

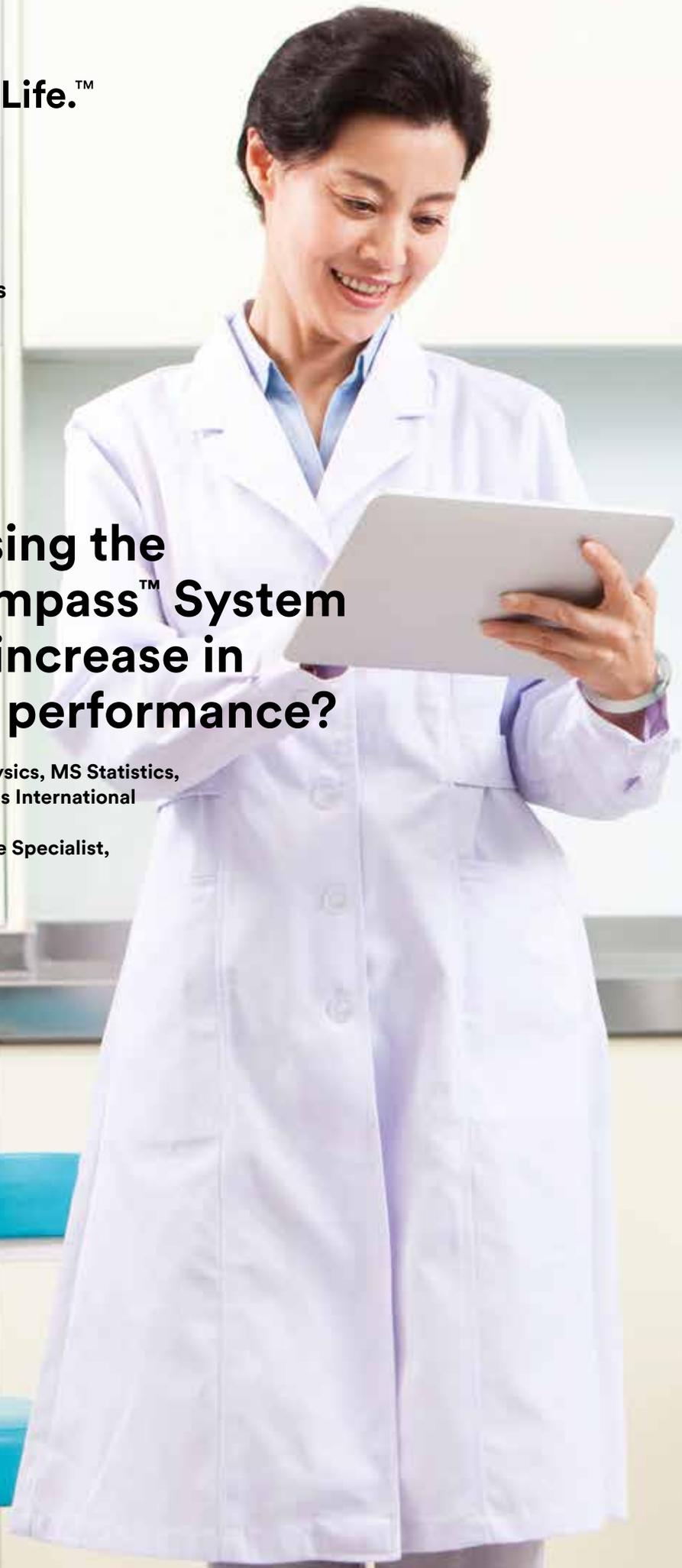
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Do hospitals using the 3M™ 360 Encompass™ System experience an increase in case mix index performance?

Gary M. Jeppson, MA Medical Biophysics, MS Statistics,
Statistical Consultant, Object Systems International

Clarissa George, Business Intelligence Specialist,
3M Health Information Systems



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Executive summary

Two separate studies were performed by different researchers working independently to address the question, “What impact does the implementation of the 3M 360 Encompass System have on a hospital?” The intent of both studies was to statistically identify if there is a measurable return on investment (ROI) benefit for those hospitals that use 3M 360 Encompass.

