THE MEASUREMENT OF EXPENDITURES FOR OUTPATIENT PHYSICIAN AND DENTAL SERVICES: METHODOLOGICAL FINDINGS FROM THE HEALTH INSURANCE STUDY

PREPARED UNDER A GRANT FROM THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

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PREFACE

This research was carried out as part of Rand's Health Insurance Study, an inquiry into the consequences of alternative types of health insurance being conducted under the sponsorship of the U.S. Department of Health, Education, and Welfare. The HIS includes the analysis of existing data as well as the generation and analysis of new data through a large-scale social experiment (see Newhouse, 1974).

This report is the first to analyze data gathered by the HIS. It is one of a number of studies that will appear in the next few years reporting on the methodology of collecting certain kinds of data. Many of these studies will take up issues in the measurement of health status. This report, however, is concerned with techniques for measuring outpatient medical expenditures.

The data suggest that an unbiased measure of private sector financed expenditures for outpatient physician and dental services, including third-party payments, can be found by using certain household survey techniques, but that other survey techniques lead to bias. Estimates of outpatient expenditures net of insurance payments appear to be biased under all the techniques analyzed if third-party payments are more than a small fraction of the total. It appears impossible to measure public sector outpatient expenditures by means of one-time, household surveys.

Expenditure data were also collected from dentist records. Both these data and the data from the household survey appear to contain large amounts of measurement error with potentially serious implications for estimation accuracy and precision.

If research objectives include estimation of out-of-pocket or public sector expenditures, and an analysis of gross individual expenditures, data collection techniques other than a one-time survey are necessary. The experimental design of the HIS includes such a technique.

This report was presented at the November 1975 meeting of the American Public Health Association.

SUMMARY

This study examines the extent to which one-time surveys can obtain precise, unbiased estimates of expenditures for outpatient medical care.

It appears that many survey respondents cannot report amounts spent on their behalf by the public sector (e.g., Medicare, welfare) but that item nonresponse is not a serious problem in respondent estimates of privately financed health expenditures.

In this report, estimates of mean gross and net (family out-of-pocket) expenditures obtained by two indirect personal interview approaches and one direct, self-administered approach are compared with expenditure estimates based on nonsurvey data compiled by the Social Security Administration. Mean estimates obtained by the two surveys using indirect approaches correspond closely with the Social Security estimates of gross and net dental expenditures and gross physician expenditures. However, these surveys produced higher estimates of net expenditure means for outpatient physician care. All mean expenditure estimates derived from the self-administered surveys exceeded those of the Social Security Administration.

Examination of the pitfalls of using record checks to estimate survey bias reveals that pure prospective and retrospective designs can produce results that make random measurement error appear as bias. Results of the Health Insurance Study's record check of reported gross expenditures for dental care show that interview estimates exceed record estimates. This finding is probably due to prospective record check design bias, because a comparison of the mean derived from the whole sample to the nonsurvey estimate did not indicate any bias.

A procedure developed in this study for estimating response error variance showed that 44 percent of the total measured variance in the HIS interview reports of gross dental expenditures is response error and that 39 percent of the total variance in record reports is response error. A "best estimate" strategy, based on a least squares solution using both interview and record data, resulted in a new expenditure

measure. Only 26 percent of total measured variance in this new measure is response error.

The authors conclude that surveys can obtain unbiased estimates of gross private sector expenditures but that problems created by the large amount of response error remain. Response error will reduce estimation precision and attenuate standardized bivariate and multivariate coefficients of association, such as the product-moment correlation.

ACKNOWLEDGMENTS

The Health Insurance Study survey data were collected by the Urban Opinion Surveys Division of Mathematica, Inc. We wish to acknowledge the valuable data processing assistance of Mrs. Sally Hanes and the helpful comments of Drs. Ronald Andersen and Michael Polich. Any remaining errors are the responsibility of the authors.

CONTENTS

I. INTRODUCTION

Data on medical care expenditures are probably the most convenient means for determining the quantity of resources devoted to medical care; they are also critical for assessing the distribution of the burden of payment for medical services. As such, they are central to many analyses of medical care organization. In this report, we discuss and evaluate techniques for gathering data on expenditures for outpatient physician and dental services.

There are at least three sources of data on outpatient expenditures: consumers, providers, and fiscal intermediaries. Because the two latter sources seldom furnish much information on the characteristics of individuals, estimates of the joint distribution of expenditure and socioeconomic variables usually require that data be collected through surveys. However, the use of surveys to collect data is open to many challenges: Can respondents even report expenditure information? If so, can they report without major bias or error?

Answers to these questions require methodological work with health expenditure surveys, and such work has been rare in the past. However, there has been enough research on expenditure surveys in general to suggest that estimates derived from household surveys are subject to large recall decay errors and a large catalog of other types of unwanted sources of variation (see, for example, the review by Neter, 1970).

Within the domain of health surveys, some researchers assert that recall of certain expenditure data is virtually impossible, leading to item nonresponse or large response error. Others have attempted to minimize the problem of recall error by using an indirect method based on recall aids, e.g., by asking about components of expenditure, by probing for major illness episodes and eliciting associated costs, or by first enumerating the providers used and then obtaining expenditures for each. There is evidence, however, that the foundations for these indirect approaches--information about illness or health service use--are also subject to recall and other response errors (see, for example, the discussion by Marquis, 1970).

In the following discussion, we will examine several survey estimates of expenditures for outpatient physician and dental services. Our aim is to estimate the effect of alternative survey methods on the quality of the data. Our measures of quality are item nonresponse (missing data because the respondent cannot provide an answer or estimate), systematic response bias (effect on the mean), and amount of random response error (effect on variance). We pay particular attention to the record-check method of estimating response bias and also present a general method of estimating response errors in each of two matched data sources. We rely extensively on data obtained by the Health Insurance Study. For a general description of that study, see Newhouse (1974).

