SAMPLE DESIGN RESEARCH FOR THE 1985 NATIONAL AMBULATORY MEDICAL CARE SURVEY

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Introduction

The National Ambulatory Medical Care Survey (NAMCS) is being conducted by the National Center for Health Statistics (NCHS) to collect information about the provision and use of ambulatory medical care services in the United States. Ambulatory medical care consists of those health services obtained by individuals under their own will at a time when they are not inpatients of a hospital or other health care institution. Currently, the NAMCS target population consists of all office visits within the conterminous United States made by ambulatory patients to physicians who are in office-based practices but not specialists in anesthesiology, pathology, and radiology or in Federal service. It is expected that NAMCS will eventually include visits to hospital-based physicians and neighborhood health centers, which are currently excluded.

NAMCS results are released in the form of statistical tabulations containing information about the patients' sex, race, ethnicity, reason for visit, diagnosis, diagnostic services rendered, and disposition. Periodically, questions regarding specific health care issues are added to the questionnaire. This data is used by health planners and policymakers, health care managers, educators, and in analyzing trends in the use and types of ambulatory medical services over time.

NAMCS was conducted annually through 1981 and will be conducted triennially beginning in 1985. In previous cycles of NAMCS, NAMCS was designed to produce estimates of office based ambulatory care without respect to specialties and, hence, the sample was selected without differential sampling by specialty. However, estimates by specialties are now important, too. So, for the 1985 NAMCS, design emphasis is on stratifying the sample by specialty. This became necessary when the survey changed from an annual survey to a triennial one. When the survey was conducted annually, data from two or more consecutive years could be used to produce estimates for the smaller specialties. Data for consecutive years will not be available in 1985 or thereafter.

Using data from the last survey cycle, sample sizes were computed for 11 patient visit characteristics and 14 physician specialties. This paper will discuss the research conducted for optimizing these sample sizes which contributed to the 1985 NAMCS sample design.

Background

Since 1973, the National Center for Health Statistics (NCHS) has provided national statistics on the use and provision of ambulatory medical care services through the National Ambulatory Medical Care Survey (NAMCS). A 5-year feasibility study period began in 1967 to develop and evaluate alternative instruments and procedures for collecting ambulatory care data from office-based physicians on a continuing basis. This period involved exploratory studies, field tests, and extensive discussions with practicing physicians, potential contractors, statisticians, and experts in the health care field. As a result, the current NAMCS has evolved as a tool for collecting comprehensive and high-quality information about ambulatory patient visits in office-based practices.

NAMCS uses a three-stage design that involves sampling geographic areas as primary sampling units (PSU's), physicians' practices within PSU's, and visits within physicians' practices. For the 1985 NAMCS, the first-stage sample of 84 PSU's was selected by the National Opinion Research Center (NORC) using a modified probability-proportional-to-size (pps) procedure with separate frames for standard metropolitan statistical areas (SMSA's) and for nonmetropolitan counties. The 1980 Census counts of occupied housing units were the measures of size used in the calculation of the probability of selecting each PSU, which corresponds to individual counties or groups of contiguous counties across the United States, excluding Alaska and Hawaii.

The second-stage sample was selected from a list of physicians in office-based practice compiled from files that are maintained by the American Medical Association (AMA) and the American Osteopathic Association (AOA). The physicians were selected using systematic random sampling techniques after ordering by specialty within PSU.

The third stage sample consists of patient visits from the physician's annual practice. This involves two steps. First, each physician is randomly assigned to one of the 52 weeks in the year and asked to supply data on visits made in that week. Second, the visits within the physician's survey week are selected by the physician using systematic random sampling procedures and a sampling rate that varies from a 100 percent sample for very small practices to a 3.33 percent sample for very large practices. The sampling rate is assigned to the physician during an induction interview and is determined by the number of office visits the physician expects during his reporting week. In prior cycles, the sample included an average of about 30 visits per participating physician who saw patients during his survey week.