The **first study compared the 2015 case mix index (CMI)** of randomly chosen hospitals that had used 3M 360 Encompass for at least a year (*the treatment group*) with the CMI of randomly chosen hospitals of comparable size that had **never** used 3M 360 Encompass (*the control group*). The necessity of pairing hospitals with similar admission volumes was important since it will be shown in this paper that the number of admissions correlates significantly to the CMI. Pairing hospitals (treatment vs. control) with similar admission volumes removes the effect of the admission volume factor from influencing the outcome of the observed changes in CMI.

However, many other factors can influence CMI. Since this study randomly selected all hospitals for both the treatment and control groups, the impact of all other factors not being measured in the study was spread equally across both the treatment and control hospital pairings, thus mitigating their overall impact within any sufficiently large sample. The first study focused on the differences in CMI for 37 treatment vs. control pairings, with the null hypothesis that there is no significant difference in their 2015 CMI.

The second study looked at coder “work habits,” that is, whether coders using 3M 360 Encompass were using the full functionality of the software to assist with coding or were relying more on memory or reference sources to directly enter codes. The level of “direct usage” of 3M 360 Encompass at the end of fiscal year 2015 was compared to the direction of change in their CMI levels from 2014 to 2015. The question to answer was whether there were any significant, non-random patterns in CMI changes that could be associated with the levels of direct coding.

Summary of findings: The results of both studies showed the hospitals using 3M 360 Encompass have higher CMI than those who do not. In addition, the studies concluded that in the hospitals using 3M 360 Encompass, the less coders used direct coding methods, the more likely the organization would see an increase in CMI over time.



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Study 1: What is the impact of the 3M™ 360 Encompass™ System on CMI?

Conducted by Gary M. Jeppson, Statistics Consultant, Object Systems International

Study 1 procedural explanation: A snapshot

Treatment group selection:

- **Criteria:** Hospitals installed and fully trained on 3M™ 360 Encompass™ System before fiscal MEDPAR year 2015 (October 1, 2014)
- 35 hospitals randomly selected:
 - Ranged in annual inpatient admissions from 318 to 53,722
 - Geographically scattered over 13 states in the U.S.
- Statistical consultant purposely shielded from CMI performance data from all 35 sites

Control group selection:

- **Criteria:** Hospitals must never have used 3M 360 Encompass or license any other 3M Health Information Systems products
- 2 hospitals randomly selected to pair with each treatment group hospital; criteria included:
 - Yearly inpatient admissions equal to or very close to treatment site
 - Same geographical area where possible
- No CMI performance data was available before pairings of treatment and control hospitals

Adjustment: Original sample size was reduced from 70 pairings to 37, because for 33 pairings, one or both of the CMI values either did not exist or was not public knowledge.

Discovery: There is significant variability in CMI for hospitals with less than 2,500 annual inpatient admissions; this factor was studied and accounted for in Study 1.

Conclusions from Study 1

There was a significantly higher ($p=0.031$) CMI performance for hospitals using the 3M 360 Encompass System when compared with hospitals of similar yearly admissions that do not have the 3M system. The average improvement in CMI for 37 comparably paired hospitals (those with 3M 360 Encompass versus those without 3M 360 Encompass) was +0.1086, with 95 percent confidence that the average improvement in CMI will be between +0.0102 and +0.2069.

The financial ROI for a hospital could be substantial. With an average federal blended rate of \$6,429 and an average yearly inpatient admission rate of 5,769, the typical range of ROI yearly dollars impacted by an improved CMI (using the 95 percent confidence interval from the paired t-test) would range from **\$378,000 to as high as \$7.67 million.**

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What can influence case mix index?

Many factors can impact the CMI of a hospital, including:

- Changes in the volume of surgical CMI admissions
- Changes in the volume of medical CMI admissions
- Whether the hospital is a teaching facility or part of the Disproportionate Share Hospital (DSH) program
- Major changes in bed size or admission criteria
- The critical importance of coding accuracy

