The mortality reduction patterns produced by cancer screening

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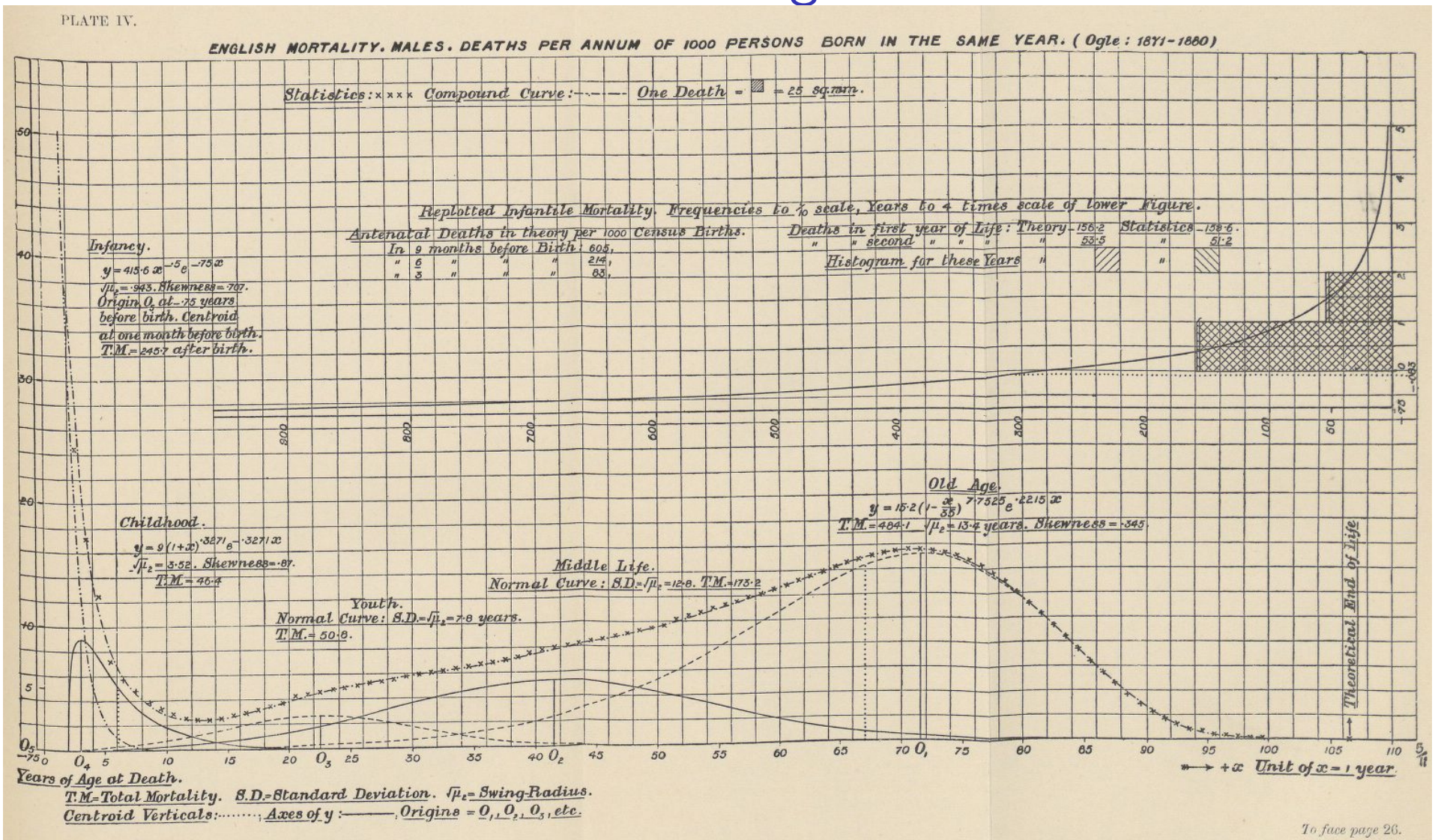
Outline

Animations of the force of mortality - Turner & Hanley SSC 2009

Models/simulations/animations to study mortality patterns in cancer screening - Liu SSC2012/2013

Pearson's fitted 5-component mixture for frequency distribution of age at death



Analyzed in his 1897 essay *The Chances of Death*.

Rendered by Karl Pearson's wife, Maria Sharpe Pearson.

