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Estimates of National Hospital Use from Administrative Data and Personal Interviews

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Data sets that merge claims data with health surveys are a rich source of information for estimating hospital use. However, comparisons of claims data with reported use for one survey (the Longitudinal Study of Aging) show that claims data may systematically understate use by Medicare beneficiaries in the United States because of processing lags or programmatic factors. The comparisons also show that self-reports are consistently closer to use measured by claims than are proxy reports, even though survey participants were age 70 or older. Standard techniques are used to adjust national estimates based on the discrepancy between self-reports and claims data, and a composite standard error for the adjusted estimate is derived based on the complex survey design effect and the value of the adjusted estimate. Although the specific correction factor would not apply to other data sets, the process for detection of discrepancies between survey and administrative data and of adjusting for such discrepancies (when resolution of the discrepancies is not possible) has general applicability.

Key words: Longitudinal Study of Aging; self-reports; proxy reports.

1. Introduction

The availability of data in electronic form and expanded data processing capabilities enable the creation of merged data sets. Such data sets are a valuable resource because data from administrative files can be associated with characteristics of individuals measured by surveys and, in the case of longitudinal surveys, with changes in these characteristics over time.

One challenge in using these data sets comes in understanding the limitations and possible gaps in the data. In particular, the combination of data from multiple sources may result in contradictory reports. Although in theory two sources should yield identical information, no one should be surprised when they do not. While such inconsistencies do not lessen the value of the data, careful review of the merged file is required so that inferences and estimates are reasonable.

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An example of such an inconsistency occurred after claims data from the Medicare program in the United States were merged with data from a longitudinal survey that included queries about hospitalizations over the prior year. In contrast to much of the existing literature, we found that reports of hospitalization exceeded the available claims. Because of a concern that some claims were missing from the administrative files, we proposed a process of modifying estimates based on survey reports. A subsequent update from the claims file verified that some claims were missing from the original files and provided a point of comparison for the modified estimates of national hospital use.

2. Prior Studies

Several researchers have analyzed the extent to which claims data correspond to survey reports of hospital use. Marquis (1984) provided a review of studies, most of which showed that the probability of hospitalization reported on surveys was lower than indicated by the claims. However, Marquis noted that the claims data are also subject to error and that an absolute standard as to which source is better does not exist. In an analysis of the National Health and Nutrition Examination Surveys (NHANES) I Epidemiologic Followup Study, Reuben, Pickle, Madans, Rothwell, Kleinman, and Feldman (1991) found that 86% of the stays reported by respondents were also on Medicare files and that 70% of claims on Medicare files were reported; these authors also showed that the probability of correct recall declined by 7% to 12% for every decade of age over 65 and that the spouse was the most accurate proxy respondent. Similarly, in a comparison of reports on the pretest of the National Medical Expenditure Survey (NMES) with Medicare claims files, Calore and Lim (1989) found that 77% of the reported hospital stays were matched to Medicare claims, while 71% of claims stays were reported. In both studies, the number of claims for stays not reported exceeded the number of reported stays for which a claim was not found.

Evidence on factors associated with reporting bias is mixed. Rodgers and Herzog (1987) did not find evidence of worse reporting by older persons on certain items that were checked in administrative records, but Herzog and Rodgers (1988) found that survey response rates decline with age. Jobe, Keller, and Smith (1996) reviewed three studies to demonstrate that older persons have problems with recall, and that dated events are particularly difficult to recall. Jobe, White, Kelley, Mingay, Sanchez, and Loftus (1990) showed that older persons tend to underreport physician visits. In a review of the literature on self/proxy reporting differences, Moore (1988) noted that although there is little support that self-reports are definitely of higher quality, the absence of such evidence does not ensure that proxy reports are of equivalent quality.

