Electronic Health Records and Administrative Claims in Drug Development: Will FDA get beyond the warts to make it worth the effort?

Harry A Guess Memorial Annual Lecture

Cynthia J Girman, DrPH, FISPE
Founder and President
www.CERobs.com

April 27, 2022
Harry Guess, MD, PhD – 1940-2006
A Father of Pharmacoepidemiology
A gentleman and a scholar

*Brilliance with grace, charm, and humor*

**Harry-isms**

- First and foremost, we must do the right thing.
- Science & politics sometimes diverge...
- Does it pass the NY Times <red face> test?

There’s an idea, now here’s a good one....

- What really makes the most sense is not always the path forward....
- Choose your battles...

- Things need to be laid out so anyone with reasonable intelligence can apply it....

Care for a diet coke?
At the outset of careers in science and public health, many feel that they are facing a *choice between applied work, solving practical problems or elegant scholarship*....

*Harry’s entire career was a demonstration that practical problems call for the most refined scholarly thinking, and that academic work is most valuable when there are applications waiting.....* Sue West and Darren Dewalt

- If we do the best we possibly can scientifically, we can defend it. Anything short of that is less believable...

- *Time goes in one direction only....*
Disclosures

Career Experience

- **CERobs Consulting, LLC**: Founder & President

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<thead>
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<th>AbbVie</th>
<th>BPL</th>
<th>Currax</th>
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<th>Outcome Insights</th>
<th>Ritter</th>
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<td>Adgero</td>
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<td>Avenue</td>
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<td>Pfizer</td>
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<td>Boehringer</td>
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<td>Greenleaf</td>
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<td>Regeneron</td>
<td>Urvant</td>
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</table>

- **Merck & Co**: Retired in 2014 after 33 years
  
  Executive Director & Head, Data Analytics & Observational Methods, Center for Observational and Real-World Evidence

- Stockholder of various pharmaceutical & healthcare companies

- Royalties from Elsevier Sciences: Pragmatic Randomized Trials Using Primary Data Collection or Electronic Health Records, Girman CJ, Ritchey ME (editors).

Academic/Professional:

- **UNC Gillings School of Global Public Health**
  - Adjunct Professor, Epidemiology
  - Alum, Biostatistics

- **PCORI: Patient-Centered Outcomes Research Institute**
  - Member of Methodology Committee, 2014-
  - Clinical Trials Advisory Panel, 2016 -

- **ISPE: International Society for Pharmacoepidemiology**
  - Fellow
  - Previous board member
  - Co-lead, RWE & Regulatory Decisions workgroup, ISPE RWE Task Force
Focus

• Real World Data (RWD) to inform product development
• Feasibility of RWD
• FDA perspectives (CDER/CBER) on RWE
• What can industry and academia do?
• Summary
Real World Evidence to Support Drug, Biologic or Device Development

UNDERSTAND THE DISEASE AND PATIENTS

UNDERSTAND CURRENT THERAPIES

UNDERSTAND THE PRE-LAUNCH ENVIRONMENT

UNDERSTAND THE PRODUCT POST-LAUNCH

Phase I-II
Phase I-II
Phase II-III
Phase IV
Effective Epidemiology Strategies to Support Drug Development

“...to understand the **Drug**, it is necessary to understand the **Disease**”

Informing Clinical Trial Planning and Product Development

PRE-DEFINED DISEASE COHORTS FOR PATIENTS WITH PLANNED INDICATION
- Analyses across all phases
- Quick response to safety, regulatory or development questions

Progression over time and background rates:
- Endpoints over time
- AE Background rates
- Risk factors
- External control arms

Feasibility of Inclusion/Exclusion Criteria
- Impact of inclusion / exclusion criterion on N (Consort style)
- Common treatments, dosing, augmentation

Recruitment Strategy
- Geographic pockets with higher disease prevalence
- Diversity and rare disease
Types of Studies Using RWD for Regulatory Purposes

