

Validation of a Claims-Based Algorithm to Characterize Episodes of Care

Chad Ellimoottil, MD, MS; John D. Syrjamaki, MPH; Benedict Voit, MBA; Vinay Guduguntla, BS; David C. Miller, MD, MPH; and James M. Dupree, MD, MPH

Hospitals are increasingly being held accountable for services and expenditures that occur beyond the hospitalization through episode-based performance measures.¹⁻⁶ Postdischarge expenditures, such as postacute care and readmissions, have been cited as the fastest growing spending categories over the last 2 decades and have been the target of many national programs focused on reducing healthcare costs.³ For example, CMS recently implemented the Comprehensive Care for Joint Replacement bundled payment program, which will hold hospitals financially accountable for expenditures occurring from admission through 90 days post discharge.⁷ In addition, accountable care organizations were developed to reduce costs that occur both outside of and during hospitalizations.⁸ Based on the prevalence and growth of episode-based payment programs, it is evident that many payers believe the key to reducing healthcare expenditures is to hold hospitals responsible for efficiency along the entire patient care episode.

Despite enthusiasm for increased episode efficiency, identifying specific high-cost events, such as readmissions, can be challenging for hospitals for several reasons. First, it is difficult for hospitals to track events outside of the initial hospitalization. In fact, hospitals are often not even aware of postdischarge events that occur at outside facilities. Secondly, unless directly affiliated with the hospital, postdischarge providers are not incentivized to report utilization patterns to hospitals. Furthermore, many small hospitals may not have internal resources to monitor and track postdischarge events and spending.

In Michigan, one response to these challenges was the development of the Michigan Value Collaborative (MVC).⁹ Established in 2012 and funded by Blue Cross Blue Shield of Michigan (BCBSM), MVC's mission is to provide hospitals with episode-level data and promote high-quality care at the lowest reasonable costs.¹⁰ One particular area of interest has been postacute care, specifically rehabilitation. MVC hospitals have begun to use episode-level data to monitor rehabilitation expenditures, especially for conditions such as acute myocardial infarction (AMI) and hip replacement,

ABSTRACT

OBJECTIVES: Although hospitals face increasing pressure from payers to improve the efficiency of healthcare delivery beyond the index hospitalization, they often lack information on postdischarge events. The Michigan Value Collaborative (MVC) developed a claims-based algorithm to provide hospitals with data on events that occur to patients beyond the hospitalization. Herein, we discuss the validation of MVC's claims-based algorithm.

STUDY DESIGN: Retrospective analysis of a claims-based algorithm's ability to identify specific medical events, such as index hospitalizations, 30-day readmissions, emergency department visits, skilled nursing facility admissions, home health visits, and rehabilitation services. The claims-based events were validated using a primary review at 63 hospitals.

METHODS: We selected 1830 Blue Cross Blue Shield of Michigan episodes from MVC data and asked 63 Michigan hospitals to query their medical records for the presence or absence of specific events. We then calculated agreement statistics and improved our algorithm using feedback from hospitals.

RESULTS: All 63 hospitals participated in the validation process and successfully identified 99% of episodes in their medical records. The initial agreement between our algorithm and medical records was moderate for 4 postdischarge events (kappa ranging from 0.62-0.78) and poor for rehabilitation services (0.16). Much of the disagreements occurred because hospitals could not identify postdischarge events occurring outside of their hospital systems. Other disagreements occurred because of hospital coding practices. Through this analysis, the claims-based algorithm was improved to better reflect real-world coding practice.

CONCLUSIONS: Our findings suggest that the MVC claims-based algorithm identifies and classifies claims with high fidelity and outperforms medical records in the identification of postdischarge events. These findings provide important insight to policy makers, payers, and hospital administrators about the value of claims-based data for the implementation of episode-based programs.

Am J Manag Care. 2017;23(11):e382-e386

where more than one-third of all patients are discharged to rehabilitation facilities (Table 1). However, a necessary step in this process is to ensure that MVC's claims-based identification of postdischarge services is accurate.

In this context, we describe a large-scale medical records–based validation of the algorithm used by MVC to define clinical episodes of care in commercial claims. We believe that the MVC validation experience will provide useful insight to hospitals and payers about the advantages and limitations of using claims to track events that occur after hospitalization.

METHODS

Data Sources

The MVC collects claims data for BCBSM beneficiaries admitted to 1 of 63 Michigan hospitals for 21 medical and surgical conditions.

TAKEAWAY POINTS

The Michigan Value Collaborative (MVC)'s claims-based algorithm identifies postdischarge events with high fidelity, often outperforming medical records.

- ▶ The creation of this algorithm and its subsequent validation demonstrates that deriving episode-level utilization from administrative claims is achievable.
- ▶ With an increasing focus on improving efficiency of care after the index hospitalization, hospitals need accurate information. To this end, MVC's claims-based algorithm provides precise episode-level data on postdischarge care.
- ▶ Given that administrative claims data outperformed medical records, hospitals should seek to collect such data, possibly by participating in a statewide, regional, or health-system value improvement collaborative or asking payers for claims-based analytic data.

We consulted clinical experts who used *International Classification of Diseases, Ninth Revision (ICD-9)* diagnosis/procedure and Current Procedural Terminology (CPT) codes to define the conditions. Then, we utilized variables such as revenue codes, diagnosis-related groups (DRGs), facility identification, and CPT codes to classify individual claims into: inpatient, skilled nursing facility (SNF), home health, emergency department (ED), inpatient rehabilitation, outpatient rehabilitation, and general outpatient claims. Cases with readmissions to hospitals other than the index facility were

TABLE 1. Number of Total Episodes and Percentage of Episodes With a Postdischarge Event, by Condition

Condition and/or Procedure	Number of Episodes	Percent Readmitted	Percent Using ED	Percent Using SNF	Percent Using HH	Percent Using Rehab
Appendectomy	3499	4%	8%	0%	2%	4%
AMI	8905	8%	15%	1%	10%	36%
Cesarean section	27,494	1%	7%	0%	0%	3%
CABG	2270	7%	16%	1%	67%	54%
CHF	3196	17%	16%	2%	18%	6%
Cholecystectomy	4244	5%	11%	0%	2%	3%
Colectomy	3819	9%	13%	2%	24%	4%
Disc herniation	8044	3%	10%	0%	7%	34%
Hip fracture	482	6%	9%	12%	53%	53%
Hip replacement	8377	2%	7%	3%	53%	56%
Hysterectomy	13,491	3%	10%	0%	1%	4%
Knee replacement	15,903	2%	8%	3%	55%	85%
Non-Cesarean section birth	53,958	1%	5%	0%	0%	3%
PCI	3388	9%	17%	0%	2%	22%
Pneumonia	6263	10%	16%	2%	9%	6%
Prostatectomy	2918	2%	10%	0%	4%	10%
RYGB	2877	4%	14%	0%	6%	4%
Sleeve	4787	3%	10%	0%	6%	4%
Spine, other	6795	3%	11%	1%	9%	33%
Trauma	12,969	7%	13%	3%	17%	39%
Valve	1104	12%	16%	2%	59%	37%

AMI indicates acute myocardial infarction; CABG, coronary artery bypass graft; CHF, congestive heart failure; ED, emergency department; HH, home health; PCI, percutaneous coronary intervention; Rehab, rehabilitation; RYGB, Roux-en-Y gastric bypass; SNF, skilled nursing facility.

TRENDS FROM THE FIELD

TABLE 2. Agreement Between Hospital Medical Chart and Administrative Claims

	Identified by Administrative Claims	Identified by Medical Charts	Not Identified by Medical Charts
30-day readmissions	183	168 (92%)	15 (8%)
ED visits	452	292 (65%)	160 (35%)
SNF admissions	64	43 (67%)	21 (33%)
Home health visits	949	781 (82%)	168 (18%)
Rehabilitation visits	1223	350 (29%)	873 (71%)

ED indicates emergency department; SNF, skilled nursing facility.

excluded from the readmissions validation step. **eAppendix A** (eAppendices available at ajmc.com) further details the entire attribution process. Table 1 presents the characteristics of episodes identified from claims data by condition type, including use of postdischarge services. This study was deemed exempt from review by the Michigan Institutional Review Board.