II. RESPONDENT KNOWLEDGE OF PERSONAL HEALTH EXPENDITURES: ITEM NONRESPONSE

Some researchers have questioned whether it is even feasible to collect data on gross expenditures (including amounts paid by third parties) from surveys. For example, Wilder (National Center for Health Statistics, 1974) recently concluded that "it is difficult if not impossible for family members to report the amounts paid through insurance benefits, government programs such as Medicare and Medicaid, welfare, philanthropy, and other third party payers." Although Wilder doubts that useful information about *gross* expenditures can be collected, he apparently does believe that respondents can give information concerning *out-of-pocket* expenditures, since he presents such data. By contrast, Andersen et al. (1973) reported that most families could report the gross costs of health services used during a past time period but that nonresponse was strongly associated with the receipt of publicly financed health care (e.g., Medicare or welfare).[1]

Data from the Health Insurance Study's Baseline Pretest[2] corroborates Andersen's observation concerning publicly financed care. The recall-based survey technique employed was one in which families were asked to report the gross costs of health care received during the "past 12 months," including costs paid by public agencies and other third parties.[3] Over half of the sample persons whose physician services were covered by public sector programs could not report the total

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[1]There was item nonresponse for 23 percent of physician services. Andersen reports this was strongly associated with the poor and the aged, the groups in which publicly financed care is concentrated.

[2]The pretest, conducted in late 1973, was a 1½ hour, personal interview of a stratified sample of families residing in Dayton, Ohio, and the surrounding area. Interviews were completed with 130 families. Low-income families were oversampled. Both household head and spouse (if any) were required to respond. All members of the family were sample persons.

[3]Physician and dental expenditure information was obtained in separate parts of the interview. The procedure used was to probe extensively for the names of providers used by the family in the "past

charges for their outpatient physician services. Similar nonresponse rates occurred for total dental treatment expenditures. As a result, for the main (i.e., nonpretest) sample in Dayton,[4] questions about gross expenditures were asked only when health care was financed within the private sector. Within this sample, expenditure item nonresponse rates were acceptably low (see Table 1).

Item nonresponse is low enough not to rule out the use of recall-based surveys for measuring health care expenditures in the private sector. However, item nonresponse is high for publicly financed care. Therefore, alternatives to the recall-based survey should be considered[5] for collecting data on expenditures within groups where publicly financed care is concentrated, principally the poor and the aged. The Current Medicare Survey is an example of such an alternative. It is a panel study in which respondents are asked to save bills for medical care expenses in a special folder. The interviewer reviews these documents with the respondent monthly, if necessary, to obtain estimates of both total expenditure and net expenditure. The panel period is 12 to 15 months long, during which respondents presumably learn to keep accurate records. Contacting providers for the amount of charges for the publicly financed services is another alternative to recall-based population surveys.

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12 months." Then, for each patient-provider unit (family member X and doctor Y), a question was asked about the number of visits that the patient made to the provider. The visit question was followed by a question about gross expenditure: "What was the *total* cost of those visits, including anything paid by insurance or someone else...?"

[4]The main study in Dayton involved a stratified random sample of approximately 2000 families representative of Dayton, Ohio, and the surrounding area. The response rate was 80 percent of eligible families and yielded interviews with about 1600 families (approximately 4400 persons). Both the family head and spouse (if any) were required to respond. Each was paid $5 for participating.

[5]Pearl (1968) provides a comprehensive discussion of alternative methods of collecting expenditure data from consumers.

Table 1

PERCENTAGE DISTRIBUTION OF ITEM NONRESPONSE FOR PERSONS WITH ANY PRIVATE SECTOR HEALTH CARE EXPENDITURES, BY TYPE OF EXPENDITURE QUESTION ASKED

Type of Expenditure Question Asked	Percent of Persons with Item Nonresponse[a]	Number of Persons with Any Private Sector Health Care Expenditures[b]
Outpatient Physician Services		
Gross expenditure:		
"What was the *total cost* of those visits, including costs covered by insurance?"	15	3202
Out-of-pocket expenditure:		
"What was the cost to (you/the family) of those visits, *not including costs covered by insurance*?"	7	3202
Dental Services		
Gross expenditure:		
"What was the *total cost* of those visits, during the past 12 months, including costs covered by insurance?"	5	1993
Out-of-pocket expenditure:		
"What was the cost of those visits to (you/your family), not including costs covered by insurance?"	4	1993

[a]Missing data on one or more provider expense questions for the person.

[b]Persons with *all* expenditures in the expenditure category covered by "Medicare, Medicaid, welfare, or any other state program" are excluded from this analysis, as are persons who reported no expenditures.

III. SURVEY AND NONSURVEY ESTIMATES OF MEAN EXPENDITURES: COMPARISONS USING AGGREGATE DATA

In this section, we will evaluate three survey approaches to measuring privately financed outpatient physician and dental expenditures in order to determine if surveys based on retrospective recall yield biased mean expenditure estimates.

The simplest approach is the direct one of asking respondents to report expenditures for health care services in various aggregate categories, such as physician and dental services. This approach was used, for example, in the 1962 and 1971 National Health Surveys conducted by the National Center for Health Statistics (NCHS, 1966; NCHS, 1974).

A more complex, indirect, approach is first to probe for episodes that may be associated with large health care expenditures, such as pregnancies, hospitalizations, chronic conditions, severe accidents, and so forth, and then ask questions about treatment and expenditures for each episode. Residual expenditures are accounted for by a series of "clean-up" questions. This is the approach used by the Center for Health Administration Studies (CHAS) in the 1964 and 1971 cross-section household survey program (Andersen and Anderson, 1967; Andersen et al., 1973).

Another indirect approach is one used by the Health Insurance Study (HIS) to obtain expenditure data in its baseline interview. Instead of asking about illness episodes, the technique elicited names of providers of health services likely to have been used by families. Probes for usual sources of care, specialists visited, and use of emergency rooms and clinics were used to maximize the probability that the respondent mentioned any provider who was actually used. Then, for each provider mentioned, a supplement was completed to ascertain who received services, how many visits were made, and the total and out-of-pocket costs for each family member. (See Table 1 for type of expenditure questions asked.)[6]

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[6]The set of probe questions to obtain names of medical and dental providers is given in Document HIEI 15 and is available on request. Questions on outpatient medical care expenditures are contained in

We will evaluate these three techniques by comparing survey data collected by the alternative techniques with nonsurvey data. The nonsurvey estimates were constructed using Social Security Administration (SSA)[7] data on expenditures for physician and dental services. SSA data were derived primarily from gross practice income reported to the Internal Revenue Service. Per capita expenditures were derived by using Bureau of Census estimates of the noninstitutional population.[8]

Adjustments to published data from SSA and NCHS were made to account for important conceptual differences in physician expenditures among the data sources. The HIS definition of outpatient physician expenditures excludes inpatient services but includes hospital outpatient clinic and emergency room expenditures. The SSA and NCHS data on physician expenditures include both inpatient and outpatient physician services but exclude hospital clinics and emergency room care. Expenditure components estimated from the 1970 CHAS data were used to convert the values from the other studies to the HIS definition. Thus, while our tables use the labels CHAS, SSA,and NCHS, it should be remembered that the data presented in them contain adjustments that we have made to the original results of the other studies.