21st century animation of Pearson's Bridge of Life

Mortality Reductions Produced by Cancer Screening Programs & Trials

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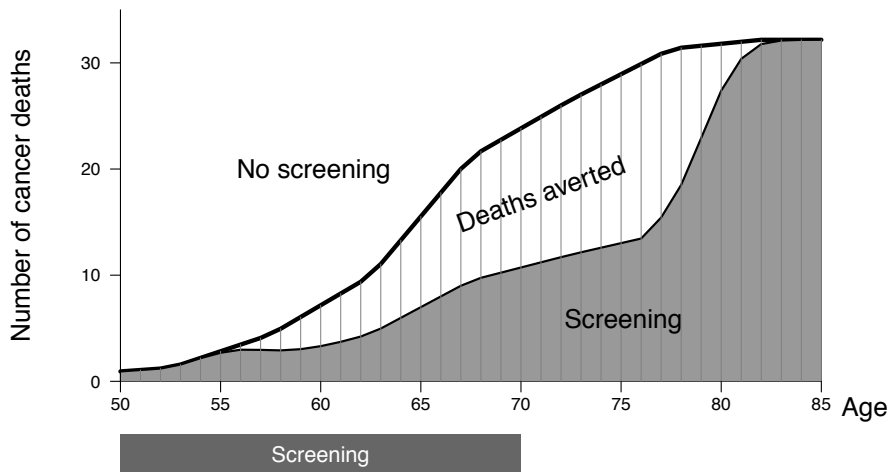
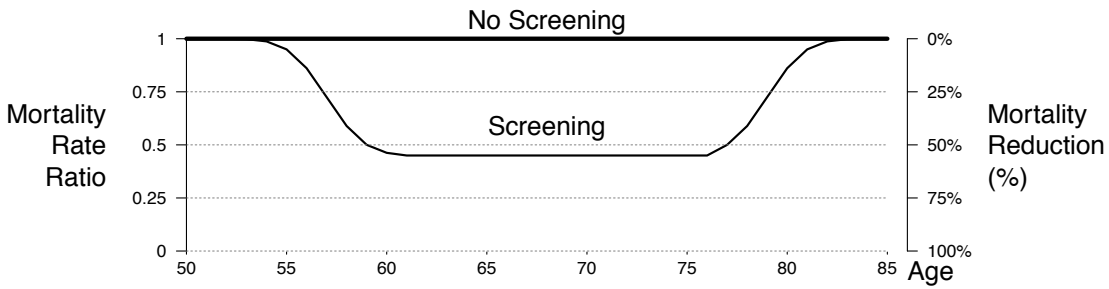


(b) The corresponding cancer mortality rate ratio curve



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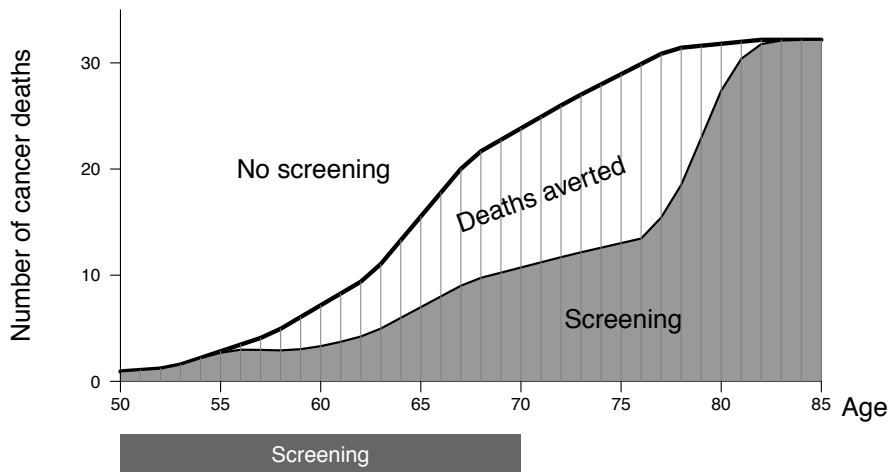

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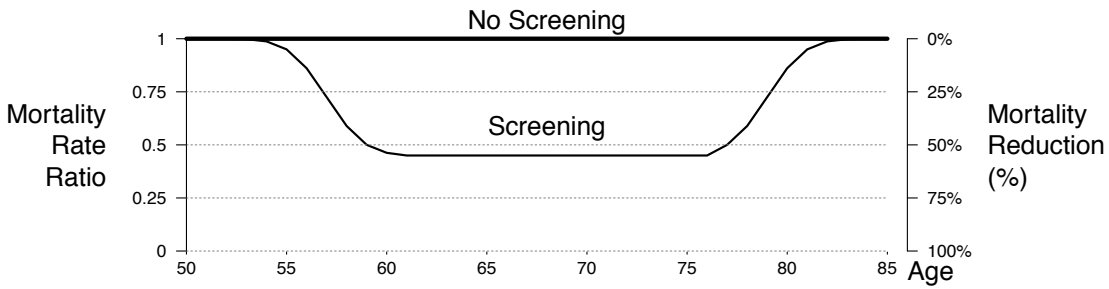

