Use of SRTR CUSUM charts: When should I hit the panic button?

Jon Snyder, PhD
Nicholas Salkowski, PhD
Andrew Wey, PhD
Overview

Background & Overview - Snyder

Posttransplant CUSUMs - Salkowski

Pretransplant CUSUMs - Wey
Transplant Center Quality Assessment Using a Continuously Updatable, Risk-Adjusted Technique (CUSUM)

D. A. Axelrod, M. K. Guidinger, R. A. Metzger, R. H. Wiesner, R. L. Webb and R. M. Merion

Introduction

The provision of timely, risk-adjusted outcome information is crucial to improving clinical care processes. Frequent, real-time monitoring of surgical outcomes allows physicians to validate clinical process improvements or to identify potentially correctable practice patterns. While standard statistical techniques, including average mortality, risk-adjusted average mortality and multivariate modeling, can be used to identify changing levels of performance at a national level, they have been found to be relatively insensitive to small changes in outcomes that occur at the hospital level (1–4). Furthermore, over time, these methods are likely to produce false positive results due to the need for multiple comparisons of the same data.
Meeting Report

Report of a Consensus Conference on Transplant Program Quality and Surveillance

B. L. Kasiske\textsuperscript{a,b,*}, M. A. McBride\textsuperscript{c}, D. L. Cornell\textsuperscript{d}, R. S. Gaston\textsuperscript{e}, M. L. Henry\textsuperscript{f}, F. D. Irwin\textsuperscript{g}, A. K. Israni\textsuperscript{a,b,h}, N. W. Metzler\textsuperscript{i}, K. W. Murphy\textsuperscript{j}, A. I. Reed\textsuperscript{k}, J. P. Roberts\textsuperscript{l}, N. Salkowski\textsuperscript{b}, J. J. Snyder\textsuperscript{b,h} and S. C. Sweet\textsuperscript{m}

\textsuperscript{a}Department of Medicine, Hennepin County Medical Center, University of Minnesota, Minneapolis, Minnesota

Assess outcomes at small-volume transplant programs should be developed. More data on waiting list risk and outcomes should be provided. Monitoring and reporting of short-term living donor outcomes should be enhanced. Overall, there was broad consensus that substantial improvement in reporting outcomes of transplant programs in the United States could and should be made in a cost-effective manner.
I.4. Provide transplant centers, the MPSC and CMS with tools such as the cumulative sum (CUSUM) technique and tools to allow subgroup analysis to facilitate quality assessment and performance improvement.
Special Article

New Quality Monitoring Tools Provided by the Scientific Registry of Transplant Recipients: CUSUM

J. J. Snyder¹,* , N. Salkowski¹, D. Zaun¹, S. N. Leppke¹, T. Leighton¹, A. K. Israni¹,² and B. L. Kasiske¹,²

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²Department of Medicine, Hennepin County Medical Center, Minneapolis, MN
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specific report; SPC, statistical process control; SRTR, Scientific Registry of Transplant Recipients; STAC, SRTR Technical Advisory Committee

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Introduction
CUSUMs (**cumulative sum**) are currently provided for the following metrics:

- Posttransplant Graft/Patient Survival
- Offer Acceptance
Post-transplant CUSUMs

Nicholas Salkowski, PhD
One-Sided vs. Two-Sided CUSUM Charts

Two-Sided (Observed-Expected) vs. One-Sided (statistical test)
Three-year period
The line is the cumulative sum of O-E for each day covered by the chart.
How the two-sided chart is calculated

• On every day of the three-year period, any patient who is within 1 year of their transplant is included in the chart on that day.

• For each day, we calculate two numbers:
  • The number of graft failures reported on that day (O)
  • The number of expected (E) graft failures on that day for the patients who were at risk on that day. This is based on the risk adjustment models.