3. Comparison of Reported Use and Claims Data in the LSOA

The Longitudinal Study of Aging (LSOA) is a survey based on a nationally representative sample of 7,527 individuals who were living in the community (i.e., noninstitutional population) in the United States and who were 70 or older in 1984 (Kovar, Chyba, and Fitti 1992). The baseline survey was the Supplement on Aging

to the 1984 National Health Interview Survey (Fitti and Kovar 1987). Reinterviews (with the sample participant or a proxy) were conducted in 1986, 1988, and 1990.

The details of linking the survey data to the Medicare claims files are in Kovar et al. (1992). Briefly, staff at the National Center for Health Statistics (NCHS) submitted Health Insurance Claim (HIC) numbers (or social security numbers if HIC numbers were not available) obtained during the survey to the Health Care Financing Administration (HCFA) for matching to the Master Enrollment File (MEF). Names and addresses were not provided to HCFA for confidentiality reasons. Eight percent of the sample had no identification number reported (and therefore could not be matched to the MEF). HCFA returned information on matches to the MEF to NCHS staff for verification using name, address, date of birth, sex, and race. The verification showed that 80% of the records of LSOA participants were matched correctly to the MEF; the remaining 12% of the sample did not match correctly to the MEF because of an error in reporting or transcribing the identification number. Only persons who matched the MEF were matched to the claims files.

Hospitalizations reported by the respondent and Medicare claims were analyzed for the 80% of the sample that matched correctly to the MEF. In 1986, 1988, and 1990, sample members (or proxies) were asked for the number of times they had been hospitalized overnight in the 12 months prior to the interview. (Persons who were hospitalized at the time of the interview were counted as having one or more hospitalizations.) These data were compared to the number of claims for the interview month and the 12 months prior to the interview. The specific date of the interview was not available, so the interview month and 12 months prior were used for the comparison to be as inclusive as possible. Since the 13-month period for identifying claims exceeded the 12-month recall period of the interview, overreporting (reports exceed claims) should be reduced, and underreporting (claims exceed reports) should be increased. Therefore, the difference between over- and underreporting should be a minimum estimate of the true difference.

In contrast to the studies noted above, we found that reported hospitalizations were higher than the claims records showed. Table 1 summarizes the comparisons using dichotomous indicators of whether the sample person had (a) one or more hospital claims and (b) one or more reported hospitalizations for each year. There is some reporting error in both directions. However,

- In each year, reported use exceeded use measured by the claims.
- The proportion of cases with reported admissions but no Medicare claims was higher each year. In contrast, the proportion of cases with no reported admissions but one or more Medicare claims stayed roughly constant.

Additional comparisons in Table 1 show that the rate of inconsistent comparisons was less for self-reports than for proxy reports, and the degree of over- or underreporting was greater in both directions for the proxy reports. However, the rate of overreporting was always greater than the rate of underreporting and the net difference between over- and underreporting increased each year. The higher utilization estimates associated with proxy interviews may be explained by evidence that persons with proxy respondents were sicker and older (Fitti and Kovar 1987). However, it is

Table 1. Comparison of annual probability of hospitalization: reported use and Medicare claims

Comparison category	Interview year		
	1986	1988	1990
*Total sample**	3,417	4,240	3,473
a. Percent with consistent comparisons	91.5%	90.7%	88.6%
0 claims, 0 reported stays	72.5%	73.8%	72.4%
1+ claims, 1+ reported stays	19.0%	16.9%	16.2%
b. Percent with inconsistent comparisons	8.5%	9.3%	11.4%
0 claims, 1+ reported stays ("over")	4.9%	6.1%	7.9%
1+ claims, 0 reported stays ("under")	3.6%	3.2%	3.5%
c. Difference ("over" minus "under")	1.3%	2.9%	4.4%
Sample with self-report	2,630	3,269	2,611
a. Percent with consistent comparisons	93.0%	91.9%	90.1%
b. Percent with inconsistent comparisons	7.0%	8.1%	9.9%
0 claims, 1+ self-reported stays ("over")	3.8%	5.3%	6.5%
1+ claims, 0 self-reported stays ("under")	3.2%	2.8%	3.4%
c. Difference ("over" minus "under")	0.6%	2.5%	3.1%
Sample with proxy report	787	971	862
a. Percent with consistent comparisons	86.5%	87.0%	84.2%
b. Percent with inconsistent comparisons	13.5%	13.0%	15.8%
0 claims, 1+ proxy-reported stays ("over")	8.6%	8.6%	12.0%
1+ claims, 0 proxy-reported stays ("under")	4.9%	4.4%	3.8%
c. Difference ("over" minus "under")	3.7%	4.2%	8.2%