Validation Process

Our validation process occurred in 2 phases (pilot and full validation). During the pilot, 6 hospitals were asked to review 10 to 20 BCBSM preferred provider organization (PPO) cases from between January 1, 2013, and October 31, 2014. For matching purposes, the clinical condition, national provider identifier, date of birth, gender, admission date, and discharge date for each patient was provided. Specifically, participants were instructed to indicate if the patient listed had records demonstrating that a specified event occurred within 90 days of their discharge date. These events included 30-day readmissions, ED visits, SNF admissions, home health visits, and rehabilitation services (inpatient and outpatient).

The lessons learned from the pilot were used to inform the full validation. Here, we distributed the same key variables to all 63 MVC participants. Each hospital was provided 30 cases to review, with the exception of hospitals that participated in the pilot (which were asked to review 20 cases). We selected conditions based on volume, prevalence of associated postdischarge services, and suggestions from clinical experts. The conditions included colectomy, coronary artery bypass graft, AMI, pneumonia, congestive heart failure, hip replacement, knee replacement, cesarean delivery, vaginal delivery, trauma, and spine surgery. In total, 1830 BCBSM PPO cases were selected for data validation from these 11 conditions.

Statistical Analyses

We identified areas of agreement and disagreement between MVC's claims-based algorithm and medical records. First, we looked for agreement that these episodes occurred and were attributed to the correct hospital and to the correct condition. Next, we used a kappa statistic to assess agreement for postdischarge services (**eAppendix B**). For each disagreement in a case, 2 members of the MVC team, a clinician and an analyst, reviewed the specific

claims. After determining the cause of the discordance, we adjusted our algorithm to better capture hospital events and re-evaluated the level of agreement.

In the cases where MVC reported a postdischarge event that did not match a hospital's medical records, we used confirmatory evidence from the claims to improve our confidence that the event occurred. Specifically, we examined the following items: 1) Did the postdischarge event have more than 2 claim

line items with dates following the index admission?; 2) Did the place of service designation on the claims support the assignment of the claim to the postdischarge service?; and 3) Did the revenue center code on the claims support the assignment of the claim to the postdischarge service?

RESULTS

One hundred percent of hospitals (n = 63) participated in the validation process. Hospitals matched 1812 of the 1830 (99%) MVC episodes to records in the hospital's medical charts.

Information

The agreement for the occurrence of postdischarge services ranged from 0.16 to 0.78, with rehabilitation services having the poorest agreement. **eAppendix B** contains details of the validation process.

30-Day Readmissions

Using administrative claims, we were able to identify 183 readmissions for 1812 episodes (10% readmission rate). Of these, there were 15 cases in which MVC observed a 30-day readmission that was not evident in the hospital data (**Table 2**). These were due to readmissions to a hospital different than the index facility and, per the methods section, were excluded. There were 24 discordant readmissions which MVC did not identify and a hospital did; these cases were classified as observation unit stays in MVC data (**eAppendix B**).

ED Visits

We identified 452 ED visits (25% of episodes). Of these visits, 292 (65%) were identified by hospitals. Importantly, there were 160 out of 452 cases (35%) in which MVC observed an ED visit that was not reported in the hospital clinical data (**Table 2**). Of the 160 discordant cases, 122 (76%) of these ED visits occurred at a different facility than the index admission. All 160 cases had confirmatory evidence of a valid ED visit.

There were 85 episodes (5%) in which a hospital reported an ED visit that was not evident in the MVC data. Upon review, many of these were classified elsewhere. For example, 38 preceded an index

admission or a readmission and the ED services are grouped with this hospitalization in the MVC episode (eAppendix B).

SNF Admissions

We identified 64 SNF admissions (4% of episodes). Of these, 43 (67%) admissions were identified by hospitals. There were 21 cases (33%) in which MVC identified a SNF admission but the admissions were not reported by hospitals (Table 2). We found evidence in the claims data to confirm that all 21 visits occurred. There were only 9 cases in which hospitals reported care in a SNF, and we found no evidence of a SNF admission in the MVC claims data (eAppendix B).

Home Health Visits

We identified 949 home health visits (52% of episodes). Of these visits, 781 (82%) were identified by hospitals (Table 2). Of those reported by hospitals, there were 168 cases (21%) in which MVC observed a home health visit that was not evident in the hospital clinical data. There were 99 cases (10% of episodes) in which a hospital observed a home health visit that was not evident in the MVC data (eAppendix B).

Rehabilitation

The algorithm identified 1223 rehabilitation visits (67% of episodes). Of these visits, 350 (29%) were reported by hospitals. There were 873 cases (71%) in which MVC observed a rehab visit that was not evident in the hospital clinical data (Table 2). Of the 873 discordant cases, 851 (97%) had confirmatory evidence in the MVC claims for utilization of rehabilitation services. There were only 42 cases (3% of episodes) in which a hospital observed a rehab visit that was not evident in the MVC data (eAppendix B).

Improvements to the Claims-Based Algorithm

After reviewing all cases of discordance between the claims-based algorithm and the medical records, we identified several areas for improvement, the most important being to update the *ICD-9* codes used to identify postdischarge claims to better reflect the coding practices used by hospitals. For example, *ICD-9* code V57.8 (care involving other specified rehabilitation procedure) was initially not considered by MVC as a related diagnosis code for patients after joint replacement. However, this code was used for a large number of rehabilitation services after joint replacement. After making this and other improvements, we re-evaluated the level of agreement between our algorithm and the medical records and found improvement in agreement for all services (eAppendix B).

DISCUSSION

In this study, we validated the MVC's claims-based algorithm for the identification and classification of postdischarge events. During the process, we found a high episode match rate between MVC data and

medical records. Much of the disagreement was due to the inability of hospitals to identify readmissions, rehabilitation services, and other postdischarge events. Collectively, these findings suggest that this claims-based algorithm outperforms medical records in identifying postdischarge events.

Previous investigators have convincingly demonstrated that variation in episode spending is largely due to postdischarge events.^{3,11-16} Preventable readmissions and variations in postacute care could indicate areas to improve hospital efficiency and outcomes. Others have also validated and demonstrated on a health-system level the success of claims-based algorithms in identifying hospital events.¹⁷⁻¹⁹ Existing literature has demonstrated the effectiveness of utilizing these tools to identify high-cost inpatient events and improve the value of care.²⁰ It is reasonable to believe that by using this same approach to identify postdischarge events, institutions could potentially achieve similar results outside the hospital setting. The current study findings demonstrate, on a large statewide scale, that accurately identifying and measuring postdischarge utilization may be difficult for hospitals using medical records alone. A claims-based algorithm could better identify postdischarge events, especially those that occur outside hospitals' networks. With the current national focus on episode efficiency, identification of these events is imperative to driving high-value care.

Limitations

Our study has several limitations. First, we only included BCBSM patients in our validation process. Due to CMS privacy restrictions, we were unable to validate our algorithm with Medicare beneficiaries. Second, the MVC algorithm may not be generalizable for other commercial payers, although BCBSM is the largest commercial payer in Michigan. Third, we did not have hospitals look for readmissions that occurred outside of the hospital where the index event occurred. This decision was primarily made to reduce the chart review burden to hospitals; we received early feedback that hospitals could not identify these particular events. Finally, we did not validate our classification algorithm for other postdischarge events (eg, outpatient procedures) and intensity of services (eg, SNF length of stay). However, this study was focused on validating the occurrence of major postdischarge services. Although we did not end with perfect agreement between the MVC data and the medical records, there were only a few events identified by hospitals not seen in MVC claims (0.5%-4%).

CONCLUSIONS

Our findings will help stakeholders understand the opportunities and challenges of using a claims-based algorithm to measure episode spending. Relevant to hospital administrators, the finding that the claims-based algorithm used in this study outperformed medical records suggests that such data provide more complete

TRENDS FROM THE FIELD

intelligence about the postdischarge period. This finding should encourage hospital administrators to obtain additional claims data by participating in a statewide, regional, or health-system collaboration and by asking payers to share these data. Without these claims data, hospitals will be limited in their ability to measure and optimize services provided outside of their facilities. This is particularly important as CMS and commercial payers are increasingly using episode-based performance measurement and payment bundling.

