DESIGN AND ESTIMATION INNOVATIONS IN THE MEDICAL EXPENDITURE PANEL SURVEY FOR THE MEASUREMENT OF HEALTH CARE QUALITY AND EXPENDITURES

Steven B. Cohen
Center for Cost and Financing Studies
Agency for Healthcare Research and Quality

Design and Estimation Strategies and Innovations in the Medical Expenditure Panel Survey for the Measurement of Health Care Expenditures and Quality
Steven B. Cohen, Ph.D., Center for Cost and Financing Studies, AHRQ

1. Introduction
Efforts are underway in the Department of Health and Human Services towards the development of a national health care quality reporting system. The purpose of the reporting system is to provide an annual profile of the nation's quality of care and to help measure improvements over time. Quality is often defined as meeting customers' expectations. Consequently, the quality reporting system will need to include a comprehensive set of indicators that characterize several dimensions of patient satisfaction and consumer satisfaction with providers, health plans and access to care. This paper will focus on statistical and methodological design strategies and innovations in the Medical Expenditure Panel Survey (MEPS) to ensure the underlying objectives, subject to cost constraints, are realized. More specifically, a detailed discussion of the criteria that were considered in the identification of medical conditions that are to be given special emphasis for healthcare quality measurement in the MEPS is provided. Attention is given to sample design strategies, estimation issues and data collection strategies to improve the quality of resultant survey data, particularly in terms of precision of survey estimates and sample yields. Finally, the methodologies used to identify a set of additional patient satisfaction and health care quality measures for inclusion in the survey are also discussed. This paper will also focus on the statistical and methodological design features and innovations to the survey to support the measurement of health care expenditures and insurance coverage and to yield accurate national estimates.

2. Background
The Medical Expenditure Panel Survey was designed to produce national and regional annual estimates of the health care utilization, expenditures, sources of payment and insurance coverage of the U.S. civilian non-institutionalized population. The MEPS includes a survey of medical providers, to supplement the data provided by household respondents. The design of the MEPS survey permits both person based and family level estimates. The scope and depth of this data collection effort reflects the needs of government agencies, legislative bodies, and health professionals for the comprehensive national estimates needed in the formulation and analysis of national health policies. The survey is sponsored by the Agency for Healthcare Research and Quality (AHRQ).

The MEPS collects data on the specific health services that Americans use, how frequently they use them, the cost of these services and how they are paid, as well as data on the cost, scope, and breadth of private health insurance held by and available to the U.S. population. MEPS is unparalleled for the degree of detail in its data, and its ability to link health service medical expenditures and health insurance data to the demographic, employment, economic, health status, utilization of health services, and other characteristics of survey respondents. Moreover, the MEPS provides a foundation for estimating the impact of changes in sources of payment and insurance coverage on various economic groups or special populations of interest, such as the poor, the elderly, veterans, the uninsured, and racial and ethnic minorities (J. Cohen, 1997).

The set of households selected for the MEPS is a subsample of those participating in the National Health Interview Survey (NHIS). The MEPS Household Component (HC) consists of an

overlapping panel design in which any given sample panel is interviewed a total of 5 times over 30 months to yield annual use and expenditure data for two calendar years. Design specifications for the 2001 MEPS required that the full series of interviews necessary to acquire calendar year information for 2001 should be completed in approximately 13,500 households. The same panel of households were interviewed in person three times over the course of the survey to obtain data on their health care experience for 2001 (S. Cohen, 2000). The sample reflects an over-sample of households with Hispanics and blacks at the following approximate ratios of representation relative to the remaining households (Hispanics 2.0:1, blacks 1.5:1). The targeted survey response rate based on response to the NHIS and three waves of data collection for the new MEPS 2001 panel (waves three through five for the 2000 panel) is 67 percent.

