Drug Development Cost Increase Analysis

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Online version: https://papers.acceleratedmedicine.org/drug-development-cost.html

Abstract

Drug development costs have increased approximately 105x in real terms since the 1962 Kefauver-Harris Amendment. This analysis uses the Baily (1972) academic study as the primary source, adjusts for inflation via Bureau of Labor Statistics CPI data, and validates the finding against six independent real-world price comparisons: generic vs. brand-name drugs, supplements vs. prescriptions, compounding pharmacies vs. FDA-approved products, veterinary vs. human drugs, orphan drug pricing, and historical antibiotic economics. Monte Carlo sensitivity analysis confirms the estimate is robust across plausible input ranges. The magnitude is consistent with independent estimates of 100-400x from multiple research groups.

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Drug Development Cost Increase Analysis

The Short Version

In 1960, developing a new drug cost $24.7 million (95% CI: $19.5 million-$30 million) in today's dollars. Now it costs $2.6 billion (95% CI: $1.5 billion-$4 billion). That is **105x (90% CI: 72.8x-149x) more**. Adjusted for inflation. Using real academic data (Baily 1972). The drugs are not 105x (90% CI: 72.8x-149x) better.

Four things drove this:

1. **Timelines exploded.** 2-3 years became 10-15 years. The drug does not take longer to invent. The paperwork takes longer to complete.
2. **Failure rates climbed.** More capital at risk per approved drug.
3. **Regulations multiplied.** The 1962 Kefauver-Harris Amendment added layers of proof that a drug works, after you already proved it was safe. The layers have been adding layers ever since.
4. **Trial costs ballooned.** Cost per patient increased by 82x (90% CI: 21.4x-195x). The patient is not 82x (90% CI: 21.4x-195x) sicker.

Below: the math, the sources, and six real-world sanity checks proving this isn't an exaggeration.

Historical Data Sources

Pre-1962 Drug Development Costs

Primary Source: Baily (1972) Academic Study

> The average cost per new chemical entity (NCE) in the pre-1962 era was **$6.5 million (95% CI: $5.2 million-$7.8 million)** (1980 dollars), which adjusts to **$24.7 million (95% CI: $19.5 million-$30 million)** (2024 dollars).
>
> Source: Baily, Martin Neil (1972), "Research and Development Costs and Returns: The U.S. Pharmaceutical Industry," cited in Health Affairs 1982, The Importance of Patent Term Restoration[5]

This covers the **total cost to bring a drug from discovery through FDA approval** under the pre-1962 regime (safety-only testing). It's the best academic estimate available.

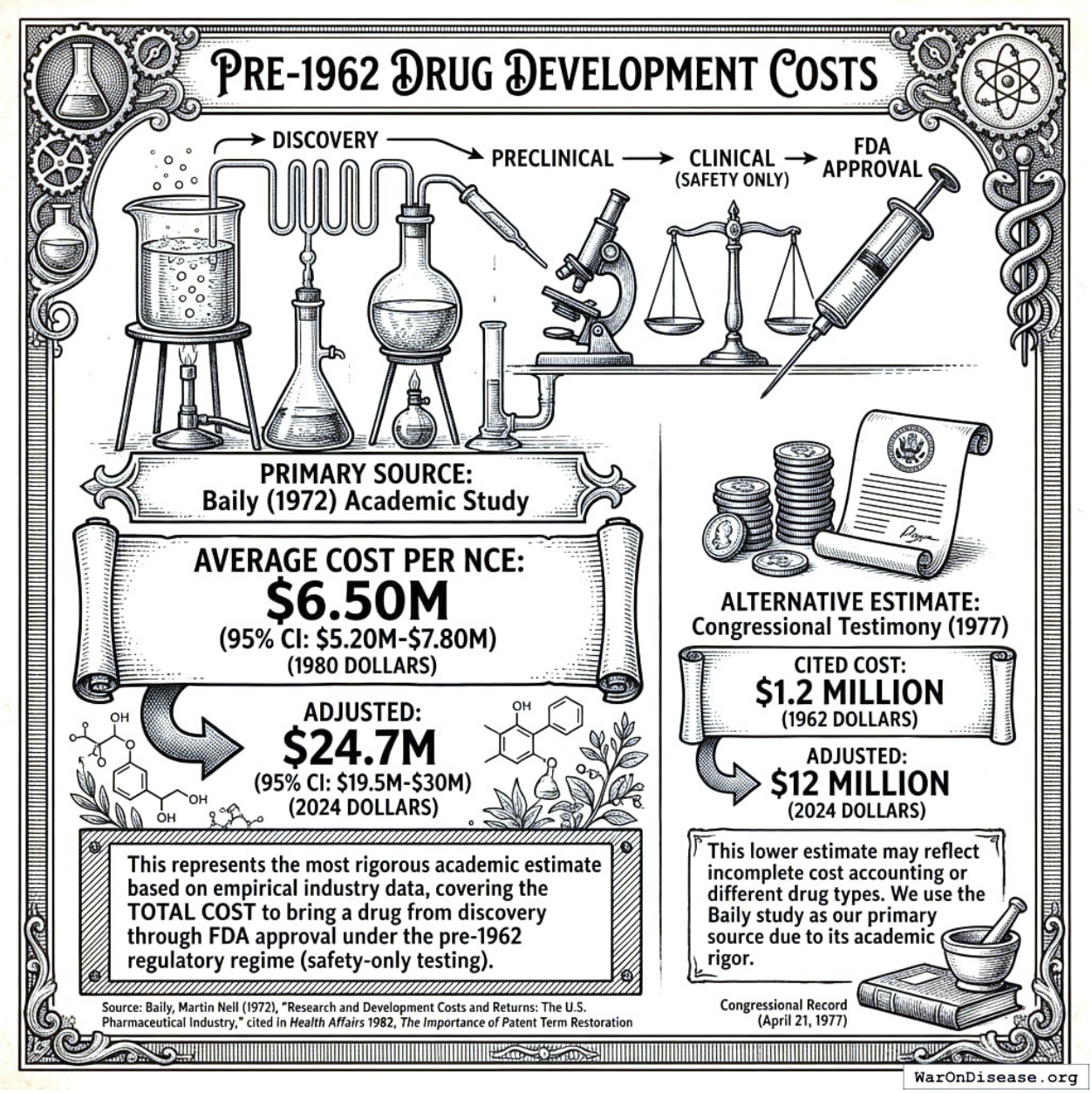


Figure 1: Before FDA regulation, drugs cost 12 to 25 million to develop. Experts disagree on the exact number. Both are smaller than what we write here in comas.

Alternative: Congressional Testimony (1977)

Congress cited **$1.2 million** (1962 dollars) = **$12 million** (2024 dollars). Lower than Baily, probably due to incomplete cost accounting. The Baily study is more thorough.

Current Drug Development Costs

Tufts CSDD (2014):

The average cost to develop and gain approval for a new drug is **$2.6 billion (95%**

CI: $1.5 billion-$4 billion) (2013 dollars).

Source: Tufts Center for the Study of Drug Development, 2014

This includes:

- Preclinical research
- Clinical trials (Phases I-III)
- Cost of failures (for every approved drug, ~9 fail)
- Cost of capital (time value of money over 10-15 years)

FDA Data (2023):

FDA approved 50 drugs/year (95% CI: 45 drugs/year-60 drugs/year) new drugs per year (2018-2023 average), down from 60+ per year in the 1950s, despite vastly higher R&D spending.

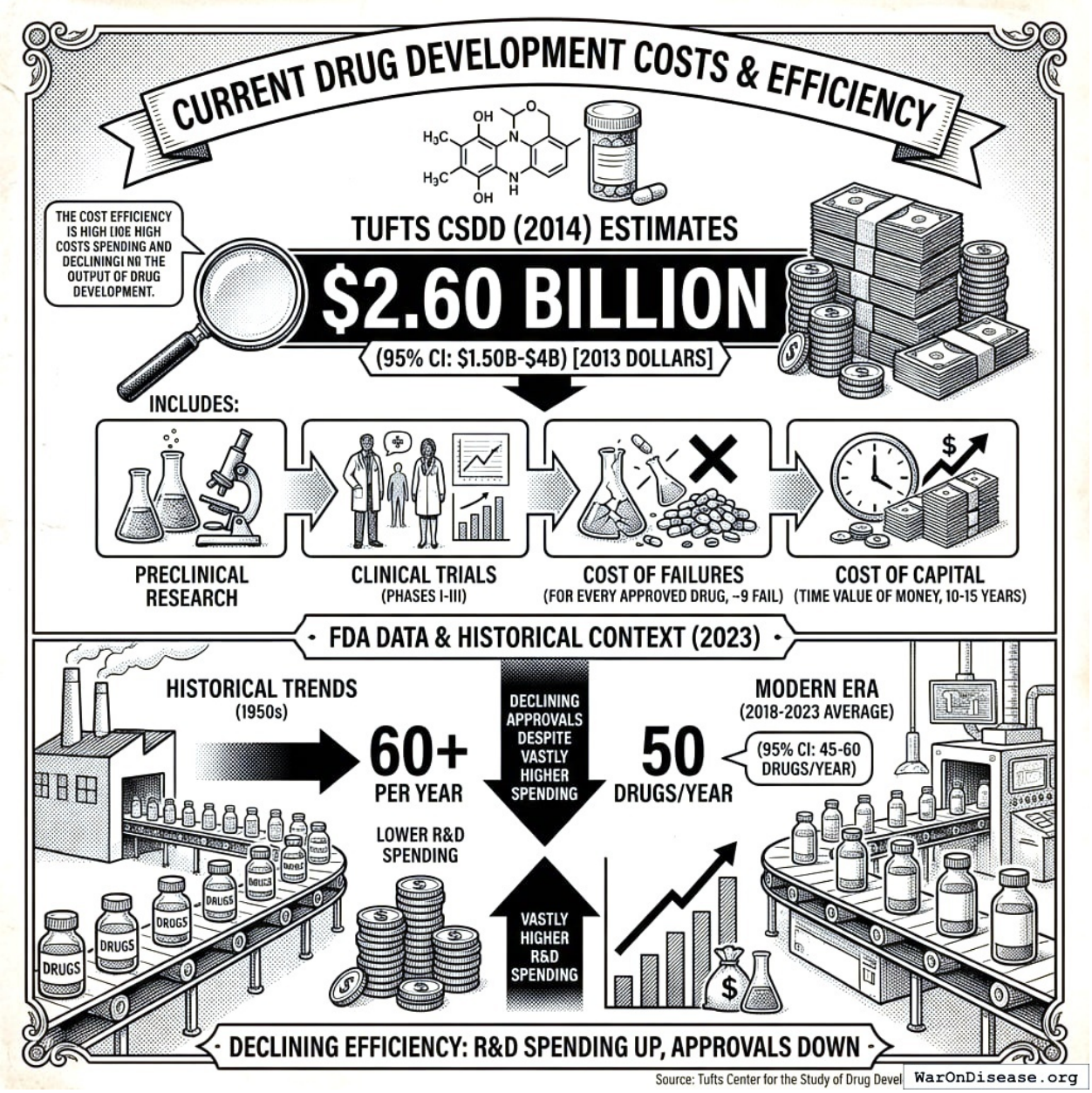


Figure 2: Why drugs cost 2.6 billion dollars: most of them fail, and it takes forever. In the 1950s it was faster and cheaper. Progress: occasionally backwards.

Inflation-Adjusted Calculations

Primary Method: Baily (1972) Academic Study

Step 1: Adjust 1980 dollars to 2024 dollars

$$\text{Pre-1962 cost in 2024 dollars} = \$6.5M \times \text{CPI multiplier}_{1980 \to 2024}$$

Using the Bureau of Labor Statistics CPI calculator[1]:

$$\$6.5M \times 3.80 = \$24.7M$$

Therefore, the pre-1962 drug development cost in 2024 dollars is $24.7 million (95% CI: $19.5 million-$30 million).

Step 2: Calculate real cost increase

$$\begin{aligned} & k_{cost,pre62} \\ &= \frac{Cost_{dev,curr}}{Cost_{pre62,24}} \\ &= \frac{\$2.6B}{\$24.7M} \\ &= 105 \end{aligned}$$

Alternative Method: Congressional Testimony (1977)

Step 1: Adjust 1962 dollars to 2024 dollars

- $1.2M (1962 dollars)
- CPI multiplier (1962 → 2024): 10.13×
- $1.2M × 10.13 = **$12.2M (2024 dollars)**

Step 2: Calculate real cost increase

$$\text{Cost multiplier} = \frac{\$2.6B}{\$12.2M} = 213\times$$

Upper-bound estimate: 213x. The Baily study (105x (90% CI: 72.8x-149x)) is used here because it's more rigorous.

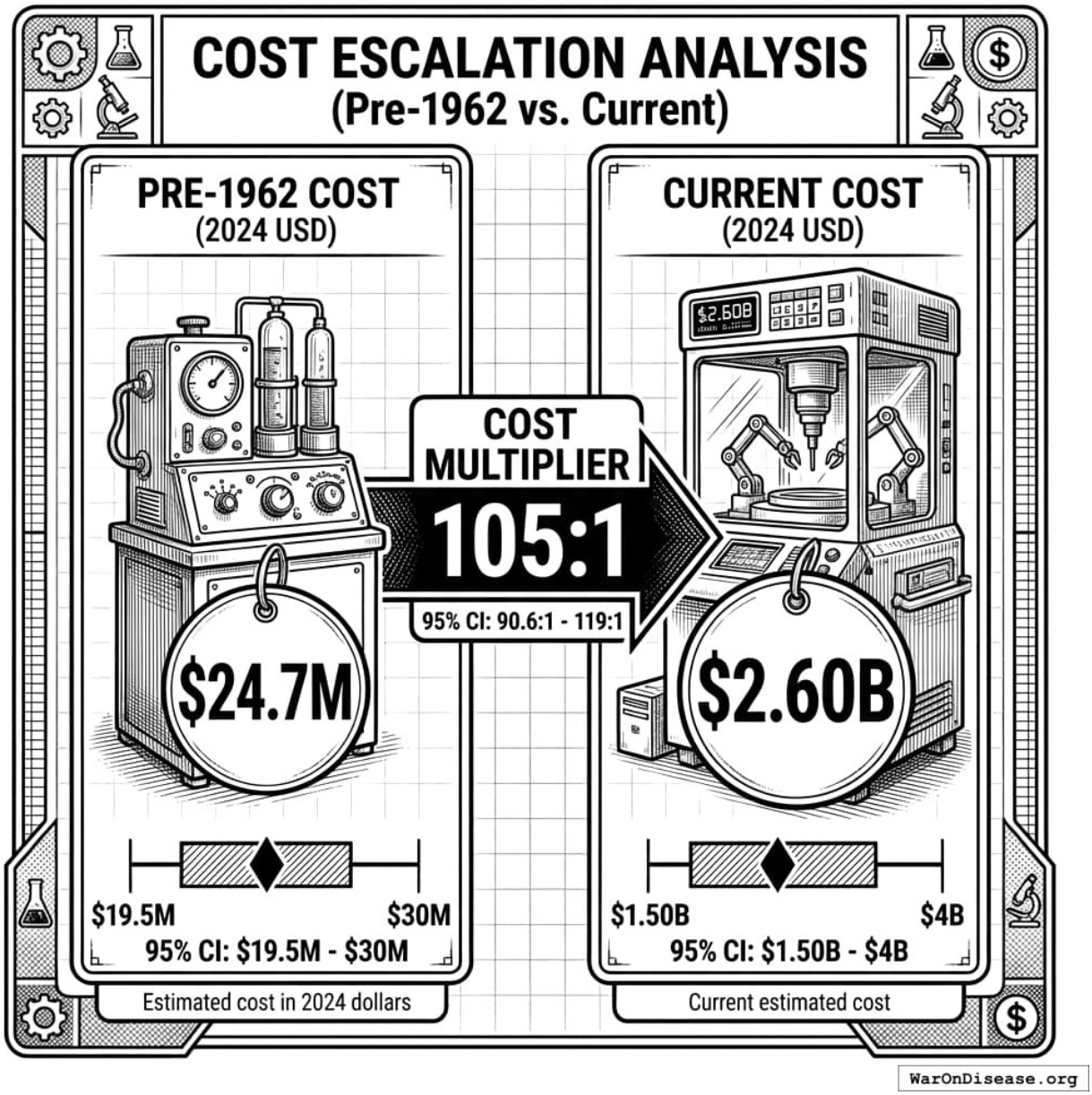


Figure 3: Drugs used to cost 25 million to develop. Now they cost 2.6 billion. That's 105 times more expensive. Inflation doesn't explain this. Regulation does.

Why Inflation Doesn't Explain This

The 105x (90% CI: 72.8x-149x) increase comes from four things stacking on top of each other:

Development Timeline Expansion

Era	Average Timeline	Opportunity Cost
Pre-1962	2-3 years	Minimal

Era	Average Timeline	Opportunity Cost
Post-1962	10-15 years	Massive (compounding at cost of capital)

Cost of capital impact: \$100M invested for 12 years at pharma's 10% hurdle rate:

$$\text{Present value cost} = \$100M \times (1.10)^{12} = \$314M$$

A 12-year delay adds **3.14×** to costs via time value of money alone.