Moving forward, research in this area should focus on how these data can be refined to provide more granular information to hospitals. For instance, providing hospitals with data on the average length of stay and intensity of services provided at SNFs may help providers understand the efficiency of facilities where patients are sent after discharge. Ultimately, the value of episode-based performance measurement and bundled payment programs as mechanisms to drive high-value care will strongly depend on the accurate measurement of episode-level payments and utilization. ■

Acknowledgments

The authors thank Dr Vinita Bahl (University of Michigan), Kelly Rice (Beaumont Health System), Steve Lewis (St. Joseph Mercy Health System), Meghan Coughlin (MidMichigan Medical Center), and John Robertson (Hillsdale Community Health Center) for their comments and insight during the course of this research. They would also like to thank Dr David Share, Ellen Ward, Tom Leyden, and the Value Partnerships at BCBSM for their ongoing support of the Michigan Value Collaborative and this manuscript.

Author Affiliations: Institute for Healthcare Policy and Innovation (CE, DCM, JMD), and Dow Division of Health Services Research, Department of Urology (CE, JDS, DCM, JMD), and Michigan Value Collaborative (CE, JDS, BV, VG, DCM, JMD), University of Michigan, Ann Arbor, MI.

Source of Funding: This research was supported by the Agency for Healthcare Research and Quality (1F32HS024193-01 to Dr Ellimoottil). Dr Miller receives salary support from Blue Cross Blue Shield of Michigan for his role as the director of the Michigan Urological Surgery Improvement Collaborative and the Michigan Value Collaborative. Dr Dupree receives salary support from Blue Cross Blue Shield of Michigan for his role as the co-director of the Michigan Value Collaborative and his involvement in the Michigan Urological Surgery Improvement Collaborative. Mr Voit receives salary support from the Michigan Value Collaborative as an account manager and is an employee of ArborMetrix.

Author Disclosures: The authors are employed by University of Michigan, which has a contract from Blue Cross Blue Shield of Michigan to operate the Michigan Value Collaborative.

Authorship Information: Concept and design (CE, JDS, DCM, JMD); acquisition of data (CE, JDS, BV, DCM); analysis and interpretation of data (CE, JDS, BV, VG, DCM, JMD); drafting of the manuscript (CE, JDS, BV, VG, DCM);

critical revision of the manuscript for important intellectual content (CE, JDS, BV, VG, DCM, JMD); statistical analysis (JDS, VG); provision of patients or study materials (JMD); obtaining funding (JMD); administrative, technical, or logistic support (CE, JDS, VG, DCM, JMD); and supervision (JDS, JMD).

Address Correspondence to: Chad Ellimoottil, MD, MS, University of Michigan, 2800 Plymouth Rd, Bldg 16, 1st Fl, Room 100S, Ann Arbor, MI 48109-2800. E-mail: cellimoo@med.umich.edu.

REFERENCES

- Chen LM, Meara E, Birkmeyer JD. Medicare's Bundled Payments for Care Improvement initiative: expanding enrollment suggests potential for large impact. *Am J Manag Care.* 2015;21(11):814-820.
- Newcomer LN, Gould B, Page RD, Donelan SA, Perkins M. Changing physician incentives for affordable, quality cancer care: results of an episode payment model. *J Oncol Pract.* 2014;10(5):322-326. doi: 10.1200/JOP.2014.001488.
- Chandra A, Dalton MA, Holmes J. Large increases in spending on postacute care in Medicare point to the potential for cost savings in these settings. *Health Aff (Millwood).* 2013;32(5):864-872. doi: 10.1377/hlthaff.2012.1262.
- Newcomer LN. Trying something new: episode payments for cancer therapy. *Am J Manag Care.* 2012;18(spe no 1):SP5.
- Rosen AB, Aizcorbe A, Ryu AJ, Nestoriak N, Cutler DM, Cherner ME. Policy makers will need a way to update bundled payments that reflects highly skewed spending growth of various care episodes. *Health Aff (Millwood).* 2013;32(5):944-951. doi: 10.1377/hlthaff.2012.1246.
- Cutler DM, Ghosh K. The potential for cost savings through bundled episode payments. *N Engl J Med.* 2012;366(12):1075-1077. doi: 10.1056/NEJMp1113361.
- Mechanic RE. Mandatory Medicare bundled payment—is it ready for prime time? *N Engl J Med.* 2015;373(14):1291-1293. doi: 10.1056/NEJMp1509155.
- Ackerly DC, Grabowski DC. Post-acute care reform—beyond the ACA. *N Engl J Med.* 2014;370(8):689-691. doi:10.1056/NEJMp1315350.
- Michigan Value Collaborative website. michiganvalue.org. Published 2015. Accessed March 13, 2016.
- Share DA, Campbell DA, Birkmeyer N, et al. How a regional collaborative of hospitals and physicians in Michigan cut costs and improved the quality of care. *Health Aff (Millwood).* 2011;30(4):636-645. doi: 10.1377/hlthaff.2010.0526.
- Grenda TR, Pradarelli JC, Thumma JR, Dimick JB. Variation in hospital episode costs with bariatric surgery. *JAMA Surg.* 2015;150(12):1109-1115. doi: 10.1001/jamasurg.2015.2394.
- Cram P, Ravi B, Vaughan-Sarrazin MS, Lu X, Li Y, Hawker G. What drives variation in episode-of-care payments for primary TKA? an analysis of Medicare administrative data. *Clin Orthop Relat Res.* 2015;473(11):3337-3347. doi: 10.1007/s11999-015-4445-0.
- Schoenfeld AJ, Harris MB, Liu H, Birkmeyer JD. Variations in Medicare payments for episodes of spine surgery. *Spine J.* 2014;14(12):2793-2798. doi: 10.1016/j.spinee.2014.07.002.
- Bozic KJ, Ward L, Vail TP, Maze M. Bundled payments in total joint arthroplasty: targeting opportunities for quality improvement and cost reduction. *Clin Orthop Relat Res.* 2014;472(1):188-193. doi: 10.1007/s11999-013-3034-3.
- Miller DC, Gust C, Dimick JB, Birkmeyer N, Skinner J, Birkmeyer JD. Large variations in Medicare payments for surgery highlight savings potential from bundled payment programs. *Health Aff (Millwood).* 2011;30(11):2107-2115. doi: 10.1377/hlthaff.2011.0783.
- Birkmeyer JD, Gust C, Baser O, Dimick JB, Sutherland JM, Skinner JS. Medicare payments for common inpatient procedures: implications for episode-based payment bundling. *Health Serv Res.* 2010;45(6 pt 1):1783-1795. doi: 10.1111/j.1475-6773.2010.01150.x.
- Horwitz LI, Grady JN, Cohen DB, et al. Development and validation of an algorithm to identify planned readmissions from claims data. *J Hosp Med.* 2015;10(10):670-677. doi: 10.1002/jhm.2416.
- Sacks GD, Dawes AJ, Russell MM, et al. Evaluation of hospital readmissions in surgical patients: do administrative data tell the real story? *JAMA Surg.* 2014;149(8):759-764. doi: 10.1001/jamasurg.2014.18.
- Wijesundera DN, Austin PC, Hux JE, Beattie WS, Buckley DN, Laupacis A. Development of an algorithm to identify preoperative medical consultations using administrative data. *Med Care.* 2009;47(12):1258-1264. doi: 10.1097/MLR.0b013e3181bd479c.
- Lee VS, Kawamoto K, Hess R, et al. Implementation of a value-driven outcomes program to identify high variability in clinical costs and outcomes and association with reduced cost and improved quality. *JAMA.* 2016;316(10):1061-1072. doi: 10.1001/jama.2016.12226.