3. Design and Content Modifications to the MEPS to Support Quality of Care Analyses at the National Level

The data currently collected from MEPS will support quality of health care research directed to the following broad areas: access to care, patient/customer satisfaction, health insurance coverage, health status, health services utilization and expenditures. The attached table provides a summary of the topic-specific component measures currently available to support health care quality analyses at the national level. For the access to care measures, national estimates of the population with a usual source of care, and by site of care can be derived from the survey in addition to estimates of the percent of families with members experiencing difficulty or delay in obtaining health care, or not receiving need care. The survey also permits the derivation of national estimates of satisfaction with one=s usual source of care and continuity of care. The survey is particularly powerful in its capacity to produce national estimates of the uninsured, in addition to the sources of coverage for the insured population and their satisfaction with their plans. Furthermore, the health care utilization and expenditure data collected in the survey facilitate analyses of variation in service utilization, medical expenditures and sources of payment for individuals with the same health conditions and health status, both at the national and regional levels.

3.1 Set of medical conditions to be given special emphasis for planning the MEPS health care quality enhancements

The planned MEPS healthcare quality enhancements call for a significant household survey sample expansion of individuals with certain illnesses of national interest in terms of patient satisfaction with care received, the quality of the care and the burden of disease. The intent of this planned enhancement was to permit more focused analyses of the quality of care received for these special populations. In order to move forward with sample design analyses and MEPS questionnaire design modifications according to schedule, it was necessary to finalize the set of medical conditions that would be given special emphasis with respect to health care quality measurement and patient satisfaction. A set of formal criteria were established to guide the decision making process regarding the selection of the set of medical conditions that were to be given special attention for implementing the planned MEPS healthcare quality enhancements. More specifically, the selection decision was based on an evaluation of conditions using the following criteria: Sufficient prevalence to support reliable estimates; availability of diagnostic questions used in other national surveys; accuracy of household reported conditions; availability of evidence-based quality measures, and level of medical expenditures for treatment of the condition.

Table 1: Available Data in MEPS to Support Quality of Care Analyses at the National Level

Component Measures	
Access to Care	Is there a usual source of care. Type of usual source of care provider (office based, hospital outpatient or clinic, emergency room). Waiting time to see provider.
Barriers to Care	Families experiencing difficulty or delay in obtaining health care, or not receiving need care.
Satisfaction with Usual Source of Care	Satisfaction with overall level of quality of care. Satisfaction with professional staff Confidence in provider=s ability to help with medical problem Continuity of care (provider asks about prescription medications or treatments from other doctors)
Health Status	General health status, mental health status, limitations in activities because of a physical or mental health problem.
Medical Conditions	Related to physical conditions, accidents and injuries, mental or emotional problems.
Limitations	Does person receive assistance from other household member due to a physical or mental health problem. ADL=s and IADL=s
Health Care Utilization	Annual number of medical provider office-based visits, inpatient stays, outpatient facility visits, emergency room visits, dental visits, home health, prescribed medicines.
Health Care Charges and Payments	total charge, total payments, source of payment
Disability Days	Days missed from work or school because of a physical illness, injury , mental or emotional problem.
Health Insurance Coverage	Coverage, satisfaction with plan

Source: Medical Expenditure Panel Survey, Center for Cost and Financing Studies, AHRQ

A threshold of 3 percent was established as the desired lower bound for the national prevalence rate for the medical condition. This was determined based on precision requirements to support national estimates for all individuals with the condition as well as for population subgroups. Based on an overall sample of ~35,000 participants in the 2001 MEPS, an expected yield of 1050 individuals would yield a 95% confidence interval of +/- 4% on a 50% estimate assuming a survey design effect of 1.6 .

Based on the review of the criteria under consideration, it was recommended that the following medical conditions be given special attention for implementing MEPS healthcare quality enhancements based on their capacity to meet most or all of the specified targets: Diabetes, Asthma, Hypertension, Ischemic Heart Disease, Arthritis, Stroke and COPD. It should be noted that the selection of diabetes and ischemic heart disease as targeted conditions also cover two clinical areas that are the focus of the forthcoming DHHS Report on Health Care Disparities

