ENGELBERG CENTER for Health Care Reform at BROOKINGS

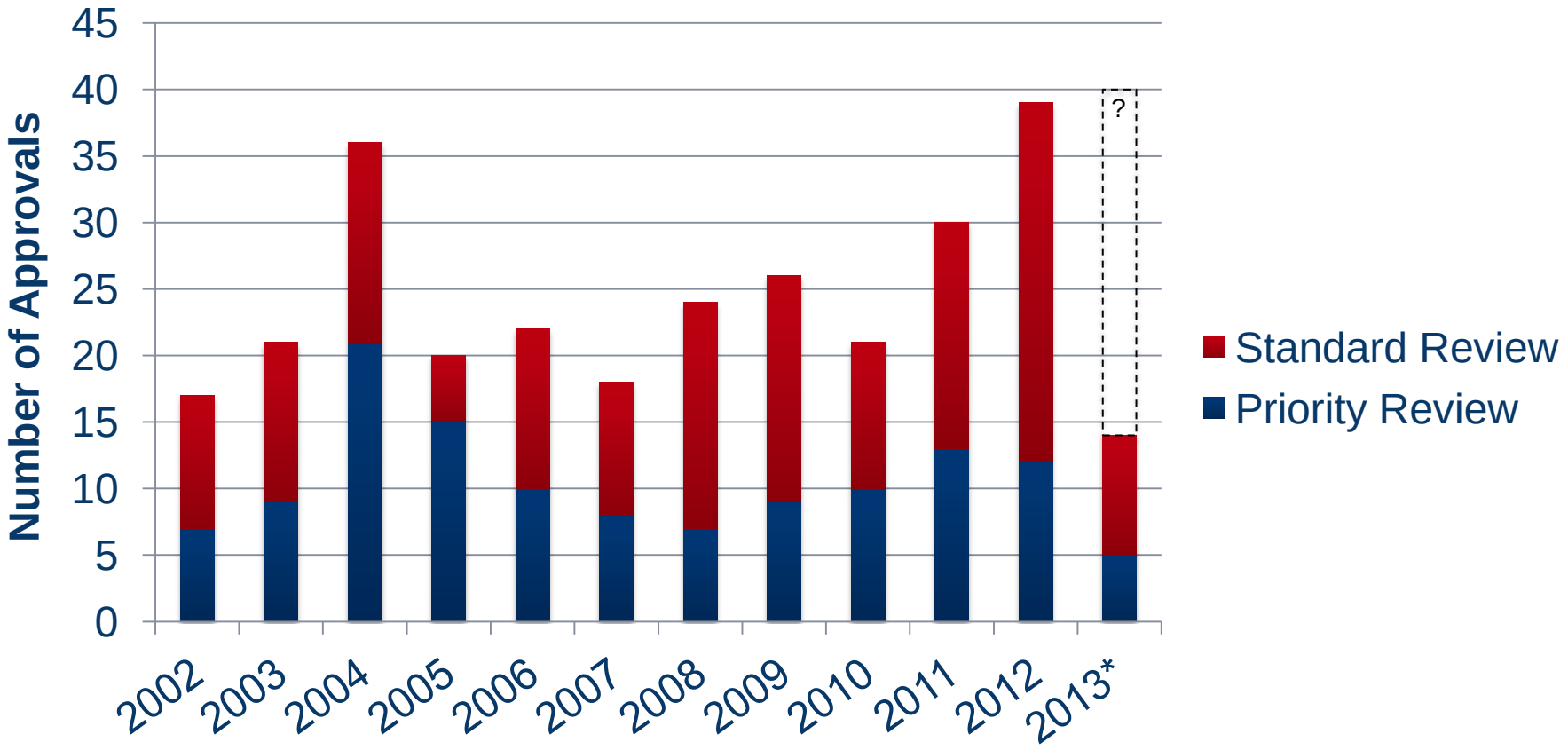
State of Biomedical Innovation Conference