Full text and PDF at www.ajmc.com

eAppendix A. Facility Claims

Inpatient	Claims with a room and board revenue code ¹ (excluding revenue codes for inpatient rehab) occurring in a BCBSM facility considered a Hospital Unit, Hospital, Long-Term Acute Care, or Unknown (excluding claims with revenue codes or DRGs associated with rehab) ²
SNF	Claims with a revenue code starting with '019' or occurring in a facility designated by BCBSM as a SNF
ED	Claims with a revenue code or CPT code associated with ED service use ³
HH	Claims with a revenue code or CPT code associated with Home Health ⁴ or from a facility designated by BCBSM as HHC
IP Rehab	Claims with an IP Rehab revenue code or a rehab DRG or an inpatient claim with a primary dx of rehabilitation ⁵
OP Rehab	Claims with either a CPT or revenue code associated with physical, speech, occupational, ⁶ or cardiac therapy ⁷
Outpatient ⁸	Remaining outpatient claims

Professional Claims

OP Rehab	CPT codes for physical, speech, occupational services: 92506, 92507, 92508, 92526, 92597, 92605, 92606, 92607, 92608, 92609, 97001, 97002, 97003, 97004, 97010, 97012, 97016, 97018, 97022, 97024, 97026, 97028, 97032, 97033, 97034, 97035, 97036, 97039, 97110, 97112, 97113, 97116, 97124, 97139, 97140, 97150, 97530, 97533, 97535, 97537, 97542, 97750, 97755, 97760, 97761, 97762, 97799, G0281, G0282, G0283, G0329
	CPT Codes for cardiac rehab: 93797, 93798, G0422, G0423
ED	CPT Codes: 99281, 99282, 99283, 99284, 99285
Remaining claims assigned based on Berenson Eggers Type of Service (BETOS)⁹ classification.	
Surgical Procedures	BETOS Groups: P1, P2, P3, P4
Anesthesia	BETOS Groups: P0
Other Procedures	BETOS Groups: P5, P6, P7, P8, P9
E&M Office Visit	BETOS Groups: M1
E&M Hospital Visits	BETOS Groups: ED (from above) and M2
E&M Consults and	BETOS Groups: M3, M4, M5, M6

Other	
Imaging	BETOS Groups: I1, I2, I3, I4
Tests	BETOS Groups: T1, T2
DME	BETOS Groups: D1
Ambulance	BETOS Groups: O1
Other	BETOS Groups: Y1, Y2, Z1, Z2, Other

Sources: BCBSM Facility and Professional Claims files; Medicare MedPAR (IP and SNF), OP, Hospice, HHA, Physician/Supplier files

1. Revenue codes starting with: 010, 011, 012, 013, 014, 015, 016, 017, 018, 020 or 021
2. Revenue codes: 0118, 0128, 0138, 0148, 0158. DRGs: 945, 946
3. Revenue codes: 0450, 0451, 0452, 0453, 0454, 0455, 0456, 0457, 0458, 0459. CPT codes: 99281, 99282, 99283, 99284, 99285
4. Revenue codes beginning with: 055, 056, 057, 058, 059, 060. CPT codes: G015X, G0160, G0161, G0162, G0163, G0164
5. Revenue codes: 0118, 0128, 0138, 0148, 0158. ICD-9 Diagnosis Codes: V528, V529, V571, V572, V573, V5789, V579. DRGs: 945, 946. Unlike Medicare, BCBSM provided facility classifications do not specifically identify inpatient rehab facilities
6. CPT codes: 92506, 92507, 92508, 92526, 92597, 92605, 92606, 92607, 92608, 92609, 97001, 97002, 97003, 97004, 97010, 97012, 97016, 97018, 97022, 97024, 97026, 97028, 97032, 97033, 97034, 97035, 97036, 97039, 97110, 97112, 97113, 97116, 97124, 97139, 97140, 97150, 97530, 97533, 97535, 97537, 97542, 97750, 97755, 97760, 97761, 97762, 97799, G0281, G0282, G0283, G0329. Revenue codes: 0420, 0421, 0422, 0423, 0424, 0429, 0430, 0431, 0432, 0433, 0434, 0439, 0440, 0441, 0442, 0443, 0444, 0449
7. CPT codes: 93797, 93798, G0422, G0423. Revenue codes: 0943
8. This group includes a mix of services including: outpatient labs, bloodwork, DME, radiology, outpatient surgical procedures, etc
9. BETOS categorizations and mappings can be found here: <https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and->

[Reports/MedicareFeeForSvcPartsAB/downloads/betosdescodes.pdf](#);

<http://www.cms.gov/Medicare/Coding/HCPCSReleaseCodeSets/BETOS.html>

eAppendix B

Michigan Value Collaborative (MVC) Data Validation

Introduction and Aims

The data validation project provided the MVC Coordinating Center (CC) and participating hospitals with an opportunity to examine the level of agreement between services assigned to episodes of care by the MVC claims data algorithms and services identified in clinical data maintained by the hospitals.

The project had three specific aims. First, the results of the project provided detailed information to participating hospitals about the reliability of the MVC data. Second, the clinical data provided by hospitals informed refinements to our inclusion and exclusion algorithms for care occurring after the index hospital stay, thereby enhancing the validity of reports provided to hospitals. Third, the findings confirmed MVC's ability to identify and describe services occurring within an episode that are often not visible in medical records.

Methods Description

As a first step, 1,830 BCBSM PPO cases with index hospitalization admission dates from January 1, 2013 through October 31, 2014 were selected from the following 11 conditions:

- Acute Myocardial Infarction (AMI)
- Congestive Heart Failure (CHF)
- Pneumonia
- Hip Replacement
- Knee Replacement
- Colectomy
- Coronary Artery Bypass Graft (CABG)
- Spine Surgery
- Trauma
- Vaginal Birth
- Caesarean Section

These conditions were selected based on high volumes across hospitals, a high prevalence of associated post-discharge services, and recommendations from clinical experts. In order to identify MVC episodes in their own data, hospitals were provided with the condition, patient date of birth and gender, index hospitalization admission and discharge dates, and provider NPI (when available).

Participating hospitals were provided with a list of 30 patients identified in MVC data and asked to indicate if the patients listed had information in the available clinical data demonstrating that post-discharge services occurred within 90 days of their discharge date. The following post-discharge services were examined:

- 30-day inpatient readmissions
- Home Health visits
- Skilled Nursing Facility (SNF) admissions
- 90-day inpatient readmissions
- Emergency Department (ED) visits
- Rehabilitation services (inpatient & outpatient)

Episode Match Rate Results

Hospitals were able to successfully match 1,812 of the 1,830 episodes within their records, for a **99% match rate**. This rate provides confirmation that these hospital episodes did in fact take place, were attributed to the correct hospital, and were assigned to the correct condition.

Presentation of Post-Discharge Service Validation Results

The results presented in this report summarize the observed level of agreement between the MVC claims data and clinical data provided by hospitals. For each type of post-discharge service, the results are presented initially in a table with the following general structure and format:

Level of Agreement for 30-day Readmissions (Kappa Statistic=X)			
<i>Service identified in MVC claims data</i>	<i>Service identified in Hospital clinical data</i>		Total
	No (0)	Yes (1)	
No (0)	A	B	
Yes (1)	C	D	
Total			1,812

In this example, cells ‘A’ and ‘D’ denote episodes with agreement between MVC and hospital data. Cell ‘A’ represents readmissions that were identified in neither MVC nor Hospital data. Cell ‘D’ represents readmissions that were identified in both MVC and hospital data.

Cells ‘B’ and ‘C’ denote episodes with disagreement between MVC and hospital data. Specifically, cell ‘B’ represents episodes with readmissions that were identified in hospital data, but not identified in MVC claims. Cell ‘C’ represents episodes with readmissions that were identified in MVC data, but not identified in medical records. If there is perfect agreement between MVC and hospital data, then the values in these cells would both be zero.

The ‘Kappa Statistic’ is a statistic that measures inter-rater agreement (in this case between hospital data and MVC claims), and accounts for agreement occurring merely by chance.¹⁰ We considered several publications when determining an acceptable level of agreement between the two data sources. Landis and Koch¹¹ consider 0.61-0.80 to be ‘substantial agreement’ and 0.81-

10. Cohen, Jacob. 1960. “A statistic of agreement for nominal scales”. *Education and Psychological Measurement*: 20-1. doi: 10.1177/001316446002000104.

