Published in final edited form as:

Hemodial Int. 2017 July ; 21(3): 422–429. doi:10.1111/hdi.12497.

Re-evaluation of Re-hospitalization and Rehabilitation in Renal Research

Eugene Lin¹, Manjula Kurella Tamura^{1,2}, Maria E. Montez-Rath¹, and Glenn M. Chertow¹

¹Division of Nephrology, Stanford University School of Medicine, Palo Alto, CA

²Geriatric Research and Education Clinical Center, Palo Alto VA Health Care System, Palo Alto, CA

Abstract

Introduction—The use of administrative data to capture 30-day readmission rates in end-stage renal disease (ESRD) is challenging since Medicare combines claims from acute care (IP), inpatient rehabilitation (IRF), and long-term care hospital (LTCH) stays into a single “Inpatient” file. For data prior to 2012, the United States Renal Data System (USRDS) does not contain the variables necessary to easily identify different facility types, making it likely that prior studies have inaccurately estimated 30-day readmission rates.

Methods—For this report, we developed two methods (a “simple method” and a “rehabilitation-adjusted method”) to identify IP, IRF, and LTCH stays from USRDS claims data, and compared them to methods used in previously published reports.

Findings—We found that prior methods overestimated 30-day readmission rates by up to 12.3% and overestimated average 30-day readmission costs by up to 11%. In contrast, the simple and rehabilitation-adjusted methods overestimated 30-day readmission rates by 0.1% and average 30-day readmission costs by 1.8%. The rehabilitation-adjusted method also accurately identified 96.8% of IRF stays.

Discussion—Prior research has likely provided inaccurate estimates of 30-day readmissions in patients undergoing dialysis. In the absence of data on specific facility types particularly when using data prior to 2012, future researchers could employ our method to more accurately characterize 30-day readmission rates and associated outcomes in patients with ESRD.

Background

Patients with end-stage renal disease (ESRD) shoulder a high burden of hospitalization, as well as hospital readmission, with over 30% of hospital discharges followed by another hospitalization within 30 days, as compared to 17% of discharges for non-ESRD Medicare beneficiaries.^{1,2} Consequently, the Centers for Medicare and Medicaid Services (CMS) has prioritized reducing 30-day readmission rates among patients receiving dialysis and will financially penalize dialysis providers with high 30-day readmission rates through its Quality Incentive Program (QIP).³

Any study investigating determinants and/or consequences of 30-day readmission requires an accurate estimate of actual 30-day readmission rates. Most researchers studying patients

receiving dialysis use the United States' Renal Data System (USRDS), a data registry jointly sponsored by the National Institutes of Health (NIH) and CMS that contains virtually all Part A and Part B Medicare claims from the United States ESRD program.^{4,5} Despite its comprehensiveness, estimating 30-day readmission rates remains a challenge because of the complexity of Medicare's payment structure.⁵

Hospitalizations and re-hospitalizations in Medicare are difficult to study because the Medicare Administrative Research Files (including those contained in the USRDS), combine all acute care (inpatient, or IP), inpatient rehabilitation facility (IRF), and long-term care hospital (LTCH) claims into the "Inpatient" claims file.⁶ The Research Files mirror Medicare's consideration of IP, IRF and LTCH as inpatient facilities.⁷⁻⁹ Notably, other institutional facilities such as skilled nursing facilities (SNF), outpatient institutional facilities, home health, and hospice are covered separately under Medicare Part A, and are thus not included in the Inpatient claims file.^{6,8}

Researchers investigating acute hospitalizations (and 30-day readmissions) should first separate IP claims from IRF and LTCH claims. Otherwise, they may mistakenly count transfers from acute care to post-acute care as separate admissions (and 30-day readmissions). The Centers for Medicare and Medicaid Services concurs with this distinction, and has excluded IRF and LTCH stays from its Readmissions Reduction Program.¹⁰

Virtually all prior studies using USRDS data have not separated acute and post-acute care claims, so that 30-day readmission rates were likely overestimated.^{2,4,11-17} Some studies have attempted to account for post-acute care transfers by combining hospital stays occurring within one day of each other.^{2,15} However, this correction overestimates the *overall* rate of hospitalization by calculating a lower number of days at risk, and underestimates the readmission rate by ignoring transfers from IRF and LTCH back to IP. It also overestimates the *average* cost and length of stay of acute-care (IP) hospitalizations.