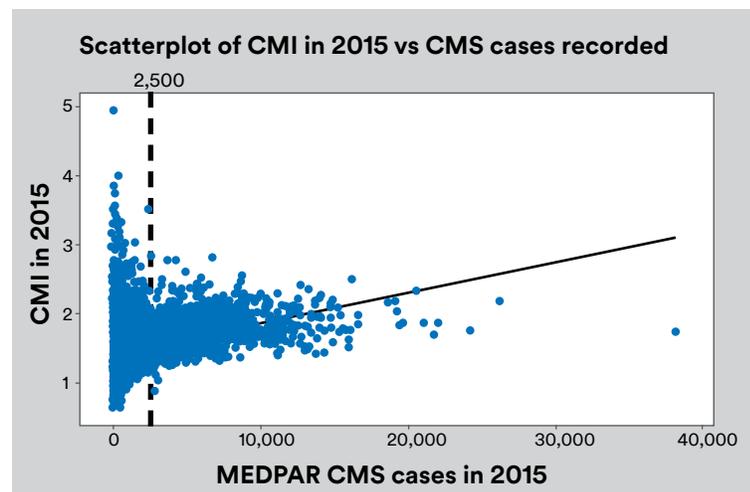
With so many factors, it was important to randomly select the control and treatment facilities so that the influence of all of these factors would be spread equally across both study groups in Study 1.

But why was such effort taken to ensure the treatment and control pairings were of **comparable inpatient admission sizes**? This is an important factor for Study 1, because a significant linear relationship exists between the number of yearly admissions at a facility and its CMI.

Because yearly admissions seriously impact CMI, this factor was carefully controlled in a paired t-test approach between the hospitals that used 3M 360 Encompass (the treatment group) and those who did not (the control group). In spite of the large levels of variability exhibited in the CMI data, a strong positive impact was found in hospitals using 3M 360 Encompass: Their overall CMI was found to be significantly ($p=0.031$) improved.

As shown in *figure 1*, when looking at the 2015 MEDPAR data for 3,414 hospitals, as the number of admissions increases, the CMI also tends to increase. This correlation is strongly significant ($p<<0.001$) and demonstrates that if two CMIs are going to be compared, failure to take into account the facilities' admission volumes could create a larger difference in CMI measurements (as would occur in the random pairing of a large hospital with a small hospital).

Figure 1. When the number of admissions increase, the CMI also tends to increase



Discovery: CMI variability in hospitals with less than 2,500 annual inpatient admissions

For hospitals with less than 2,500 yearly admissions, the CMI results vary significantly, but after 2,500 admissions, the “thickness” of the variability tends to become more constant.

Since different levels of CMI variability appear between hospitals with more than 2,500 yearly admissions and those with fewer than 2,500, Study 1 tried to better understand the relationship between CMI and yearly admissions within each group. This was necessary so that any adjustments in CMI between the treatment and control pairings due to admission volume would take into account the correlated trend, thus removing as much impact as possible on CMI based on the random admission volume pairings.

The Study 1 researcher recognized a strong linear relationship between CMI and admissions for both groups—those with more and those with less than 2,500 yearly admissions. The higher the admission level, the greater the tendency for a higher CMI. Only 1.6 percent of the total variability could be explained by a regression line. Thus, if there is an impact on CMI from using the 3M™ 360 Encompass™ System with the treatment group, that impact will have to be very strong if it is to be detected as significant. See *Appendix A for the related scatterplots and additional details around this finding.*

What did Study 1 reveal about CMI and the 3M 360 Encompass System?

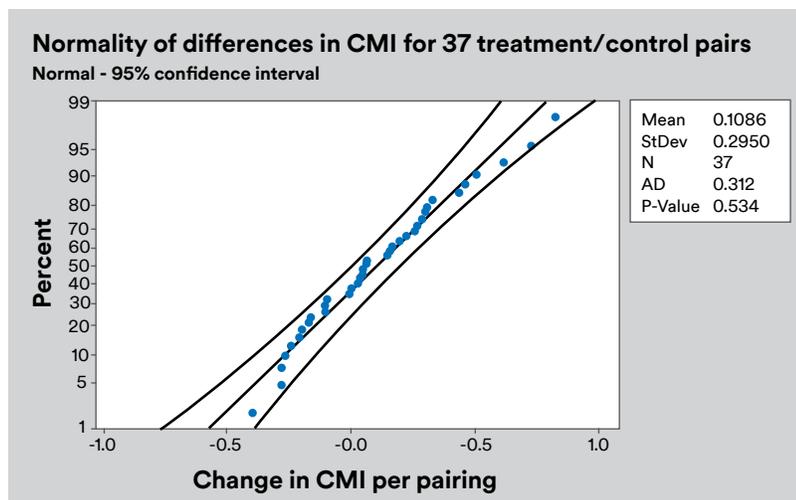
With the importance of pairing treatment and control hospitals with very similar yearly admissions established, 70 pairings were blindly created without any knowledge of CMI performance. Two randomly chosen hospitals were selected for each of the 35 treatment hospitals. After the pairings, the 2015 CMI for each hospital was then identified for all treatment and control hospitals. However, for 33 of the pairings, one or both of the CMI values either did not exist or was not public knowledge, so the sample size was reduced from 70 to 37 pairings.