11. Landis, J. Richard, and Gary G. Koch. 1977. “The Measurement of Observer Agreement for Categorical Data”. *Biometrics* 33 (1). International Biometric Society: 159–74. doi:10.2307/2529310.

1.00 to be ‘almost perfect’ agreement. Similarly, Altman¹² regards 0.61-0.80 as ‘good’ agreement and 0.81-1.00 as ‘very good’ agreement. Finally, Fleiss¹³ considers 0.40-0.75 to be ‘fair to good’ agreement and 0.75-1.00 to be ‘excellent’ agreement. Based on these guidelines, we decided *a priori* that a Kappa Statistic of 0.80 represents an acceptable level of agreement for confirming validity of the MVC claims algorithms.

The key lessons from the validation process came from examining the episodes in the discordant cells (i.e., cells B and C in the table above). Using readmissions as an example, the diagrams below summarize the logic used by the MVC CC to deconstruct and understand these discordant cells, as well as the steps we will take to improve the classification and identification of services based on this information.

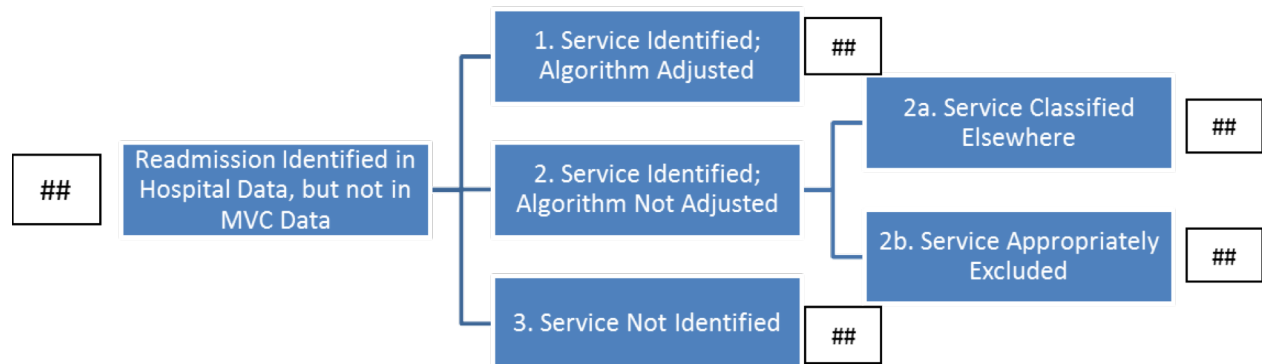
The flow diagram below represents our general approach in reconciling discordant episodes in Cell B (service identified by hospital but not MVC) for each of the services examined.

Box 1 refers to readmissions MVC was able to identify in additional claims data and should have been captured by the MVC algorithm. The MVC algorithm will be adjusted to capture these claims in the future.

Box 2a refers to claims that MVC was already capturing but were classified in a different cost category, such as outpatient surgery or an ED or observation stay visit.

Box 2b refers to claims that MVC had excluded from the episode. Additional review of those claims confirmed that they were appropriately excluded from the episode.

Box 3 refers to readmissions that could not be identified by MVC despite a thorough evaluation of all available claims for that patient.

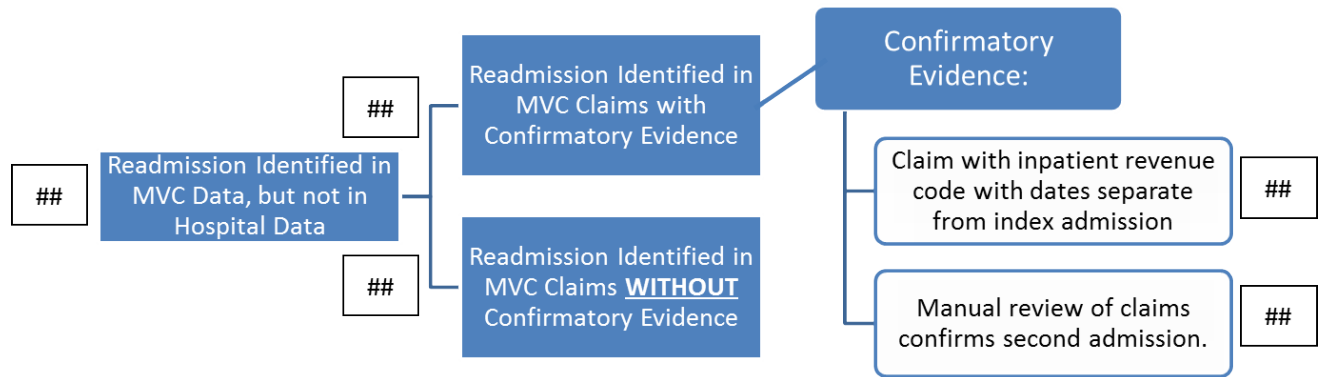


The flow diagram below pertains to the discordant episodes found in Cell C (services identified by MVC but not by hospitals). For services that were identified in MVC claims but not in

12. Altman, Douglas G. *Practical statistics for medical research*. London New York: Chapman and Hall, 1991.

13. Fleiss, Joseph L. *Statistical methods for rates and proportions* (2nd ed.). New York: Wiley, 1981.

hospital data, we required that at least two confirmatory criteria were met to conclude that the services were actually provided.



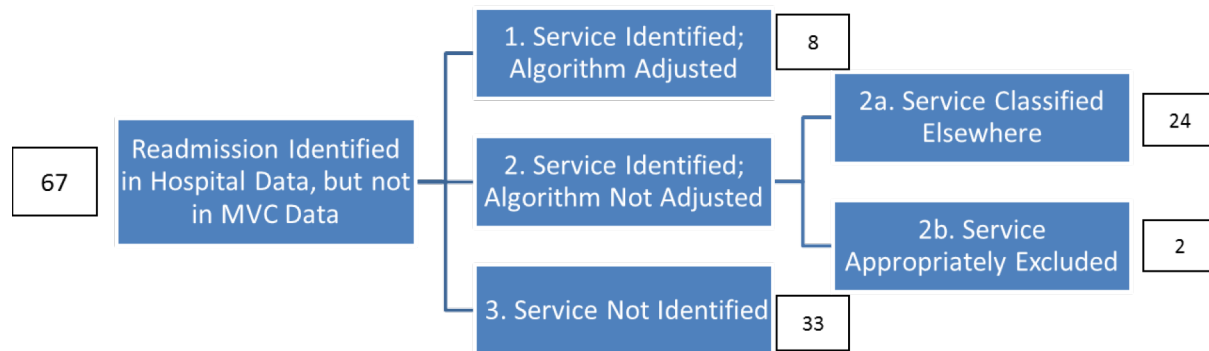
30-DAY READMISSIONS

Among patients with a 30-day readmission identified in the MVC data, only those who were readmitted to the same facility as their index hospitalization were sent to hospitals for the validation analyses.

Level of Agreement for 30-day Readmissions (Kappa Statistic=0.78)			
<i>Service identified in MVC claims data</i>	<i>Service identified in Hospital clinical data</i>		Total
	No (0)	Yes (1)	
No (0)	1,562	67	1,629
Yes (1)	15	168	183
Total	1,577	235	1,812

Investigation of Discordance

Cell B: There were 67 cases in which a hospital observed a 30-day readmission that was not evident in the MVC data.



Box 1: Of the 67 episodes with discordant data, 8 had claims with ICD-9 diagnosis codes that should reasonably be attributed to the index hospitalization episode but were excluded based on the current MVC algorithm. As a consequence, the algorithm was adjusted to include these codes.

Box 2: In 26 of the discordant cases, a readmission or related service was identified in MVC, but was either classified elsewhere in the episode or was appropriately excluded.

a. The large proportion of the 24 cases that were classified elsewhere in the MVC episodes did not have inpatient claims related to a readmission, but instead had claims indicating an observation unit stay following an ED visit, outpatient operating room services, or time spent in a recovery room. In the remaining cases, there were multiple readmissions identified by hospitals that occurred beyond the 30-day window, and are therefore classified elsewhere as 90-day readmissions.