3.2 MEPS design recommendation to increase the size of the 2001 sample and method of

sample allocation.
The planned MEPS healthcare quality enhancements call for a significant household survey sample expansion of individuals with certain illnesses of national interest in terms of quality of care and burden of disease. The intent of this planned enhancement was to permit more focused analyses of the quality of care received for these special populations and the level of satisfaction with the care received. To further improve the precision of the survey estimates beyond the gains from the increase in geographic areas, in particular for individuals with at least one of the medical conditions given special attention for implementing MEPS healthcare quality enhancements, a decision was made to increase the 2001 MEPS sample by ~3,500 households (responding for all 5 rounds of data collection) to a total sample of 13,500. In addition, the following two sample allocation methods were under consideration for implementing the desired sample increase: 1) the adoption of a uniform sample size increase versus 2) a targeted oversample of individuals with specific conditions. As a consequence of the subsampling method within households adopted in the National Health Interview Survey to obtain medical condition data (the selection of only one adult and, when available, one child to answer the questions related to medical conditions), it was recognized that the implementation of a targeted oversample of individuals with specific conditions would be significantly limited by the constraints of the NHIS design.

The NHIS design limitations that affect the implementation of a targeted oversample in MEPS of individuals with specific medical conditions are :
C   Only half of the NHIS sample is available to MEPS each year (~20,000 households).
C   The last quarter of the NHIS sample (October-December) is delivered to AHRQ too late to be fielded in MEPS, further restricting the available sample (~15,000 households).
C   In order to add 8,500 additional households in MEPS (3,500 addition for the enhancements over the 5,000 new cases introduced each year in MEPS) that have responses for all five rounds of the survey, it will be necessary to select 11,000 new cases from the 2000 NHIS. Since only 15,000 households are available for implementing an oversample, 73 percent of the available sample will be selected in 2001.
C   The condition questions are not administered to the full set of NHIS participants.
C   NHIS response rates for the condition enumeration component are in the low 80 percent range.
Based on the results of sample design analyses, it was noted that a targeted oversample would produce less than a 10 percent gain in sample yields for individuals with the targeted conditions above the 35 percent expected increase in sample through a uniform sample size expansion from 10,000 to 13,500 households. Furthermore, adoption of a targeted oversampling strategy would achieve lower levels of precision for national estimates of health care parameters relative to the uniform sample size expansion.

Consequently, the sample design recommendation was to implement a sample size increase in MEPS that would enhance the representation and precision of the targeted conditions without a targeted oversample . This sample design modification has the following attractions :
For fixed sample size, it will achieve greater precision in national estimates of general population characteristics relative to a targeted oversample; it requires only minimal modifications to the current MEPS sample selection procedures; and there are minimal additional complexities in the development of MEPS estimation weights. However, the level of precision in survey estimates for individuals with the targeted conditions will be modestly lower than expected relative to a design

that implemented a targeted oversample. In addition to the improvements in precision for individuals with the targeted conditions, the adoption of this sample enhancement in MEPS for 2001 will also facilitate gains in precision for minorities and ethnic groups which support the Department=s Initiative to Eliminate Racial and Ethnic Disparities, for adults with functional limitations and for children with special health care needs.

3.3 Inclusion of Additional Questions in a MEPS Self Administered Questionnaire (SAQ) to Measure Quality of Care and Patient Satisfaction

The selection of a core set of questions that measure quality of care and patient satisfaction was governed by the need to adopt measures that were carefully tested and validated, to insure the collection of meaningful and reliable information. Consequently, a subset of questions that were developed for the Consumer Assessments of Health Plans Study (CAHPS) were selected for inclusion in a self-administered questionnaire (SAQ) in the MEPS to measure several dimensions of healthcare quality and patient satisfaction. In addition, the Self Administered Questionnaire included the complete set of questions from the SF-12 (Medical Outcomes Study, Short Form) to improve the survey=s capacity to measure health status. It also included the set of questions that comprise the EuroQol 5D (EQ-5D), including the visual analogue scale, to facilitate international comparisons on health status and quality measurement (D. Lefkowitz, 2000 and Westat, 2000). A copy of the MEPS SAQ can be accessed through the MEPS website (www.ahrq.gov).

4. Statistical and methodological design features and innovations to support the measurement of health care expenditures, utilization and insurance coverage

The accuracy and the level of quality that characterize estimates derived from surveys such as the MEPS are inseparably linked to the underlying survey design and its success in satisfying response rate targets, precision requirements, and controlling remaining sources of survey error. This paper also summarizes a set of statistical and methodological investigations that have provided major insights regarding the impact of survey nonresponse and other sources of survey error on resultant estimates in the MEPS. Particular attention is given to the following topics: benchmarking the survey estimates derived from the MEPS with comparable estimates obtained from other national data sources; estimation strategies to reduce nonresponse bias in MEPS survey estimates; use of a prediction model to oversample individuals with high levels of medical expenditures; design and estimation considerations for the measurement of health care expenditures.