Requirements of 1985 Sampling Design

The new sampling design was required to produce separate estimates for the 14 largest physician specialties or specialty groupings. The specified specialties are: general and family practice, internal medicine, pediatrics, general surgery, obstetrics and gynecology, orthopedic surgery, cardiovascular disease, dermatology, urology, psychiatry, neurology, ophthalmology, otolaryngology, and allergy. It was desired that estimates for one percent of the visits to any specialty have relative standard errors (RSE's) no greater than 30 percent and

that the precision of larger proportions of visits be reasonable. Reasonable precision was interpreted as including 10 percent RSE's for estimates of 10 percent or more of the visits and 15 percent RSE's for estimates of 5-9 percent of the visits in each specialty.

A three-stage design similar to that used in the prior cycles was also stipulated. In particular, sample physicians were to again be asked to participate for exactly one week. Also, no more than 30 visits were to be selected on the average from each physician who would see patients during his/her survey week. These limits on response burden were used in the prior cycles and were considered necessary to achieve the same response rates as were attained in the earlier cycles. This rate was about 79 percent in 1981.

In addition, the number of PSU's was to be limited to about 100 since a larger number would probably require the use of two or more contractors to field the survey. Further, to conserve resources the PSU's were to be selected with probability-proportional-to-size (pps), with size being correlated to the decennial Census, as was done in prior cycles of NAMCS. Theoretically, PSU's selected with pps to physician counts should yield the best precision. However, an analysis of the numbers of physicians and the numbers of persons per PSU in the prior NAMCS sample PSU's confirmed a high correlation between the two counts (McLemore, 1983). Thus, any improvement in the precision yielded from a PSU sample selected with pps to physician counts over that from a sample selected with pps to decennial census counts would probably not justify the extra resources required to prepare a sampling frame of PSU's with numbers of physicians in each PSU.

Methodology for Optimizing Sample Sizes

Formulae for the required sample sizes at each stage were derived using the method of Lagrange multipliers as presented by Hansen, Hurwitz, and Madow (1953). The procedure obtains the optimum sample sizes that maximize precision for a fixed survey cost or minimize the cost for a fixed level of precision. For the NAMCS, precision was fixed at four levels of relative standard errors (0.30, 0.15, 0.10, and 0.05), while costs were minimized.

For simplicity in formulations, the population in each specialty and stratum is treated as though each PSU contains the same number of physicians, each physician's practice contains the same number of patient visits, and that the sampling fractions within PSU's and physicians' practices are constant across the PSU's and physicians within the specialty and stratum. The function that must be solved for optimizing values may then be formulated as:

$$F = \lambda\,(V_r^2 - V^2) + f(C) \qquad (1)$$

where:

- λ is the Lagrange multiplier.
- V_r^2 is the relvariance of the characteristic of interest, X, given by:

$$V_r^2 = \frac{1}{\bar{X}^2}\left[\sum_h^L A_h^2\left(\frac{1}{a_h} - \frac{1}{A_h}\right) S_{1h}^2 + \sum_h^L \frac{A_h^2\,\bar{M}_h^2}{a_h}\left(\frac{1}{\bar{m}_h} - \frac{1}{\bar{M}_h}\right) S_{2h}^2 + \sum_h^L \frac{A_h^2\,\bar{M}_h^2\,\bar{\bar{N}}_h^2}{a_h\,\bar{m}_h}\left(\frac{1}{\bar{n}_h} - \frac{1}{\bar{\bar{N}}_h}\right) S_{3h}^2\right] \qquad (2)$$

where:

L=2, the number of strata,
h=1 for metropolitan or 2 for nonmetropolitan PSU, A_h, $\bar{M}_h$, and $\bar{\bar{N}}_h$ represent estimated counts of PSU's, physicians, and patient visits in the population, respectively, and a_h, $\bar{m}_h$, and $\bar{\bar{n}}_h$ represent the corresponding sample sizes by strata. S_{1h}^2, S_{2h}^2, and S_{3h}^2 are the estimated population variances between units aggregated at each stage of sampling. These variances were approximated by first estimating the population variance components for visit means in a three-stage sampling design. Then the first and second stage components for means were multiplied by the estimated average numbers of visits per PSU and per physician, respectively, to yield estimates for the corresponding components for visit aggregates. Atkinson and Shimizu (1985) give details of the methodology used to estimate the variances used in the current study. The variance estimates were based on 1980 NAMCS data.