The Brookings Institution
July 16, 2013

The Biomedical Innovation Project at Brookings

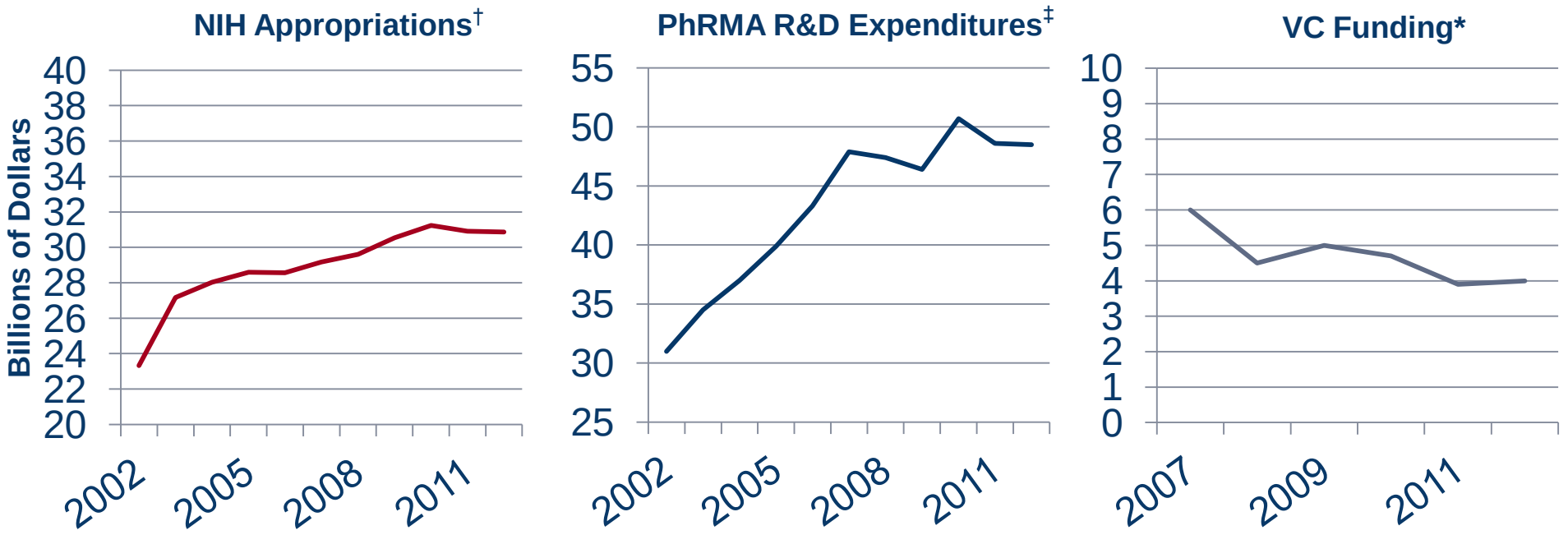
- Aims and Objectives
  - To highlight recent trends in the development of innovative treatments and interventions
  - To explore novel policy solutions to the challenges facing medical product development
  - To expand the policy discussion around innovation, moving beyond traditional measures of success to include patient outcomes and economic value

Recent trends in drug approval



*2013 approvals through Q2.
Includes both new molecular entities filed under New Drug Applications and therapeutic biologics filed under Original Biologic License Applications.
Sources: For 2001-2010 approvals: http://www.fda.gov/Drugs/DevelopmentApprovalProcess/ HowDrugsareDevelopedandApproved/ DrugandBiologicApprovalReports/PriorityNDAandBLAApprovals/default.htm
For 2011 approvals: FDA Approval Review, Washington Analysis, January 2012; FY 2011 Innovative Drug Approvals, FDA, November 2011
For 2012 approvals: FDA Approval Review, Washington Analysis, January 2013
For 2013 approvals: FDA approval Review, Washington Analysis, April 2013

