Clinical Trials: Highlights from Design to Conduct

Masha Kocherginsky, PhD
Biostatistics Collaboration Center
Department of Preventive Medicine
Statistically Speaking ...

What’s next?

Friday, October 21
Clinical Trials: Highlights from Design to Conduct Masha Kocherginsky, PhD, Associate Professor, Division of Biostatistics, Department of Preventive Medicine

Tuesday, October 25
Finding Signals in Big Data Kwang-Youn A. Kim, PhD, Assistant Professor, Division of Biostatistics, Department of Preventive Medicine

Friday, October 28
Enhancing Rigor and Transparency in Research: Adopting Tools that Support Reproducible Research Leah J. Welty, PhD, BCC Director, Associate Professor, Division of Biostatistics, Department of Preventive Medicine

All lectures will be held from noon to 1 pm in Hughes Auditorium, Robert H. Lurie Medical Research Center, 303 E. Superior St.
BCC: Biostatistics Collaboration Center

Who We Are

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BCC Director

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   Senior Stat. Analyst
2. Tameka L. Brannon
   Financial | Research
   Administrator

Biostatistics Collaboration Center | 680 N. Lake Shore Drive, Suite 1400 | Chicago, IL 60611
BCC: Biostatistics Collaboration Center

What We Do

Our mission is to support FSM investigators in the conduct of high-quality, innovative health-related research by providing expertise in biostatistics, statistical programming, and data management.
BCC: Biostatistics Collaboration Center

How We Do It

Are you writing a grant?

**YES**

- We provide:
  - Study Design
  - Analysis Plan
  - Power Sample Size

  BCC faculty serve as Co-Investigators; analysts serve as Biostatisticians.

**NO**

Short or long term collaboration?

**Short**

- Recharge Model (hourly rate)

**Long**

- Subscription Model (salary support)

The BCC recommends requesting grant support at least **6-8 weeks** before submission deadline.

Statistical support for **Cancer-related** projects or **Lurie Children’s** should be triaged through their available resources.

Every investigator is provided a **FREE** initial consultation of up to 2 hours with BCC faculty of staff.

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How can you contact us?

- **Request an Appointment**
  - [http://www.feinberg.northwestern.edu/sites/bcc/contact-us/request-form.html](http://www.feinberg.northwestern.edu/sites/bcc/contact-us/request-form.html)

- **General Inquiries**
  - [bcc@northwestern.edu](mailto:bcc@northwestern.edu)
  - 312.503.2288

- **Visit Our Website**
  - [http://www.feinberg.northwestern.edu/sites/bcc/index.html](http://www.feinberg.northwestern.edu/sites/bcc/index.html)
What we’ll be talking about today
Outline

• What is a clinical trial?
• Why a clinical trial?
• What do we think of when we hear “clinical trial”?
• Highlights of clinical trial design and conduct:
  – What’s the big question?
  – Choosing endpoints
  – Clinical trial phases and designs
  – Logistics
• Conclusions
What is a clinical trial?
What Is a Clinical Trial?

NIH Definition (October 23, 2014, NOT-OD-15-015)

A research study in which one or more human subjects are prospectively assigned to one or more interventions (which may include placebo or other control) to evaluate the effects of those interventions on health-related biomedical or behavioral outcomes.
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– Research means a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge.

45 CFR 46.102(d)
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- **Human subject** means a living individual about whom an investigator (whether professional or student) conducting research obtains
  (1) data through intervention or interaction with the individual, or
  (2) identifiable private information

45 CFR 46.102(d)
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− **Prospectively assigned** refers to a pre-defined process (e.g., randomization) specified in an approved protocol that stipulates the assignment of research subjects (individually or in clusters) to one or more arms (e.g., intervention, placebo, or other control) of a clinical trial.

− **Note: all subjects in a trial could be assigned to the same intervention (single arm trials)**
What Is a Clinical Trial?

NIH Definition (October 23, 2014, NOT-OD-15-015)

A research study in which one or more human subjects are prospectively assigned to one or more interventions (which may include placebo or other control) to evaluate the effects of those interventions on health-related biomedical or behavioral outcomes.

