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Accuracy of Hospital Discharge Codes in Medicare Claims for Knee and Hip Replacement Patients

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Abstract

Background.—Despite the importance of the hospital discharge destination field (“discharge code” hereafter) for research and payment reform, its accuracy is not well established.

Objectives.—To examine the accuracy of discharge codes in Medicare claims.

Data Sources.—2012–2015 Medicare claims of knee and hip replacement patients.

Research Design.—We identified patients’ discharge location in claims and compared it to the discharge code. We also used a mixed-effects logistic regression to examine the association of patient and hospital characteristics with discharge code accuracy.

Results.—Approximately 9% of discharge codes were inaccurate. Long-term care hospital discharge codes had the lowest accuracy rate (41%), followed by acute care transfers (72%), inpatient rehabilitation facility (80%) and home discharges (83%). Most misclassifications occurred within two broad groups of post-acute care settings: home-based and institutional care. The odds of inaccurate discharge codes were higher for Medicaid-enrolled patients and safety-net and low-volume hospitals.

Conclusions.—Inaccurate hospital discharge coding may have introduced bias in studies relying on these codes (e.g., evaluations of Medicare bundled payment models). Inaccuracy was more common among Medicaid-enrolled patients and safety-net and low-volume hospitals, suggesting more potential bias in existing study findings pertaining to these patients and hospitals.

Keywords

Administrative data uses; health economics; Medicare

INTRODUCTION

Hip/knee replacements are the most common inpatient surgeries for Medicare beneficiaries.¹ However, hip/knee replacement spending and quality of care vary depending on the type of post-acute care patients receive after surgery.^{2–7} Medicare has focused on post-acute care use among hip and knee replacement patients by implementing payment reforms, including the Bundled Payments for Care Improvement Initiative (BPCI) and Comprehensive Care for

Joint Replacement (CJR) Model. The common way of identifying types of post-acute care is to use the hospital discharge destination field from Medicare inpatient claims.^{2,3,6} This field includes approximately 30 values that indicate the type of discharge location after the hospital stay.⁸

Despite the importance of the hospital discharge destination field (“discharge code” hereafter) for research and payment reform, its accuracy is not well established. Hospitals provide the discharge code based on the discharge summary, but this may be incomplete.⁹ For example, arrangement for home health care may not occur until a few days following discharge. In this scenario, the discharge code on the claim would likely be “home,” **not** “home health.” While hospitals are responsible for correcting each patient’s discharge code, hospitals may not become aware of changes in care arrangements.¹⁰

Discharge code accuracy may affect the evaluations of Medicare payment reforms designed to improve care for joint replacement patients, such as the BPCI and CJR models. These models hold hospitals accountable for spending on all Medicare services during care episodes (index hospitalization and 90 days post-discharge in most cases). Hospitals receive a bonus if their spending is lower than a quality-adjusted spending benchmark. They pay a penalty if spending exceeds the benchmark. Because these models may lead hospitals to avoid discharges to costly institutional post-acute care settings, researchers are interested in tracking patient discharge locations. Discharges codes are a common source of this information.¹¹⁻¹³

Discharge codes are not used to determine Medicare payments, but can affect payments under Medicare’s Post-Acute Care Transfer Policy. For certain Medicare Severity Diagnosis-Related Groups (MS-DRGs) (including 469 and 470 – hip/knee replacements), Medicare pays per-diem rates for hospital stays if patients are discharged to settings other than home, and per-diem rates are lower than standard MS-DRG payment rates. Medicare pays the standard rates if the patient is discharged to home. Therefore, Medicare may overpay for hospital stays if the discharge code was incorrectly reported as “home.”¹⁴⁻¹⁶

This study had two objectives. First, we assessed the accuracy of discharge codes for Medicare patients who underwent hip/knee joint replacements. Second, we examined whether the inaccuracy of the discharge code was associated with patient and hospital characteristics.

