EBM Calculator

Formulas for Effect Estimates

	Outcome	No Outcome	Total
(+)	a	b	$a + b$
(−)	c	d	$c + d$
Total	$a + c$	$b + d$	$a + b + c + d$

$z = 1.959964$ for 95% CI

Experimental Event Rate

$$EER = \frac{a}{a + b}$$

Control Event Rate

$$CER = \frac{c}{c + d}$$

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Absolute Risk Reduction

$$\text{ARR} = \text{CER} - \text{EER}$$

Confidence Interval (Wilson score bounds with error propagation)

Lower Bound: $\text{ARR} - z \cdot \sqrt{\dfrac{u_2(1 - u_2)}{r_1} + \dfrac{w_1(1 - w_1)}{r_2}}$

Upper Bound: $\text{ARR} + z \cdot \sqrt{\dfrac{u_1(1 - u_1)}{r_2} + \dfrac{w_2(1 - w_2)}{r_1}}$

where...

$$r_1 = a + b, \quad r_2 = c + d$$

$$u_1 = \frac{2c + z^2 + z\sqrt{\frac{4(c \cdot d)}{r_2} + z^2}}{2r_2 + 2z^2}$$

$$u_2 = \frac{2a + z^2 + z\sqrt{\frac{4(a \cdot b)}{r_1} + z^2}}{2r_1 + 2z^2}$$

$$w_1 = \frac{2c + z^2 - z\sqrt{\frac{4(c \cdot d)}{r_2} + z^2}}{2r_2 + 2z^2}$$

$$w_2 = \frac{2a + z^2 - z\sqrt{\frac{4(a \cdot b)}{r_1} + z^2}}{2r_1 + 2z^2}$$

Risk Ratio

$$\text{RR} = \frac{\text{EER}}{\text{CER}}$$

Confidence Interval (Log-normal, Zhou)

Lower Bound: $\exp\left(\ln(\text{RR}) - z \cdot \sqrt{\left(\dfrac{1}{a} - \dfrac{1}{a + b}\right) + \left(\dfrac{1}{c} - \dfrac{1}{c + d}\right)} \right)$

Upper Bound: $\exp\left(\ln(\text{RR}) + z \cdot \sqrt{\left(\dfrac{1}{a} - \dfrac{1}{a + b}\right) + \left(\dfrac{1}{c} - \dfrac{1}{c + d}\right)} \right)$

Relative Risk Reduction

$$RRR = 1 - RR$$

Confidence Interval (Derived from Log-normal RR)

Lower Bound: $1 - \exp\left(\ln(RR) + z \cdot \sqrt{\left(\dfrac{1}{a} - \dfrac{1}{a+b}\right) + \left(\dfrac{1}{c} - \dfrac{1}{c+d}\right)} \right)$

Upper Bound: $1 - \exp\left(\ln(RR) - z \cdot \sqrt{\left(\dfrac{1}{a} - \dfrac{1}{a+b}\right) + \left(\dfrac{1}{c} - \dfrac{1}{c+d}\right)} \right)$

Odds Ratio

$$OR = \frac{ad}{cb}$$

Confidence Interval (Log-normal)

Lower Bound: $\exp\left(\ln(OR) - z \cdot \sqrt{\dfrac{1}{a} + \dfrac{1}{b} + \dfrac{1}{c} + \dfrac{1}{d}} \right)$

Upper Bound: $\exp\left(\ln(OR) + z \cdot \sqrt{\dfrac{1}{a} + \dfrac{1}{b} + \dfrac{1}{c} + \dfrac{1}{d}} \right)$

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Formulas for Diagnostic Tests

	Disease	No Disease	Total
(+)	a	b	$a + b$
(−)	c	d	$c + d$
Total	$a + c$	$b + d$	$a + b + c + d$

$$z = 1.959964 \text{ for 95\% CI}$$

Sensitivity

$$\text{Sensitivity} = \frac{a}{a + c}$$

Confidence Interval (Wilson Score)

$$\text{Lower Bound: } \frac{(2 \cdot a) + z^2 - z \cdot \sqrt{\left(\frac{4ac}{a+c}\right) + z^2}}{2 \cdot (a + c) + 2z^2}$$

$$\text{Upper Bound: } \frac{(2 \cdot a) + z^2 + z \cdot \sqrt{\left(\frac{4ac}{a+c}\right) + z^2}}{2 \cdot (a + c) + 2z^2}$$