Delay (usually ignored in data-analysis) explained in later slides

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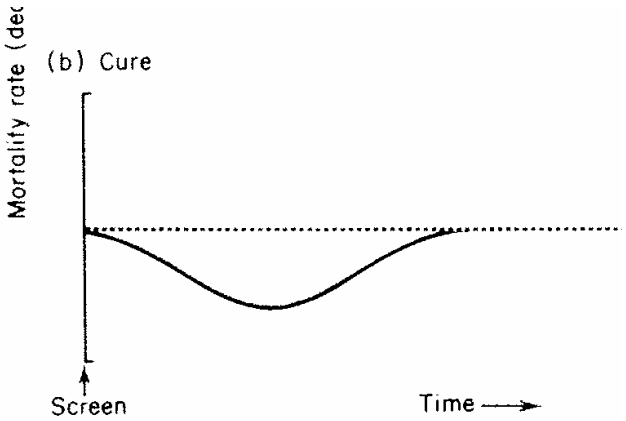
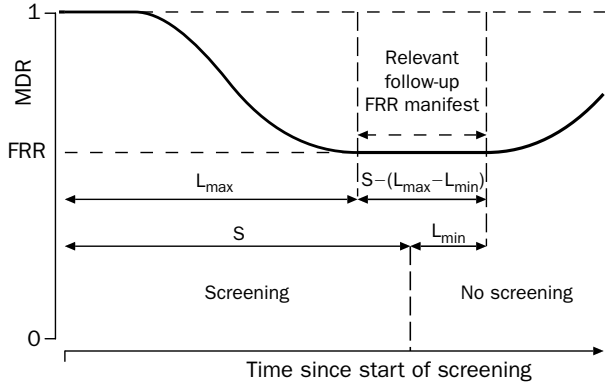
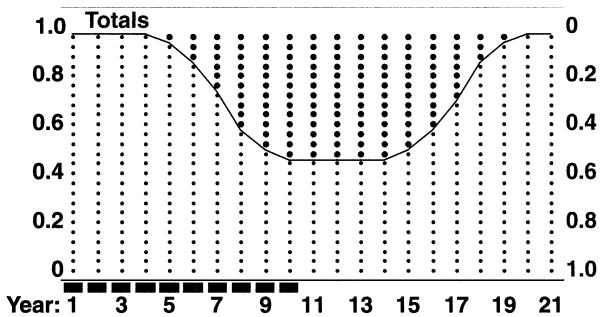


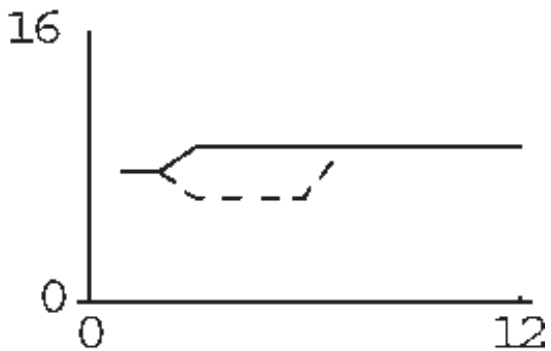
(a) Morrison [6]



(b) Miettinen et al. [8]



(c) Hanley [9]



(d) Baker et al. [10]

(a) 1985 textbook (b) 2002 The Lancet (c) 2005 Epidemiology (d) 2008 J Med Screening

BUT... (a), (c), and (d) don't explain how bathtub shape arises

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- Adopt simple model for reductions produced by 1 round
- Can fit this model to observed data in trial(s)
- What shape should this parametric model take?

