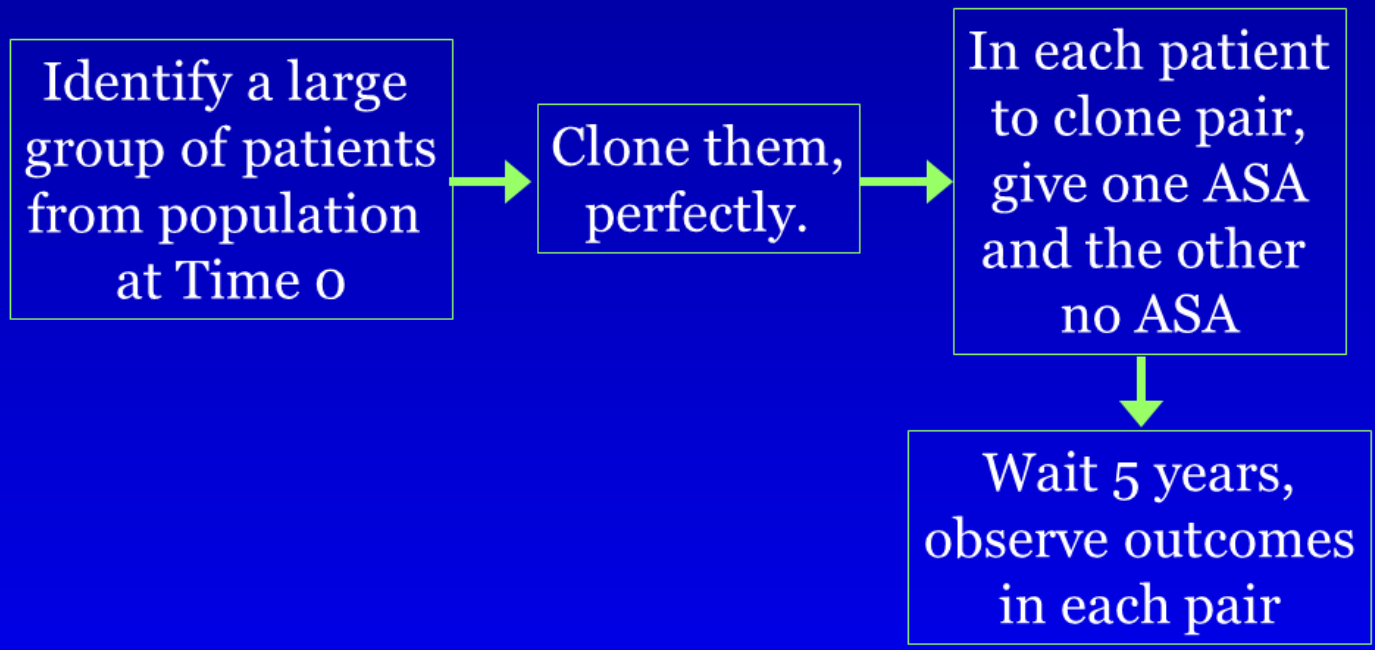
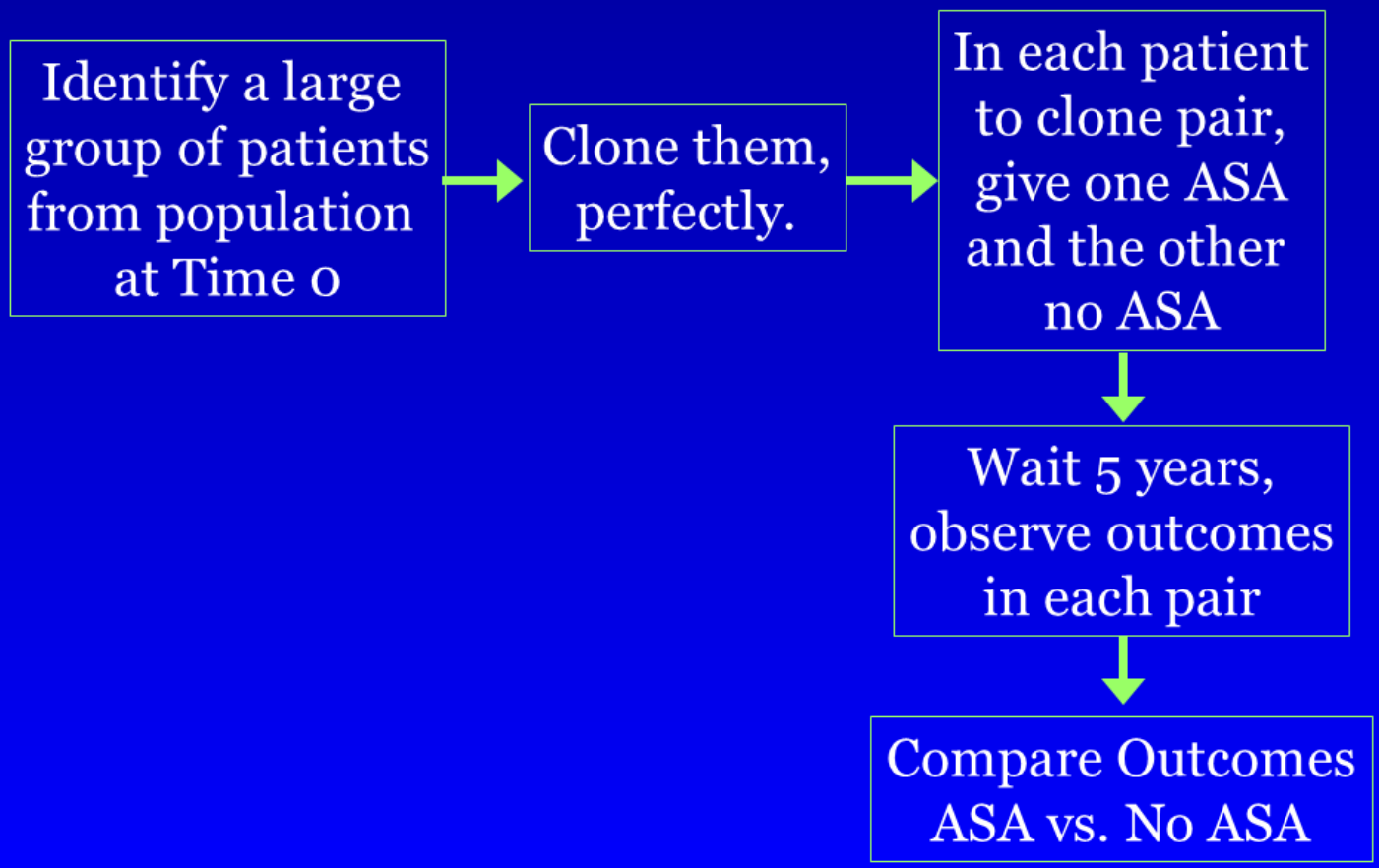