- Intervention - a manipulation of the subject or subject’s environment for the purpose of modifying one or more health-related biomedical or behavioral processes and/or endpoints. Examples include:
  - drugs
  - biologics
  - devices
  - procedures (e.g., surgical techniques)
  - delivery systems (e.g., telemedicine, face-to-face interviews)

  - strategies to change health-related behavior (e.g., diet, cognitive therapy, exercise)
  - prevention strategies
  - diagnostic strategies
What Is a Clinical Trial?

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A research study in which one or more human subjects are prospectively assigned to one or more interventions (which may include placebo or other control) to evaluate the effects of those interventions on health-related biomedical or behavioral outcomes.

- **Health-related biomedical or behavioral outcome** - pre-specified goal(s) or condition(s) that reflect the effect of the intervention on human subjects’ biomedical or behavioral status or quality of life.

- Examples include changes in:
  - physiological or biological parameters (e.g., improvement of lung capacity, gene expression)
  - psychological outcomes (e.g. mood management intervention in smokers)
  - neurodevelopmental outcomes (e.g. school performance in children)
  - disease processes
  - health-related behaviors
  - quality of life
Classification of clinical research


Figure 1: Algorithm for classification of types of clinical research
Why a clinical trial?
Clinical Trials vs. Other Study Designs

• Other types of studies include:
  – Case reports and anecdotal evidence
  – Case series and observational studies
  – Database analyses
  – Case-control studies
  – Prospective cohort studies

• A variety of limitations:
  – selection bias
  – lack of appropriate controls
  – recall bias (retrospective assessment)
  – confounding

• Clinical trials:
  – prospective and planned
  – assign treatment by design
  – eliminate many biases via randomization, blinding, and appropriate controls
Example: Women’s Health Initiative (WHI) trials

- Leading causes of mortality and morbidity among postmenopausal women:
  - osteoporosis
  - cardiovascular disease (CHD)
  - cancer

- Age-related estrogen deficiency believed to play a role

- Based on observational studies, hormone replacement therapy (HRT) was widely used for disease prevention via treatment of postmenopausal estrogen deficiency

- 1991: NIH policy to require inclusion of women in clinical research
Example: Women’s Health Initiative (WHI) trials

- Women’s Health Initiative (WHI) was initiated by NIH, and conducted three large randomized controlled prevention clinical trials
  - Postmenopausal women, age 50-79, 40 clinical centers
  - 15 years, $625M funding, >112,000 women enrolled
  - Findings:
    - HRT increased risk of CHD, stroke and dementia, breast cancer
    - No effect on overall mortality
    - Many of the original hypotheses were not supported by the clinical trials
    - Overall risks far outweigh the benefits
  - Dramatic reduction in HRT use, followed by reduction in breast cancer rates
  - $37.1B return on investment (reduction in health expenditure and better quality adjusted life-years)
What do we think of when we hear “clinical trial”? 
What do we think of when we hear “clinical trial”?

- Clinical trials frequently get reported in the news
  - Large trials
  - Expensive trials
  - Or when things go wrong
Drug Development Cycle

Time in years

0 1 2 3 4 5 6 7 8 9 10 11

BASIC RESEARCH | DRUG DISCOVERY | PRE-CLINICAL | CLINICAL TRIALS | FDA REVIEW | POST-APPROVAL RESEARCH & MONITORING

PHASE I | PHASE II | PHASE III | PHASE IV

POTENTIAL NEW MEDICINES

IND SUBMITTED | NUMBER OF VOLUNTEERS | FDA APPROVAL

TENS | HUNDREDS | THOUSANDS | NDA/BLA SUBMITTED


* The average R&D cost required to bring a new, FDA-approved medicine to patients is estimated to be $2.6 billion over the past decade (in 2013 dollars), including the cost of the many potential medicines that do not make it through to FDA approval.

Drug development is expensive and time-consuming (10-12 years)
Clinical trials are the longest and most expensive component
Most drugs fail in larger clinical trials

“The average R&D cost required to bring a new, FDA-approved medicine to patients is estimated to be $2.6 billion over the past decade (in 2013 dollars), including the cost of the many potential medicines that do not make it through to the FDA approval.”
ClinicalTrials.gov: 183,164 registered trials globally