Source: Longitudinal Study of Aging, Version 4.

*Sample is defined as LSOA participants who were Medicare enrollees who matched to Master Enrollment File and who responded (self or proxy) to the LSOA Survey in the year indicated.

Note: The percentages are for the sample and have not been calculated using survey weights.

not clear that these considerations would have caused the rate of consistent comparisons to be lower for the persons with proxy respondents than for persons with self-reports.

The reported use undoubtedly contains some error. For example, retrospective reports of hospital use may overstate the number of hospitalizations due to telescoping. Telescoping may be particularly likely in the LSOA since: (1) the follow-up interview questions asked about hospitalizations during the past 12 months did not refer to specific dates, and (2) questions pertaining to nursing home use referred to use since the last interview (an interval of generally two years). However, the consistency with which the claims were less than the reported use led to a concern that claims were missing from Medicare statistical files, either at the time of the original match (due to processing delays) or possibly due to programmatic reasons (such as Health Maintenance Organization (HMO) enrollment). This type of discrepancy might not have occurred in earlier studies because of differences in the lag time allowed for claims to be put on the administrative files. To the extent that claims were missing, the claims data might systematically understate actual utilization. Therefore, we developed procedures to combine the estimates of hospital use in order to obtain more accurate estimates of use.

4. Reconciling Inconsistencies

While the consistently higher recall reports of hospital use provide evidence consistent with a possible problem of missing claims data, the net effect of a difference in the likelihood of hospitalization in 1990 of 4.4% between reported use and claims may seem relatively minor. For some applications, however, such as the estimation or prediction of hospital use for planning purposes, the implications of this difference can be substantial.

This problem can be illustrated using national estimates of the use of hospital services during the year prior to the 1990 interview by 3,473 sample members who: (a) participated in the 1984 LSOA; (b) were considered to be enrolled in Medicare; and (c) had complete interviews in 1990. While this group represents only Medicare enrollees age 76 or older who were not institutionalized in 1984 and is therefore only a subset of total enrollees in 1990, the estimates show the magnitude of the error that may occur in projections of hospital use.

As noted earlier, only 80% of the sample was matched to the Medicare claims file. A logistic regression revealed that the persons who matched were more likely to be younger, male, or a self-respondent in 1984 than those who did not. In addition, sample persons who had not died by 1990 were more likely to have a completed 1990 interview if they were younger, had attended college, or did not live alone in 1984.

The survey weights were first rescaled by multiplying them by a ratio according to the factors associated with matching to the Medicare files (sex, age, and self-respondent status). The numerator of the ratio was the estimated population with the corresponding characteristics for the full sample, and the denominator was the estimated population with the corresponding characteristics for the sample for

Table 2. Self versus proxy reports of predicted hospital use: comparisons of reported use and claims data for 1990

Measures of hospital use	Type of interview			
	Total	Self-report	Proxy (household)	Proxy (contact)
Sample and estimated population				
LSOA sample participants	3,473	2,611	695	167
Medicare enrollees represented[a]	12,409,430	9,238,383	2,537,615	633,432
Estimates of population use[b]				
Use measured by claims				
One or more part A claims	19.5%	16.5%	27.3%	32.2%
(Standard error)	(0.688)			
Use measured by interview reports				
One or more hospitalizations	24.1%	19.6%	36.8%	38.4%
(Standard error)	(0.751)			
Reconciled estimates of use				
Adjusted use assuming self-report to be correct	23.0%	19.6%	31.7%	36.9%
(Composite standard error)	(0.739)			
"Weighted" adjusted use assuming truth is between self-report and claims[c]	21.8%	18.6%	30.2%	35.4%
(Composite standard error)	(0.725)			

Source: Longitudinal Study of Aging, Version 4.