The HIS estimates of expenditures from the Dayton area were adjusted to the 1974 age-distribution of the United States for comparison with the national SSA data. Regional or urban effects that might be present in the HIS data were not adjusted for, because there was no satisfactory method for computing such effects. However, it seems unlikely that such effects are large. For example, per capita expenditure estimates from the CHAS survey for the national population and urban North Central SMSA's (of which Dayton is one) do not differ significantly. Details of the adjustment strategy used are given in the appendix.

Document HIEI 25; dental care expenditure questions are available in Document HIEI 27.

[7]Worthington, 1975; Rice and Cooper, 1968, 1972; Cooper et al., 1974.

[8]U.S. Bureau of the Census 1963, 1971, 1973, 1975. SSA expenditure reports include expenditures for the entire population, including the military living on base and other institutionalized persons. However, private sector expenditures for outpatient care for these persons are small and no adjustment was made.

The two survey estimates based on an indirect approach (CHAS and HIS) are compared with SSA data in Table 2. Estimates of gross expenditures for private sector outpatient physician and dental services are very similar in each case to SSA data for the respective year. In none of the four cases do the survey estimates differ by more than two approximate standard errors from the nonsurvey estimates.[9] These data suggest that personal interviews using 1-year recall and indirect questioning can obtain unbiased estimates of gross expenditures for these services.

By contrast, the personal interview estimates of out-of-pocket expenditures for physician care are much higher than those of the nonsurvey estimates. If the nonsurvey estimates are accurate, then surveys considerably overstate out-of-pocket expenditures for physician services: 19 percent in the case of the CHAS, and 31 percent in the case of the HIS. On the other hand, both of the surveys' estimates of out-of-pocket expenditures for dental care are essentially the same as SSA's. The difference in the reporting of out-of-pocket costs for the two services suggests that respondents appear to overstate out-of-pocket costs of health services where costs are likely to be covered, in whole or part, by a third party, such as an insurance plan.

Survey respondents may tend to overstate their out-of-pocket expenditures because it is easy to remember writing a check for the total cost but more difficult to recall receiving the reimbursement check from the insurance company.[10] (Most office visits are covered by major

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[9] The estimation of sampling errors did not take into account the complex multistage designs of the samples, the geographic clustering, or the full effect of poststratification weights. Had these effects been taken into account, they would probably have increased the estimated standard errors, had no effect on the means, and thus would not have affected the conclusions stated in the text. The effects of imputation for missing data on the variance estimates made for the CHAS data were also ignored.

[10] Our conclusion that recall of gross outpatient expenditure yields acceptable data but that recall of out-of-pocket expenditure is unsatisfactory may well not apply to inpatient services. In the case of inpatient services, the patient may only be billed for this share of the bill, if any; in this case he may not know the gross amount of the bill.

Table 2

MEAN PRIVATE SECTOR EXPENDITURES PER PERSON FOR OUTPATIENT PHYSICIAN AND DENTAL SERVICES: COMPARISON OF INDIRECT SURVEY TECHNIQUES AND NONSURVEY DATA

Type of Expenditure	1970		1974	
	CHAS Personal Interview	SSA Records	HIS Personal Interview[a]	SSA Records[b]
Outpatient Physician Services				
Gross expenditure:				
Mean ($\bar{x}$)	$40	$42	$62	$60
Approximate S.E. $\bar{x}$	1.3		1.8	
N	11,445[c]		4,340	
Out-of-pocket expenditure:				
Mean ($\bar{x}$)	$32	$27	$47	$36
Approximate S.E. $\bar{x}$	1.1		1.4	
N	11,445[c]		4,340	
Dental Services				
Gross expenditure:				
Mean ($\bar{x}$)	$27	$26	$31	$28
Approximate S.E. $\bar{x}$	1.3		1.6	
N	11,445[c]		4,340	
Out-of-pocket expenditure:				
Mean ($\bar{x}$)	$25	$24	$29	$26
Approximate S.E. $\bar{x}$	1.2		1.6	
N	11,445[c]		4,340	

[a]Approximate fiscal year. The HIS interview was administered in June-August 1974; respondents were asked to report about the previous 12 months. HIS estimates are adjusted to the age distribution of the national population. Estimates were derived by assuming that the distribution of expenditures for persons with missing data was the same as the distribution for other persons in the same age cohort who had received care.

[b]Fiscal year.

[c]Unweighted sample size.

medical policies that reimburse the patient directly. See Phelps, 1975.) If this inference is correct, surveys will become less and less useful in estimating out-of-pocket costs of health services as third-party coverage that reimburses the individual directly becomes more extensive.

The NCHS expenditure estimates, based on self-administration of direct questions (e.g., "How much did all of the dentist bills for this person come to for the past 12 months?"), are compared with non-survey estimates in Table 3. The NCHS estimates appear to be uniformly high. Thus, the direct approach in the context of a self-administration form does not appear to be as good in eliminating biases as the two indirect approaches.

Table 3

MEAN PRIVATE SECTOR EXPENDITURES FOR OUTPATIENT PHYSICIAN AND DENTAL SERVICES: COMPARISON OF DIRECT, SELF-ADMINISTRATION TECHNIQUE AND NONSURVEY DATA

Type of Expenditure	Mean Expenditure per Person ($)	
	NCHS Self-administration of Direct Questions	SSA Records
Outpatient Physician Services		
Gross expenditure (1962 data)	36[a]	28
Out-of-pocket expenditure (1970 data)	47[b]	27
Dental Services		
Gross expenditure (1962 data)	19[a]	12
Out-of-pocket expenditure (1970 data)	29[c]	24

[a]The questionnaire was administered in July-December 1962; respondents were asked to report about the previous 12 months.