<table>
<thead>
<tr>
<th>Study and Intervention Type (as of October 18, 2016)</th>
<th>Number of Registered Studies and Percentage of Total</th>
<th>Number of Studies With Posted Results and Percentage of Total***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>228,174</td>
<td>22,874</td>
</tr>
<tr>
<td>Interventional</td>
<td>183,164</td>
<td>21,363 (93%)</td>
</tr>
<tr>
<td>Drug or biologic</td>
<td>112,204 (61%)</td>
<td>17,274</td>
</tr>
<tr>
<td>Behavioral, other</td>
<td>53,287 (29%)</td>
<td>3,484</td>
</tr>
<tr>
<td>Surgical procedure</td>
<td>19,845 (11%)</td>
<td>1,106</td>
</tr>
<tr>
<td>Device**</td>
<td>21,051 (11%)</td>
<td>2,435</td>
</tr>
<tr>
<td>Observational</td>
<td>43,972</td>
<td>1,511 (6%)</td>
</tr>
<tr>
<td>Expanded Access</td>
<td>367</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Registered trials that are currently recruiting patients (N=40,072)

The chart below shows the distribution of locations for recruiting studies registered on ClinicalTrials.gov.

Percentage of Recruiting Studies by Location (as of October 18, 2016)
Total N = 40,072 studies

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Recruiting Studies and Percentage of Total (as of October 18, 2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-U.S. only</td>
<td>22,331 (56%)</td>
</tr>
<tr>
<td>U.S. only</td>
<td>15,581 (39%)</td>
</tr>
<tr>
<td>Both U.S. and non-U.S.</td>
<td>2,160 (5%)</td>
</tr>
<tr>
<td>Total</td>
<td>40,072</td>
</tr>
</tbody>
</table>
How do we design and conduct clinical trials?
Investigator-initiated trials (IIT)

- We are an academic medical center, not a pharma or medical device company
- Industry clinical trials
  - Typically designed and developed by pharma
  - Hospitals (such as NM) are asked to join as one of the sites
  - Can accept or decline participation, but usually little say in study design
- Investigator-initiated trials (IIT)
  - If you are designing a trial, it will likely be an IIT
  - Can still be supported by industry (financial support or drug supply)
  - Why?
    - New ways of using or combining existing treatments or regimens
    - Evaluate new technologies developed at a research institution
    - Comparison of competitor treatments
Example of an Investigator-initiated trial:

• Drug interaction clinical trial
  • Grapefruit juice is known to interact with many drugs
  • Usually it’s a problem, but we thought “Why not decrease the drug dose?”
  • ~150 patients enrolled in a series of Phase I trials; looked at PK
  • Were able to reduce the dose of sirolimus (cancer drug) from 90mg/week (effective dose) to about 25-35mg
  • Fewer side effects and cheaper
Key steps in designing and conducting a clinical trial?

• Ethics and patient protection (IRB)
• What’s the Big Question?
• Clinical trial designs
• Study Logistics
  – Recruitment and retainment
  – Treatment administration
  – Safety monitoring
  – Follow-up
• Data: collection, storage and safety
• ClinicalTrials.gov registry
• Data analysis and interpretation of the results
Ethics in clinical trials

• Conflicting goals of gaining scientific knowledge and helping the patient
  • and sometimes from financial or other conflicts of interest

• Clinical trials are and ethically appropriate way to acquire new knowledge

• Aspects of ethical conduct of clinical trials:
  – Randomization
    • when there is genuine uncertainty about the best treatment (equipoise)
  – Informed consent (IC)
    • informs of the potential risks and benefits of study participation, and of
      alternatives and the voluntary nature of participation
  – Confidentiality
    • privacy of personal health information (PHI and HIPAA)
  – Interim monitoring
    • ability to stop trial early for safety, futility or efficacy (especially larger trials)
Institutional Review Board (IRB)

• “The IRB Office is primarily responsible for developing and directing the University’s Human Subject Protection Program (HSPP) [...]. The HSPP mission is to be a model program of excellence in protecting the rights and welfare of human subjects involved in research.”

• Northwestern IRB Web site contains useful resources, including:
  – Good Clinical Practice (GCP) document
  – Information on submitting protocols for review
  – Templates of clinical trial protocols, consent forms and letters to subjects
  – Guidelines on recruitment materials

• Register in eIRB+ which is Northwestern University’s electronic submission and review system for human subjects research projects

• http://www.irb.northwestern.edu
What’s the Big Question?
How to form an answerable clinical question?

