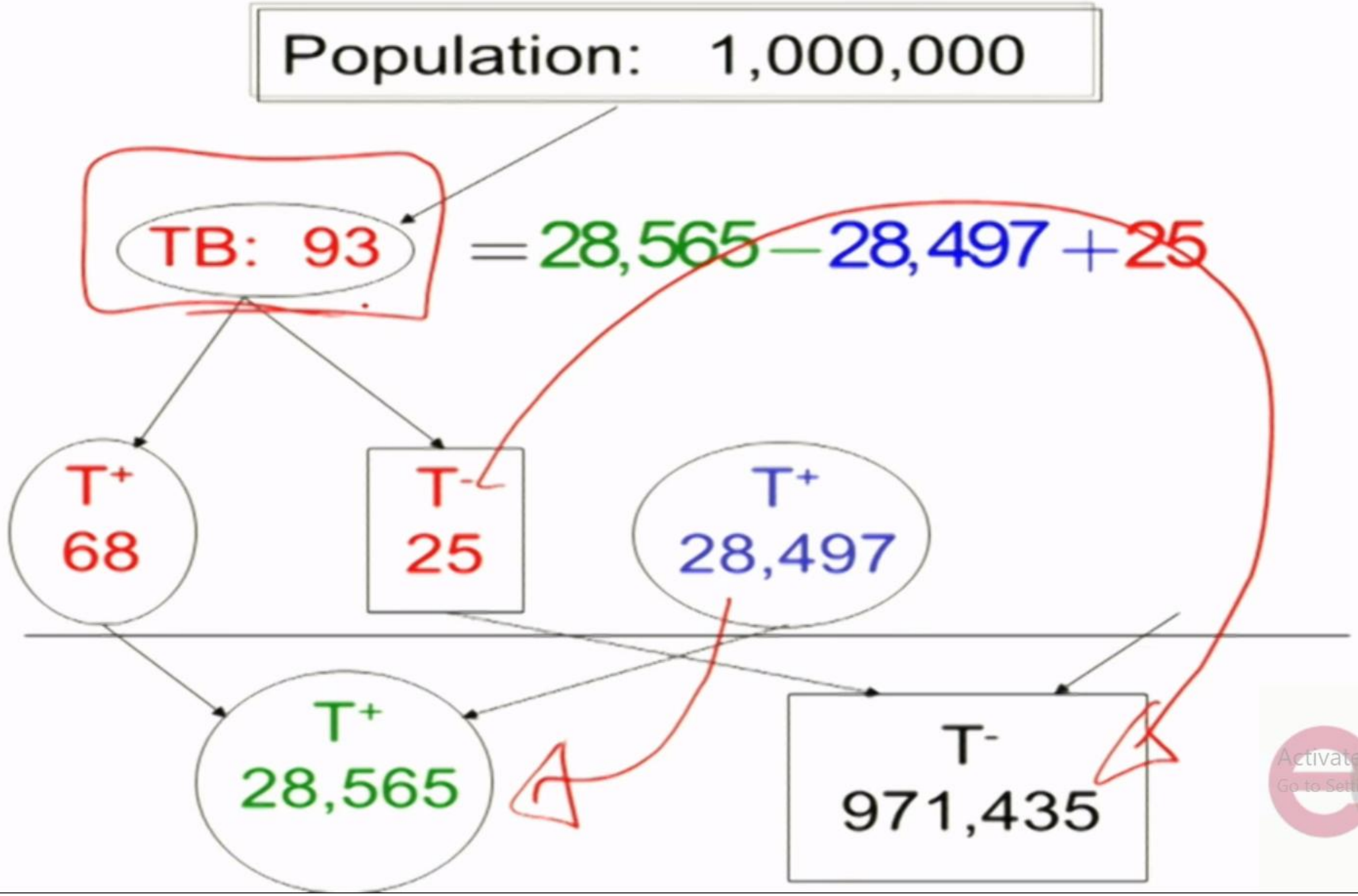
Estimating Prevalence



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Formula for estimating prevalence

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Formula for estimating prevalence

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1,000,000

$$= 28{,}565 - \{(1 - \text{prev}) \times (1\text{-spec}) - \text{prev} \times (1 - \text{sens})\}1{,}000{,}000$$

$$\text{prev} = \frac{\boxed{\dfrac{28{,}565}{1{,}000{,}000}} - (1 - \text{spec})}{\text{sens} - (1 - \text{spec})}$$

$$\boxed{\text{prevalence} = \frac{\text{"prop +ve"} - (1 - \text{spec})}{\text{sens} - (1 - \text{spec})}}$$