ASA & Mortality: Next Best Study



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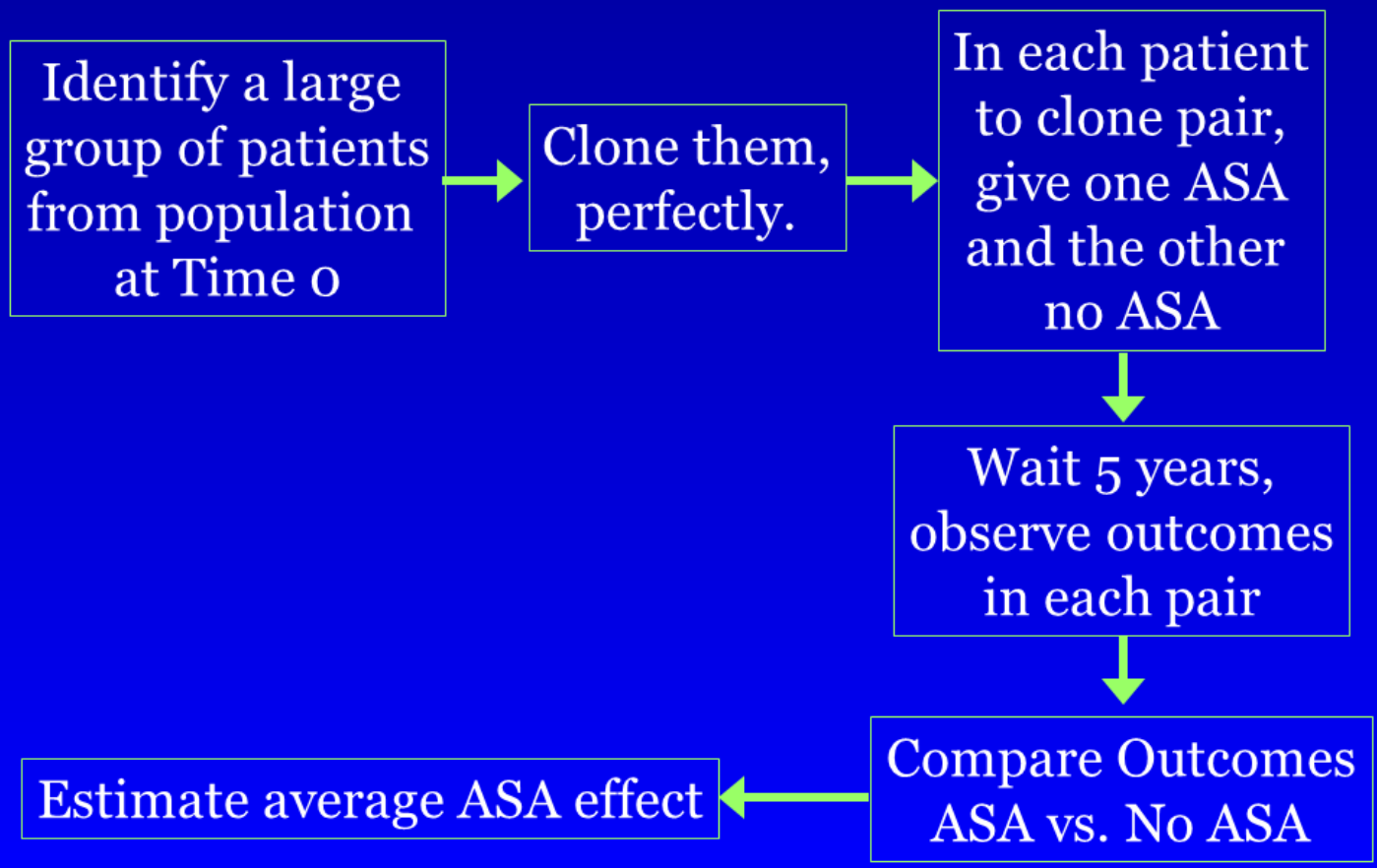
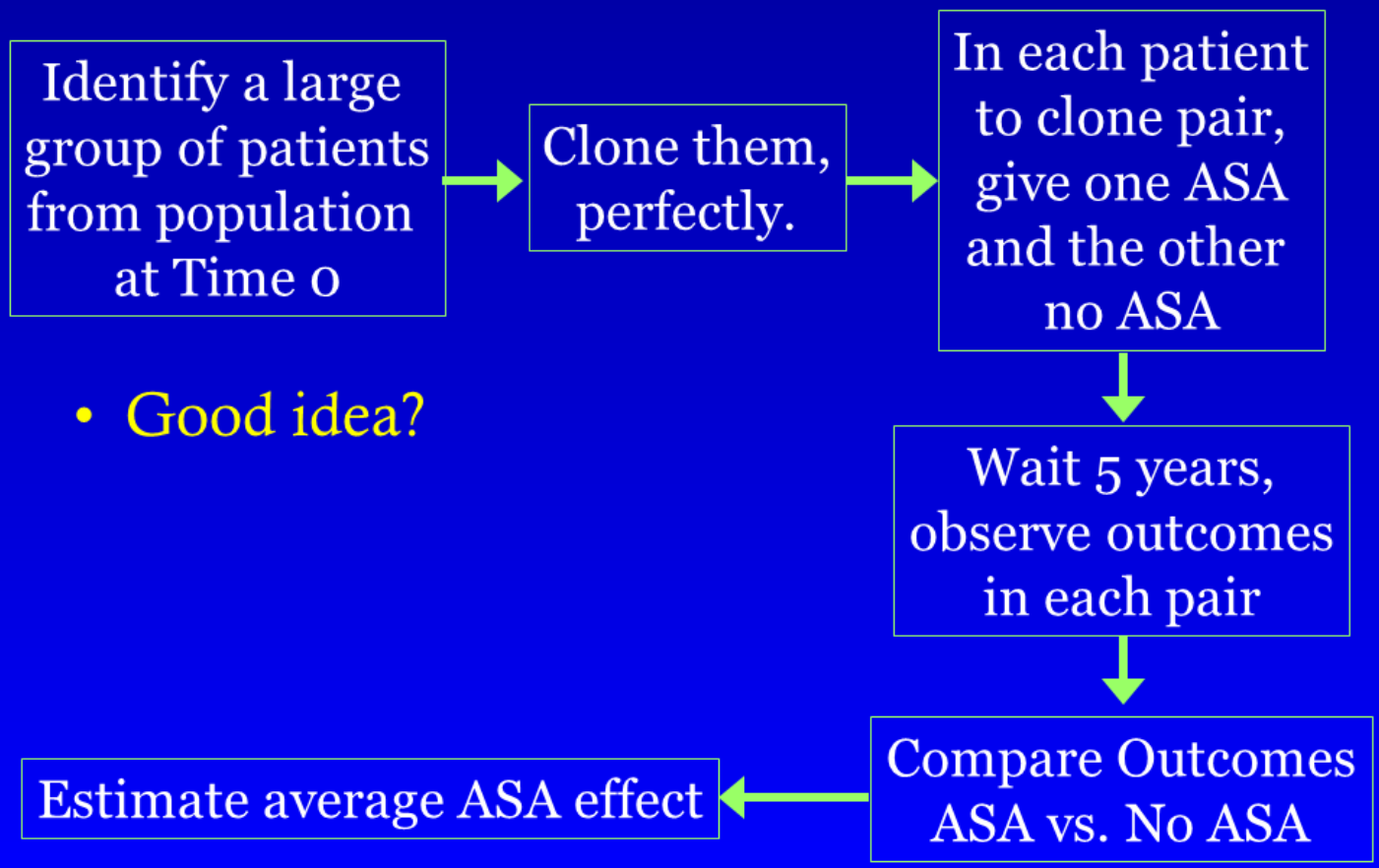
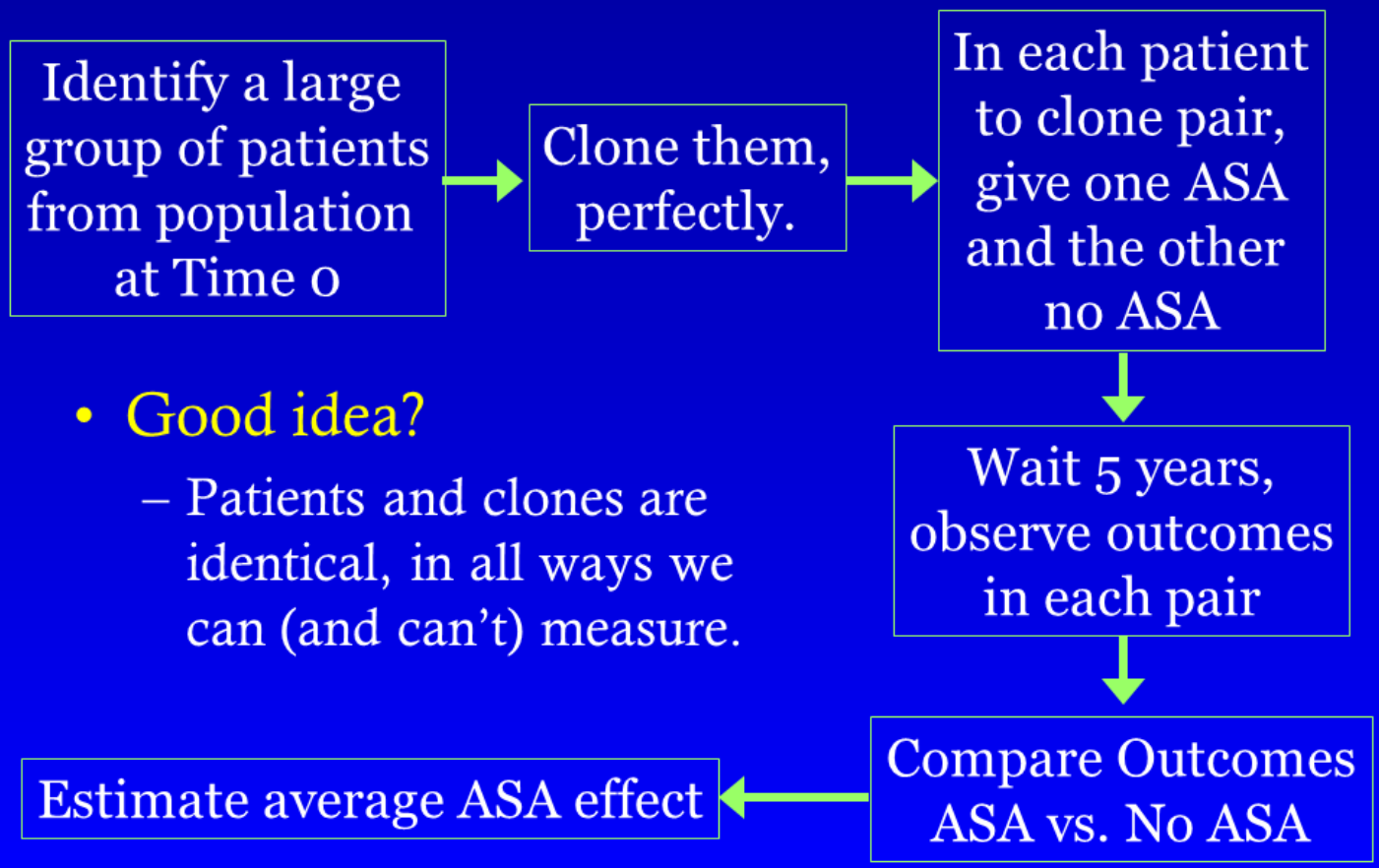