[a]The estimate is based on persons who participated in the 1984 LSOA, were determined to be enrolled in Medicare (i.e., reported enrollment or matched to files), and responded (self or proxy) to the 1990 interview. The total population estimate of 12.4 million represents the number of Medicare enrollees who were aged 76 or older in 1990 *and* who were living in the community in 1984 (i.e., persons who were not living in the community in 1984 but were still alive in 1990 are not included in this estimate).

[b]Estimates and standard errors have been calculated using SUDAAN. The survey weights were rescaled for nonmatches to the Master Enrollment File and incomplete 1990 survey responses.

[c]Reported use is weighted at 2/3, and claims use is weighted at 1/3.

whom claims were available. The weights were then further rescaled with a similar ratio adjustment according to the factors associated with having completed an interview in 1990 (age, college attendance, or living alone). Using the rescaled weights, the 3,473 sample members represented an estimated 12.4 million Medicare enrollees age 76 or older in 1990.

The estimates in Table 2 show that 24.1% of the people age 76 or older in 1990 who were not institutionalized in 1984 had one or more hospitalizations based on reported use and 19.5% had one or more hospitalizations based on the claims file. If the reported use is correct, then the difference in these estimates of 4.6 percentage points represents a *minimum* of 570,834 people among the 12.4 million persons estimated to be alive who had hospital stays that are missing from the claims file. Furthermore, these people represent 19.1% of persons with reported stays.

Table 2 also shows these estimates according to the type of respondent to the 1990 interview. Again, the reported use measures are higher for each comparison, and the discrepancy between reported use and use measured by claims is smallest for persons who responded for themselves.

5. Alternative Estimates

Given the inconsistencies between claims and reported use, it may be useful to combine the information to obtain an alternative estimate. For example, if one believes that the self-reported data are the most reliable information on hospital use, then it would be appropriate to develop a correction factor, δ, which is equal to the ratio of odds for self-reported use and claims data. Specifically, let

p_s = probability of hospitalization based on self-report for self-respondent
p_c = probability of hospitalization based on claims for self-respondent

Then

$$\delta = \frac{(p_s)/(1-p_s)}{(p_c)/(1-p_c)}. \tag{1}$$

The greater the self-reported use is relative to use measured by claims for the self-respondents, then the greater is δ.

The correction factor can then be applied to the odds for the probability of hospitalization for proxy respondents (household or other contact person) to get an "adjusted odds" (AO). Specifically, let

p_p = estimated probability of hospitalization based on claims for persons with proxy respondents.

Then

$$AO = \delta \times \frac{(p_p)}{(1-p_p)}. \tag{2}$$

In effect, the adjusted odds has been increased based on the extent to which the self-report exceeds the claim for the self-respondent interviews. The adjusted odds can be

converted to an adjusted estimate of hospital use for persons with proxy respondents based on the following formula

$$\textit{Adjusted probability of hospital use} = \frac{AO}{AO+1}. \tag{3}$$

This formula represents a reverse transformation that results in a proportion that falls within the range from zero to one.

As an example, using the data in Table 2, the correction factor based on the information for self-respondents is

$$\delta = \frac{(19.6/80.4)}{(16.5/83.5)} = 1.234.$$

Therefore, the estimated odds of hospitalization for sample participants who had a proxy respondent will be based on claims utilization adjusted upwards by 23.4%. Table 2 shows the effect of this adjustment on the probability of hospital use for the two types of proxy respondents. The net effect on the estimated probability of hospitalization for the total population is that 23.0% of Medicare beneficiaries aged 76 or older in 1990 (that were not institutionalized in 1984) had one or more hospitalizations during the prior year.