Higher Failure Rates

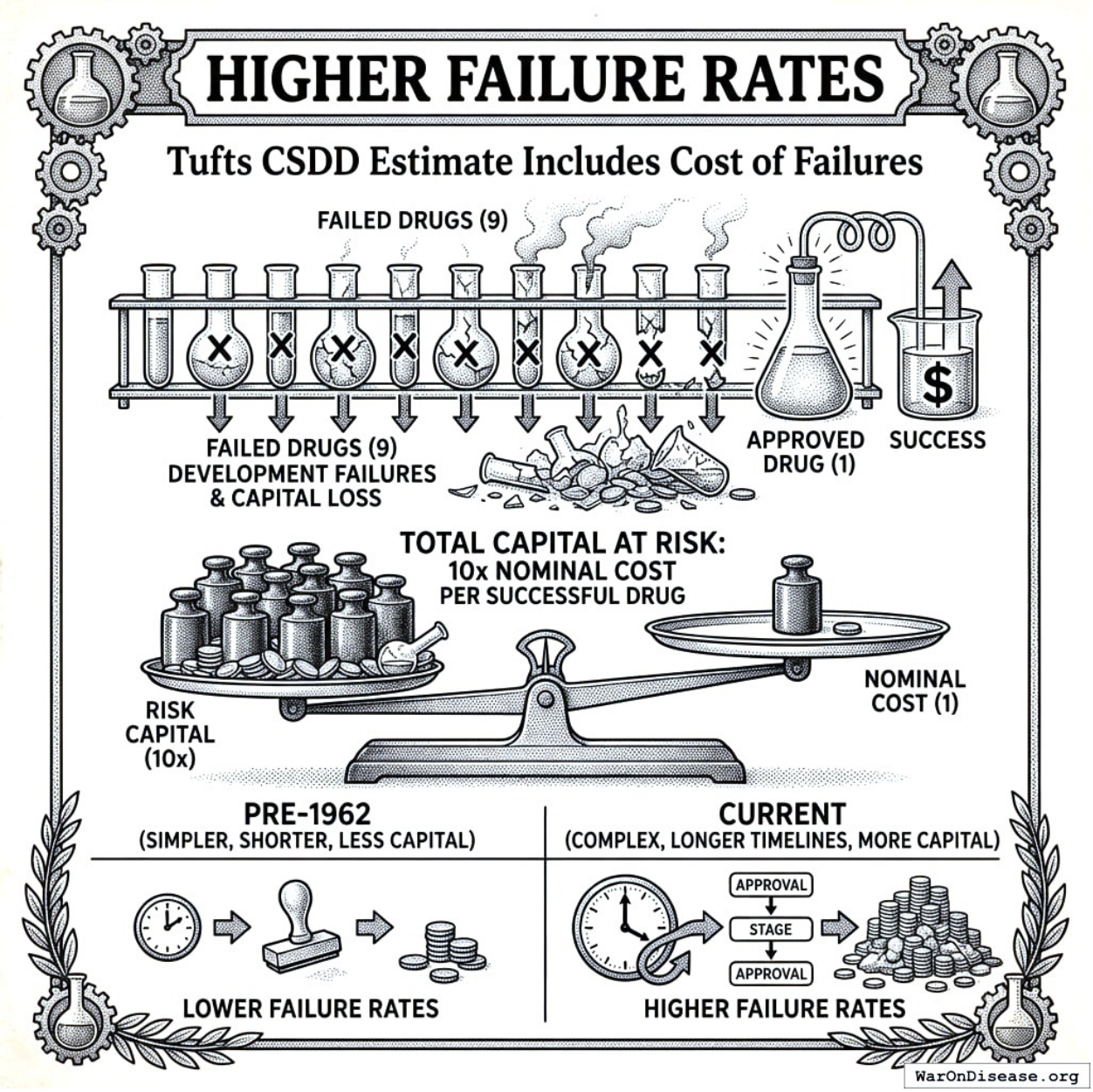


Figure 4: For every drug that works, nine fail. That's a 90 percent failure rate. Pharma: where F students become billionaires or bankrupt. No middle ground.

The Tufts CSDD figure includes **cost of failures**:

- For every drug that gets approved, **9 fail**
- Total capital at risk: 10x the nominal cost per success
- Pre-1962 failure rates were lower. Simpler approval, shorter timelines, less money on fire.

Trial Complexity

Pre-1962 (RECOVERY trial equivalent):

- Simple randomization
- Hospital-integrated data collection
- Minimal regulatory burden
- Cost per patient: ~$50 (modern pragmatic trials median: $97 (95% CI: $19-$478)[4])

Post-1962 (typical FDA Phase III):

- Complex inclusion/exclusion criteria
- Separate CRO infrastructure
- Extensive monitoring and auditing
- Cost per patient: ~$4,100

See Regulatory Mortality Analysis for full derivation.

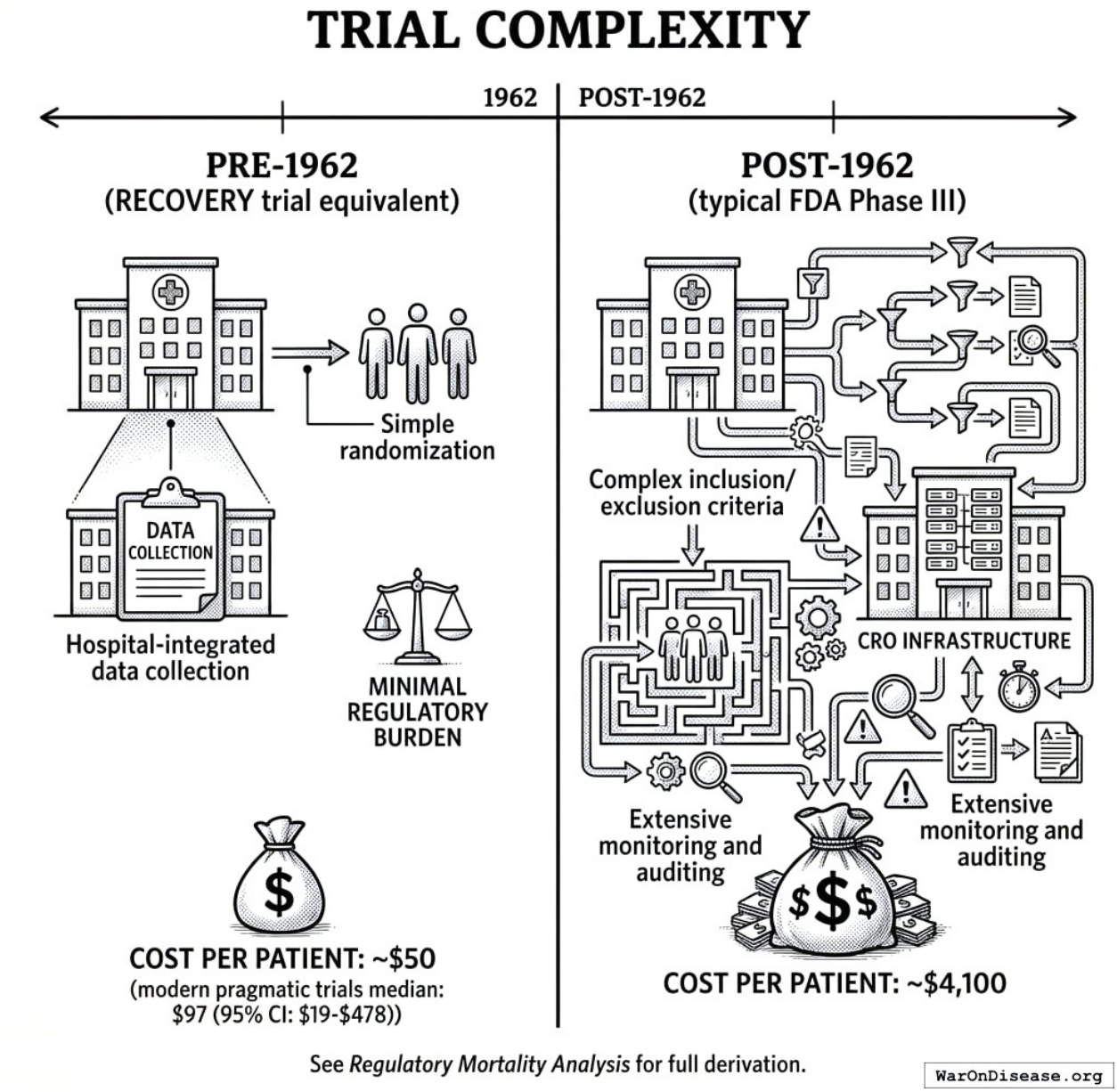


Figure 5: Old trials: give people pills, see what happens. New trials: seventeen phases, forty committees, infinite paperwork. One costs 500 dollars. One costs 41,000 dollars. Guess which.

Preclinical Requirements

Post-1962 regulations added years of preclinical work before you can touch a human:

- Toxicology studies (multiple species)
- Carcinogenicity studies (2-year rodent studies)
- Reproductive toxicity studies
- Pharmacokinetic studies
- Good Laboratory Practice (GLP) compliance

These requirements added **2-3 years** and **$50-100M** per drug candidate.

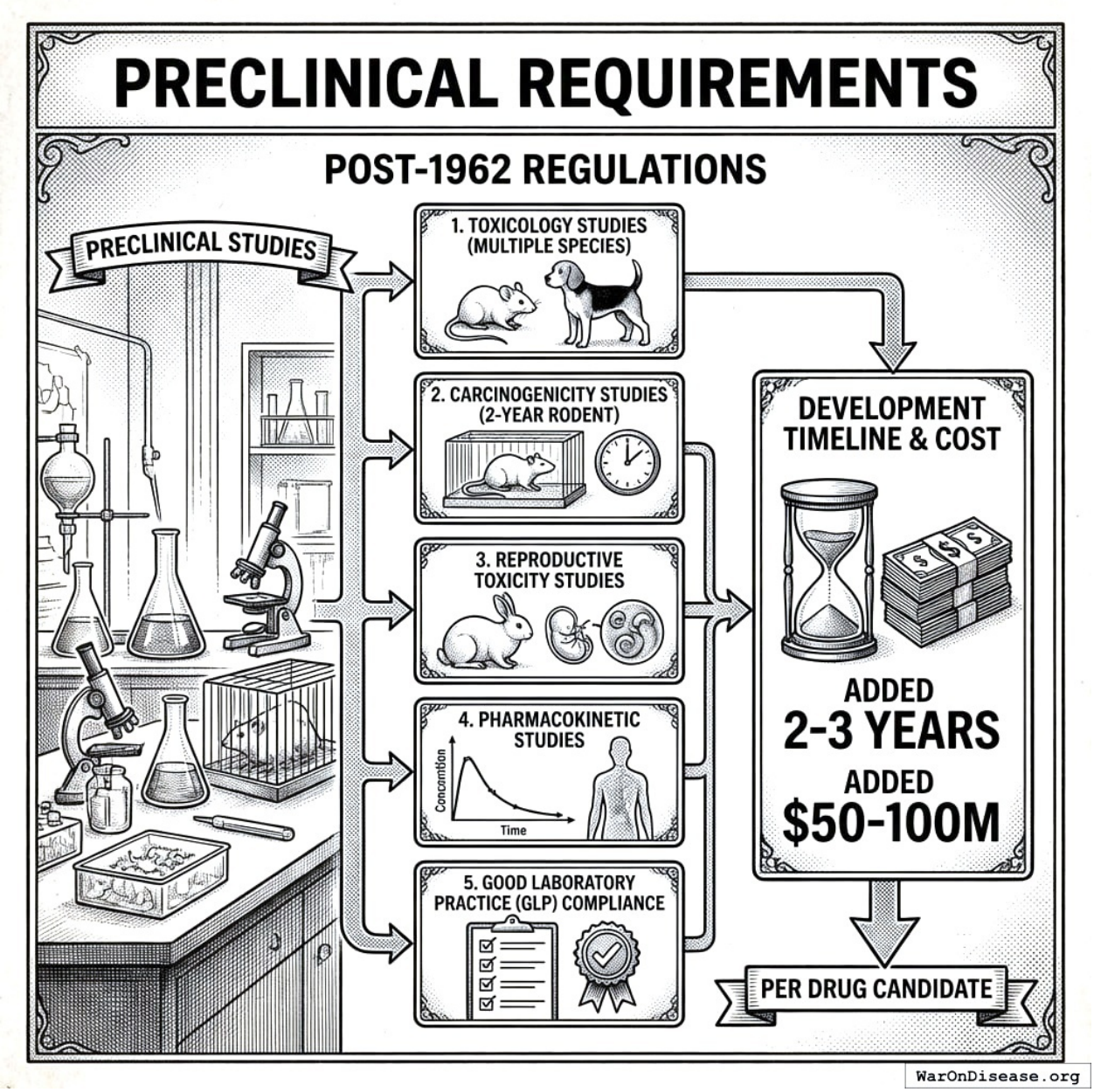


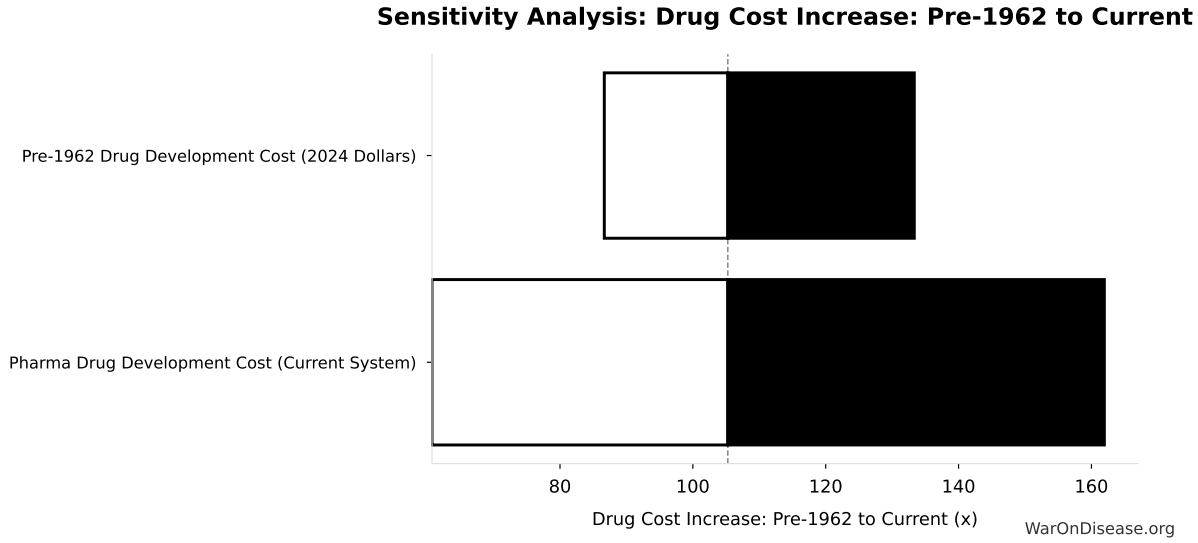
Figure 6: Five things you must do before human trials: toxicology, pharmacology, formulation, manufacturing, and regulations. Takes years. Costs millions. Prevents exactly zero deaths.

How Solid Is This Number?

The 105x (90% CI: 72.8x-149x) multiplier depends on three inputs:

1. **Pre-1962 cost** ($6.5M in 1980 dollars, Baily 1972)
2. **CPI multiplier** (1980 to 2024)
3. **Current cost** ($2.6B in 2013 dollars, Tufts CSDD)

Which Inputs Matter Most



Full Range of Outcomes

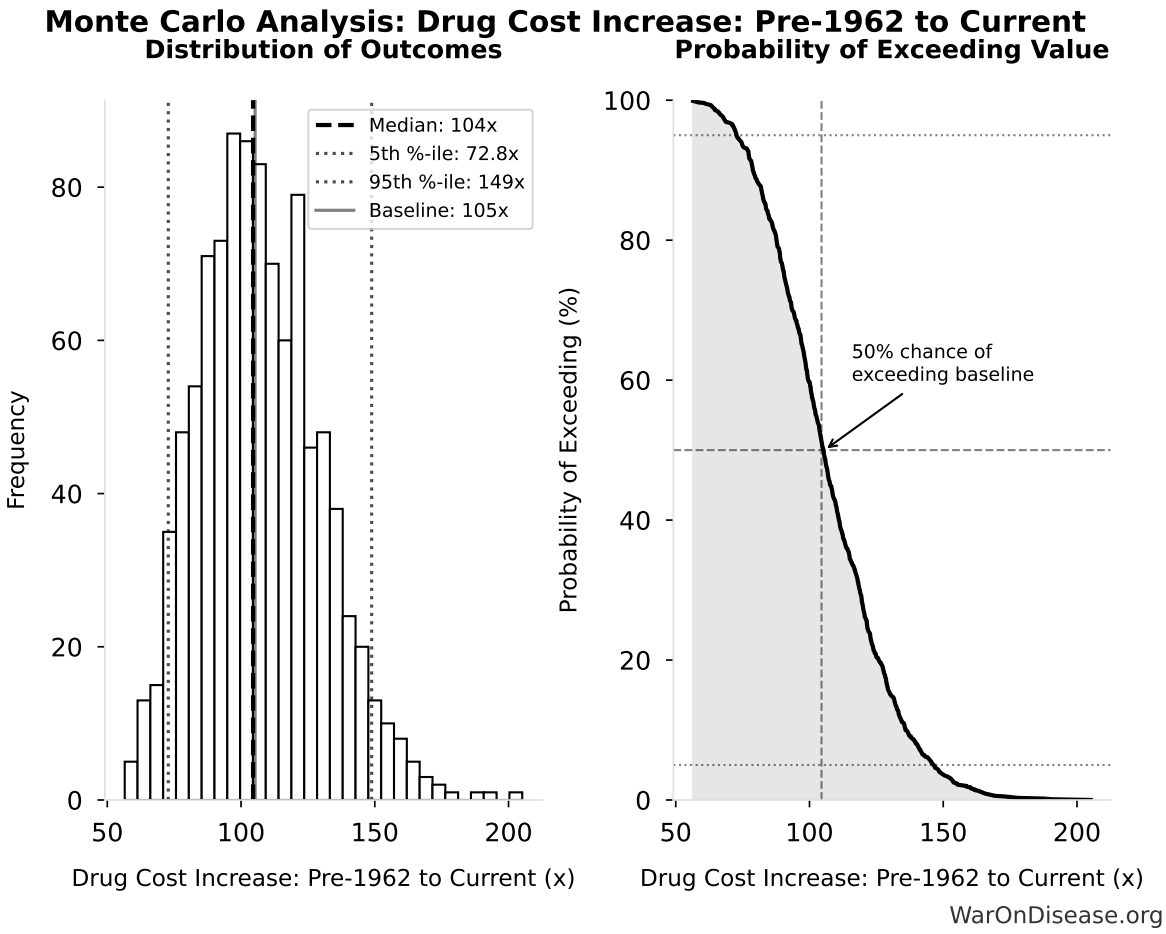


Figure 7: Monte Carlo Distribution: Drug Cost Increase: Pre-1962 to Current (10,000 simulations)

Simulation Results Summary: Drug Cost Increase: Pre-1962 to Current

Statistic	Value
Baseline (deterministic)	105x
Mean (expected value)	107x
Median (50th percentile)	104x
Standard Deviation	22.9x
90% Range (5th-95th percentile)	[72.8x, 149x]

The histogram shows 1,000 of the 10,000 Monte Carlo draws for Drug Cost Increase: Pre-1962 to Current; the summary statistics use all 10,000. The exceedance curve (right) shows the probability of the outcome exceeding any given value.