ASA & Mortality: Next Best Study



- Good idea?

ASA & Mortality: Next Best Study



- Good idea?
  - Patients and clones are identical, in all ways we can (and can't) measure.

ASA and Mortality in Heart Patients

- Designing the Study

We want to understand aspirin's effect on all-cause five-year mortality among patients undergoing stress echocardiography.

- OK.
- What's the best **practical** study?

ASA & Mortality: RCT

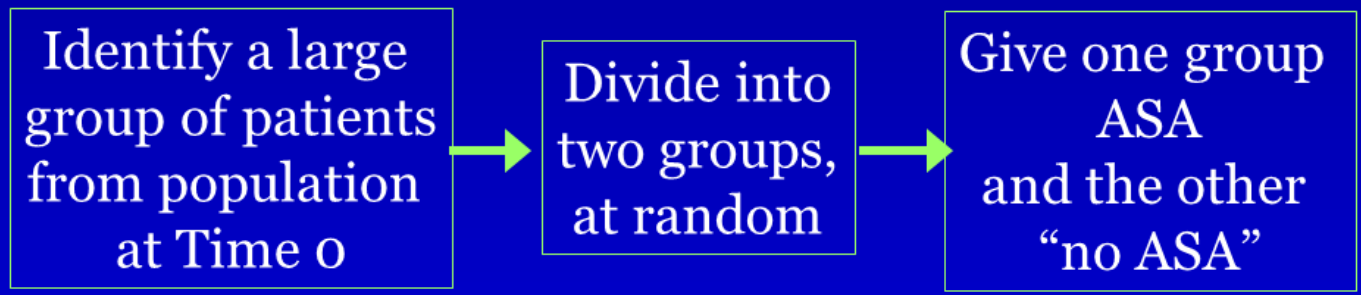
Identify a large group of patients from population at Time 0