METHODS

Data and Sample

We used 2012-2015 Medicare enrollment files and inpatient, skilled nursing facility, and home health agency claims to identify discharges, post-acute care use, and patient characteristics.¹⁷ We obtained hospital characteristics from the CMS Provider of Services and Specific Files.^{18,19}

Our sample included all hospital discharges after a hip or knee replacement surgery (identified using MS-DRG 469 and 470). We excluded patients not continuously enrolled in

Medicare Parts A/B from one year before the index admission to 90 days following discharge. We also excluded patients for whom Medicare was not the primary payer and patients whose discharge codes could not be verified through inpatient, skilled nursing, or home health claims. These included discharges to an intermediate care facility, psychiatric hospital, non-Medicare certified nursing facility, or hospice. sFigure 1 details all exclusions. Our sample consisted of 1,175,093 beneficiaries receiving 1,305,335 joint replacement surgeries.

Determination of Discharge Destination

We observed each patient's post-acute care use in Medicare claims and classified discharge destination into home without home health visits ("home" hereafter), home with home health visits ("home health" hereafter), skilled nursing facility, swing bed, inpatient rehabilitation facility, long-term care hospital, or acute care transfer (sFigure 2).

We used provider number to identify swing beds from skilled nursing facility claims, and to identify inpatient rehabilitation and long-term care hospital from inpatient claims. Discharges to skilled nursing were identified as skilled nursing facility claims that were not for swing beds. Acute care transfers were identified as inpatient claims not flagged as inpatient rehabilitation, long-term hospital, emergency department visit, or subsequent hip/knee replacement surgery claims. Discharge to home health was identified from home health agency claims.

We determined discharge destination by checking for claims within a specified number of days from hospital discharge. We allowed for 0-7 days for home health claims and 0-1 day for other claim types. We also tested 0-2 days as the window for non-home-health claims. These thresholds were based on the distribution of days between hospital discharge and first claim for each type (sFigure 3). We determined discharge destinations based on the earliest post-acute care claim. Discharges without claims in the corresponding windows were identified as being discharged to home. We excluded 194 discharges for which multiple types of post-acute care started on the same day.

Accuracy of Discharge Codes

We compared the discharge code to the actual discharge destination identified using claims and calculated positive and negative predictive values for each discharge code (sTable 1).

Association between Inaccurate Discharge Codes and Patient and Hospital Characteristics

We used a mixed-effects logistic regression model with hospital random effects to estimate the association between the likelihood of inaccurate discharge codes and patient and hospital characteristics. sTable 2 provides definitions of these characteristics. To see whether the association between inaccurate codes and characteristics was similar across discharges to home-based and institutional care, we ran stratified regressions for each subgroup of discharges.

RESULTS

About 65% of joint replacements were for females, and 90% were for whites (Table 1). Most replacements occurred at for-profit hospitals (72%) and 15% occurred at safety-net hospitals.

Approximately 9% of discharges had misclassified discharge codes. Table 2 shows the distribution of actual discharge destination for each discharge code. The shaded boxes across the diagonal show the positive predictive value of each discharge code. For example, among discharges to home, 82.5% had an actual destination of home while 13.8% and 2.7% received home health and skilled nursing care, respectively. Discharge codes of home health, skilled nursing facility, and swing bed care had high accuracy rates, above 95%. Long-term care discharge codes had the lowest accuracy (41.1%), followed by acute care transfers (72.0%), inpatient rehabilitation (79.7%) and home discharges (82.5%).

Misclassifications often occurred *within* two broad groups of post-acute care: home-based care (i.e. discharges to home and home health) and institutional care (discharges to skilled nursing facility, inpatient rehabilitation facility, swing-bed care, and long-term care hospital). Across discharges to home-based care, 90.6% were actually discharged to home or home health. Similarly, among all discharge codes to some type of institutional care, 92.2% were actually discharged to institutional care.

All discharge codes exhibited high negative predictive values, above 95% (sTable 1).

Table 3 shows the associations between misclassification rates and patient and hospital characteristics. Discharges for Medicaid-enrolled patients (OR=1.16, 95% CI=1.14-1.19) and discharges from safety-net hospitals (OR=1.07, 95% CI=1.03-1.12) had greater odds of misclassification.

Our findings were mixed with regard to patients' health status. Patients who experienced major complications or comorbidities during the hospital stay (OR=0.81, 95% CI=0.78-0.84) and hip fracture patients (versus elective surgery) (OR=0.81, 95% CI=0.79-0.83) had lower odds of misclassification. In contrast, the odds of misclassification were higher for patients with higher baseline comorbidity (OR=1.05, 95% CI=1.03-1.07) and patients with longer hospital stays (4-5 days – OR=2.09, 95% CI=2.04-2.14; 6+ days – OR=2.16, 95% CI=2.09-2.23).