Recent trends in stakeholder spending



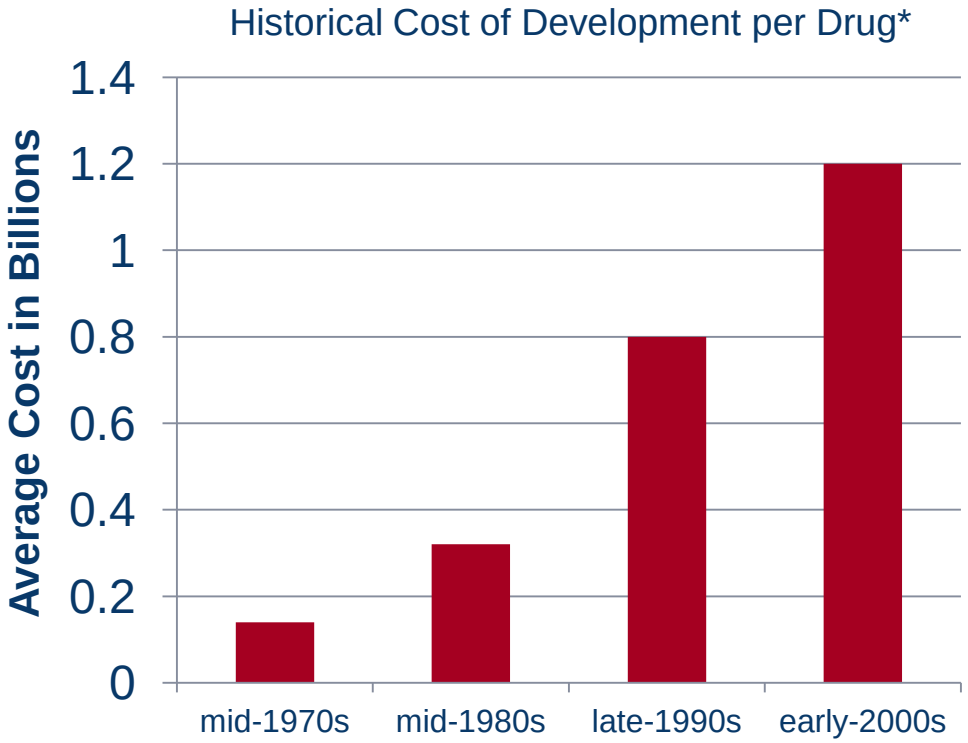
†'History of Congressional Appropriations, Fiscal Years 2000-2012.' National Institutes of Health Office of Budget. Accessed on July 8, 2013: http://officeofbudget.od.nih.gov/pdfs/FY12/Approp.%20History%20by%20IC)2012.pdf

‡'Biopharmaceutical Research Industry Profile 2013.' Pharmaceutical Research and Manufacturers of America. 2013.

* 'Biotech and Pharma 2012 Year in Review.' EvaluatePharma. 2013.

Trends in development costs for new drugs

- December 2012 Office of Health Economics Report (UK) finds the average cost of developing a new drug is **$1.5 bn** (2011 dollars)
- Previous estimates (2011 dollars):
  - DiMasi et al. 2003: **$1.0 bn**
  - Paul et al. 2010: **$1.9 bn**
- The graph at right depicts PhRMA's averaging of multiple analyses in 2000 dollars