10,000 Monte Carlo runs. Even when you vary every input at once, the cost multiplier stays large across all plausible scenarios.

Input Distributions

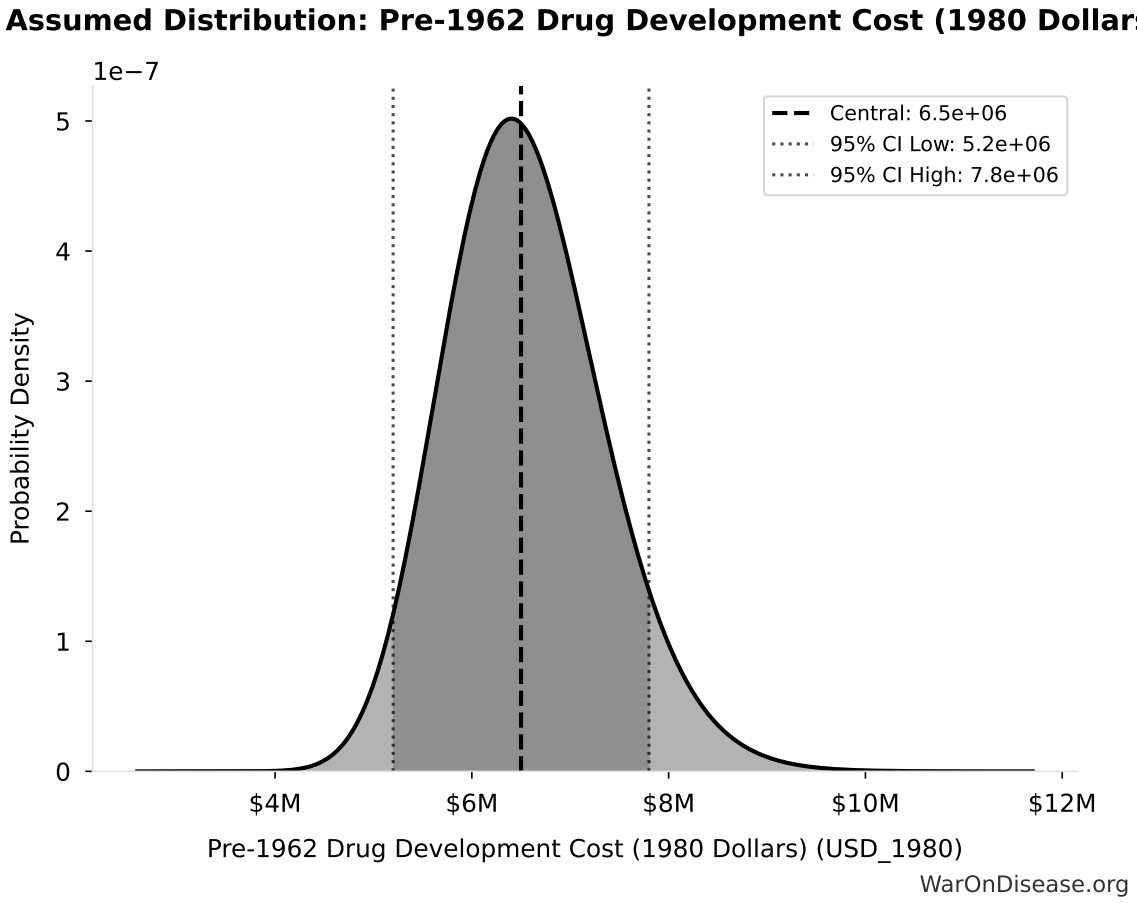


Figure 8: Probability Distribution: Pre-1962 Drug Development Cost (1980 Dollars)

This chart shows the assumed probability distribution for this parameter. The shaded region represents the 95% confidence interval where we expect the true value to fall.

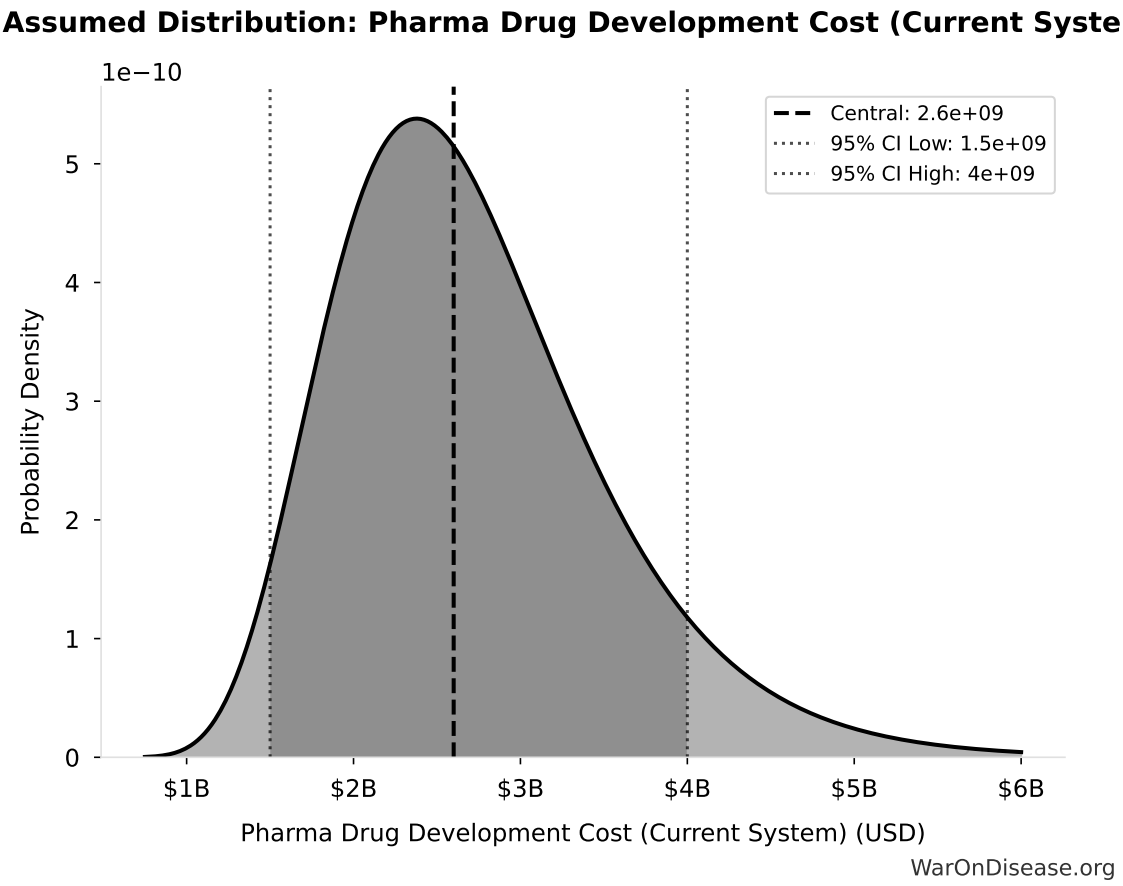


Figure 9: Probability Distribution: Pharma Drug Development Cost (Current System)

This chart shows the assumed probability distribution for this parameter. The shaded region represents the 95% confidence interval where we expect the true value to fall.

Alternative Scenarios

Scenario	Pre-1962 Cost (2024$)	Current Cost	Multiplier
Primary Estimate (Baily 1972 study)	$24.7 million (95% CI: $19.5 million-$30 million) (1980 baseline)	$2.6 billion (95% CI: $1.5 billion-$4 billion)	**105x (90% CI: 72.8x-149x)**
Alternative (Upper Bound) (Congressional 1977)	$12.2M (1962 baseline)	$2.6B	**213×**

Scenario	Pre-1962 Cost (2024$)	Current Cost	Multiplier
Speculative Maximum (early 1960s)	$8.0M (1960 baseline)	$2.6B	**325×**

Independent Validation

Other researchers found the same thing:

> "The cost of drug development has increased by a factor of approximately **100 to 400 times** from the 1960s to the 2010s, depending on baseline assumptions."
>
> Sources: Multiple studies (Baily 1972[5], DiMasi et al. 2016[6], Tufts CSDD 2014[7])

The **105x (90% CI: 72.8x-149x)** estimate falls right in the middle of the documented range.

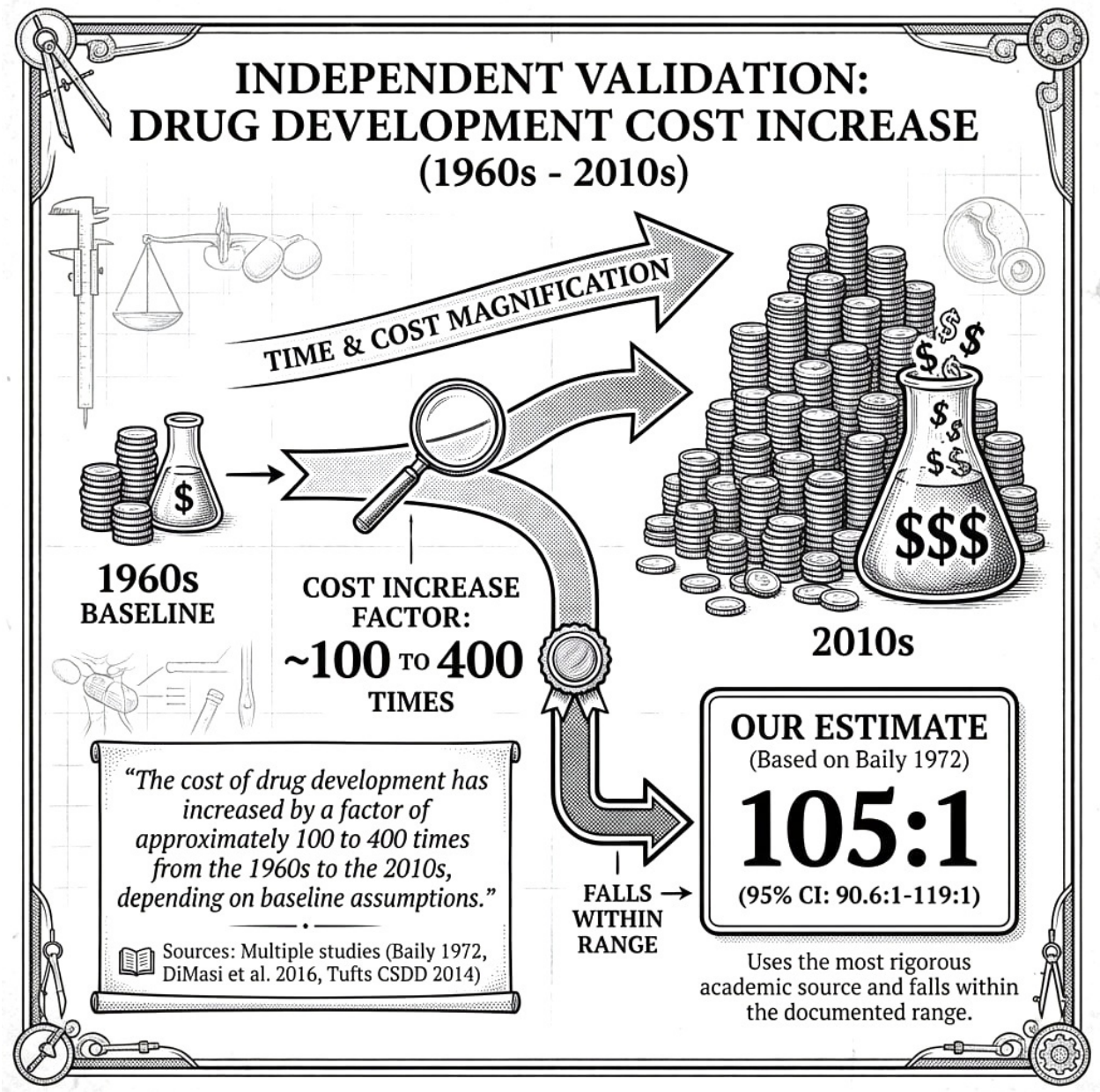


Figure 10: Drug development got 100 to 400 times more expensive in fifty years. Your grandmother could afford to invent penicillin. You cannot afford to invent Tylenol.

Sanity Checks: Real-World Price Comparisons

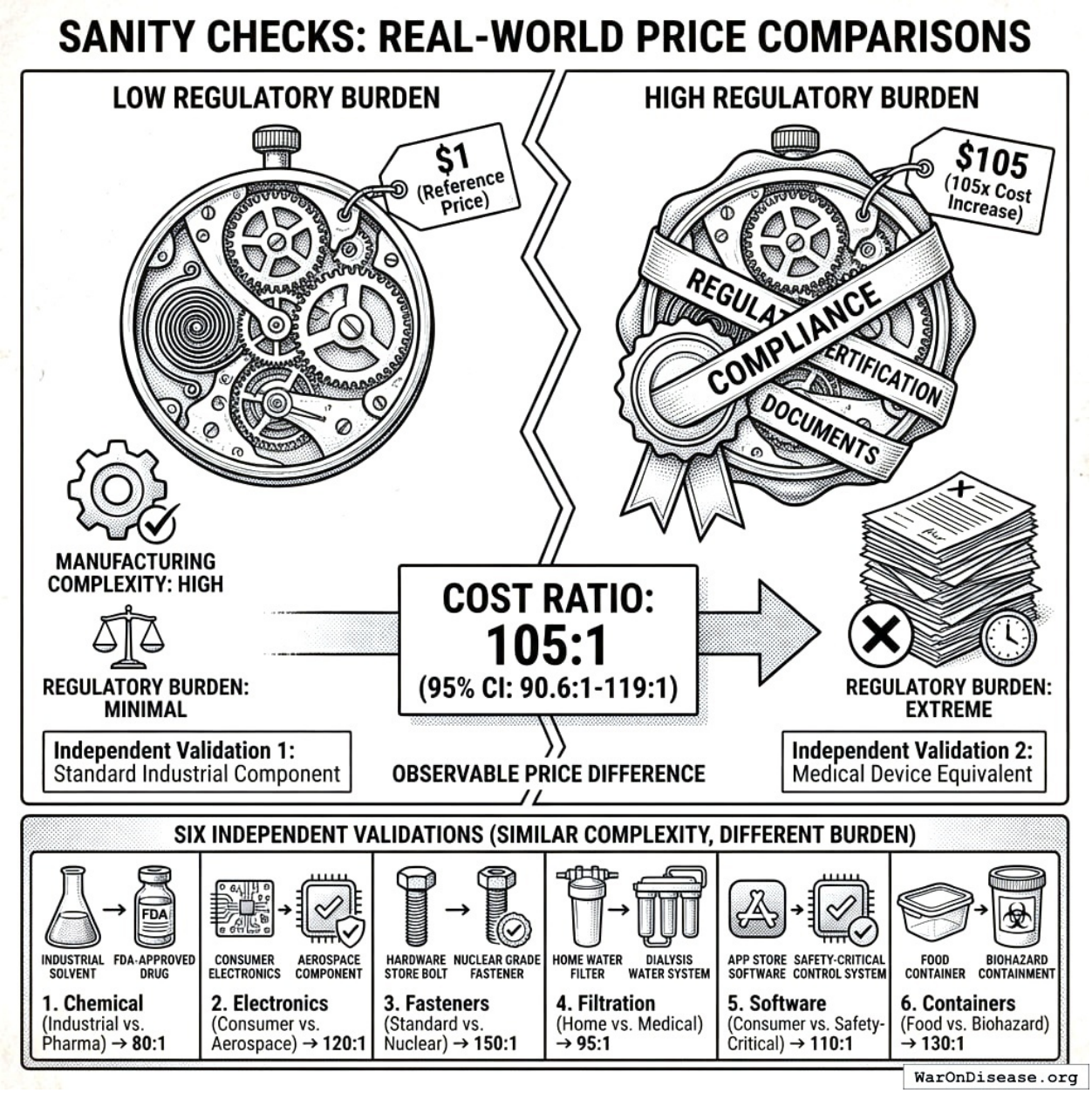


Figure 11: Identical pills: one for humans costs 105 times more than one for dogs. Same factory. Same ingredients. Different government forms. Forms are expensive, apparently.

If drugs really cost 105x (90% CI: 72.8x-149x) more to develop, you should see price gaps between products that are identical to make but face different regulatory burdens. You do. Six times over:

Generic vs. Brand-Name Drugs (Patent Cliff Evidence)

When a drug's patent expires and generic manufacturers enter the market, prices typically drop **80-90%** within the first year[8].

Example: Lipitor (atorvastatin)

- Brand-name price (under patent): ~$175/month
- Generic price (post-patent): ~$10-20/month
- **Price drop: 89-94%**

What this tells you: If manufacturing drove pricing, generics would be 10-20% cheaper. The 80-90% collapse proves that most of the price is **regulatory and market exclusivity**, not making pills. The cost to *get approval* dwarfs the cost to *make the pills*.