4.1 Benchmarking MEPS Survey Estimates

An important objective of MEPS is to produce descriptive estimates of health care use, expenditures, sources of payment, and insurance coverage for the U.S. civilian noninstitutionalized population. As part of the quality control process in preparing selected MEPS data for release, the MEPS estimates on health care use, expenditures, and insurance coverage are compared to similar estimates obtained from other national surveys and administrative data sources. These surveys include the Current Population Survey, Survey of Income and Program Participation, National Health Interview Survey, National Hospital Discharge Survey, the National Health Accounts, the National Health Care Survey, and the Medicare Current Beneficiary Survey. When significant differentials in estimates are noted across comparable data sources relative to the MEPS, more detailed evaluation studies are undertaken to discern the underlying factors that would account for the observed differentials.

4.2 Estimation Strategies to Reduce Nonresponse Bias in MEPS Survey Estimates

In panel designs with multiple waves of data collection, the overall survey response rate is a multiplicative function of the wave specific response rates (Cohen and Carlson, 1995, Cohen et al,

1989). The Medical Expenditure Panel Survey (MEPS) Household Component follows this model, requiring five rounds of data collection with the same panel of sampled households, to acquire data on health care use, expenditures, insurance coverage and sources of payment that cover two consecutive calendar years. To inform the specification of nonresponse adjustment strategies in MEPS to correct for survey attrition, studies are undertaken to identify the characteristics that distinguish survey participants across waves from those that only participate in initial rounds and then discontinue their survey participation (Cohen and Machlin, 2000).

Prior study findings from the MEPS revealed that non-respondents in the first round of the survey were more likely to be from single or two person households located in large metropolitan areas with a higher level of income and were more likely to include healthy elderly members. Reluctant respondents in the first round of the survey were significantly more likely to become non-respondents in the second round. As with non-respondents in the first round, MEPS non-respondents in subsequent rounds were also more likely to be located in large metropolitan areas. In addition, they were more likely to reside in the larger households with 5 or more members, to be elderly, and more likely to be either married or separated relative to individuals who were never married. These findings informed the specification of weighting class adjustments to correct for nonresponse in the Medical Expenditure Panel Survey (Cohen, Machlin and Branscome, 2000; Cohen et al., 1999). To the extent that one can determine the factors that distinguish the respondents from the nonrespondents, and incorporate this information into the development of the nonresponse adjustments to the survey specific estimation weights, a reduction in nonresponse bias is attainable. Comparable analyses are undertaken each year in MEPS to inform the specification of the nonresponse adjustments.

4.2.1 Evaluation of the Effectiveness of Nonresponse Adjustments for Attrition in the MEPS

To discern the impact of survey attrition on national estimates of health insurance coverage in the 1997 Medical Expenditure Panel Survey, separate estimates were derived from each of the MEPS panels. Here, the survey estimates derived from the Panel 1 sample were based on an overall response rate of 70.2, where the survey participants were responding to the third round of the MEPS data collection. Alternatively, the Panel 2 sample was characterized by a 77.9 percent response rate, with survey respondents responding to the first round of the 1997 MEPS data collection. More specifically, national estimates of the percent of the civilian noninstitutionalized population with private health insurance, in addition to the percent uninsured were derived separately for each of the MEPS component samples in 1997. The overlapping panel design of the MEPS is a particularly attractive feature that permits such evaluations of the effectiveness of nonresponse adjustments for survey attrition.