For each of the 37 pairs, the CMI for the control hospital was subtracted from the CMI of the treatment hospital. If there was a positive difference, this would mean that the hospital using 3M 360 Encompass had a higher CMI than its control counterpart. The **null hypothesis (Ho)** was there is no difference between the control and the treatment group, the difference in the CMI should theoretically be 0.0000.

Because the randomly selected hospital pairs had some slight differences in yearly admissions, an adjustment was made to compensate for those differences based on the slope of the least squared fitted regression line. For example, if the hospital with 3M 360 Encompass had 100 more patient admissions than the hospital without 3M 360 Encompass, then the CMI for the hospital without the 3M system was adjusted upward, according to the slope of the regression line, to compensate for that difference.

Since the slope for hospitals with admissions greater than 2,500 is 0.000027, then the CMI was increased by $100 * 0.000027 = 0.0027$. The 37 differences were examined for normality, and the data was found to be normally distributed (see figure 2).

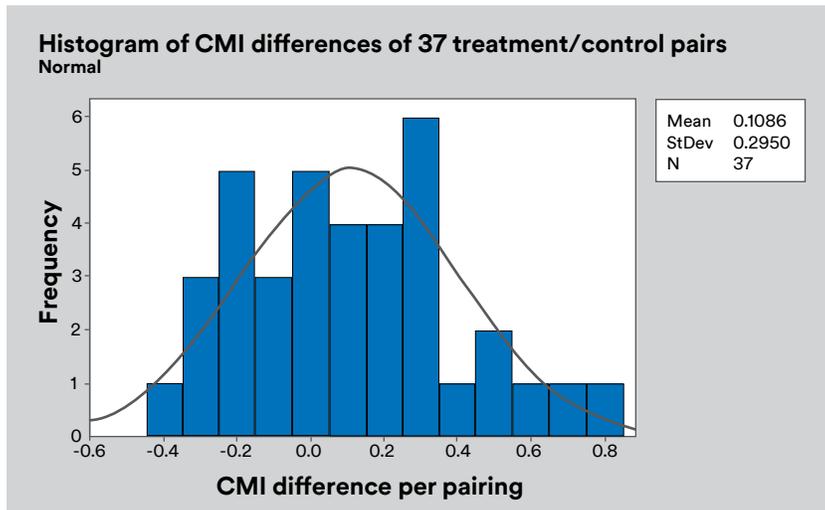
Figure 2. The normality of CMI differences in the 37 treatment/control pairs



(**Note:** The 95 percent confidence interval—CI—signifies a 95 percent confidence that the true CMI improvement for sites with 3M 360 Encompass is somewhere between the two values that define the interval.)

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Figure 3. Histogram of the paired differences



A histogram of the paired differences (see figure 3) shows there were more positive pairings (24) than negative pairings (13), with a slight skew to the right, with the:

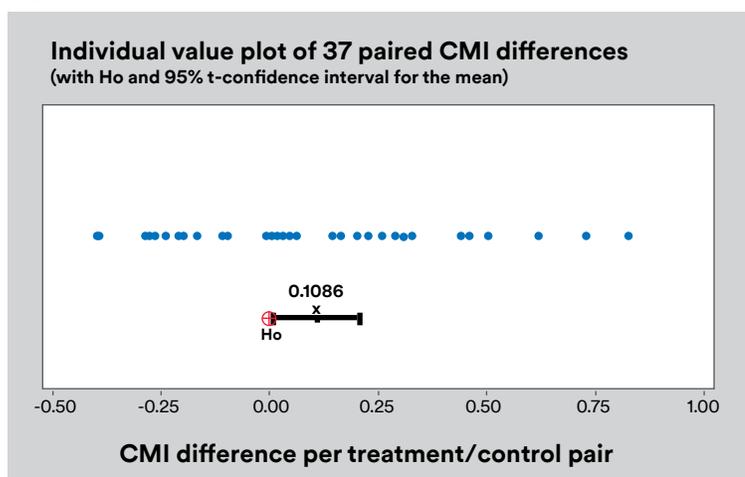
- Maximum positive difference in CMI equal to 0.8285
- Maximum negative difference in CMI equal to -0.3969

Thus, not only were there more positives than negatives, but the magnitude of the maximum positive difference in CMI was more than twice that of the negative maximum.

