PERSPECTIVE

Financial impact of a targeted reduction in cardiac enzyme testing at a community hospital

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Objectives: Nearly one-third of healthcare costs are potentially avoidable and would not compromise medical care if eliminated. Therefore, we sought to evaluate the financial impact of reduction in use of creatinine kinase (CK)-MB and myoglobin tests after removing them from the cardiac enzyme order set at a community hospital.

Methods: Grand rounds were held, and an email notification was sent to de-emphasize the use of CK, CK-MB, myoglobin, SGOT (glutamic-oxaloacetic transaminase), and SGPT (serum glutamic-pyruvic transaminase) in acute coronary syndrome (ACS) work up. The above tests were removed from the pre-checked cardiac enzyme order set in the computerized physician order entry on February 13, 2014. The tests continued to be available, but needed to be ordered individually. The mean monthly volume of cardiac enzyme tests for 12 months after this intervention was compared with the mean monthly volume of 12 months before the change. Total cost savings were calculated.

Results: After the intervention, the number of CK, CK-MB, myoglobin, SGOT, and SGPT tests utilized for ACS workup decreased dramatically (p <0.001). The volume of troponin testing remained the same (p = 0.283). The total annual savings of billable charges to healthcare payers was $463,744.7.

Conclusions: Removal of CK-MB, myoglobin, CK, SGOT, and SGPT tests from cardiac enzyme order sets can successfully reduce unnecessary laboratory testing for ACS workup, leading to significant cost savings to the healthcare system.

Keywords: quality improvement; cost reduction; CK-MB; myoglobin; troponin; acute coronary syndrome

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Received: 6 July 2016; Accepted: 4 August 2016; Published: 26 October 2016

Due to federal budget deficits and growing healthcare expenditures, the need to control healthcare costs has reached a critical level (1). It is estimated that nearly one-third of healthcare costs (more than $700 billion per year) are potentially avoidable and would not compromise medical care if eliminated (2). Overuse and misuse of diagnostic testing are areas actively being reviewed for reducing healthcare waste. Evolution of new and more sensitive tests has made some older tests significantly less useful for everyday use.

In the arena of testing for acute coronary syndrome (ACS), cardiac troponin assays have become an essential tool to help diagnose myocardial infarction. This is due to their significantly higher sensitivity and specificity compared to other cardiac markers (3). Multiple studies have illustrated the fading role of creatinine kinase (CK)-MB and myoglobin, in the diagnosis of ACS (4–7). In 2012, the American College of Cardiology Foundation Task Force recommended against checking cardiac biomarkers other than troponins for diagnostic use for ACS risk assessment. This was based on the integration and acceptance of cardiac troponin testing over the past decade (8). Despite the above evidence and recommendations, large variations in the use of myoglobin and CK-MB in individual practices still exist. This is, likely, based on personal preference, ordering habits, and prompting in computerized order sets.

As of January 2014, Saint Agnes Hospital was still using a cardiac enzyme order set in computerized physician order entry (CPOE). This included pre-checked CK, CK-MB, myoglobin, SGOT, and SGPT tests from cardiac enzyme order sets can successfully reduce unnecessary laboratory testing for ACS workup, leading to significant cost savings to the healthcare system.
and $182,445, respectively. With the aim of practicing high-value care, we removed CK-MB, myoglobin, CK, SGOT, and SGPT from the cardiac enzyme order set to decrease the use of these outdated biomarkers. Our next step was to assess the financial impact of the intervention.

**Materials and methods**

This study was completed at Saint Agnes Hospital in Baltimore, Maryland. This inner city 307-bed community hospital is also the home of the first Chest Pain Emergency Center in the world. Interventional cardiology services are available, but the hospital does not provide open heart surgery.

Upon review of lab ordering data, the testing volumes of both CK-MB and myoglobin totaled over 10,000 a year despite increased evidence of their low specificity and sensitivity in ACS workup verses troponins (3). Examination of the cardiac enzyme order set in newly implemented CPOE revealed a possible explanation. The laboratory tests in the cardiac enzyme order set included CK-MB, myoglobin, CK, SGOT, and SGPT, and all were pre-checked. As a result, providers were more likely to order all these tests due to convenience.