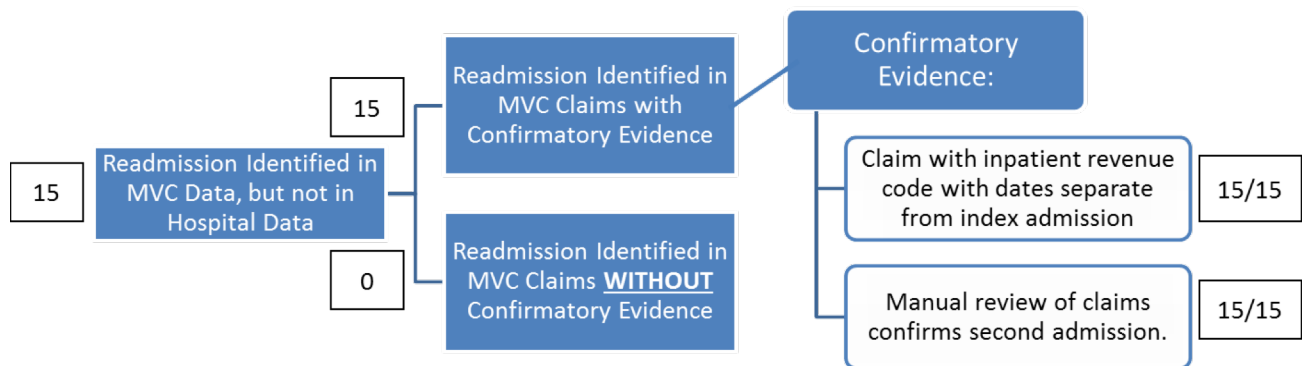
b. There were 2 cases in which a readmission was evident in the MVC claims, but was being appropriately excluded from the episode based on the ICD-9 diagnosis codes present on the claims.

The following table lists the relevant condition(s), ICD-9 diagnosis code, and code description.

Condition	ICD-9 Diagnosis Code	Code Description
Knee Replacement	5770	Acute pancreatitis
Knee Replacement	57400	Calculus of gall bladder with acute cholecystitis without obstruction

Box 3: There were 33 cases in which we found no evidence of a readmission in the MVC claims data despite an exhaustive search of all available claims for that patient.

Cell C: There were 15 cases in which MVC observed a 30-day readmission that was not evident in the hospital data.



Among the 15 discordant cases, each had confirmatory evidence in the MVC claims of a valid readmission. The relevant confirmatory evidence included claims with inpatient revenue codes with dates separate from the index admission and within 30 days of the discharge date.

Additionally, these readmissions were confirmed following a manual review of the facility claims.

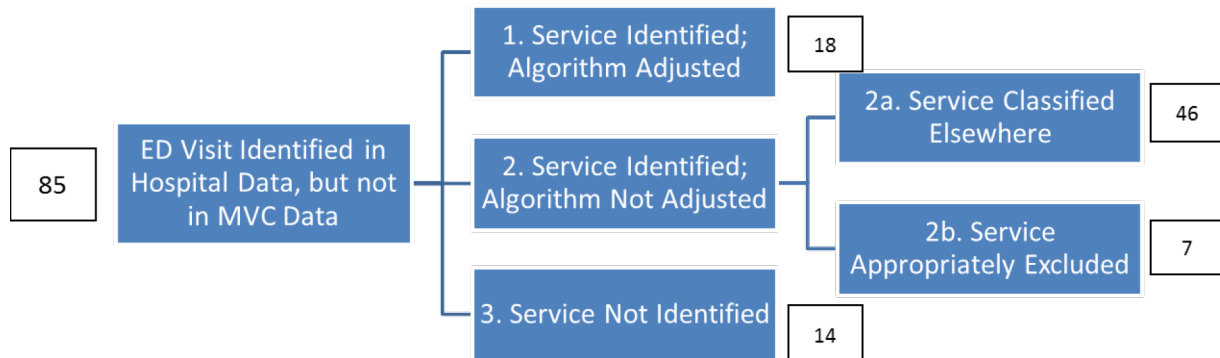
After accounting for these findings and making the appropriate adjustments, the Kappa Statistic for 30-day readmissions would increase from 0.78 to 0.91.

EMERGENCY DEPARTMENT VISITS

Level of Agreement for ED Visits (Kappa Statistic=0.62)			
<i>Service identified in MVC claims data</i>	<i>Service identified in Hospital clinical data</i>		Total
	No (0)	Yes (1)	
No (0)	1,274	85	1,359
Yes (1)	160	292	452
Total	1,434	377	1,811

Investigation of Discordance

Cell B: There were 85 cases in which a hospital observed an ED visit that was not evident in the MVC data.



Box 1: Of the 85 discordant cases, 18 had claims with ICD-9 diagnosis codes that should reasonably be attributed to the index hospitalization episode but were excluded based on the current MVC algorithm. The algorithm was adjusted to include these codes.

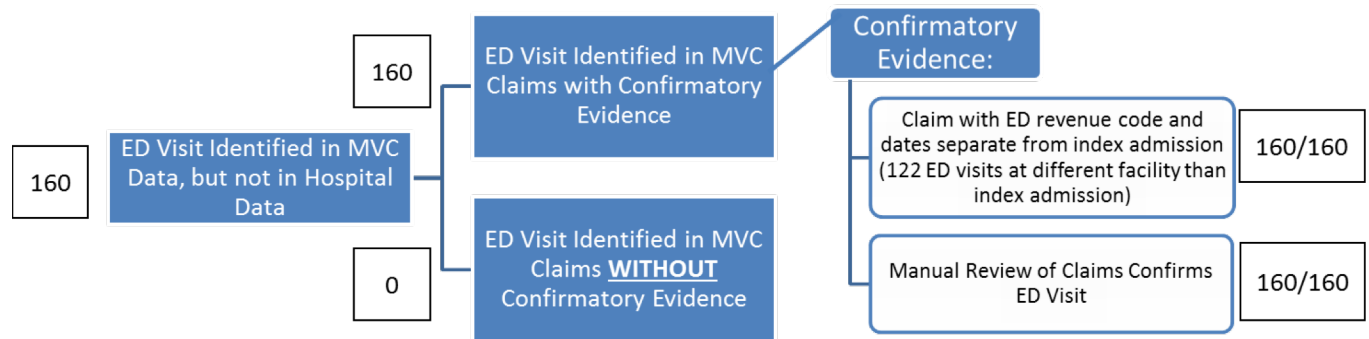
Box 2: In 53 of the episodes with discordant data, the ED visit was identified in MVC, but was either classified elsewhere in the reports or was appropriately excluded.

Of the 46 ED visits that were classified elsewhere, 38 preceded an index admission or a readmission and the ED services are grouped with this hospitalization in the MVC episode. The remaining 8 discordant cases had claims for outpatient operating room services, but no ED visit claims.

There were 7 cases in which an ED visit was evident, but was being appropriately excluded from the episode based on the ICD-9 diagnosis codes present on the claims.

Box 3: There were 14 cases in which we found no evidence of an ED visit in the MVC claims data.

Cell C: There were 160 cases where MVC observed an ED visit that was not evident in the hospital clinical data.



Of the 160 discordant cases, each had confirmatory evidence in the MVC claims of a valid ED visit. These cases had claims with ED revenue codes with dates separate from the index admission. In addition, 122 of these ED visits occurred at a different facility than the index admission, making hospital identification of these visits difficult (and highlighting the value of MVC data for identifying care delivered after an episode of hospitalization).