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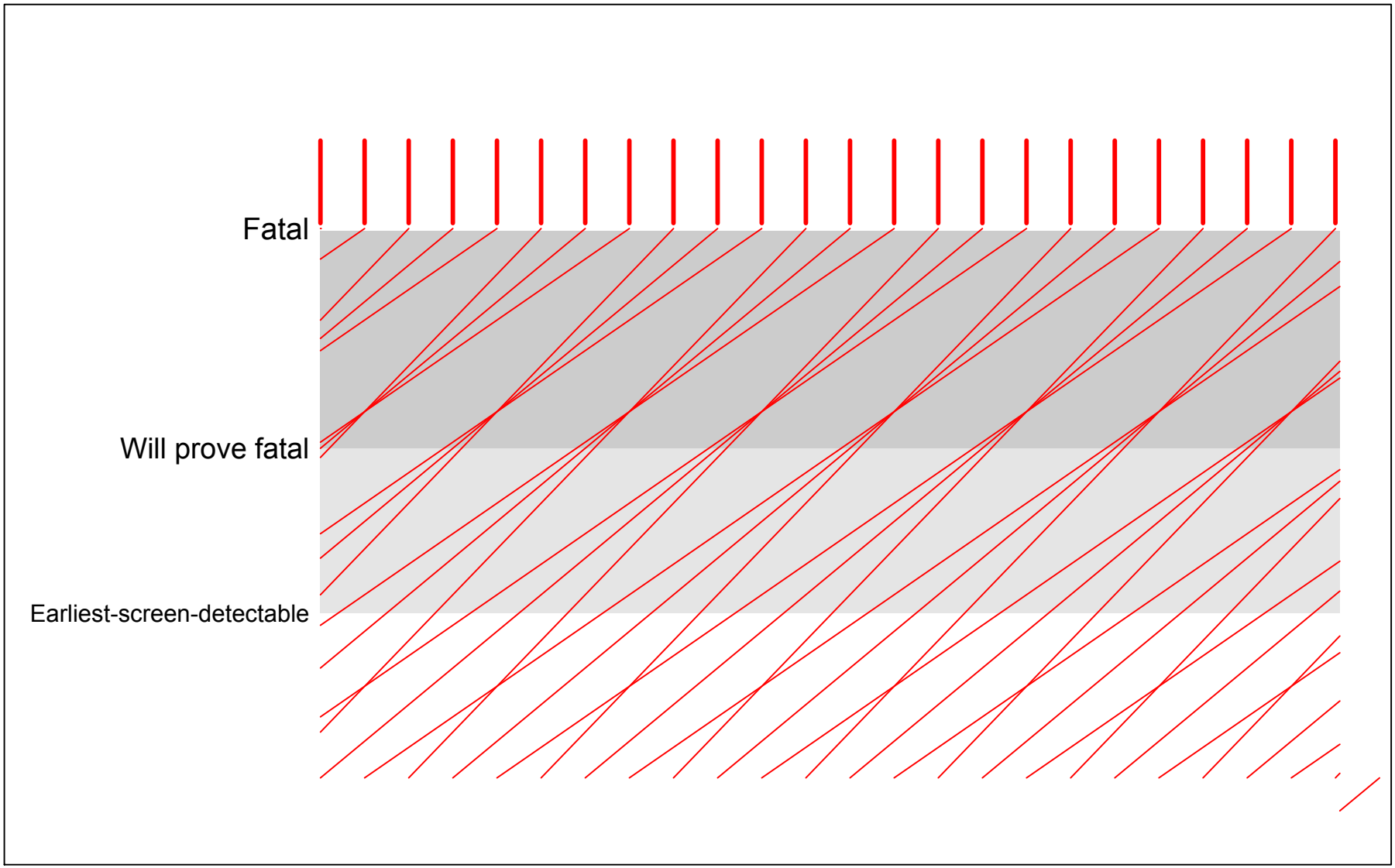
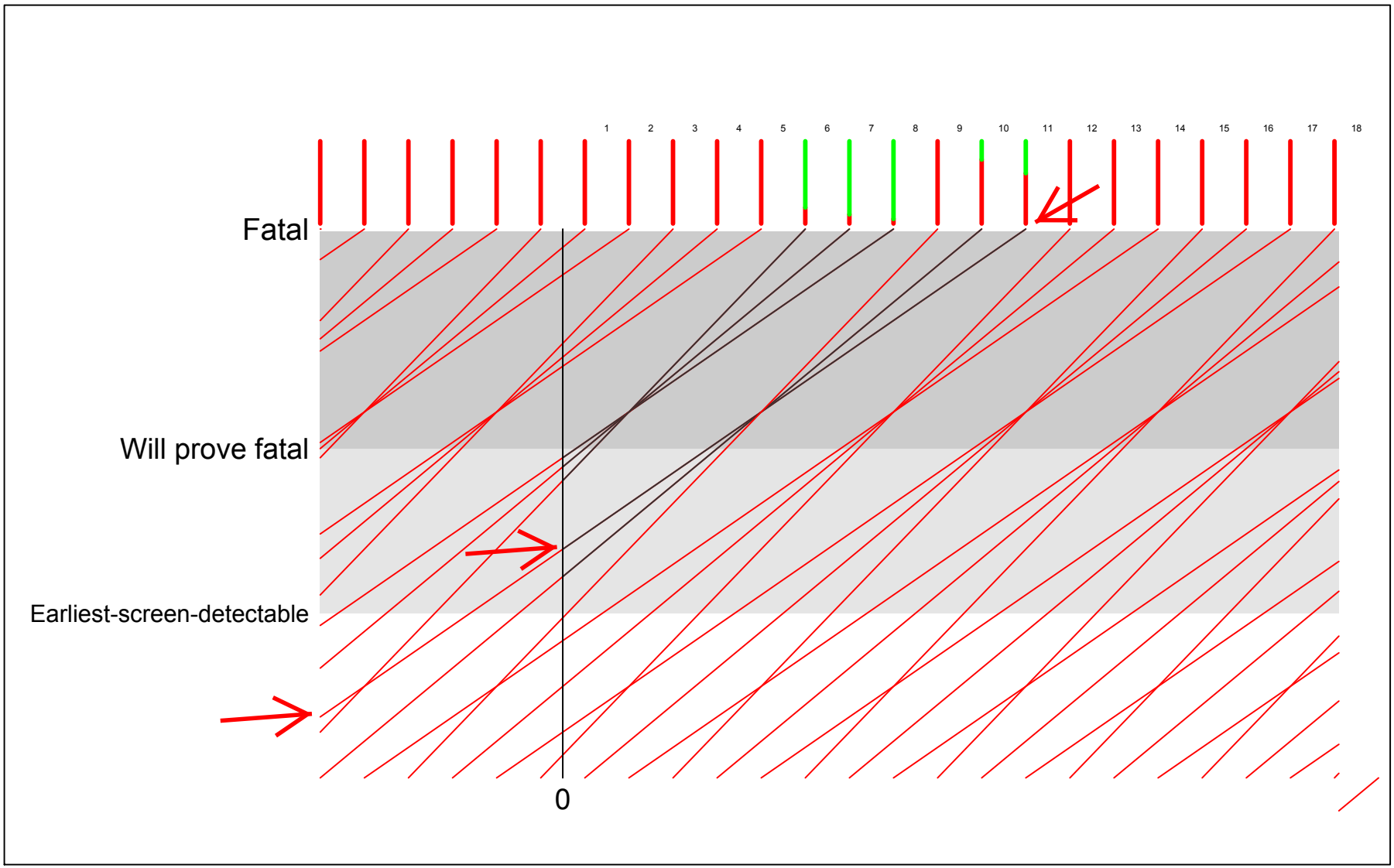
- posit latest date when still curable & earliest date detectable