ASA & Mortality: RCT

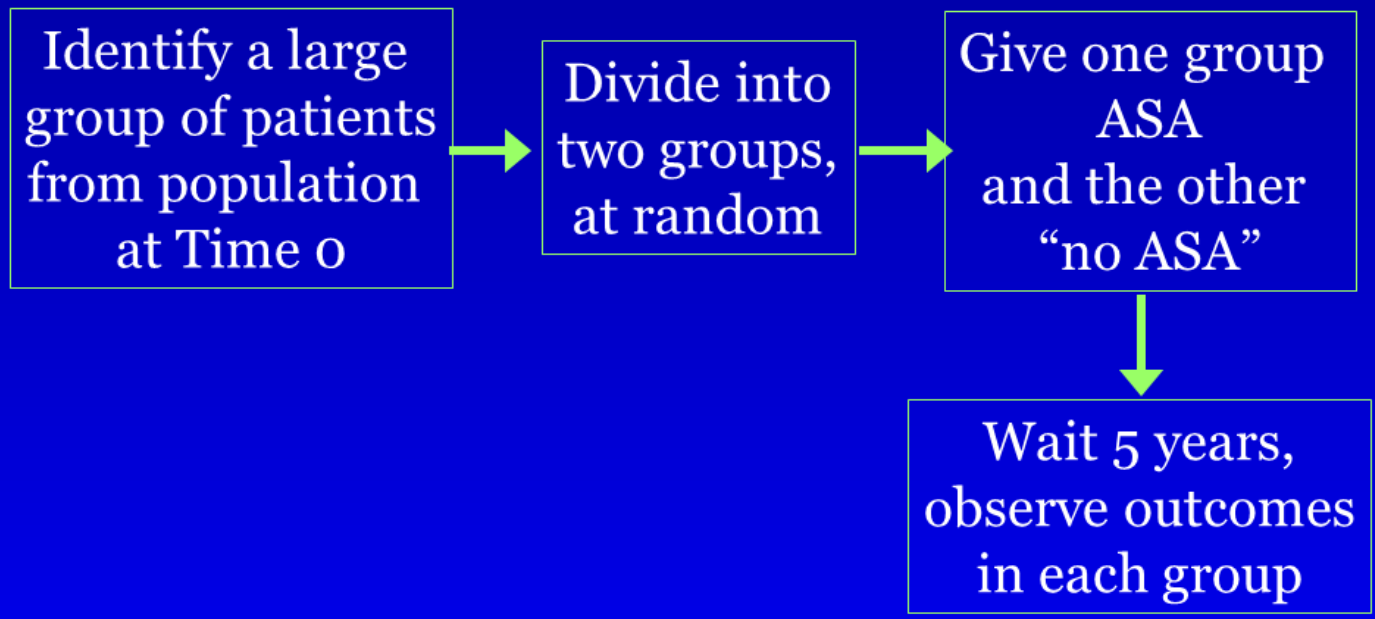
Identify a large group of patients from population at Time 0