- **External Control Groups**
  - Regulatory approval (esp. rare disease)
- **Post-Marketing Safety**
- **Comparative Effectiveness Research** (propensity score approaches)
- **Case-Control studies**
- **Post-marketing commitments**
- **Studies for new indications/labeling changes**
- **Comparative studies often needed for reimbursement**
- **Regulatory approval (esp. rare disease)**
- **Internal**
- **External Control Groups**
- **Natural history data for context**
- **Drug utilization**
- **Post-Marketing Safety**

**Epidemiology data**
- **Patient characteristics**
  - inform trial design
  - treatment environment

**Pragmatic (Hybrid) Randomized Trials**

**SLRs RCTs**

**www.cerobs.com**

Comparative studies often needed for reimbursement.
Food and Drug Administration RWE Program

- 21st Century Cures Act mandated FDA to explore using RWD to improve efficiency and expedite patient access to effective products
  - Views on RWD and RWE at FDA vary widely; RWE advocates to clinical trial purists
  - Randomized (and blinded) trials will always be considered the gold standard

- Duke Margolis “Characterizing RWD Quality & Relevancy for Regulatory Purposes” Oct 2018
  - [https://healthpolicy.duke.edu/sites/default/files/atoms/files/characterizing_rwd.pdf](https://healthpolicy.duke.edu/sites/default/files/atoms/files/characterizing_rwd.pdf)

- Framework for FDA’s RWE program – Dec 2018
  - [https://www.fda.gov/media/120060/download](https://www.fda.gov/media/120060/download)

- Assessing EHR and Claims data to support regulatory decisions – Sept 2021
  - [Assessing Electronic Health Records and Medical Claims Data To Support Regulatory Decision-Making for Drug and Biological Products](https://www.fda.gov/media/120060/download)
Data Relevancy (Framework)

**Availability of key data elements**
- Population
- Exposures
- Outcome(s)
- Covariates

**Representativeness**
- Do patients reflect those who will use product?
- Data from other countries/healthcare systems relevant?

**Sufficient subjects**
- Sufficient persons and follow-up time (person-time) to detect treatment effect?

**Longitudinal data**
- Can patients be followed for outcome over time?

Data Quality (Framework)

**Accuracy**
- Validity of data elements and algorithms
- Conforms to internal standards / external data models
- Plausibility – e.g., range of labs
- Consistency (related data fields and over time)

**Completeness**
- Extent & mechanism of missingness
- Potential bias due to missingness
- Methods to compensate

**Provenance**
- Documentation of inputs and systems
- Processes from source to analytic file

**Transparency of data processing/QA**


Girman – HGML 4/27/2022
“Fit For Purpose”
Tools matched to specific research question and regulatory needs

RWE Study design, RWD data quality & adequacy of data capture

“fit for the specific research question and regulatory purpose”

From Duke-Margolis White Paper

“Determining if a real-world dataset is fit-for-regulatory-purpose is a contextual exercise....”


Ritchey ME, Girman CJ. Evaluating the feasibility of using electronic health records or administrative claims for specific research questions or regulatory purposes. Ther Innov Reg Sci 2020; doi.org/10.1007/s43441-020-00139-x.
Is RWD FIT FOR PURPOSE?

Feasibility

Population identifiable?

Data quality adequate / missing data minimized?

Study design/ analysis adequate for research question?

Exposure Defined Adequately?

Biases mitigated by design/ methods, addressed by QBA, sensitivity analyses?

Outcomes Validly Ascertained?

Effect size large enough to detect?

RWD Strategy

Overall Product Development Strategy

Components of Feasibility

Biases mitigated by design/ methods, addressed by QBA, sensitivity analyses?

Study design/ analysis adequate for research question?

Data quality adequate / missing data minimized?

Exposure Defined Adequately?

Population identifiable?

Outcomes Validly Ascertained?

Effect size large enough to detect?