3-speed model - no screening



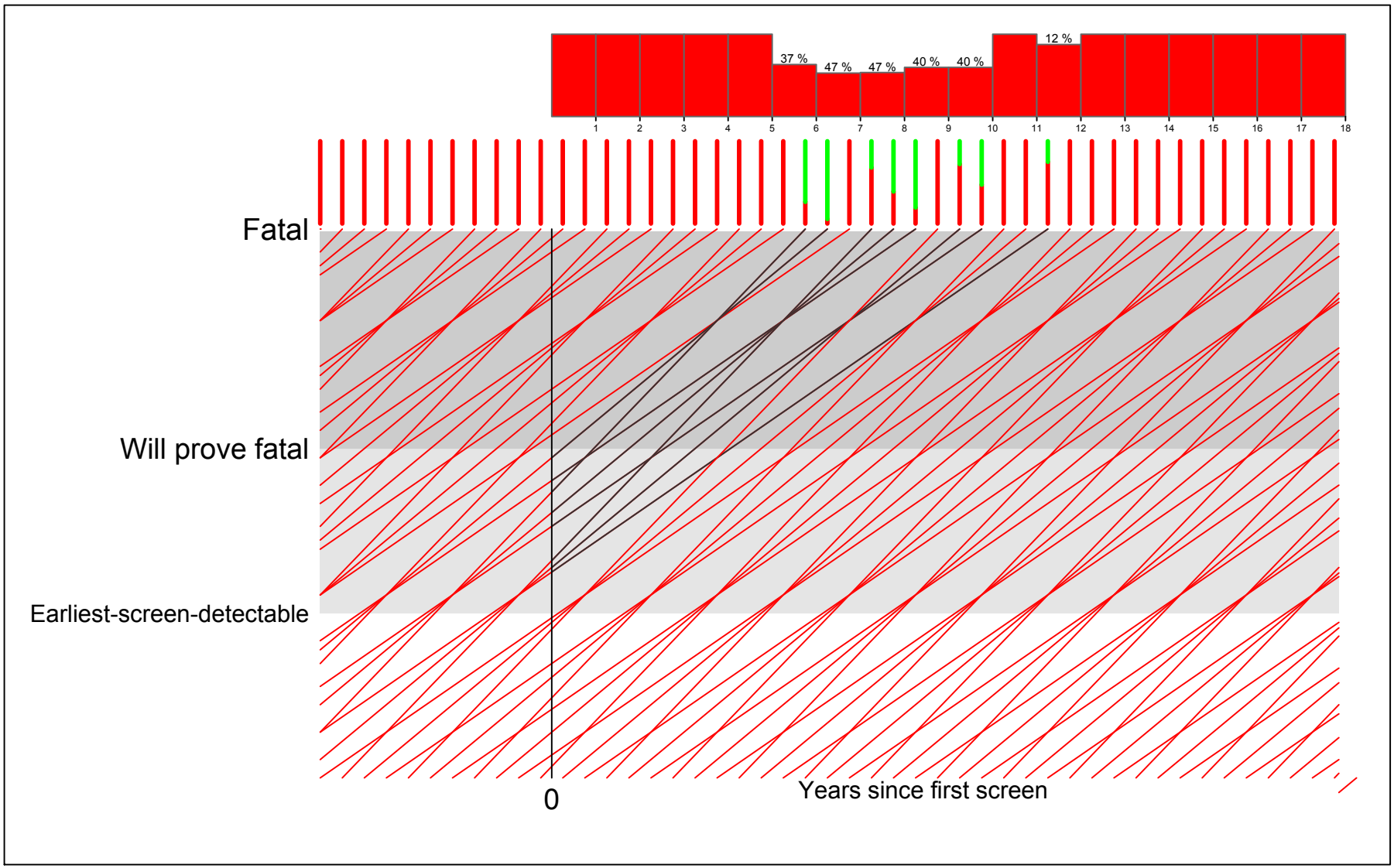
y-axis: 'stage'; x-axis: time ; diagonal line: progress of cancer