- V^2 is the fixed value for the relvariance.
- f(C) is the cost function consisting of the costs associated with each stage of the survey.

$$f(C) = C_o + \sum_h^L a_h C_{1h} + \sum_h^L a_h \bar{m}_h C_{2h} + \sum_h^L a_h \bar{m}_h \bar{\bar{n}}_h C_{3h} \qquad (3)$$

where C_o represents a fixed cost associated with the survey, which does not vary or depend on the sample sizes, and C_{ih} are variable costs associated with each stage. These costs were derived using cost figures from the 1980-81 survey cycles.

The function F is differentiated with respect to each unknown sample size and λ, resulting in

equations which are set equal to zero and solved simultaneously. The derived formulae for sample size allocation are:

1st Stage (PSU's):

$$a_h = \frac{A_h \bar{M}_h \bar{\bar{N}}_h \sqrt{S^2_{3h}}}{\bar{m}_h \bar{\bar{n}}_h} \left[\frac{T_h}{B_h} \right] \qquad (4)$$

where:

$$T_h = \sum_h^L \frac{A_h \bar{m}_h \bar{\bar{n}}_h S^2_{1h}}{\bar{M}_h \bar{\bar{N}}_h \sqrt{S^2_{3h}}} + \sum_h^L \frac{A_h \bar{M}_h \bar{\bar{n}}_h S^2_{2h}}{\bar{\bar{N}}_h \sqrt{S^2_{3h}}} \left(1 - \frac{\bar{m}_h}{\bar{M}_h}\right) + \sum_h^L \frac{A_h \bar{M}_h \bar{\bar{N}}_h S^2_{3h}}{\sqrt{S^2_{3h}}} \left(1 - \frac{\bar{\bar{n}}_h}{\bar{\bar{N}}_h}\right)$$

$$B_h = X^2 V^2 + \sum_h^L A_h S^2_{1h}$$

2nd Stage (Physicians):

$$\bar{m}_h = \bar{M}_h \sqrt{\frac{(C_{1h} / C_{2h})(S^2_{2h} - \bar{\bar{N}}_h S^2_{3h})}{S^2_{1h} - \bar{M}_h S^2_{2h}}} \qquad (5)$$

3rd Stage (Patient Visits):

$$\bar{\bar{n}}_h = \bar{\bar{N}}_h \sqrt{\frac{S^2_{3h} (C_{2h} / C_{3h})}{S^2_{2h} - \bar{\bar{N}}_h S^2_{3h}}} \qquad (6)$$

Eleven visit characteristics were selected from the 1980 NAMCS such that each would apply to one or more of 14 physician specialties. The characteristics are:

- Patient is given drug treatment
- Patient's age is 15-44 years
- Clinical lab test is done for visit
- Disposition is to return to physician if needed
- Diagnostic services: General history and examination
- Principal diagnosis is disease of the respiratory tract
- No diagnostic services during visit
- Principal diagnosis is disease of the circulatory system
- Psychotherapy or therapeutic listening
- Diagnostic services: Mental status exam
- Endoscopy

In the optimizing research, physicians were stratified by specialty and, for the 6 most common specialties, by metropolitan status. To conserve resources, physicians in the remaining specialties were not stratified by metropolitan status. However, it appeared that most physicians in the remaining specialties were in the metropolitan areas and, hence, the total number of PSU's needed for them would likely be less than indicated for a design in which PSU's were not stratified by metropolitan status. Therefore, completion of the research was not felt to be crucial in producing an acceptable sample design for the 1985 NAMCS.