The comparisons revealed no statistically significant differences in national estimates of health insurance coverage across the independent MEPS samples (Panel 1 and Panel 2) when testing at an alpha level of significance (Vistnes et al., 1999). These results held for national estimates of the percent of the civilian noninstitutionalized population with private health insurance and for the percent uninsured, and by further cross-classifications of the population based on the following socio-demographic measures: sex, race/ethnicity, metropolitan statistical area and census region. The results indicate that even with a loss in the overall survey response rate of 7.7 percent, as a consequence of additional survey attrition based on two additional rounds of data collection for the 1996 MEPS sample relative to the 1997 MEPS sample, the respective national survey estimates of health insurance coverage were comparable. The findings suggest that the survey nonresponse adjustments made to the 1996 MEPS sample estimation weights to correct for

additional survey attrition experienced by this cohort were successful in correcting for potential nonresponse bias attributable to survey attrition for the national estimates of health insurance coverage (Cohen and Machlin, 2000).

4.3 Use of a Prediction Model to Oversample Individuals With High Levels of Medical Expenditures

Efforts to improve the precision of health care estimates associated with individuals that incur high levels of medical expenditures were considered in the 1997 Medical Expenditure Panel Survey. The concentration of health care expenditures in a relatively small percentage of the population serves to motivate additional efforts to insure sufficient sample representation of this core analytical domain, to support subgroup analyses. Using data from the 1987 National Medical Expenditure Survey, a probabilistic model was developed to identify individuals likely to incur high levels of medical expenditures, based on their prior health care experience.

Among the sample domains to be oversampled in the main survey are individuals ages 18-64 who are predicted to be likely to incur high medical expenditures. An individual's medical care expenditures in a future year were unknown when the 1996 NHIS interview was administered. Therefore, a prediction model based on NMES data was used to determine whether a household should be oversampled as part of the high-medical-expenditures group because one or more of the family members were expected to incur high medical expenditures in the subsequent year. More specifically, a logistic regression model was developed to estimate the expected probability that an individual ages 18-64 will incur high medical expenditures (top 15 percent of the health expenditure distribution) in a subsequent year based on predictive measures obtained during the NHIS interview. Households with at least one person with a predicted probability above a certain threshold value were oversampled. The group was restricted to individuals ages 18-64, since persons 65 and over who were functionally impaired were separately targeted to be oversampled. For purposes of sampling, all individuals with a predicted probability of .4 or greater were classified as likely to incur high medical expenditures in the subsequent year. This threshold was selected as the value that was expected to best limit prediction errors. Research is now underway to examine the accuracy of this model to predict individuals likely to incur high levels of medical expenditures, using data from the 1997 Medical Expenditure Panel Survey. The results will help inform improvements to the model to enhance its predictive capacity in the future.

4.4 Design and Estimation Considerations for the Measurement of Health Care Expenditures
The MEPS included a Medical Provider Component (MPC) survey to collect data on expenditures for medical services provided to MEPS sample persons. The MPC was primarily designed to reduce the bias associated with national medical expenditure estimates, derived from household reported data, that was a function of item nonresponse and poor quality data. Data from the MPC are critical in the development of MEPS national medical expenditure estimates because household respondents are not always a reliable source of information on medical expenditures. In a significant number of instances, they are simply not aware of the total amount billed, services received, or how much the provider is paid for these services. This is especially true of individuals enrolled in the Medicaid program, where financial transactions occur only between the provider and the State Medicaid agency, and enrollees of managed care plans, who may be aware only of paying a predetermined copayment that is not necessarily related to the total amount the provider receives. In addition, inpatient hospital stays often produce bills that survey respondents are likely to overlook in the interview, such as bills from an anesthesiologist or pathologist that are paid separately from the main hospital bill (Machlin and Taylor, 2000).

The sample for the MPC was chosen from a representative sample of medical care providers identified in the HC as having provided care to MEPS sample persons in 1996. The major categories of providers included were: (1) Office-based medical doctors (MDs), doctors of osteopathy (DOs), and other medical providers under the supervision of MDs and DOs; (2) Hospitals providing inpatient care, outpatient care (including visits to all provider types), or emergency room care: (3) Home health agencies . The MEPS medical expenditure estimation strategy was dependent on the household reported health care utilization as the building block and elemental unit of interest. Utilization was measured in terms of a visit to a specific doctor or clinic, and in terms of events such as a hospitalization. The first stage of the MEPS expenditure estimation strategy required matching the provider reported expenditure data to the household reported utilization. A computerized matching algorithm, referred to as AutoMatch (1996), was used to match household and provider reports of medical care utilization using probabilistic matching techniques (M. Jaro, 1989). The matching criteria were based on the probability of agreement between what the household and the provider report with respect to information that included the type of medical encounter (visit or event), and included a medical provider identifier, date of encounter, place of encounter and reason for encounter. A determination was made whether the two agreed, disagreed, or partially agreed, and a probability associated with a "true" match was attached to each possible outcome.