Ritchey ME, Girman CJ. Evaluating the feasibility of using electronic health records or administrative claims for specific research questions or regulatory purposes. *Ther Innov Reg Sci* 2020; doi.org/10.1007/s43441-020-00139-x

Girman – HGML 4/27/2022
Feasibility: Adequate Capture of Critical Data Elements

Sources:
Ritchey ME, Girman CJ. Evaluating the feasibility of using electronic health records or administrative claims for specific research questions or regulatory purposes. Ther Innov Reg Sci 2020; doi.org/10.1007/s43441-020-00139-x.
Is RWD FIT FOR PURPOSE?

- Population identifiable?
- Data quality adequate / missing data minimized?
- Exposure Defined Adequately?
- Outcomes Be Validly Ascertained?
- Study design/ analysis adequate for research question?
- Biases mitigated by design/ methods, addressed by QBA, sensitivity analyses?
- Effect size large enough to detect?


Ritchey ME, Girman CJ. Evaluating the feasibility of using electronic health records or administrative claims for specific research questions or regulatory purposes. *Ther Innov Reg Sci* 2020; doi.org/10.1007/s43441-020-00139-x

Girman – HGML 4/27/2022
Effect Sizes in RWE Often Smaller than RCTs

Practical Issues

- Usually an active comparator, not placebo
- Less control of dosing and titration

Noisier

- Broader population (disease severity, comorbidities, concomitant medications)
- More loss to follow-up
- Less compliance to protocol and medication adherence

- Is effect size large enough to detect despite the noise, or is it a non-inferiority study?
Selection bias
- Restrict to responders or persistent users
- Population does not reflect product label

Time-related biases
- Restrict by follow-up time, use follow-up info for eligibility or apply different start of follow-up
- Deaths, censoring events not accounted for

Misclassification
- Misclassification (outcomes, exposure, population)
- Sensitivity analyses / quantitative bias analysis

Confounding
- Can you balance the measured confounders between groups?
- PS or weighted approaches and metrics to assess balance

Are Biases Minimized?
by design and/or analysis

**FDA has a strong preference for randomization**

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How **Justify** to FDA that RWD is “Fit-For-Purpose”? Can We Learn from Other Areas?

**Parallels with Clinical Outcome Assessments (COAs) & Patient Reported Outcomes (PROs)**

2018-2022   PFDD GUIDANCES issued by FDA
2010-2017   C-PATH INITIATIVE
2010-2017   Clinical Outcome Assessment Terminology
2010-2017   Process for Development and Validation of PROs refined
2009   **FINAL PRO GUIDANCE** issued by FDA
2006-2009   Significant feedback given to FDA
2006   **DRAFT PRO GUIDANCE** issued by SEALD division of FDA (Chantilly, VA meeting)
2005   QOL Expert Donald Patrick (UWa) sabbatical at FDA
2000-2005   ISOQOL and Community of QOL researchers attempt to standardize approaches

<1990’s – the “Wild West” – Investigators and Sponsors ‘made up’ questionnaires for trials
## Justifying Fit-for-Purpose for Labeling - COA/PROs vs RWE

### COA/PRO Process to Justify Fit-for-Purpose

- Request FDA meeting to discuss COA/PRO in context of specific labeling claim
- Briefing document
  - Trial design, hypothesis/endpoint hierarchy, trial population, draft protocol synopsis, SAP
  - Justify COA/PROs fit-for-purpose to support claims / new indication
    - Meaningfulness/relevance to patients (content validity)
    - Interpretability / comprehension to patients
    - Reliability
    - Construct validity (correlation with clinical measures)
    - Responder definition
- FDA-Sponsor meeting to discuss how COA/PRO supports indication/claim
- Revise COA/PRO plans as needed; include in ph III
- Submit NDA with COA/PRO results and labeling

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## Justifying Fit-for-Purpose for Labeling - COA/PROs vs RWE