In summary, the essence of the correction is to: (1) assume that self-respondent reports of hospitalizations are true; (2) calculate the ratio of the odds of a self-respondent reporting stays to the odds of having claims in the file for the stays; and (3) estimate the proportion of proxy respondents who have hospital stays by inflating the claims for those with proxy respondents by the ratio. Each of these steps is based on standard statistical techniques.

The above calculations are based on the assumption that self-reports provide a "true" measure of hospital use. However, it is possible that the self-reports of hospital use are exaggerated due to telescoping or confusion between hospital care and other types of inpatient care such as nursing home care; in addition, the self-reports of hospitalizations would include any hospital stays that were not covered by Medicare (such as stays in Veterans' Administration hospitals). In adjusting the estimates of hospital use, therefore, it may be preferable to use a weighted average of the self-reports and claims data to calculate a weighted correction factor δ^*, based on a weight ϕ and defined as

$$\delta^* = \frac{(\phi \times (p_s) + (1-\phi) \times (p_c))}{\dfrac{(\phi \times (1-p_s) + (1-\phi) \times (1-p_c))}{(p_c)/(1-p_c)}}. \tag{4}$$

The weights ϕ could represent the degree of "data quality" of the various measures, though in practice selection of the weight might be ad hoc. For example, if we believe that the self-reported use is correct two-thirds of the time and that the claims are correct one-third of the time, then $\phi = 2/3$, $\delta^* = 1.15$, and the estimated probability of hospitalization during the prior year for the total population of Medicare beneficiaries aged 76 in 1990 that were not institutionalized in 1984 would be 21.8%.

6. Standard Errors and Confidence Intervals

It would be useful to calculate standard errors and confidence intervals for the alternative estimates. Such calculations must address two considerations: the complex survey design, and the fact that the estimate is a composite of the estimates from two different sources.

We addressed the first issue by using SUDAAN, a statistical package that calculates estimates and their standard errors according to a specific sample design and unequal weighting if appropriate (Shah, Barnwell, Hunt, and LaVange 1991). The estimates for the total column in Table 2 were calculated using SUDAAN with survey weights that were adjusted to reflect differences between sample members included in the estimation and sample members excluded from the estimation; the estimates were calculated under the assumption of a multi-stage design with replacement at the first stage.

We addressed the second issue by first comparing the standard error for the complex survey design with the standard error under simple random sampling and then using the larger standard error in deriving an estimate of the standard error for the composite estimate. Specifically, the design effect is defined as the ratio of the variance of a statistic from a complex sample to the variance of the same statistic from a simple random sample of the same size. The following formula holds for a binomial variable

$$Design\ Effect = \frac{Variance_{Complex\ sample}}{Variance_{Simple\ Random\ Sample}} = \frac{(se)^2}{p(1-p)/n} \tag{5}$$

where p represents the probability for a binomial variable such as the probability of hospitalization, se represents the standard error computed according to the sample design, and n represents the sample size (Kish 1965). Using the information from Table 2, the design effect for the claims estimate is 1.046, while the design effect for the reported-use estimate is 1.071. The larger of the two is used to produce a conveniently available approximate estimate of the standard error for the composite estimate. An estimate of the standard error of the composite estimate can be obtained using the following formula

$$se_{composite} = \sqrt{Maximum\ Design\ Effect} \times \sqrt{p_{composite}(1-p_{composite})/n}. \tag{6}$$

Composite standard errors calculated using this formula are provided in Table 2 for the alternative estimates. These standard errors are then applied in Table 3 to obtain confidence intervals for the percent of the Medicare-enrolled population aged 76 or older (that were not institutionalized in 1984) expected to have one or more hospitalizations in 1990 based on the four estimates of use.