Divide into two groups, at random

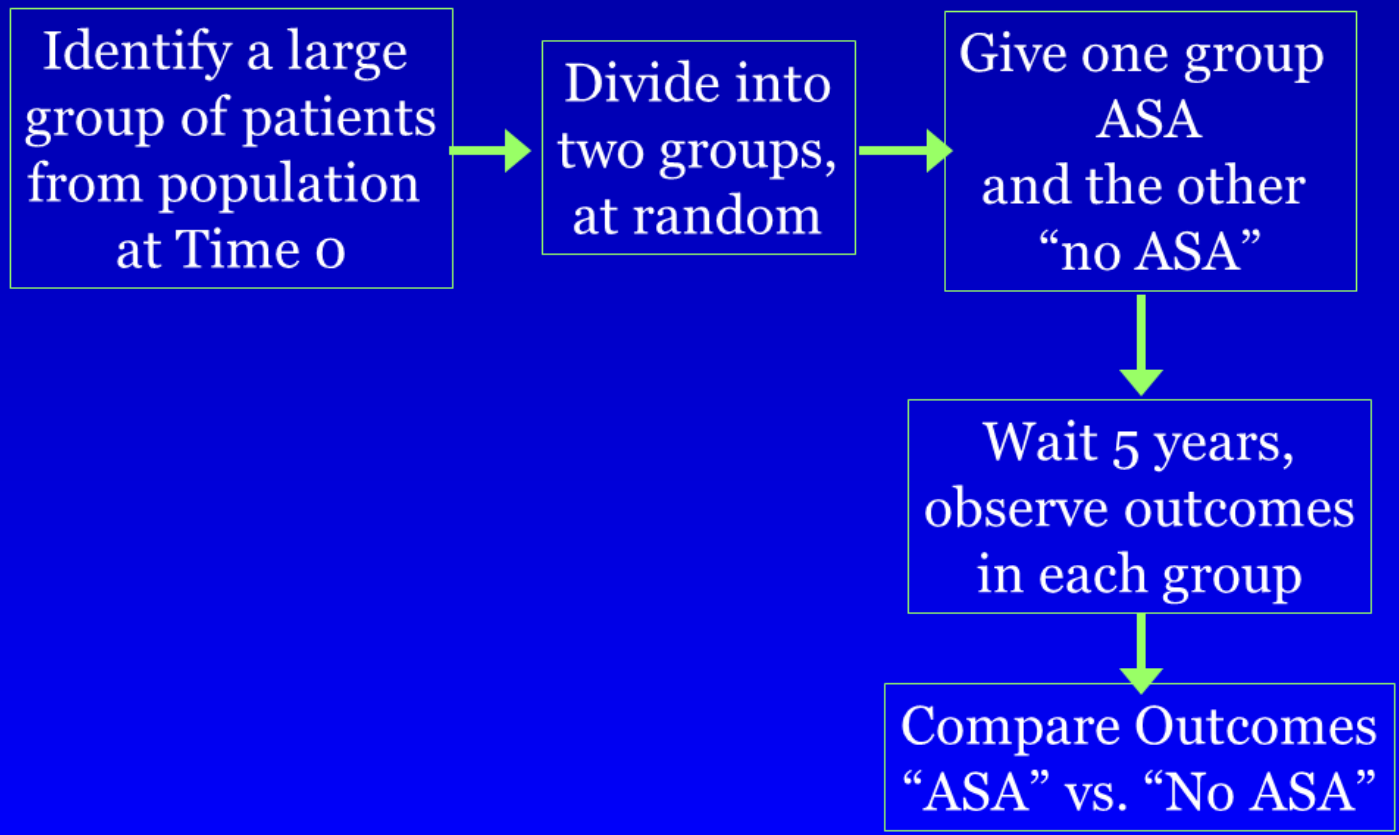
ASA & Mortality: RCT



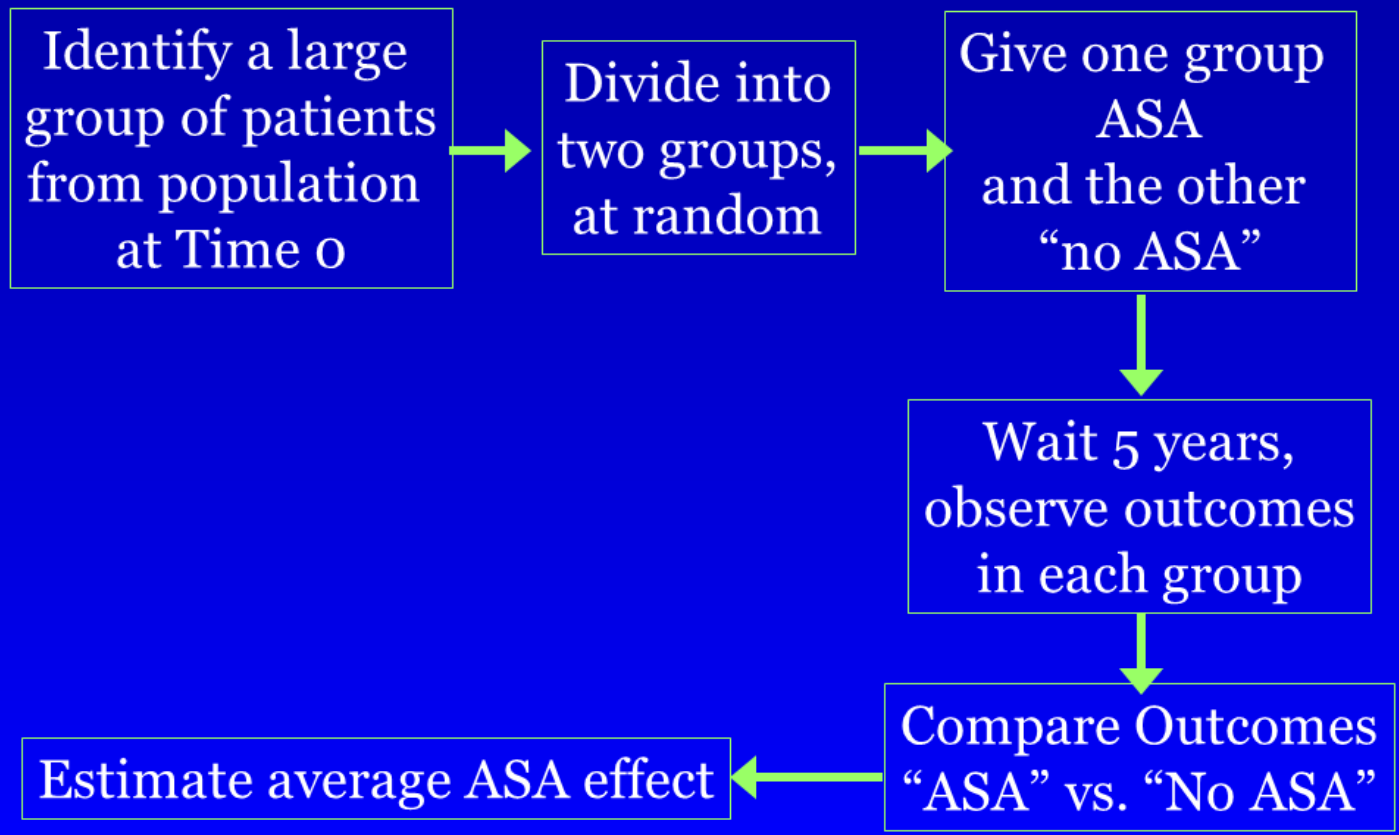
ASA & Mortality: RCT



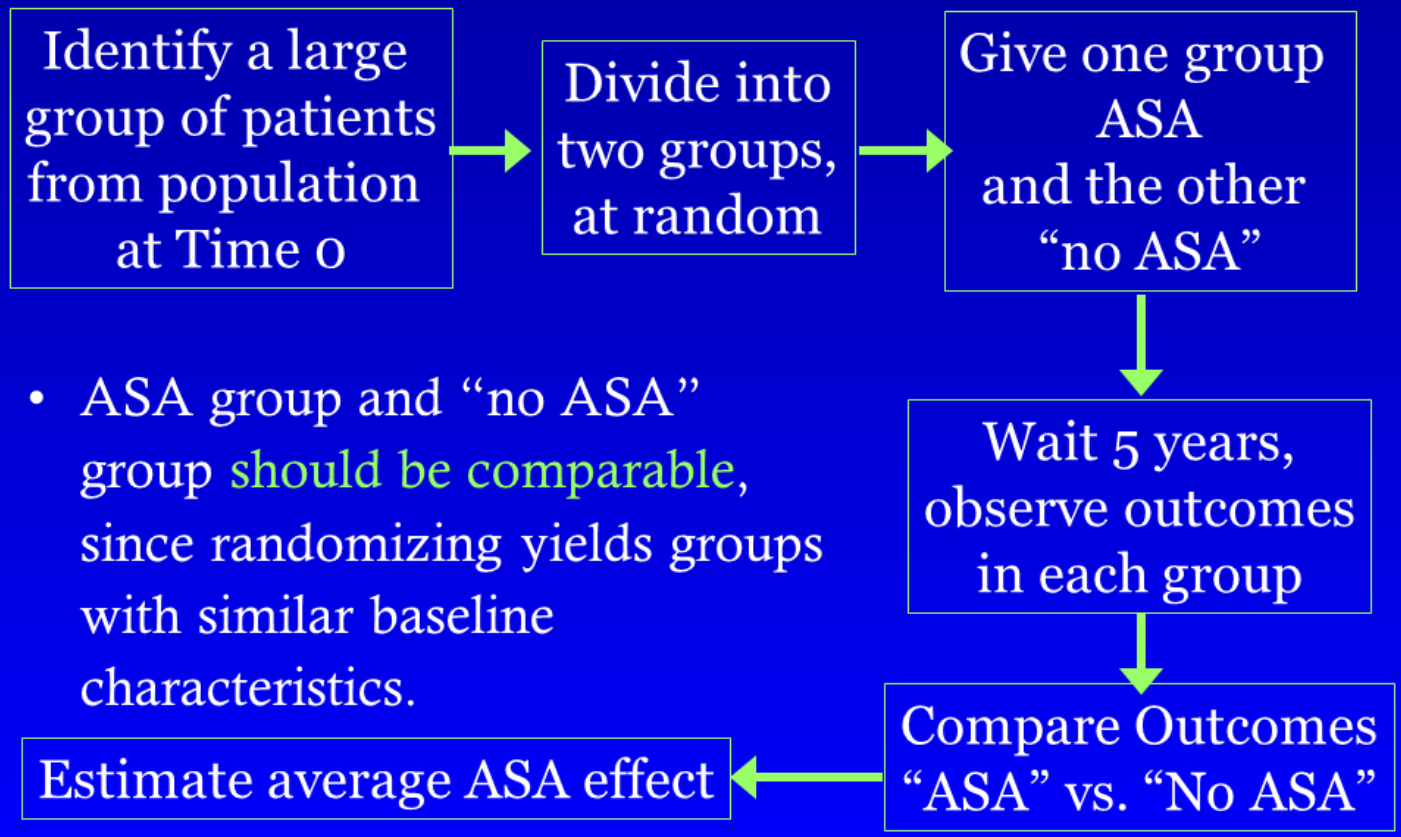
ASA & Mortality: RCT



ASA & Mortality: RCT



ASA & Mortality: RCT



- ASA group and "no ASA" group should be comparable, since randomizing yields groups with similar baseline characteristics.