- **PICO(T)** – approach for summarizing research questions
  - **(P)** – patient population (among.....)
    - Among postmenopausal women
  - **(I)** – intervention (does....)
    - Among postmenopausal women, does hormone replacement therapy (HRT)
  - **(C)** – comparison (versus ....)
    - Among postmenopausal women, does hormone replacement therapy (HRT) vs the standard of care (placebo)
  - **(O)** – outcome (affect...)
    - Among postmenopausal women, does hormone replacement therapy (HRT) vs the standard of care (placebo) reduce the risk of coronary heart disease?
  - **(T)** – time (duration of study and data collection)

- Cincinnati Children’s hospital tutorial on “How to Form and Answerable Clinical Question”
Primary and secondary objectives and endpoints

• Clinical trials must have a primary objective and a primary endpoint
  – **Objectives** are study goals
    • To assess the major health benefits and risks of the most commonly used combined hormone preparation in the United States.
  – **Endpoints** are quantitative outcome measures
    • The primary endpoint was coronary heart disease (CHD) (nonfatal myocardial infarction and CHD death), with invasive breast cancer as the primary adverse outcome.
  – Objectives and endpoints should be **clearly defined** in the study protocol
Hierarchy of Clinical Trial Objectives

• **Primary objective/endpoint:**
  – Usually just one
  – Power and sample size are based on this outcome

• **Secondary objective(s)/endpoint(s):**
  – Usually several planned and pre-specified secondary objectives
  – Less weight
  – Don’t pick too many!

• **Exploratory objective(s)/endpoint(s):**
  – Exploratory and hypothesis-generating
  – Often evaluating non-validated biomarkers, sub-studies, etc.

• **SAFETY outcomes:**
  – Always collected/reported (especially adverse event (AE))
Choosing the Primary Endpoint: Cancer Trials Example

• In cancer, the ultimate outcome of interest is overall survival (OS)
  – Poor-prognosis cancers: events (deaths) can be observed during the trial → OS may be a feasible primary outcome
  – Better-prognosis cancers: longer-term survival → OS is not a feasible primary outcome

• Treatment may still have other benefits, for example:
  – Shrink or stabilize tumors
  – Delay tumor growth
  – Improve a biomarker (e.g. CA-125 in ovarian cancer)
Choosing the Primary Endpoint: Cancer Trials Example

• Such endpoints are called **surrogate endpoints**:  
  – A measure of the effect of a treatment that correlates with a real clinical endpoint  
  – May be used instead of real endpoints (e.g. OS)  
  – Trial results can be obtained sooner (may allow earlier approval – *can be good or bad*)  
  – **But**: surrogate endpoints are not always true indicators of how well a treatment works; they must be validated
Choosing the Primary Endpoint: Cancer Trials Example

- What is the most clinically relevant endpoint, and can we use it?

- If not, is there a well-validated surrogate endpoint?
  - E.g. tumor response and progression-free survival (PFS) are validated surrogate endpoints in cancer

- How is the endpoint measured?
  - Tumor size is measured by radiographic imaging using RECIST criteria
  - Inter-rater variability in tumor diameter measurements?
  - Continuous tumor size vs. standard response categories *(complete (CR) or partial (PR) response, stable (SD) or progressive (PD) disease)*?
  - PFS – also based on RECIST
Choosing the Primary Endpoint: Cancer Trials Example

- **Is the endpoint relevant for the mechanism of action of the treatment?**
  - Historically, most drugs in cancer were cytotoxic (cause tumor shrinkage)
  - Newer drugs stabilize tumor growth (cytostatics) → clinical benefit
  - Immunotherapy (e.g. delayed response in some PD-1/PD-L1 checkpoint inhibitors)?

- **Is the detectable effect size clinically important?**
  - Want a realistic effect size that can be detected, and is it “worth it”
Core outcome sets (COS) for clinical trials

• Heterogeneity in outcomes in other disease areas

• Proposed solution: develop core outcome sets - an agreed, standardized collection of outcomes measured and reported in all trials for a specific disease

• Some COS’s already exist:
  – Rheumatology (OMERACT, since 1992)
  – More than 50 groups have been working on COS including pain, maternity care, and some pediatric specialties
  – COMET Initiative – defined an approach to development of COS’s
  – Check your specific disease area

Get a statistician involved

• Why?
  – Not all questions can be answered with data
  – Not all endpoints are created equal (e.g. some more variable than others)
  – Clinical trial design depends on the objectives and endpoints
  – Sample size and feasibility depend on the design
  – Fancy statistical analyses cannot fix poor study design
  – Because we are fun people (especially Dr. Kwasny)