Odds of misclassification were higher for low-volume hospitals with 1-7 replacements a year (OR=2.93, 95% CI: 1.79-4.78) and for joint replacements that occurred in later years (2014 – OR=1.10, 95% CI=1.08-1.12; 2015 – OR=1.27, 95% CI=1.24-1.29). Hospitals affiliated with skilled nursing facilities or home health agencies had lower odds of misclassification (OR=0.86, 95% CI: 0.80-0.94).

Results were similar for a sensitivity analysis allowing 0-2 days between hospital discharge and the start of institutional post-acute care (sTable 3). We also ran separate regressions for discharges to home-based care and discharges to institutional care (sTable 4). Associations for some characteristics (e.g., sex, age, race/ethnicity, length of stay, fracture status, and

safety-net hospital status) differed in direction and magnitude across the two discharge types. For example, being black or Hispanic had higher odds of misclassification among discharges to home-based care, but had lower odds among discharges to institutional care. Similarly, the odds of misclassification were higher for patients with longer hospital stay among discharges to home-based care, but the relationship was reversed among discharges to institutional care.

DISCUSSION

In this claims analysis of Medicare patients who underwent hip/knee replacement between 2012 and 2015, the discharge code was inaccurate for 9% of discharges. Long-term care discharge codes had the lowest accuracy rate (41.1%), followed by acute care transfers (72.0%), inpatient rehabilitation facility (79.7%) and home discharges (82.5%). Most misclassifications occurred within two broad groups of post-acute care settings: home-based and institutional care. Furthermore, the odds of misclassification varied across different types of patients and hospitals. Medicaid-enrolled patients and patients discharged from safety-net or low-volume hospitals had higher odds of misclassification. The odds of misclassification increased over time.

Low accuracy rates for long-term care hospital discharges may be related to claims processing. Because long-term care hospital discharges are rare (0.2% of all discharges), hospital coders may be unfamiliar with these discharges and therefore misclassify them. Low accuracy rates for Medicaid-enrolled patients may be related to lack of resources in hospitals where they received surgeries. Hospitals with limited resources may not have systems for verifying coding accuracy or sufficient numbers of hospital coders, which may contribute to lower accuracy. This may also apply to safety-net and low-volume hospitals. A higher rate of misclassification over time could be due to the rapid administrative changes within health systems (e.g., electronic health records adoption), although more research is necessary to identify possible causes.

To our knowledge, only one study has assessed the accuracy of discharge codes.²⁰ They validated discharges to long-term care hospitals using 2006 Medicare claims across all DRGs and found 72.6% accuracy for long-term care hospital discharges, which was higher than our finding (41.1%). This suggests that discharge code accuracy may vary across years and DRGs.

Our findings have three implications. First, researchers should directly observe post-acute care claims rather than discharge codes to determine specific types of home-based or institutional post-acute care. However, the inaccuracy of discharge codes may not significantly bias results if researchers use discharge codes to distinguish broadly between home-based and institutional post-acute care. Misclassifications mostly occurred *within* the two broad groups of post-acute care settings, home-based and institutional care.

Second, inaccurate discharge codes may have affected evaluations of Medicare payment reforms targeting joint replacements, such as BPCI and CJR models. Studies have reported that under these models, switching patients' discharge location to a less costly post-acute

care setting has been hospitals' response.^{11-13,21,22} However, these results may suffer from bias if studies used discharge codes to assess patient discharge location. Furthermore, findings pertaining to Medicaid-enrolled patients and safety-net or low-volume hospitals are more likely to be biased. This is problematic because existing study findings influence future policy design.

Third, discharge code inaccuracy may have resulted in Medicare overpayments. Only 82.5% of home discharge codes were accurate, suggesting that Medicare may be overpaying for 17.5% of these claims under the Post-Acute Care Transfer Policy.