3-speed model - 1 round of screening



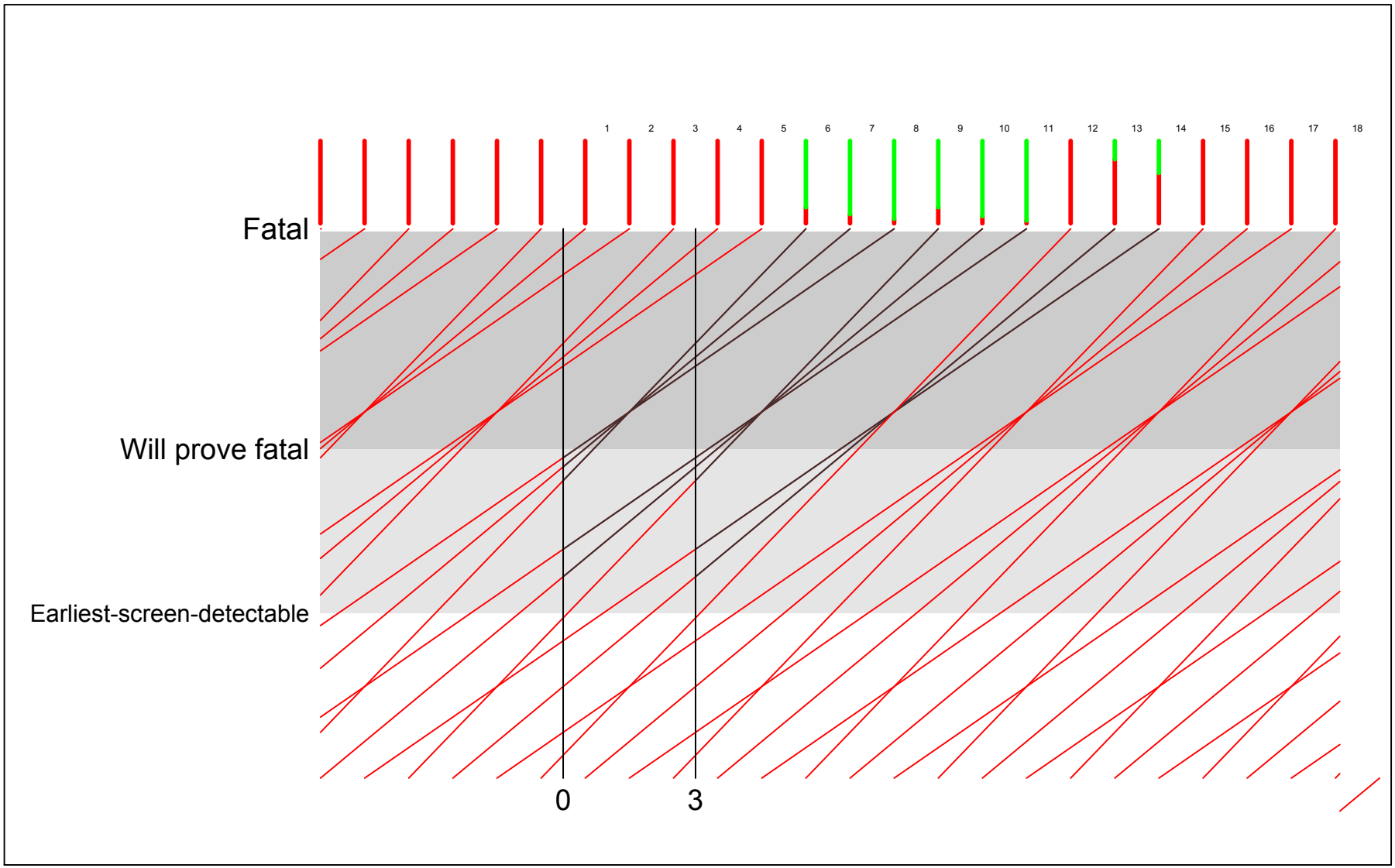
vertical line: 1 screen: diagonal line: progress possibility arrested; | probability