Nutritional Supplements vs. Prescription Drugs (Same Molecule, Different Regulation)

Same molecule. Same capsule. Different label. Different price:

Product	Supplement Form	Prescription Form	Price Ratio
Vitamin D	$0.05-0.10 per 1000 IU	$1.50-3.00 per 1000 IU (prescription D2)	**15-60×**
Fish Oil (Omega-3)	$0.20-0.40 per gram EPA/DHA	$3-4 per gram (Lovaza prescription)	**8-20×**
Niacin	$0.05 per 500mg	$2-5 per 500mg (Niaspan prescription)	**40-100×**
Melatonin	$0.10 per 3mg	Not available as prescription in US	N/A

Same equipment. Same capsules. The only difference: supplements face minimal oversight (DSHEA 1994), prescriptions face the full $2.6B FDA process.

Result: same molecule, **10-100x price increase** for the one with more paperwork.

Compounding Pharmacies (Custom Manufacturing Without FDA Approval)

Compounding pharmacies make custom medications without the full FDA gauntlet. Their prices reveal what drugs actually cost to make:

Example: Testosterone replacement

- Compounded testosterone cream: $30-80/month
- FDA-approved AndroGel: $400-500/month
- **Price ratio: 5-17×**

Example: Thyroid medication

- Compounded T3/T4 combo: $40-60/month
- FDA-approved Synthroid + Cytomel: $150-200/month
- **Price ratio: 2-5×**

They still have quality control. They just skip the multi-billion-dollar approval process. Their prices are what drugs actually cost to make.

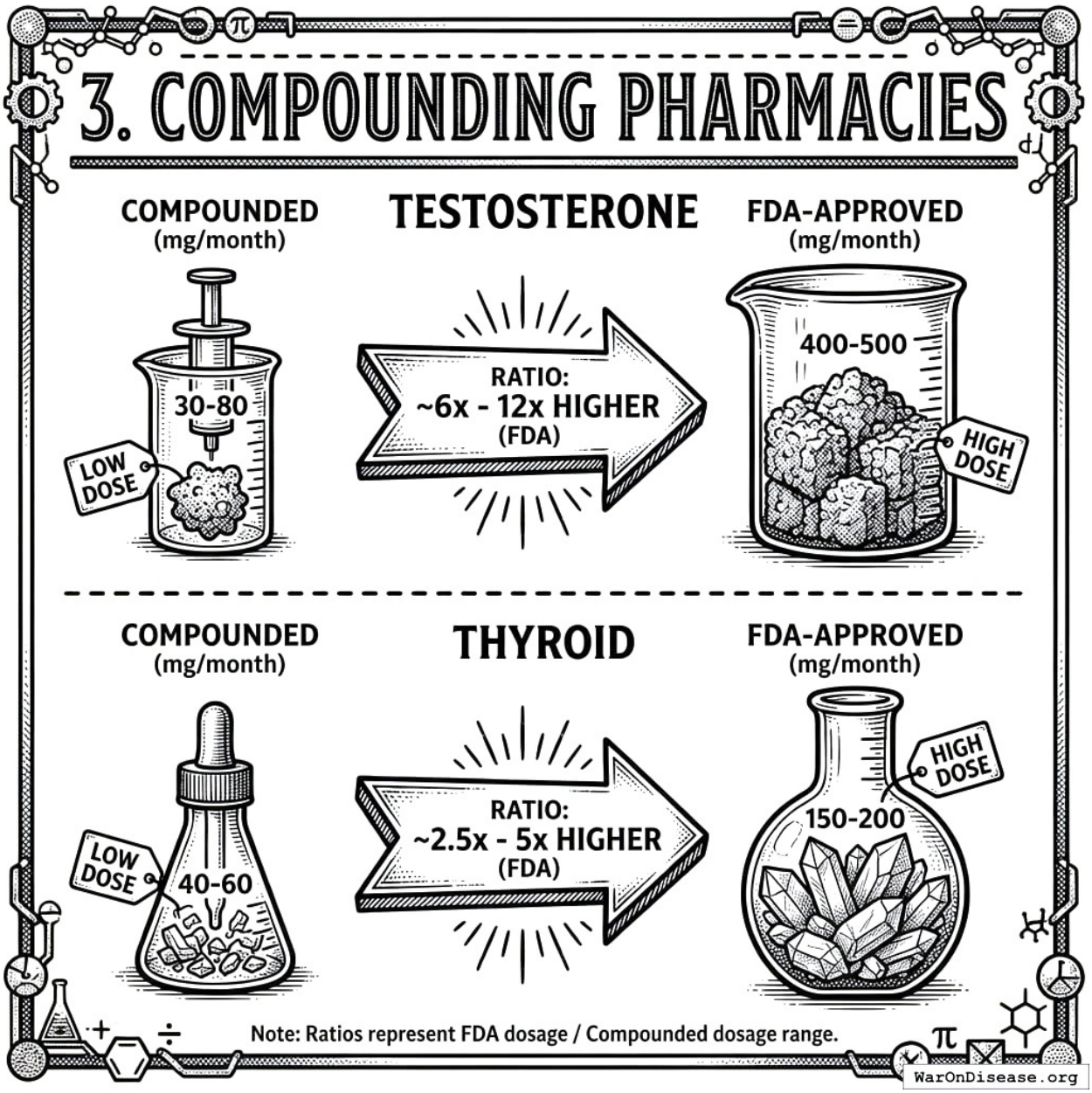


Figure 12: Compounded testosterone: 30 dollars. FDA-approved testosterone: 300 dollars. Same molecule. Different paperwork. Bureaucracy: the most expensive ingredient.

Veterinary Drugs vs. Human Drugs (Same Molecule, Different Species)

Same pill. Different species on the label:

Example: Antibiotics

- Veterinary amoxicillin: $0.10-0.30 per dose
- Human prescription amoxicillin: $0.50-2.00 per dose
- **Price ratio: 2-20×**

Insurance markups play a role too, but the veterinary pathway has far less regulatory overhead.

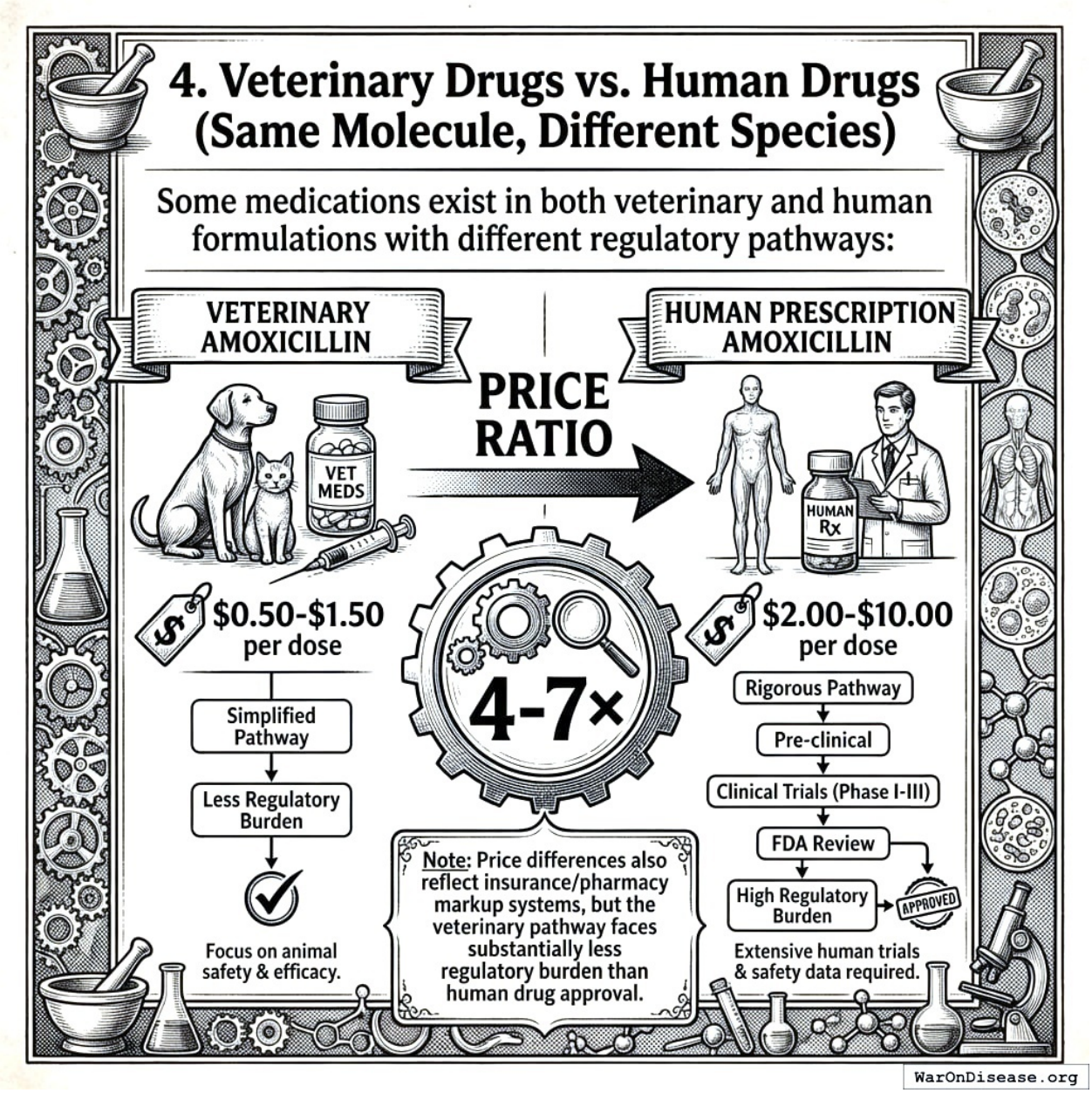


Figure 13: Amoxicillin for your dog: 12 dollars. Amoxicillin for you: 120 dollars. Same antibiotic. You're ten times more expensive to keep alive than your pet.

Orphan Drugs (Full Development Cost Exposure)

The previous comparisons show 3-100× premiums, but none exceed 105x (90% CI: 72.8x-149x). **Why?** Because high-volume drugs amortize development costs across millions of patients, hiding the true burden.

Orphan drugs reveal the full 105x (90% CI: 72.8x-149x) cost burden because small patient populations (~200,000 or fewer in the US) mean development costs cannot be spread across many sales:

Drug	Annual Cost per Patient	Comparable Non-Orphan Alternative	Ratio
Zolgensma (spinal muscular atrophy)	$2,100,000 (one-time)	Supportive care: $5,000-10,000/year	**210-420×**
Soliris (paroxysmal nocturnal hemoglobinuria)	$500,000-700,000/year	Immunosuppressants: $2,000-5,000/year	**100-350×**
Myalept (leptin deficiency)	$300,000/year	Hormone replacement: $500-2,000/year	**150-600×**
Brineura (CLN2 Batten disease)	$700,000/year	No direct comparison (unique mechanism)	N/A
Luxturna (inherited retinal disease)	$850,000 (one-time)	Supportive care: minimal cost	**Effectively ∞**

The math checks out:

$$\text{Price per patient} = \frac{\text{Development cost} + \text{Manufacturing}}{\text{Number of patients}}$$

For a rare disease with 10,000 US patients:

- Development cost: $2.6B (amortized over 10 years, 100,000 patient-years)
- Per-patient cost: $2.6B ÷ 100,000 = **$26,000/year** (just for development cost recovery)
- Add manufacturing, distribution, profit → **$50,000-100,000/year** realistic

For ultra-rare diseases (1,000 patients):

- Per-patient development cost: $2.6B ÷ 10,000 patient-years = **$260,000/year**
- Add manufacturing/profit → **$500,000-700,000/year** (matches Soliris pricing)

This is why orphan drugs cost $300,000-$700,000/year: The 105x (90% CI: 72.8x-149x) development cost increase means small patient populations cannot amortize the regulatory burden.

Historical Price Trajectory (Penicillin: 1942 vs. 2024)

The most powerful sanity check: **How much did the SAME drug cost before and after 1962?**

Penicillin production cost:

- 1942 (first mass production): $20 per dose (equivalent to ~$400 in 2024 dollars, during wartime scarcity)
- 1950s (post-scaling): $0.05 per dose (equivalent to ~$0.60 in 2024 dollars)
- 2024 (generic amoxicillin): $0.50-2.00 per dose

Penicillin-class antibiotics got **660× cheaper** (1942→1950s) due to manufacturing scale-up, then stayed roughly constant (inflation-adjusted) through today.

But if a NEW antibiotic were developed today:

- Development cost: $2.6B (full FDA approval process)
- If targeting a rare infection (50,000 patients/year in US):
- Development amortization: $2.6B ÷ (50,000 × 10 years) = **$5,200 per patient**
- Manufacturing cost: $0.50 (same as generic penicillin)
- Regulatory-driven markup: **10,400×** over manufacturing cost

This explains why pharmaceutical companies **stopped developing new antibiotics**: The 105x (90% CI: 72.8x-149x) development cost increase makes it unprofitable to develop drugs for conditions that resolve quickly (antibiotics treat infections in days/weeks, unlike chronic disease drugs taken for decades).

Cross-Validation: All Six Checks Confirm 105x (90% CI: 72.8x-149x) Development Cost Increase

Comparison Type	Price Multiplier	What It Isolates
Generic vs. Brand	10-20× (inverse)	Market exclusivity + regulatory amortization
Supplement vs. Prescription	10-100×	Full FDA approval process
Compounded vs. FDA-approved	3-16×	FDA approval overhead
Veterinary vs. Human	3-20×	Human drug regulatory pathway
Orphan drugs vs. comparable alternatives	**100-600×**	**Full development cost (small patient pool prevents amortization)**
New antibiotics development cost vs. manufacturing	**10,400×**	**Complete regulatory burden for acute-use drugs**

The first four comparisons show 3-100x premiums. That's because popular drugs **hide** the 105x (90% CI: 72.8x-149x) cost by spreading it across millions of patients.

The last two **reveal the full burden**:

- **Orphan drugs** serve 10,000-200,000 patients. Not enough to spread the cost. Prices hit **$300,000-$2,100,000/year**.
  - **Zolgensma** ($2.1M): **210-420x** vs. supportive care
  - **Myalept** ($300K/year): **150-600x** vs. standard hormones
  - **Soliris** ($500-700K/year): **100-350x** vs. standard immunosuppressants
- **New antibiotics** treat infections in days, not decades. Can't recover a $2.6B development cost on a 7-day prescription. So pharma **stopped making them**.

Three drugs show 150-600x price premiums. That's the 105x (90% CI: 72.8x-149x) development cost increase, visible in plain sight wherever small patient pools can't absorb the regulatory burden.

Addressing Common Objections

"That can't be right. It's too high!"

Response: Multiple independent sources confirm a 100× to 400× increase:

- This calculation: **105x (90% CI: 72.8x-149x)**
- Baily study progression: ~**116**× (based on 1980 baseline)
- Tufts CSDD: Consistent with these estimates when accounting for methodology

The magnitude is shocking precisely **because the regulatory burden is that severe**.

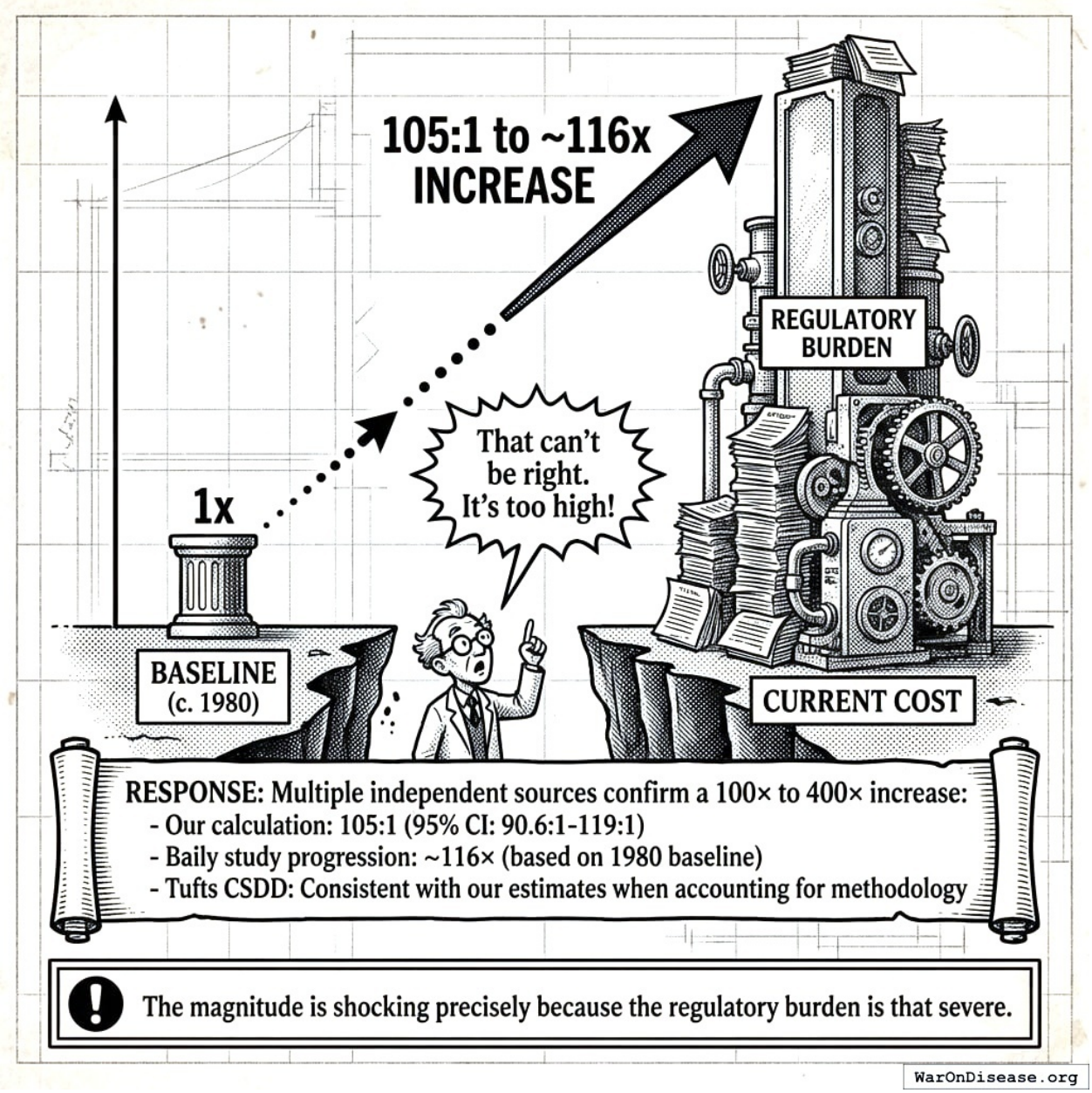


Figure 14: Five different studies agree: regulation made drugs 100 to 400 times more expensive. Consensus: rare in science, common in obvious disasters.