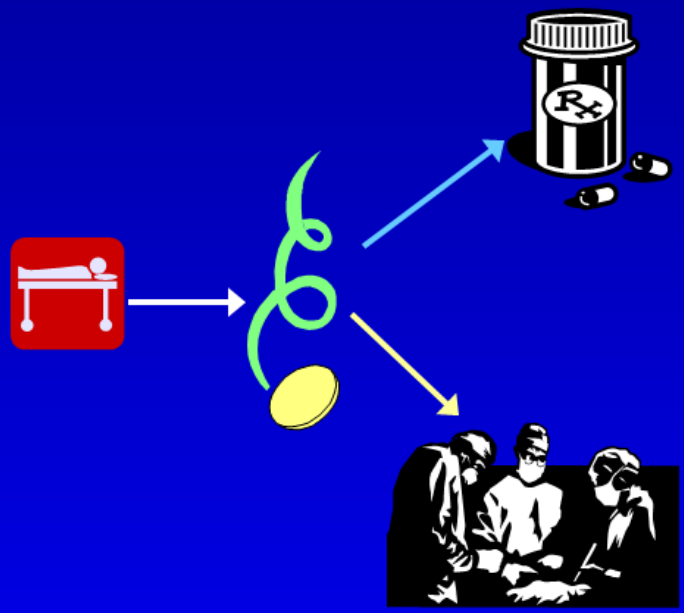
ASA and Mortality in Heart Patients

- Designing the Study

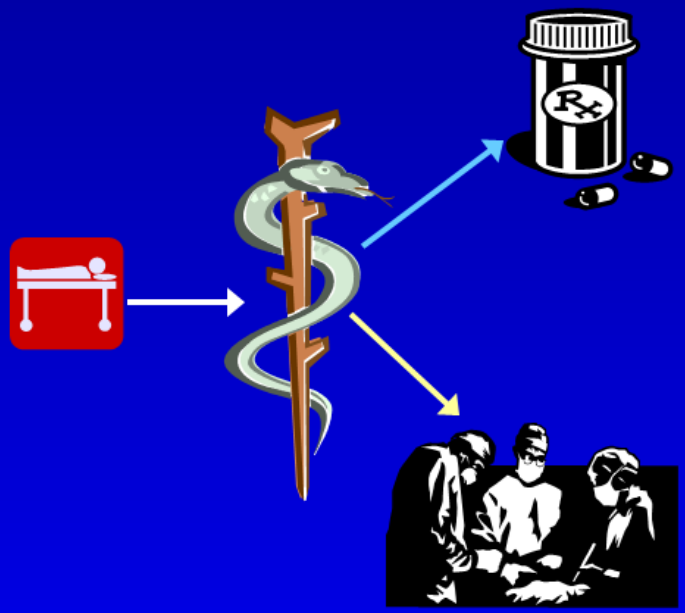
We want to understand aspirin's effect on all-cause five-year mortality among patients undergoing stress echocardiography.

- But what if we **cannot** do an RCT?

Randomized vs. Observational Studies



Randomization ensures that subjects receiving different treatments are comparable.



In observational studies, the researcher does not randomly allocate the treatments.

ASA & Mortality: **Observational Study**

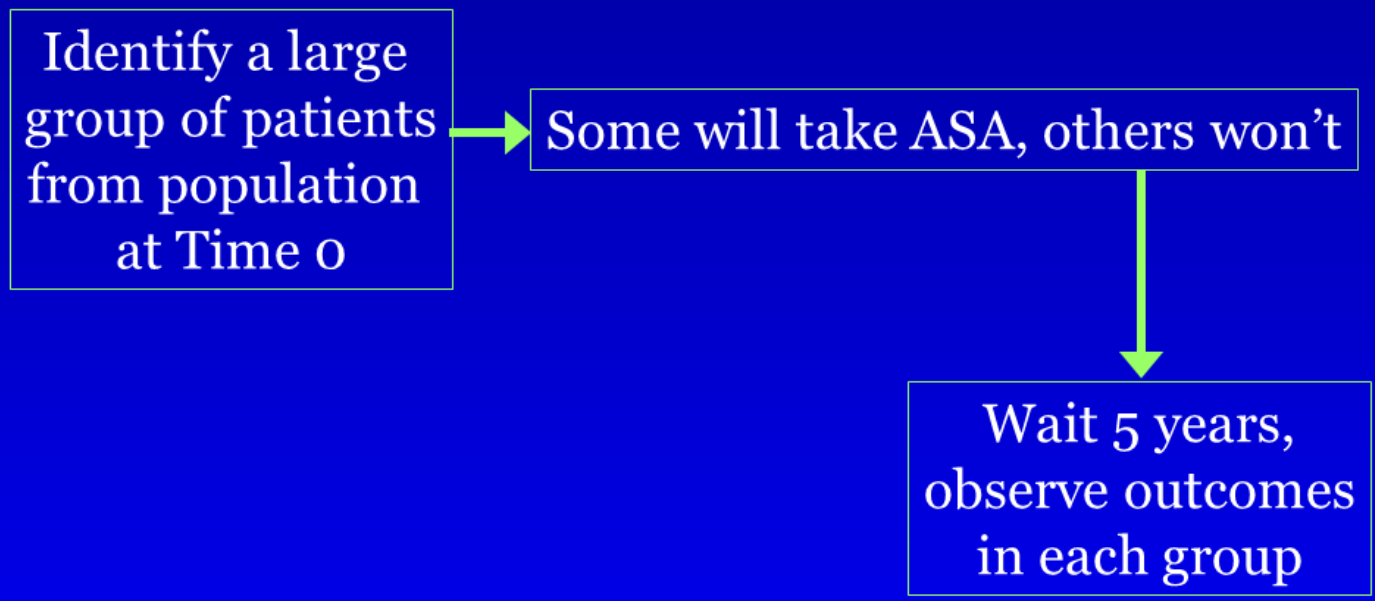
Identify a large group of patients from population at Time 0