Our findings have limitations. First, our analysis did not include Medicaid claims for patients enrolled in both Medicare and Medicaid. However, post-acute care is primarily paid by Medicare, not Medicaid, for this patient population. Second, we may have captured home health visits unrelated to rehabilitation after joint replacements. However, this is unlikely given that we required home health visits to start within 7 days of discharge. Third, we could not directly verify discharges to home. Fourth, our analyses identified factors associated with misclassification, not causal reasons for misclassification. Finally, our findings may not be generalizable to other payers **and** conditions.

In summary, discharge codes for hip/knee replacement surgeries were inaccurate for 9% of discharges. Inaccuracy was more common among Medicaid-enrolled patients and safety-net and low-volume hospitals. Future studies should examine the accuracy of discharge codes for other conditions and payers.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

REFERENCES

1. Center for Medicare and Medicaid Services. Comprehensive Care for Joint Replacement (CJR) Model. 2015 Available at: <https://innovation.cms.gov/resources/cjr-finalruleintro.html>. Accessed April 2, 2019.
2. Buntin MB, Colla CH, Deb P, et al. Medicare spending and outcomes after postacute care for stroke and hip fracture. *Med Care* 2010; 48: 776–784. [PubMed: 20706167]
3. Deutsch A, Granger CV, Fiedler RC, et al. Outcomes and reimbursement of inpatient rehabilitation facilities and subacute rehabilitation programs for Medicare beneficiaries with hip fracture. *Med Care* 2005; 43: 892–901. [PubMed: 16116354]
4. Mallinson TR, Bateman J, Tseng H, et al. A comparison of discharge functional status after rehabilitation in skilled nursing, home health, and medical rehabilitation settings for patients after lower-extremity joint replacement surgery. *Arch Phys Med Rehabil* 2011; 92: 712–720. [PubMed: 21530718]
5. Mechanic R Post-acute care — The next frontier for controlling Medicare spending. *N. Engl. J. Med* 2014; 370: 692–694. [PubMed: 24552315]
6. Ponnusamy KE, Naseer Z, Dafrawy MHE, et al. Post-discharge care duration, charges, and outcomes among Medicare patients after primary total hip and knee arthroplasty. *J. Bone Jt. Surg* 2017; 99, e55.
7. Tian W, DeJong G, Horn SD, et al. Efficient rehabilitation care for joint replacement patients: skilled nursing facility or inpatient rehabilitation facility? *Med. Decis. Making* 2012; 32: 176–187. [PubMed: 21487103]

8. ResDAC. Patient Discharge Status Code (FFS). 2018 Available at: <https://www.resdac.org/cms-data/variables/patient-discharge-status-code-ffs>. Accessed April 2, 2019.
9. Virnig B Introduction to the use of Medicare data for research - using Medicare hospitalization information and the MedPAR. 2012 Available at: <https://www.resdac.org/training/workshops/intro-medicare/media/5>. Accessed April 2, 2019.
10. Center for Medicare and Medicaid Services. Clarification of Patient Discharge Status Codes and Hospital Transfer Policies. 2015 Available at: <https://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNMattersArticles/downloads/SE1411.pdf>. Accessed April 2, 2019.
11. Jubelt LE, Goldfeld KS, Chung W, et al. Changes in discharge location and readmission rates under Medicare bundled payment. *JAMA Intern. Med* 2016; 176: 115–117.
12. Dundon JM, Bosco J, Slover J, et al. Improvement in total joint replacement quality metrics: year one versus year three of the Bundled Payments for Care Improvement Initiative. *J. Bone Jt. Surg* 2016; 98: 1949–1953.
13. Iorio R, Clair AJ, Inneh IA, et al. Early results of Medicare's Bundled Payment Initiative for a 90-day total joint arthroplasty episode of care. *J. Arthroplasty* 2016; 31: 343–350. [PubMed: 26427938]
14. Office of Inspector General. Medicare inappropriately paid hospitals' inpatient claims subject to the postacute care transfer policy. 2014 Available at: <https://oig.hhs.gov/oas/reports/region9/91302036.pdf>. Accessed April 2, 2019.
15. HCPro. Note from the instructor: Update to the CMS Post-Acute Transfer Policy qualifying DRGs. 2014 Available at: <http://www.hcpro.com/CCP-311077-5091/Note-from-the-instructor-Update-to-the-CMS-PostAcute-Transfer-Policy-Qualifying-DRGs.html>. Accessed April 2, 2019.
16. Landis J Post-acute care cheat sheet: post-acute care transfer policy (PACT). 2018 Available at: <https://www.advisory.com/research/post-acute-care-collaborative/members/resources/cheat-sheets/post-acute-care-transfer-policy>. Accessed April 2, 2019.
17. ResDAC. Research Data Assistance Center. 2019 Available at: <https://www.resdac.org/cms-data>. Accessed April 2, 2019.
18. CMS. Provider of Services File. 2017 Available at: <http://www.nber.org/data/provider-of-services.html>. Accessed April 2, 2019.
19. CMS. CMS Provider Specific File Data. 2016 Available at: <http://www.nber.org/data/cms-provider-specific-files.html>. Accessed April 2, 2019.
20. Kahn JM, Iwashyna TJ. Accuracy of the discharge destination field in administrative data for identifying transfer to a long-term acute care hospital. *BMC Res Notes* 2010; 3: 205. [PubMed: 20663175]
21. Finkelstein A, Ji Y, Mahoney N, et al. Mandatory Medicare bundled payment program for lower extremity joint replacement and discharge to institutional postacute care: interim analysis of the first year of a 5-year randomized trial. *JAMA* 2018; 320: 892–900. [PubMed: 30193277]
22. Barnett ML, Wilcok A, McWilliams M, et al. Two-year evaluation of mandatory bundled payments for joint replacement. *N. Engl. J. Med* 2019; 380:252–262. [PubMed: 30601709]