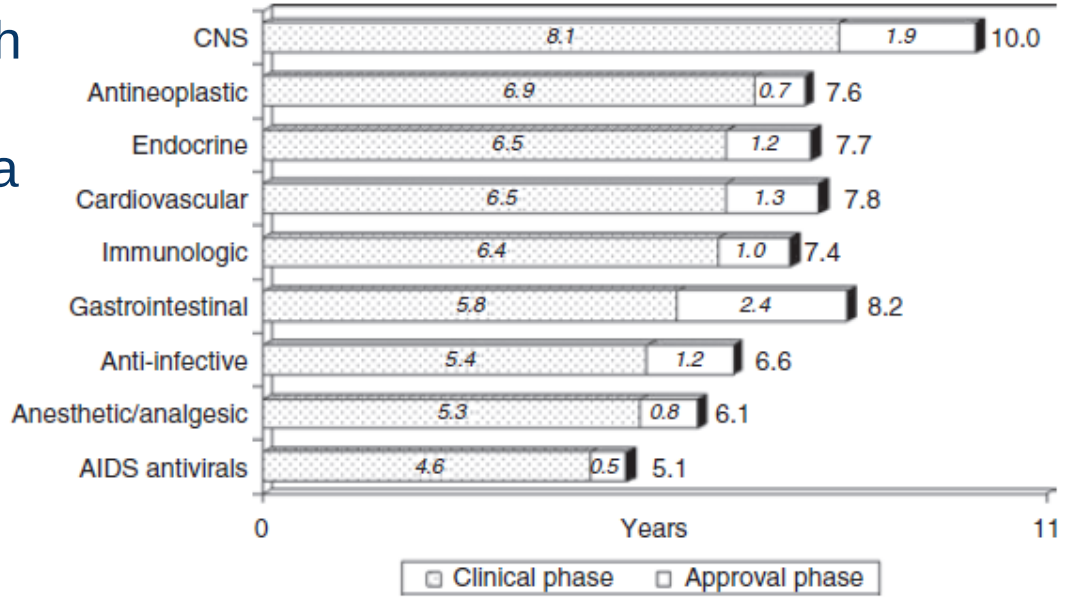


* Adapted from 'Biopharmaceutical Research Industry 2013 Profile.' Pharmaceutical Research and Manufacturers of America. 2013.

Trends in development time

- December 2012 Office of Health Economics Report finds the average time taken to develop a new drug is **11.5 years**
- Work by Kaitin and DiMasi at right analyzed the length of development for products by therapeutic area

Mean Clinical Development and Regulatory Review Times by Therapeutic Area, 2005-2009*



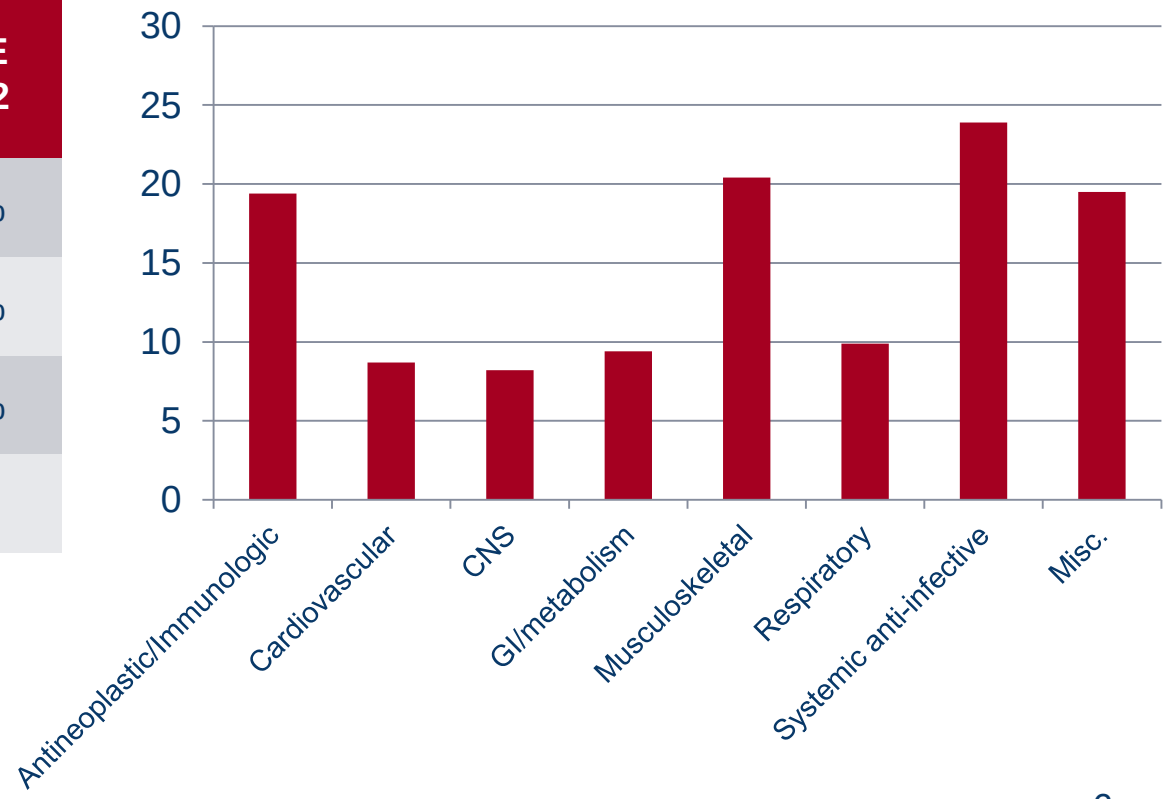
* 'Pharmaceutical Innovation in the 21st Century: New Drug Approvals in the First Decade, 2000-2009.' KI Kaitin and JA DiMasi. Clinical Pharmacology and Therapeutics 89(2), 183-88 (February 2011).