1 round of screening, smoother example



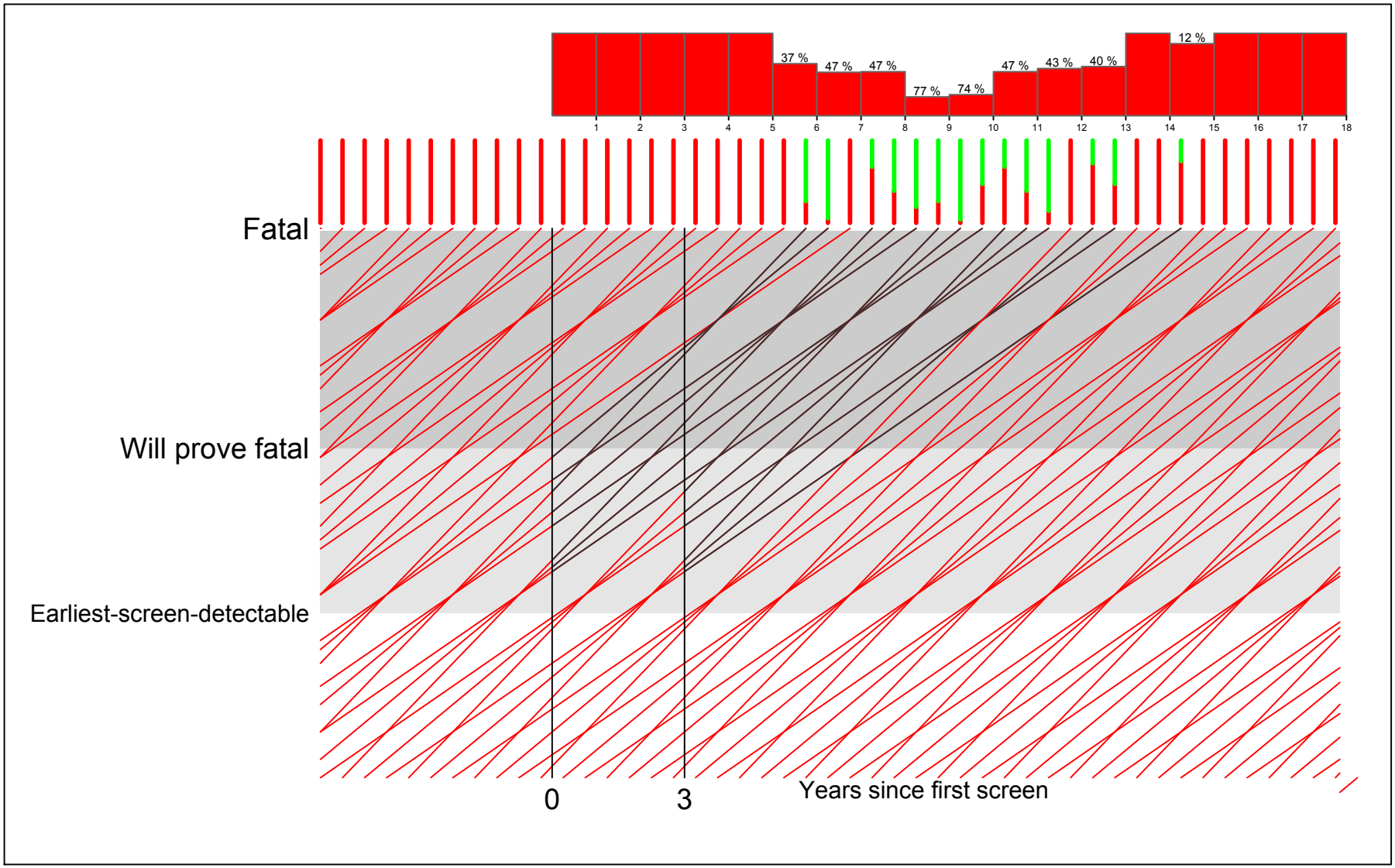
w.l.o.g. 2 'otherwise fatal' cancers/year; %↓ would apply whatever no./year

2 rounds of screening

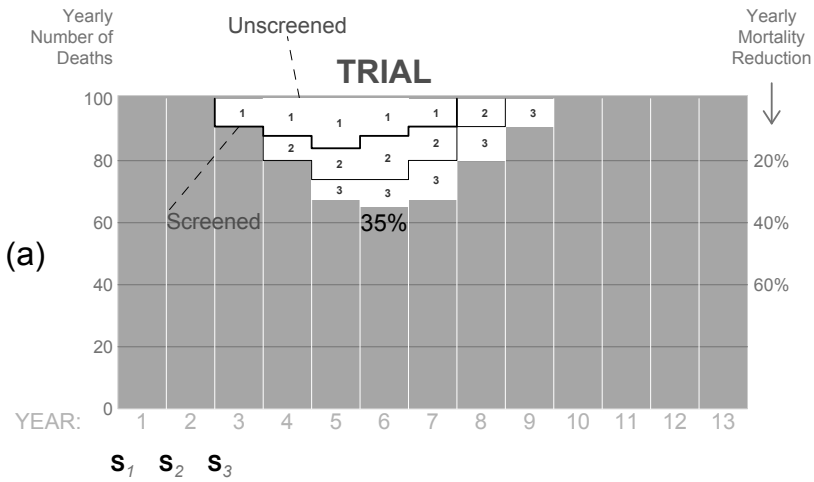


cancer has 2 chances to be detected & have its course altered;