ASA & Mortality: **Observational Study**

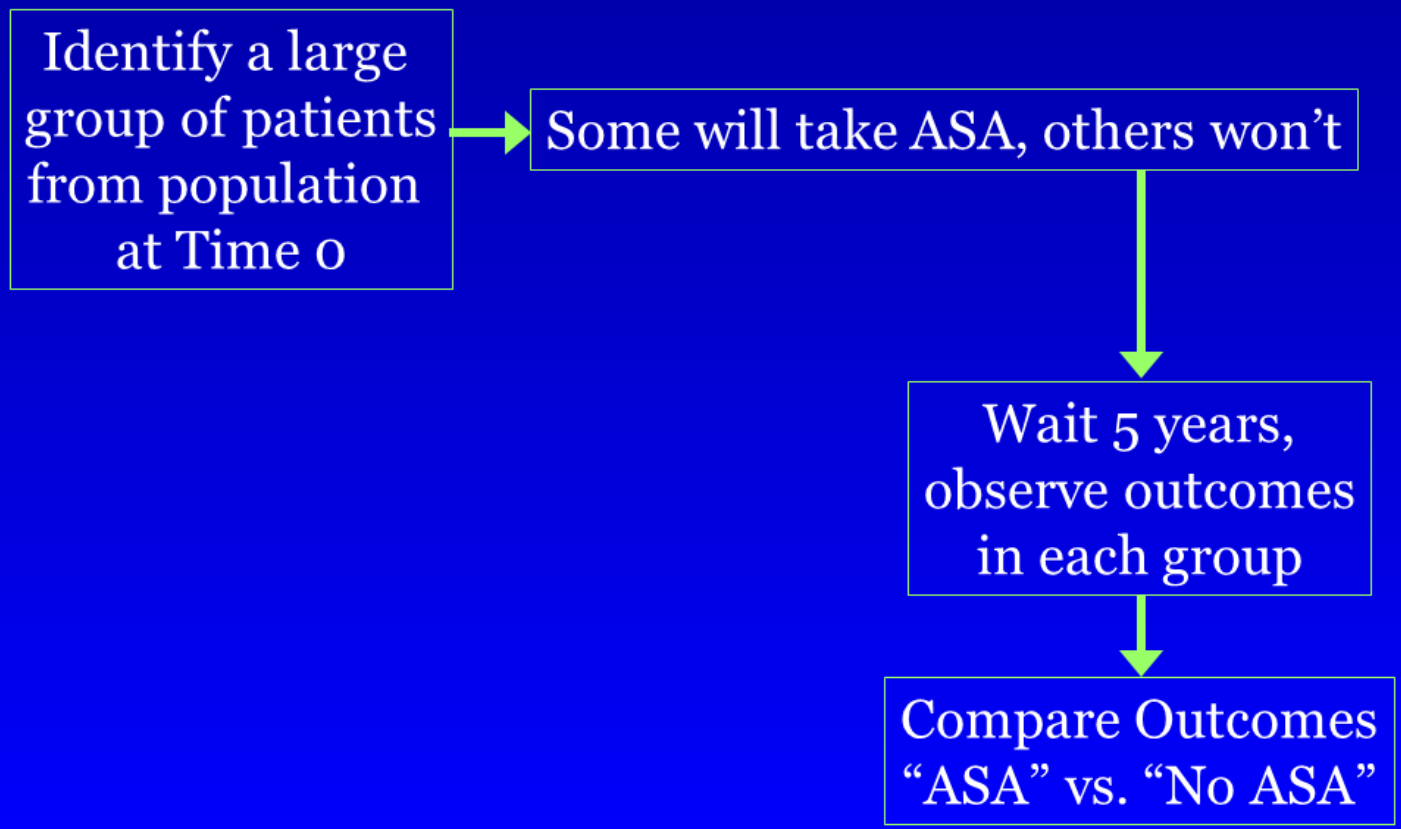
Identify a large group of patients from population at Time 0

→ Some will take ASA, others won't

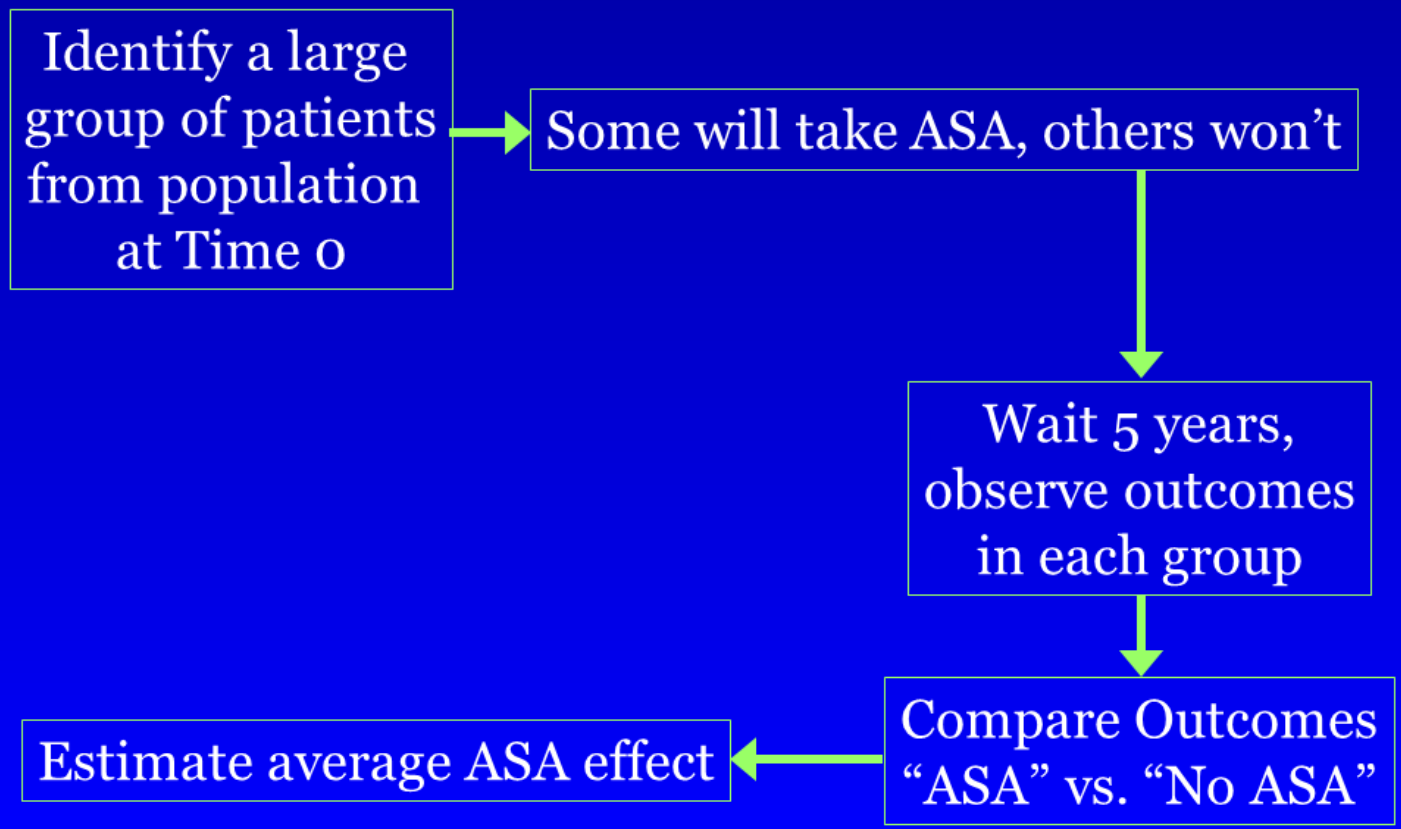
ASA & Mortality: **Observational Study**