<table>
<thead>
<tr>
<th>COA/PRO Process to Justify Fit-for-Purpose</th>
<th>RWE Possible process to Justify Fit-for-Purpose</th>
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<tbody>
<tr>
<td>✓ Request FDA meeting to discuss COA/PRO in context of specific desired labeling</td>
<td>✓ Request FDA meeting to discuss RWE in context of specific new indication/labeling</td>
</tr>
<tr>
<td>✓ Briefing document</td>
<td>✓ Briefing document</td>
</tr>
<tr>
<td>✓ Trial design, hypothesis/endpoint hierarchy, trial population, draft protocol synopsis, SAP</td>
<td>✓ RWE study design, hypothesis hierarchy, study population, draft synopsis, SAP (confounding)</td>
</tr>
<tr>
<td>✓ Justify adequacy (fit-for-purpose) of COA/PROs to support the specific claims/new indication</td>
<td>✓ Justify adequacy (fit-for-purpose) of RWE to support the specific claims/new indication</td>
</tr>
<tr>
<td>✓ Meaningfulness/relevance to patients (content validity)</td>
<td>✓ Data capture adequate, meaningful &amp; relevant</td>
</tr>
<tr>
<td>✓ Easily interpreted / comprehended by patients</td>
<td>✓ Data captured can be interpreted, quality assurance</td>
</tr>
<tr>
<td>✓ Reliability</td>
<td>✓ Reliability</td>
</tr>
<tr>
<td>✓ Construct validity (correlation with clinical measures)</td>
<td>✓ Outcome ascertainment and validity</td>
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<tr>
<td>✓ Responder definition</td>
<td>✓ Ability to detect effect size</td>
</tr>
<tr>
<td>✓ FDA-Sponsor meeting to discuss how COA/PRO supports indication/claim</td>
<td>✓ FDA-Sponsor meeting to discuss how study supports indication/claim</td>
</tr>
<tr>
<td>✓ Revise COA/PRO plans, include in phase 3</td>
<td>✓ Revise and resubmit protocol</td>
</tr>
<tr>
<td>✓ Submit sNDA with COA/PRO results and labeling</td>
<td>✓ Submit sNDA with RWE results and labeling</td>
</tr>
</tbody>
</table>

Girman, Ritchey, McNeill, Sundell, Meyer. Demonstrating that Real World Evidence is Fit-For-Purpose to Support Labeling: Parallels to Patient Reported Outcomes in the Pursuit of Labeling Claims. Ther Innov Reg Sci 2021; https://doi.org/10.1007/s43441-020-00252-x
Foundational and Fundamental to Believability

→ A rigorous pre-specified formal protocol and statistical analysis plan

Protocol template

- Rationale & Objectives clearly stated
- **Unambiguous pre-specified hypotheses**
- Study design details
- Outcomes clearly defined (with validated operational algorithms)
- **Exposure** (handling of switch, discontinuation, augmentation)
- **Target population** (inclusion, exclusion, time window of interest)
- Data source description and features; algorithms to define population

- Detailed operational definitions and data extraction procedures
- Statistical methods; handling of potential biases and therapy changes during trial, sample size justification, analysis population
- **Handling of multiplicity** – comparisons, tests, timepoints, methods
- **Sensitivity analyses**
- **Bias quantification**
- Replication
It’s Truly a Balancing Act!

Assessment of feasibility involves a balance among the data availability and adequacy for the research question at hand, the anticipated treatment effect, potential bias and the available sample size.

Sufficient sample size
Anticipated treatment effect size

Potential for bias
Right-sized study

Adequacy of data

Source:

Therapeutic Innovation & Regulatory Science
https://doi.org/10.1007/s43441-020-00139-x

Original Research

Evaluating the Feasibility of Electronic Health Records and Claims Data Sources for Specific Research Purposes

Mary E. Ritchey, PhD, FISPE; Cynthia J. Girman, DrPH, FISPE

Girman – HGML 4/27/2022
Is the RWD source and RWE study Fit-For-Purpose?