Data collected in the 1980 survey was used to estimate population variances required by the sample size formulae for each of 11 selected visit characteristics for each of the 14 targeted specialties. Estimates for A_h, $\bar{M}_h$, and $\bar{\bar{N}}_h$, were also derived. The 1980 data set included data for 2,284 physicians and 46,081 patient visits. Computations were done using equations (4) - (6) to determine the sample sizes required at each stage. Even though the results for some visit characteristics were not meaningful for all specialties, the required sample sizes were computed for all 11 visit characteristics for all 14 physician specialties to simplify the computer programming. For example, the percent of patients receiving treatment from a psychiatrist for diseases of the circulatory system was negligible and, hence, was ignored in determining the sample sizes required in the psychiatrists' stratum.

Results and Discussion

Sample sizes of PSU's, physicians, and patient visits in the optimum design were computed for each of the 11 selected visit characteristics and 14 physician specialties. Table 1 gives the optimum sample sizes needed to produce visit statistics with the desired RSE's. For each specialty, five groups of visit characteristics were defined on the basis of the frequency with which they occurred in the specialty, i.e., characteristics occurring in 0-4, 5-9, 10-24, 25-49, and 50 or more percent of the visits. Sizes were added across metropolitan status strata for the six most common specialties. Empty table cells indicate that for that specialty no estimates fell in that frequency group from the 1980 survey for the research variables. Asterisked table cells indicate that for all visit characteristics falling in that cell, fixes had to be made during computations to prevent the computer from stopping due to negative or zero terms appearing under radical signs. For example, if the difference $S^2_{2h} - \bar{\bar{N}}_h S^2_{3h}$ in (5) or (6) was negative, $\bar{\bar{n}}_h$ and $\bar{m}_h$ could not be computed. In this case $\bar{\bar{n}}_h$ was set equal to minimum (30, $\bar{\bar{N}}_h$) and $\bar{m}_h$ was set equal to $\bar{M}_h$, where 30 was the maximum number of sample visits possible under response burden limits set for each physician.

As shown in Table 1, optimum samples vary by specialty and by frequency of the visit characteristic. Table 2 condenses Table 1 by presenting the largest sample sizes required across

frequency groups to produce desired precision levels. For each specialty, asterisked sample sizes from Table 1 were ignored if un-asterisked samples sizes were available for another frequency group since the asterisked sizes were obtained only after assigning the maximum permissible sample sizes to the first or second stage samples in order to permit the computer to proceed with computations. Also ignored are sample sizes involving more than 120 PSU's because of the requirement to keep the PSU's to a number (about 100 or less) in which a single contractor could maintain field interviewers. This latter action affects only the characteristics occurring in 50 percent or more visits to the less common specialties where the sampling designs were not stratified by metropolitan status. It is noted, however, that based on the 1980 NAMCS, almost all the physicians in these specialties appear to be in metropolitan areas. It is, thus, likely that the variance between strata is large relative to the variance within strata and, hence, that smaller sample sizes would satisfy the target precision requirements under a stratified design for these specialties. However, the reduction that would result from a stratified design for these specialties can only be speculated without further computations. For lack of those further computations, the sample sizes in Table 1 were used as the required sizes for those specialties.

The figures in Table 2 were used as a guide in designing the 1985 NAMCS sample. As shown in Column A, the number of PSU's varies from 13 to 111. It should be noted at this point, however, that these figures were not actually used to design the sample. They were obtained after an error in the computer program, affecting only the numbers of PSU's, was discovered too late to reselect the sample. The numbers in Column B were used instead, but these are, in general, larger than those in Column A. The exception is for a specialty with an asterisk, i.e., where the sample sizes shown are believed to be larger than actually needed. Since the sample sizes resulting from the use of the numbers in Column B are larger than those which would be obtained by using the numbers in Column A, it was felt that the required level of precision would still be obtained for the desired estimates. It can be seen that the contractor's national stratified sample of 84 PSU's appears to be sufficient for 9 of the 14 specialties. Hence, the sample was used for all specialties since the remaining 5 specialties are among those for whom the listed sample sizes are believed likely to be larger than actually needed.