Conditions for formula to make sense

$$\boxed{\text{prevalence} = \frac{\text{"prop +ve"} - (1 - \text{spec})}{\text{sens} - (1 - \text{spec})}}$$

$$\text{"prop +ve"} - (1 - \text{spec}) \geq 0$$

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or

$$\text{sens} + \text{spec} \geq 1$$

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HIV newborn screening New York 11/87—3/90

Region	Positive	Tested	Percent
NYS not NYC	601	346,522	0.17
NYC Suburban	329	120,422	0.27
Mid-Hudson	71	29,450	0.24
Upstate Urban	119	88,088	0.14
Upstate Rural	82	108,562	0.08
New York City	3650	294,062	1.24
Manhatten	799	50,364	1.59
Bronx	998	58,003	1.72
Brooklyn	1352	104,613	1.29
Queens	424	67,474	0.63
Staten Island	77	13,608	0.57

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Detection limit of instrument

$$\text{prevalence} = \frac{\text{"prop +ve"} - (1 - \text{spec})}{\text{sens} - (1 - \text{spec})}$$

$$\text{"prop +ve"} - (1 - \text{spec}) \geq 0$$

$$0 \quad \text{"prop +ve"} \geq (1 - \text{spec})$$

So, for Upstate Urban NY where 119 tested positive out of 98,088 = 0.14% we need a specificity of better than

$$1 - 0.0014 = 0.9986 \text{ or } 99.86\%$$

Sensitivity, Specificity, PPV, NPV, and Bayes Theorem

The World Health Organization conducts surveys in countries who are trying to prove that they have achieved **neonatal tetanus (NT) elimination.**

To diagnose NT deaths in rural locations, women are interviewed using the **oral autopsy method**, to determine if the mother gave birth to an infant that died of NT.

It is important to understand the **sensitivity and specificity of the oral autopsy** method in order to obtain accurate estimates of the prevalence of NT deaths among all live births in a country.

Sensitivity, Specificity, PPV, NPV, and Bayes Theorem

Notation:

D^+ event that a woman had an infant who died of NT
D^- event that she had an infant who did not die of NT.

T^+ event that the oral autopsy concluded a NT death occurred
T^- event that the oral autopsy concluded a NT death didn't occur

Using data from Kenya,
The **sensitivity** of the oral autopsy method is 90%
The **specificity** was found to be 79%.

Suppose that in the population being surveyed, 0.1% of the women had an infant die of NT.

Snow R, Armstrong J.R.M, Forster D. et al. Childhood deaths in Africa: Uses and limitations of verbal autopsies, *Lancet*, 1992,340:351-355.

Sensitivity, Specificity, PPV, NPV, and Bayes Theorem

1. What is the probability that the oral autopsy method declares a neonatal tetanus death when the woman had an infant die of neonatal tetanus?

$$P(T^+ \mid D^+) = 90\%$$

2. What is the probability that the oral autopsy method does not declare a neonatal tetanus death when the woman did not have an infant die of neonatal tetanus? What is this value called?

Sensitivity, Specificity, PPV, NPV, and Bayes Theorem

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Sensitivity, Specificity, PPV, NPV, and Bayes Theorem

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Speci

Sensitivity, Specificity, PPV, NPV, and Bayes Theorem

3. What is the probability that a woman had an infant die of NT, given that the oral autopsy method declared a NT death? What is this value called?

$$P(D^+ \mid T^+) = \frac{P(T^+ \mid D^+)\,P(D^+)}{P(T^+ \mid D^+)\,P(D^+) + P(T^+ \mid D^-)\,P(D^-)}$$

p

$1-p$

$$= \frac{0.9 \cdot 0.001}{0.9 \cdot 0.001 + (1-0.79)(0.999)}$$

$$= 0.004$$

$\boxed{\text{PPV}}$

Sensitivity, Specificity, PPV, NPV, and Bayes Theorem

4. What is the probability that a woman did not have an infant die of NT when the oral autopsy method does not declare a NT death? What is this value called?