Probability of successful development

Probabilities of success by development phase

	DiMasi et al. 2003	Paul et al. 2010	OHE 2012
Phase I	71%	54%	44%
Phase II	44%	34%	31%
Phase III	68.5%	70%	63%
Overall	21.5%	12.9%	7%

Clinical approval success rate by therapuetic area DiMasi 2010

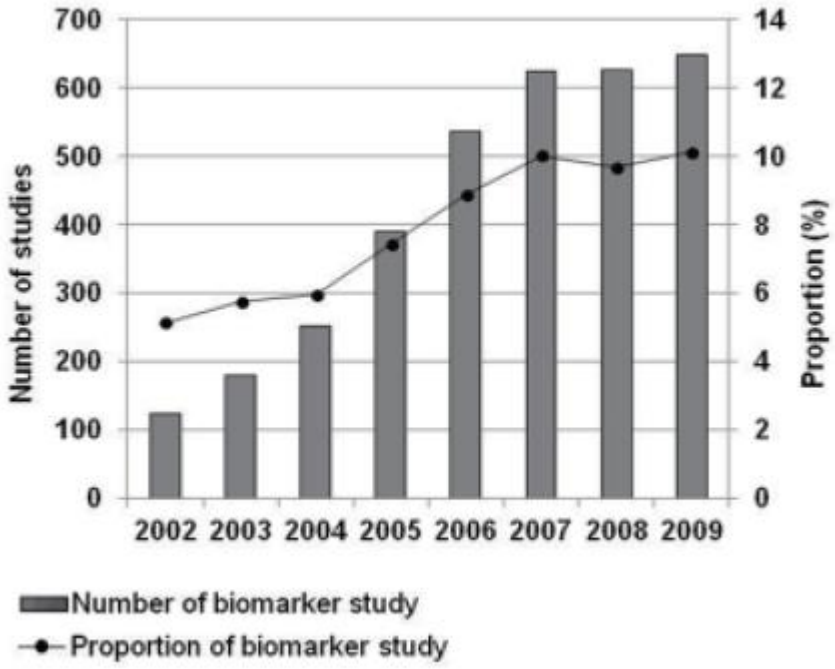


Rise of pre-competitive collaborations

- A 2010 AltshulerGray analysis presented to IOM surveyed the inter-organizational research landscape
  - 10 industry-only collaborations
    - E.g., AstraZeneca-Merck cancer partnership, Pfizer-GSK HIV partnership
  - 11 industry-academic collaborations
    - E.g., Biomarkers Consortium, CAMD, CDISC, Sage Bionetworks

- The number of pre-competitive collaborations built for improving drug development continues to grow
  - TransCelerate BioPharma, established in 2012, is an important example of industry coming together to jointly address development challenges

Use of biomarkers in clinical studies



- Hayashi et al. explored the use of biomarkers in registered clinical studies
  - From 2002 to 2009, the number of studies using biomarkers increased almost 6x
  - In the same period, studies using biomarkers rose as a percentage of the whole by 5%

Application of novel trial designs and methodologies

- An increasing number of adaptive trial designs are making clinical studies more efficient
  - BATTLE (2006)
  - I-SPY 2 (2010)
- Clinical trials networks and master protocols are expanding, lowering costs for conducting trials
  - Friends of Cancer Research lung cancer master protocol (2013)
- These advancements are in turn promoting the implementation of dedicated research and training programs such as:
  - Duke's Clinical Trials Transformation Initiative
  - MIT's New Drug Development ParadIGmS (NEWDIGS)

Today's panel discussions

- Session I will explore stakeholder efforts and policy initiatives to establish a robust data infrastructure capable of supporting efficient, patient-centric medical product development
- Session II will highlight the novel applications of big data in improving product development and care delivery
- Session III will dig into current metrics and trend data to outline next steps in improving measurement and R&D productivity