[b]Exceeds SSA reported gross expenditure of $42.

[c]Exceeds SSA reported gross expenditure of $26.

The survey measurement literature, at present, does not enable us to conclude whether simple, direct questions under personal interview conditions yield unbiased annual health expenditure estimates. Such knowledge is needed to guide decisions regarding the design of health surveys in the future.

In sum, personal interviews employing indirect approaches and 1-year recall appear to yield unbiased estimates of gross, private sector expenditures for outpatient physician and dental services. The technique of self-administration of direct questions appears to overestimate gross expenditures. It is not certain whether the estimation bias is due to the use of the direct approach or to the self-administration. Recall-based surveys are less successful in avoiding biased estimates of out-of-pocket expenditures for these services, perhaps because respondents do not recall the amount of reimbursement from the third party.

IV. USE OF RECORD CHECKS TO ESTABLISH BIAS

Rather than compare survey data with aggregate data, the health survey field has been inclined to evaluate response bias in surveys by means of record-check studies.[11] Such studies have tended to show that both overreporting and underreporting are problems, and many of the survey techniques used today are attempts to minimize the effects of these problems.

In this section, we will explain how the presence of only random error in record and/or interview data can appear as bias when certain types of record-check designs are used.

There are four types of record-check designs: prospective, retrospective, full, and ideal. Following the logic of Hansen et al. (1964) for 0, 1 outcomes, we will illustrate the four designs by Fig. 1. Net bias is estimated as the ratio of the difference between the two types of mismatches (cells B - C) to the total number of cases (N = A + B + C + D). Bias has also been estimated in the literature as B/(A + B) and C/(A + C).

In a pure *prospective* design, the names of providers of health services are obtained from an interview. Utilization and/or expenditure data for the interviewed person are then obtained from each of the mentioned providers whose services were used. Because records are not used to confirm negative reports in the interview, expenditure and utilization data are not obtained from providers in cell C. In the example of Fig. 1, inconsistencies in information on whether services were received are only detected in cell B, and if net bias is calculated, either as (B - C)/N or B/(A + B), a positive sign will be obtained if both sources of data contain only random error.

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[11] Examples of record-check studies in the health survey field: Suchman et al. (1958); Sanders (1959); Mooney (1962); Cannell and Fowler (1963; NCHS, 1965a); Cartwright (1963); Balamuth et al. (NCHS, 1965b); Cannell et al. (NCHS, 1965c); Madow (NCHS, 1967; NCHS, 1973); Loewenstein (1969); Meltzer and Hochstim (1970); Cash and Moss (NCHS, 1972a); Marquis et al. (NCHS, 1972b); Sudman et al. (1974).

Respondent Reports Services Received	Record Indicates Services Received: Yes	Record Indicates Services Received: No
Yes	A	B
No	C	D

Fig. 1—Matrix classification for results of record-check studies

On the other hand, using a pure *retrospective* record-check design, one can locate positive information in records and then verify the information by interviewing the persons receiving the services. For this design, respondents in cell B are not contacted. Negative net bias will be calculated if both sources of data contain random error. Thus, random (unbiased) error in survey and/or record observations will appear to be bias when either the pure retrospective or the pure prospective record-check design is used.

An ideal design yields unbiased estimates of sample values for each of the four cells. The ideal design does not make observations from one source conditional on the other. That is, observations are obtained for an unbiased sample of all patient-provider pairs in the domain. Further, an ideal design permits generalization because it yields unbiased estimates of values for each of the four cells for the *population* of interest. Unfortunately, an ideal design is extremely expensive to carry out, so various approximations to it have been used. The approximations have involved working with populations that are not necessarily representative or are not sampling records from the universe of all providers. We call these approximately ideal designs *full* designs. If results are to be generalized to cross-section surveys, the use of small, isolated communities or persons enrolled in prepaid medical plans is not completely satisfactory. An ideal design would sample from the general population of interest, rather than from groups whose records are conveniently available.

The effects of record-check design on conclusions about survey estimate bias can be seen from the data given in Table 4. These data concern visits but illustrate the general point.

The first two data sets used a full record-check design. In each case, data from the full design suggest that errors in the two sources were counterbalancing (random). However, by using a prospective or retrospective strategy to analyze the data, one would conclude that bias was present in either the survey or the record data.

The first data set is based on a sample of members of the Kaiser Foundation Health Plan, Southern California Region (NCHS, 1973). Special medical records for sample persons were filled out for a 12-month period by physicians in the Plan. At the end of the period, sample persons were interviewed about their health and use of health services, using 12-month recall. The study differs from the pure retrospective design in that known members of the Plan were sampled rather than known users of services.

The data set from the Cartwright study (1963) included a sample of persons in a postwar housing estate in England. Persons were interviewed about their use of health services in the previous 4 weeks. Practitioners in the area had agreed prior to the study to keep records on all of their consultations during the period covered by the survey. The doctors' records were obtained for all persons reporting utilization of health services and for a one-in-four sample of persons reporting no utilization of services.

The data from the Health Insurance Study do not come from a full design according to our definition. They will be discussed in the next section.

Each data set has been analyzed in three ways. For the prospective design, estimates of the mean characteristic reported by providers are derived by using observations from those providers whom patients said they visited. For example, the 0.80 estimate in column (1) is the percentage of respondents who said they sought medical care from the Health Plan; however, there was not always confirmation in provider records. Provider records verified treatment for 94 percent of those persons reporting that they had received medical care, implying a

Table 4

MEAN HEALTH SERVICE CHARACTERISTICS, BY TYPE OF RECORD-CHECK DESIGN[a]