To separate post-acute care stays from IP stays, the Research Data Assistance Center (ResDAC, www.resdac.org), a CMS contractor that distributes Medicare claims data, recommends using a Medicare-assigned provider number to determine the source of the claim (IP, IRF, or LTCH) (Appendix A, "Gold Standard").¹⁸ Although these provider numbers are available in all USRDS' claims data after 2012, they are not present in older claims distributed by the USRDS.¹⁹ Because these provider numbers are missing, investigators cannot easily determine if claims prior to 2012 represent acute or post-acute care.

In this study, we investigated the effectiveness of four potential strategies to determine the source of an inpatient claim without relying on the Medicare-assigned provider number. By using 2012 USRDS claims data, we were able to compare these strategies to a "gold standard," which we constructed using the provider numbers. The first two strategies used the most commonly employed methods of separating acute care claims from post-acute care claims: an "ungrouped claims method," which treats each inpatient claim as an individual IP admission and a "naïve method," which combines claims with overlapping dates in a single

IP admission. To address the potential shortcomings of these first two strategies, we developed two methods, a “simple method” and a “rehabilitation-adjusted method,” to determine the source of an inpatient claim. We then validated these methods by comparing to the gold standard approach.

Methods

Data Source and Population

The study was approved by the Stanford Institutional Review Board. To ensure that we accounted for all inpatient healthcare utilization, we excluded patients without Medicare Parts A and B coverage at any point during the study period of March 1, 2012, to December 31, 2012. We used all inpatient claims of the included patients during the study period. In addition to the variables from the publically available portion of the USRDS, we obtained Medicare provider variables from the USRDS to generate a “gold-standard” for determining the location of an inpatient claim (Appendix A). Because Medicare provider variables are only available from the years 2012 and later, and because our methods required a lag period to reliably identify post-acute care services, we chose to start our study period on March 1, 2012 instead of the beginning of the calendar year.

Construction of Admissions

We used five distinct algorithms to group “inpatient” claims into admissions (Figure 1, Appendix A for technical details). Admissions were subsequently assigned a location: short-term acute hospital care (IP), inpatient rehabilitation facility (IRF), or long-term care hospital (LTCH). We assigned admission and discharge dates to each admission, corresponding to the “from date” of the first claim and the “through date” of the last claim, respectively. Admissions for each beneficiary could not span multiple locations and were not allowed to overlap by more than one day.

The first three algorithms were modeled after methods identified in previously published research. We refer to these algorithms respectively as: (a) gold standard, (b) ungrouped claims method, and (c) naïve method.^{2,4,11–17} Gold standard admissions were created using the Medicare provider codes to determine the location of each inpatient claim (i.e., IP, IRF, or LTCH). By using discharge codes and claim dates, we grouped claims that represented a transfer of care to the same location type or a continuation of the same institutional stay. The ungrouped claims method assumed that each individual claim belonged to a distinct IP admission. It did not use dates or other information from the claims to determine the admission location. The naïve method assumed that all claims with overlapping dates originated from the same IP admission and grouped the claims accordingly.

We subsequently developed two algorithms for constructing admissions, which we refer to as: (d) simple method and (e) rehabilitation-adjusted method (see Appendix B for SAS code). For the simple method, if claims had overlapping dates, the location of service was inferred using the discharge code of the previous claim. We then grouped claims of the same location type into the same admission. The rehabilitation-adjusted method modified the

simple method's algorithm by incorporating rehabilitation Diagnosis Related Group (DRG) codes.