The paired t-test and its results

A paired t-test was performed with the null hypothesis of no difference in CMI between hospitals with the 3M 360 Encompass System and those without it. The results of the paired t-test are shown in figure 4 and table 1.

Figure 4. Results of the paired t-test



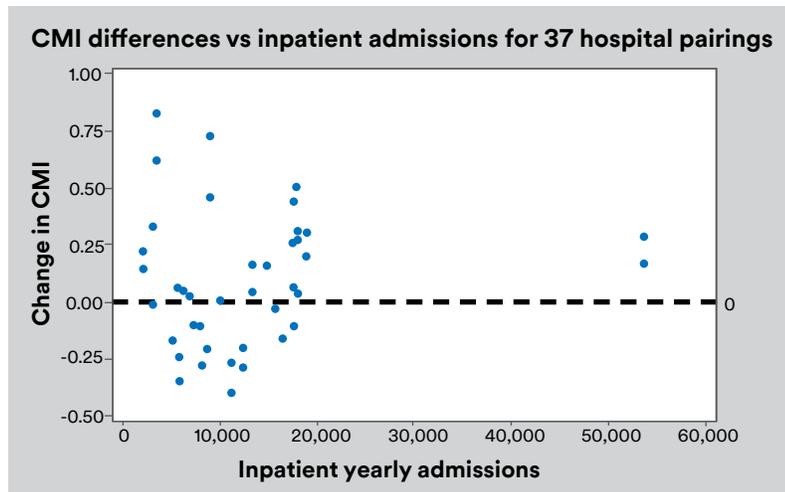
From the results shown in table 1, there is a significant increase ($p=.031$) in CMI for hospitals who have used 3M 360 Encompass for more than a year when compared to comparably sized hospitals who don't use 3M 360 Encompass. This improvement was not detected for just the larger hospitals, but for hospitals at all levels of yearly admissions (see figure 5).

The data suggests 95 percent confidence that the change in CMI for a hospital who uses 3M 360 Encompass will be between +0.0102 and +0.2069.

Table 1. Paired t-test and CI (confidence interval): 3M client with 3M™ 360 Encompass™ vs. a non-3M client

Paired T for 3M customer with 3M™ 360 Encompass™ – Non-3M customer				
	N	Mean	StDev	SE Mean
3M customer	37	1.6928	0.3321	0.0546
Non-3M customer	37	1.5842	0.3325	0.0547
Difference	37	0.1086	0.2950	0.0485
95 percent CI for mean difference: (0.0102, 0.2069)				
T-Test of mean difference = 0 (vs ≠ 0): T-Value = 2.24 P-Value = 0.031				

Figure 5. CMI differences for hospitals at all levels of yearly admissions



The data also suggests that although there is an overall significant positive improvement, 35.1 percent (13 of 37) of the pairings exhibited a negative change in CMI. But since the other factors that influence CMI were spread evenly across both the treatment and control groups, it is reasonable to expect that within any given randomly chosen pair, a negative CMI outcome would occur.

The key result? In spite of the high levels of variability introduced by other factors into the study, overall there was still a significant positive CMI impact for those sites using the 3M 360 Encompass System.

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Study 2: Is there an association between the direct coder acceptance method and CMI?

Conducted by Clarissa George, Business Intelligence Specialist,
3M Health Information Systems

Study 2 procedural explanation: A snapshot

Study group selection:

- 53 hospitals were identified as installed, “live” and operational on the 3M 360 Encompass System since April 2013
- All 53 hospitals were initially included, with the assumption that the coders and hospitals had sufficient time to get familiar with the 3M system before the beginning of fiscal year 2014 (October 1, 2013)
- Each hospital’s MEDPAR data for fiscal year 2014 was compared to fiscal year 2015*
- Of the 53, 34 hospitals had identifiable data to compare CMI for each of the two years
- One site had discontinued use of the 3M system and did not have data for the complete period
- As a result, 33 hospitals were used in Study 2

Adjustment: CMI change from 2014 to 2015 was compared to September 2015 coder acceptance method data, because coder acceptance method data from September 2014 was insufficient.