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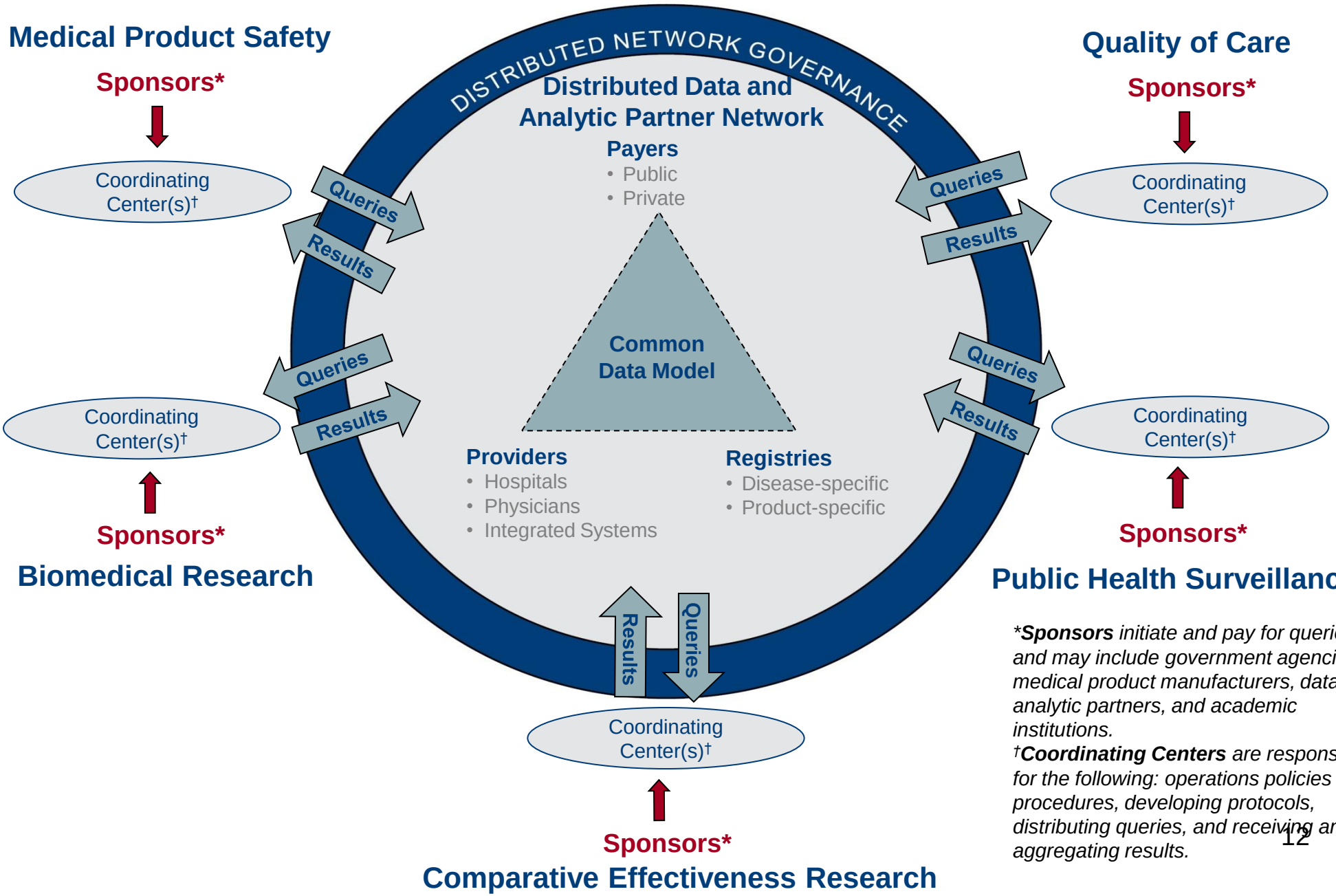
The Sentinel System



Sponsors initiate and pay for queries and may include government agencies, medical product manufacturers, data and analytic partners, and academic institutions.

†**Coordinating Centers** are responsible for the following: operations policies and procedures, developing protocols, distributing queries, and receiving and aggregating results.