We compared the estimates in Table 3 to an estimate of the number of Medicare enrollees aged 76 or older who had hospitalizations in 1990 based on data provided by the Bureau of Data Management and Strategy (BDMS) in 1992. The BDMS data do not necessarily provide a true measure of use, and the population and data set definitions vary somewhat.[1] However, BDMS data do provide a point of comparison

[1] We had to estimate the number of enrollees with hospitalizations because the Bureau of Data Management and Strategy could only provide data for five-year intervals from age 75 and older and only for calendar years. We assumed that four-fifths of the enrollees age 75–79 were age 76–79 and used an average of 1989 and 1990 data.

Table 3. National estimates and confidence intervals for probability of hospital use by Medicare enrollees age 76 or older in 1990[a]

	Expected value	95% confidence interval	
		Lower bound	Upper bound
Use measured by claims			
Percent with one or more hospitalizations	19.5%	18.3%	20.7%
Persons with one or more hospitalizations	2,419,839	2,270,926	2,568,752
Use measured by interview reports			
Percent with one or more hospitalizations	24.1%	22.7%	25.5%
Persons with one or more hospitalizations	2,990,673	2,816,941	3,164,405
Adjusted use assuming self-report to be correct			
Percent with one or more hospitalizations	23.0%	21.5%	24.4%
Persons with one or more hospitalizations	2,848,144	2,668,504	3,027,781
"Weighted" adjusted use assuming truth is between self-report and claims[b]			
Percent with one or more hospitalizations	21.8%	20.4%	23.2%
Persons with one or more hospitalizations	2,706,603	2,530,192	2,883,015

Source: Longitudinal Study of Aging, Version 4.

[a] Estimated population of 12,409,430 enrollees. Excludes persons who were institutionalized in 1984.

[b] Reported use is weighted at 2/3, and claims use is weighted at 1/3.

for the estimates derived through the process in the preceeding section. To the extent that claims were missing from the LSOA data files because of a lag in processing, the Medicare claims files used by BDMS may have been more complete by 1992. Our estimate, based on those data, is that there were approximately 2.96 million enrollees with hospitalizations. The estimate from all the interview reports of use comes closest to BDMS's number, and the estimate based on the assumption that data from self-respondents are correct is slightly smaller and includes the BDMS estimate within the 95% confidence interval. The LSOA estimate should be a bit lower than the BDMS number since the LSOA excluded persons who were institutionalized in 1984.

7. Results from an Update of the Claims File

Because of the concerns about missing claims data, a repeat request for claims data from 1986 through 1990 was made by NCHS to HCFA late in 1992. Table 4 shows that additional claims were available, and that the original files were missing from 3.7% to 8.0% of claims each year.

Several points about the updated claims are noteworthy. First, while the completeness of the claims file was generally better for earlier years, 1986 was an exception. The reason for this exception is not known, though possibilities include nonavailability of claims from some intermediaries at the time of the initial merge. Second, although most of Table 4 is based on a calendar year, the last two columns in Table 4 show the estimate of persons with one or more missing claims for the year prior to the interviews in 1986, 1988, and 1990 for the full sample and for the proxy respondents, respectively. As discussed earlier, these estimates may be "minimum bound" estimates of the percent of persons missing claims originally in the sense that 13 months of claims data were compared to reported use based on a twelve-month period. (However, the estimate may have been high if a substantial number of the reported stays were not covered by Medicare.)

The percent of claims missing from the original files (column 4 in Table 4) was substantially greater than the estimated percent of persons missing claims from the survey reports based on the whole sample (column 5). However, the percent of missing claims was much closer to the estimated percent of persons missing claims for proxy respondents (column 6). To the extent that most persons were missing one claim, this finding raises the possibility that proxy reports for hospital use by elderly persons may be fairly reliable. To explore this issue, the same types of comparisons that were provided in Table 1 were made for 1990 using the updated claims files. This analysis indicated that the difference between inconsistent comparisons fell from 4.4% to 2.1% for the full sample, from 3.1% to 1.7% for the self-report, and from 8.2% to 3.3% for the proxy reports. Although the reduction in inconsistent comparisons was greatest for the proxy reports, it is interesting that the direction of the difference still suggests that reports exceed claims. The remaining difference may be due to stays that were not expected to be on the claims files (e.g., Medicare HMO stays or stays not covered by Medicare). Though the issue is not explored in more detail here, it is possible that the correction factor used for Table 3 was too