2 rounds of screening, smoother example



From Trial Data to Program projections, via (same) 3 parameters for each round



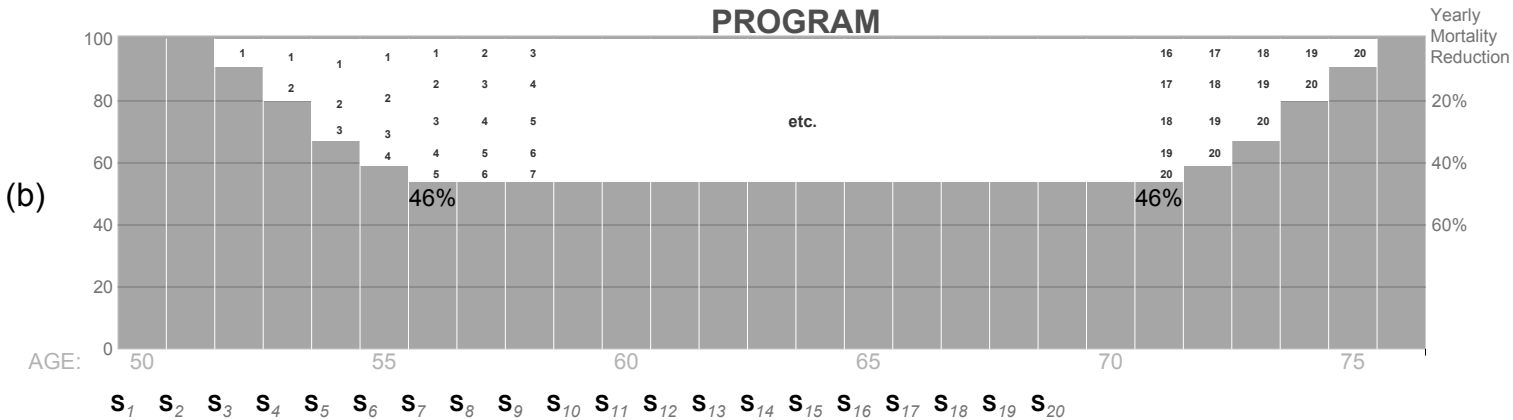
Remarks

If one round of screening reduces mortality in each of 5 future years, then in a trial, 3 rounds of screening -- S1, S2 and S3 -- would produce 3 'waves' of mortality reductions ('1', '2', '3'), each 5 years wide, over 7 years (Y3-Y9).

In such a trial, the maximal reduction (35%, year 6) would be smaller than the sustained (46%) reductions produced by a 20-year screening program.

The average reduction, computed over 13 years of follow-up in such a trial would be an even more serious underestimate of the impact of a 20-year program.

Annual mortality reductions produced by once-a-year screening that begins when women reach 50, and ends when they reach 69



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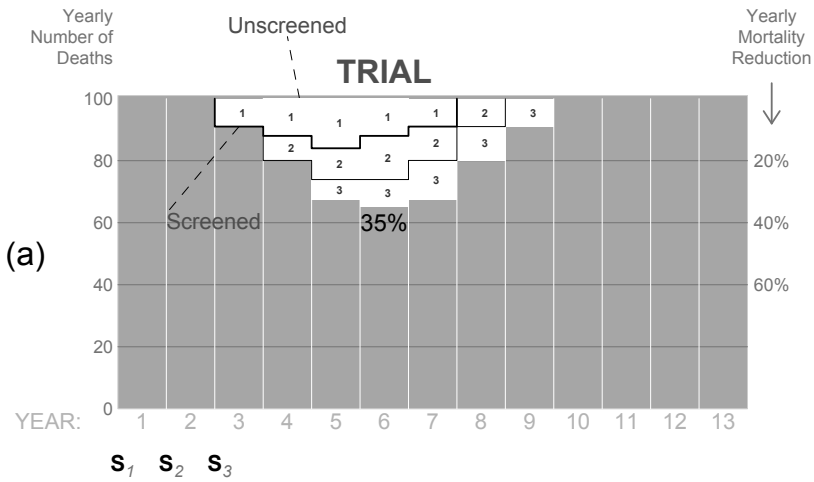

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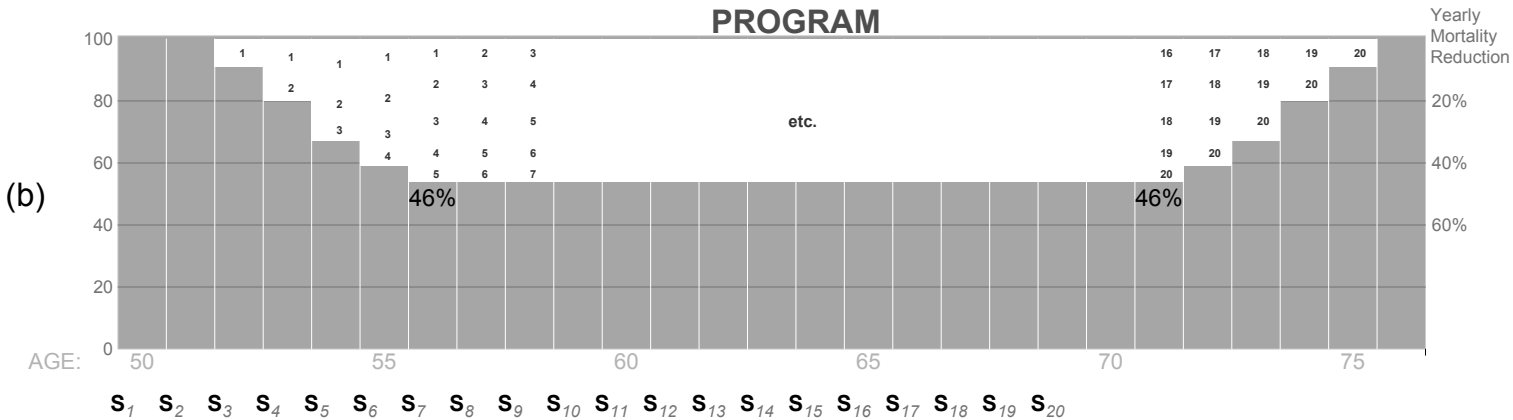

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Use 3 parameters to model deficit due to each round & apply to any schedule.

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- Time needs to be a carefully considered and modelled
- Graphics (static/dynamic) help us model, and explain.