Population Cohorts

Before performing any construction of admissions or analyses, we randomly divided patients into two distinct cohorts, a "calibration cohort" and a "verification cohort." We used these cohorts to validate the simple and rehabilitation-adjusted methods. We developed the simple method using prior knowledge of the structure of the USRDS claims data, and we tested the method using the calibration cohort. Because the simple method did not accurately identify IRF or LTCH claims, we subsequently created the rehabilitation-adjusted method, which we then tested using the verification cohort. Since the two cohorts were split by patient rather than by hospitalization, the numbers of hospitalizations in the calibration and verification cohorts were not identical.

Assigning 30-day Readmissions

We calculated 30-day readmission rates by determining the proportion of IP discharges with a subsequent IP admission within 30 days. Admissions ending in death were not eligible for readmission and were thus excluded in calculating readmission rates.

Statistical Analysis

We performed all database management and analytic functions using SAS 9.4 (SAS Institute, Cary, NC, United States). Using each method, we determined the number of admissions that matched the gold standard in location and dates, which was identical to comparing whether claims were grouped identically since admissions were not allowed to overlap. We used net reclassification percentages to compare the performance of the various methods developed. These were calculated by subtracting the proportion of admissions that were reclassified incorrectly from the proportion of admissions that were reclassified correctly.

Results

During the study period, a total of 274,115 "inpatient" claims were grouped using the gold standard into 266,769 admissions, with 94.8% of admissions made up of IP stays (Table 1, Gold Standard). The remaining admissions were split relatively evenly among IRF (2.5%) and LTCH (2.8%) stays.

Using the ungrouped claims method led to the correct identification of 92.6% of admissions, indicating that the majority of inpatient admissions were IP stays with one claim (Table 1). Most of the assignment errors were due to having an incorrect location (5.2% of all admissions), with the rest of the errors coming from having incorrect dates (2.2% of all admissions) (Table 2). A small group of admissions had both incorrect dates and location (0.1% of all admissions). The naïve method had a lower identification rate, with 86.5% of admissions correctly classified. In addition to having 5.2% of admissions with erroneous location, 12.9% of admissions had incorrect dates, and 4.6% of admissions had errors in both dates and location.

On the other hand, the simple and rehabilitation-adjusted methods correctly identified 98.4% and 99.0% of total inpatient admissions respectively, and both methods identified almost all IP admissions (99.7% and 99.8%). Although the simple method identified 78.5% of IRF admissions, the rehabilitation-adjusted method correctly identified 96.8% of IRF admissions, with 18.3% of rehabilitation stays correctly reclassified (Supplemental Table S3). Whereas 21.3% of IRF stays were assigned an incorrect location by the simple method, 2.6% of IRF stays were assigned an incorrect location by the rehabilitation-adjusted method (Table 2). Neither of the methods performed particularly well at identifying LTCH stays, with the simple method and rehabilitation-adjusted method both identifying 73% of LTCH admissions correctly.

The choice of method changed the estimated frequency, length of stay, and cost of hospitalizations and 30-day readmissions (Table 3, Figure 2). For instance, using the ungrouped claims method or the naïve method led to an overestimation of the *average* cost of IP hospitalization by 2.2% and 12.9% (\$15,230 and \$16,833 *versus* \$14,903 with the gold standard), while the rehabilitation-adjusted method overestimated the average cost by 1.1% (\$15,070). Similarly, the ungrouped claims method and the naïve method overestimated the average length of stay of an IP stay (8.1 days and 9.0 days *versus* 7.6 days with the gold standard). On the other hand, the simple and rehabilitation-adjusted methods estimated length of stay as 7.8 and 7.7 days respectively. Using the ungrouped claims method led to an overestimate of the proportion of admissions leading to a 30-day readmission (42.0% of admissions *versus* 37.4% of admissions with the gold standard). Conversely, the naïve method led to an underestimate of this proportion (35.4%). Compared to the gold standard, the simple and the rehabilitation-adjusted methods yielded similar rates of 30-day readmissions (37.4%) and associated average cost (\$15,274 and \$15,220 *versus* \$15,000).