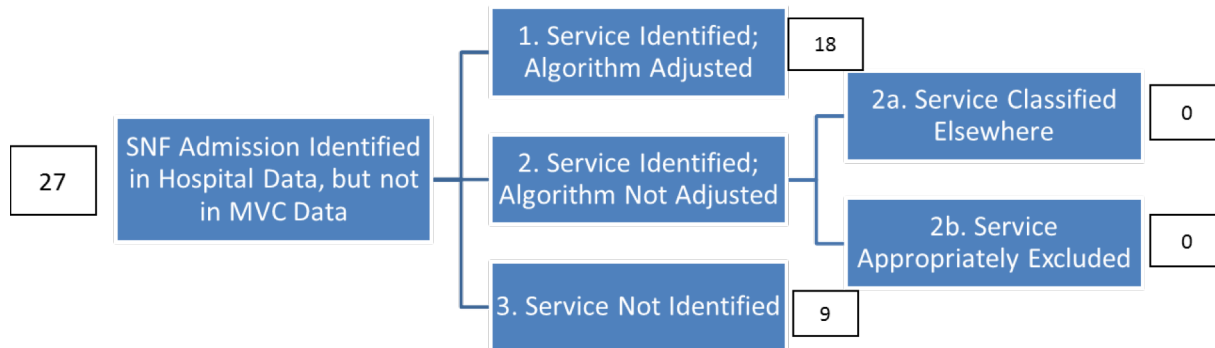
After accounting for these findings and making appropriate adjustments, the Kappa Statistic for ED visits would increase from 0.62 to 0.98.

SKILLED NURSING FACILITY ADMISSIONS

Level of Agreement for SNF Admissions (Kappa Statistic=0.63)			
<i>Service identified in MVC claims data</i>	<i>Service identified in Hospital clinical data</i>		Total
	No (0)	Yes (1)	
No (0)	1,721	27	1,748
Yes (1)	21	43	64
Total	1,742	70	1,812

Investigation of Discordance

Cell B: There were 27 cases in which a hospital observed a SNF admission that was not evident in the MVC data.



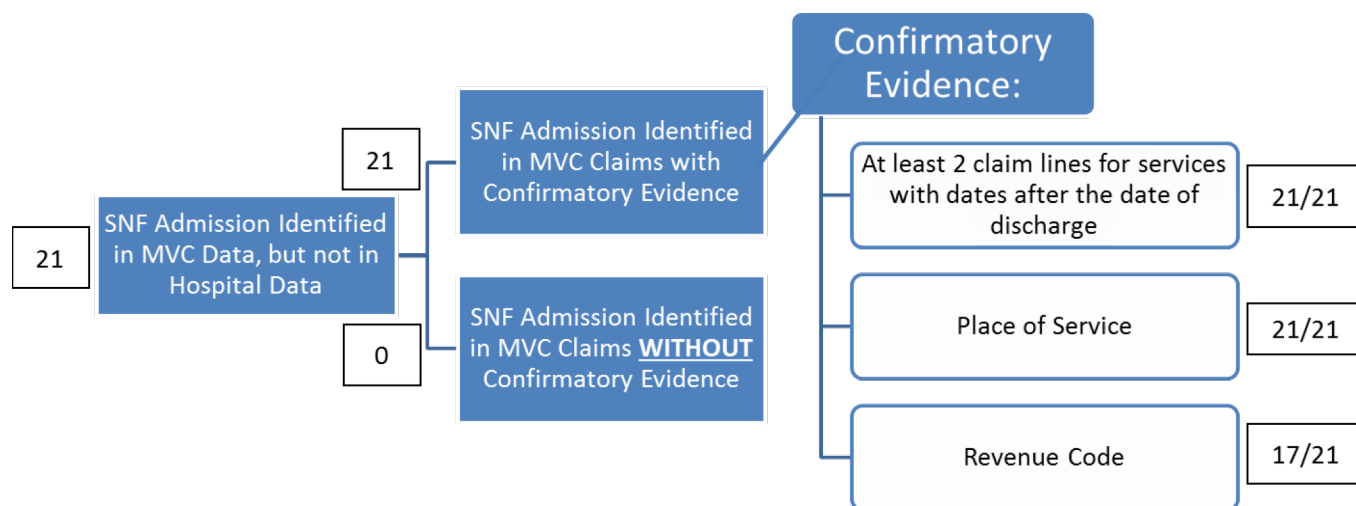
Box 1: Of the 27 discordant cases, 18 had a SNF admission identified in the MVC claims and investigation of these episodes yielded improvements in the MVC algorithms. First, the V5789 ICD-9 diagnosis code was being incorrectly excluded based on the current algorithm. Each of the

excluded claims with this diagnosis code had valid SNF revenue codes and a SNF place of service designation. Second, some of these 18 cases had SNF valid claims that were currently unpriced due to the lack of a corresponding code in the Medicare data (the source of payment data for the MVC algorithms). Our methods will be adjusted to accurately price these claims.

Box 2: There were 0 cases in which the service was identified, but was classified elsewhere or appropriately excluded.

Box 3: There were 9 cases where hospitals reported care in a SNF and we found no evidence of a SNF admission in the MVC claims data despite an exhaustive search of all available claims.

Cell C: There were 21 cases in which MVC observed a SNF admission that was not evident in the hospital clinical data.



Of the 21 discordant cases, each had confirmatory evidence in the MVC claims of care provided in a skilled nursing facility. Specifically, the available claims for each of the cases met two or more of the following conditions:

21 had at least 2 claim lines for a SNF admission with dates following the index admission

21 had claims with a SNF place of service designation

17 had claims with a common, valid inpatient SNF revenue code

The mean SNF payment for these 21 cases was \$2,308.25 and the median payment was \$1,531.62.

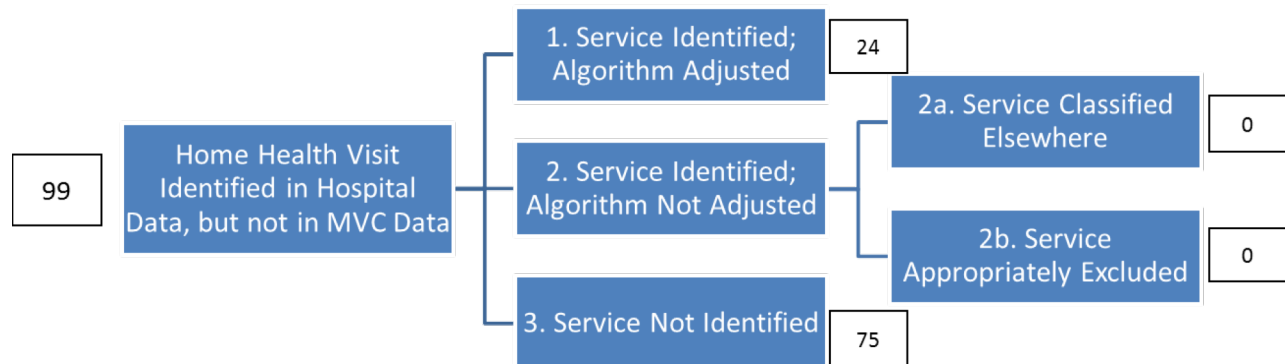
After accounting for these findings and making the appropriate adjustments, the Kappa Statistic for skilled nursing facility services would increase from 0.63 to 0.95.

HOME HEALTH VISITS

Level of Agreement for Home Health Visits (Kappa Statistic=0.71)			
<i>Service identified in MVC claims data</i>	<i>Service identified in Hospital clinical data</i>		Total
	No (0)	Yes (1)	
No (0)	764	99	863
Yes (1)	168	781	949
Total	932	880	1,812

Investigation of Discordance

Cell B: There were 99 cases in which a hospital observed a home health visit that was not evident in the MVC data.