Health Service Characteristic	Prospective Design[b]			Retrospective Design[c]			Full Design		
	(1) Patient Report (A+B)	(2) Record Report (A)	(3) Net Difference	(4) Patient Report (A)	(5) Record Report (A+C)	(6) Net Difference	(7) Patient Report (A+B)	(8) Record Report (A+C)	(9) Net Difference
1. Proportion of persons receiving medical care from Kaiser Foundation Health Plan (from data in NCHS, 1973)									
Mean estimate	.80	.75	.05	.75	.81	-.06	.80	.81	-.01
Approximate standard error of estimate	.006	.006	.003	.006	.006	.003	.006	.006	.005
Number of cases	5027	5027	5027	5027	5027	5027	5027	5027	5027
2. Number of physician visits per person per month (from data in Cartwright, 1963)									
Mean estimate	.33	.30	.03	.29	.33	-.04	.33	.33	.00
Approximate standard error of estimate	.02	.02	.01	.02	.02	.01	.02	.02	.01
Number of cases	2040	2040	2040	2040	2040	2040	2040	2040	2040
3. Number of visits per person-dentist pair per year (from HIS data)									
Mean estimate	1.29	1.18	.11	1.13	1.25	-.12	1.29	1.25	.04
Approximate standard error of estimate	.04	.04	.02	.03	.04	.02	.04	.04	.03
Number of cases[d]	4317	4317	4317	4317	4317	4317	4317	4317	4317

[a]The letters in the column heads refer to the cells of Fig. 1 that are included in the column. For example, let P_a, P_b be the patient report of the amount of the characteristics in cells A and B, respectively; the patient reports 0 in cells C and D. Let R_a, R_c be the record report of the amount of the characteristics in cells A and C, respectively; the record indicates 0 in cells B and D. Then the patient estimate for the prospective design is $(P_a + P_b)/N$, and the record estimate is R_a/N.

[b]Estimates for the prospective design were derived by treating positive record reports as zero in the cases where the respondent had not reported treatment in the interview.

[c]Estimates for the retrospective design were derived by treating positive respondent reports as zero in the cases where the record had not indicated treatment.

[d]Excludes 9 verified cases with missing data from the patient about number of visits.

treatment rate of 75 percent of persons per year (.94 × .80 = .75; see column (2)). It can be readily seen that by using a prospective design, one would conclude that patients are *overreporting* the characteristic of interest, and that the extent of overreporting is not negligible.

For the retrospective design, provider records are used to ascertain names of patients whom providers said they treated. Patient responses on surveys are then used to verify the patient report. In each case, one would conclude that *underreporting* bias existed.

The values of -0.01 and 0.00 found in the full design (column (9) of Table 4) for the first two data sets, plus the value of 0.04 for the third data set (which has some upward bias),[12] suggest that both survey patient reporting and provider records provide unbiased data, although both contain random error. If, in fact, the error in both sources is random, then the net differences shown for the prospective and retrospective designs show how random error can appear as bias with one-directional record-check studies. Although not shown here, the same record-check design features can lead to erroneous conclusions about correlates of response bias. For example, when a retrospective record-check design is used, a subgroup, such as the poor, whose survey reporting is subject to larger random response error than another group, such as the nonpoor, will appear to be underreporting to an even greater extent than the remainder of the population.

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[12] In the case of the Health Insurance Study results, an important deviation from the ideal design occurs because the only records sought were those of dentists who were mentioned by respondents as being usual providers or who were reported as having been visited by any family member; records of unmentioned providers were not sought. Hence, the value for cell C in Fig. 1 is underestimated. This would cause some upward bias in the net difference for the full design results and, indeed, the 0.04 net difference (3 percent) is somewhat greater than any difference found in the data from the other two studies.

V. ESTIMATES OF MEAN DENTAL EXPENDITURE: COMPARISON OF PERSONAL INTERVIEW RESPONSE WITH RECORDS

The Health Insurance Study's (HIS) methodology program involved verification of recall-based interview data with health service providers at its first site, Dayton, Ohio. The following discussion focuses on the verification of dental expenditures.

During June-August 1974, interviews were completed with a cross-section sample of 1597 families in the Dayton, Ohio, area. Families headed by persons under 18 or over 65 were excluded. The interviews lasted an average of 90 minutes. Questions were asked about family composition, income, and health insurance, and about the type, frequency, and cost of health care services used in the past 12 months by each family member. The questions about dental services came about two-thirds of the way through the interview. They began with a question to elicit the names of dentists usually used by the family. A series of probes followed to obtain the names of other providers of dental services. After a provider was listed, the interviewers determined which family members were treated by him in the last 12 months, and which family members were not treated. This procedure generated 5569 person-provider pairs. For about half of these pairs, the sample person was reported not to have received treatment (e.g., a sample person and a "usual" provider who was not seen by the sample person during the year, or a sample person and a dentist visited by another family member but not by the sample person). When permission was received from the respondent, each provider of dental services mentioned in the interview was sent a questionnaire in the mail. The form asked the dentist to report the number of visits and total treatment cost for the listed individual during the 12-month reference period.[13] The named provider was sent a form for each individual in

[13]The questionnaire mailed to the dentists is Document HIEI 24 and is available upon request. The procedure to match patient response about dental care received with the information provided by the dentist involved a processed link form available as Document HIEI 30.

the family, including members who were reported to have received no treatment. Providers were also asked to report amounts paid by insurance and other third parties. Most dentists could not furnish this information. Therefore, it is possible to carry out the record-check analysis only for gross expenditures for dental care and not for out-of-pocket expenditures.

Attempts were made to verify reported visit and cost data for 3547 persons who mentioned providers (5174 person-provider pairs). Verification for 395 person-provider pairs was not attempted because of the individual's refusal to sign a verification permission form. Verification was completed for 2836 persons (80 percent of attempts) involving 4326 person-provider pairs (84 percent of attempts). Incomplete verification was due to provider nonresponse and inability to match interview and provider data.

The mean per person cost of dental services according to respondents in the verification sample was $34.84[14] for 12 months (Table 5). This is $4.64 greater than the comparable estimate based on provider data.[15] The difference is statistically significant. On the other hand, the comparison of the full sample HIS survey data (weighted for age) with the SSA per person dental expenditure estimate (Table 2) did not suggest a response bias.

Our hypothesis is that the discrepancy observed when verification sample data are used is the result of the record-check design bias discussed above. The design used is an improvement over the pure prospective strategy, but it is not an ideal design. It still underrepresents false negative survey reports (incorrect reports of no dental service use), because a survey report of no dental utilization could

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[14]This mean is higher than the one reported in Table 2 partly because of differences in the samples. The verification sample is not representative of the entire survey sample, and contains a higher proportion of persons who claimed to have used dental services. In the verification sample, 57 percent of the sample persons were said to have used services, whereas the figure for the entire sample was 49 percent.