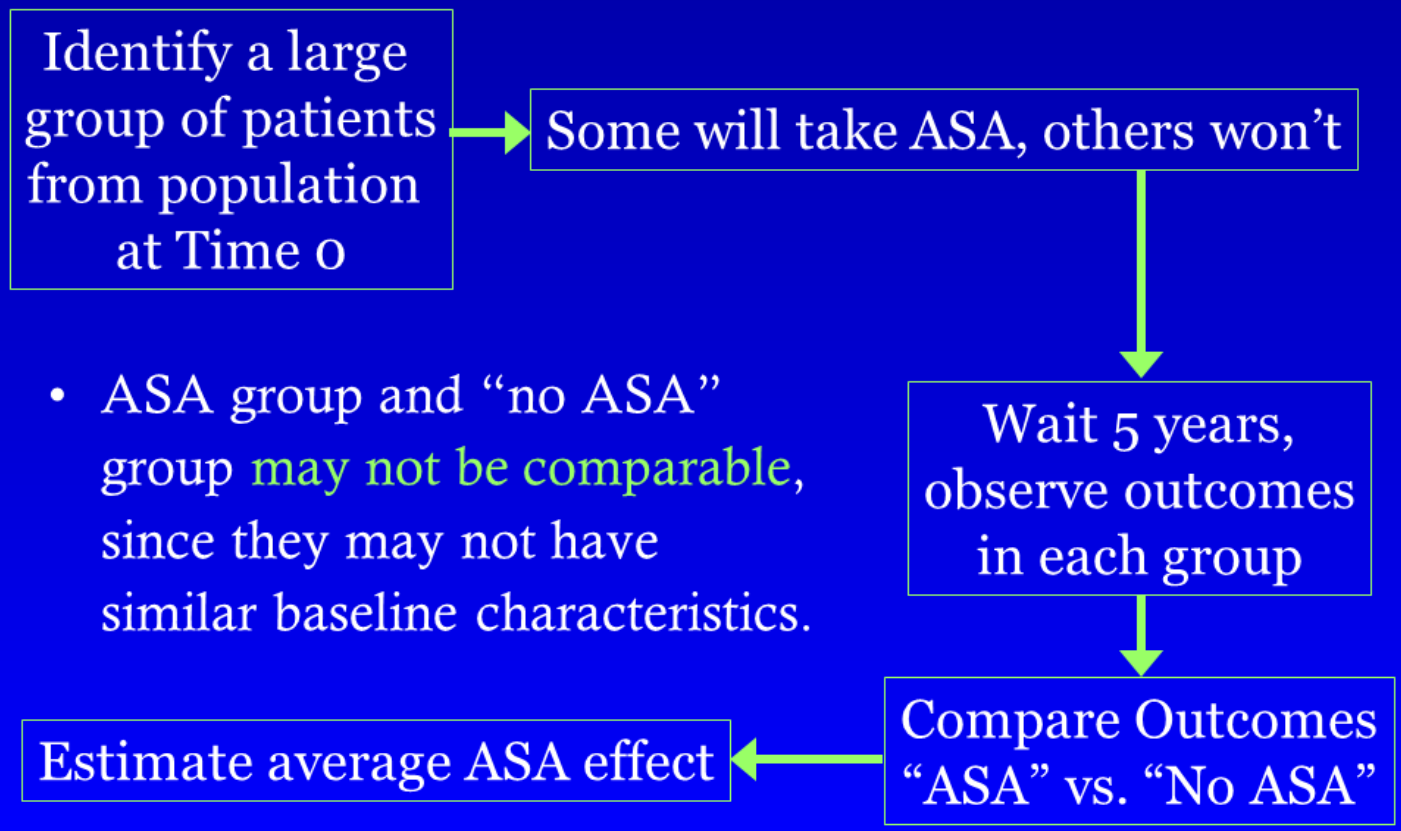
ASA & Mortality: **Observational Study**



ASA & Mortality: **Observational Study**



ASA & Mortality: **Observational Study**



- ASA group and "no ASA" group may not be comparable, since they may not have similar baseline characteristics.

How Do We Avoid Being Misled?

- What differentiates an observational study from a randomized controlled trial?
  - One key element: potential for selection bias.
- What is selection bias and what can we do about it?
  - Baseline characteristics of comparison groups are different in ways that affect the outcome.

We will often distinguish between overt and hidden bias.

- Overt Bias (seen in data - propensity scores can help)
- Hidden Bias (required data not collected - requires sensitivity analyses)

Aspirin Use and Mortality - The Real Study

6174 consecutive adults at CCF undergoing stress echocardiography for evaluation of known or suspected coronary disease[1].

- 2310 (37%) were taking aspirin (treatment).
- Main Outcome: all-cause mortality
  - Median follow-up: 3.1 years
- Univariate Analysis: 4.5% of aspirin patients died, and 4.5% of non-aspirin patients died.
  - Unadjusted Hazard Ratio: 1.08 (0.85, 1.39)

More on this study to come.

[1] Gum PA et al. Aspirin use and all-cause mortality among patients being evaluated for known or suspected coronary artery disease: A propensity analysis JAMA 2001 Sep 12; 286(10): 1187-94. https://pubmed.ncbi.nlm.nih.gov/11559263/

Section 2

Next Time...

Recorded Lecture 2

- How Can We Avoid Being Misled by Observational Studies?
  - What is **selection bias** and why should I care about it?
  - What can be done to deal with selection bias in observational studies?
- What is a propensity score, and how do we ...
  - estimate it,
  - see how well it's working, and
  - use it to estimate causal effects?

The slides I use will be posted to the Class 02 README.

Next Zoom - Thursday 2025-01-23

We'll meet via Zoom from 10 to 11:00 AM. Key things we'll discuss include:

- Lab 0
- Welcome to 500 survey
- Rosenbaum (2023) Chapters 1-3
- STROBE statement Items 13-21
- Abramson Chapter 2
- McGowan blog post
- Bradford Hill (1965)