Ritchey ME, Girman CJ. Evaluating the feasibility of using electronic health records or administrative claims for specific research questions or regulatory purposes. *Ther Innov Reg Sci* 2020; doi.org/10.1007/s43441-020-00139-x
Real-World Data: Assessing Electronic Health Records and Medical Claims Data To Support Regulatory Decision-Making for Drug and Biological Products

Guidance for Industry

DRAFT GUIDANCE

This guidance document is being distributed for comment purposes only.

Comments and suggestions regarding this draft document should be submitted within 60 days of publication in the Federal Register of the notice announcing the availability of the draft guidance. Submit electronic comments to https://www.regulations.gov. Submit written comments to the Dockets Management Staff (HFA-305), Food and Drug Administration, 5630 Fishers Lane, Rm. 1061, Rockville, MD 20852. All comments should be identified with the docket number listed in the notice of availability that publishes in the Federal Register.

For questions regarding this draft document or the RealWorld Evidence Program, please email CDERMedicalPolicy-RealWorldEvidence@fda.hhs.gov

U.S. Department of Health and Human Services
Food and Drug Administration
Center for Drug Evaluation and Research (CDER)
Center for Biologics Evaluation and Research (CBER)
Oncology Center of Excellence (OCE)

September 2021
Real World Data/Real World Evidence (RWD/RWE)
• Adequacy and relevance of RWD to address specific research questions, validation, QA/data quality/provenance of data elements

• Study design and analytic techniques, including handling of confounding, to be addressed in a forthcoming guidance

• Not limited to new product indications or labeling changes, nor to non-interventional studies. Encompasses RCTs in EHR/claims

• Tries to incorporate many RCT inefficiencies into RWE studies
  • Attempts broad applicability to RCTs and observational studies in EHR/claims without considering important differences between them

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Adequacy and Relevance of the Data Source

FDA recommended:

• Conceptual / operational definitions of elements of research question (PICOT(S))

• Adequacy of data sources evaluated in context of research question and regulatory decision (e.g., approval, labeling change, new indication)

**Opportunities for FDA:** Acknowledge that no RWD source is entirely complete and error-free, → RWD can often still be useful despite some missing data or variables

  **RCTs not entirely complete or error-free either**

  **Missing data for some variables may have little impact on study conclusions**

• Quantitative bias analyses (QBA) and sensitivity analyses for operational definitions/missing data assumptions encouraged & pre-specified

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2 Girman CJ, Ritchey ME, Lo Re III V. Real world data: Assessing electronic health records and medical claims data to support regulatory decisions for drug and biological products: Commentary from ISPE. PDS 2022


Girman – HGML 4/27/2022
Critical Data for Consideration

**FDA recommended:** Critical information not in EHR/claims data to consider: Coverage on formulary, tiering/stepped therapy, ‘prior authorizations’ restricting medications

- Routinely part of pharmacoepidemiologist thinking at feasibility
- Variation in medical practices, diagnostic criteria, treatment patterns across health care systems / countries
- Continuity of care: follow-up (person-time) & capture of study outcomes

**What about intercurrent events?**

- Surgical or other procedures
- Use of other medications for indication or outcome
- Death
- Hospitalizations / admission to skilled nursing facilities
- Other events that might limit interpretability of findings

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Missing Data and Linkage

**FDA recommends:** Linking to other data sources to supplement EHR or claims data when critical data elements are missing or poorly measured

- Tokenization is making linkage more tenable

**Opportunities for FDA - Acknowledge:**

- Linkage not always possible - lack of linking variables, privacy, legal issues for sharing data and/or data integrity
- With linkage, may reduce cohort size, potential loss of generalizability
- Sometimes missing data may be unobtainable

**FDA acknowledged:** Data elements may be in unstructured fields in EHR (e.g., clinical notes)

- Recommended thoroughly describing process for extracting / verifying such data, manually or automated

**Opportunity for FDA:** Preferred process for unstructured data? ‘validation’?

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Quality Assurance Procedures