Table 1.

Patient and hospital characteristics for discharges from hip or knee replacement surgery between 2012 and 2015 (N=1,305,335)

	No. (%)
Patient Characteristics	
<i>Demographics</i>	
Age	
66-74	650,301 (50)
75-84	495,189 (38)
85+	159,845 (12)
Female	851,813 (65)
Race/Ethnicity	
(Non-Hispanic) White	1,179,665 (90)
(Non-Hispanic) Black	59,127 (5)
Hispanic	40,288 (3)
Asian/Pacific Islander	15,182 (1)
American Indian/Alaska Native	4,769 (0.4)
Other	6,304 (0.5)
Enrolled in both Medicare and Medicaid	112,529 (9)
<i>Health Conditions</i>	
Experience of major complication or comorbidity during hospital stay ^a	65,185 (5)
Surgery Type	
Hip fracture surgery	193,054 (15)
Elective replacement	1,112,281 (85)
Days of hospital stay	
0-2 days	326,274 (25)
3 days	641,031 (49)
4-5 days	234,868 (18)
6+ days	103,162 (8)
Medically complex ^b	176,236 (14)
Hospital Characteristics	
Major teaching hospital	269,119 (21)
Ownership type	
For profit	935,958 (72)
Non-profit	225,668 (17)
Government	143,709 (11)
Safety-net hospital ^c	201,982 (15)
Affiliated with skilled nursing facility or home health agency	236,376 (18)
Size of hospital (in # beds)	
Large (400+)	449,518 (34)
Medium (200-399)	449,151 (34)

	No. (%)
Small (1-199)	406,666 (31)
Annual number of Medicare hip/knee replacements	
1st quartile, (135+)	1,197,671 (92)
2nd quartile (28-134)	104,566 (8)
3rd quartile (8-27)	2,975 (0.2)
4th quartile (1-7)	123 (0.01)

Note:

^a Major complication or comorbidity were identified as discharges with MS-DRG 469 as opposed to 470.

^b Patients with Charlson Comorbidity Index scores in the top 10% (> 8). We used claims one year before index admission to calculate Charlson comorbidity score.

^c Hospitals in the top quartile of disproportionate share hospital index.

