Statistical Properties of Composite and All-or-None Core Measure Compliance Metrics

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submitted for oral (preferred) or poster presentation

Abstract

Several studies indicate that consistent compliance with the medical evidence base across a wide range of chronic and acute conditions is dismally low.\(^1\) Partly in response, core measure sets and “bundles” of care processes known to improve clinical outcomes are becoming a common means for evaluating medical process quality and compliance to best practices. For example, a ventilator associated pneumonia prevention bundle includes four patient care activities: elevating the head of the bed to an appropriate angle, daily sedation vacations to assess readiness to extubate, peptic ulcer disease prophylaxis, and deep venous thrombosis prophylaxis. The Joint Commission, Center for Medicare and Medicaid, Agency for Healthcare Research and Quality, Institute for Healthcare Improvement, and others have advocated several similar core measure sets for congestive heart failure, acute myocardial infarction, surgical site infection, total joint replacement, coronary artery bypass graft surgery, and numerous others\(^2\) – sometimes linked to comparative ranking, pay-for-performance, and reimbursement.

Compliance typically is measured either by a composite measure of the fraction of all indicated care elements that a sample of patients actually receive or by an “all-or-none” (AON) measure in which a patient must receive all bundle elements to be counted as a “success”.\(^3\)\(^-\)\(^5\) Although AON measures generally are considered advantageous for creating heightened patient-centered awareness, the statistical properties and sensitivity of each metric and the best way, statistically, to measure and identify changes in care quality remain unclear and largely uninvestigated. We therefore compute and compare the statistical properties and operating characteristics (sensitivity, specificity, time to signal) of each measure for detecting various magnitudes of within-hospital improvements and between-facility differences. Exact probability distributions, statistical process control charts, and other statistical methods (confidence intervals, hypothesis tests, sequential probability ratio tests) also are derived for each compliance metric,\(^6\) with their performance compared both mathematically and via Monte Carlo analysis.

Composite measures, interestingly, are shown to usually have significantly better sensitivity than AON measures for detecting care process changes, contrary to current trends and suggestions in the literature. The exact statistical methods for composite bundles similarly are shown to perform better than conventional methods for detecting process improvement or worsening – which is intuitive due to the discarding and discretizing of information when forming the AON measure, since “nothing” can occur in several ways (eg, a patient receiving 3 of 4 elements versus receiving 0 of 4). These methods and their improved performance are illustrated using several central line infection, surgical site infection, ventilator associated pneumonia, and other core measure sets. The above results have implications on the best way to measure compliance
to core measure sets in order to accelerate improvement and identify performance differences. In particular, despite the current popularity of AON measures, composite measures should not be completely abandoned in favor of all-or-none measurement, which may in fact slow improvement efforts. The best balanced approach likely is to use both measures for their complimentary statistical and motivational benefits.

References

2. Center for Medicare & Medicaid Services (CMS), Clinical conditions and measures for reporting and incentives. 2003.
3. Nolan T, Berwick D. All-or-none measurement raises the bar on performance. JAMA. 2006;295:1168-1170