Specificity

$$\text{Specificity} = \frac{d}{b + d}$$

Confidence Interval (Wilson Score)

$$\text{Lower Bound: } \frac{(2 \cdot d) + z^2 - z \cdot \sqrt{\left(\frac{4db}{b+d}\right) + z^2}}{2 \cdot (b + d) + 2z^2}$$

$$\text{Upper Bound: } \frac{(2 \cdot d) + z^2 + z \cdot \sqrt{\left(\frac{4db}{b+d}\right) + z^2}}{2 \cdot (b + d) + 2z^2}$$

Positive Likelihood Ratio

$$LR(+) = \frac{\text{Sensitivity}}{1 - \text{Specificity}} = \frac{a/(a+c)}{b/(b+d)}$$

Confidence Interval (Log-normal, Zhou)

$$\text{Lower Bound: } \exp\left(\ln\left(\frac{(b+d)\cdot a}{(a+c)\cdot b}\right) - z \cdot \sqrt{\left(\frac{c}{a\cdot(a+c)}\right) + \left(\frac{d}{b\cdot(b+d)}\right)}\right)$$

$$\text{Upper Bound: } \exp\left(\ln\left(\frac{(b+d)\cdot a}{(a+c)\cdot b}\right) + z \cdot \sqrt{\left(\frac{c}{a\cdot(a+c)}\right) + \left(\frac{d}{b\cdot(b+d)}\right)}\right)$$

Negative Likelihood Ratio

$$LR(-) = \frac{1 - \text{Sensitivity}}{\text{Specificity}} = \frac{c/(a+c)}{d/(b+d)}$$

Confidence Interval (Log-normal, Zhou)

$$\text{Lower Bound: } \exp\left(\ln\left(\frac{(b+d)\cdot c}{(a+c)\cdot d}\right) - z \cdot \sqrt{\left(\frac{a}{c\cdot(a+c)}\right) + \left(\frac{b}{d\cdot(b+d)}\right)}\right)$$

$$\text{Upper Bound: } \exp\left(\ln\left(\frac{(b+d)\cdot c}{(a+c)\cdot d}\right) + z \cdot \sqrt{\left(\frac{a}{c\cdot(a+c)}\right) + \left(\frac{b}{d\cdot(b+d)}\right)}\right)$$

Positive Predictive Value

$$PPV = \frac{a}{a+b}$$

Confidence Interval (Wilson Score)

$$\text{Lower Bound: } \frac{(2\cdot a) + z^2 - z \cdot \sqrt{\left(\frac{4ab}{a+b}\right) + z^2}}{2\cdot(a+b) + 2z^2}$$

$$\text{Upper Bound: } \frac{(2\cdot a) + z^2 + z \cdot \sqrt{\left(\frac{4ab}{a+b}\right) + z^2}}{2\cdot(a+b) + 2z^2}$$

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Negative Predictive Value

$$NPV = \frac{d}{c + d}$$

Confidence Interval (Wilson Score)

Lower Bound: $\dfrac{(2 \cdot d) + z^2 - z \cdot \sqrt{\left(\frac{4dc}{c+d}\right) + z^2}}{2 \cdot (c + d) + 2z^2}$

Upper Bound: $\dfrac{(2 \cdot d) + z^2 + z \cdot \sqrt{\left(\frac{4dc}{c+d}\right) + z^2}}{2 \cdot (c + d) + 2z^2}$

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Formulas for Post-Test Probability

Post-Test Probability

$$PostProb = \frac{PostOdds}{PostOdds + 1}$$

Post-Test Odds

$$PostOdds = PreOdds \times LR$$

Pre-Test Odds

$$PreOdds = \frac{PreProb}{1 - PreProb}$$

Conversions

$$Odds = \frac{Probability}{1 - Probability}$$

$$Probability = \frac{Odds}{Odds + 1}$$

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