$$P(D^- | T^-) = \frac{P(T^- | D^-)P(D^-)}{P(T^- | D^-)P(D^-) + P(T^- | D^+)P(D^+)}$$

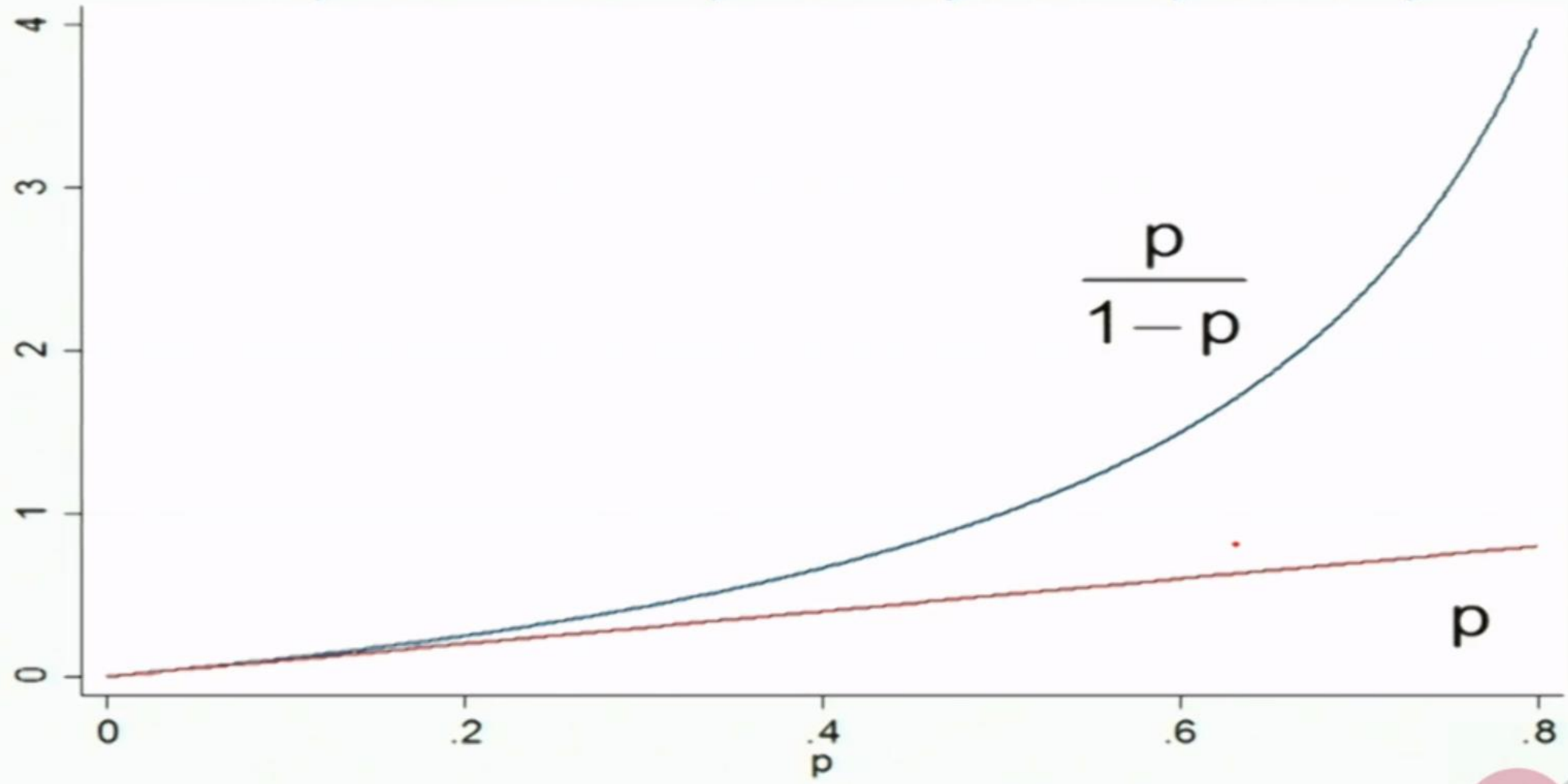
Sensitivity, Specificity, PPV, NPV, and Bayes Theorem