Assumption: Coders used the 3M product during fiscal year 2015, so coder behavior in September 2015 reflected the hospital’s level of product usage at the end of the year.

*MEDPAR data reports the CMI of a hospital’s billed Medicare cases at the end of each fiscal year.

Conclusions from Study 2

As the percentage of change in CMI was identified for each hospital between fiscal year 2014 and fiscal year 2015, the Study 2 researcher noted that 14 hospitals increased their CMI and 19 hospitals decreased their CMI. Because some hospitals with the 3M™ 360 Encompass™ System increased in CMI and some decreased from year to year, Study 2 sought to determine whether coder behavior and use of the 3M software was associated with the CMI change from fiscal year 2014 to fiscal year 2015.

Study 2 showed there was a significant ($p=.0151$) association for hospitals that saw an increase in CMI from fiscal year 2014 to fiscal year 2015 (as measured from MEDPAR data) and hospitals whose coders used a direct entry coding method **less than 20 percent of the time**. Study 2 suggests there is an increased probability the more coders use the 3M 360 Encompass System coding and the less they directly enter codes, the higher the likelihood that their CMI will increase over time.

What are 3M 360 Encompass coder acceptance methods?

To see if coder behavior related to either increased or decreased CMI, the Study 2 researcher examined coder acceptance methods, and, in the course of the research, the findings helped to further explain exactly what the 3M 360 Encompass System coding acceptance methods are.

There are many ways a coder can use 3M 360 Encompass to derive—and “accept”—a final code for each patient visit. Several ways involve 3M’s **computer-assisted coding (CAC) engine**, code annotations or the built-in 3M logical coding pathways designed to assist the coder.

However, a coder can also bypass the 3M CAC and logic and simply enter the code directly, either recalling the code from memory or by looking it up in an external resource. This approach is called the “direct” coder acceptance method. Other coding acceptance methods include codes that are interfaced into the system or unassigned codes, which are codes that were added and not tracked through a specific coder acceptance method.

The combined total of “other” codes averaged **less than 2 percent across the 33 hospitals** in Study 2 and was deemed to be “noise” that did not affect any of the hospitals outcomes. For purposes of Study 2, the direct coder acceptance method (relying on coder memory or external sources) was compared with the combination of other coder acceptance methods, all of which offer some level of assistance to the coder in making final code assignments. Study 2 determined that the less a coder or facility uses the direct coding acceptance method, the more fully they are using the 3M 360 Encompass System.

Coder acceptance in the two groups of hospitals

Coder acceptance was analyzed for trends and associations between CMI increasing or decreasing among the 33 hospitals. Specifically, the direct coder acceptance method was examined because if the coder used less direct coding, they would be using the 3M™ 360 Encompass™ System more.

The **null hypothesis** was there would be no relationship between the direct coder acceptance method and any of the 3M 360 Encompass System methods that assisted the coder. The Study 2 researcher graphed the percent change of CMI from 2014 to 2015 and compared it to September 2015 coder acceptance method data. While it would have been preferable to compare the percent change for coder acceptance data from September 2014 to September 2015, the data for coder acceptance methods from September 2014 was insufficient. September 2015 data was used with the argument that since the coders had the 3M product all through fiscal year 2015, coder behavior in September 2015 would reflect the hospital's level of product usage at the end of the year.

Next it was assumed that hospitals using the product to derive **80 percent or more of their codes**—meaning hospitals that only used the direct coding acceptance method for 20 percent or less of their codes—would see more advantage from the 3M product and an increase in CMI from year to year. This data appears in the scatterplot shown in *figure 6*.

Looking at *figure 6*, there is an interesting relationship between the four quadrants of the graph. If the relationship between the changes of CMI from fiscal year 2014 to fiscal year 2015 were completely random, it would be reasonable to expect multiple hospitals to appear scattered across the upper right quadrant on the graph (that is, hospitals with greater than 20 percent direct coder acceptance method and a positive change in CMI). **However, this is not the case.** There are only two hospitals in that quadrant, and their direct coder acceptance method is barely above 20 percent. This suggests the relationship between CMI and direct coder acceptance is not random.