Based on these findings and pursuant discussion, the leadership in Departments of Internal Medicine, Cardiology, and Pathology and Laboratory reached an agreement that, given the high sensitivity, specificity, and easy availability of cardiac troponin testing, there was no need for physicians to routinely order CK-MB and myoglobin along with CK, SGOT, and SGPT as part of workup for ACS in the vast majority of patients. Therefore, those tests would be removed from the cardiac enzyme order set.

After the above agreement was approved by the hospital administration, provider education to de-emphasize the use of CK-MB and myoglobin in diagnosing ACS was conducted through grand rounds (held on November 7, 2013) on high-value care and conferences to the staff. In addition, this information was sent via email notice (was sent on November 22, 2013) co-signed by the chiefs of Cardiology, Pathology and Internal Medicine to all licensed medical providers in Internal Medicine and Emergency Medicine Departments at the institution informing of the change and the evidence behind the change.

The order set change was accomplished on February 13, 2014. The other tests remained available as stand-alone assays to be used in conditions such as re-infarction or infarction extension. This study was approved by the Institutional Review Board of Saint Agnes Hospital.

**Statistical analysis**

Numbers of tests ordered (based on lab procedure charges) from February 2013 through January 2014 (year 1) and March 2014 through February 2015 (year 2) were provided by Reimbursement & Compliance Department.

Student’s t-test was used to compare the mean difference in utilization of these tests before and after the intervention. All tests with \( p < 0.05 \) were considered to be statistically significant.

**Results**

As can be seen from Fig. 1, before CK, CK-MB, myoglobin, SGOT, and SGPT were removed from the routine ACS order set, the yearly testing volumes of the above tests were 36,435; 11,768; 11,420; 4,403; and 4,032, respectively (does not include numbers of SGOT and SGPT as part of a liver function panel or comprehensive metabolic panel). Since the change was implemented in February 2014, the annual volumes of CK, CK-MB, myoglobin, SGOT, and SGPT dropped to 4,121; 2,063; 1,561; 4,043; and 4,032. Notably, there was a decrease in the volumes of CK, CK-MB, and myoglobin before the CPOE change, which was most likely the result of grand rounds and email notification in November.

As shown in Table 1, the mean tests volume of CK, CK-MB, myoglobin, SGOT, and SGPT was significantly decreased due to the intervention (Table 2), while the mean volume of troponin test remained the same (\( p = 0.283 \)). The mean monthly volume of CK decreased from 3,036.3 to 343.4 (88.7% of reduction); the mean monthly volume of CK-MB dropped from 980.7 to 171.9 (82.5% of reduction); the mean monthly volume of myoglobin decreased from 951.7 to 130.1 (86.3% of reduction); and the mean monthly volume of SGOT and SGPT dropped from 336.9 to 100.3 (70.0%) and 336.0 to 100.2 (70.2%), respectively.

**Discussion**

It has been noted (9) that there is a large variability in healthcare costs based on geography, which cannot all be explained by varying charges or population differences, and there is a general recognition of stylistic differences in medical practice within or amongst institutions as well. One of the possible explanations for the substantial variation in testing practices could be that a large fraction of tests may be unnecessary (9). Identification of appropriate and necessary tests with elimination of those not proven essential or useful is crucial to providing high-value health care. The ‘Choosing Wisely Campaign’ by ABIM and its partners has been invaluable in highlighting areas for change.

CK, liver enzymes (esp. SGOT), and LDH were some of the first biomarkers used in the diagnosis of ACS, but in comparison with troponins, their utility has waned (10). A recent study suggested that a positive myoglobin result did not offer an additional diagnostic value, but rather led to an additional confirmatory testing compared with troponin I testing (4). When reviewing the utility of CK-MB, the slight lag in troponin rise compared to CK-MB could be the reason for its continued use in ACS protocols.
due to the fear of missing early ACS (5). However, Volz reviewed 11,092 ED patient encounters and concluded that CK-MB is not necessary in the initial screening for AMI (acute myocardial infarction) and may safely be excluded in patients with negative troponins (6). The only potential indication for the CK-MB assay is in the case of re-infarction or an extension of recent infarction in a patient with ACS. However, according to a recent study, even in this scenario, CK-MB could be safely substituted by serial troponin testing (7).

University of Missouri-Kansas City reported an exciting study at their institution involving removal of these older biomarkers, facilitated by close collaboration between Cardiology and Pathology Departments (7). It also highlighted the importance of early involvement of the ED and medical leadership, which was consistent with our experience as well (7). Our study, which was conducted in a community hospital setting, re-emphasizes the paramount importance of joint efforts among different specialties and departments. This collaborative initiative has clearly led to significant yearly cost savings (based on billable charges) of $463,744.7.