Discussion

Using USRDS claims data, we reliably determined the location of IP and IRF claims by constructing two methods that distinguished between acute care and post-acute care hospitalizations. The simple method was not as reliable at identifying IRF or LTCH claims because CMS does not obligate an IP stay immediately prior to an LTCH or IRF admission.^{8,9} We improved the identification of IRF claims by utilizing rehabilitation-oriented DRG codes in the rehabilitation-adjusted method. Because CMS reimburses LTCH stays with the same DRG codes as IP, we could not create a similar solution for LTCH.²⁰

Previous studies examining hospitalizations and 30-day readmissions have treated all claims as IP using either the ungrouped claims method or a variation of the naïve method.^{2,4,11–17} As we have illustrated, by using these methods, prior studies have likely made inaccurate estimates of 30-day re-hospitalization rates. Although researchers could alleviate some of these inaccuracies by utilizing the gold standard approach, Medicare provider variables are only available from the USRDS in claims data after 2012.¹⁹ Because the USRDS has only released data through the end of 2013, investigations using the gold standard are limited to two years of claims data. Our method would help researchers and policy makers more accurately estimate 30-day readmission rates when using data older than 2012.

The main limitation of our study is that the analyses were limited to 2012 claims. It is possible that our approach does not perform as well with previous years of the USRDS claims data, although the same variables (DRG and discharge codes) used to improve classification accuracy were available at least as far back as 2007.²¹ A second limitation of our study was that we were unable to reliably identify LTCH stays.

In summary, we have developed an accurate method to identify acute hospitalizations (IP) and rehabilitation (IRF) stays without using the Medicare provider number, which is only available in data after 2012. Future studies could pursue how to refine this algorithm to more accurately identify LTCH claims.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The authors would like to thank Dr. Allan Collins for his evaluation of our methods and his expertise on the structure of USRDS and Medicare claims data.

This work was supported by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) of the National Institutes of Health. Dr. Lin is supported by NIDDK F32DK107123. Dr. Chertow was supported by NIDDK K24 DK085466. Dr. Kurella Tamura is supported by U01DK102150 from the National Institutes of Diabetes and Digestive and Kidney Diseases. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References

1. Barrett, M., Wier, LM., Jiang, HJ., Steiner, C. HCUP Statistical Brief #199. 2015. Statistical Brief #199
2. Saran R, et al. US Renal Data System 2014 Annual Data Report: Epidemiology of Kidney Disease in the United States. *Am J Kidney Dis.* 2015; 66:A7.
3. Centers for Medicare & Medicaid Services. ESRD QIP Summary: Payment Years 2014–2018. 2016.
4. United States Renal Data System. 2015 USRDS Annual Data Report: Epidemiology of kidney disease in the United States. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2015.
5. Foley RN, Collins AJ. The USRDS: what you need to know about what it can and can't tell us about ESRD. *Clin J Am Soc Nephrol CJASN.* 2013; 8:845–851. [PubMed: 23124788]
6. Chronic Condition Data Warehouse & Centers for Medicare & Medicaid Services. CCW Technical Guidance: Getting Started with CMS Medicare Administrative Research Files. 2015.
7. Medicare.gov. Your Medicare Coverage: Inpatient Hospital Care.
8. Centers for Medicare & Medicaid Services. Medicare Benefit Policy Manual.
9. Medicare.gov. What are Long-Term Care Hospitals?. 2015.
10. Department of Health and Human Services: Centers for Medicare and Medicaid Services. Medicare Program; Hospital Inpatient Prospective Payment Systems for Acute Care Hospitals and the Long-Term Care Hospital Prospective Payment System Policy Changes and Fiscal Year 2016 Rates; Revisions of Quality Reporting Requirements for Specific Providers, Including Changes Related to the Electronic Health Record Incentive Program; Extensions of the Medicare-Dependent, Small Rural Hospital Program and the Low-Volume Payment Adjustment for Hospitals. *Fed Regist.* 2015; 80:49326–49843.
11. Brunelli SM, Wilson S, Krishnan M, Nissenson AR. Confounders of mortality and hospitalization rate calculations for profit and nonprofit dialysis facilities: analytic augmentation. *BMC Nephrol.* 2014; 15:121. [PubMed: 25047925]