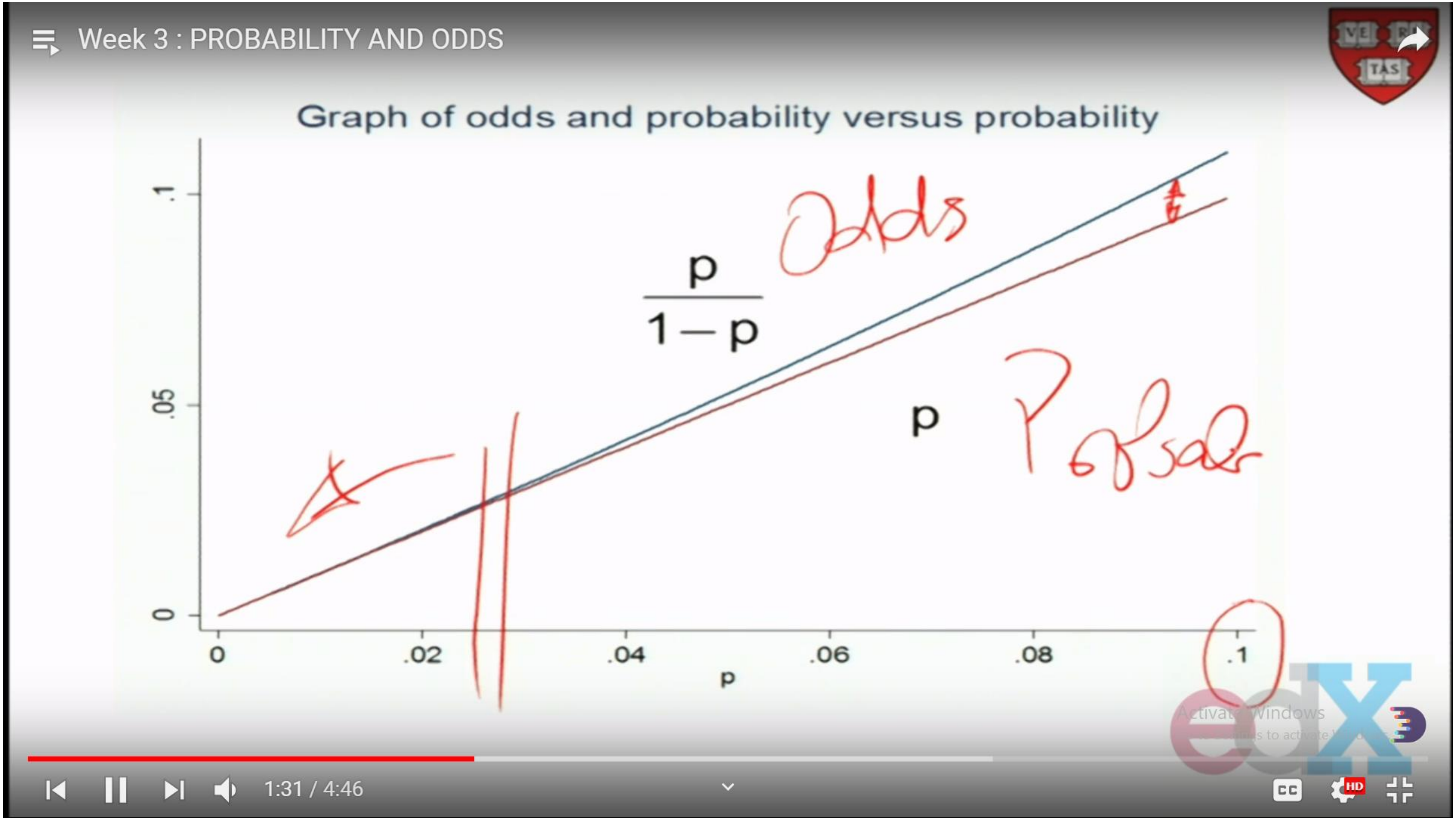
4. What is the probability that a woman did not have an infant die of NT when the oral autopsy method does not declare a NT death? What is this value called?

$$P(D^- \mid T^-) = \frac{\underline{P(T^- \mid D^-)}\,\underline{P(D^-)}}{P(T^- \mid D^-)\,P(D^-) + \underline{P(T^- \mid D^+)}\,\underline{P(D^+)}}$$

$$= \frac{0.79 \cdot (1 - 0.001)}{0.79 \cdot (1 - 0.001) + (1 - 0.9) \cdot 0.001}$$

Graph of odds and probability versus probability




Week 3 : PROBABILITY AND ODDS
Graph of odds and probability versus probability
.1
.05
0
0
.02
.04
.06
.08
.1
p
$\frac{p}{1-p}$
Odds
p
1:31 / 4:46

Graph of odds and probability versus probability