Table 2.
Distribution of actual discharge destination for each hospital discharge code (N=1,305,335)

Discharge code	Actual discharge destination						
	Home	Home health	Skilled nursing facility	Swing bed	Inpatient rehabilitation facility	Long-term care hospital	Transfer to other hospitals
Home	18.5%	82.5%	13.8%	2.7%	0.2%	0.6%	0.005%
Home health visits	32.2%	3.8%	95.2%	0.7%	0.03%	0.2%	0.002%
Skilled nursing facility	36.6%	1.0%	0.5%	95.9%	1.4%	1.1%	0.02%
Swing bed	1.4%	0.7%	2.7%	96.2%	0.2%	0.005%	0.0%
Inpatient rehabilitation facility	10.4%	0.6%	17.5%	0.7%	79.7%	0.1%	1.1%
Long-term care hospital	0.2%	3.3%	42.1%	1.6%	10.3%	41.1%	0.4%
Transfer to other hospitals	0.7%	3.7%	9.0%	3.3%	9.0%	0.2%	72.0%
Total Discharges	1,305,335	17.3%	33.2%	37.3%	2.6%	8.7%	0.1%

Notes: (1) Dark shaded cells represent positive predictive value of each discharge code. The positive predictive value is the number of "true positives" (inpatient claims with the specific discharge code that agrees with the actual destination), divided by the sum of true and false positives (inpatient claims with the specific discharge code regardless of agreement with the actual destination).

Table 3.

Association between misclassified hospital discharge codes and patient and hospital characteristics
(N=1,305,335)

	Unadjusted Misclassification Rates (%)	Odds Ratio	P-value	95% CI	
Patient Characteristics					
Demographics					
Age					
(66-74)	8.7				
75-84	9.3	1.04	<0.001	1.02	1.05
85+	8.7	0.97	<0.01	0.95	0.99
Female	9.1	1.00	0.58	0.98	1.01
Race/Ethnicity					
(Non-Hispanic White)	8.7				
Non-Hispanic Black	11.6	1.00	0.93	0.97	1.03
Hispanic	12.0	1.04	0.05	1.00	1.08
Asian/Pacific Islander	9.9	0.93	0.011	0.87	0.98
American Indian/Alaska Native	10.8	1.09	0.10	0.98	1.21
Other	9.3	1.01	0.78	0.93	1.11
Enrolled in both Medicare and Medicaid	11.3	1.16	<0.001	1.14	1.19
Health Conditions					
Experience of major complication or comorbidity during hospital stay ^a	8.2	0.81	<0.001	0.78	0.84
Hip fracture surgery	8.7	0.81	<0.001	0.79	0.83
Days of hospital stay					
(0-2 days)	5.7				
3 days	10.0	2.03	<0.001	1.99	2.07
4-5 days	10.0	2.09	<0.001	2.04	2.14
6+ days	9.9	2.16	<0.001	2.09	2.23
Medically complex ^b	9.7	1.05	<0.001	1.03	1.07
Hospital Characteristics					
Major teaching hospital	8.5	1.10	<0.01	1.04	1.17
Ownership type					
(For profit)	8.8				
Nonprofit	8.6	0.99	0.75	0.94	1.05
Government	9.0	1.00	0.97	0.94	1.07
Safety-net hospital ^c	11.0	1.07	<0.01	1.03	1.12
Affiliated with skilled nursing facility or home health agency	7.7	0.86	<0.001	0.80	0.94
Size of hospital					
(Large (400+ beds))	8.6				
Medium (200-399 beds)	8.8	0.92	0.02	0.86	0.99
Small (1-199 beds)	9.0	0.89	<0.01	0.83	0.96

	Unadjusted Misclassification Rates (%)	Odds Ratio	P-value	95% CI	
				Lower	Upper
Annual number of Medicare hip/knee replacements					
(1st quartile, (135+))	8.6				
2nd quartile (28-134)	10.3	1.10	<0.001	1.04	1.15
3rd quartile (8-27)	18.7	1.82	<0.001	1.59	2.08
4th quartile (1-7)	24.4	2.93	<0.001	1.79	4.78
Region					
(Midwest)	6.8				
Northeast	9.6	1.11	0.05	1.00	1.22
South	9.9	1.49	<0.001	1.38	1.62
West	8.4	1.36	<0.001	1.24	1.50
Year					
(2012)	8.5				
2013	8.4	1.00	0.69	0.99	1.02
2014	8.8	1.10	<0.001	1.08	1.12
2015	9.6	1.27	<0.001	1.24	1.29

Notes:

^aMajor complications or comorbidities were identified as discharges with MS-DRG 469 as opposed to 470.

^bPatients with Charlson Comorbidity Index scores in the top 10% (> 8). We used claims one year before index admission to calculate Charlson comorbidity score.

^cHospitals in the top quartile of disproportionate share hospital index.