In the era of nearly ubiquitous electronic medical records and CPOE, the process of changing physician practice with clinical decision support or by developing order sets is a rapidly evolving area of health care (7). Given the presumed variability in resources and practice between community hospitals and university hospitals, one may argue that what can be done in a university program may not be applicable at a community hospital. Our ability to successfully launch the project and maintain continued support with minimal resources may motivate other institutions to explore opportunities to

![Graph showing reduction in cardiac enzyme testing after CPOE change](https://via.placeholder.com/150)

**Fig. 1.** The ACS order set test volume from February 2013 to February 2015.

|        | LFT      | CK       | CK-MB    | Troponin  | Myoglobin |
|--------|----------|----------|----------|-----------|-----------|
| Total Y1 | $24,649.30 | $173,066.30 | 139,803.80 | 787,584.60 | 180,892.80 |
| Total Y2 | $10,469.40 | $19,574.80  | $24,508.40 | $762,973.20 | $247,26.20  |
| TS by test | $14,179.90 | $153,491.50 | $115,295.40 | $246,11.40  | $156,166.60 |

TS, total savings; LFT, liver function test; CK, creatinine kinase

**Table 1.** Cost savings analysis
Y2: March 2014 through February 2015 (after CPOE intervention).

Y1: February 2013 through January 2014 (before CPOE intervention).

Table 2. Mean monthly tests volume before and after the intervention

| Test      | Group | N  | Mean  | SD    | p    |
|-----------|-------|----|-------|-------|------|
| CK        | Y1    | 12 | 3036.3| 331.9 | <0.001|
|           | Y2    | 12 | 343.4 | 203.0 |      |
| CK-MB     | Y1    | 12 | 980.7 | 71.0  | <0.001|
|           | Y2    | 12 | 171.9 | 185.2 |      |
| Myoglobin | Y1    | 12 | 951.7 | 86.5  | <0.001|
|           | Y2    | 12 | 130.1 | 180.1 |      |
| SGOT      | Y1    | 12 | 336.9 | 34.9  | <0.001|
|           | Y2    | 12 | 100.3 | 77.5  |      |
| SGPT      | Y1    | 12 | 336.0 | 33.6  | <0.001|
|           | Y2    | 12 | 100.2 | 77.6  |      |
| Troponin  | Y1    | 12 | 3314.8| 276.2 | 0.283|
|           | Y2    | 12 | 3211.2| 172.9 |      |

Y1: February 2013 through January 2014 (before CPOE intervention).

Y2: March 2014 through February 2015 (after CPOE intervention).

assist all providers in practicing high-value care. High-value cost-conscious care and stewardship of resources have been proposed as the seventh general competency for all physicians (11). Many recent studies provide successful examples of involving physician trainees in quality improvement at an institutional level, leading to significant cost savings both to the healthcare system and to the medical center (12). Engaging residents and medical students not only provides them the learning opportunities in principles of quality improvement and high-value care, but also teaches them the practical tools for process change (12). This is an essential component in changing the overall culture of overconsumption and improving the value of healthcare delivery (13).

One limitation of our study was that education interventions, including grand rounds and email notifications, were held around 3 and 2 months prior to actual CPOE change respectively, which makes statistical analysis challenging. However, this is practically acceptable (since it is difficult to implement all changes at the same time), and both the education and the CPOE changes helped care providers to change their behavior. Further, despite the pre-CPOE implementation decline in test ordering, the number of tests ordered in year 2 was significantly reduced from year 1. Education made the change mentally acceptable, and CPOE consolidated the change. Another potential limitation of this study was the lack of outcome data. No change in the overall morbidity or mortality across the entire hospital patient population was noted during the 2, 12-month periods of comparison (year 1 vs. year 2). Exploring these comparisons may certainly be an important next step in rationalizing value versus quality of care.

Acknowledgements

The authors thank Mitchell Lomax who provided original data for the study; Dr. Jeffrey Seibel, Chair of Pathology, and Dr. Carlos Ince, section chief of Cardiology at St. Agnes Hospital, for their assistance with the implementation of the change; Dr. Seunggu J. Han and Tiffany Jones who provided helpful information on how to estimate direct cost to institute.

Conflict of interest and funding

The authors declare no conflicts of interest.

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