Reference Value

The **reference value** (commonly denoted as k) in CUSUM analysis represents the **target or expected failure rate** for a procedure. It defines the benchmark against which actual outcomes are compared on a case-by-case basis.

Purpose

k acts as a **tolerance threshold**:

- If a case has a worse outcome than k, the CUSUM score increases.
- If the outcome is better than k, the CUSUM score decreases or resets (depending on the method used).

Choosing the Right Reference Value

The choice of k depends on:

- Published standards or meta-analyses
- Institutional audit data
- Expert consensus

For example:

- If the **acceptable complication rate** for ICP monitor placement is 10%, then k = 0.1.
- For a high-risk procedure with a 25% expected failure rate, k = 0.25.

Example

• Success (0) vs. Reference (k = 0.1):

 $\rightarrow C_n = C_{n-1} + (0 - 0.1) = C_{n-1} - 0.1 \rightarrow \text{trend down}$

- Complication (1) vs. Reference (k = 0.1):
- \rightarrow C_n = C_{n-1} + (1 0.1) = C_{n-1} + 0.9 \rightarrow trend up

Why It Matters

The reference value determines the **sensitivity of the CUSUM chart**. A lower k makes the chart more reactive to poor performance, while a higher k gives more leeway.

A well-chosen reference value ensures:

- Fair benchmarking across surgeons and institutions
- Meaningful interpretation of trends
- Appropriate threshold setting for alerting deviations

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