12. Kutner NG, Zhang R, Huang Y, Wasse H. Gait speed and hospitalization among ambulatory hemodialysis patients: USRDS special study data. *World J Nephrol.* 2014; 3:101–106. [PubMed: 25332901]
13. Kutner NG, Zhang R, Huang Y, Painter P. Gait Speed and Mortality, Hospitalization, and Functional Status Change Among Hemodialysis Patients: A US Renal Data System Special Study. *Am J Kidney Dis Off J Natl Kidney Found.* 2015; 66:297–304.
14. Tangri N, et al. Effect of intravenous iron use on hospitalizations in patients undergoing hemodialysis: a comparative effectiveness analysis from the DEcIDE-ESRD study. *Nephrol Dial Transplant Off Publ Eur Dial Transpl Assoc - Eur Ren Assoc.* 2015; 30:667–675.
15. Yan G, et al. Race/ethnicity, age, and risk of hospital admission and length of stay during the first year of maintenance hemodialysis. *Clin J Am Soc Nephrol CJASN.* 2014; 9:1402–1409. [PubMed: 24948142]
16. Suri RS, Li L, Nesrallah GE. The risk of hospitalization and modality failure with home dialysis. *Kidney Int.* 2015; 88:360–368. [PubMed: 25786099]
17. Erickson KF, Winkelmayer WC, Chertow GM, Bhattacharya J. Physician visits and 30-day hospital readmissions in patients receiving hemodialysis. *J Am Soc Nephrol JASN.* 2014; 25:2079–2087. [PubMed: 24812168]
18. Research Data Assistance Center. Research Data Assistance Center, University of Minnesota; 2013.
19. United States Renal Data System. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2015.
20. Centers for Medicare & Medicaid Services. Elements of LTCH PPS. 2013.
21. Centers for Medicare & Medicaid Services. Clarification of Patient Discharge Status Codes and Hospital Transfer Policies. 2015.

Figure 1.

Figure 2.

Table 1

Number of Claims and Admissions Assigned Correctly by Each Method

<u>Gold Standard</u>		<u>Ungrouped Claims Method</u>				<u>Naïve Method</u>			
		N	%	Correct	Incorrect	N	%	Correct	Incorrect
All Claims		274,115	100.0%	259,913	94.8%	14,202	5.2%	259,913	94.8%
IP	**	259,913	94.8%	259,913	100.0%	0	0.0%	259,913	100.0%
IRF		6,647	2.4%	0	0.0%	6,647	100.0%	0	0.0%
LTCH		7,555	2.8%	0	0.0%	7,555	100.0%	0	0.0%
All Admissions		266,769	100.0%	247,084	92.6%	19,685	7.4%	230,810	86.5%
IP		252,808	94.8%	247,084	97.7%	5,724	2.3%	230,810	91.3%
IRF		6,600	2.5%	0	0.0%	6,600	100.0%	0	0.0%
LTCH		7,361	2.8%	0	0.0%	7,361	100.0%	0	0.0%

<u>Gold Standard</u>		<u>Simple Method*</u>				<u>Rehabilitation-Adjusted Method*</u>			
		N	%	Correct	Incorrect	N	%	Correct	Incorrect
All Claims		274,115	100.0%	134,868	98.5%	2,031	1.5%	135,853	99.0%
IP		259,913	94.8%	129,438	99.8%	281	0.2%	129,947	99.8%
IRF		6,647	2.4%	2,612	78.4%	720	21.6%	3,211	96.9%
LTCH		7,555	2.8%	2,818	73.2%	1,030	26.8%	2,695	72.7%
All Admissions		266,769	100.0%	131,069	98.4%	2,114	1.6%	132,223	99.0%
IP		252,808	94.8%	125,717	99.7%	410	0.3%	126,393	99.8%
IRF		6,600	2.5%	2,597	78.5%	712	21.5%	3,187	96.8%
LTCH		7,361	2.8%	2,755	73.5%	992	26.5%	2,643	73.1%

* The simple and rehabilitation-adjusted methods used the calibration cohort (136,899 claims and 133,183 admissions) and verification cohort (137,216 claims and 133,586 admissions) respectively.