Get a statistician involved at this early stage!
Clinical trial design
Clinical Trials Phases

• *Pre-clinical – animal and other lab studies*
• Pilot and Feasibility Trials
  – Obtain preliminary data for larger studies
  – Work out logistical details
• Phase I
  – Dose finding – recommended Phase II dose (RP2D)
  – Safety
• Phase II
  – Further evaluation of safety at RP2D
  – Preliminary evidence of efficacy
Clinical Trials Phases

• Phase III
  – Gold standard
  – Safety and Efficacy
  – Usually randomized, parallel control

• Phase IV (post-market)
Design considerations

• Primary endpoint and objective determine design and sample size

• Endpoint data types:
  – Continuous (e.g. blood pressure)
  – Binary (e.g. disappearance of an infection after antibiotic treatment)
  – Time-to-event (e.g. time from randomization to death or to CHD)
  – Other types (count data, ordinal scales, competing risks)

• Continuous endpoints allow more power
  – E.g. comparing time to death (OS) vs. comparing 2-year survival rates
Be prepared

• Preliminary data for the primary endpoint
  – Response rates
  – Median survival
  – Mean and variance

• From where?
  – Your own preliminary data
  – Published literature

• Choose
  – Type I error rate $\alpha$ (pursuing a false positive)
  – Power (missing a promising treatment)
Pilot and feasibility clinical trials

• Why conduct a pilot study?
  – Scientific - obtain preliminary data for larger study design
  – Process – recruitment rates, logistics, time and budget, data collection

• Must have a clear decision rule for a “go-no-go” decision, e.g.:
  – Can we enroll at least 10 pts/month?
  – Is enrollment rate ≥75%?

• Pilot trials need to have well-defined endpoints and objectives, e.g.:
  – Obtaining preliminary data – base the sample size on the desired precision of the estimate (the confidence interval approach)
Phase I

• Typically 10-20 subjects
• Goals: dose finding, typically for safety
• Basic idea: assess toxicity at a variety of doses
• Many ways to do this, depending on the disease setting

• In cancer, “3+3” design is the most common
Phase II

• Typically 30-100 subjects
• Assess efficacy
• Continue safety assessment
• Make the “go-no-go” decision for the subsequent Phase III trial

• Design considerations:
  – Historic controls vs. parallel control arm
  – Single arm vs randomized
  – Play-the-winner design if multiple treatments
  – Multi-stage designs
Phase III

- Usually large randomized controlled trials (100’s or 1000’s of subjects)

- Usually straightforward question, comparing treatments A vs. B
  - Null hypothesis, $H_0$: no differences between A and B
  - Alternative hypothesis, $H_A$: A is better than B by $\geq \delta$ (effect size)
  - Typically $\alpha = 0.05$ (false positives) and 90% power

- Usually must have interim analyses and stopping rules:
  - early stopping rules (futility or efficacy)
  - pre-specified in the design and statistical analysis plan
  - independent Data and Safety Monitoring Board (DSMB)
Randomized Trials: Intent-to-Treat Analysis

• Intent-to-treat analysis - one of most fundamental principles underlying analysis considerations for randomized clinical trials

• Two major elements:
  – Once randomized, always analyzed (regardless of adherence/dropout)
  – Analyzed according to group to which randomized (regardless of adherence)

• ITT allows for unbiased hypothesis testing
Example of an adaptive design

**BATTLE-1 Trial: Biomarker-integrated Approaches of Targeted Therapy for Lung Cancer Elimination**

**Chemorefractory NSCLC**

- Markers assessed:
  - EGFR mut., exons 18-21, Gene copy, high polysomy/amp
  - KRAS mut., codons 12, 13 & 61
  - BRAF mut., exons 11 & 15
  - VEGF protein expression
  - VEGFR2 protein expression
  - RXR α, β, γ protein expression
  - Cyclin-D1 protein expression
  - CCND1, gene amplification
  - No Marker

Nov 2006 - Oct 2009

- Erlotinib (EGFR)
- Vandetanib (VEGFR)
- Erlotinib + Bexarotene (retinoid-EGFR)
- Sorafenib (KRAS/BRAF)