[15]The provider figure includes data from individuals who reported no utilization, but for whom utilization was found in provider records.

Table 5

PERCENTAGE DISTRIBUTION OF DENTAL PATIENTS, BY GROSS EXPENDITURE FOR DENTAL SERVICES AND SOURCE OF DATA

Gross Expenditure per Person in Past 12 Months ($)	Percent Distribution of Dental Patients by Data Source	
	Interview Reports	Dentist Records
0	47	52
1-25	25	21
26-50	14	13
51-75	4	5
76 or more	10	9
Mean per person cost ($)	34.84	30.20
Approximate standard error of the mean[a]	1.82	1.74
Number of persons[b]	2636	2636

[a]Standard errors are approximate because the potential effects of multistage, clustered sample, if any, are ignored.

[b]Excludes 108 persons with incomplete expenditure information from the survey, 87 persons with orthodontia treatment (the interview did not ask for expenditure for this treatment), and 5 persons for whom dentists furnished incomplete expenditure information.

be verified only by checking with the dentists whom the respondents mentioned. Reports of no dental services used in the past 12 months were strongly associated with failure to mention a usual provider, in which case we could not contact providers of dental treatment.[16]

[16]Of respondents reporting dental visits, 97 percent named to usual provider; however, only 69 percent of persons reporting no dental visits named a usual provider.

VI. ESTIMATES OF RESPONSE ERROR VARIANCE IN DENTAL EXPENDITURE: COMPARISON OF PERSONAL INTERVIEW RESPONSE WITH RECORDS

The Health Insurance Study's verification data for gross dental expenditures may also be used to estimate the portion of the variance in reported expenditure that is due to response error. When dental expenditure is used as a dependent variable in a regression, random error affects the estimated standard errors of regression coefficients. The unstandardized regression coefficient, of course, is unaffected. However, other coefficients of association, such as correlations, standardized regression coefficients, and coefficients of determination are attenuated by random measurement error. In this section, we will develop a procedure for estimating response error in continuous variables that will provide estimates of response error in both the respondent and record data. We will show that the estimated response error in both sources is substantial. If this finding is generalizable, it implies that researchers using recall-based survey data must use considerably larger sample sizes than would otherwise be necessary to attain comparable degrees of precision for unstandardized regression coefficients.

Let X^t be the true expenditure for dental care during the period. Two estimates of expenditure are available: X_p the expenditure reported by the patient, and X_d the expenditure reported by the dentist. We define

$$X_p = X^t + U_p \ ,$$

$$X_d = X^t + U_d \ ,$$

where the U are errors made in reporting expenditures. We define DiffX to be the difference between the two estimates:

$$\text{DiffX} = X_p - X_d = U_p - U_d \ .$$

The observed covariance between the difference score and each of the measured scores can be expressed in terms of covariances of the unobserved true scores and response errors. That is,

$$\text{Cov}\ (\text{DiffX},X_p) = \text{Cov}\ (U_p,X^t) - \text{Cov}\ (U_d,X^t) - \text{Cov}\ (U_d,U_p) + \text{Var}\ (U_p)$$

$$\text{Cov}\ (\text{DiffX},X_d) = \text{Cov}\ (U_p,X^t) - \text{Cov}\ (U_d,X^t) + \text{Cov}\ (U_d,U_p) - \text{Var}\ (U_d)\ .$$

We assume, based on the data reported in Table 2, that (U_p) and (U_d) have zero mean and are uncorrelated with the true value of expenditures. We also assume that the errors have constant variance for all persons and that the observations are independent, i.e., that the patient error (U_p) and dentist error (U_d) are uncorrelated. Given these assumptions, the first three terms on the right-hand side of each equation are zero. Cov (DiffX,X_p) is thus equal to the patient response error variance and Cov (DiffX,X_d) provides an estimate of dentist response error variance.

The data in Table 6 are estimates of the error variance in each HIS source of dental expenditure data. The index of inconsistency reported indicates the ratio of the error variance relative to total

Table 6

ESTIMATES OF VARIANCE COMPONENTS IN DENTAL EXPENDITURE DATA, BY SOURCE OF DATA

Variance Component	Estimates of Variance Components by Data Source	
	Interview Reports	Dentist Records
Total variance of measure	8756	7966
Error variance in measure	3875	3085
True score variance in measure (total variance-error variance)	4881	4881
Index of inconsistency (%)	44	39
Number of cases	2636	2636

score variance. Clearly, both patient and provider data sources contain large amounts of response error. In the patient data, 44 percent of the variance can be attributed to response error. The provider data are only a slightly improved measure of the individual's expenditure; response error accounts for 39 percent of the variance in the dentist observations. Thus, for each data collection source, the effect of response error on the precision of unstandardized regression coefficients would be considerable.

Improvements in estimation precision may be achieved through a linear combination of the alternative estimates for each individual. We have adopted the requirement that the linear combination be an unbiased measure of true expenditure for each individual. We have assumed that the patient reports and the dental records are unbiased estimates (based on the analysis shown in Table 2). The requirement of no bias implies that the weights used to derive the linear combination should sum to one.[17]

A second requirement is that the weights be chosen to provide the best combination of the patient and provider estimates, best being defined as that linear combination that minimizes the error variance. This is the "least squares" solution. It may be shown that the best estimate is derived by giving each observed measure a weight proportional to the amount of true score variance that the measure contains.[18] The proportion of true score in each measure is 1 minus the index of inconsistency reported in Table 6.

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[17] Let W_p, W_d be the weights for the patient report and the dentist report, respectively. We wish to estimate W_p and W_d such that $E(W_pX_p + W_dX_d) = X^t$. Thus $E(W_pX_p + W_dX_d) = W_p\ E(X_p) + W_d\ E(X_d) = W_p\ X^t + W_dX^t = (W_p + W_d)\ X^t = X^t$ if, and only if, $W_p + W_d = 1$.