Box 1: Of the 99 discordant cases, 24 had claims with ICD-9 diagnosis codes that should reasonably be attributed to the index hospitalization episode but were excluded based on the current MVC algorithm. These cases included claims with valid home health revenue codes and a home health place of service designation. These cases had the following ICD-9 diagnosis codes or CPT codes that are now be included in our algorithms:

V571: Care involving other physical therapy

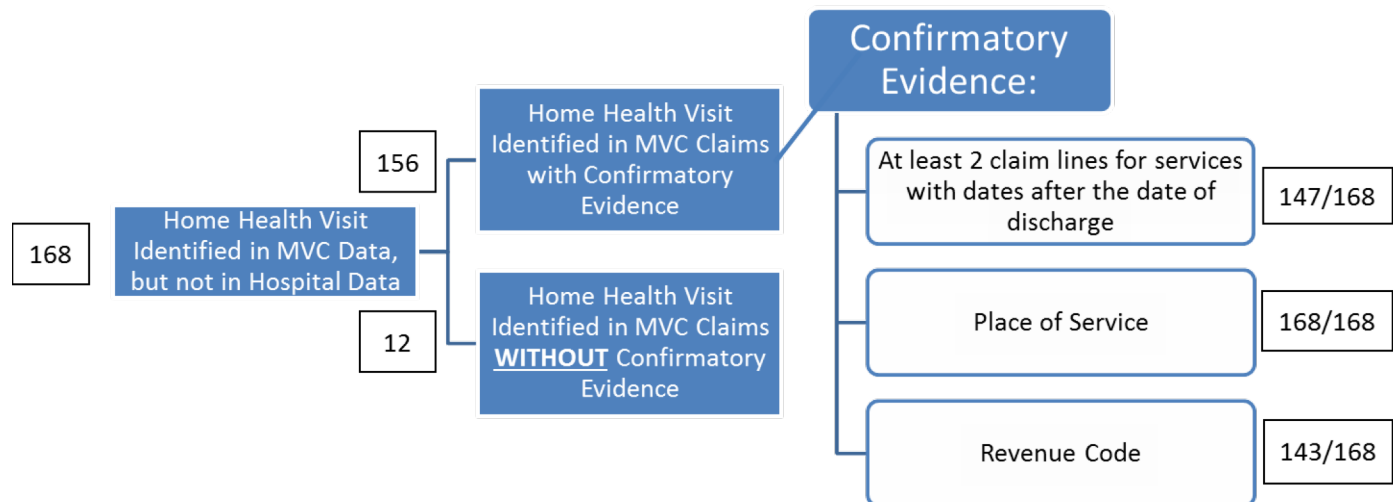
V5789: Care involving other specified rehabilitation procedure

G0154: Direct skilled nursing services of a licensed nurse in the home health or hospice setting

Box 2: There were 0 cases in which the service was identified but was classified elsewhere or appropriately excluded.

Box 3: There were 75 cases in which we found no evidence of a home health visit in the MVC claims data despite an exhaustive search of all available claims. Most of these cases had a home health discharge disposition on their index admission claims but no home health claims.

Cell C: There were 168 cases where MVC observed a home health visit that was not evident in the hospital clinical data.



Of the 168 discordant cases, 156 had confirmatory evidence in the MVC claims of provision of home health services. Specifically, the available claims for each of the cases met two or more of the following conditions:

147 had at least 2 claim lines for home health services with dates following the index admission

168 had claims with a home health place of service designation

143 had claims with a common, valid home health revenue code

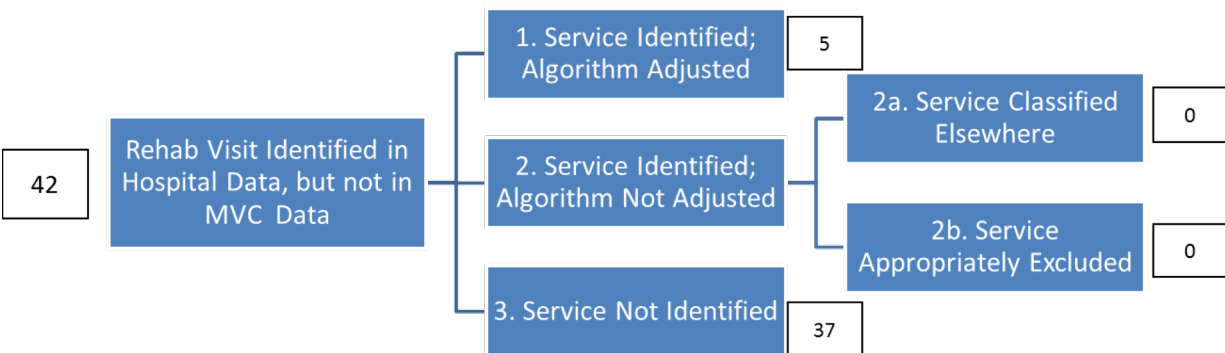
The mean home health payment for these 168 episodes with discordant data was \$916.17 and the median payment was \$552.00.

After accounting for these findings and making the appropriate adjustments, the Kappa Statistic for home health services would increase from 0.71 to 0.90.

Level of Agreement for Rehab Visits (Kappa Statistic=0.16)			
<i>Service identified in MVC claims data</i>	<i>Service identified in Hospital clinical data</i>		Total
	No (0)	Yes (1)	
No (0)	547	42	589
Yes (1)	873	350	1,223
Total	1,420	392	1,812

Investigation of Discordance

Cell B: There were 42 cases where a hospital observed a rehab visit that was not evident in the MVC data.



Box 1: Of the 42 discordant cases, 5 had claims with ICD-9 diagnosis codes that should reasonably be attributed to the index hospitalization episode but were excluded based on the current MVC algorithm. Each of these cases had claims with valid rehab revenue codes and rehab place of service designation. These cases had the following ICD-9 diagnosis codes:

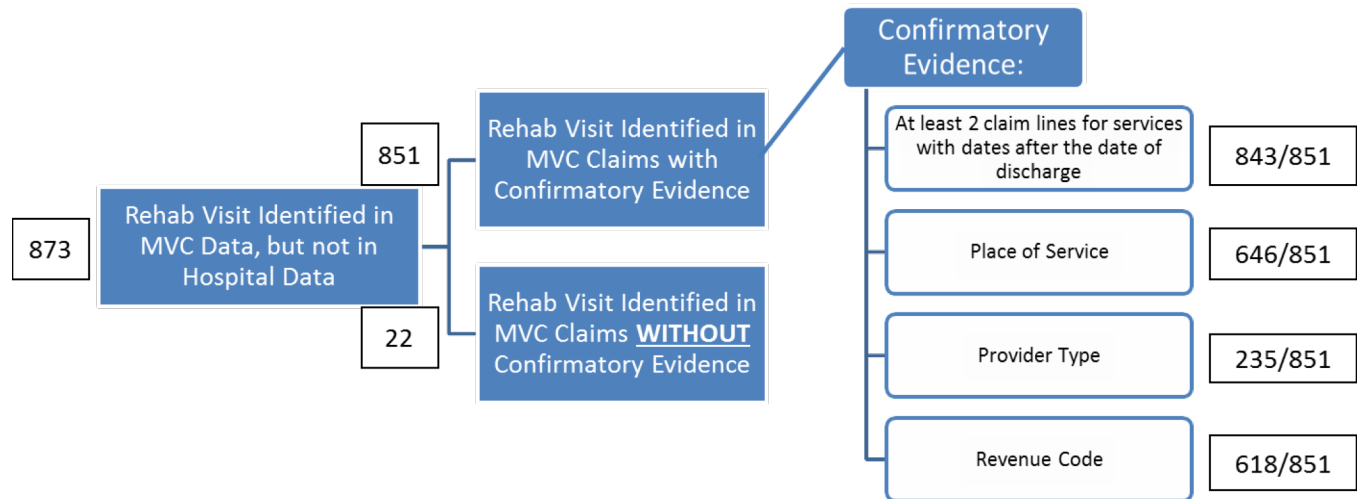
V571: Care involving other physical therapy

V5789: Care involving other specified rehabilitation procedure

Box 2: There were 0 cases in which the service was identified, but was classified elsewhere or appropriately excluded.

Box 3: There were 37 cases where hospitals reported rehab services and we found no evidence such services visit in the MVC claims data, despite an exhaustive search of all available claims.

Cell C: There were 873 cases in which MVC observed a rehab visit that was not evident in the hospital clinical data.



Of the 873 discordant cases, 851 had confirmatory evidence in the MVC claims for utilization of rehabilitation services. Specifically, the available claims for each of the cases met two or more of the following conditions:

- 843 had at least 2 claim lines for a rehab visit with dates following the index admission
- 646 had claims with a rehab place of service designation
- 235 had claims with a physical or occupational therapist identified as the type of provider in the professional claims
- 618 had claims with a common, valid rehab revenue code

The mean rehab payment for these 873 cases was \$1,576.13 and the median payment was \$998.78.

After accounting for these findings and making the appropriate adjustments, the Kappa Statistic for post-discharge rehabilitation services would increase from 0.16 to 0.93.