- 341 registered
- 255 randomized
- 244 evaluable
- 45% prior EGFR-TKI

- Primary endpoint: 8-wk disease control (DCR = rate of PR, CR or stable at 8 wks)
- Equal randomization until 40% accrual, then switch to outcome adaptive randomization based on DCR estimates dependent on treatment & markers
- Success: Bayesian estimated Prob[8-week DCR > 30%] > 80% for treatment in a marker subgroup
Additional considerations and Clinical Trial Logistics
Clinical Trial Protocol

• A comprehensive document that describes how a clinical trial will be conducted
• Pre-specifies all objectives, endpoints, design and statistical analysis plan
• Includes:
  – Background and preliminary data
  – Objective, purpose and study rationale
  – Study design
  – Patient population (inclusion/exclusion criteria)
  – Treatment administration details
  – Study assessments (efficacy, safety, adverse events)
  – Statistics (design, sample size, interim monitoring and statistical analysis plan)
  – Other details including ethics, quality control, data management, publication policy, and any relevant supplementary material
Protocol Template from FDA and NIH (Draft, 61 pages)
Study Logistics

• Usually need a study coordinator and a data manager

• Pilot clinical trial to work out logistics details
  – Recruitment
  – Subject retention (establishing a personal relationship or financial incentives)
  – Development of data collection tools
  – Safety monitoring and reporting (regulatory issues and cumulative safety assessment procedures)
  – Follow-up (minimize the loss to follow-up)
Data Management

• We recommend using REDCap: Research Electronic Data Capture
• Web-based application for building and managing research databases
• REDCap Consortium has over 295,000 projects

• Why REDCap?
  – Easy to create data collection forms
  – Web-based data entry and access from multicenter studies
  – Audit trails for tracking history of database and entry
  – Compliant with HIPAA standards for security
  – Free (to the investigator) to use at NU

• Must attend mandatory New Project Owner Intro Session
Please use your most recent available 12-month period for the following questions.

1) Site number
   * must provide value

2) Time Period
   * must provide value

   **< 3 mo.**

   3) # QNS Patients (< 3 mo.)
      * must provide value

   4) Total # Patients Tested (< 3 mo.)
      * must provide value

   5) % QNS (< 3 mo.)

   **> 3 mo.**

   6) # QNS Patients (> 3 mo.)
      * must provide value

   7) Total # Patients Tested (> 3 mo.)
      * must provide value

   8) % QNS (> 3 mo.)

9) Comments
ClinicalTrials.gov - registry and results database

• **ClinicalTrials.gov** is a database of clinical studies of human participants conducted around the world
  – Initial law passed by Congress (1997)
  – NIH Releases ClinicalTrials.gov website (2000)

• Applicable clinical trials must be registered on [www.clinicaltrials.gov](http://www.clinicaltrials.gov)
  – Non-NIH funded trials
    • Drug, biological, and device products and pediatric post-market surveillance (essentially FDA-regulated)
    • Does not apply to phase 1 trials or small feasibility device studies
  – NIH-funded trials
    • **All clinical trials funded NIH** (wholly or partially)
    • Includes Phase 1 clinical trials and trials that do not involve any FDA regulated product such as trials involving only behavioral interventions

• Results must be reported *(within 12 months of study end)*:
  • participant flow information
  • demographics and baseline characteristics of the enrolled participants
  • primary and secondary outcomes, including results of any appropriate statistical tests
  • adverse events
Statistical data analysis

• Clinical trial was well-designed, and statistical analysis plan developed
• Statistical analysis plan is pre-specified

• Statistical analysis should be easy – but it never is!
  – Data quality (late data, missing data, outliers, etc)
  – Protocol deviations
  – Unanticipated problems (e.g. slow accrual)
  – Loss-to-follow-up

• Primary analysis + many more (secondary and exploratory analyses)
• Sensitivity analyses
Conclusions

• Clinical trials:
  – The most definitive method of determining whether an intervention has the postulated effect!
  – Usually a time-consuming and expensive endeavor!
  – Many scientific and logistical details to consider
  – Are a statistics-heavy endeavor, because they are essentially designed experiments, and data will be collected and analyzed

• Team science between clinicians and statisticians to:
  – Refine study objectives and hypotheses
  – Select appropriate endpoints
  – Develop clinical trial design, sample size and statistical analysis plan

Talk to a statistician as early as possible – we can help!
Thank You
Questions?
Statistically Speaking ... 

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