[18] See, for example, Hauser and Goldberger (1971). The best unbiased weights are

$$W_p = \frac{\frac{\text{Var } X^t}{\text{Var } X_p}}{\frac{\text{Var } X^t}{\text{Var } X_p} + \frac{\text{Var } X^t}{\text{Var } X_d}}; \qquad W_d = \frac{\frac{\text{Var } X^t}{\text{Var } X_d}}{\frac{\text{Var } X^t}{\text{Var } X_p} + \frac{\text{Var } X^t}{\text{Var } X_d}}.$$

In the case of the HIS dental data, the best linear combination of the alternative expenditure estimates gives a weight of .48 to the patient report and a weight of .52 to the provider measure. The estimator of expenditure, using both patient and provider information, has a mean of $32.42. The standard error of the mean is 1.58; the error variance is 26 percent of the total variance.[19]

Given these results, collection of data from providers may not be necessary to achieve most of the potential gains in precision. From the estimates of relative reliability of patient and dentist data, it may be seen that by combining two estimates from the patient (an independent test, retest design), it is possible to obtain a linear combination estimate having approximately the same gains as those of the provider-patient combination, provided, of course, that the survey response errors are uncorrelated over time.

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[19]The variance of the new estimator is $(W_p + W_d)^2$ Var $X^t + W_p^2$ Var $U_p + W_d^2$ Var U_d. The weights W_p and W_d have been chosen to sum to 1; therefore, the first term in the equation is Var X^t. The second two terms are the error variance of the new measure: the error variance of the new measure is a weighted combination of the error variance in the dentist record and in the patient report (Table 6).

VII. CONCLUSIONS

Should recall-based surveys be used in research on outpatient physician and dental expenditures? The answer is a qualified "yes" if one's objectives are limited. Such surveys do not accurately estimate out-of-pocket expenditures for outpatient services whose costs are covered in more than small amounts by private sector third parties and services whose costs are covered by the public sector. Even in instances in which surveys provide minimally biased estimates of the mean, such as gross expenditure, the estimates of the variance of the (true) distribution appear severely biased. This has implications for most researchers analyzing variation in expenditures because estimates of strength of association and/or estimation precision are substantially affected when on the order of half of the variance in the dependent variable is response error.

A byproduct of this analysis is the conclusion that an alternative source of gross dental expenditure data, the providers of services, does not appear to be any more accurate and only a little more precise than survey respondents, under the same conditions of a 12-month recall. A further conclusion is that accurate information about third-party payments cannot be obtained from either consumers (based on our analysis of physician expenditure) or providers of health care services (based on our dental record-check experience). If the research goals dictate precise estimates of relationships, especially when effective sample sizes are small, alternatives to recall-based surveys should be considered. If research goals involve estimates of public sector health expenditures or out-of-pocket expenditures for individuals in a sample, alternative primary data collection strategies are imperative.

Appendix

DERIVATION OF ESTIMATES

The Social Security Administration (SSA)[1] publishes calendar and fiscal year estimates of national health expenditures by source of funds and type of care. Estimates of expenditures for the services of physicians, dentists, and other health professionals are based primarily on gross incomes from self-employment reported to the Internal Revenue Service. The SSA estimates also take account of gross incomes of incorporated practices, the expenses of prepayment plans in providing physician care, and salaries of visiting nurses.

Estimates of private insurance benefit payments for physician services, dental services, and services of other health practitioners published by SSA are based on industry statistics. Consumer direct payments are estimated as a residual amount after deducting government, philanthropic, and private insurance expenditures from the total expenditures for each type of service.

The private health care expenditures reported by SSA are estimates for the entire U.S. population during the year, including persons who died during the year and those who were institutionalized or nonresidents at the end of the period. The Center for Health Administration Studies (CHAS), National Center for Health Statistics (NCHS), and Health Insurance Study (HIS) estimates are based on the civilian, noninstitutionalized population[2] at the time of the survey.[3]

Differences in the universes would result in lower mean expenditure estimates from the surveys than from the SSA. The expected discrepancy would be greatest in comparisons of hospital expenditures, because the survey estimates exclude deceased persons and persons in

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[1] See Worthington (1975); Rice and Cooper (1968, 1972); Cooper et al. (1974).

[2] Includes military personnel living off base.

[3] CHAS obtains information on individuals who were residents of the household at any time during the year. To increase comparability of the surveys, however, persons not residents at the time of the survey are excluded from the data presented here.

long-term health facilities. Estimates of expenditures for outpatient physicians' services and outpatient dental care would be less affected by the differences in the population. Because the comparisons are confined to the latter expenditure categories, no adjustments were made for the differences in universes sampled.

The population used to derive per capita expenditures from the SSA data was the civilian,[4] noninstitutionalized population in March for the 1970 and 1962 calendar years; the average population in March 1973 and March 1974 was used for the fiscal 1974 estimate.[5]

The HIS survey included the civilian, noninstitutionalized population in the Dayton, Ohio, area. Expected differences in HIS and SSA estimates, due to urban and regional effects on medical care expenditure rates, were estimated from the CHAS data. Mean expenditure estimates for the national population, adjusted to the 1974 age distribution, were compared with mean expenditure estimates for persons living in an SMSA in the North Central region, also adjusted to the 1974 age distribution of the national population.[6] The comparisons are shown in Table A. Since the differences were not statistically significant, we conclude that regional and urban effects do not bias the comparison of HIS data and SSA data.

Rates of item nonresponse for the expenditure items for HIS are shown in Table 1. The estimated expenditure rates for HIS in the other tables were derived by assuming that the distribution of expenditures for persons with missing data was the same as the distribution of known expenditures for persons in the same age cohort who had received care. The mean expenditure for each age cohort was estimated as $p_i\bar{X}_i$, where $\bar{X}_i$ is the mean known expenditure for persons in the ith cohort who had received care and p_i is the proportion of persons in

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[4]Includes military personnel living off base and personnel living on base with families.

[5]References: U.S. Bureau of the Census 1963, 1971, 1973, 1975.

[6]Age Adjusted Estimator = $\Sigma\, w_i\bar{X}_i$, where w_i is the proportion in the age group in 1974 and $\bar{X}_i$ is the mean 1970 expenditure for the age group. The following age groups were used: under age 17, age 17-24, age 25-44, age 45-64, and age 65 or older.