Table 4. Number of claims before and after update to LSOA claims

(1) Calendar year	(2) Number of claims in original LSOA	(3) Number of claims in update[a]	(4) Percent claims missing from original LSOA	(5) Estimated percent persons missing claims in Table 1 (Full sample)	(6) Estimated percent persons missing claims in Table 1 (Proxy report)
1986	1,998	2,160	7.5%	1.3%	3.7%
1987	1,978	2,053	3.7%	–	–
1988	1,741	1,817	4.2%	2.9%	4.2%
1989	1,633	1,713	4.7%	–	–
1990	1,513	1,645	8.0%	4.4%	8.2%

[a]The updated claims are available in the CD-ROM release of Version 4 of the LSOA. Updated claims were not obtained for 1984 or 1985.
The data in columns 5 and 6 refer to interview year rather than calendar year.

small, and that a correction factor assuming the proxy report to be correct might have been more accurate.

8. Discussion and Recommendations

While claims data merged with health survey data provide a rich data source, the comparisons presented in this paper have identified some possible gaps in the completeness of such claims data and have highlighted the need for caution in relying exclusively on such data, particularly for making national estimates of hospital use. Key points are

- Use of claims data from merged surveys such as the LSOA may result in underestimates of use.
- Retrospective survey reports of use in the LSOA provide an estimate of hospital use that appears to be much closer to actual use than do claims data that were originally released.
- One process for obtaining reasonable estimates from merged surveys such as the LSOA may be to increase estimates based on claims by a correction factor.
- Based on an update to the claims files, it appears that proxy reports of hospital use for the elderly may be fairly reliable.

The advantages of the correction factor procedure presented here are that it is fairly simple and it involves essentially negligible bias *if* having missing claims is a random event. However, if persons with proxy respondents differ from self-respondents in the likelihood of having missing claims, then the correction using either the difference between claims and self-report *or* proxy reports might be biased. Furthermore, an update to the claims provided evidence that 8% of claims were missing from the original file for 1990. This comparison shows that using proxy reports in developing a correction factor may be an appropriate way to proceed (though the quality of proxy reports may vary considerably for different surveys).

The magnitude of the correction factor is dependent on the size of the discrepancy between reported use and claims data, and the magnitude of the correction factor will decrease as the completeness of the claims data increases. While it is not possible to make a recommendation about a correction factor for other data sets, analysts using data from administrative records merged with survey data should be aware that the administrative records may not be more accurate, especially for the most recent time periods. They should investigate their own data and might want to develop their own correction factor. The appropriate factor could change over time and will probably differ among different administrative records. It will certainly depend on such factors as the length of time required before the administrative records are complete. For example, Gaumer and Stavins (1992) had to drop three states from their analysis of Medicare claims because the bills had been returned to the intermediary and had not yet been reentered into the central system.

Appropriate correction will also depend on whether records are available for all survey participants. For example, there are no claims in the Medicare files for many persons enrolled in HMOs. We did not have information from the LSOA on

who was enrolled in an HMO although this information could be obtained through a survey. It would also be possible to determine from a survey the number of stays that were not covered by Medicare.

This analysis has focused on implications of missing claims data for making national estimates. In many cases, however, data sets such as the LSOA are used for inferential analyses of relationships between patient characteristics and use of hospital services. While random measurement error in the dependent variable of hospital use does not lead to bias in estimates of the coefficients of explanatory variables, systematic underreporting of hospital use could cause bias in coefficient estimates. For example, people enrolled in HMOs may, on average, be healthier. Possible corrections for that kind of problem are more complicated than the adjustments discussed in this paper and are not addressed here.

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