Once the matching of household and medical provider records was completed, the MEPS expenditure estimation strategy was implemented. For all household and provider reported events that matched, and for which MPC reported expenditure data were available, the data acquired from the MPC was used to determine the value of the expenditure. The household data was used as the appropriate value of the expenditure for all remaining household reported events for which a household reported expenditure was present . The remaining household reported events for which no household reported expenditure data were present were corrected by an imputation strategy using a weighted hot-deck methodology (Cox and Cohen, 1985).

In producing the national estimates of medical expenditures, it was recognized that a very small proportion of the population account for a disproportionate component of the overall costs incurred for health care. Based on findings from the 1996, the top one percent of the health care expenditure distribution were associated with 27 percent of the total health care expenditures incurred by the civilian non-institutionalized population (Berk and Monheit, 2001). Furthermore, the top 5 percent of the population by magnitude of health care expenditures accounted for 55 percent of the total. Consequently, additional attention and prioritization has been given to data collection procedures and estimation strategies that help improve the quality of the survey estimates that characterize this policy relevant population subgroup. More specifically, the MEPS population estimates of decedents (who are associated with higher annual medical expenditures than the national average) are further poststratified to national mortality counts and comparable poststratification adjustments based on survey data are implemented for estimates of individuals entering nursing homes in a given calendar year. In the expenditure imputation procedures, donor records are required to match on decedent status for event level records with missing expenditure data. Furthermore, there is a prioritization employed in the fielding of the medical provider sample to prioritize efforts to enhance response rates for the sample associated with decedents and other cases likely to incur high levels of medical expenditures (cases with inpatient care and long

lengths of stay). By adopting additional quality control procedures in the data collection and data expenditure estimation procedures for the population subset characterized by high levels of medical expenditures, the overall accuracy of the national expenditure estimates are improved.

5. Summary

This paper has focused on statistical and methodological issues that must be addressed in the design of patient satisfaction and healthcare quality measurement surveys to ensure the underlying objectives are realized, subject to cost constraints. A detailed discussion of the criteria that were considered in the identification of medical conditions that are to be given special emphasis in the Medical Expenditure Panel Survey is also provided. Attention is also given to sample design strategies, estimation issues and data collection strategies to improve the quality of resultant survey data, particularly in terms of precision of survey estimates and sample yields. The methodologies used to identify a set of additional patient satisfaction measures and health care quality measures for inclusion in the survey has also been discussed.

The accuracy and the level of quality that characterize estimates derived from surveys such as the MEPS are inseparably linked to the underlying survey design and its success in satisfying response rate targets, precision requirements, and controlling remaining sources of survey error. This paper also summarizes a set of statistical and methodological investigations that have provided major insights regarding the impact of survey nonresponse and other sources of survey error on resultant estimates in the MEPS. Particular attention has been given to the topics of bias and precision, the dual components of mean square error that affect the overall quality of survey estimates. The statistical and methodological studies are further connected by their substantive focus on the measurement of health care parameters at the national level that summarize the population=s health care utilization, expenditures, insurance coverage, sources of payment, access to care and quality of healthcare.

Analytical enhancements have already been realized in the MEPS as a consequence of design modifications that changed the survey=s periodicity from a ten year cycle to an on-going annual national medical expenditure survey, the inclusion of a longitudinal panel covering the health care experience over a two year period, and a design capacity that permits an efficient oversampling of policy relevant population subgroups. Since many of the design features of the MEPS are similar to other national survey efforts both within and outside the field of health, the research findings that are presented in this paper should serve to inform design improvements for comparable survey efforts. Both the data collection and estimation strategies that were implemented to mitigate the impact of nonresponse bias associated with survey attrition in the MEPS should serve as an effective model that warrants replication. It is the hope of this author that some of the statistical and methodological results that have been presented will serve to improve the quality of other related survey efforts.

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