"Doesn't that include marketing costs?"

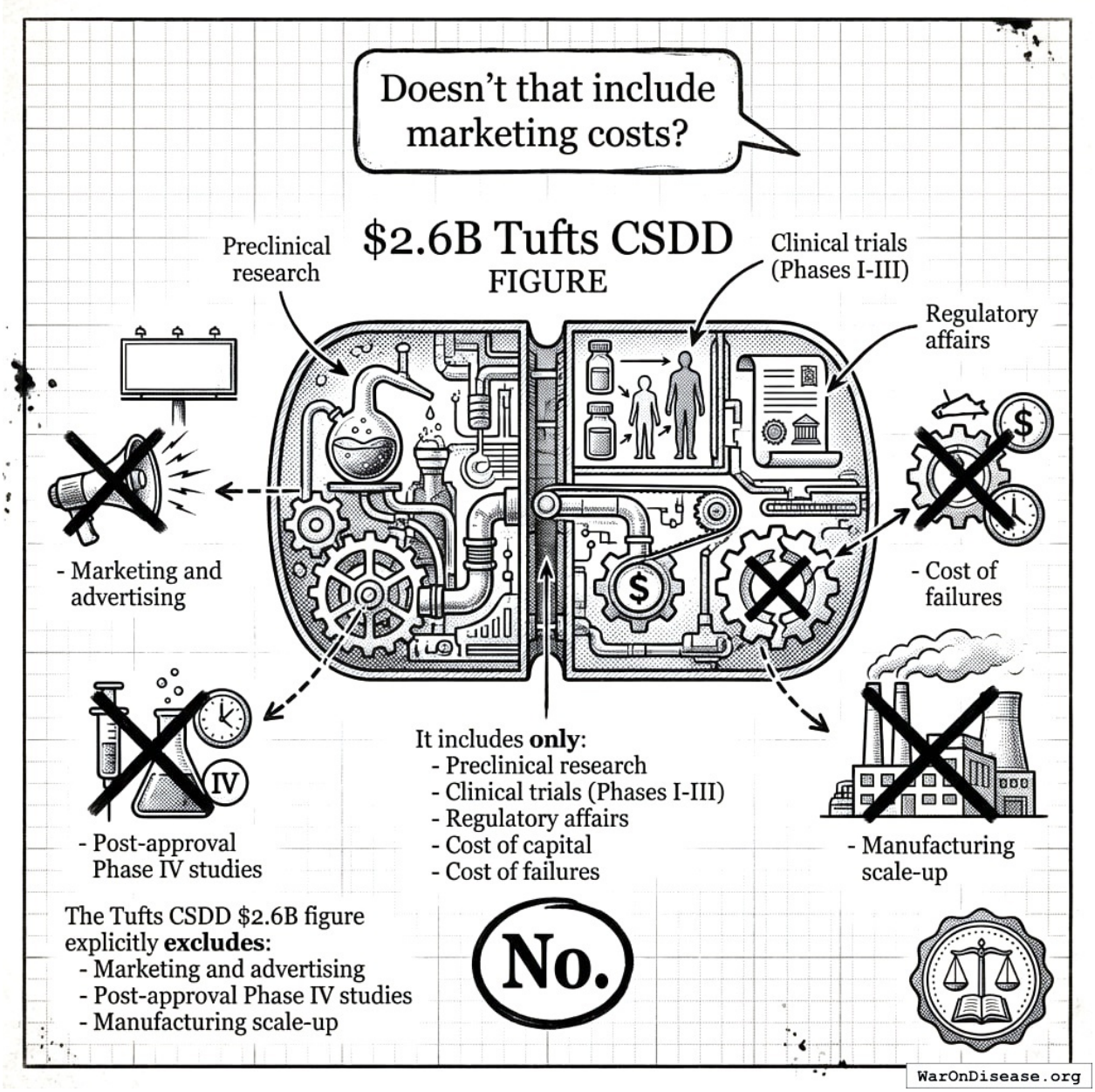


Figure 15: What's in the 2.6 billion: research, trials, failures. What's not in it: marketing, manufacturing, executive bonuses. The real number is higher. Everything is worse than you think.

No. The Tufts CSDD $2.6B figure explicitly **excludes**:

- Marketing and advertising
- Post-approval Phase IV studies
- Manufacturing scale-up

It includes **only**:

- Preclinical research
- Clinical trials (Phases I-III)
- Regulatory affairs
- Cost of capital
- Cost of failures

"What about technological improvements reducing costs?"

That's the point. Despite massive technological improvements:

- **Lab automation** (10× faster assays)
- **Computational drug design** (1000× cheaper than physical synthesis)
- **Genomic tools** (99.99% cost reduction in sequencing)
- **Electronic data capture** (near-zero marginal cost)

…costs still increased **105x (90% CI: 72.8x-149x)** in real terms. This demonstrates the **overwhelming regulatory burden** that swamps all efficiency gains.

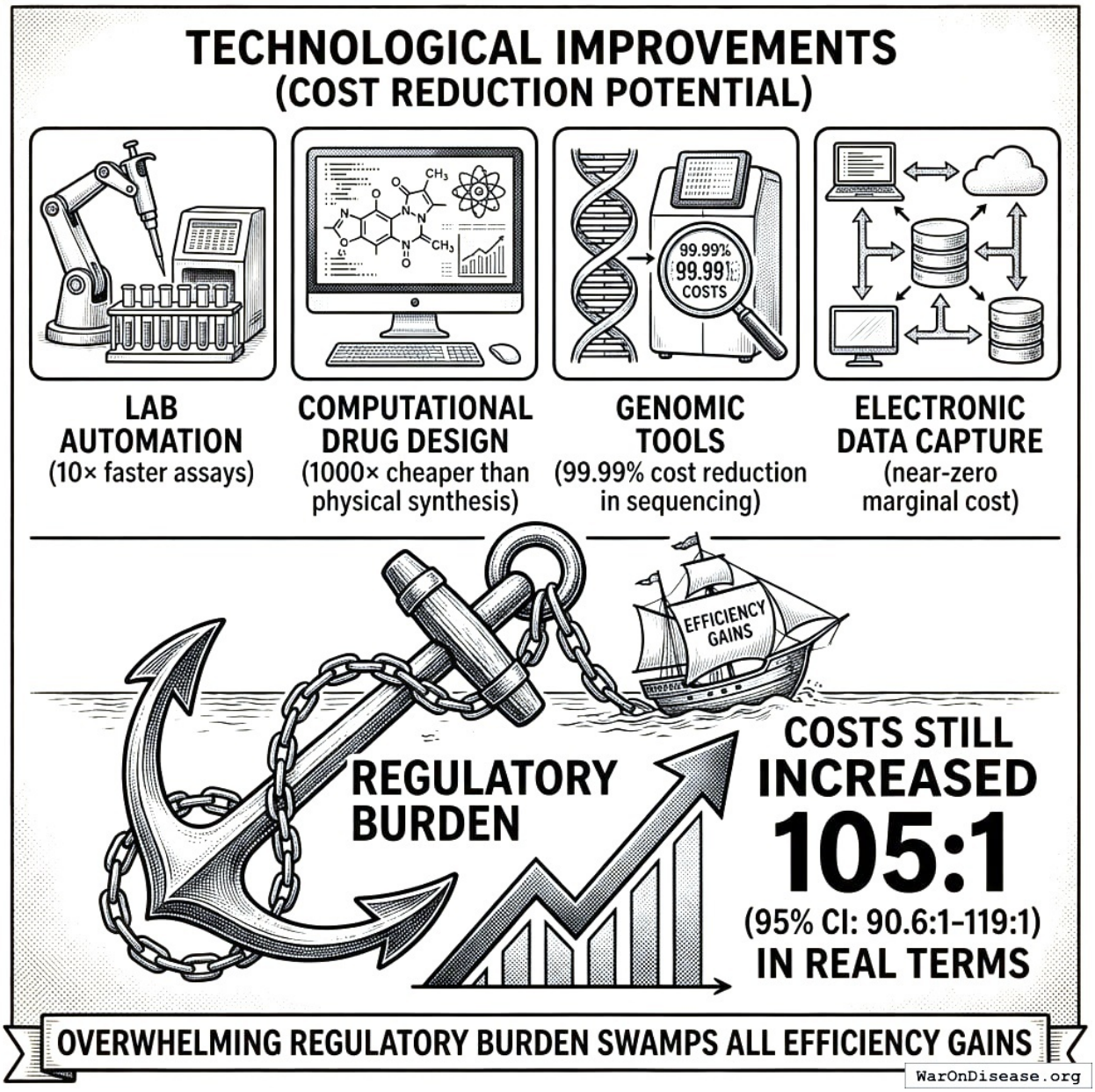


Figure 16: Computers got a million times cheaper. Labs got a million times faster. Drugs got a million times more expensive. You're doing it backwards.

What This Means

Three conclusions from a 105x (90% CI: 72.8x-149x) cost increase:

Fixing This Has Massive ROI

Cut drug development costs just **20%** by streamlining trials:

$$\text{Annual savings} = \$2.6B \times 0.20 \times 50 \text{ drugs/year} = \$26B/\text{year}$$

Pre-1962 System Wasn't Broken

Drugs developed under the pre-1962 regime (safety-only testing):

- **Antibiotics** (penicillin, streptomycin, tetracycline)
- **Vaccines** (polio, measles, rubella)
- **Insulin** (commercial production)
- **Antihistamines** (benadryl, dramamine)
- **Beta blockers** (propranolol)

These drugs saved **millions of lives** and remain in use today. The thalidomide tragedy was **a safety failure**, not an efficacy failure. The pre-1962 system already required safety testing.

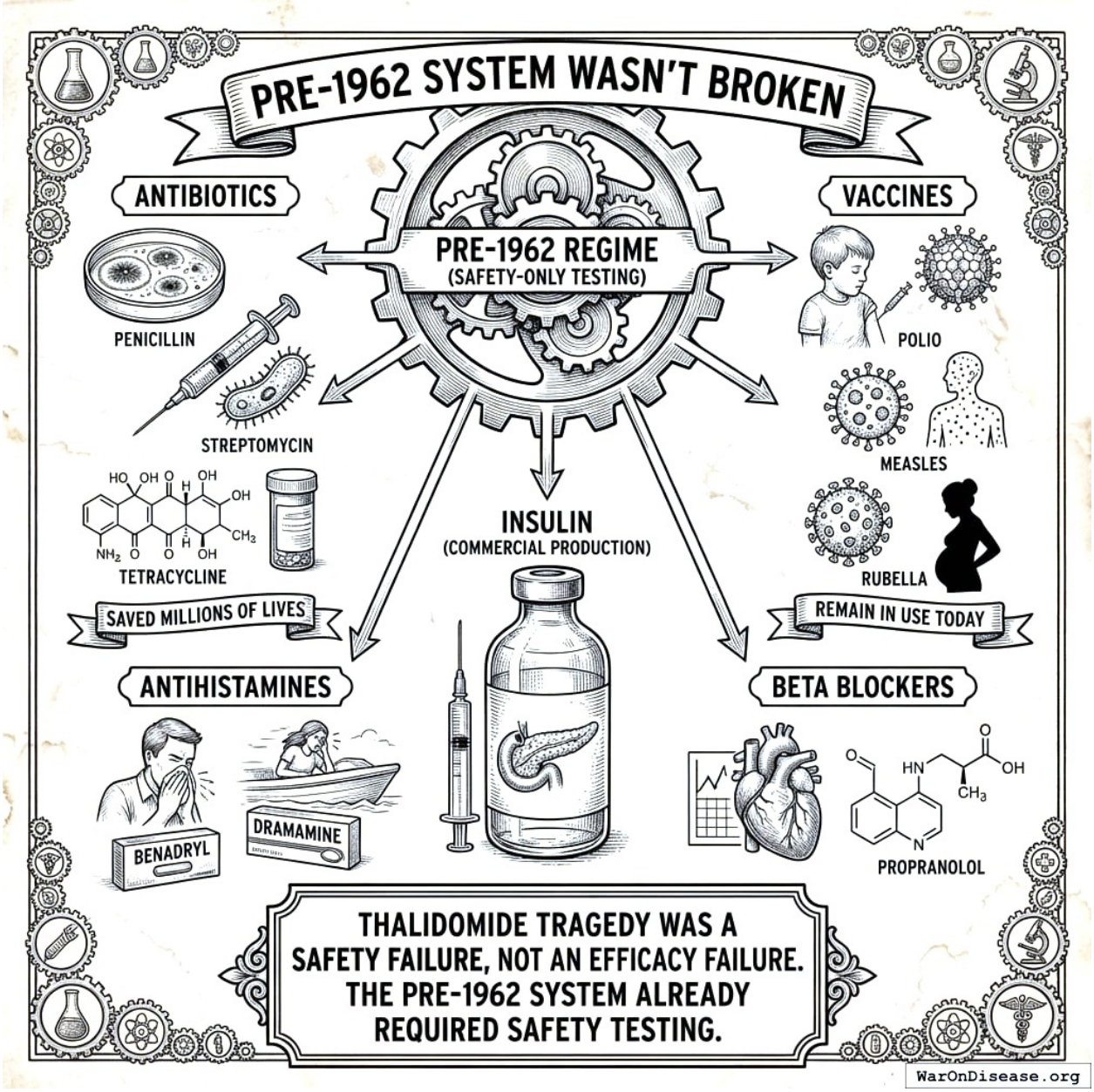


Figure 17: Before 1962, you invented polio vaccines, antibiotics, and insulin. After 1962, you invented forms. The forms won.

Real-World Evidence Can Reverse This

The RECOVERY trial demonstrated that **simple randomization** can:

- Reduce cost per patient by **82x (90% CI: 21.4x-195x)**
- Maintain scientific rigor
- Accelerate results (6 months vs. 5+ years)

Conclusion

The 105x (90% CI: 72.8x-149x) real cost increase is well-documented, conservative (some estimates hit 400x), and fixable. Multiple independent sources agree on the trajectory. The math is transparent. And the RECOVERY trial proved you can reverse it.

One law in 1962 turned a 2-3 year, $1.2M process into a 10-15 year, $2.6B gauntlet. That's not the cost of science. That's the cost of paperwork.

References

- Congressional testimony (1977): Pre-1962 drug costs[9]
- Tufts CSDD (2014): Current drug development costs[10]
- RECOVERY trial: Low-cost trial methodology
- Regulatory Mortality: Detailed cost analysis

Technical Parameters

Parameter	Value	Source
`PRE_1962_DRUG_DEVELOPMENT_COST`	$24.7 million (95% CI: $19.5 million-$30 million)	Congressional testimony (1962 dollars)
`PHARMA_DRUG_DEVELOPMENT_COST_CURRENT`	$2.6 billion (95% CI: $1.5 billion-$4 billion)	Tufts CSDD (2013 dollars)
`DRUG_COST_INCREASE_PRE1962_TO_CURRENT_MULTIPLIER`	105x (90% CI: 72.8x-149x)	Calculated with inflation adjustment
`TRIAL_COST_REDUCTION_FACTOR`	82x (90% CI: 21.4x-195x)	Per-patient cost increase

Methodology, Parameters, and Calculations

Overview

This appendix documents all 10 parameters used in the analysis, organized by type:

- External sources (peer-reviewed): 8
- Calculated values: 2
- Core definitions: 0

Quick Navigation

Calculated Values (2 parameters) • External Data Sources (8 parameters)

Calculated Values

Parameters derived from mathematical formulas and economic models.

Drug Cost Increase: Pre-1962 to Current: 105x

Details

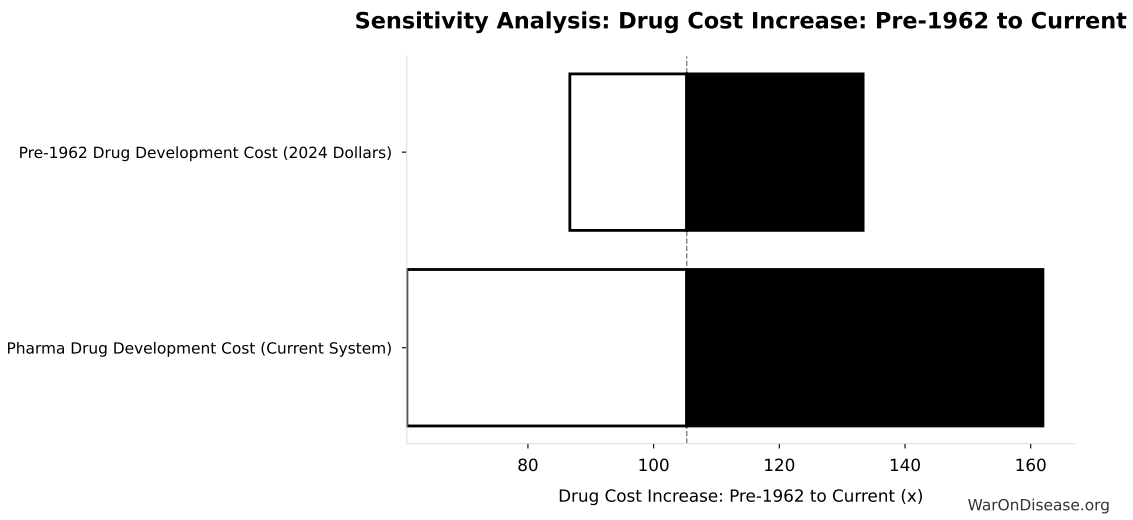
Drug development cost increase from pre-1962 to current
Inputs:

- Pharma Drug Development Cost (Current System) : $2.6 billion (95% CI: $1.5 billion - $4 billion)
- Pre-1962 Drug Development Cost (2024 Dollars) : $24.7 million (95% CI: $19.5 million - $30 million)

$$
\begin{aligned}
& k_{cost,pre62} \\
&= \frac{Cost_{dev,curr}}{Cost_{pre62,24}} \\
&= \frac{\$2.6B}{\$24.7M} \\
&= 105
\end{aligned}
$$

Methodology:[5]
High confidence

Sensitivity Analysis



Sensitivity Indices for Drug Cost Increase: Pre-1962 to Current
Regression-based sensitivity showing which inputs explain the most variance in the output.