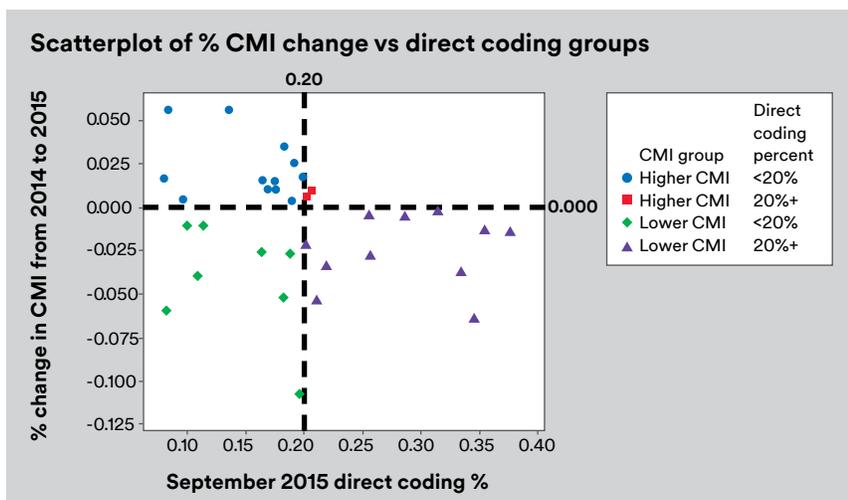
Looking at *figure 6* we also see:

- 12 hospitals increased in CMI year over year and used less than 20 percent direct coding method
- 8 hospitals had decreased CMI while using less than 20 percent direct coder acceptance method
- 2 hospitals increased CMI while using greater than 20 percent direct coder acceptance method
- 11 sites had decreased CMI year over year while using more than 20 percent direct coder acceptance method

Because of the upper right quadrant, there could be a relationship between lower usage of the direct coder acceptance method and an increase in CMI. If the relationship were completely random, it could be expected that more than two sites with greater than 20 percent coder acceptance would have also experienced an increase in CMI.

After examining the layout of the hospitals on *figure 6*, the Study 2 researcher wanted to test if the relationship in the graph was statistically significant.

Figure 6. Scatterplot showing CMI changes vs. direct acceptance groups



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Applying Fisher's exact test

To determine the statistical significance of the above results, Fisher's exact test was applied to the data; the results appear in *table 2*.

Table 2. Fisher test results for Study 2

Change in CMI based on usage of direct coder acceptance method			
	<20% direct coder acceptance method	>20% direct coder acceptance method	Total (sites)
Increase in CMI	12	2	14
Decrease in CMI	8	11	19
Total (sites)	20	13	33
Fisher's exact test: P-Value=0.0151			

The results of the Fisher's exact test indicate a significant relationship ($p=0.0151$) between using the direct coder acceptance method to derive less than 20 percent of codes and an increase in CMI outcomes. In other words, hospitals that used 3M 360 Encompass methods to derive 80 percent or more of their codes were significantly more likely to have an increase in CMI.

Variation in data

Clearly, many reasons could cause an increase in CMI year over year besides the coders manually entering codes through direct entry. For example, there may have been a change in the actual number of surgical cases or differences in training, turnover and individual coder skill throughout a hospital. Any of these factors have an equal chance of happening at any of the sites involved in the study.

However, regardless of the many reasons why CMI can increase, Study 2 revealed a clear association between a hospital's decreased use of the direct coder acceptance method and the increased likelihood of an increase in CMI over time.

About the authors

Gary earned his Master's degree in Medical Biophysics from the University of Utah and his Master's of Science degree in Statistics from Iowa State University. For more than 35 years, he worked for 3M Health Information Systems in software engineering, client support, quality and as a statistical consultant. He is now a statistical consultant with Object Systems International, a vendor engaged by 3M Health Information Systems.

Clarissa earned her Bachelor of Science degree in Business Administration with an emphasis in Marketing from Brigham Young University and joined 3M Health Information Systems in 2013. She has enjoyed different roles focusing on data analysis and strategy in the Centralized Marketing Department and now works on the Business Intelligence team where she helps to analyze and improve performance metrics.

Learn more

If you would like additional information on the 3M 360 Encompass System, please contact your 3M representative today. You may also call us at **800-367-2447**, or visit us online at **www.3m.com/his**.