**FDA recommends** QA processes for data accrual and curation similar to or **beyond** requirements for primary data collection in phase 3 RCTs for product approval

Throughout, FDA refers to complete (100%) verification of all study variables (PICO and all covariates) as “most rigorous approach”, stating ‘*may not be feasible*’

**Verification**
- Data **verification** in RCTs involves confirming the data for specific data fields at a given visit for a given patient
  -> impossible for **all** variables in a study
- Not expected for RCTs nor is it performed by FDA in Sentinel System to evaluate safety signals

**Validation** assesses performance of operational definition compared to a reference standard

If ref standard is medical records, **FDA recommends:**
- Blinding data abstractors/adjudicators to exposure to reduce bias
- Using standardized, abstraction/ adjudication processes to minimize intra- and inter-rater error

**Opportunity for FDA:**
- How do we validate EHR data when EHR is the medical record?

Girman – HGML 4/27/2022
Validation of Exposures, Outcomes, Covariates

Opportunity for FDA:

Clarify which of the many variables in a study need validation

*In RCTs, data may be collected for medical hx from charts/using patient recall (i.e., not validated)*

RCTs (primary data collection) often use risk-based approaches; 100% verification is rare

Achieving 100% accuracy and completeness is impractical, requires extraordinary efforts and likely will not change results

→ Opportunity for FDA:

Require Sponsors to **justify adequacy** of critical study elements (exposure, primary outcomes, key confounders) and encourage analyses to assess sensitivity of results to misclassification and data errors
## FDA expectations for RWD compared to RCTs

<table>
<thead>
<tr>
<th>FDA Recommendation/ Requirement</th>
<th>Recommendation in FDA Guidance for Effectiveness/Safety Studies in EHR/Claims*</th>
<th>Requirements for RCTs for Product Approval†‡</th>
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<tr>
<td>Pre-specified: protocol and analysis</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>sensitivity &amp; subgroup analyses</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Define outcomes operation</td>
<td></td>
<td></td>
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<tr>
<td>Verification of outcomes</td>
<td>“Most rigorous approach”</td>
<td>Dependent on study outcome, may or may not be required</td>
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<tr>
<td>Validation: Outcomes</td>
<td>No provided</td>
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<td>Variables defining population</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Treatment definitions</td>
<td>Yes</td>
<td>Data collection and pill counts; crossover assessed</td>
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<tr>
<td>Covariates</td>
<td>Yes</td>
<td></td>
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<tr>
<td>QA/QC: at time of data collection</td>
<td>Yes, but impractical for Sponsors (&amp; data providers)</td>
<td>Yes</td>
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<tr>
<td>at data checking/cleaning</td>
<td>Yes, but impractical; documentation from data provider not available</td>
<td>Yes, procedures documented</td>
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<tr>
<td>at transformation to analytic file</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traceability/Auditable</td>
<td>Yes, but detailed documentation from data provider may not be obtainable</td>
<td>Yes</td>
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Data Quality/Quality Assurance

**FDA recommends** documenting all QA during data accrual, curation, transformation to final analytic dataset

*Impractical to verify data against source records or even obtain documentation from commercially licensed databases*

- Focus on QA that sponsors can influence and document, e.g., from receipt of licensed data to analysis
- QA procedures driven by how potential misclassification/errors/bias might affect conclusions (risk-based)
- Stringent QA, auditing and data provision requirements for all covariates, *regardless of their association with outcomes, significantly increases inefficiencies* (in contrast to FDA mandate to reduce inefficiencies)
- FDA should work with data providers and academia to encourage transparency of QA procedures and to replicate analyses of Sponsors

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Summary

• Draft FDA guidance is welcome as a leap forward to ‘carve a path’, albeit arduous, for use of RWD to support regulatory decision-making—Unlikely to address current inefficiencies of RCTs and clinical research

FDA recommends that Sponsors discuss plans for using RWE with the relevant review division early …..

Using what mechanism? When? How often?