• The CUSUM value is arrived at by summing the O and E values from the start of the chart up until the specific day; thus the cumulative sum.
Y-Axis:
Observed – Expected (O-E)

-1 = 1 fewer failure than expected
1 = 1 more graft failure than expected
Trending down: Better than expected rates of failure
Trending up: Worse than expected rates of failure
Accompanying One-Sided CUSUM

Attempts to discern whether the observed trends are "statistically significant" or perhaps just random noise.
Accompanying One-Sided CUSUM

One-Sided CUSUM: All Donor Adult One-Year Graft Failure

Has a red “5% Threshold line at the top of the chart. If the line hits the threshold, we conclude there is sufficient evidence of a real trend.
Accompanying One-Sided CUSUM

It is called the “5% threshold” because there is about a 5% chance of a false positive if the chart hits this line.
Accompanying One-Sided CUSUM

Y-axis is more difficult to interpret (i.e., don’t worry about the value). It is the value of the CUSUM test statistic. Importantly, it is not O-E.
O-E = 6.75

The liver program experienced almost 7 more failures than expected over the three-year period. Is this trend statistically significant?
This chart signaled on 11/4/2016. This is when the chart had accumulated enough evidence that the observed trend was more than statistical noise (with a 5% chance this is a false positive).
Offer Acceptance
CUSUM charts

Andrew Wey, PhD
What is offer acceptance?

Offer acceptance is the propensity of programs to accept an offer compared to national acceptance practices after accounting for candidate and donor characteristics.

In other words, is a program more or less likely to accept a given offer?
Why care about offer acceptance?

Offer acceptance practices impact allocation efficiency: Above average acceptance practices were associated with higher organ yield (more transplants per donor) in kidney, liver, lung, and heart transplant.

Offer acceptance impacts the probability of waitlist mortality: Programs with above average offer acceptance transplant candidates at a higher rate, which lowers the probability of a candidate dying on the waiting list.
SRTR resources for offer acceptance

SRTR provides several resources for programs interested in offer acceptance practices:

- Program-specific reports summarize acceptance practices over a year, includes figures to illustrate acceptance relative to other programs
- CUSUM reports provide a trajectory of acceptance practices over time and a separate summary of recent acceptance practices within certain subgroups
- An OPO offer acceptance report summarizes the acceptance practices of programs for certain categories that may be hard-to-place
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Audience poll...

How many people use the offer acceptance CUSUM reports?
Accessing offer acceptance CUSUMs
Accessing offer acceptance CUSUMs
Accessing offer acceptance

CUSUMs
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The offer acceptance report for the liver program at SRTR. The report provides detailed information on offer acceptance behavior across time (CUSUM Charts) and important subgroups, e.g., donor quality (Across Donor Characteristics). The reported offer acceptance behavior is relative to the national acceptance behavior after adjusting for donor quality and candidate characteristics.

The report evaluates the acceptance behavior for offers from donors recovered between 01/01/2018 and 04/30/2018. The expected number of acceptances are based on the offer acceptance model estimated with offers from donors recovered between 07/01/2016 and 06/30/2017.
### Offer Acceptance Report

**Center Code:**
- SRTR

**Transplant Program (Organ):**
- Liver

**Data From:**
- 07/31/2018

**Cohort Start:**
- 01/01/2018

**Cohort End:**
- 04/30/2018

**Feedback:**
- SRTR@SRTR.org
- 1.877.970.SRTR (7787)
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Offer acceptance report:

Expected-Observed (Two-sided) CUSUM

The two-sided (or, Expected-Observed) CUSUM assesses the cumulative offer acceptance behavior over the cohort period. The y-axis is the cumulative number of expected acceptances minus observed acceptances. Thus, upward slopes suggest below-average offer acceptance behavior, while downward slopes suggest above-average acceptance behavior.
Offer acceptance report:

Expected-Observed (Two-sided) CUSUM

There was a period of below average acceptance but was it out significantly below expected?

We can use the one-sided CUSUM to help answer this question.
Offer acceptance report

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Expected-Observed CUSUM

One-Sided CUSUM
Offer acceptance report:

One-sided CUSUM
Offer acceptance report:

One-sided CUSUM

The initial spike is visible in the one-sided CUSUM but it does not reach the signal limit at the top of the graph. This indicates that acceptance was not ‘out of control’ at the beginning of the period.
The offer acceptance report for the liver program at SRTR. The report provides detailed information on offer acceptance behavior across time (CUSUM Charts) and important subgroups, e.g., donor quality (Across Donor Characteristics). The reported offer acceptance behavior is relative to the national acceptance behavior after adjusting for donor quality and candidate characteristics.

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Offer acceptance report

Overview

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Offer acceptance reports

The offer acceptance reports provide information on several different aspects of acceptance practices:

• Identifies changes in acceptance practices at different times during the year.
• Identifies above or below average acceptance practices for different categories of offers.
References


Best mode of contact:
SRTR@SRTR.org

@SRTRNews

Scientific Registry of Transplant Recipients

SRTR