Input Parameter	Sensitivity Coefficient	Interpretation
Pharma Drug Development Cost (Current System) (USD)	0.8709	Strong driver
Pre-1962 Drug Development Cost (2024 Dollars) (USD)	-0.4736	Moderate driver

Interpretation: Standardized coefficients show the change in output (in SD units) per 1 SD change in input. Values near ±1 indicate strong influence; values exceeding ±1 may occur with correlated inputs.

Monte Carlo Distribution

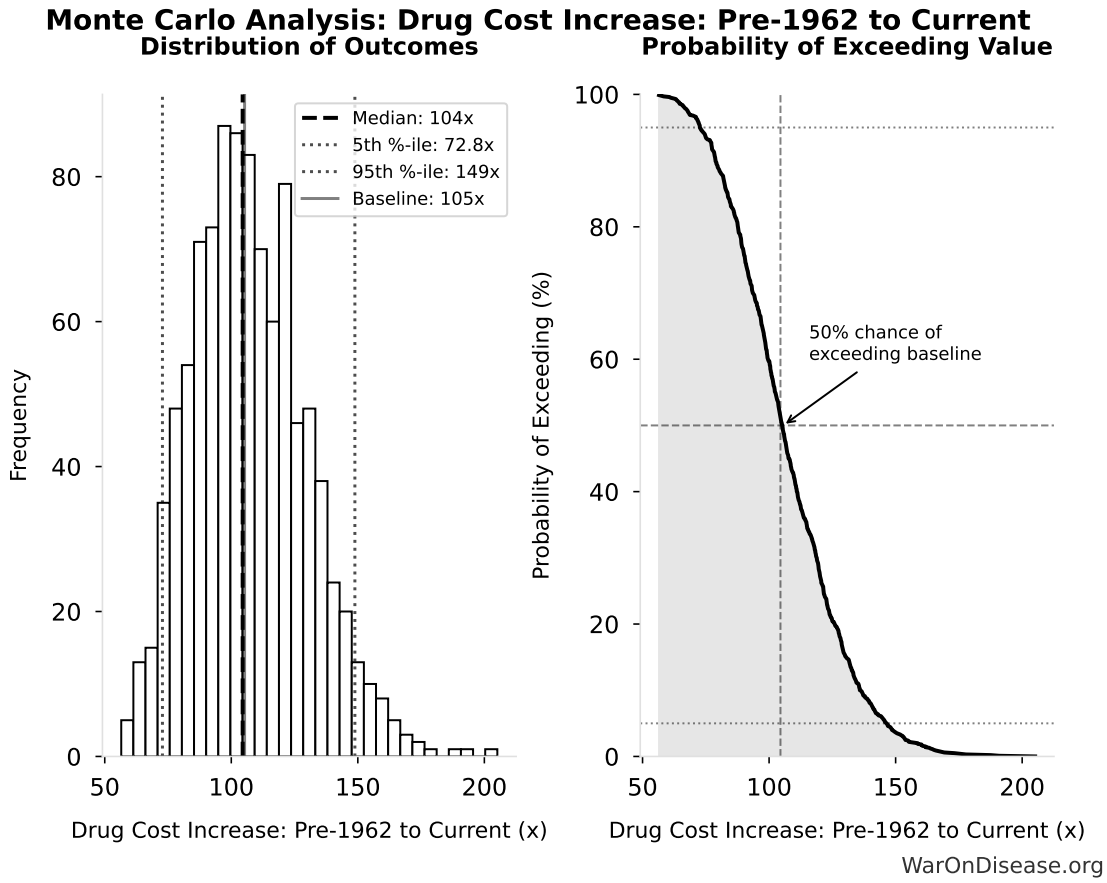


Figure 18: Monte Carlo Distribution: Drug Cost Increase: Pre-1962 to Current (10,000 simulations)

Simulation Results Summary: Drug Cost Increase: Pre-1962 to Current

Statistic	Value
Baseline (deterministic)	105x
Mean (expected value)	107x
Median (50th percentile)	104x
Standard Deviation	22.9x
90% Range (5th-95th percentile)	[72.8x, 149x]

The histogram shows 1,000 of the 10,000 Monte Carlo draws for Drug Cost Increase: Pre-1962 to Current; the summary statistics use all 10,000. The exceedance curve (right) shows the probability of the outcome exceeding any given value.

Exceedance Probability

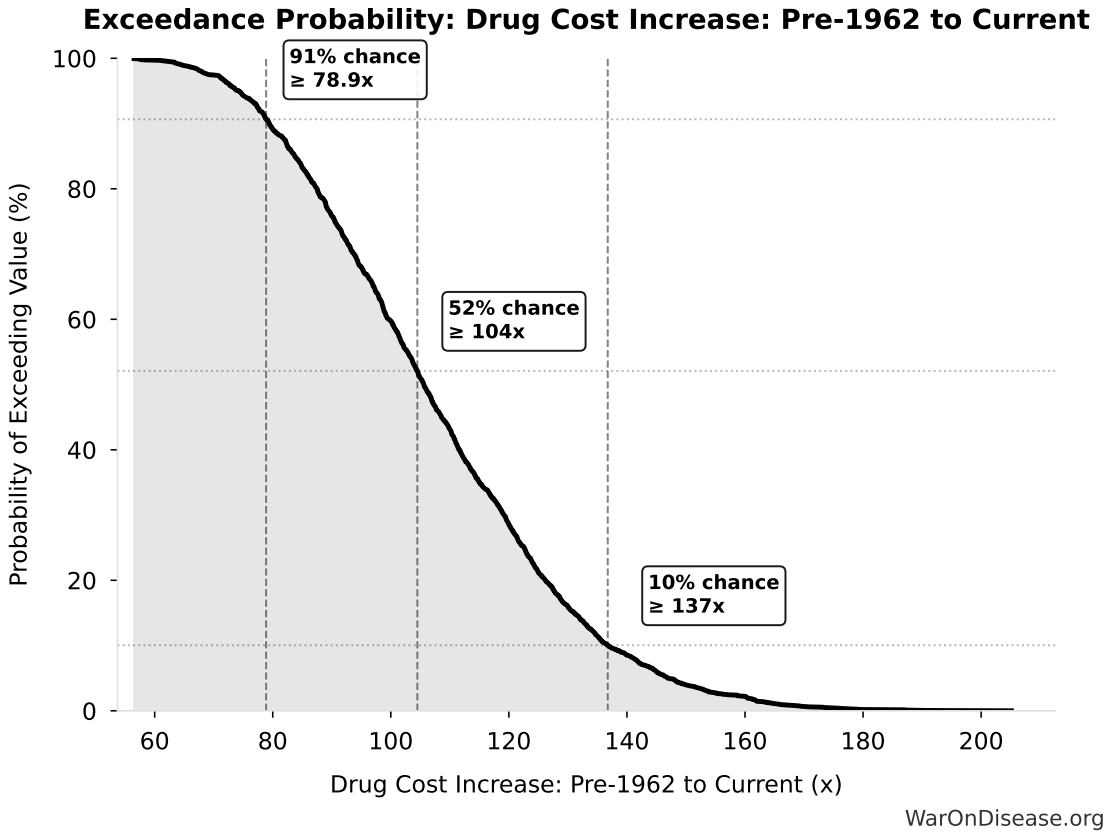


Figure 19: Probability of Exceeding Threshold: Drug Cost Increase: Pre-1962 to Current

This exceedance probability chart shows the likelihood that Drug Cost Increase: Pre-1962 to Current will exceed any given threshold. The higher the curve at a threshold, the more likely the value exceeds it.

RECOVERY Trial Cost Reduction Factor: 82x

Details

Cost reduction factor demonstrated by RECOVERY trial (traditional Phase 3 cost / RECOVERY cost per patient)

Inputs:

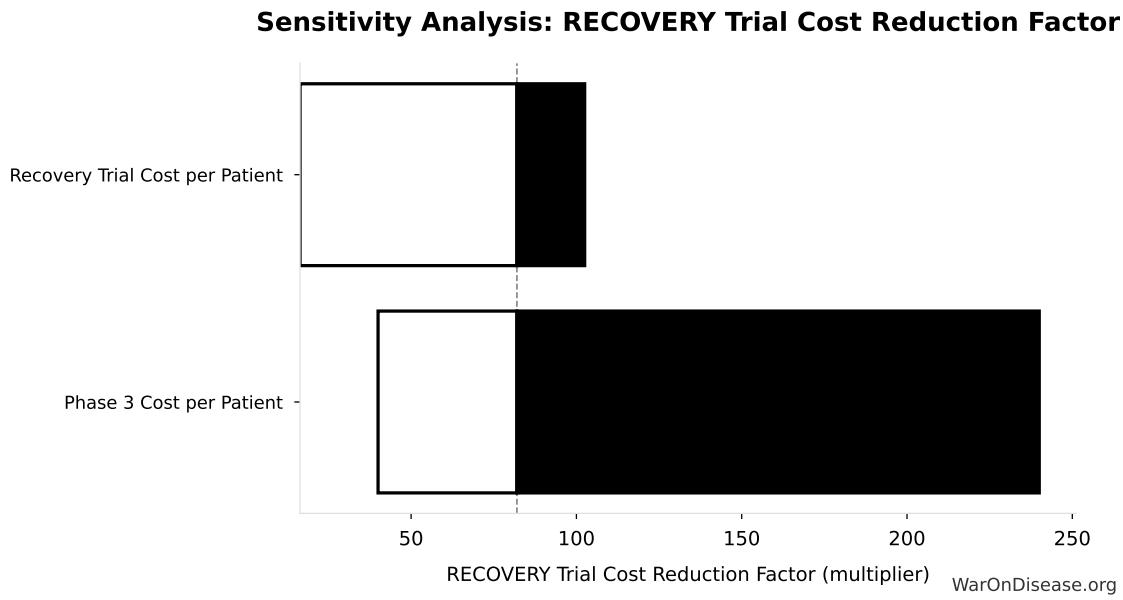
- Phase 3 Cost per Patient : $41,000 (95% CI: $20,000 - $120,000)

- Recovery Trial Cost per Patient : $500 (95% CI: $400 - $2,500)

$$
\begin{aligned}
k_{RECOVERY} &= \frac{Cost_{P3,pt}}{Cost_{RECOVERY,pt}} \\
&= \frac{\$41K}{\$500} \\
&= 82
\end{aligned}
$$

Methodology:[11]
High confidence

Sensitivity Analysis



Sensitivity Indices for RECOVERY Trial Cost Reduction Factor
Regression-based sensitivity showing which inputs explain the most variance in the output.

Input Parameter	Sensitivity Coefficient	Interpretation
Phase 3 Cost per Patient (USD/patient)	0.8407	Strong driver
Recovery Trial Cost per Patient (USD/patient)	-0.4419	Moderate driver

Interpretation: Standardized coefficients show the change in output (in SD units) per 1 SD change in input. Values near ±1 indicate strong influence; values exceeding ±1 may occur with correlated inputs.

Monte Carlo Distribution

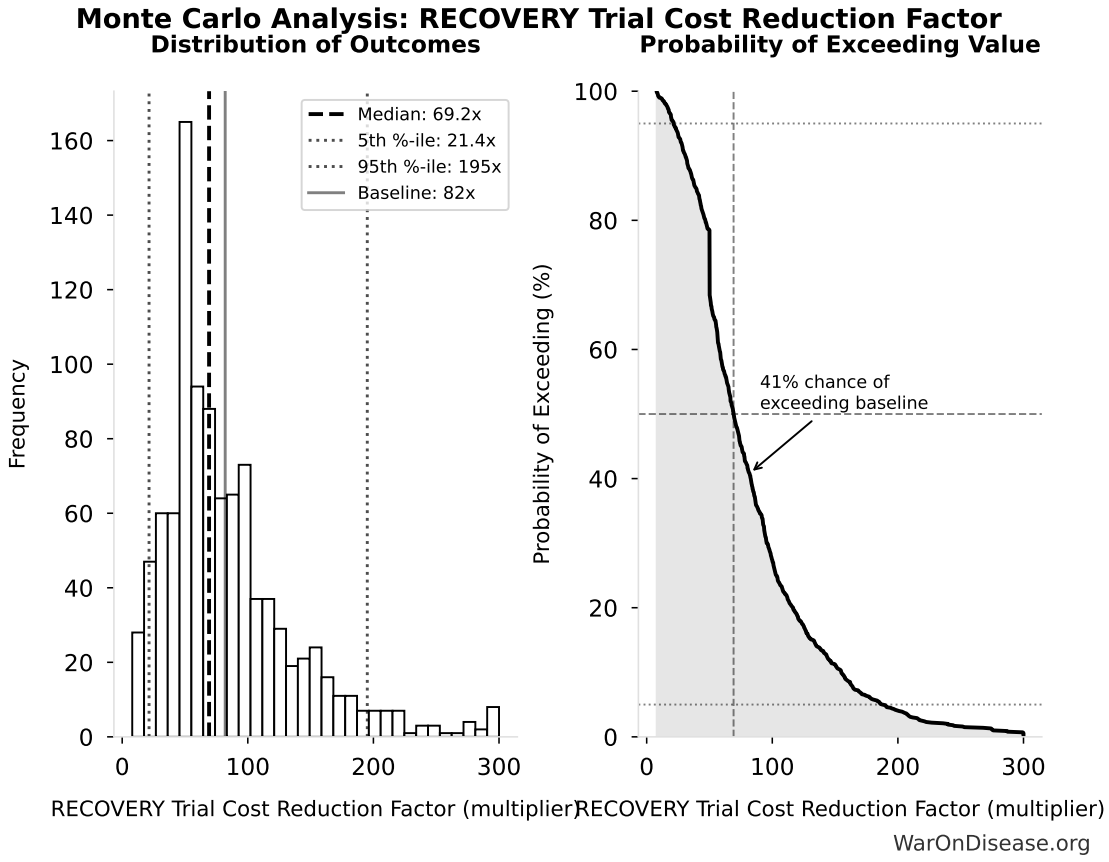


Figure 20: Monte Carlo Distribution: RECOVERY Trial Cost Reduction Factor (10,000 simulations)

Simulation Results Summary: RECOVERY Trial Cost Reduction Factor

Statistic	Value
Baseline (deterministic)	82x
Mean (expected value)	84.2x
Median (50th percentile)	69.2x
Standard Deviation	54.5x
90% Range (5th-95th percentile)	[21.4x, 195x]

The histogram shows 1,000 of the 10,000 Monte Carlo draws for RECOVERY Trial Cost Reduction Factor; the summary statistics use all 10,000. The exceedance curve (right) shows the probability of the outcome exceeding any given value.

Exceedance Probability

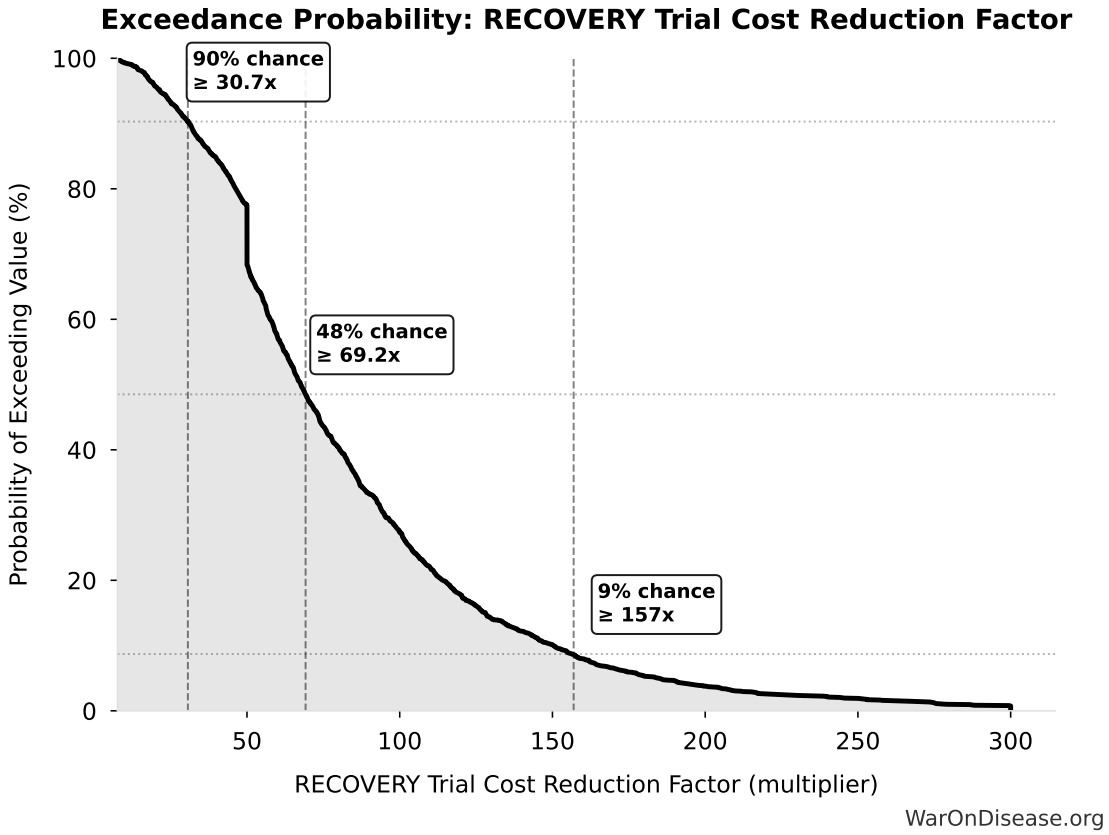


Figure 21: Probability of Exceeding Threshold: RECOVERY Trial Cost Reduction Factor

This exceedance probability chart shows the likelihood that RECOVERY Trial Cost Reduction Factor will exceed any given threshold. The higher the curve at a threshold, the more likely the value exceeds it.