For the physician sample, the products of the average numbers of physicians per PSU and the number of PSU's were inflated by the respective specialty response rates experienced in 1981 to yield the minimum sample sizes to be selected from each specialty. These minimum sizes were then used to determine the sampling intervals for selecting systematic random samples from the listed physicians in the sample PSU's and the respective specialties.

For the visit sample, the average number of visits per physician varies across specialties from 16 to the maximum allowed of 30. To simplify operations, the average number of visits per physician was set at 30 since this was required for some specialties.

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TABLE 1: OPTIMUM SAMPLE SIZE REQUIREMENTS FOR THE 1985 NAMCS

PERCENT RANGE OF THE ESTIMATE		0 - 4	5 - 9	10 - 24	25 - 49	50 +
RELATIVE STANDARD ERROR		.30	.15	.10	.10	.05
PHYSICIAN SPECIALTY	STAGE	SAMPLE SIZES				
General Practice	PSU's	14	12	15	7	11
	Doctors	64	84	80	30	20
	Visits	1925	1415	1286	582	464
Internal Medicine	PSU's	10	15	19	9	8
	Doctors	35	29	69	25	31
	Visits	1047	872	1166	468	489
Pediatrics	PSU's	* 11	16		16	19
	Doctors	39	62	--	31	20
	Visits	871	992		605	599
General Surgery	PSU's	* 10	21	22	10	
	Doctors	12	40	51	27	--
	Visits	342	1085	988	423	
Obstetrics/Gynecology	PSU's	10		11	13	9
	Doctors	15	--	55	19	15
	Visits	454		958	356	304
Psychiatry	PSU's	* 39	* 97		* 24	* 20
	Doctors	56	111	--	32	18
	Visits	1704	1939		527	450
Cardiovascular Disease	PSU's	39	66	111	79	261
	Doctors	49	66	111	79	261
	Visits	1478	1980	3330	2370	7830
Dermatology	PSU's	66	42	* 116	* 111	229
	Doctors	66	42	178	170	229
	Visits	1980	1260	5339	5109	6870
Orthopedic Surgery	PSU's	35	40	92	64	
	Doctors	94	119	172	64	--
	Visits	2821	2416	4121	1920	
Ophthalmology	PSU's	77		77	51	
	Doctors	219	--	133	51	--
	Visits	4812		2952	1530	
Otolaryngology	PSU's	19	57		* 66	251
	Doctors	19	57	--	97	251
	Visits	573	1710		2900	7530
Neurology	PSU's	* 86	* 45	84	* 82	294
	Doctors	56	29	54	53	190
	Visits	1667	872	1628	1590	5699
Urology	PSU's	* 26	* 164	101	* 66	248
	Doctors	38	239	101	96	248
	Visits	1134	7156	3030	2880	7440
Allergy	PSU's		* 62	* 100	* 90	* 319
	Doctors	--	24	39	35	125
	Visits		729	1175	1058	3750

* Fixes made during computations

TABLE 2: LARGEST SAMPLE SIZE REQUIREMENTS FOR THE 1985 NAMCS

PHYSICIAN SPECIALTY	PSU'S		AVERAGE NO. PHYS./PSU	AVERAGE NO. VISITS/DR.
	A	B	C	D
General Practice	15	43	5.6	22.9
Internal Medicine	19	38	3.6	16.9
Pediatrics	19	24	3.3	16.0
General Surgery	22	53	2.3	21.3
Obstetrics/Gynecology	13	31	4.2	17.4
Psychiatry	* 97	* 77	1.1	17.5
Cardiovascular Disease	111	113	1.0	30.0
Dermatology	66	64	1.0	30.0
Orthopedic Surgery	92	92	1.9	24.0
Ophthalmology	77	76	2.8	22.0
Otolaryngology	57	56	1.0	30.0
Neurology	84	86	0.6	30.1
Urology	101	102	1.0	30.0
Allergy	* 100	* 98	0.4	30.1

* Fixes made during computations