Table A

MEAN PRIVATE SECTOR EXPENDITURES FOR OUTPATIENT PHYSICIAN AND DENTAL CARE: COMPARISON OF NATIONAL POPULATION AND NORTH CENTRAL SMSA RESIDENTS

Type of Expenditure	Mean Private Sector Expenditures per Person					
	National Population		Persons Residing in SMSA, North Central Region		Difference Between National Population and North Central SMSA	
	Estimate in 1970 Dollars	Estimate in Fiscal 1974 Dollars	Estimate in 1970 Dollars	Estimate in Fiscal 1974 Dollars	Estimate in 1970 Dollars	Estimate in Fiscal 1974 Dollars
Outpatient Physician Services						
Gross expenditure:						
Mean ($\bar{x}$)	$40.40	$47.40	$37.60	$44.10	$2.80	$3.30
Approximate S.E. $\bar{x}$	1.3	1.5	3.1	3.6	3.4	4.0
N	11,445		1,059[a]			
Out-of-pocket expenditure:						
Mean ($\bar{x}$)	$32.10	$37.70	$30.50	$35.80	$1.60	$1.90
Approximate S.E. $\bar{x}$	1.1	1.3	2.6	3.0	2.8	3.3
N	11,445		1,059[a]			
Dental Services						
Gross expenditure:						
Mean ($\bar{x}$)	$27.00	$31.70	$28.30	$33.20	$-1.30	$-1.50
Approximate S.E. $\bar{x}$	1.3	1.5	4.0	4.7	4.2	4.9
N	11,445		1,061[b]			
Out-of-pocket expenditure:						
Mean ($\bar{x}$)	$25.60	$30.00	$27.00	$31.60	$-1.40	$-1.60
Approximate S.E. $\bar{x}$	1.2	1.4	3.9	4.6	4.1	4.8
N	11,445		1,061[b]			

[a]Three cases with the expenditures in excess of $1000 were eliminated; the cases accounted for less than 1 percent of the weighted sample.

[b]One case with expenditures in excess of $900 was eliminated; the case accounted for less than 1 percent of the weighted sample.

the cohort receiving care. The expenditure estimate for each age cohort was weighted by the age distribution of the national population to derive the age-adjusted mean expenditure. (The HIS sample underrepresented the elderly population.[7])

There are also conceptual differences in the component expenditures measured by the surveys and the SSA. The HIS collects information on expenditures for outpatient medical treatment, including

> Treatment by a physician in the patient's home, physician's office, or a clinic.
>
> Treatment at a hospital outpatient department or emergency room.
>
> Treatment by other health professionals (except dentists) in the patient's home, practitioner's office, or any clinic.

Physician expenditure estimates from NCHS and the SSA include

> Treatment by a physician in the patient's home, physician's office, or a clinic. (Treatments at hospital outpatient clinics and emergency rooms are excluded.)
>
> Treatment by a physician while a patient is in the hospital (except care provided by physicians on the staff of hospitals).

Estimated gross private expenditures for the services of other health professionals are also available from SSA. However, this component is excluded from the published NCHS estimates and from the published SSA out-of-pocket estimates.

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[7] Two percent of the HIS sample was age 65 or older compared with 10 percent for the national population.

In the 1971 CHAS survey, per capita gross and out-of-pocket expenditures for each of the following components were obtained from respondents:

> Treatment by a physician in the patient's home, physician's office, or a clinic.
>
> Treatment by a physician while patient is in a hospital.
>
> Treatment at a hospital outpatient department or emergency room.
>
> Treatment by other health professionals.

The CHAS estimates in this report are the sum of the component estimates for outpatient treatment by a physician, treatment by other health professionals, and treatment of a hospital outpatient clinic or emergency room.

The component estimates from the 1971 CHAS survey were used to adjust the SSA and NCHS physician expenditure estimates to match the HIS definition of expenditure for outpatient medical care.

The 1971 CHAS survey per capita estimates of out-of-pocket expenditures for treatment by other health professionals (excluding dentists) and for treatment at a hospital clinic or emergency room were added to the 1970 NCHS and SSA published estimates. Estimates of out-of-pocket expenditures for inpatient physician care from the CHAS survey were subtracted from the NCHS and SSA data. The 1974 SSA estimates were adjusted by using estimates of the components from the CHAS data inflated to fiscal 1974 dollars by the Consumer Price Index (BLS, 1971, 1974, 1975) for physician fees (for inpatient physician services and services of other health professionals) and hospital services (hospital clinics).[8] The adjustment procedure increased the

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[8] In the case of hospital services, 1970 dollars were inflated to 1972 dollars, using the index for medical services. 1972 dollars were inflated to fiscal 1974 dollars, using the hospital services index (BLS, 1971, 1973, 1974, 1975). This procedure was followed because the hospital price index changed its definition in 1972. The estimates are not sensitive to this treatment.

1970 calendar and 1974 fiscal SSA estimates of out-of-pocket physician expenditures by 2 percent and the NCHS 1970 estimate by 1 percent.

NCHS estimates of gross outpatient expenditures in 1962 were adjusted in a similar manner. The component estimates from the CHAS survey were deflated to 1962 dollars by using the Consumer Price Index for medical care services (BLS, 1963, 1971). The procedure reduced the NCHS published estimate by 16 percent.

Gross private expenditures for treatment by other health professionals was directly available from SSA publications. The published SSA estimate of this component and the estimate derived from the CHAS data (and used to adjust the 1962 NCHS data) differed by less than one dollar, lending confidence to the adjustment procedure.

The SSA estimates of gross expenditures for physician services and for services of other health professionals were adjusted to match the HIS definition by adding CHAS estimates of expenditures for outpatient hospital care and subtracting inpatient physician care. Adding the SSA estimate of expenditures for other health professionals and using the adjustment estimates from CHAS decreased the SSA 1974 published estimate of expenditures for physician services by 13 percent, the 1970 estimate by 17 percent, and the 1962 estimate by 16 percent.

Estimates of expenditures for dental care from the surveys and SSA are more directly comparable, with respect to the definitions of services used. The HIS estimates include imputed expenditures for orthodontia treatment received during the year, based on the application of average cost per visit for all other dental services to each orthodontia visit reported to HIS. The estimate of aggregate expenditures for orthodontia treatment, using the imputation procedure, was 10 percent of the aggregate expenditures for all dental services. Data from the Continental Casualty Company (Grubb, 1964) provided a similar estimate. The data were charges incurred during a year by families enrolled in a group dental policy issued to the Dentists' Supply Company of New York. From these data, it was estimated that 11 percent of all charges incurred were for orthodontia treatment.

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