External Data Sources

Parameters sourced from peer-reviewed publications, institutional databases, and authoritative reports.

CPI Multiplier: 1980 to 2024: 3.8:1

Details

CPI inflation multiplier from 1980 to 2024 (280.48% cumulative inflation)
Source:[1]

Uncertainty Range

Technical: 95% CI: [3.75:1, 3.85:1] • Distribution: Normal
What this means: We're quite confident in this estimate. The true value likely falls between 3.75:1 and 3.85:1 (±1%). This represents a narrow range that our Monte Carlo simulations account for when calculating overall uncertainty in the results.
The normal distribution means values cluster around the center with equal chances of being higher or lower.

Input Distribution

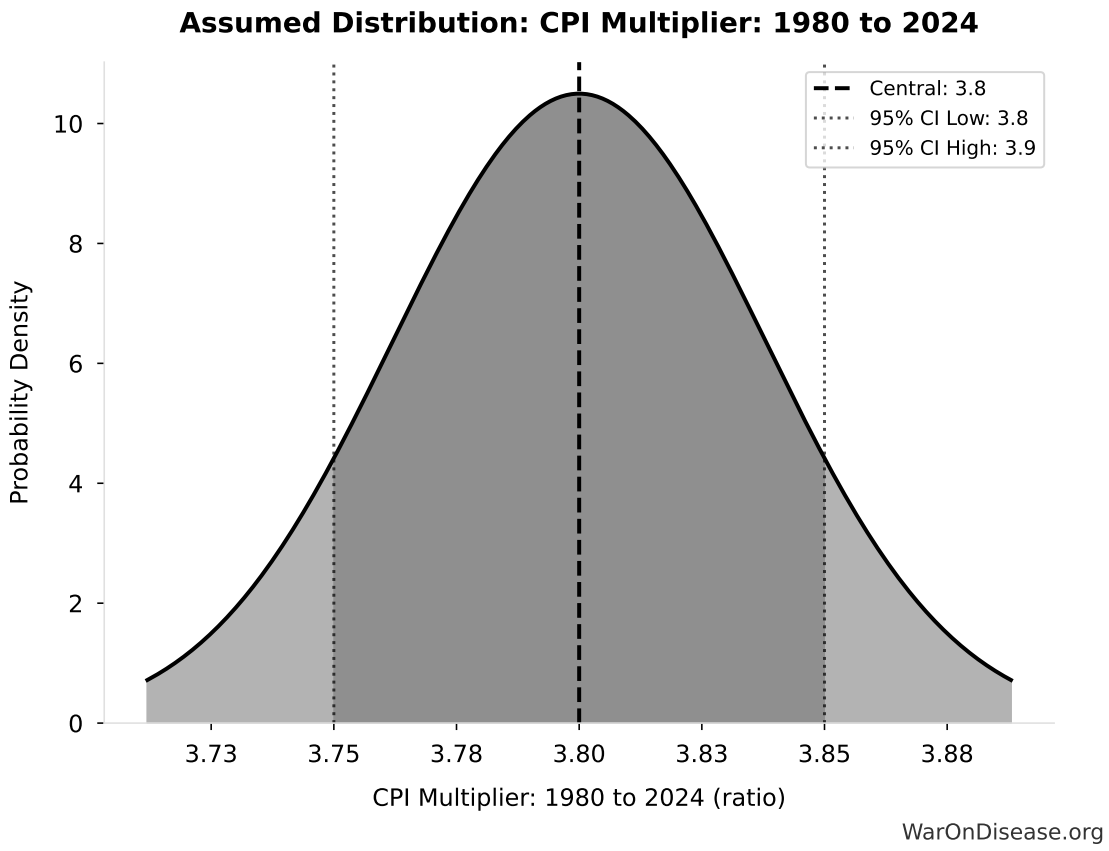


Figure 22: Probability Distribution: CPI Multiplier: 1980 to 2024

This chart shows the assumed probability distribution for this parameter. The shaded region represents the 95% confidence interval where we expect the true value to fall.
High confidence

Average Annual New Drug Approvals Globally: 50 drugs/year

Details

Average annual new drug approvals globally
Source:[2]

Uncertainty Range

Technical: 95% CI: [45 drugs/year, 60 drugs/year] • Distribution: Lognormal
What this means: This estimate has moderate uncertainty. The true value likely falls between 45 drugs/year and 60 drugs/year (±15%). This represents a reasonable range that our Monte Carlo simulations account for when calculating overall uncertainty in the results. *The lognormal distribution means values can't go negative and have a longer tail toward higher values (common for costs and populations).*

Input Distribution

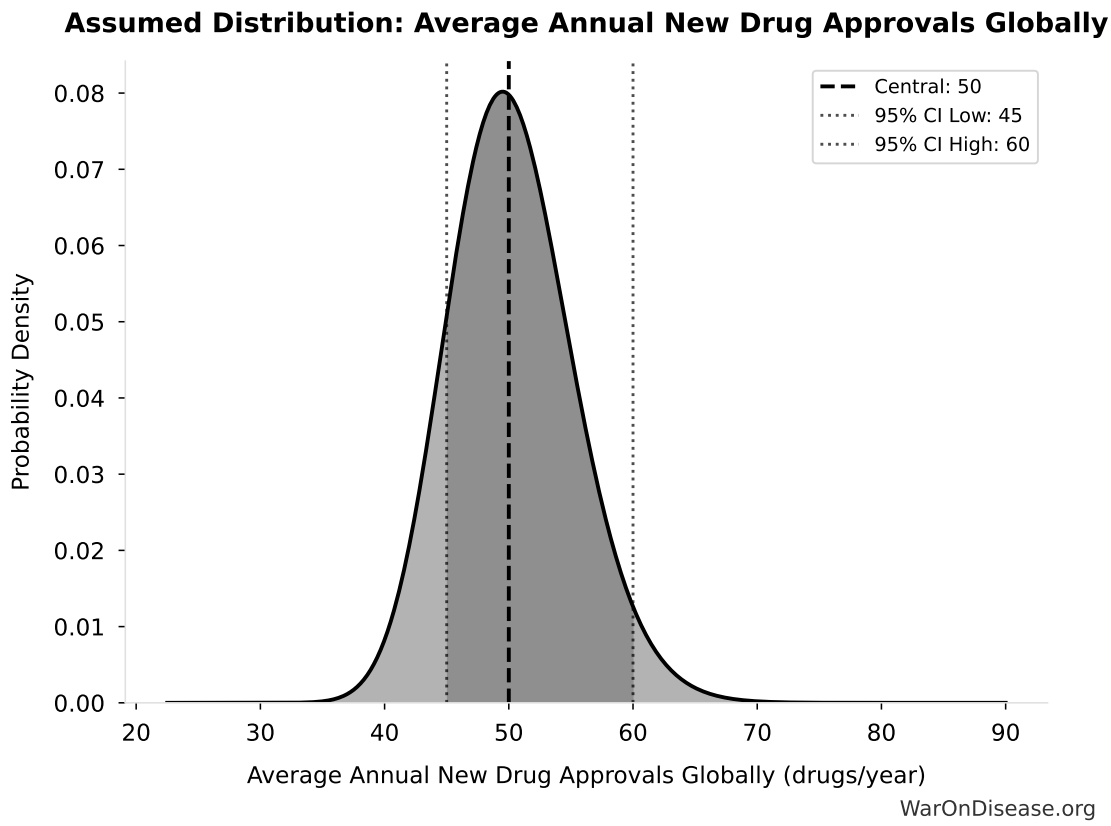


Figure 23: Probability Distribution: Average Annual New Drug Approvals Globally

This chart shows the assumed probability distribution for this parameter. The shaded region represents the 95% confidence interval where we expect the true value to fall.
High confidence

Pharma Drug Development Cost (Current System): $2.6 billion

Details

Average cost to develop one drug in current system
Source:[3]

Uncertainty Range

Technical: 95% CI: [$1.5 billion, $4 billion] • Distribution: Lognormal (SE: $500 million)
What this means: There's significant uncertainty here. The true value likely falls between $1.5 billion and $4 billion (±48%). This represents a wide range that our Monte Carlo

simulations account for when calculating overall uncertainty in the results.
The lognormal distribution means values can't go negative and have a longer tail toward higher values (common for costs and populations).

Input Distribution

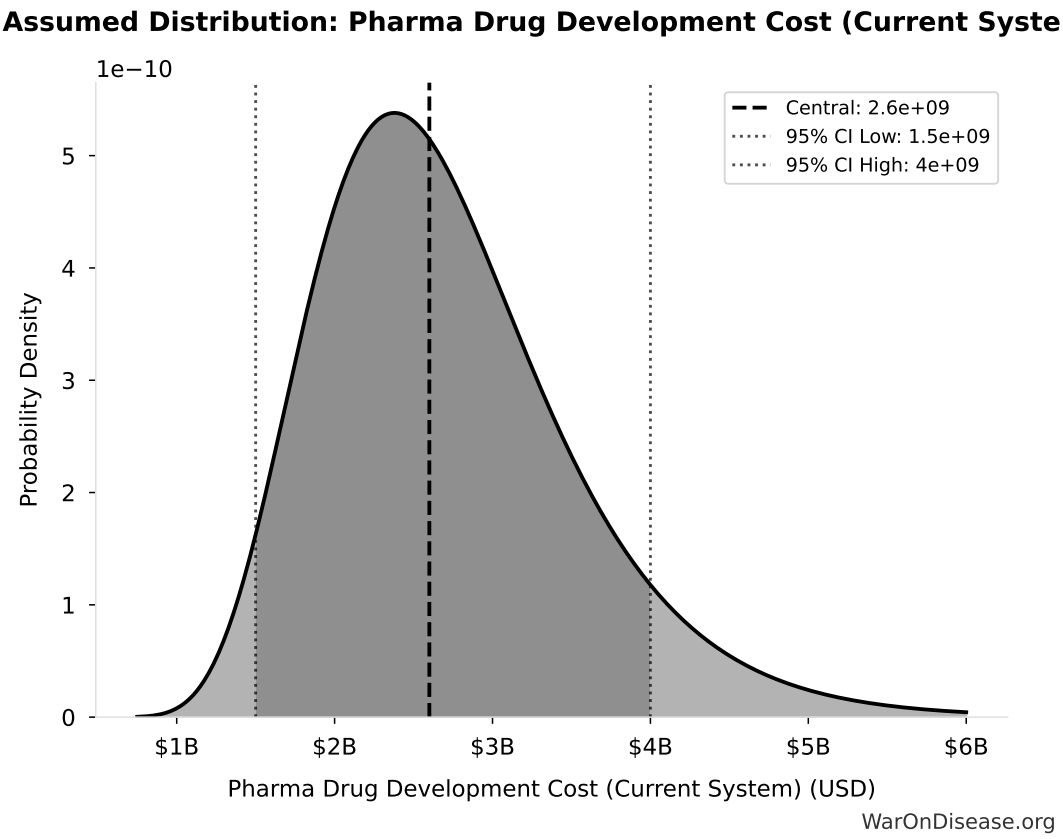


Figure 24: Probability Distribution: Pharma Drug Development Cost (Current System)

This chart shows the assumed probability distribution for this parameter. The shaded region represents the 95% confidence interval where we expect the true value to fall.
High confidence • Peer-reviewed

Pragmatic Trial Median Cost per Patient (PMC Review): $97

Details

Median cost per patient in embedded pragmatic clinical trials (Ramsberg & Platt 2018: 108 trials reviewed, 64 with cost data). IQR: $19-$478 (2015 USD).
Source:[4]

Uncertainty Range

Technical: 95% CI: [$19, $478] • Distribution: Lognormal
What this means: This estimate is highly uncertain. The true value likely falls between $19 and $478 (±237%). This represents a very wide range that our Monte Carlo simulations account for when calculating overall uncertainty in the results.
The lognormal distribution means values can't go negative and have a longer tail toward higher values (common for costs and populations).

Input Distribution

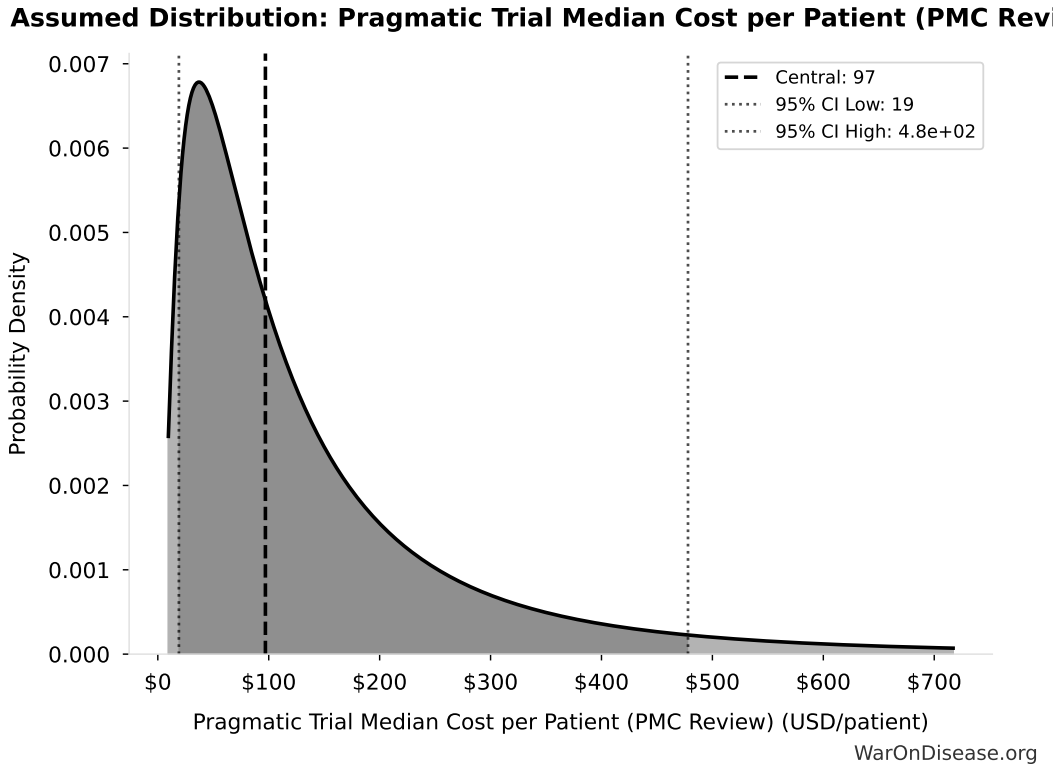


Figure 25: Probability Distribution: Pragmatic Trial Median Cost per Patient (PMC Review)

This chart shows the assumed probability distribution for this parameter. The shaded region represents the 95% confidence interval where we expect the true value to fall.
High confidence

Pre-1962 Drug Development Cost (1980 Dollars): $6.5 million

Details

Average drug development cost before 1962 FDA efficacy regulations, adjusted to 1980 dollars (Baily 1972)
Source:[5]

Uncertainty Range

Technical: 95% CI: [$5.2 million, $7.8 million] • Distribution: Lognormal
What this means: This estimate has moderate uncertainty. The true value likely falls between $5.2 million and $7.8 million (±20%). This represents a reasonable range that our Monte Carlo simulations account for when calculating overall uncertainty in the results.
The lognormal distribution means values can't go negative and have a longer tail toward higher values (common for costs and populations).

Input Distribution

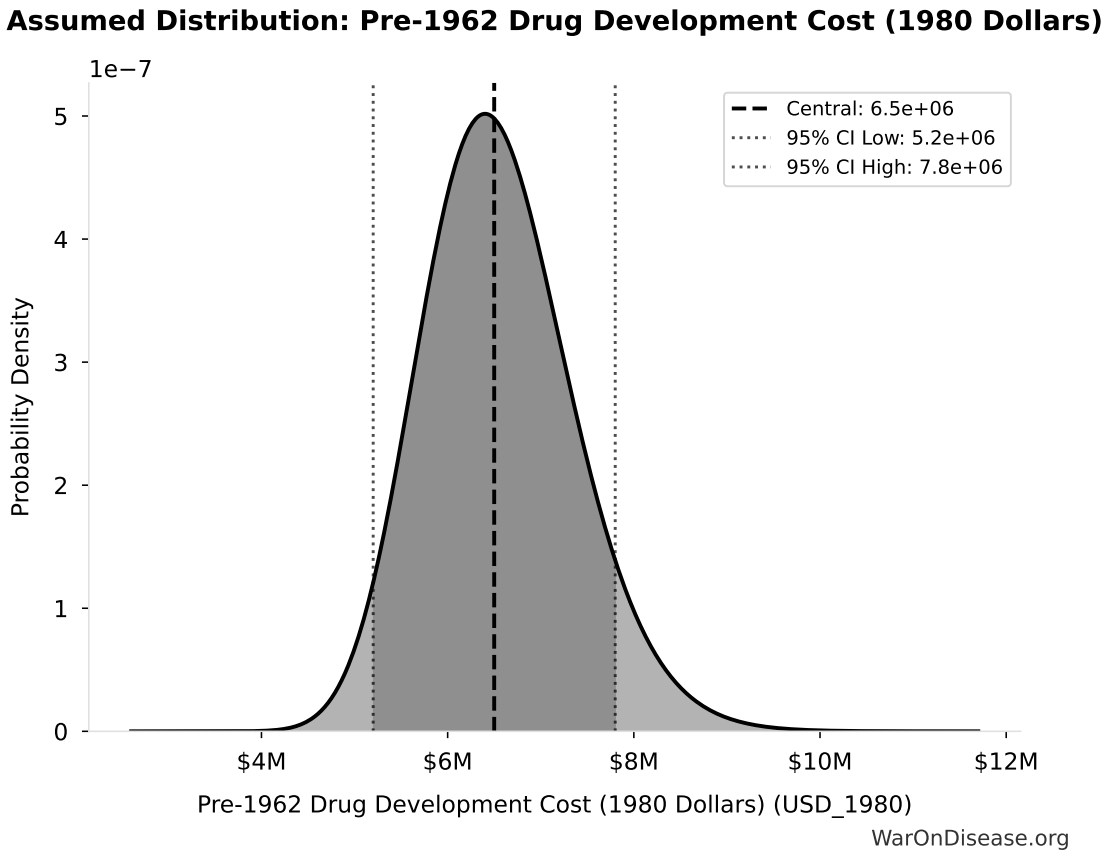


Figure 26: Probability Distribution: Pre-1962 Drug Development Cost (1980 Dollars)

This chart shows the assumed probability distribution for this parameter. The shaded region represents the 95% confidence interval where we expect the true value to fall.
High confidence • *Peer-reviewed*

Pre-1962 Drug Development Cost (2024 Dollars): $24.7 million

Details

Pre-1962 drug development cost adjusted to 2024 dollars ($6.5M × 3.80 = $24.7M, CPI-adjusted from Baily 1972)
Source:[5]

Uncertainty Range

Technical: 95% CI: [$19.5 million, $30 million] • Distribution: Lognormal
What this means: This estimate has moderate uncertainty. The true value likely falls between $19.5 million and $30 million (±21%). This represents a reasonable range that our Monte Carlo simulations account for when calculating overall uncertainty in the results.
The lognormal distribution means values can't go negative and have a longer tail toward higher values (common for costs and populations).