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Improving R&D *and* measurement

Scientific and Development Measures	• No. of validated biomarkers • Failure rates between clinical phases • No. and amount of government grant mechanisms
Traditional Productivity Measures	• Total product approvals • Average development time • Average development cost
Measures of Innovation	• No. of Breakthrough/Expedited Review designations • No. of outcomes-based reimbursement models • Percent of patient population impacted by product • Measureable impacts on quality and outcomes • Measureable impacts on value and health care costs

Trends in FDA expedited reviews and approvals

- Products utilizing FDA expedited review processes are generally viewed as addressing unmet need or represent significant improvement over standard of care

Year	Fast Track Status	Priority Review	Accelerated Approval
2012	14/39 (36%)	16/39 (41%)	4/39 (10%)
2011	14/30 (47%)	15/30 (50%)	3/30 (10%)

- An additional potential proxy measure can be developed from the number of Breakthrough Therapy designations granted by FDA
  - This designation, established by legislation last summer, is given to those investigational compounds that show significant clinical effect early in development
  - To date, 20 Breakthrough designations have been granted, 17 of which have been publically announced;
  - Metrics could reflect both approvals and milestones in the development process

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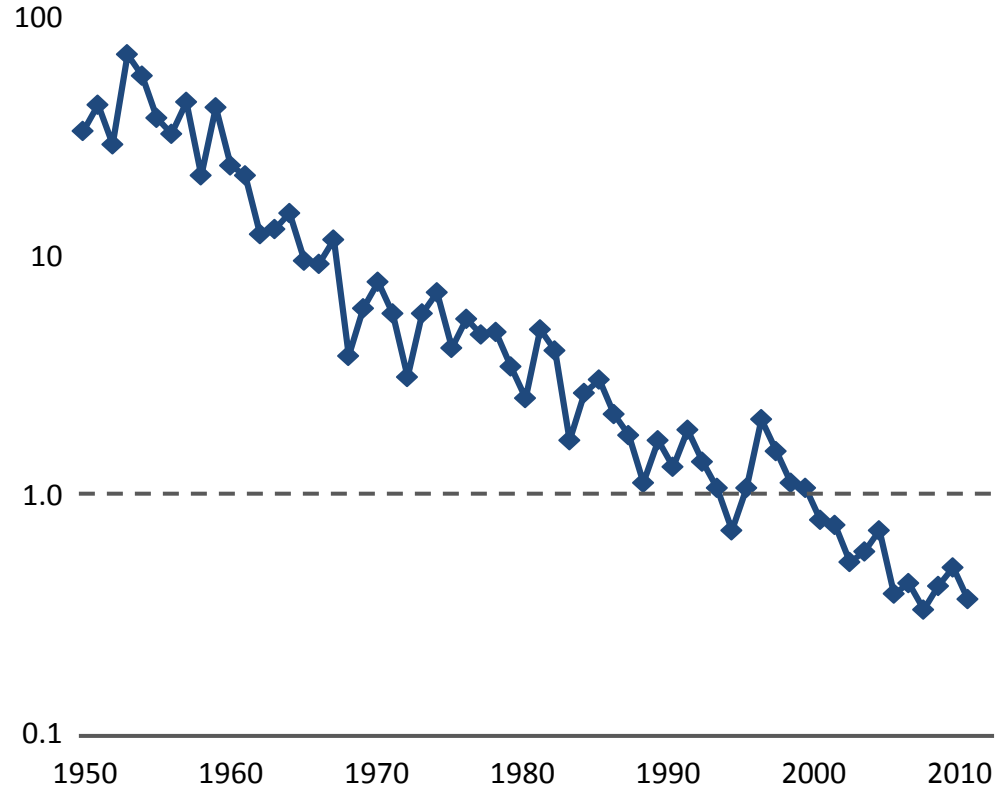
BioMedical Innovation Metrics

Jonathan S. Leff
Partner, Deerfield Management
Chairman, Deerfield Institute
July 16, 2013