** IP refers to acute care stays, IRF refers to inpatient rehabilitation facility, and LTCH refers to long-term care hospital

Table 2

Reasons for Incorrect Admission Assignment

Method Used	Reason for Incorrect Assignment	All Patients							
		All Admissions (N=266,769)	IP* (N=252,808)	IRF (N=6,600)	LTCH (N=7,361)				
		N	%	N	%	N	%	N	%
Ungrouped Claims Method	By Dates	5,972	2.2%	5,724	2.3%	30	0.5%	218	3.0%
	By Location	13,961	5.2%	0	0.0%	6,600	100.0%	7,361	100.0%
	Both	248	0.1%	0	0.0%	30	0.5%	218	3.0%
	Total**	19,685	7.4%	5,724	2.3%	6,600	100.0%	7,361	100.0%
Naïve Method	By Dates	34,364	12.9%	21,998	8.7%	5,813	88.1%	6,553	89.0%
	By Location	13,961	5.2%	0	0.0%	6,600	100.0%	7,361	100.0%
	Both	12,366	4.6%	0	0.0%	5,813	88.1%	6,553	89.0%
	Total	35,959	13.5%	21,998	8.7%	6,600	100.0%	7,361	100.0%
Simple Method	Calibration Cohort								
		(N=133,183)		(N=126,127)		(N=3,309)		(N=3,747)	
	By Dates	663	0.5%	337	0.3%	155	4.7%	171	4.6%
	By Location	1,780	1.3%	91	0.1%	704	21.3%	985	26.3%
Rehabilitation-Adjusted Method	Both	329	0.2%	18	0.0%	147	4.4%	164	4.4%
	Total	2,114	1.6%	410	0.3%	712	21.5%	992	26.5%
	Verification Cohort								
		(N=133,156)		(N=126,681)		(N=3,291)		(N=3,614)	
	By Dates	458	0.3%	235	0.2%	53	1.6%	170	4.7%
	By Location	1,122	0.8%	70	0.1%	84	2.6%	968	26.8%
	Both	217	0.2%	17	0.0%	33	1.0%	167	4.6%
	Total	1,363	1.0%	288	0.2%	104	3.2%	971	26.9%

* IP refers to acute care stays, IRF refers to inpatient rehabilitation facility, and LTCH refers to long-term care hospital

** Incorrect assignment can be due to either incorrect dates, incorrect location, or both.

Table 3

Characteristics of Acute IP* Admissions and 30-day Readmissions

	Gold-Standard	Ungrouped Claims Method	Method Used		
			Naïve Method	Simple Method	Rehabilitation-Adjusted Method
Acute Inpatient Stays					
N	252,808	274,115	248,019	255,152	254,133
Average Length of Stay	7.6	8.1	9.0	7.8	7.7
Average Cost	\$14,903	\$15,230	\$16,833	\$15,108	\$15,070
% Change from Gold Standard	-	2.2%	12.9%	1.4%	1.1%
Total # days	1,911,575	2,223,856	2,236,766	1,986,944	1,968,978
Total Cost	\$3,767,627,231	\$4,174,780,032	\$4,174,780,032	\$3,854,719,083	\$3,829,832,258
30-day Readmissions					
N	87,243	106,323	80,315	88,040	87,714
Rate (per inpatient stay)	37.4%	42.0%	35.4%	37.4%	37.4%
% Change from Gold Standard	-	12.3%	-5.5%	0.0%	0.1%
Average Cost	\$15,000	\$16,626	\$16,651	\$15,274	\$15,220
% Change from Gold Standard	-	10.8%	11.0%	1.8%	1.5%
Total Cost	\$1,308,673,269	\$1,767,747,220	\$1,337,336,949	\$1,344,686,254	\$1,335,037,638

* IP refers to acute care stays

** To facilitate comparison of total costs among methods, we used the entire patient cohort to calculate admission characteristics for all methods. Average length of stay and average cost did not change for the simple or rehabilitation-adjusted methods when using the calibration and verification cohorts.