Input Distribution

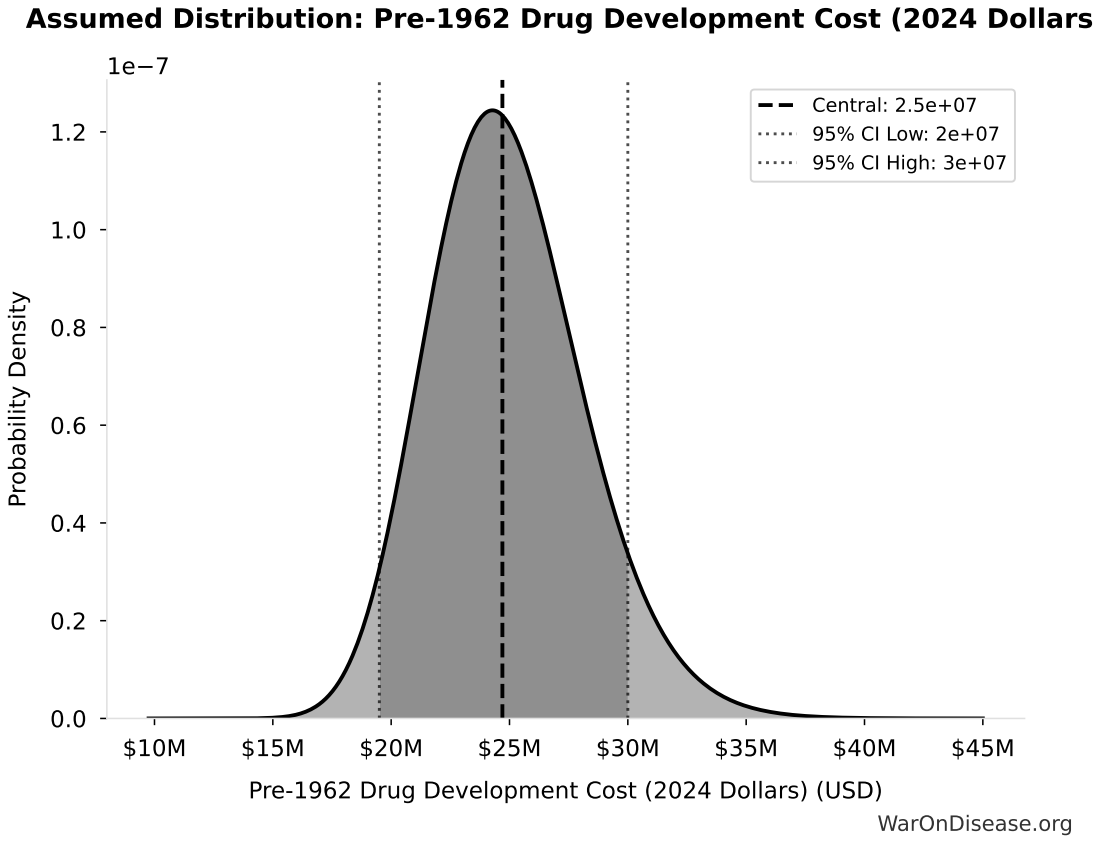


Figure 27: Probability Distribution: Pre-1962 Drug Development Cost (2024 Dollars)

This chart shows the assumed probability distribution for this parameter. The shaded region represents the 95% confidence interval where we expect the true value to fall.
High confidence • *Peer-reviewed*

Recovery Trial Cost per Patient: $500

Details

RECOVERY trial cost per patient. Note: RECOVERY was an outlier - hospital-based during COVID emergency, minimal extra procedures, existing NHS infrastructure, streamlined consent. Replicating this globally will be harder.
Source:[12]

Uncertainty Range

Technical: 95% CI: [$400, $2,500] • Distribution: Lognormal

What this means: This estimate is highly uncertain. The true value likely falls between $400 and $2,500 (±210%). This represents a very wide range that our Monte Carlo simulations account for when calculating overall uncertainty in the results.
The lognormal distribution means values can't go negative and have a longer tail toward higher values (common for costs and populations).

Input Distribution

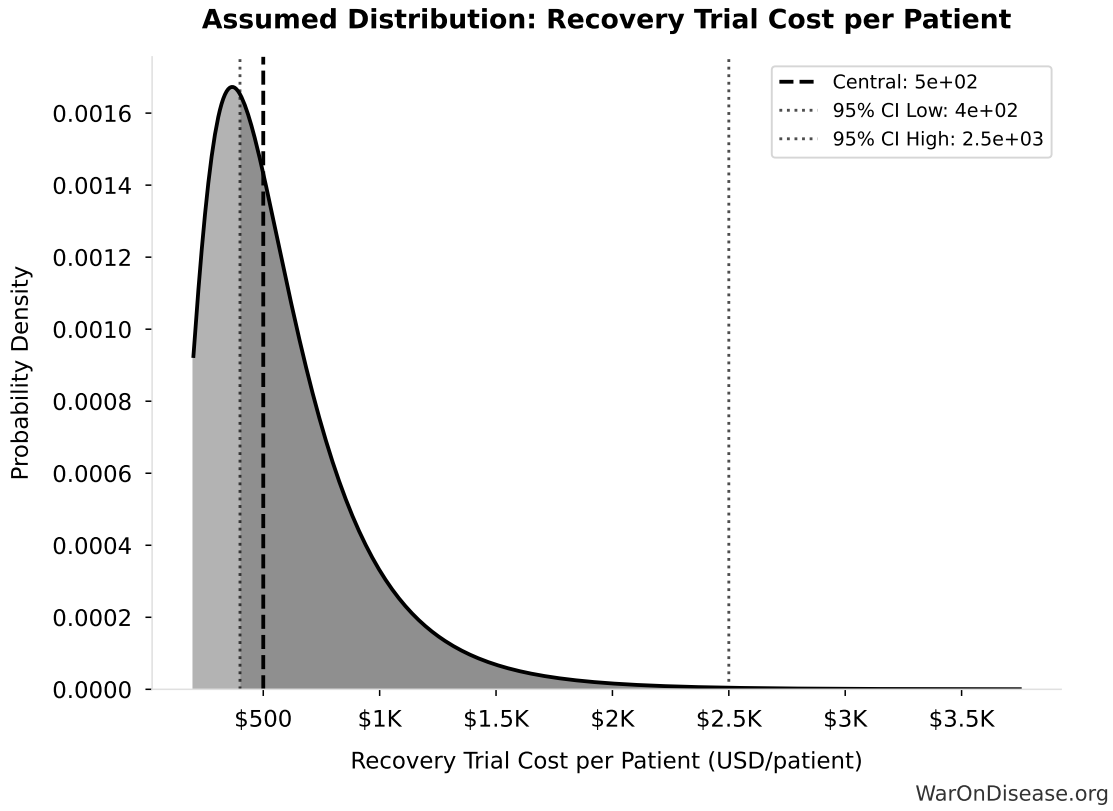


Figure 28: Probability Distribution: Recovery Trial Cost per Patient

This chart shows the assumed probability distribution for this parameter. The shaded region represents the 95% confidence interval where we expect the true value to fall.
High confidence

Phase 3 Cost per Patient: $41,000

Details

Phase 3 cost per patient (median from FDA study)
Source:[13]

Uncertainty Range

Technical: 95% CI: [$20,000, $120,000] • Distribution: Lognormal
What this means: This estimate is highly uncertain. The true value likely falls between $20,000 and $120,000 (±122%). This represents a very wide range that our Monte Carlo simulations account for when calculating overall uncertainty in the results.
The lognormal distribution means values can't go negative and have a longer tail toward higher values (common for costs and populations).

Input Distribution

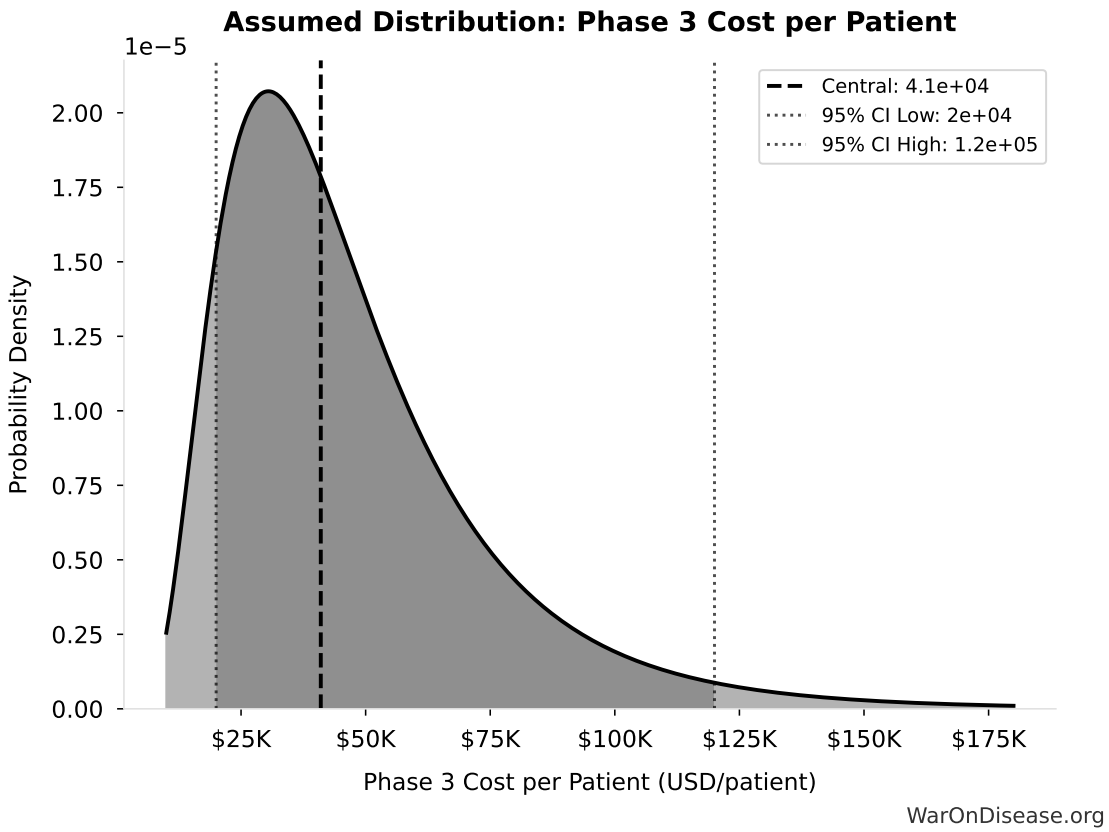


Figure 29: Probability Distribution: Phase 3 Cost per Patient

This chart shows the assumed probability distribution for this parameter. The shaded region represents the 95% confidence interval where we expect the true value to fall.

High confidence

Source Quotes and References

1. U.S. Bureau of Labor Statistics. CPI inflation calculator. (2024)
CPI-U (1980): 82.4 CPI-U (2024): 313.5 Inflation multiplier (1980-2024): 3.80× Cumulative. inflation: 280.48% Average annual inflation rate: 3.08% Note: Official U.S. government inflation data using Consumer Price Index for All Urban Consumers (CPI-U). Additional sources: https://www.bls.gov/data/inflation_calculator.htm
2. C&EN. Annual number of new drugs approved globally: 50. *C&EN* https://cen.acs.org/pharmaceuticals/50-new-drugs-received-FDA/103/i2 (2025)
50 new drugs approved annually Additional sources: https://cen.acs.org/pharmaceuticals/50-new-drugs-received-FDA/103/i2 | https://www.fda.gov/drugs/development-approval-process-drugs/novel-drug-approvals-fda
3. Tufts CSDD. Cost of drug development.
Various estimates suggest $1.0 - $2.5 billion to bring a new drug from discovery through FDA approval, spread across 10 years. Tufts Center for the Study of Drug Development often cited for $1.0 - $2.6 billion/drug. Industry reports (IQVIA, Deloitte) also highlight $2+ billion figures.
4. Ramsberg, J. & Platt, R. Pragmatic trial cost per patient (median $97). *Learning Health Systems* https://pmc.ncbi.nlm.nih.gov/articles/PMC6508852/ (2018)
Meta-analysis of 108 embedded pragmatic clinical trials (2006-2016). The median cost per. patient was $97 (IQR $19–$478), based on 2015 dollars. 25% of trials cost <$19/patient; 10 trials exceeded $1,000/patient. U.S. studies median $187 vs non-U.S. median $27. Additional sources: https://pmc.ncbi.nlm.nih.gov/articles/PMC6508852/
5. Baily, M. N. Pre-1962 drug development costs (baily 1972). *Baily (1972)* https://samizdathealth.org/wp-content/uploads/2020/12/hlthaff.1.2.6.pdf (1972)
Pre-1962: Average cost per new chemical entity (NCE) was $6.5 million (1980 dollars). Inflation-adjusted to 2024 dollars: $6.5M (1980) $22.5M (2024), using CPI multiplier of 3.46× Real cost increase (inflation-adjusted): $22.5M (pre-1962) → $2,600M (2024) = 116× increase Note: This represents the most comprehensive academic estimate of pre-1962 drug development costs based on empirical industry data Additional sources: https://samizdathealth.org/wp-content/uploads/2020/12/hlthaff.1.2.6.pdf
6. DiMasi, J. A., Grabowski, H. G. & Hansen, R. W. Innovation in the pharmaceutical industry: New estimates of r&d costs. *Journal of Health Economics* https://doi.org/10.1016/j.jhealeco.2016.01.012 (2016) doi:10.1016/j.jhealeco.2016.01.012.
7. Tufts Center for the Study of Drug Development. Cost to develop and win marketing approval for a new drug is $2.6 billion. (2014).
8. FDA. Generic drug substitution savings. *FDA* https://www.fda.gov/drugs/generic-drugs/generic-drug-facts.

9. *Pre-1962 Drug Development Costs (Congressional Testimony, Alternative Estimate).* https://www.congress.gov/95/crecb/1977/04/21/GPO-CRECB-1977-pt10-2-3.pdf (1977)
1962: Average cost $1.2 million (in 1962 dollars) 1972: $11.5 million 1977: Projected $40. million Inflation-adjusted to 2024 dollars: $1.2M (1962) $12M (2024), using CPI multiplier of 10× Real cost increase (inflation-adjusted): $12M (1962) → $2,600M (2024) = 217× increase Note: Lower estimate than Baily (1972); may reflect incomplete cost accounting or different drug types. Baily's $6.5M (1980 dollars) = $22.5M (2024 dollars) is the more rigorous academic estimate Additional sources: https://www.congress.gov/95/crecb/1977/04/21/GPO-CRECB-1977-pt10-2-3.pdf

10. Tufts Center for the Study of Drug Development. Tufts center drug development cost estimate 2021. (2021)
Total cost to develop a new drug estimated at $2.6 billion as of 2021, nearly a 3-fold increase from $802 million in 2003 (inflation-adjusted).

11. Manhattan Institute. RECOVERY trial 82× cost reduction. *Manhattan Institute: Slow Costly Trials* https://manhattan.institute/article/slow-costly-clinical-trials-drag-down-biomedical-breakthroughs
RECOVERY trial: $500 per patient ($20M for 48,000 patients = $417/patient) Typical clinical trial: $41,000 median per-patient cost Cost reduction: 80-82× cheaper ($41,000 ÷ $500 82×) Efficiency: $50 per patient per answer (10 therapeutics tested, 4 effective) Dexamethasone estimated to save >630,000 lives Additional sources: https://manhattan.institute/article/slow-costly-clinical-trials-drag-down-biomedical-breakthroughs | https://pmc.ncbi.nlm.nih.gov/articles/PMC9293394/

12. Oren Cass, Manhattan Institute. RECOVERY trial cost per patient. *Oren Cass* https://manhattan.institute/article/slow-costly-clinical-trials-drag-down-biomedical-breakthroughs (2023)
The RECOVERY trial, for example, cost only about $500 per patient... By contrast, the median per-patient cost of a pivotal trial for a new therapeutic is around $41,000. Additional sources: https://manhattan.institute/article/slow-costly-clinical-trials-drag-down-biomedical-breakthroughs

13. FDA Study via NCBI. Trial costs, FDA study. *FDA Study via NCBI* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6248200/
Overall, the 138 clinical trials had an estimated median (IQR) cost of $19.0 million ($12.2. million-$33.1 million)... The clinical trials cost a median (IQR) of $41,117 ($31,802-$82,362) per patient. Additional sources: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6248200/