Biopharma R&D Productivity

No. of New Drugs Approved per $BN of R&D Spending

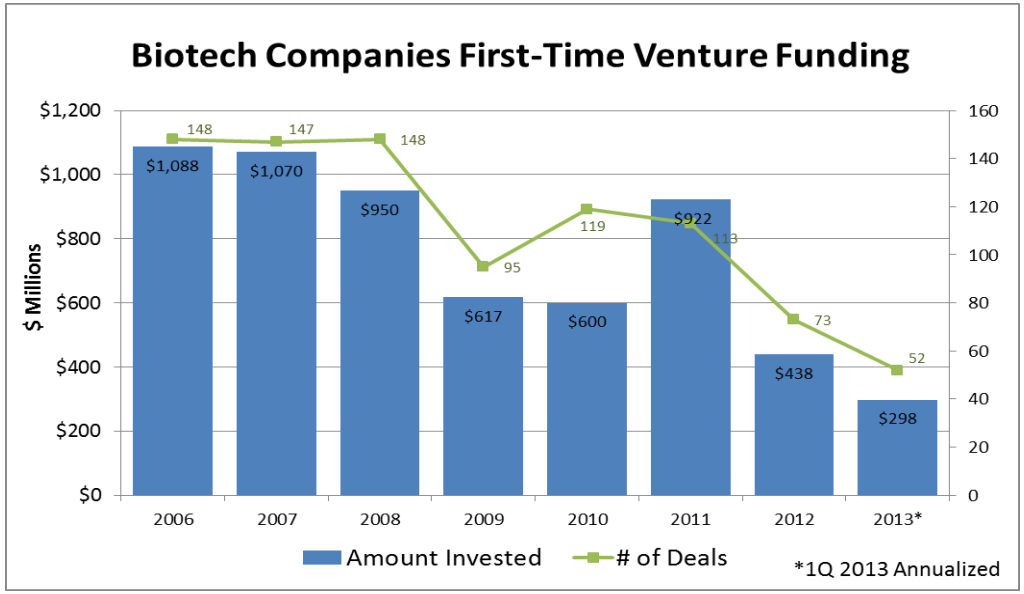


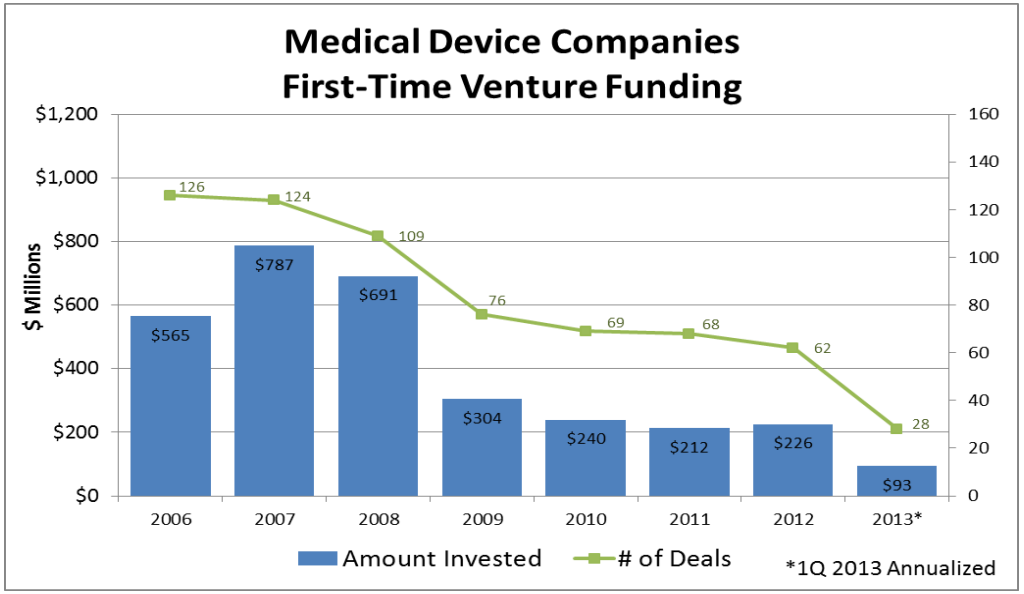
"Eroom's Law": R&D productivity has roughly halved every 9 years for the last 6 decades!

- 80x decrease in productivity
- Primarily driven by escalating time and cost of drug development

Source: Scannell et. al, *Nature Reviews Drug Discovery* 11, 191-200 (March 2012).

Venture Capital Investment in Biomedical Start-Ups





Source: NVCA/PWC MoneyTree

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