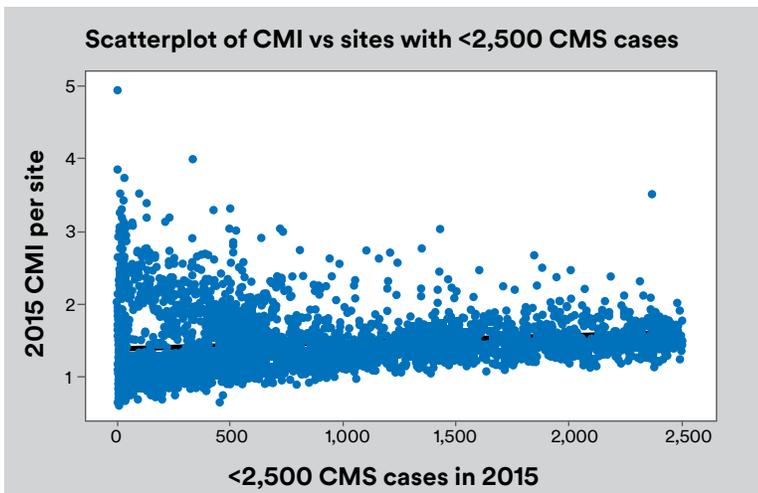
Appendix A

During the course of Study 1, it was discovered that hospitals with less than 2,500 yearly admissions display significant variability in CMI results, but after 2,500 the “thickness” of the variability tends to become more constant. The scatterplots and discussion below examine the results for <2,500 and >2,500.

The large variability for hospitals with less than 2,500 admissions could be attributed to specialty facilities, where the mixture of just a few medical CMI and/or certain types of surgical CMI patients could greatly impact the overall CMI outcome for a hospital.

With the random selection of Study 1’s treatment group, only two hospital pairings in the study had less than 2,500 yearly admissions. Even with the variability exhibited in *figure A-1*, the slope of the least squares regression significantly differed from 0.0 ($p < 0.001$), and there clearly exists a positive correlation between CMI and yearly admissions.

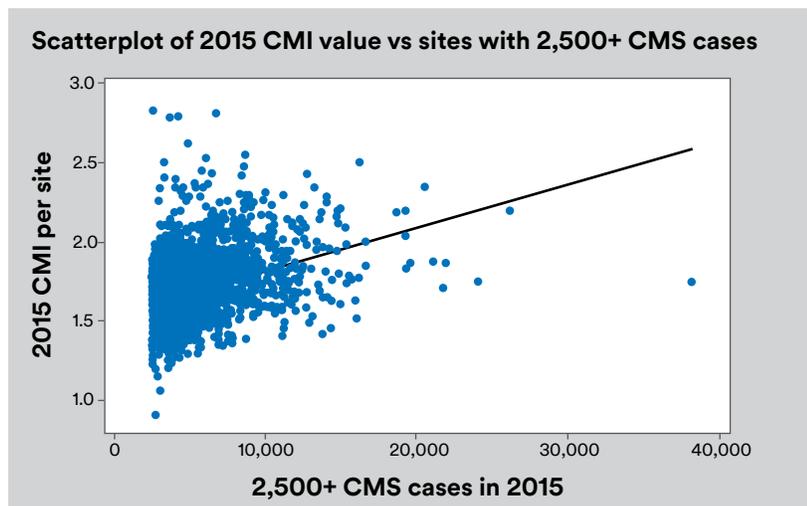
Figure A-1. Scatterplot with a fitted regression line shown for hospitals with less than 2,500 yearly admissions



The higher the admission level, the greater the tendency for a higher CMI. Only 1.6 percent of the total variability is explained by the regression line. This means that if there is an impact on CMI from using the 3M™ 360 Encompass™ System with Study 1's treatment group, that impact will have to be very strong if it is to be detected as significant. In *figure A-2*, the relationship between yearly admissions and CMI was plotted for all hospitals with more than 2,500 yearly admissions.

The slope of the least squares regression was again significantly different from 0.0 ($p < 0.001$), so there is also a strong linear relationship between CMI and admissions for the group with more than 2,500 yearly admissions. Study 1 found that 13.8 percent of the total variability seen in the graph is explained by the regression line. Thus, as was true with the findings in *figure A-1*, to detect any significant difference between the treatment and control pairings—given the large amount of variability—the strength of the difference in CMI between paired hospitals would have to be very strong to be detected.

Figure A-2. Scatterplot of the relationship between yearly admissions and CMI for all hospitals with more than 2,500 yearly admissions



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575 West Murray Boulevard
Salt Lake City, UT 84123 U.S.A.
800 367 2447

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