Guidance recommends practices that would significantly limit ability to use RWD to generate reliable results of effectiveness / safety for regulatory purposes

Imposes numerous inefficient RCT processes on observational studies

FDA broadened guidance to cover RCTs using EHR and claims for recruitment or follow-up but failed to draw important distinctions between RWE for approved products and RCTs for approval

Guidance could be enhanced by:

Risk-based approach to prioritize operational definition validation and QA/QC

Recommending pre-specified sensitivity analyses/QBA to give FDA more confidence in findings
What Should Academia and Pharma Do?

Need to advocate for:

**Transparency** in metrics/data curation procedures from data providers

Push **data providers to provide patient-level data** to FDA to support drug, biological and device submissions around the world

**Rigorous methodology & increased use of QBA / sensitivity analyses**

**Resources to help identify fit for purpose data and methods** for RWE

**Approach to justify adequacy of unstructured data**

**Replicate** studies

This would better address the congressional charge to FDA to identify ways that RWD can be used to **more efficiently and more rapidly generate evidence on product effectiveness and safety**
Is RWE Fit for Purpose?
Evaluate within Context of Research Question and Regulatory Decision

- **Transparency**: data handling and QA documented; **Auditable**
- **Relevance**: Study population representative of patients who may receive product
- **Data quality**: Key data elements for research question adequately captured; validated definitions; accuracy & completeness
- **Bias and uncertainty**: quantified, **missing data handling** documented
- **Sample size and longitudinal data**: adequate, detectable **effect size**

**Prespecified study design & analysis in registered protocol** that appropriately minimizes bias

**ISPE 2021 Symposium: What Makes RWE Believable?**

Girman – HGML 4/27/2022
UNC Epidemiology/PharmacoEpi Students

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Ji Hye Park
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Jess Young (post-doc)

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Olivia (Xiaomeng) Chen
Disha Subramaniam
Rebecca Robinstein

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Yuer Yan
Zhiwen Liu
Anita Bhat
Hilda Razzaghi
Jin-Liern Hong
Mona Cai
Maio Maio Liu
Quoc Nguyen
Xia Li
Nikhil Khankari
Rishi Desai
Jessica Rinskey
Nikhil Khankari

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Ritchey Wyss
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- Michele Jonsson-Funk
- Charlie Poole
- Michael Webster-Clark
- Ritchey Wyss
- Liz Garry
- Magdelene Assimon

**Novisci/TargetRWE**
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- Alex Breskin
- Bethany DiPrete

**Harvard**
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- Kate Bykov
- Elisabetta Potorno
- Liz Suarez
- Eric Rimm
- Frank Hu

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- Hongbo Yuan
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- Sanni Ali
- Steve Jacobsen
- Michael Lieber
- Deb Jacobson
- Aruna Sarma
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- Jenny Christian
- Priscilla Valentgas
- Nancy Dreyer
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- Emily Brower
- Rachel Sobel
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- Mark Danese
- Peter Leese
- Kristy Iglay
- Jerrod Nelnms
- Doug Watson
- Rob Epstein
- Katie Brind’Amour
- Molly Aldridge
- Pradeep Rajan
- Susan Hartmaier
- Katherine Harris
- Panagiotis Mavros
- Suzanne Cook
- Leah McGrath

Much of the work presented was in collaboration with Mary Beth Ritchey, PhD, FISPE

*Numerous pharmacoepidemiologists and outcomes researchers at clients with whom we collaborate...*
To my family... thanks for your support

**Alec Girman**
June 21, 1999-Oct 20, 2021
Talented young coder with a great sense of humor and a huge heart. Gone way too soon...

**Tom Girman, CPIM**
General Manager, CERobs Consulting
Avid bird & wildlife photographer
Excellent chef and life partner

**Vera Girman, BFA**
*summa cum laude*
Savannah College of Art & Design
Fashion photographer/artist extraordinaire

And Mom, my sister, my extended family, and many close friends....
Questions?
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